FINAL REPORT

STOCK ASSESSMENT OF COLUMBIA RIVER ANADROMOUS SALMONIDS

VOLUME I: CHINOOK, COHO, CHUM AND SOCKEYE SALMON STOCK SUMMARIES

by

Philip Howell
Kim Jones
Dennis Scarnecchia
Oregon Department of Fish and Wildlife

Larrie LaVoy
Washington Department of Fisheries

Will Kendra
Washington Department of Game

David Ortmann
Idaho Department of Fish and Game

Other Contributors

Connie Neff
Charles Petrosky
Russel Thurow

Prepared for

Larry Everson, Project Manager

U.S. Department of Energy

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I. Introduction

ORIGIN AND PURPOSE OF STUDY

Section 704 (h) (2c) of the Columbia River Fish and Wildlife Program (NPPC 1984) calls for an assessment of salmonid stocks in the Columbia River Basin to ensure their proper use and to maintain their genetic integrity. In 1983 the Bonneville Power Administration, which administers funding for the program, contracted the Oregon Department of Fish and Wildlife (ODFW) to conduct such a study. The purpose of the stock assessment study was to identify and characterize the wild and hatchery stocks of salmon and steelhead in the Columbia River Basin on the basis of currently available information. This report provides a comprehensive compilation of data on the status and life histories of Columbia Basin salmonid stocks.

Since the Northwest Power Act of 1980 directs that the Columbia River and its tributaries be treated as an integrated system, the stock assessment study was a cooperative effort involving fisheries agencies in Oregon, Washington, and Idaho. ODFW assembled information relating to stocks produced in Oregon and was responsible for coordinating the work of the other participating agencies Washington Department of Game (WDC) and Washington Department of Fisheries (WDF) were subcontracted by ODFW to provide information on steelhead and salmon stocks in Washington, respectively. Existing contracts between BPA and the Idaho Department of Fish and Game (IDFG) were modified to provide funding for IDFG to compile information on Idaho salmonid stocks. The Columbia River Intertidal Fish Commission (CRITFC) participated in coordination meetings and reviewed the report drafts. Previous drafts were also reviewed by the individual Indian tribes in the basin, National Marine Fisheries Service, U.S. Fish and Wildlife Service, and the staff of the Northwest Power Planning Council.

STOCK DEFINITION

The stock concept is based on the premise that a single species may be divided into groups or stocks based on distinctive characteristics. Differences between stocks are genetically based which may be expressed phenotypically by differences in behavior, morphology, and physiology. As a result of these differences, stocks vary in their habitat requirements, disease tolerances, survival rates, stock-recruitment relationships, harvest potential, escapement needs, etc. Thus the various stocks must be identified and characterized so that management of those stocks can be tailored as much as possible to their particular characteristics.

An initial problem in assessing Columbia River salmonid stocks is developing a set of common criteria for defining stocks. The term “stock’ has been rather loosely applied to various groups of salmonids depending to some extent on purpose or frame of reference. For example, there are so-called wild stocks and hatchery stocks, production units and harvest units. For harvest management, stocks are often lumped into larger aggregates, which reflects the mixing of stocks that frequently occurs at the time the fish are harvested. For purposes of protecting wild stocks and maintaining genetic diversity, stocks may be more finely split along the lines of genetic differences or spawning/production locations.

Although the process of stock definition may appear to be essentially a semantic exercise, how stocks are defined influences many decisions that will determine the future of the fishery resources in the Columbia Basin. This includes protection of wild stocks, particularly those that are declining rapidly; maintenance of genetic diversity; development and use of hatchery stocks; and establishment of harvest and escapement levels. The stock assessment study is viewed as an important element in the implementation of several measures of the Columbia River Fish and Wildlife Program: program goals for anadromous fish (section 2011, integration of artificial and natural production [section 704 (k)], hatchery reprogramming [section 704 (g)], hatchery effectiveness [section 704 (h) (2)], and specific hatchery construction and operation [section 704 (i)].

Several stock definitions have been proposed in the literature. Many of these are refinements of Ricker's (1972) definition:

> "the fish spawning in a particular lake or stream (or portion of it) at a particular season, which... to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season.'

The key elements of this definition are that stock differentiation is based on breeding populations and either geographic or temporal isolation at the time of breeding.

The tendency of adult anadromous salmonids to return to their natal streams to spawn forms a logical basis for identifying stocks by the various tributary systems and mainstem areas of the Columbia River where spawning occurs. As straight-forward as this might first appear, there are several problems in trying to apply this definition. It is well documented that homing in salmon is not perfect. For example, some straying is essential to colonize habitat. The extent of straying between stocks in the Columbia system has not been well documented, but there is evidence that in some cases it could be "substantial." In the Deschutes River (Oregon), an estimated 80% of the summer steelhead run in 1981 were strays from other wild and hatchery stocks (Lindsay et al. 1981). It is not known how many of these strays reproduced in the Deschutes River system; however, strays have been captured as far upstream as the Pelton Regulation Dam (RK 161), which is the upper limit to adult migration.

Just as major stocks may be distinguished by major tributary systems in which they spawn, differences in populations within those systems may define further stock or substock divisions. Differences among stocks in a single river may be greater than differences among stocks in different rivers (Larkin 1981). Again the question arises as to whether there is substantial interbreeding among spawning populations within a drainage basin and whether there are significant differences among stocks or substocks that warrant different management strategies.

The problem of stock identification is complicated by the widespread introductions of hatchery stocks. The extent of interbreeding of hatchery and wild stocks and the relative contribution of hatchery vs. wild stocks to natural production is unknown in many streams.

It may also be difficult to segregate stocks according to time of migration and spawning. Upriver races of chinook in the Columbia are separated by the time of passage at Bonneville Dam: spring chinook--March l-May 31, summer chinook--June l-July 31,fall chinook--August l-November 30. However, tagging studies indicate that tributary chinook stocks within those races migrate through the lower Columbia at the same time (Galbreath 1965). Many hatchery stocks tend to spawn earlier than the wild stocks from which they were developed since a disproportionate number early arriving fish at the hatchery have been used for broodstock to ensure an adequate egg take. These timing differences themselves may not be great but could substantially affect production. Differences in time of spawning between hatchery and wild coho stocks in Oregon may be responsible for the failure of presmolt releases to increase natural production in coastal streams (M. Solazzi, ODFW, personal communication).

Kutkuhn's (1981) stock definition emphasizes the genetic similarities within stocks:

> "a unit fish stock is one consisting of randomly interbreeding members whose genetic integrity persists whether they remain spatially or temporally isolated as a group, or whether they alternately segregate for breeding and otherwise mix freely with members of other unit stocks of the same species."

This definition would seem to hold true for purely wild stocks within the bounds of natural genetic variability but may not fit wild stocks that are periodically if not routinely infused with genetic material from hatchery introductions. Hatchery stocks usually have limited temporal isolation and mating is not random (Ihssen et al. 1981), sometimes purposely. Early returning adults were specifically selected for broodstock to develop the Big Creek winter steelhead stock. The genetic make-up of some hatchery stocks is also quite mixed. Some of the broodstock for Bonneville upriver bright fall chinook are taken from adults trapped at Bonneville Dam which are bound for various spawning areas and hatcheries above Bonneville. Other hatchery stocks have been developed from several different stocks.

Genetic characteristics are useful in identifying stocks since they represent desirable attributes for survival and are more or less consistently perpetuated generation after generation. Most stock definitions, including those used by the agencies participating in this study, incorporate the notion of genetic integrity at least implicitly. However, for the most part there is insufficient information on genetic characteristics of salmonid populations in the Columbia Basin to discriminate stocks. The Oregon State University Cooperative Fisheries Research Unit is currently attempting to identify some of the Columbia salmonid stocks on the basis of genetic information from electrophoretic, morphometric, and meristic studies.

To date, stock differentiation has largely depended on phenotypic characteristics, such as life history patterns (e.g., time of migration and spawning and spawning location. Ihssen et al. (1981) state that such a classification may sometimes be adequate for management purposes, and genetic differences between stocks may be of little consequence for some mangement

commsions. Booke (1981) further argues that necessary genetic variation would probably be maintained if recognized phenotypically defined stocks were managed for persistence.

In addition to meeting biological requirements, Larkin (1972) specified in his definition that a stock must be manageable:

> "a population of organisms which, sharing a common environment and participating in a common gene pool, is sufficiently discrete to warrant consideration as a self-perpetuating system which can be managed."

In the final analysis, stocks are best defined by a composite of characteristics:

1. Genotypic and phenotypic characteristics indicate important biological differences between stocks.

2. These genetic characteristics combined with an understanding of habitat characterictics help describe the interactions between genetic and environmental factors that lead to stock-specific adaptations.

3. Management capabilities and philosophies dictate how stock distinctions will be applied to production and harvest management.

Stock identification ultimately relies on somewhat arbitrary, judgemental decisions. Stocks vary over a gradual continuum, like the habitat characteristics they mirror, rather than being sharply defined. The further stocks are apart on that continuum, the more apparent are their differences. Closely related stocks are more difficult to distinguish.

In this report each of the participating agencies (ODFW, WDF, WDG, IDFG) identified the stocks in their respective management areas. Some stocks are managed jointly by the agencies (e.g., Early Run Coho). Apparent differences in approaches to defining stocks reflect differences in management philosophies of the agencies and the availability of information.

Oregon stocks were separated into two major categories: wild stocks and hatchery stocks. According to Oregon Administrative Rule 635-07-501, stocks include:

Wild Type A--"a fish or stock naturally spawned and reared in a given stream system. These fish have significant genetic value and may represent pristine stocks that have remained reproductively isolated or are the progeny of fish that have spawned and reared in the stream for at least three generations."

Wild Type B--"a fish or stock naturally spawned and reared regardless of the origin of the parents."

"Hatchery" means "a fish or stock spawned and/or reared under artificial conditions regardless of the history of the parent stock."

Wild stocks in Oregon were generally segregated by the major drainages where spawning and rearing occur. Additional stock or substock separations may occur within these major stocks, particularly in the larger, more complex tributary systems of the Columbia River. For example, there may be several wild Willamette winter steelhead and Grande Ronde summer steelhead stocks, even though they were treated as a single stock in this report. Some stocks were combined in a single summary where there was little or no information on individual stocks and they were assumed to be similar [e.g., Lower Columbia River (Oregon) Winter Steelhead (wild)]. Besides summarizing current data for wild stocks, information on stock characteristics prior to introduction of hatchery stocks was also included so that possible changes in these characteristics could be evaluated and so hatchery stocks currently released in those streams and potential stock transfers could be compared with native stocks.

Hatchery stocks were primarily separated on the basis of the source of the eggs or broodstock used for development or currently in use. In some cases a hatchery stock was further subdivided in areas where it is given more specialized management consideration even though it may have the same genetic roots as its parent stock (e.g Umatilla Upriver Bright Fall Chinook).

Some of the summary headings/stock labels correspond to present management unit designations and in some cases they do not. We attempted to present the best existing biological information on what were considered to be more or less discrete stocks so that future management decisions (e.g., refinements in management unit delineations and stock transfers) could be made in light of biological stock distinctions.

The term "stock," as utilized by Washington Department of Fisheries to identify salmon stocks in Washington, was defined as a population of a single species that possesses known phenotypic and/or genotypic characteristics that are significantly different from other populations. A stock can have substock classifications with phenotypic or genotypic characteristics that are similar or expected to be similar based on either a geographic association with a specific drainage basin or from other factors. Substock populations do exhibit some differences but the overall profile does not necessarily indicate discrete stock status.

Washington Department of Game defined steelhead stocks as follows:

Wild stock--genetically unique populations which have maintained reproduction successfully without supplementation from hatcheries.

Hatchery stock--a stock which is artificially spawned, incubated and reared normally to return to a hatchery.

IDFG's Anadromous Fish Management Plan (1985) defines a stock as "a genetically distinct group of fish capable of being maintained as a self-sustaining, interbreeding population with definable characteristics, through either artificial or natural production." The Idaho stocks described in this report were limited to those identified as donor stocks in the Anadromous Fish Management Plan for which sufficient background information is available.

IDFG'S plan recognizes three categories of stocks:

1. Wild fish--a stock of fish maintaining a population through natural production with no hatchery supplementation, often the indigenous stock.

2. Hatchery fish--fish produced in hatcheries or other artificial facilities such as hatching and rearing channels or hatching boxes.

3. Natural fish--progeny of hatchery fish which have reproduced in natural environments.

OBJECTIVES AND METHODS

Objective 1. Summarize existing information on salmon and steelhead trout stocks in the Columbia Basin.

Methods

Published and unpublished data derived from a literature review and contacts with biologists and hatchery personnel were assembled into stock summaries. The following information was included:

- Production
  - Production emphasis (wild, hatchery, or mixed)
  - Typical release numbers, types (smolts, fry, etc.), years of releases
- Geographic Location
  - Streams where stock occurs
  - Artificial propogation facilities
- Origin
  - Source of broodstock or eggs for hatchery stocks
  - History of hatchery stock introductions (stocks used, dates of introduction, release numbers, sizes or types)
- Adult Life History
  - Run size, catch, and escapement
    - Catch distribution (coded-wire tag recoveries)
    - Escapement goal
  - Time of migration
  - Spawning period
  - Spawning areas
    - Present
    - Historical
  - Age composition
  - Size
  - Sex ratio
  - Fecundity
  - Biochemical-genetic characteristics

Juvenile Life History
- Time of emergence
  - Incubation period
- Time, age, and size at migration
  - Time, age, and size at release for hatchery stocks
- Survival rate

Disease History

These summaries were prepared with the intent that the final product would be an overview of available information on individual stocks. Consequently, stocks were generally not compared. Due to the scope and time constraints of the project, most of the information presented has not been analyzed beyond that in the original sources. The information varies from specific conclusions based on substantial data to general statements which have not been verified. Certain information which is available in other documents (e.g., complete hatchery release data) is not covered in detail in these summaries. Because of the changing status of some runs due to shifts in fishing pressure, habitat alterations, and increased artificial production, information after 1970 was emphasized, with the exception of the stock origin section. Some available data on Columbia River salmonids was collected without reference to individual stocks and, therefore, was inappropriate for inclusion.

Objective 2. Suggest interim stock transfer guidelines.

Methods

Development of stock transfer guidelines requires policy level decisions and participation beyond the stock assessment study. Recommendations based on this study should follow a systematic analysis of the stock characteristics summarized in this report. Stock transfer guidelines are currently being developed as part of the Columbia River negotiations (U.S. v. Oregon). This report does present existing stock transfer policies and guidelines of the participating agencies in Section III.

Objective 3. Identify additional information needed to improve knowledge of stocks and better recommend transfer guidelines.

Methods

Information gaps in each of the summaries are identified where “No information” is indicated for a stock characteristic. In addition, each summary contains a “Priority Information Needs” section that highlights the most important information needs for that stock. This includes the characteristics for which there is no information and where existing information is inadequate. General stock information needs for the Columbia Basin are discussed in Section IV.

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LOWER COLUMBIA RIVER WILD FALL CHINOOK

The Lower Columbia River Wild Fall Chinook stock (LRW) is one of four major stocks of fall chinook in the Columbia River. The other fall chinook stocksinclude: Lower Columbia River Hatchery (LRH), Bonneville Pool Hatchery (BPH), and Upriver Bright (URB). URB and LRW fall chinook are sometimes referred to as 'Brights'. BPH and LRH fish are commonly called 'Tules'.

Within the LRW stock, there is the primary wild stock in the North Fork Lewis River, and wild population substocks in the East Fork Lewis, Cowlitz, and Sandy rivers. The Cowlitz River contributes to two different stocks - the hatchery produced component to LRH fall chinook and the naturally produced run to LRW fall chinook. This summary will contain data on all the LRW populations. Additional specific information for the Sandy River component is contained in the Sandy River fall chinook summary.

PRODUCTION

LRW fall chinook stocks and substocks are almost exclusively natural spawners. Exceptions occur at the Lewis River and Speelyai hatcheries on the North Lewis River, which have intermittently released fingerlings from the spawning of local fall chinook returns to Merwin Dam fish trap. Since 1971, progeny released from adults collected at Merwin Dam have not exceeded 550,000 fingerlings and have typically ranged from 50,000 to 150,000 fish. Most of these releases have been offspring of an early spawning segment of the run.

GEOGRAPHIC LOCATION

Streams

LRW fall chinook are produced in the Lewis, Cowlitz, and Sandy River systems.

Hatcheries

Lewis River and Speelyai hatcheries release LRW fall chinook

ORIGIN

LHW fall chinook originate from natural spawning populations in the Lewis, Cowlitz, and Sandy rivers. The stock of fall chinook in the Lewis system has maintained a significant population with negligible hatchery influences, unlike any other lower Columbia River stock (McIsaac 19791.

ADULT LIFE HISTORY

Run size, catch, and escapement

Between 1970 and 1984, the freshwater run has averaged 36,000 adults with about 17,000 harvested in the fisheries (Table 1). From 1979 to 1984, the harvest of LRW in the fisheries was determined primarily by expanding the number of coded wire tags recovered during fishery sampling. Prior to 1979, harvest was determined by applying the 1979 stock specific catch per escapement proportions in the various fisheries to the stock escapement for each year. Escapement from 1980 to 1984 represents the actual number of LRW adults that returned to all Columbia River areas based on coded wire tag analysis. Natural escapement to the North Lewis River (Table 2) comprised about 85 percent of the total LRW natural escapement, including Sandy River, during 1980-1984. The Sandy River natural spawning population averages about 1,000 fish (P. Hirose, ODFW, personal communication). Because of negligible hatchery releases, hatchery returns of LRW fall chinook are low.

Most of the overall harvest occurs in the Alaska and British Columbia troll fisheries, based on coded wire tag recoveries of 1977 brood North Lewis wild stock (Table 3). The tributary sport fishery in the North Lewis River harvests a larger percentage of the North Lewis run, compared to the tributary fisheries for the other major Columbia River fall chinook stocks. Percent of the overall run harvested in the lower Columbia commercial fishery is similar to URB fall chinook, based on 1977 brood (LRW) and 1976 brood (URB) coded wire tag recoveries.

Time of migration

Based on sampling in the spawning areas and tributary sport fishery, the migration period is broader than other fall chinook stocks. Freshwater migration generally commences in early to mid-August and peaks during September and October. However, North Lewis River wild stock fall chinook have been caught in the North Lewis sport fishery in July, based on coded wire tag recoveries. Live fall chinook and fresh redds have been observed in the North Lewis as late as April 19 (1985).

Spawning Period

Peak of spawning occurs about the first week of November in the Cowlitz River (Figure 1) and about 1.5-2 weeks later in the North Lewis River Spawning populations in the East Lewis and Sandy rivers are composed of two distinct segments. In both of these systems the early segment spawns in October, the late segment spawns in November through January in the East Lewis River and December through January in the Sandy River. During spawning surveys on the North Lewis, conducted between 1964 and 1982, peak fish count day (usually 50 percent dead fish) averaged about November 13 (Norman 1984).

Spawning areas

Nearly all of the spawning on the North Lewis River occurs from Mervin Dam (river mile 15.9) downstream to the Lewis River Hatchery (river mile 12.11.

Table 1. Freshwater adult run size of LRW fall chinook in Oregon and Washington, 1970-1984 (WDF 1985).

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial	Ceremonial and subsistence	Commercial	Recreational	Natural[c]	Hatchery	Total production
1970	0	0	19,300	3,800	14,700	0	37,800
1971	0	0	50,700	4,800	51,800	200	107,500
1972	0	0	35,200	3,000	41,000	100	79,300
1973	0	0	28,700	1,400	18,400	100	48,600
1974	0	0	9,700	900	16,300	0	26,900
1975	0	0	15,200	1,500	20,100	0	36,800
1976	0	0	6,100	600	8,200	0	14,900
1977	0	0	14,400	1,100	14,200	100	29,800
1978	0	0	7,100	1,100	10,100	200	18,500
1979	0	0	12,600	2,000	17,900	300	32,800
1980	100[b]	0	18,400	1,400	18,200	700	38,800
1981	0	0	1,400	1,100	21,500	900	25,000[a]
1982	0	0	1,200	1,000	10,400	300	13,000[a]
1983	0	0	600	1,500	14,100	600	16,800
1984	0	0	(2,900)	(1,700)	(8,500)	(200)	(13,300)
Mean	0	0	14,900	1,800	19,000	200	36,000

a Includes minor test fishing catch.
b Based on coded wire tag recoveries of LRW fall chinook during sampling of treaty fishery.
c Includes Lewis, Cowlitz and Sandy rivers. 1980-1984 also includes any LRW fall chinook straying to other areas
( ) (Preliminary).

Table 2. Natural spawning population estimates of LRW fall chinook based on redd count expansion (Cowlitz River) or peak fish count expansion (Cowlitz River) or peak fish count expansion (North Lewis River, East Lewis River) 1970-1984[a].

	North Lewis			East Lewis			Cowlitz		
Year	Adult	Jack	Total	Adult	Jack	Total	Adult	Jack	Total
1970[b]	4,130	17,596	21,726	657	560	1,217	9,706	844	10,550
1971[b]	19,926	483	20,409	2,142	212	2,354	28,758	587	29,345
1972[b]	18,488	710	19,198	534	134	668	21,027	1,583	22,610
1973[b]	9,120	3,909	13,029	210	328	530	8,390	350	8,740
1974[b]	7,549	1,771	9,320	420	156	576	7,566	234	7,800
1975[b]	13,859	1,045	14,904	581	37	618	4,766	304	5,070
1976[b]	3,371	828	4,199	325	28	353	3,726	324	4,050
1977[b]	6,930	049	7,779	568	36	604	5,837	313	6,210
1978[b]	5,363	766	6,129	687	281	968	3,192	1,998	5.190
1979[b]	8,023	931	8,954	716	98	814	8,253	937	9,190
1980[c]	13,882	963	14,845	311	215	526	2,418	212	2,690
1981[c]	17,946	1,942	19,888	397	41	430	2,297	829	3,126
1982[c]	7,353	037	8,190	240	106	346	1,880	0	1,880
1983[c]	11,756	1,216	12,972	148	29	177	1,216	41	1,257
1984[c]	6,847	947	7,794	140	4	144	602	14	616
Mean	10,302	2,320	12,622	538	151	689	7,309	519	7,008

a In years 1970-1979, spawning population assumed to be all LRW stock. In years 1980-1984 values shown are population estimates without a stray component determined by coded wire tag analysis.
b Kreitman (1981).
c WDF (1985).

Table 3. Harvest profile of LRW fall chinook based on coded wire tag recoveries of 1977 brood releases of North Lewis River wild stock.

Harvest componenet		Percent
Alaska:		
Troll and sport		18.0
British Columbia:		
Northern troll		12.4
Southern troll		21.1
Net and sport		4.7
Oregon :		
Troll and sport		1.0
California:		
Troll and sport		---
Washington:		
Ocean troll and sport		6.2
Other net and sport		2.3
Columbia River:		
Non-treaty commercial net		9.7
Treaty commercial net		---
Terminal sport		24.0
	Lewis wild 63-16-18	Lewis wild 63-16-19
Survival		
Smolt to all adult	3.36	1.91
Smolt to fisheries	1.85	1.32
Smolt to Columbia River	2.10	1.29

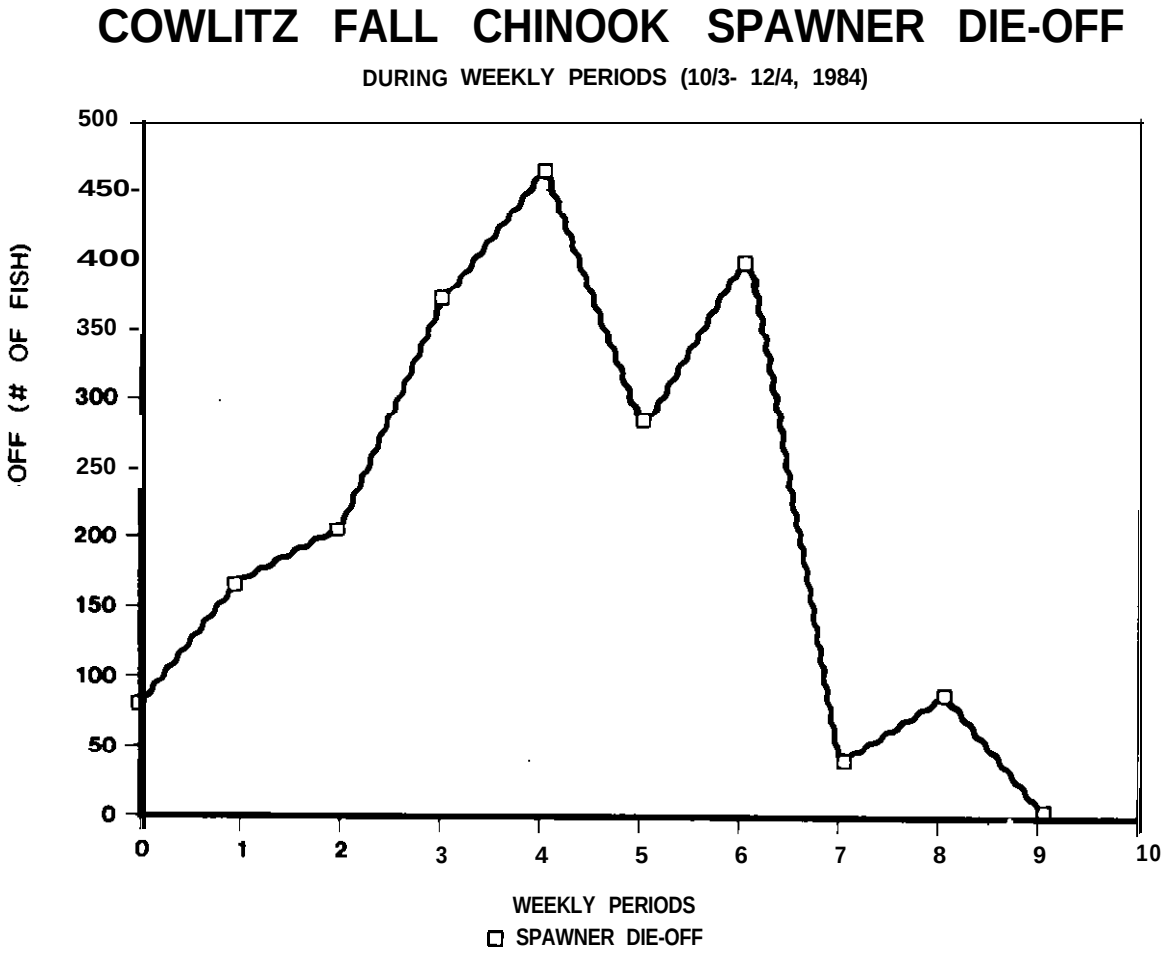


Figure 1. Fall chinook die-off in Cowlitz River (DeVore 1985).

'The primary spawning location on the Cowlitz River is in the eight mile reach between the Cowlitz Hatchery (river mile 49.6) and Blue Creek (river mile 41.3). 'This river section contained about 82 percent of the redds counted in 1964, but included Cowlitz Hatchery production fish that spawned naturally (DeVore 1985). Coded wire tag analysis was used to determine the LRW portion of the natural spawning population, but the natural spawning area was not segmented by stock. Presumably, as the distance from the hatchery increased, the LRH proportion of the natural escapement would be expected to decrease.

Age composition

Age composition is based on a combination of scale readings and coded wire tag analysis. Most of the LRW fall chinook run returns as four-year-olds (Table 4). For the 1962-1979 brood years, two-year jacks averaged about 23 percent of the returns (catch plus escapement), and adults of ages 3, 4, and 5 years about 18, 44, and 15 percent of the returns, respectively. Occasionally, six-year-old fall chinook were observed.

Size

Comparing the length information from North Lewis River spawning ground sampling in 1981-1982 (Table 5) to other Columbia River fall chinook populations indicates that the average lengths of two and three-year fish are similar to URB fall chinook but smaller than the hatchery stocks (BPH and LRH).

Fish with fork length measurements exceeding about 52 cm. could be considered adults (Figure 2). Lengths overlap substantially for adult fish of various ages.

Sex ratio

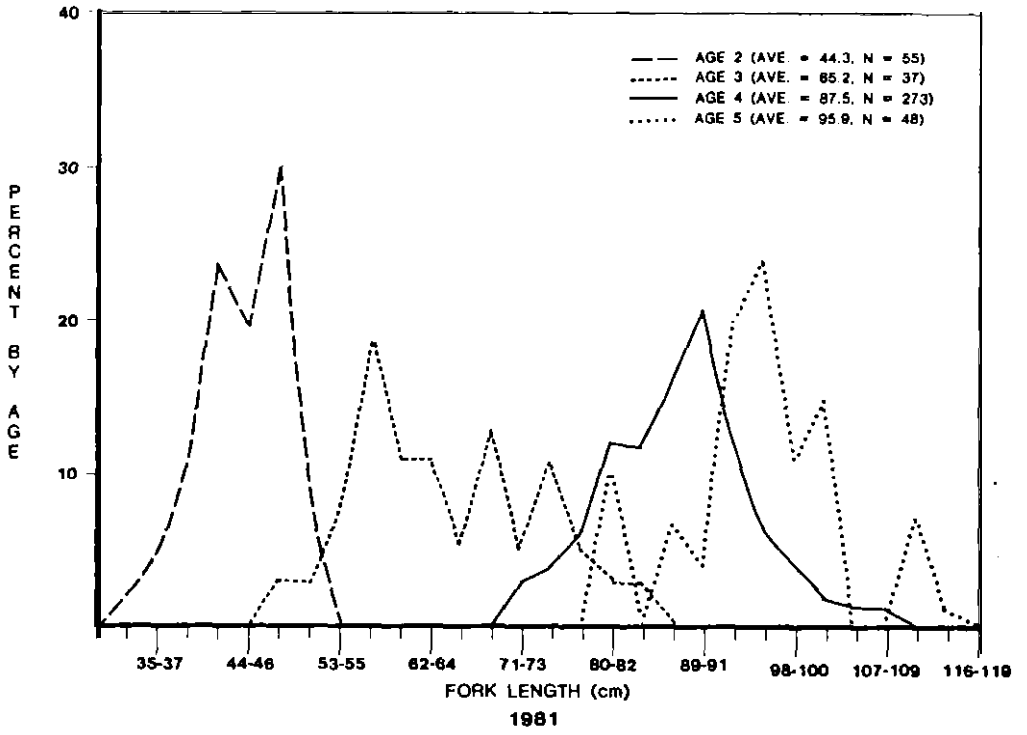
Jacks are exclusively males. Three-year-olds are predominately males and four and five-year fish are mostly females (Figure 3).

Fecundity

No information

Biochemical-genetic characteristics

Schreck et al. (1984) found a statistically significant difference in gene frequencies for one enzyme system between Lewis River Hatchery returns and the naturally spawning fish, which indicated a genetic difference between the two groups. Based on coded wire tag recoveries, strays from LRH production areas are known to enter the Merwin Dam fish trap the source of fall chinook for Lewis River hatcheries. This straying could explain the electrophoretic difference.



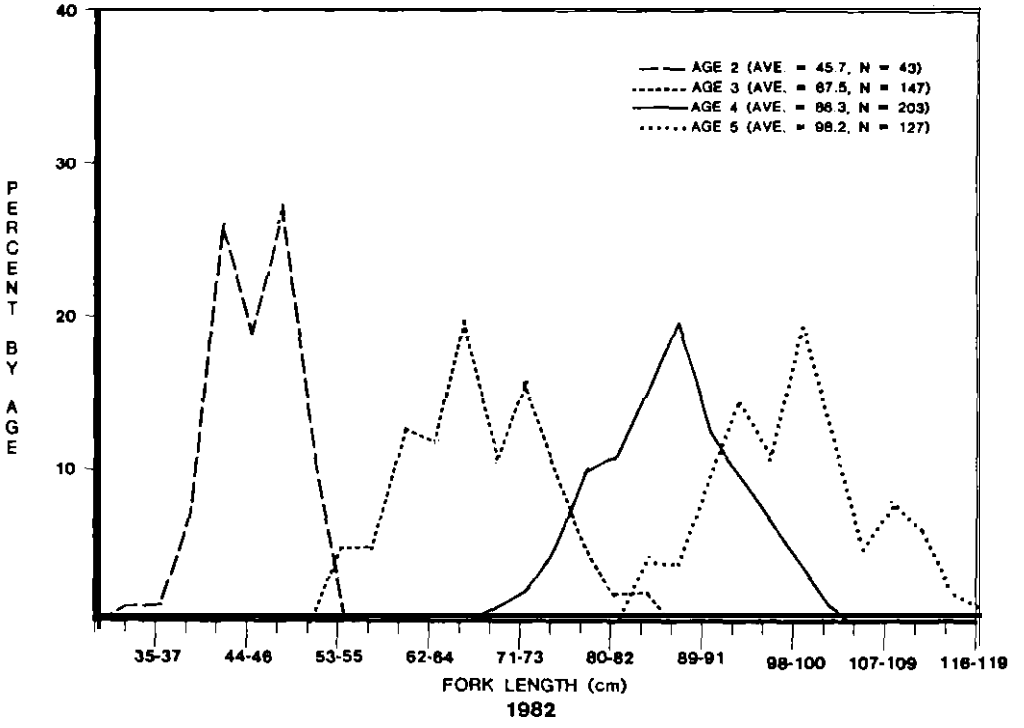


Figure 2. Length frequency of LRW fall chinook from North Lewis River, 1981 and 1982.

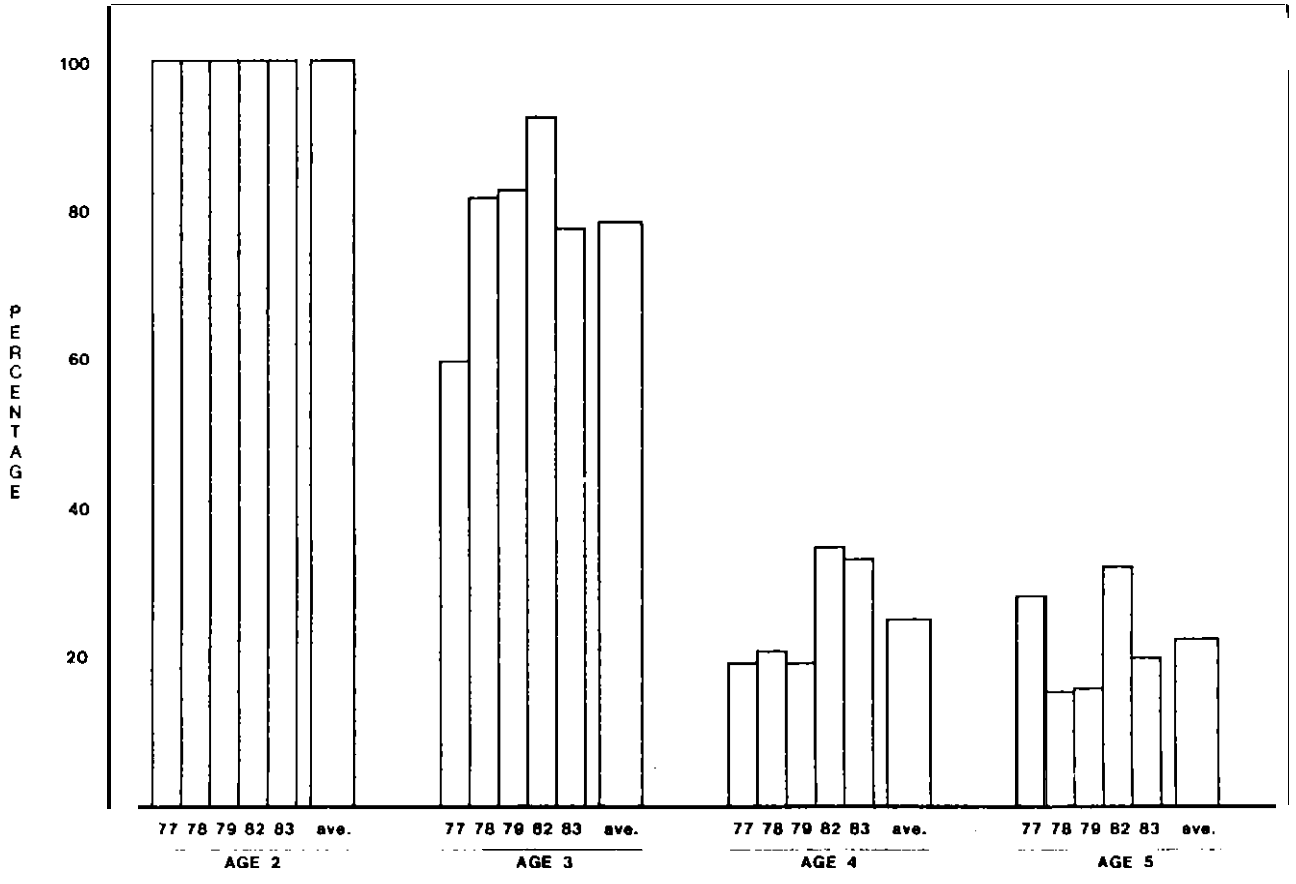


Figure Percent male LRW fall chinook from North Fork Lewis River, 1977-1979, 1982 and 1983.

Table 4. Total age specific freshwater returns to Oregon and Washington of LRW fall-chinook, 1970-1984 (WDF 1985).

Year	Age 2		Age 3		Age 4		Age 5		Total
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
1970	43,200	53.3	18,600	23.0	15,900	19.6	3,300	4.1	81,000
1971	7,900	6.9	27,900	24.1	72,300	62.7	7,300	6.3	115,400
1972	9,100	10.3	11,100	12.6	59,000	66.7	9,200	10.4	88,400
1973	15,300	24.0	10,100	15.8	25,000	39.1	13,500	21.1	63,900
1914	5,500	17.0	6,200	19.1	15,200	46.9	5,500	11.0	32,400
1975	7,700	17.3	6,900	15.5	21,900	49.2	8,000	18.0	44,500
1976	9,000	37.6	4,100	17.2	7,700	32.2	3,100	13.0	23,900
1977	7,500	20.1	8,900	23.9	14,800	39.7	6,100	16.3	37,100
1978	12,400	40.2	5,600	18.1	9,400	30.4	3,500	11.3	30,900
1979	10,400	24.1	11,800	27.4	16,500	38.3	4,400	10.2	43,100
1980	2,800	6.7	7,400	17.8	23,700	57.0	7,700	18.5	41,600
1981	5,000	16.7	3,500	11.7	18,200	60.6	3,300	11.0	30,000
1982	2,900	18.3	4,500	28.3	5,300	33.3	3,200	20.1	15,900
1983	2,700	13.9	2,200	11.3	11,100	56.9	3,500	17.9	19 500
1984	(3,300)	(17.4)	(2,300)	(14.41	(6,900)	(43.1)	(4,000)	(25.1)	(16,500)[a]
Mean	9,600	21.6	8,700	18.9	21,500	45.0	5,700	14.7	45,500

a Does not include 100 Age 6 adults.
( ) (Preliminary).

Table 5. Length according to sex and age for LRW fall chinook from North Lewis River spawning area samples, 1981-1982.

Year	Age 2		Age 3		Age 4		Age 5	
	Male	Female	Male	Female	Male	Female	Male	Female
1981								
Sample size	55	0	33	4	75	198	12	36
Average fork length (cm)	44.3		64.5	71	89.2	86.9	102.1	93.9
Range	34-52	–	49-95	66-74	66-109	71-87	89-115	80-111
Standard deviation	4.2	–	10.4	3.3	9.4	6.0	7.9	6.7
1982								
Sample size	43	0	141	7	70	134	42	85
Average fork length (cm)	45.1	–	66.6	16.4	86.8	86.3	102.0	96.3
Range	34-67	–	53-85	72-82	66-107	72-100	89-125	83-108
Standard deviation	5.8		6.9	3.4	9.0	5.9	18.4	5.9

JUVENILE LIFE HISTORY

Time of emergence

Since 1976, juvenile fall chinook have been seined from the North Lewis as part of an investigation of wild stock rearing and adult production. A primary task of this study has been the collection and coded wire tagging of naturally produced fingerlings and fry. Recently emerged fry (30-40 mm.1 have been observed as early as March 23 (McIsaac 1980) and as late as August 22 (C. Norman, WDF, personal communication). An early March timing for emergence coincides with the 1,800 Temperature Units (TU's) required for chinook fry emergence if the eggs were deposited in early November (McIsaac 1980). Peak of emergence occurs during April (G. Norman, WDF, personal communication).

Time. age, and size at migration

Coded wire tagged North Lewis fall chinook were recovered in the Columbia estuary primarily in early August, illustrating the extended freshwater rearing of this population (Table 6). This estuary recovery information, combined with the August seine catches in the North Lewis, demonstrates the significance of rearing in the natal stream. Most juveniles migrate from the North Lewis in mid to late summer at approximately 90 mm. in length. In 1983, average length of all samples collected between early June and late August increased from 48 mm to 81 mm and tagged fish grew at a rate of almost 0.75 mm per day (Table 7). Based on scale analysis, ocean entry of the juveniles occurs primarily in the fall but a few remain in freshwater until the following spring and enter the ocean as yearlings.

Survival rate

Smolt to adult survival measured in terms of all catch and escapement was 3.3 percent and 1.9 percent for two 1977 brood coded wire tag groups (codes: 63-16-18, 63-16-19).

DISEASE HISTORY

Although infectious hematopoietic necrosis (IHN) has not been detected in samples of North Lewis fall chinook, this population has a high potential of carrying this disease because of the kokanee (sockeye) in upstream reservoirs. Sockeye are common carriers of this virus. IHN was previously called sockeye disease (Rucker et al. 1953 as reported in Mullan 1984).

PRIORITY INFORMATION NEEDS

An electrophoretic comparison between Cowlitz Hatchery returns and the natural escapement would determine if there is a genetic difference between these populations.

Table 6. Coded wire tag recoveries of LRW fall chinook (North Lewis River wild stock) in the Columbia River estuary at Jones Beach (Dawley et al. 1982).

Origin	Purpose	Size at release (fish/lb)	Release		Percent of release recaptured	Recapture date			Movement rate (RM/day)
			Year	Date		Year	Median fish	First fish	Last fish	
North Fork Lewis River	Wild stock evaluation	300	1979	15-30 May	0.201	1979	30 July	05 July -	7 Sept.	1
					0.006	1980	17 June		17 June	<1
	Wild stock evaluation	200	1979	18-19 June	0.667	1979	06 Aug.	16 July -	19 Sept.	1
	Wild stock evaluation	200	1979	13-26 July	0.637	1979	04 Aug.	16 July -	14 Sept.	2
					0.022	1980	17 Mar.	17 Mar. -	29 Apr.	<1
	Wild stock evaluation		1980	11-17 June	0.434	1980	12 Aug.	03 July -	16 Sept.	1
	Wild stock evaluation		1980	07-11 July	0.186	1980	19 Aug.	22 July -	15 Sept.	1

Table 7. Average size of juvenile chinook collected on North Fork Lewis River, 1983 (Norman 1904).

	6/6-6/11	6/23	7/02	7/18	7/27	8/04	8/11	8/18	8/25	6/11-8/25
Adipose marked only										
Sample size	230	37	29	17	8	10	35	19	7	400
Average fork length (mm)	53.4	50.5	64.6	76.7	01.5	82.4	97.9	97.3	106.3	-
Total growth (mm)		5.1	6.1	12.1	4.0	0.9	15.5	-0.6	9.0	52.9
Growth rate (mm/day)	-	0.39	0.60	0.76	0.53	0.13	2.21		1.29	0.10
All samples collected										
Sanple size	530	297	159	210	206	100	316	240	255	2,409
Average fork length (mm)	48.4	52.0	62.1	59.8	59.1	66.5	11.0	02.4	01.0	-
Total growth (mm)		4.4	9.3	-2.3	-0.7	1.4	10.5	5.4	-1.4	33.3
Growth rate (mm/day)	-	0.34	1.03			1.06	1.5	0.11		0.44

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Lower Columbia River Hatchery Fall Chinook

The Lower Columbia River Hatchery Fall Chinook stock (LRH) is one of the four major Columbia River fall chinook stocks. The three other stocks include : Bonneville Pool Hatchery (BPH), Upriver Bright (URB) and Lower Columbia River Wild (LRW) fall chinook. BPH and LRH fall chinook are informally called 'Tules'.

Within the broad LRH stock group, there are also three different substocks identified as Willamette River, Kalama River, and Cowlitz Hatchery. This stock summary will contain information for all three substocks as well as general LRH stock information. A separate summary contains specific data on the Willamette River substock.

PRODUCTION

Hatchery production is the dominant component although some natural production also occurs.

During 1979-1983, fingerling releases from Oregon hatcheries ranged from 25 million (1982) to 30 million (1980) and averaged 29 million. During this period, a small number of yearlings (0.1-0.5 million1 were also released annually from Bonneville and Oxbow hatcheries.

In Washington, annual fingerling releases from Kalama River hatcheries averaged 7.6 million in 1979-1982 and 6.5 million from Cowlitz Hatchery in 1979-1983. Combined releases from other Washington facilities averaged 14.6 million fingerlings in 1979-1983. Fall release juveniles numbering 0.3-0.6 million are released annually from Washougal Hatchery.

GEOGRAPHIC LOCATION

Streams

Lower Columbia River tributaries containing LRH fall chinook include:

Oregon	Washington
Klaskanine River	Chinook River
Youngs River	Gray's River
Lewis and Clark River	Skanokawa Creek
Big Creek	Elokomin River
Gnat Creek	Abernathy Creek
Plympton Creek	Germany Creek
Clatskanie River	Mill Creek
Willanette system	Cowlitz River
Tanner Creek	Toutle River
Sandy River (as strays)	Coweeman River
Bear Creek	Green River
	Kalama River
	Washougal River
	Lewis system (as strays)

Hatcheries

Hatcheries releasing LRH fall chinook include:

Oregon	Washington
Big Creek	Sea Resources (private)
Klaskanine	Gray's
Clatsop Economic Development Comm. (CEDC)	Elokomin
Bonneville/Cascade	Abernathy NFH
Aumsville/Stayton Ponds	Cowlitz
	Kalama Falls
	Lower Kalama
	Washougal

ORIGIN

Native fall chinook were reported in the following Washington rivers: Gray's Elokomin, Cowlitz, Toutle, Kalama, Lewis (LRW stock), and Washougal (WDF and USFWS 1951).

Lower Columbia River Hatchery records from the late 1800's indicate fall chinook were raised at hatcheries on the Chinook River, Kalama River, and Clackamas River. Broodstock for the Chinook Hatchery program were collected at fish traps on the lower Columbia. Eggs for the Clackamas Hatchery were originally obtained from a collection facility on the Little White Salmon River The Clackamas program was expanded in 1900 when Tanner Creek and Eagle Creek substations were established to take additional eggs. The hatchery on the Kalama River at Fallert Creek obtained broodstock from a fish rack about one mile upstream from the confluence with the Columbia River (WDF and USFWS 1951).

More hatcheries were constructed in the mid-1900's as part of the Lower Columbia River Fisheries Development Program. Broodstock for these hatcheries were either obtained from local stock or from transfers. For example, the Toutle Hatchery received 1 million eggs from the Wind River during the first year of production (19511, but utilized local Green River stock thereafter (R. Foster, Washington Department of Fisheries, personal communication).

Initial releases in 1968 from Cowlitz Hatchery originated from a combination of native Cowlitz River and Toutle stock fall chinook. Subsequent releases have almost exclusively been progeny from Cowlitz Hatchery returns.

Excluding reprogrammed hatchery production for the URB egg-bank program, Spring Creek Hatchery fall chinook (BPH) have been the primary fall chinook stock transferred to LRH hatcheries (Table 1). Rogue River stock have also been released from Big Creek Hatchery since 1983.

Although many lower Columbia River tributaries contain fall chinook that are not directly stocked with LRH fish, the early spawning fall chinook populations in these tributaries are considered to be LRH stock. Straying of LRH fall chinook is common, evidenced by the coded wire tagged fish recovered during spawning surveys. For example, strays from Big Creek Hatchery and other stations were observed in several Oregon and Washington tributaries in the lower Columbia, although direct releases into these streams did not occur (Table 2).

Table 1. Releases of non-LRU stock fall chinook into lower Columbia River tributaries [a]/.

Stream	Brood Year	Release Year	Number released	Type	Hatchery	Stock
Chinook River	1966	1967	939,000	Unfed-fry	Grays River	Spring Creek
	1969	1970	97,500	Fingerling	Chinook River	University of Washington
	1980	1981	1,259,400	Fingerling	Sea Resources	Spring Creek
	1981	1982	590,700	Fingerling	sea Resources	Spring Creek
	1982	1983	1,713,400	Fingerling	sea Resources	Spring Creek
Elokomin	1966	1967	1,545,900	Unfed-fry	Elokomin	Spring Creek
	1966	1967	317, 100	Fingerling	Elokomin	Spring Creek
	1970	1971	132,800	Fingerling	Elokomin	Nemah
	1971	1974	38,800	Fall releases	Elokomin	Trask River
	1973	1974	39, 100	Fingerling	Elokomin	Elk River
	1980	1981	1,019,000	Fingerling	Elokomin	Klickitat
	1981	1982	225,400	Fingerling	Elokomin	Spring Creek
Alder Creek (Grays Basin)	1976	1977	1,759,400	Fingerling	WEYCO Pond	Spring Creek
	1977	1978	1,880,000	Fingerling	WEYCO pond	Spring Creek
	1980	1981	237,200	Fingerling	WEYCO pond	Klickitat
	1981	1982	1,507,500	Fingerling	WEYCO Pond	Spring Creek
	1982	1983	3,246,900	Fingerling	WEYCO Pond	Spring Creek
Clear Creek	1977	1978	29,300	Fingerling	Spring Creek	Spring Creek
	1977	1978	19,800	Fall releases	Spring Creek	Spring Creek
Coweeman	1966	1967	467,200	Fingerling	Kalama Falls	Spring Creek
Toutle	1966	1967	458,500	Unfed-fry	Speelyai	Spring Creek
Green River (Toutle Basin)	1966	1967	1,096,600	Unfed-fry	Kalama Falls	Spring Creek
Kalama	1966	1967	322,300	Unfed-fry	Kalama Falls	Spring Creek
Big Creek	1982	1983	56,700	Smolt	Big Creek	Rogue River
	1983	1984	52,800	Fingerling	Big Creek	Rogue River
	1983	1984	62,500	Smolt	Big Creek	Rogue River

[a]/ Release years 1967-1983 and complete for WDF facilities only. Does not include mainstem Columbia, Kalama egg-bank or Abernathy Creek (heavily supplemented with BPH fall chinook).

Table 2. Origin of coded-wire tagged fall chinook recovered as carcasses on spawning ground surveys of Oregon tributaries of the lower Columbia River, 1981-84 (ODFW, unpublished data).

	1981			1982			1983			1984		
Stream	No.	Release site	Carcasses examined	No.	Release site	Carcasses examined	No.	Release site	Carcasses examined	No.	Release site	Carcasses examined
Big Creek	4	Big Cr.		34	Big Cr.		18	Big Cr.		14	Big Cr.	
	1	N. Fk. Klaskanine R.		1	Columbia R.		1	Abernathy Cr.	1,463	1	Grays R.	1,370
	1	Grays R.	266	1	N. Fk. Klaskanine R.	1,682	1	Tucker Cr. (Youngs Bay)		2	Tucker Cr. (Youngs Bay)	
	2	Hammond		1	Hammond Stavebolt Cr.							
Gnat Creek	1	Big Cr.			Columbia R.		0	--	7	0	--	17
	1	White Salmon R.	5	1	Big Cr.	76						
Plympton Creek	2	Big Cr.		40	Big Cr.							
	1	Stavebolt Cr.	193		Columbia R.	2,025	11	Big Cr.	823	4	Big Cr.	453
				1	Spring Cr.		1	Grays R.				
Clatskanie R.	0		7	1	Alder Cr. (Grays R.)	36	0	--	12	0	--	1
Youngs R.	0	--	3	-	--		0	--	0	0	--	9
S. Fk. Klaskanine R.	0	--	3	0	--		0	--	17	1	Tucker Cr. (Youngs)	58
N. Fk. Klaskanine R.	0	--	19	0	--	3	0	--	35	1	N. Fk. (Youngs)	17
Lewis and Clark River	5	Hammond		4	Stavebolt Cr.	84	1	Columbia R. (Astoria)		2	S. Fk. Klaskanine	189
	13	Stavebolt Cr.		3	N. Fk. Klaskanine		2	Stavebolt Cr.		2	Tucker Cr. (Youngs Bay)	
	2	Klaskanine R.	182				3	S. Fk. Klaskanine	269			
	1	N. Fk. Klaskanine					4	N. Fk. Klaskanine				
							1	Tucker Cr.				
Bear Cr.		--		-	--		11	Big Cr.	639	7	Big Cr.	864
							2	N.Fk. Klaskanine		1	N. Fk. Klaskanine	
Sandy R.							-	--		1	Tanner Cr.	198
										1	Washougal R.	

The overall result of straying fall chinook and stock transfers at lower Columbia River hatcheries is the development of a large, blended hatchery stock and three smaller substocks.

ADULT LIFE HISTORY

Run size, catch and escapement

The LRH adult run has averaged about 148,000 fish between 1970 and 1984 (Table 3). From 1979-1984, the harvest of LRH in the freshwater fisheries was determined primarily by expansion of the coded wire tags recovered during fishery sampling. Prior to 1979, harvest was determined by applying the 1979 stock specific catch per escapement proportions in the various fisheries to the stock escapement for each year. Natural and hatchery escapement for 1980-1984 represents the actual number of LRH adults that returned to all Columbia River areas based on coded wire tag analysis. Any fish recovered in a LRH escapement area that possessed a non-LRH tag or mark was extracted from the escapement population along with a representative number of unmarked fish from an adult mark rate expansion. Similarly, LRH origin fish straying to other Columbia River areas were estimated in this same manner and added to the LRH escapement.

Annual natural escapement of LRH adults has averaged about 22,000 in Oregon (Table 4) and nearly 18,000 in Washington (Table 5).

An overall catch distribution profile for Oregon and Washington LRH releases is presented in Table 6. Three Washington tag codes and one Oregon code, representing typical hatchery production releases, were used in the analysis. LRH harvest in Alaska and British Columbia is slightly higher than BPH stock but less than LRW and URB fall chinook. LRH stock contribute significantly to the Washington coastal catch and lower Columbia River gill net fishery.

Time of migration

Upstream migration begins from early August to early September. Depending partly on early fall rains and tributary migration distances, recruitment to most hatchery collection sites is usually greatest during the middle of September.

The Cowlitz Hatchery substock arrives at the collection site slightly later and over a broader time period than other LRH stocks (Figure 1).

Spawning period

Peak of spawning occurs in late September to early October at most Oregon and Washington facilities. Spawning at the Kalama facilities peaks in early to mid-October. Cowlitz Hatchery fall chinook are spawned primarily in late October to early November. Natural spawning generally occurs concurrently with the spawning of the hatchery run.

Table 3. Freshwater adult run size of LRH fall chinook to Oreaon and Washington. 1970-1984 (WDF 1985).

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial	Ceremonial and subsistence	Commercial	Recreational[f/]	Natural	Hatchery	Total production[b/]
1970	0	0	86,800	9,000	36,000	44,900	176,700
1971	0	0	03,800	5,800	35,800	55,600	181,000
1972	0	0	62,500	5,000	42,900	41,200	151,600
1973	0	0	119,800	4,900	40,300	50,100	215,100
1974	0	0	51,300	5,300	63,400	34,200	154,200
1975	0	0	73,100	6,000	69,600	34,800	183,500
1976	0	0	63,300	5,300	50,800	51,600	171,000
1977	0	0	74,500	3,900	44,500	42,200	165,100
1978	0	0	58,300	5,800	43,200	59,200	166,500
1979	0	0	43,900	4,000	25,300	45,500	118,700
1980	100[d/]	0	57,000	2,900	20,900[b/]	24,600	105,500
1981	1,000[d/]	0	21,500	2,900	26,500[b/]	42,800[b/]	94,800[a/]
1982	1,000[d/]	0	47,300	3,800	44,000[b/]	43,100[b/]	139,400[a/]
1983	800[d/]	0	14,900	1,500	33,700[b/]	36,700	88,000[a/,c/]
1984	(1,400)[d/]	0	(29,200)	19,200)	(37,400)[b/,e/]	(27,600)[b/]	(105,300)[c/]
Mean	900 (5 yr)	0	59,100	5,000	41,100	42,300	147,800

a/ Includes minor test fishing catch.
b/ Includes a small number of LRH stock that strayed to other Columbia River areas.
c/ Includes LRH adults passing Bonneville Dam but unaccounted in upstream fisheries or escapement.
d/ Based on coded wire tag recoveries of LRH fall chinook during sampling of treaty fishery.
e/ Includes approximately 5,300 adults destined for Bonneville Hatchery that presumably spawned naturally at unknown locations.
f/ Does not include negligible harvest in Oregon tributaries, 1980-1984.
() (Preliminary).

Table 4. Estimates of naturally spawning adult and jack LRH fall chinook in Oregon tributaries, 1970-1984 (WDF 1985).

River	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
North Fork Klaskanine	9	-	48	20	180	53	7	9	40	53	99	37	5	51	7
Youngs	0	-	5	20	7	5	9	0	0	0	46	19		2	20
Lewis & Clark	0	–	2	0	0	5	3	0	2	14	101	182	164	269	236
Big Creek	12,370	2,982	2,910	1,464	1,003	1,618	867	490	3,395	449	439	143	3,362	1,835	2,159
Gnat Creek	914	151	1,873	107	22	121	60	85	37	53	85	43	170	32	31
Plymton	1,156	626	1,170	1,110	140	411	1,115	915	1,505	367	99	403	3,654	1,447	605
Clatskanie	14			10	14	36	7	3	7	29	46	29	92	29	
Clackamas	148	223	275	1,088	1.385	1,090	685	450	375	490	710	573	928	553	213
Total	14,671	3,982	6,283	3,819	2,159	3,139	2,753	1,952	5,369	1,455	1,635	2,029	0.375	5,021 a/	4,475 b/
Adult only	13,497	3,902	5,843	3,666	2,676	3,139	2,533	1.835	4,999	1,317	1,511	1,816	8,067	4,940	4,211
Willamette Falls adult count	7,500	4,900	11,600	21,800	33,900	32,900	29,300	25,700	17,400	9,900	7,100	16,300	26,0000	12,400	20.500

a/ Also includes 744 to Bear Creek and 29 to South Fork Klaskanine River.
b/ Also includes 1,100 to Bear Creek and 102 to South Fork Klaskanine River.

Table 5. Natural spawning population estimates of LRH fall chinook in Washington[1] (WDF 1985)

	1970		1971		1972		1973		1974		1975		1976		1977	
	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jac
Coweeman River	72	39	290	6	174	38	42	12	41	1	91	3	68	6	81	
Elokomin	455	40	367	8	108	8	500	22	245	8	220	14	1,682	52	568	
Grays	359	31	622	13	674	14	503	27	624	93	706	45	1,144	48	1,495	
Toutle (all)	6,726	585	16,997	409	45,676	1,181	2,951	123	6,393	199	7,862	208	4,217	318	2,652	1
Kalama	2,738	238	3,102	63	3,222	243	6,199	63	12,449	385	17,761	362	7,517	835	6,484	
Skamokawa	2,731	238	2,950	59	2,761	208	2,850	119	2,880	89	5,228	218	701	22	2,462	
Washougal	72	13	1,666	34	1,287	13	189	14	2,769	208	923	59	2,824	213	1,553	
Abernathy	1,635	123	912	0	1,365	558	1,430	475	1,278	116	688	429	753	210	1,449	
Germany/Mill	237	18	98	0	202	83	201	25	171	16	84	52	84	24	198	
Cowlitz	-	-				-	-	-	-	-						
North Lewis					-		-	-	-	-					-	
East Lewis	-	-	-	-	-	-	-	-	-	-					-	
Total	15,025	1,325	26,964	592	25,469	2,346	14,865	579	26,850	1,115	33,563	1,390	18,990	1,728	16,942	4

	1978		1979		1980		1981		1982		4983		1984	
	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks
Coweeman River	58	4	80	8	50	6	35	3	63	13	40	0	436	28
Elokomin	1,846	0	1,478	0	64	0	138	0	317	23	1,053	0	292	2
Grays	2,685	0	1,206	0	185	12	246	105	422	0	927	0	242	98
Toutle (all)	8,297	58	5,196	23	33	4	161	0	8	1	0	0		
Kalama	3,637	74	2,704	27	5,675	175	1,840	77	4,302	25	2,640	41	2,955	88
Skamokawa	3,254	32	724	72	183	1	376	10	1,035	0	1,604	0	1,744	69
Washougal	593	0	2,388	0	3,152	285	1,789	52	301	29	2,677	0	1,995	22
Abernathy	425	18	110	72	369	98	816	471	1,568	878	2,994	178	436	73
Germany/Mill	24		241	158	38	10	63	37	257	0	548	0	96	9
Cowlitz		-			0	0	1,694	0	1,144	126	2,427	0	1,973	45
Worth Lewis		-			2,512	366	1,233	0	576	0	1,409	0	86	0
East Lewis		-	-	-	0	0	0	0	0	0	157	0	52	4
Total	20,779	187	14,127	360	12,261	957	8,391	755	9,993	1,095	16,436	219	9,207	408

[1] In years 1970-1979, spawning population assumed to be all LRH stock. In 1980-1984 values shown are population estimates without a stray component as determined by coded wire tag analysis.

Table 6. Harvest profile of LRH fall chinook based on coded wire tag recoveries of 1976 brood releases.

Harvest component	Percent
Alaska:	
Troll and sport	5.0
British Columbia:	
Northern troll	4.6
Southern troll	39.7
Net and sport	9.3
Oregon :	
Troll and sport	0.8
California:	
Troll and sport	–
Washington:	
Ocean troll and sport	16.9
Other net and sport	4.4
Columbia River:	
Non-treaty commercial net	18.0
Treaty commercial net	–
Terminal sport	1.3

Survival	Kalama Falls Hatchery 63-16-39	Toutle Hatchery 63-16-40	Washougal Hatchery 63-16-41	Bonneville Hatchery 9-16-5
Smolt to all adult	1.2%	0.8%	1.6%	N/A
Smolt to fisheries	0.9%	0.7%	1.4%	0.1%
Smolt to Columbia River	0.4%	0.2%	0.6%	N/A

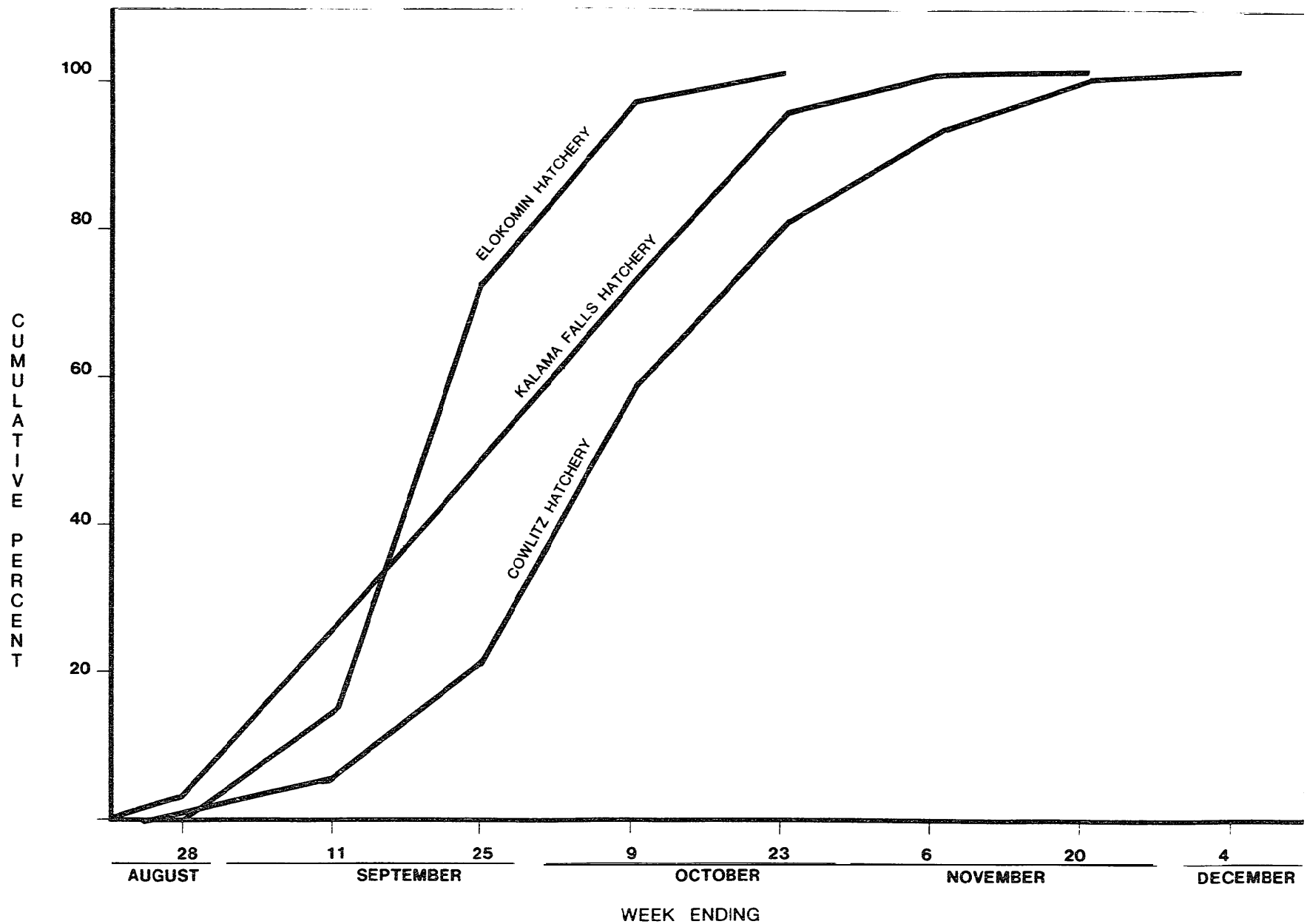


Figure 1. Cumulative percent of adult LRH fall chinook handled at Kalama Falls, Elokomin and Cowlitz hatcheries, 1979-1983.

Spawning areas

Spawning occurs in the tributary systems listed in Tables 4 and 5.

ge composition

Age composition for the entire run (all Columbia River catch and escapement) by return year is shown in Table 7. For the 1962-1979 brood years, jacks (age-2) averaged 5.5 percent of the run and adults of ages 3, 4, and 5 years old averaged 35.2 percent, 51.5 percent and 7.8 percent of the returns respectively.

Generally, returns to Oregon hatcheries have a greater proportion of three-year-old adults than what occurs at Washington facilities. During 1982 through 1984, three-year-old LRH fall chinook returning to Oregon hatcheries averaged 62 percent of total returns compared to 33 percent at Washington stations.

Size distribution of LRH fall chinook at Bonneville Hatchery (Table 8) is similar to the other Oregon and Washington hatcheries except the Cowlitx (Table 9). Lower Kalama, and Kalama Falls hatcheries (Table 10). Length-frequencies in 1981 and 1982 at Bonneville, Coulitz, and Kalama Falls hatcheries are diagrammed in Figures 2-4.

Sex ratio

Jacks (age-2) are exclusively males: Three-year-old adults are predominately males in contrast to the four and five-year-old fish that are primarily females (Figures 5-7).

Fecundity

Age or length specific fecundity is not available.

Fecundity was based on hatchery spawning reports (eggs fertilized divided by females killed for spawning) and may not precisely measure actual fecundity. Average fecundity at Big Creek, Bonneville, Cascade, and Klaskanine hatcheries ranged from 3,718 eggs per female to 5,778 eggs per female during 1978-1983. Fecundity at the Kalama facilities and at Cowlitz Hatchery averaged 4,574 and 4,346 eggs per female, respectively, during 1978-1982. At the other Washington stations fecundity averaged 4,768 eggs per female.

Biochemical-genetic characteristics

Schreck et al. (1984) determined from electrophoresis that Bonneville Hatchery fall chinook and Spring Creek Hatchery (BPH) had 11 similar isozyme gene frequencies and none dissimilar.

Table 7. Total age specific freshwater returns to Washington and Oregon of LRH fall chinook, 1970-1984 (WDF 1985).

Return Year	Age 2 Number	Age 2 Percent	Age 3 Number	Age 3 Percent	Age 4 Number	Age 4 Percent	Age 5 Number	Age 5 Percent	Total
1970	16,400	8.5	90,200	46.7	72,800	37.7	13,700	7.1	193,100
1971	8,700	4.6	51,600	21.2	123,700	65.2	5,700	3.0	189,700
1972	8,300	5.2	38,400	24.0	101,100	63.2	12,100	7.6	159,900
1973	6,700	3.0	70,100	31.6	106,500	48.0	30,500	17.4	221,800
1974	4,600	2.9	46,800	29.5	93,600	58.9	13,800	8.7	158,800
1975	9,800	5.1	39,800	20.6	123,500	63.9	20,200	10.4	193,300
1976	9,600	5.3	76,100	32.1	74,400	41.2	20,500	11.4	180,600
1977	6,400	3.7	61,600	35.9	85,900	50.1	17,600	10.3	171,500
1978	8,400	4.0	56,300	32.2	102,200	50.4	8,000	4.6	174,900
1979	7,400	5.9	50,900	40.4	57,400	45.5	10,400	8.2	126,100
1980	5,300	4.0	35,900	32.4	63,100	56.9	6,500	5.9	110,800
1981	8,200	8.0	46,600	45.2	43,100	41.8	5,100	5.0	103,000
1982	9,500	6.4	86,200	57.9	48,400	32.5	4,800	3.2	148,900
1983	3,000	3.3	44,900	49.3	40,600	44.6	2,500	2.8	91,000
1984	(5,700)	(5.17)	(53,300)a/	(48.1)	(50,200)	(45.3)	(1,700)	(1.5)	(110,900)
Mean	7,900	5.1	56,600	36.4	79,100	50.0	12,100	7.7	155,700

a/ Represents actual return in year of greatly reduced ocean harvest; 36,000 would have been expected to return from a 'normal' ocean season and would be consistent with data base.

() Preliminary.

Table 8. Fork length (cm) according to sex and age for LRH fall chinook at Bonneville Hatchery, 1981 and 1982.

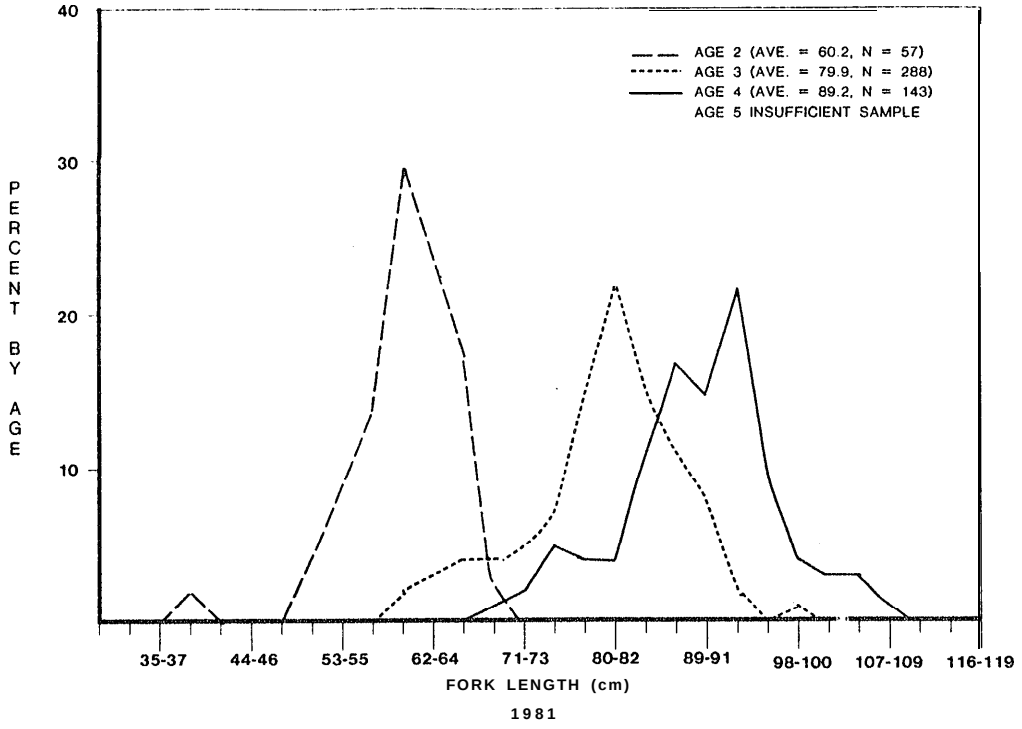
Year	Age 2		Age 3		Age 4		Age 5	
	Male	Female	Male	Female	Male	Female	Wale	Female
1981								
Sample size	57	0	186	102	67	76	3	1
Average fork length (cm)	60.2	--	80.3	79.1	90.1	08.4	91.5	94.2
Range	39-68	--	58-99	59-93	72-107	69-103	86-95	--
Standard deviation	5.0	--	0.2	6.0	8.1	6.7	4.0	--
1982								
Sample size	36	0	189	160	92	121	1	1
Average fork length (cm)	59.0	--	82.8	80.1	93.4	90.0	106.2	91.3
Range	37-66	--	64-95	60-90	65-109	71-101	--	--
Standard deviation	5.7	--	6.3	5.5	7.3	5.1	--	--

Table 9. Fork length (cm) according to sex and age for LRH fall chinook at Cowlitz Hatchery. 1981 and 1982.

Year	Age 2		Age 3		Age 4		Age 5	
	Male	Female			Male	Female	Male	Female
1981								
Sample size	N/A	0	138	152	04	151	14	44
Average fork length(cm)	--	--	73.0	72.0	00.4	83.9	91.9	90.7
Range	--	--	54-92	57-85	70-104	68-97	69-110	76-105
Standard deviation	--	--	6.7	5.5	7.1	5.0	10.7	6.1
1982								
Sample size	125	0	191	56	I78	226	25	79
Average fork length (cm)	46.0	--	67.2	72.3	87.9	83.6	98.0	90.6
Range	38-55	--	52-04	61-82	66-108	69-99	71-109	71-107
Standard deviation	3.9	--	6.4	4.7	8.6	5.3	7.9	7.0

Table 10. Fork length (cm) according to sex and age for LRH fall chinook at Kalama Falls Hatchery, 1981 and 1982

Year	Age 2		Age 3		Age 4		Age 5	
	Male	Female	Male	Female	Male	Female	Male	Female
1981								
Sample size	N/A	0	103	74	153	151	108	101
Average fork length (cm)	--	--	75.3	10.3	91.0	00.3	100.6	93.4
Range	--	--	50-94	66-91	70-109	63-103	76-121	79-107
Standard deviation	--	--	9.0	5.0	0.1	5.6	7.4	5.0
1982								
Sample size	N/A	0	60	33	65	83	10	19
Average fork length (cm)	--	--	77.3	75.5	06.0	04.3	93.1	93.4
Range	--	--	63-94	69-05	69-104	67-90	86-104	78-103
Standard deviation	--	--	7.1	4.2	7.5	6.9	5.7	5.7



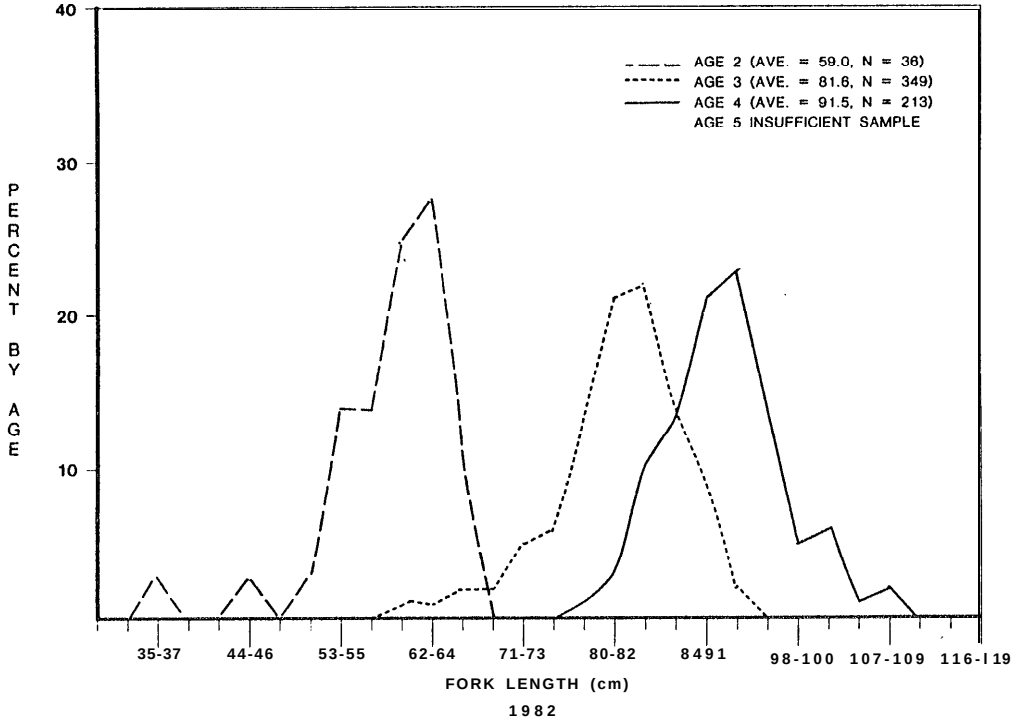


Figure 2. Length frequency of LRH fall chinook at Bonneville Hatchery, 1981-1982.

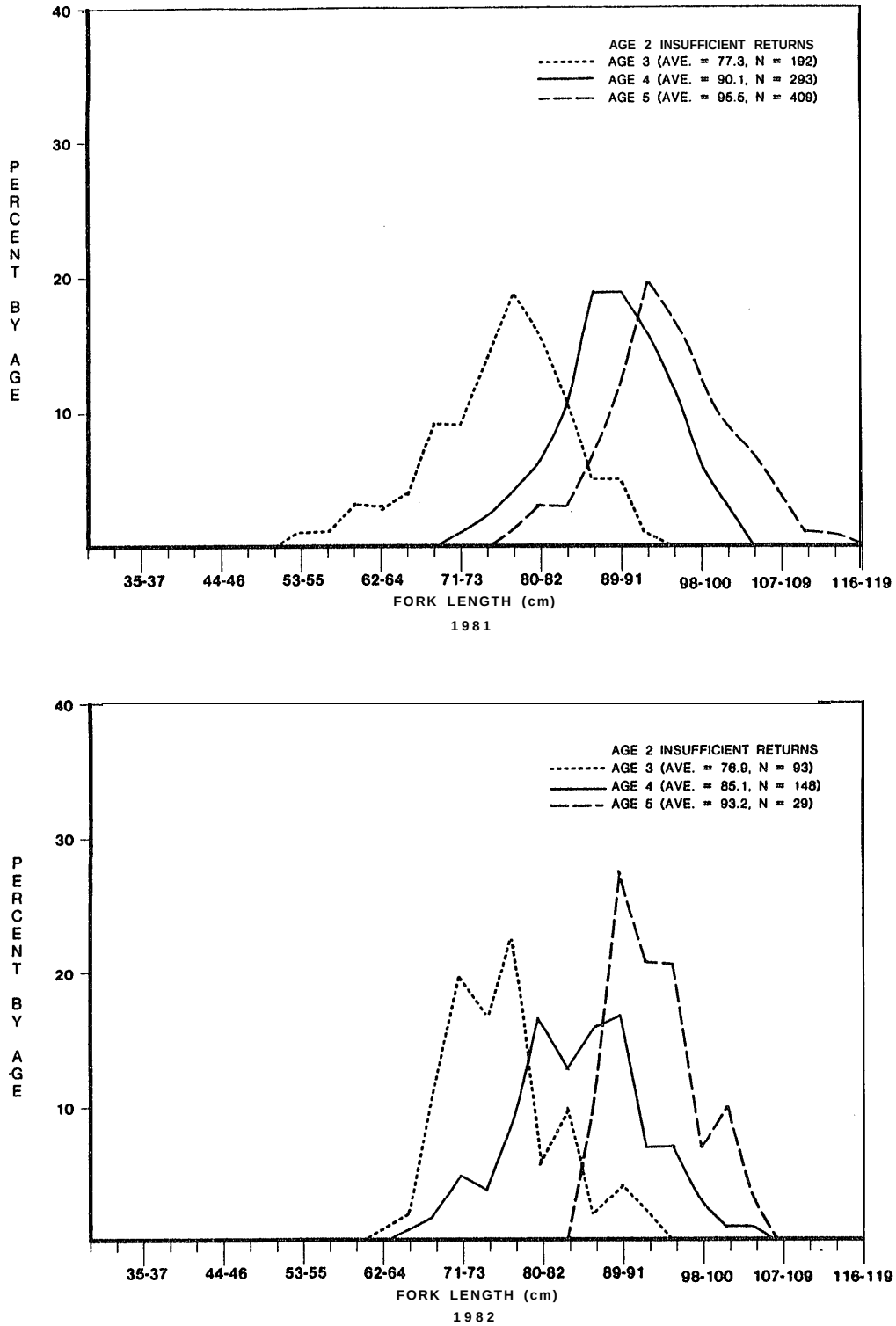


Figure 3. Length frequency of LRH fall chinook returning to the Kalama River, 1981-1982.

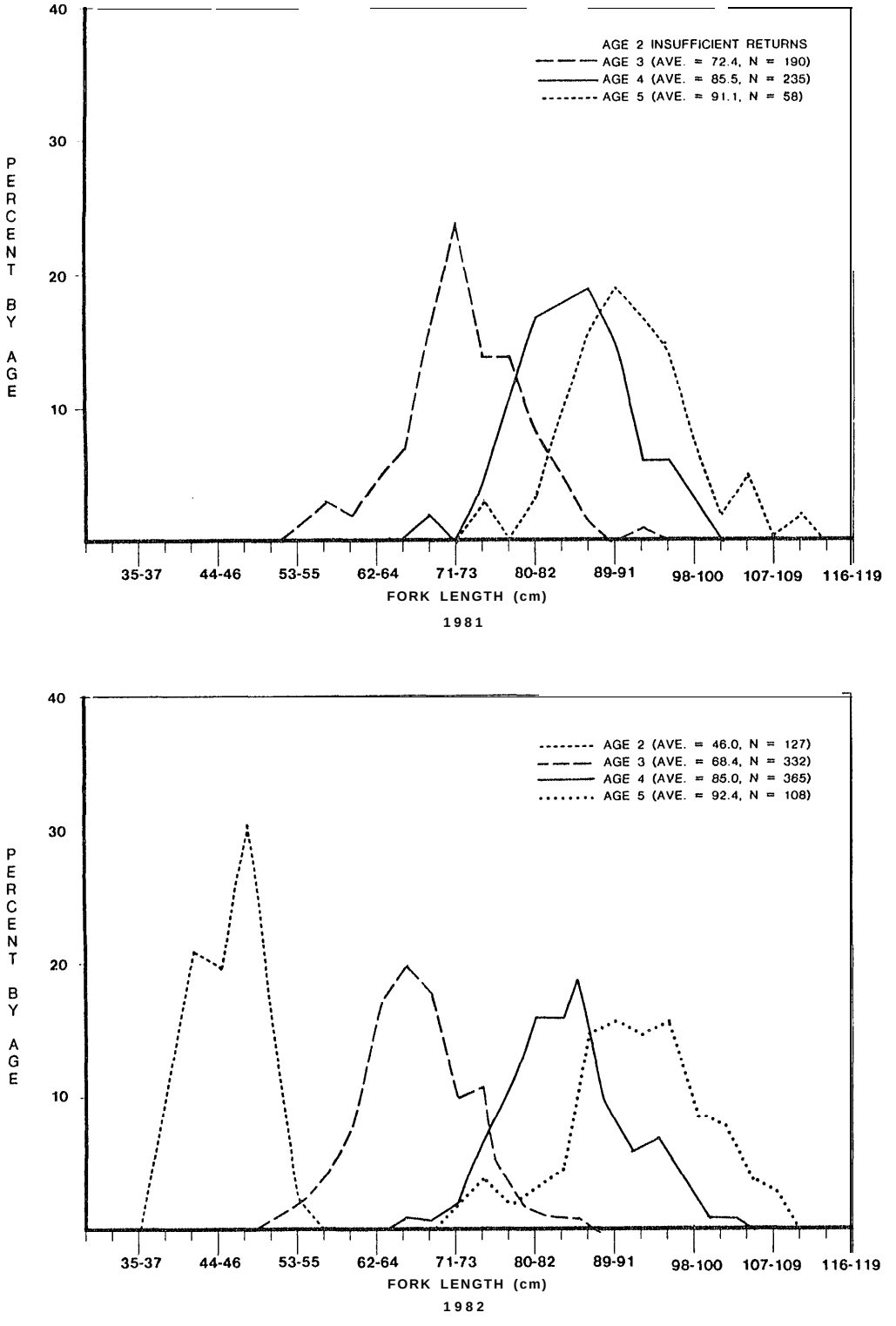


Figure 4. Length Frequency of LRH fall chinook at Cowlitz Hatchery, 1981-1982.

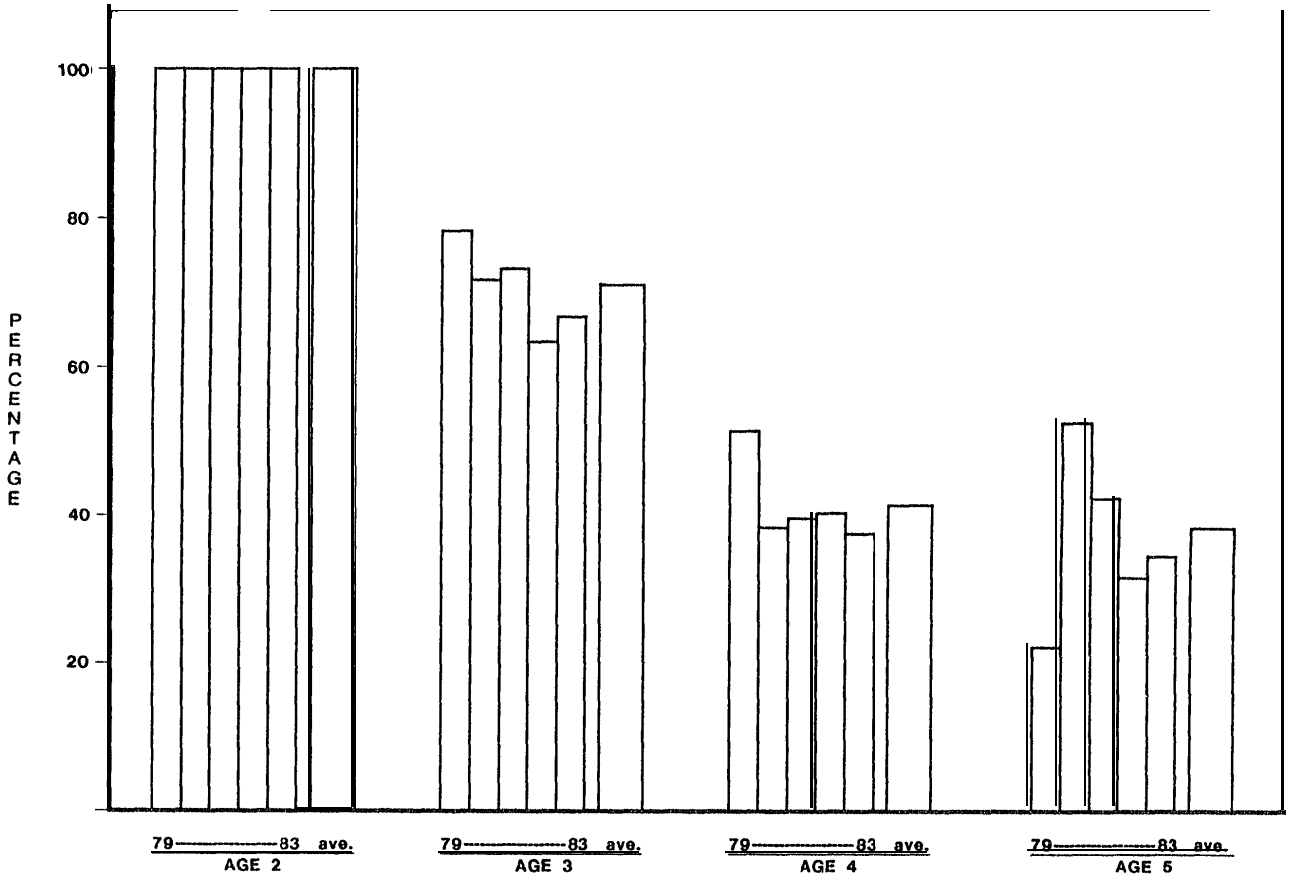


Figure 5 Percent male LRH fall chinook at Elkomin, Washougal and Bonneville hatcheries, 1979-1983.

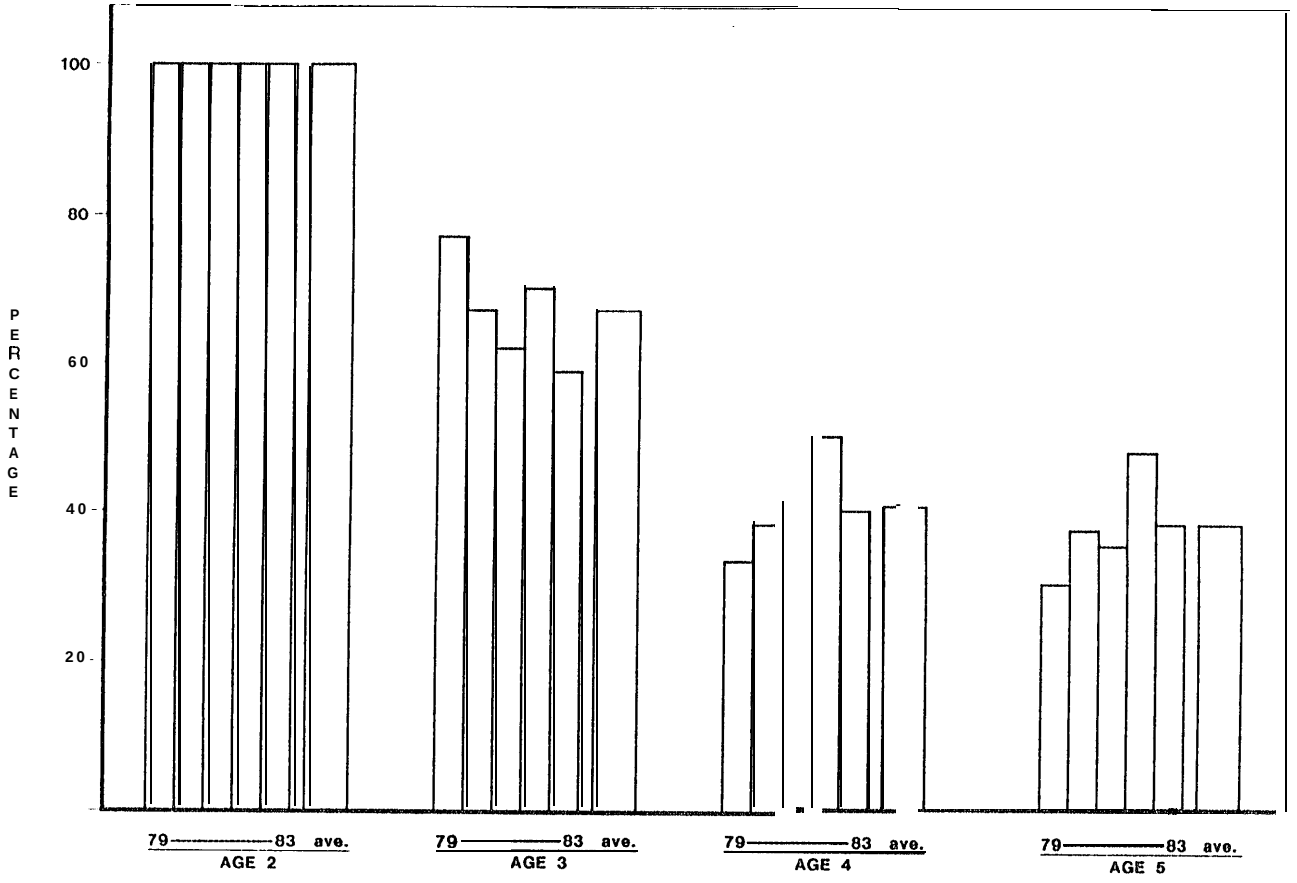


Figure 6. Percent male LRH fall chinook at Kalama Falls Hatchery, 1979-1983.

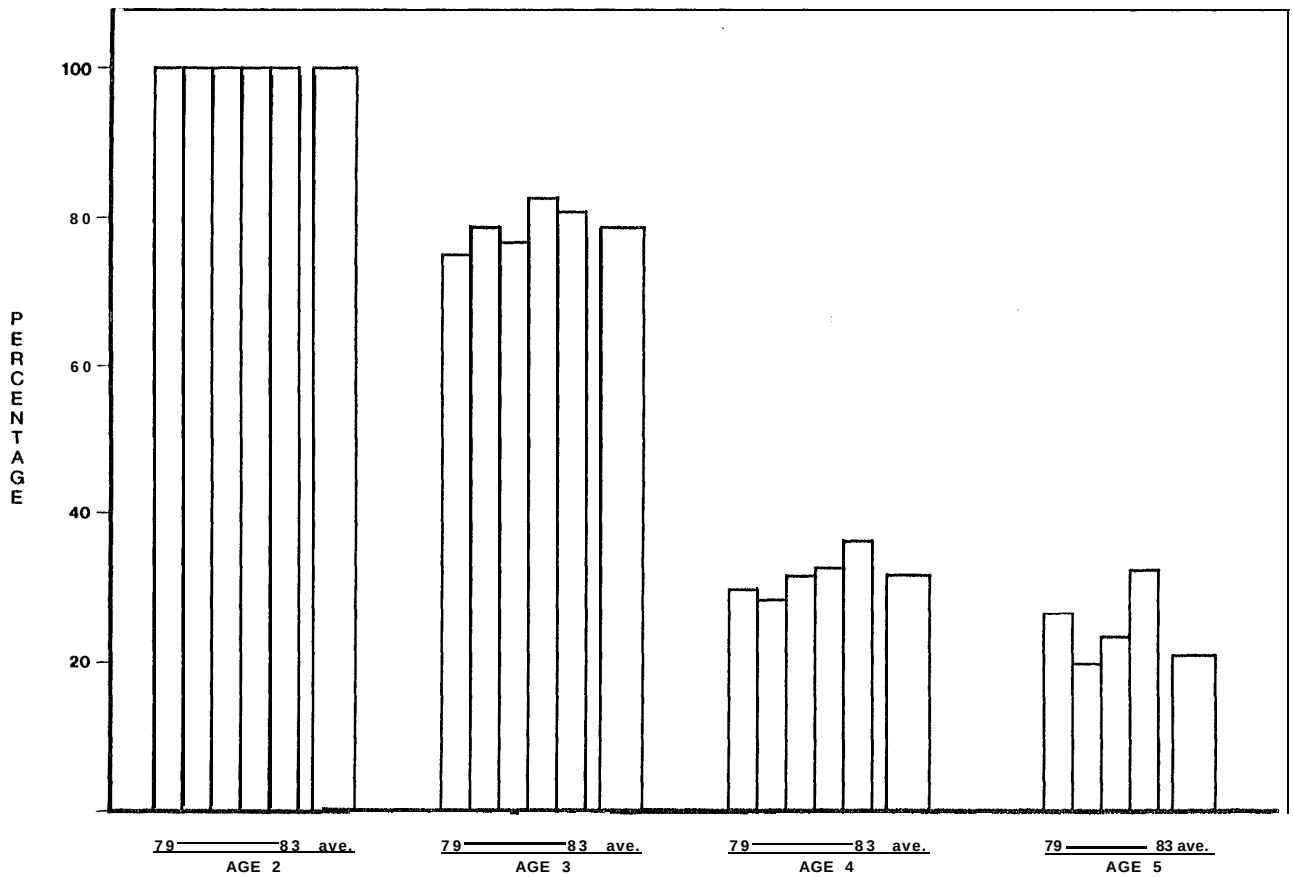


Figure 7. Percent male LRH fall chinook at Cowlitz Hatchery, 1979-1983.

JUVENILE LIFE HISTORY

Time of emergence

Emergence times of naturally produced fry were estimated to be early February on the Klaskanine River, early April on the Elokomin River, and early May for the Toutle and Kalama rivers, depending on time of egg deposition and water temperatures (Reimers and Loeffel 1967).

At Bonneville Hatchery, eggs incubate for 53 days to reach eyed-egg stage and another 53 days to "emergence" in 49°F well water. Fry are transferred to ponds from January to March.

Time, age, and size at migration

Sub-yearling smolts ("fingerlings") are released primarily in May and June at approximately 60-100 fish/pound with minor releases in the summer and early fall. Oregon facilities release small numbers of yearling LRH fall chinook also.

Median time of tag recovery in the Columbia estuary for Bonneville Hatchery fingerlings occurred 1-2 weeks after the May release in 1977-1980 (Table 11). Yearling and fall releases from Bonneville Hatchery were present in the estuary in March and April.

Some tagged hatchery releases from Kalama Falls and Cowlitz were recovered in the Columbia estuary as sub-yearlings in October and November (Table 12), much later than the Bonneville Hatchery fingerlings. Marked hatchery juveniles have been seined in the Cowlitz River in late summer (G. Norman, WDF, personal communication).

Although LRH fall chinook generally migrate downstream to the ocean as sub yearlings in the summer and fall, scale age samples from the escapement areas and fall gill net fisheries have indicated that a small proportion of LRH fall chinook enter the ocean as yearlings. These LRH fish were probably the result of hatchery releases in the fall and following spring or from extended natural rearing in the larger tributaries such as the Kalama, Washougal and Toutle (Reimers and Loeffel 1967).

Survival rate

A smolt to adult survival rate dor all LRH releases combined is not available.

For three 1976 brood tag groups from Kalama Falls, Toutle and WashougaI hatcheries representing typical Washington production releases (codes: 63-16-39, 63-16-40, and 63-16-41), survival rate to all catch and escapement ranged from 0.8-1.6 percent.

Survival rate based on adult returns to Bonneville Hatchery of 1977 and 1978 brood year chinook ranged from 0.01-0.74 percent (Table 13).

Table 11. Juvenile outmigrant timing of coded wire tagged LRH fall chinook released from Bonneville Hatchery and recovered at Jones Beach (River Mile 47) in the Columbia River estuary (Dawley et al. 1982).

Origin	Purpose	Size at release (fish/lb.)	Release Year	Release Date	Percent of release recaptured	Year	Median fish	First fish	Last fish	Movement rate (RM/day)
Bonneville Hatchery										
	Sub-yearling releases									
	Hatchery evaluation	91	1977	5 May	0.436	1977	20 May	11 Hay	27 June	6
	Hatchery evaluation	78	1979	1 May	0.148	1979	9 May	6 May	5 June	12
	Columbia River fall chinook evaluation	80	1979	21 May	0.082	1979	31 Way	26 May	7 June	10
	Stock evaluation	75	1980	22-28 May	0.075	1980	2 June	17 May	2 July	8
	Fall release									
	Stock evaluation	12	1978	30 Oct.	0.032	1979	6 Apr.	21 Mar.	1 May	<1
	Stock evaluation	14	1978	30 Oct.	0.033	1979	27 Mar.	26 Mar.	18 Apr.	<1
	Stock evaluation	9	1979	20 Nov.	0.031	1980	10 Mar.	10 Mar.	31 War.	<1
	Yearling release									
	Stock evaluation	7	1979	13 Mr.	0.356	1979	11 Apr.	21 Mar.	30 Apr.	3
	Stock evaluation	6	1900	13 Mar.	0.162	1980	7 Apr.	18 Mar.	28 Apr.	4

Table 12. Juvenile outmigrant timing of coded wire tagged LRH fall chinook released from Kalama Falls and Cowlitz hatcheries and recovered at Jones Beach (River Mile 47) in the Columbia River estuary (Dawley et al. 1982).

Origin	Purpose	Size at release (fish/lb.)	Release Year	Release Date	Percent of release recaptured	Year	Median fish	First fish	Last fish	Movement rate (RM/day)
Kalama Falls Hatchery										
	Sub-yearling releases									
	Stock evaluation	76	1977	20 May	0.665	1977	26 July	28 June-	27 Sept.	1
					0.002	1978	23 Mar.	22 Mar.-	14 Apr.	<0.5
	Production evaluation	108	1978	12 July	0.600	1978	3 Aug.	14 July-	16 Nov.	2
					0.004	1979	6 Apr.		6 Apr.	<0.5
	5 percent evaluation	119	1981	22-28 May	0.102	1981	31 May	22 May -	21 July	4
Cowlitz Hatchery										
	Sub-yearling release									
	Production evaluation	133	1978	19 June	0.316	1978	5 July	23 June-	18 Oct.	4
	5 percent evaluation	86	1981	27 June	0.473	1981	5 July	29 June-	8 Sept.	8

Table 13. Percentage return to Bonneville Hatchery of Ad+CWT-marked LRH fall chinook, 1977-80 broods (Hansen 1983)

Brood year	Number released	Size (Fish/lb)	Release date	Water supply	Percentage return at each age[a]				Total return		Age 3-5 return	
					2	3	4	5	No.	%	No.	%
1977	50,948	12.1	10/30/78	Tanner Cr.	0.000(0)	0.024(12)	0.202(103)	0.000(0)	115	0.226	115	0.226
1977	37,800	13.8	10/30/78	Well	0.000(0)	0.010(4)	0.164(62)	0.003(l)	67	0.177	67	0.177
1977	47,856	7.0	3/13/79	Well	0.244(117)	0.054(26)	0.435(208)	0.005(2)	353	0.738	236	0.494
1978	96,575	78.2	5/l/79	Well	0.004(4)	0.144(139)	0.087(84)	0.001(1)[b]	228	0.236	224	0.232
1978	95,576	47.4	5/29/79	Well	0.001(l)	0.013(13)	0.016(15)	0.0.60(2)[b]	29	0.030	28	0.029
1978	48,652	9.4	11/20/79	Well	0.000(0)	0.006(3)	0.012(6)	0.000(0)[b]	9	0.018	9	0.018
1978	48,112	6.0	3/13/80	Well	0.127(61)	0.033(16)	0.145(70)	0.013(6)[b]	153	0.318	92	0.191
1979	47,799	9.1	11/11/80	Tanner Cr.	0.002(1)	0.024(12)	0.052(25)[b]	-- (-)	39	0.080	37	0.076
1980	129,961	73.0	4/24/81	Well	0.009(12)	0.060(78)[b]	-- (-)	-- (-)	90	0.069	78	0.060
1980	102,827	44.6	5/28/81	Well	0.015(15)	0.067(69)[b]	-- (-)	-- (-)	82	0.084	69	0.067
1980	51,454	11.1	11/9/81	Well	0.004(2)	0.008(4)[b]	-- (-)	-- (-)	6	0.008	4	0.008
1980	50,072	9.6	11/9/81	Tanner Cr.	0.084(42)	0.006(3)[b]	-- (-)	-- (-)	45	0.090	3	0.006
1980	51,881	6.9	3/17/82	Well	0.195(101)	0.039(20)[b]	-- (-)	-- (-)	121	0.234	20	0.039

a Actual return is in parentheses.

b In fall 1983 a total of 6,319 female and 6,497 male adult tule stock chinook volitionally returned to Bonneville Hatchery. An additional 263 females and 5 males which returned to Cascade Hatchery were trucked to Bonneville Hatchery for maturation and spawning. This table has been adjusted accordingly and tagged returns are only for those adults returning to Bonneville Hatchery.

DISEASE HISTORY

Common diseases of LRH fall chinook in Oregon and Washington hatcheries are bacterial kidney disease, furunculosis, enteric redmouth, cold-water disease, bacterial gill disease, and ectoparasites (Table 14, 15, and 16).

The viral disease infectious hematopoietic necrosis (IHN) has not occurred in LRH fall chinook but has been detected in other stocks at Cowlitz Hatchery and Bonneville Hatchery.

PRIORITY INFORMATION NEEDS

Annually a portion of the hatchery produced adults spawn naturally in many of the lower Columbia tributaries. This number can be substantial in some instances. However, the juvenile populations that result from natural spawning of hatchery stock fall chinook is largely unknown. A priority need is to determine the capacity of LRH stock fall chinook to reproduce effectively in the natural environment and contribute to the overall Columbia fall chinook production.

Table 14. Disease history of Tule fall chinook in Oregon hatcheries.

Date/Year Release	Diseases Certifiable						Diseases Noncertifiable						
				Virus:			Bacterial						
	BKD	Furunc.	E. Redmouth	IHN, IPN VEN	Myxo-sporidian	Misc. Cert. Pathology	CWD	Columnaris	Gill Disease	Ectoparasites *Costia*, etc.	Gill Amoeba	ICH	Misc. Bact.
1958										+			+
1959									+	+			
1970							+			+			+
1971		+	+										
1972		+					+		+	+			
1973							+			+			+
1974			+						+				
1975	+	+	+				+		+	+		+	
1976	+						+			+			
1977	+						+		+	+			
1978							+		+	+			
1979	+						+			+			+
1980	+		+				+		+	+		+	
1981													

[a] Big Creek, Bonneville Cascade, Klaskanine, Oxbow, and Sandy.

Table 15. Diseases encountered by Kalama stock Tule fall chinook at Lower Kalama and Kalama Falls hatcheries, 1977-1983 (WDF 1984).

Type	Disease	Infected group
Bacterial:	LOW temperature disease	1978-1980 brood juveniles
	Bacterial kidney disease	1977 brood juveniles
	Bacterial hemorrhagic septicemia	1978, 1980, 1981 brood juveniles
	Bacterial gill disease	1978, 1981 brood juveniles
	Furunculosis	1979 adults
Parasitic:	Costia	1978-1982 brood juveniles
	Epistylis	1980 brood juveniles
	Fungus-stomach	1978 brood juveniles
	Fungus-gills	1978 brood juveniles
Viral :	None	
Other:	Coagulated yolk	1978 brood juveniles

Table 16. Diseases encountered by Cowlitz stock fall chinook at Cowlitz Hatchery 1977-1983 (WDF 1984).

Type	Disease	Infected group
Bacterial:	Furunculosis	1979 brood juveniles
	Bacterial kidney disease	1979 brood juveniles
	Bacterial hemorrhagic septicemia	1980, 1981 brood juveniles
Parasitic:	Costia	1978-1981 brood juveniles
	Ceratomyxa	1979 brood juveniles
Viral :	None	
Other:	Coagulated yolk	1978, 1979 brood eggs

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Willamette River Fall Chinook

PRODUCTION

The Willamette River currently supports wild and hatchery runs of Tule fall chinook. Hatchery fish comprised between 5% and 84% of the adult returns during the 1979-83 run years (Table 1). Between 4 and 7 million subyearlings have been released from 1978 to 1984 (Table 2).

Table 1. Run composition of fall chinook in the upper Willamette River, 1979-83 (Buckman and Warren 1983).

Run year	Age	Wild fish	Hatchery fish
1979	3 only	3,515 (49%)	3,651 (51%)
1980	3 only	3,464 (95%)	171 (5%)
1981	All ages	8,223 (46%)	9,705 (54%)
1982	All ages	7,356 (27%)	19,889 (73%)
1983	All ages	2,215 (16%)	11,626 (84%)

Table 2. Fall chinook juveniles released into the Willaaette River system, 1967-84 broods (modified from Buckman and Warren 1983).

Brood year	Numbers released (millions)	
	Tule stock	Cowlitz stock
1967	1.741	0
1968	1.341	0
1969	10.710	0
1970	10.566	0
1971	11.037	2.315
1972	11.646	0.496
1973	11.896	2.497
1974	5.544	0
1975	6.007	2.303
1976	10.889	0
1977	0.301	0.151
1978	4.692	0
1979	6.349	0
1980	5.903	0
1981	6.751	0
1982	6.911	0
1983	5.171	0
1984	4.534	0

GEOGRAPHIC LOCATION

Streams

Tributaries and the mainstem areas of the Willamette River Basin (Figure 1)

Hatcheries

The eggs to support the Willamette fall chinook program are supplied by Bonneville Hatchery. Aumsville-Stayton ponds serve as the rearing site for all Tule fall chinook released into the upper Willamette River basin. Unfed fry are received from Bonneville Hatchery and reared at Aumsville Pond until mid-February. The fry are shipped to Stayton Pond for final rearing.

ORIGIN

The fall chinook run in the upper Willamette River (above Willamette Falls) was established in the late 1960s from releases of Tule stock following improvements in water quality and passage facilities at Willamette Falls. Experimental releases of Cowlitz stock fall chinook were made from 1971-77 but were discontinued. The naturally spawning adults are primarily hatchery and wild returns of Tule stock.

ADULT LIFE HISTORY

Run size catch and escapement

Run size at Willamette Falls averaged 21,257 adults and 674 jacks during the 1974-83 period (Table 3).

British Columbia and Washington fisheries harvest the majority of Willanette fall chinook (Table 4). These fish also contribute to the Columbia River gillnet fishery. In 1982 9,000 Willamette-bound fall chinook (12% of the total catch) were caught during the Columbia River gillnet season. In addition, sport anglers harvested an average of 736 fall chinook annually in the Willamette River and its tributaries (Table 5).

The adults passing Willamette Falls minus the sport catch above the falls represent the potential spawning escapement. Redd counts in 1981, 1982, and 1983 were 4.5, 11.5, and 5.4 redds per km respectively, for the total of 582 km surveyed (ODFW 1985). The number of redds observed during 1969-78 are listed by river in Table 6.

Time of migration

Fall chinook pass Willamette Falls from late August through late September (Figure 2). The run peaks in the first half of September.

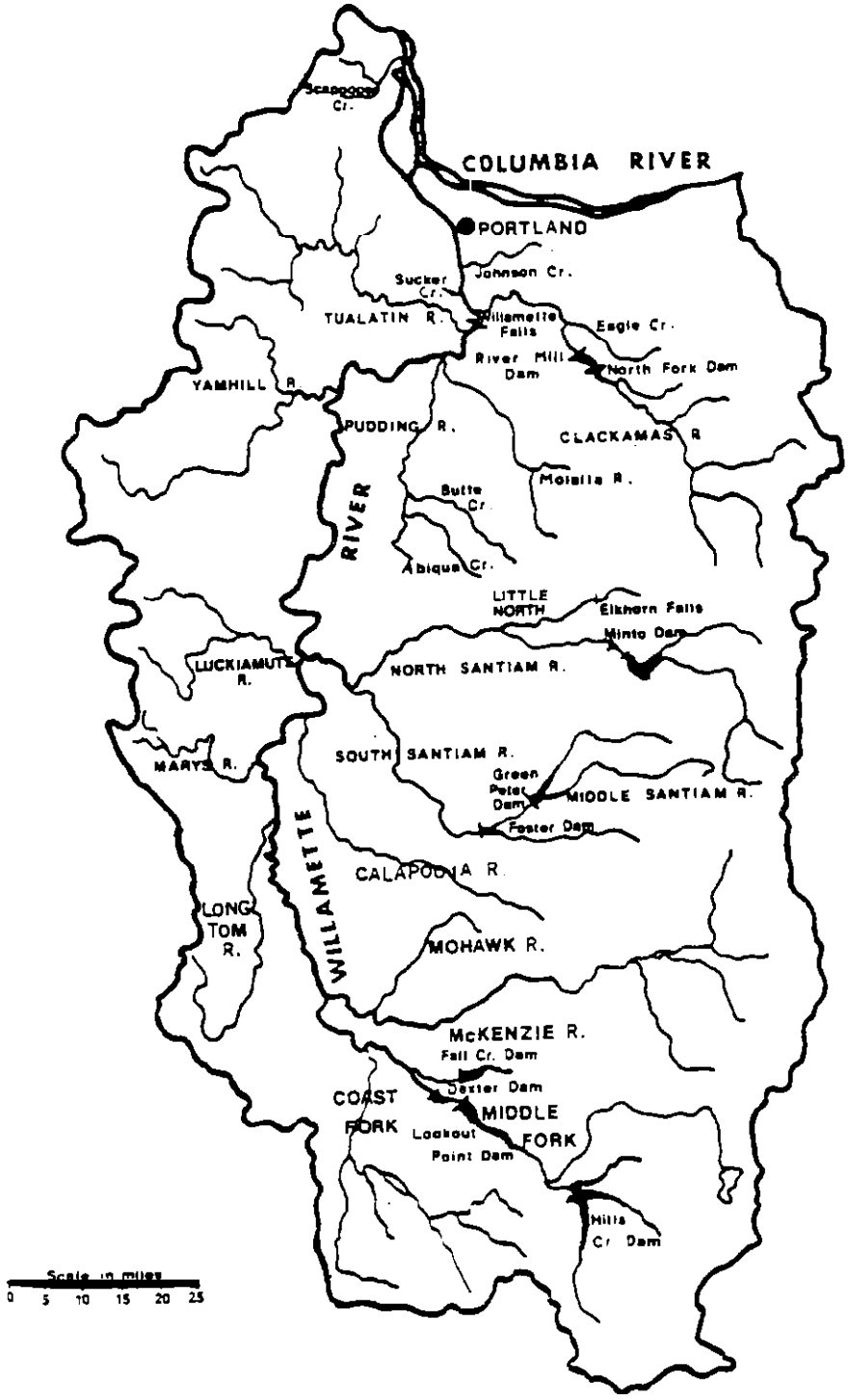


Figure 1. Willamette River system.

Table 3. Escapement of fall chinook adults and jacks over Willamette Falls, 1955-60 and 1965-84 (Bennett 1985).

Year	Adults	Jacks	Total[a]
1955	75	0	75
1956	6	15	21
1957	6	47	53
1958	96	29	125
1959	14	2	16
1960	5	4	9
1965	77	2	79
1966	771	255	1,026
1967	1,901	111	2,012
1968	4,043	203	4,246
1969	6,817	140	6,957
1970	7,457	101	7,558
1971	4,880	210	5,090
1972	11,614	212	11,826
1973	21,861	376	22,237
1974	33,924	265	34,109
1975	32,077	895	33,772
1976	29,269	931	30,200
1977	25,742	382	26,124
1970	17,437	465	17,902
1979	9,905	436	10,341
1980	7,760	625	8,385
1981	16,690	1,085	17,775[b]
1982	25,760	1,123	26,883[c]
1983	13,205	528	13,733[d]
1984	20,060	1,084	21,144[e]
10-Year avg. 1974-03	21,257	674	21,930

a The passage totals are not corrected beyond the B-hour count period for the years 1955-60 and 1965-66. However, they do include the calculated passage for days of partial counting or no counting and for 10-minute counter rest periods in the years 1955 and 1958. No corrections were applied to the small numbers counted in 1956 and 1975, and only counter rest period corrections were applied in 1959 and 1960. Since 1967, counts were fully corrected for total 24-hour passage.

b Does not include 143 adipose-marked adults, three adipose-marked jacks, and one unmarked mortality taken from the cul-de-sac leg fish trap for research purposes.

c Does not include 338 adipose-marked adults, two adiposed-marked jacks, and 12 unmarked mortalities taken from the cul-de-sac leg fish trap for research purposes.

d Does not include 105 adipose-marked adults, three adipose-marked jacks, and one unmarked mortalities taken from the cul-de-sac leg fish trap for research purposes.

Table 4. Ocean catch of coded-wire tagged Willamette fall chinook (1976-70 brood years). Catch subtotals by area, all ages combined.

		Brood years					
		1970		1971		1976	
Area	Fishery	No.	%	No.	%	No.	%
Alaska	Comm..	0	0.00	4	<1	2	1
B.C.	Comm.	905	50.47	205	31	114	39
	Sport	12	0.67	0	0	1	<1
	Combined	917	51.14	205	31	115	39
Wash.-Puget S.	Comm.	23	1.20	14	2	0	0
	Sport	90	5.47	40	5	10	6
	Combined	121	6.75	62	7	10	6
Wash.-Ocean	Comm.	300	21.19	292	32	04	20
	Sport	110	6.50	114	12	35	12
	Combined	490	27.71	406	44	119	40
Columbia R.	Comm..	130	7.25	53	6	32	11
	Sport	0	0.00	0	0	0	0
	Combined	130	1.25	53	6	32	11
Oregon-North	Comm..	33	1.04	62	7	0	0
	Sport	13	0.73	5	1	0	0
	Combined	46	2.57	67	7	0	0
Oregon-Central	Comm..	66	3.60	24	3	0	0
	Sport	0	0.00	4	<1	0	0
	Combined	66	3.60	20	3	0	0
Oregon-South	Comm..	7	0.39	9	1	2	1
	Sport	2	0.11	0	0	0	0
	Combined	9	0.50	9	1	2	1
California	Total Combined	6	0.33	3	<1	7	2
		1,793		917		295	

Tag codes
1976: 09-16-06 through 09-16-13
1977: 01-17-06 through 07-17-10, 07-11-13,07-16-26, 07-19-17, 07-19-18
1970: 07-18-42, 07-18-44, 07-10-45

Table 5. Sport catch of Willamette River fall chinook by run year, 1971-80[a] (Berry 1901).

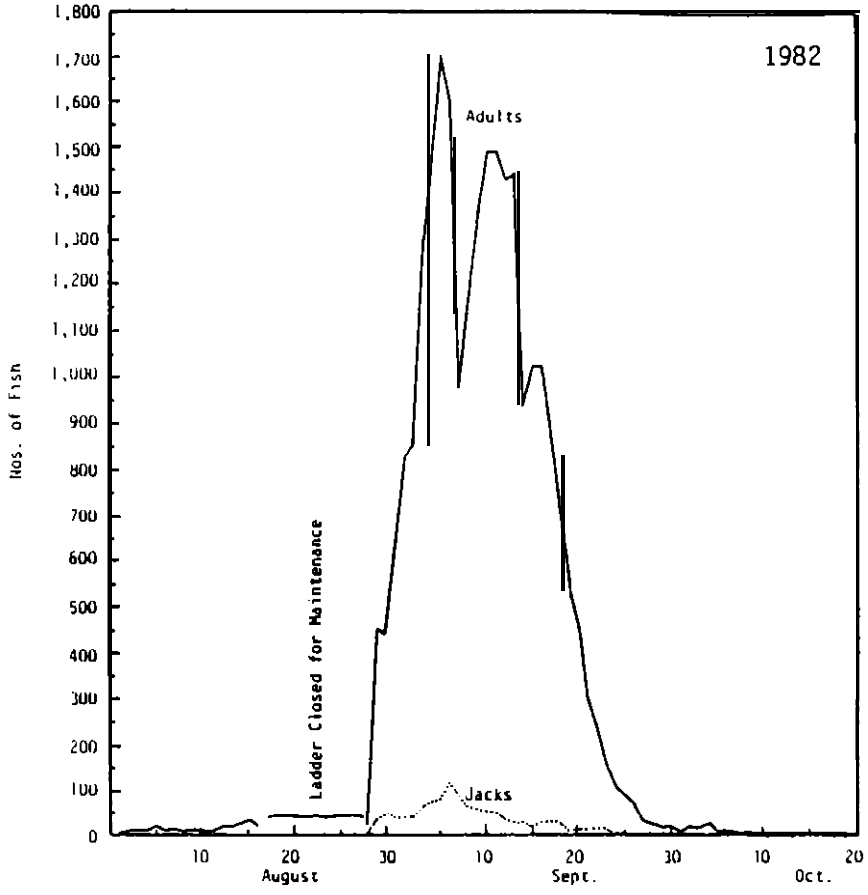
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Abiqua Cr.	--	--	--	--	--	--	0	0	3	0
Beaver Cr.	--	--	--	--	--	--	0	0	3	0
Butte Cr.	--	--	--	--	--	--	--	6	3	0
Clackamas R.	497	234	53	200	54	153	8	57	114	194
Clear Cr.	--	--	--	--	--	--	--	3	0	0
Collowash R.	--	--	--	--	--	--	3	3	0	0
Deep Cr.	--	--	--	--	--	--	--	3	0	0
Eagle Cr.	--	--	247	149	0	0	0	53	171	114
Crabtree Cr.	--	--	--	--	--	--	6	6	0	0
Fall Cr.	--	--	--	--	--	--	--	--	--	15
Marys R.	--	--	--	--	--	--	--	6	0	3
Santiam R.	0	53	353	30	3,463	320	440	88	111	89
N. Santiam R.	--	--	--	--	198	--	151	0	42	24
S. Santiam R.	--	--	--	--	107	217	280	242	144	37
Scapoose Cr.	10	0	7	0	0	0	5	12	0	12
Tualatin R.	--	--	--	--	--	--	0	0	3	0
Coast Fk. Willamette	300	356	42	98	434	177	64	101	3	0
Willamette (Upper)	--	--	--	--	--	--	0	0	24	3
Willamette (Lower)	--	--	--	--	--	--	--	32	21	18
Total	797	643	702	477	1,156	867	957	612	639	509

a Estimated from punch-card returns adjusted for non-response bias. Prior to 1977 the catch in tributaries was included in the mainstem catch.

Table 6. Number of Tule fall chinook redds observed in the Villamette River system, 1969-78[a] (Hansen and Williams 1979).

Stream	Km[b] surveyed	1969	1970	1971	1972	1973	1974	1975	1976	1977[e]	1978
Willamette River	220.4	26	101	27	391	1,326	1,041	1,134	475	505	1,423
M.F. Willamette	27.0	7	30	27	24	74	62	80	21	39	13
C.F. Willamette	47.0	8	92	8	30	17	11	10	1	1	2
Row River	12.2	1	0	3	0	20	5	3	2	3	2
McKenzie River	33.8	5	64	71	138	361	216	200	182	304	230
Calapooia River	13.2	1	5	1	0	22	1	0	0	–	–
Santiam River	18.8	225	229	224	293	781	2,175	1,393	1,260	847	644
North Santiam	43.0	165	100	36	110	685	720	1,491	510	451	264
South Santiam	60.7	382	559	348	269	780	2,570	1,054	1,881	2,310	2,102
Molalla River	42.6	162	207		614	1,171	778	340	655	767	485
Mill Creek (Salem)	35.4	-[c]	961	600	1,354	1,992	1,990	2,819	1,656	1,410[d]	1,261[g]
Total above Willamette Palls	554.9	982	2,348	1,382	3,223	7,282	9,597	8,524	6,642	6,439[f]	6,581[h]
Clackamas River	36.1	89	59	89	110	426	554	436	274	180	-[i]

a All surveys were conducted by aircraft except Mill Creek survey, which was made from boats. Surveys were made from September 23-October 10.
b Km shown extend from the mouth upstream the specified distance except for the main-stem Willamette River which is from Newberg upstream to the junction of the Coast and Middle forks of the Willamette.
c Survey not made; no fish were due to return until 1910.
d Includes 265 redds in 4.S km of Shelton Ditch.
e Includes counts from 28 km not surveyed in 1969-76.
f Includes 47 redds in Thomas Creek and 55 redds in Crabtree Creek.
g Includes 230 redds in 4.S km of Shelton Ditch.
h Includes 5 redds in Thomas Creek and 150 redds in Crabtree Creek.
i Not surveyed because of turbid water resulting from drawdown of North Fork Reservoir.



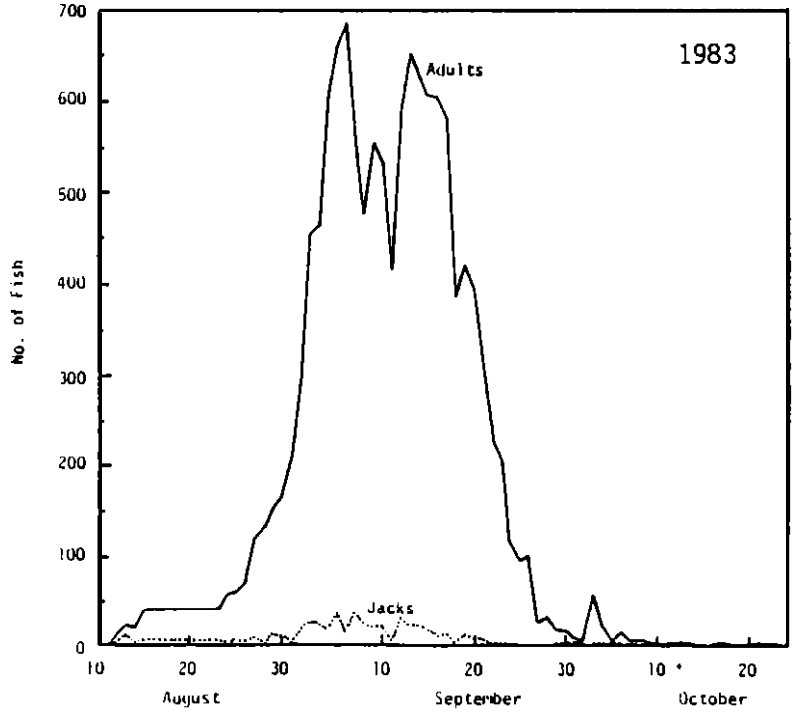


Figure 2. Daily Counts of fall chinook passing Willamette Falls, 1902 and 1903 (Bennett 1903; 1904).

Spawning Period

Most Tule fall chinook spawn in the Willamette system by the end of September.

Spawning areas

The principal spawning areas for fall chinook in recent years in the Willamette Basin (in descending order of redd densities) are as follows (Smith et al. 1982):

Mainstem Santiam River
South Santiam River
Mainstem Willamette River (mouth of McKenzie River downstream)
Clackamas River
Mill Creek (Salem)
Molalla River
McKenzie River (below Hendricks Bridge)
North Santiam River (below Stayton)

Other spawning areas are listed in Table 6.

Age composition

The ocean and Columbia River fisheries harvest primarily 3-year old fish (Table 7). The dominant age-class of Tule fall chinook returning to the Willamette River has fluctuated between 3- and 4-year old fish (Table 8).

Table 7. Age composition of coded-wire tagged Willamette fall chinook harvested in ocean and Columbia River fisheries.

		Age composition					
Brood		2	3	4	5	6	Total
1976	No.	26	209	50	2	0	295
	%	9	71	20	1	0	
1977	No.	54	643	212	0	N/A	917
	%	6	70	23	1		
1978	No.	97	1,351	345	N/A	N/A	1,793
	%	5	75	19			

Size

The lengths of Willamette Tule fall chinook returning in 1982 are listed by age class in Table 9. Males were longer than females of the same age-class.

Table 8. Age composition of Tule fall chinook determined from scales recovered from spent carcasses, Willamette River system, 1970-81[a] (Hansen and Williams 1979; Smith et al. 1902).

Year		Age class 2	3	4	5	Total
1970	No.	2	60	20	0	90
	%	2.2	66.7	31.1	0	100
1911	No.	4	47	92	0	143
	%	2.0	32.9	64.3	0	100
1972	No.	13	504	61	2	500
	%	2.2	06.9	0.5	0.4	100
1973	No.	15	713	305	0	1,121
	%	1.3	63.7	34.3	0.7	100
1914	No.	11	757	011	21	1,600
	%	0.7	47.3	50.1	1.3	100
1975	No.	24	255	1,294	18	1,591
	%	1.5	16.0	01.4	1.1	100
1976	No.	29	1,030	192	54	1,313
	%	2.2	79.1	14.6	4.1	100
1977	No.	2	405	505	0	1,000
	%	0.2	40.5	50.5	0.0	100
1978	No.	6	134	461	0	609
	%	1.0	22.0	75.7	1.3	100
1979	No.	2	106	54	5	247
	%	1.0	75.0	22.0	2.0	100
1900	No.	11	123	140	3	205
	%	4.0	43.0	52.0	<1.0	100
1901	No.	673	654	80	1	790
	%	0.0	02.0	10.0	<1.0	100

a Includes Clackamas River, except in 1970 when turbid water resulting from drawdown of North Fork Reservoir precluded surveying.

Table 9. Age, length, and number of untagged male and female tule stock fall chinook found on spawning ground surveys in the Willamette River and tributaries above Willamette Falls, 1982[a,b,c] (Hansen et al. 1902).

	Age				Total
Female					
Mean length (cm)		79.4	86.5		
95% C.I.		±0.7	±0.9	-	
Fork length range (cm)		63.0-96.0	70.0-102.0	-	
Percentage of return		25.0	19.8	0	44.8
Number		6,129	5,312	0	12,041
Male					
Mean length (cm)	60.6	84.2	94.6	99.7	
95% C.I.	±1.8	±0.8	±1.3	±6.9	
Fork length range (cm)	54.0-71.0	57.0-97.0	79.0-114.0	96.0-106.0	
Percentage of return	3.7	35.4	15.6	0.5	55.2
Number	984	9,530	4,183	145	14,852

a Based on a random sample of 739 (2.8%) fish.
b Dates of first and last return: 9/24/82-10/15/82.
c Willamette Falls count = 25,760 adults and 1,123 jacks.

Sex Ratio

The percentage of naturally spawning females during 1970-78 averaged 50% (Tables 10-11).

Table 10. Sex ratios of Tule fall chinook carcasses, Willamette River system, 1970-78 (Hansen and Williams 1979).

Year	Males No.	Males %	Females No.	Females %	Total
1970	300	46.3	340	53.7	648
1971	164	43.2	216	56.8	380
1972	481	58.4	342	41.6	823
1973[a]	1,930	61.0	1,234	39.0	3,164
1974	760	47.4	042	52.6	1,602
1975	825	50.1	821	49.9	1,646
1976	867	63.9	409	36.1	1,356
1977	364	36.0	648	64.0	1,012
1978[b]	302	47.0	343	53.0	645

a Sex ratios taken on Mill Creek tag and recovery carcass survey.
b Clackamas River excluded; turbid water resulting from drawdown of North Fork Reservoir precluded surveying.

Table 11. Sex ratios of fall chinook from the Willamette River and tributaries as determined from carcasses recovered September-October, 1978a (Hansen and Williams 1979).

Stream[a]	Males No.	Males %	Females No.	Females %
Willamette River	5	45	6	55
Molalla River	18	36	32	64
Santiam River	30	40	32	52
South Santiam River	83	71	34	29
North Santiam River	26	41	38	59
McKenzie River	24	39	37	61
Mill Creek (Salem)	116	41	164	59
Total (above falls)	302		343	
Mean %(95% CI)		47 (±4)		53 (±4)

a Clackamas River not surveyed because of turbid water resulting from drawdown of North Fork Reservoir.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Wild fry begin emerging in late December. The average time of emergence in the Willamette system is the second week of January (B. Day, ODFW, personal communication).

Time, age, and size at migration

Fall chinook are released as subyearlings from Stayton Pond from March to June (Table 12). The migration of wild juveniles peaks the first week of June at Willamette Falls, later than hatchery juveniles which pass the falls 5-7 days after release (B. Day, ODFW, personal communication). Smolts migrate to the Columbia River estuary as subyearlings (Bottom et al. 1984) and enter the ocean as subyearlings (Table 9).

Table 12. Summary of subyearling fall chinook releases from Stayton Pond into the Willamette River, 1978-82 broods (Smith et al. 1983).

Brood year	Release period	Size (gr)	Millions released	Percentage marked Ad-CWT
1978	05/07-29/79	6.8	4.7	6.3
1979	03/28-06/21/80	5.2	6.3	4.5
1980	04/28-06/15/81	6.1	5.9	4.3
1981	04/03-05/21/82	5.2	6.8	4.0
1982	04/25-05/19/83	5.0	6.9	2.4

Survival rate

Returns of 1978 and 1979 brood fall chinook to the Willanette River were 2 to 125 times higher than returns to lower Columbia River hatcheries in Oregon (Table 13). The fishery contribution of Willamette fall chinook was also 1.7 to 6.6 times higher than the contribution of lower Columbia River hatchery fall chinook (Table 14).

Total fry-to-adult survival (catch plus escapement) was 0.1% and 0.94% for the 1976 and 1978 brood, respectively (R. Williams, ODFW, personal communication). The estimate for the 1978 brood does not include 5- and 6-year old adults.

DISEASE HISTORY

There are no major disease problems at Aumsville or Stayton Ponds (B. Day, ODFW, personal communication).

Table 13. Escapement of fall chinook from four selected Columbia River rearing stations, 1980-82 (Smith et al. 1983).

Origin[a]	Brood year	Adjusted[b] escapement	Comparison ratio[c]
Stayton	1978	683	52:1
Bonneville	1978	237	18:1
Big Creek	1978	147	11:1
Klaskanine	1978	13	
Stayton	1979	125	125:1
Big Creek	1979	68	68:1
Bonneville	1979	11	11:1
Klaskanine	1979	1	

a Stayton escapements include all fish counted past Willamette Falls, other stations include hatchery returns, strays and spawning ground recoveries.
b Adjusted to common unit of release for comparisons.
c Based on least-contributing station in these analyses.

Table 14. Preliminary total fishery contribution of selected Ad+CWT groups of 1978 brood fall chinook from Columbia Basin rearing stations during 1980 and 1981 fishery seasons (Smith et al. 1983).

Origin	Adjusted[a]	Comparison ratio[b]
Stayton	1,061	6.6:1
Bonneville	430	2.7:1
Big Creek	269	1.7:1
Klaskanine	161	

a Adjusted to common unit of release for comparison.
b Based on least-contributing station in these analyses.

PRIORITY INFORMATION NEEDS

1. Reasons for higher survival of Willamette fall chinook than releases from lower Columbia hatcheries.

2. Mortality of smolts passing through facilities at Willamette Falls.

3. Validation of counts at Willamette Falls.

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COWLITZ STOCK SPRING CHINOOK
(including Kalama and Lewis rivers)

This summary contains information on Cowlitz River spring chinook and the substocks in the Kalama and Lewis rivers.

PRODUCTION

Hatchery production is emphasized in the Cowlitz, Kalama, and Lewis rivers. Between 1979 and 1983, releases from Cowlitz Hatchery averaged 0.7 million yearlings and 2.2 million fingerlings and fry. The fingerling and fry releases do contribute to adult production based on the evidence of a sub-yearling smolt migration pattern from scale readings (H. Fiscus, WDF, personal communication). Kalama River yearling releases have ranged from 0.1-0.6 million and averaged 0.3 million between 1979 and 1983. In the Lewis River, spring chinook stock sources and hatchery production levels have changed frequently since the initial release of 122,000 Cowlitz fingerlings in 1972. The overall trend in the Lewis River has been to increase hatchery production and, beginning in 1984, to shift from predominantly fall releases to yearling releases. Fall releases of spring chinook in the Lewis River have ranged between 75,600 (1974 release) to 1.1 million (1981 release) for the period 1973-1983. Yearling releases from Lewis River facilities fluctuated in 1973-1977 between about 50,000-150,000 spring chinook then were discontinued until the 1984 release of 0.8 million (preliminary).

GEOGRAPHIC LOCATION

Streams

Spring chinook are present in the Cowlitz, Kalama, and Lewis rivers.

Hatcheries

Spring chinook are reared at Cowlitz, Kalama Falls, Lewis and Speelyai hatcheries. In the upper Columbia River, Cowlitz spring chinook have been released from Ringold Springs Hatchery intermittently since 1977.

ORIGIN

Native populations of spring chinook were historically present in the Cowlitz, Kalama, and Lewis rivers (WDF and USFWS 1951). In the Lewis River spring chinook eggs were collected for hatchery production in 1926 and 1927 and from 1931-1941 (except 1936). By the 1950's only remnant populations (escapements <100) of formerly large runs existed in the Kalama and Lewis rivers. Cowlitz River escapement in the early 1950's was estimated to be about 10,400 and spawned in the Cispus River (8,100) and the upper reaches of the Toutle (4001, Tilton (200) and mainstem Cowlitz rivers (1,700). The old

Cowlitz Hatchery was abandoned in 1949 for rearing purposes but was utilized for egg-take collection for transfer to the Green River Hatchery on the Toutle system. Spring chinook reared at Green River Hatchery were planted in the upper Cowlitz River.

Current spring chinook hatchery programs began in the early 1960's on the Kalama River, and as dam mitigation projects in the late 1960's at Cowlitz Hatchery and early 1970's on the Lewis River. Cowlitz Hatchery has utilized local returns for broodstock except for two 1967 brood Willamette stock releases of 331,200 fingerlings in 1968 and 668,100 yearlings in 1969. The Willamette stock juveniles were in questionable health throughout the rearing period and survived poorly based on returns of a yearling fin-clip group (B. Foster, WDF, personal communication). Broodstock for the Kalama and Lewis hatchery programs originated from a variety of sources but included some Cowlitz stock spring chinook (Table 1).

ADULT LIFE HISTORY

Run size catch and escapement

The dominant spring chinook run in southwest Washington returns to the Cowlitz River, averaging about 19,000 adults between 1970-1984 (Table 2). The spring chinook returns to the Kalama River (Table 3) and Lewis River (Table 4) were minor until 1975 and 1976, respectively. The favorable returns to the Lewis River in 1976 and 1977 were the result of good survival of the Carson stock yearling and fall releases from Speelyai Hatchery. Most of the freshwater harvest occurs in the tributary recreational fishery, although an unknown but significant number of Cowlitz spring chinook were harvested in the April-Way commercial seasons which occurred up to 1974 and in 1977. Since 1970, an average of about 1,900 spring chinook from the Cowlitz, Kalama, and Lewis runs have been annually harvested in the February-March winter season commercial fishery.

Natural spawning population estimates from survey area peak fish counts or redd counts is presented in Table 5.

Host of the overall harvest of two 1976 brood tag groups occurred in the coastal fisheries in Washington (32 percent) and British Columbia (30 percent) (Table 6). The freshwater sport component amounted to 30 percent, which is substantially higher than what occurs for other Columbia River salmon stocks.

Time of migration

The majority of the run migrates through the lower Columbia River from mid-March to mid-May Arrival at the Cowlitz Hatchery trap peaks in late-Flay and early June (Figure 1). Return timing to fish facilities during 1962-1968 was earlier when an average of 33 percent of the total trap returns were enumerated in April (Phinney 1972). Lower Columbia River spring commercial fisheries probably influenced the 1962-1968 timing percentages at Cowlitz Hatchery by disportionately harvesting a segment of the run.

Table 1. Broodstock sources for hatchery spring chinook programs in the Kalama and Lewis rivers.

KALAMA RIVER

Brood year	Release Year	Release	Type	Source
1962	1964	178,700	Yearling	Eagle Creek
1963	1965	278,800	Yearling	Willamette
1964	1966	64,000	Yearling	Willamette
1065	1967	253,400	Yearling	Cowlitz
1966	1967	47,400	Fry	Kalama
1966-1977	1967-1978	-	-	Kalama
1977	1978	137,000	Fingerling	Little White Salmon
1978-present				Kalama

LEWIS RIVER

Brood Year	Release Year	Release	Type	Source
1971	1972	122,400	Fingerling	Cowlitz
1971	1973	45,800	Yearling	Cowlitz
1972	1974	94,400	Yearling	Carson
1973	1974	163,500	Fall release	Carson
1973	1975	114,900	Yearling	Carson
1974	1975	75,600	Fall release	Klickitat
1974	1976	128,100	Yearling	Rlickitat
1975	1976	166,400	Fingerling	Cowlitz
1975	1976	169,800	Fall release	Cowlitz
1975	1977	56,800	Yearling	Cowlitz
1976-1978	1977-1979	-	-	Lewis
1979	1980	807,400	Fall release	Kalama and Lewis
1980	1981	811,800	Fingerling	Kalama
1980	1981	161,700	Fall release	Kalaaa
1980	1981	170,900	Fall release	Carson
1981	1982	238,100	Fall release	Cowlitz
1981	1982	261,200	Fall release	Lewis
1982	1984	(800,000)	Yearling	Lewis

Table 2. Minimum freshwater adult run size of Cowlitz River stock spring chinook 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return Year	Commercial	Ceremonial and subsistence	Commercial a/	Recreational b/	Natural c/	Hatchery	Total Production
1970	0	0	1,900	d	N/A	7,000	10,300
1971	0	0	1,900	3,250 d/	N/A	6,200	11,350
1972	0	0	2,300	4,600 d/	WA	2,500	9,350
1973	0	0	2,550	4,100 d/	400	5,000	11,650
1974	0	0	1,950	4,650	N/A	15,200	21,800
1975	0	0	1,650	4,550	550	17,300	24,050
1976	0	0	800	7,050	1,350	19,500	28,700
1977	0	0	1,200	5,500	N/A	15,900	22,600
1978	0	0	2,200	4,750	700	9,350	17,000
1979	0	0	900	5,450	700	7,550	14,600
1980	0	0	100	7,950	250	15,850	24,150
1981	0	0	1,350	5,600	1,400	20,850	29,200
1982	0	0	650	7,000	500	12,250	20,400
1983	0	0	1,200	8,300	100	13,300	22,900
1984	0	0	(1,650)	(8,000)	(400) e/	(13,650)	(23,700)
Mean	0	0	1,500	5,500	650	12,100	19,500

a/ Mainstem Columbia River harvest during February-March only; based on applying 15 percent to total season catch during 1970-1974 and 22 percent to 1975-1984 harvest and then applying escapement area ratios of Cowlitz. Kalama and Lewis River spring chinook.
b/ Tributary only.
c/ Redd count times a 50 percent redd count efficiency and 2.8 fish per redd.
d/ Includes Age 2 and Age 3 jacks which comprised 70 percent of 1975-1976 sport harvest.
e/ J. DeVore, WDF, personal communication.
0 Preliminary.
N/A: Not available.

Table 3. Minimum freshwater adult run size of spring chinook returning to Kalama River, 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial	Ceremonial and subsistence	Commercial a/	Recreational b/	Natural c/	Hatchery	Total Production
1970	0	0	0	50 d/	N/A	100	150
1971	0	0	100	100 d/	N/A	450	650
1972	0	0	50	100 d/	N/A	150	300
1973	0	0	50	150 d/	N/A	100	300
1974	0	0	50	50	N/A	450	550
1975	0	0	300	1,150	400	2,400	4,250
1976	0	0	150	1,300	650	2,400	4,500
1977	0	0	100	700	100	500	1,400
1978	0	0	150	550	250	250	1,200
1979	0	0	150	900	200	1,000	2,250
1980	0	0	0	400	350	1,850	2,600
1381	0	0	150	1,050	850	1,600	3,650
1982	0	0	300	2,250	2,900	3,500	8,950
1983	0	0	300	2,100	1,150	1,750	5,300
1984	0	0	(150)	(1,000)	(300)	(800)	(2,250)
Mean e/	0	0	200	1,150	700	1,600	3,650

a/ Mainstem Columbia River harvest during February-March only; based on applying 15 percent to total season catch during 1970-1984 and 22 percent to 1975-1984 harvest and then applying escapement area ratio5 of Cowlitz, Kalama and Lewis River spring chinook.
b/ Tributary only.
c/ Peak fish count times 2.0.
d/ Includes jacks.
e/ 1975-1984 only.
0 Preliminary.
N/A: Not available.

Table 4. Minimum freshwater adult run size of spring chinook returning to the Lewis River, 19704984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial	Ceremonial and subsistence	Commercial [a]	Recreational [b]	Natural [c]	Hatchery	Total production
1970	0	0	0	150 [d]	N/A [f]	0	150
4971	0	0	0	50 [d]	N/A [f]	0	50
1972	0	0	0	100 [d]	N/A [f]	0	100
1973	0	0	0	150 [d]	N/A [f]	0	150
1974	0	0	0	100	N/A&	0	100
1975	0	0	50	350	150	0	550
1976	0	0	400	2,300	600	300	3,300
1977	0	0	200	2,750	450	350	3,750
4978	0	0	600	3,300	300	350	4,550
1979	0	0	150	1,650	800	200	2,800
1980	0	0	0	1,200	4,000	100	2,300
1981	0	0	150	2,100	350	700	3,300
1982	0	0	150	2,500	1,100	500	4,250
3983	0	0	200	2,900	800	100	4,000
1984	0	0	(300)	(3,000)	950	(450)	(4,700)
Mean e/	0	0	200	2,400	700	450	3,650

[a] / Mainstem Columbia River harvest during February-March only; based on applying 15 percent to total season catch during 1970-1974 and 22 percent to 1975-1984 harvest and then applying escapement area ratios of Cowlitz, Kalama and Lewis River spring chinook.
[b] / Tributary only.
[c] / Peak count expanded by 3.0.
[d] / Includes jacks.
[e] / 1976-1984.
[f] / Not available and probably negligible.
( ) Preliminary.

Table 5. Natural spawning population estimates of spring chinook in Cowlitz, Kalama and Lewis rivers, 1973-1983.

	COWLITZ			KALAMA			LEWIS			
Year	Redds a/	Survey miles a/	Population estimate b/	Fish a/	Survey miles a/	Population estimate c/	Fish	Survey miles	Population estimate c/	Total population
1973	73	8.0	409	NC	–	–	NC	–	–	409
1974	NC	–	–	NC	–	–	NC	–	–	–
1975	100	8.0	560	202	18	404	43	4.0	129	1,093
1976	233	8.0	1,338	318	17	636	195	4.0	585	2,553
1977	NC	–	–	61	9.7	122	153	4.0	453	581
1978	124	8.0	634	116	14.7	232	108	4.0	324	1,250
1979	125	8.0	700	95	14.7	190	264	4.0	732	1,682
1980	44	8.0	246	170	18.9	340	333	4.0	333	1,585
1981	243	8.0	1,394	424	18.3	848	115	4.0	345	2,587
1982	32	8.0	515	1,446	17.3	2,832	360	4.0	1,080	4,487
1983	21	8.0	118	575	18.3	1,150	267	4.0	801	2,069
Wean	119	8.0	664	373	16.3	757	204	4.0	613	1,830

a/ Fiscus (1984).

b/ H. Fiscus, WDF, personal communication.

c/ R. Roler, WDF, personal communication.

Table 6. Harvest profile of Cowlitz stock spring chinook based on coded wire tag recoveries of 1976 brood releases.

Harvest component	Percent
Alaska:	
Troll and sport	1.5
British Columbia:	
Northern troll	7.3
Southern troll	18.1
Net and sport	4.8
Oregon:	
Troll and sport	2.8
California:	
Troll and sport	0.1
Washington:	
Ocean troll and sport	31.8
Other net and sport	1.5
Columbia River:	
Non-treaty commercial net	2.5
Terminal sport	29.6

		Cowlitz	Hatchery
	Code :	63-17-9	63-17-15
Survival	Type :	Yearling	Fall release
Smolt to adult		8.6%	0.5%
Smolt to fisheries		7.0%	0.4%
Smolt to Columbia River mouth		6.5%	0.3%

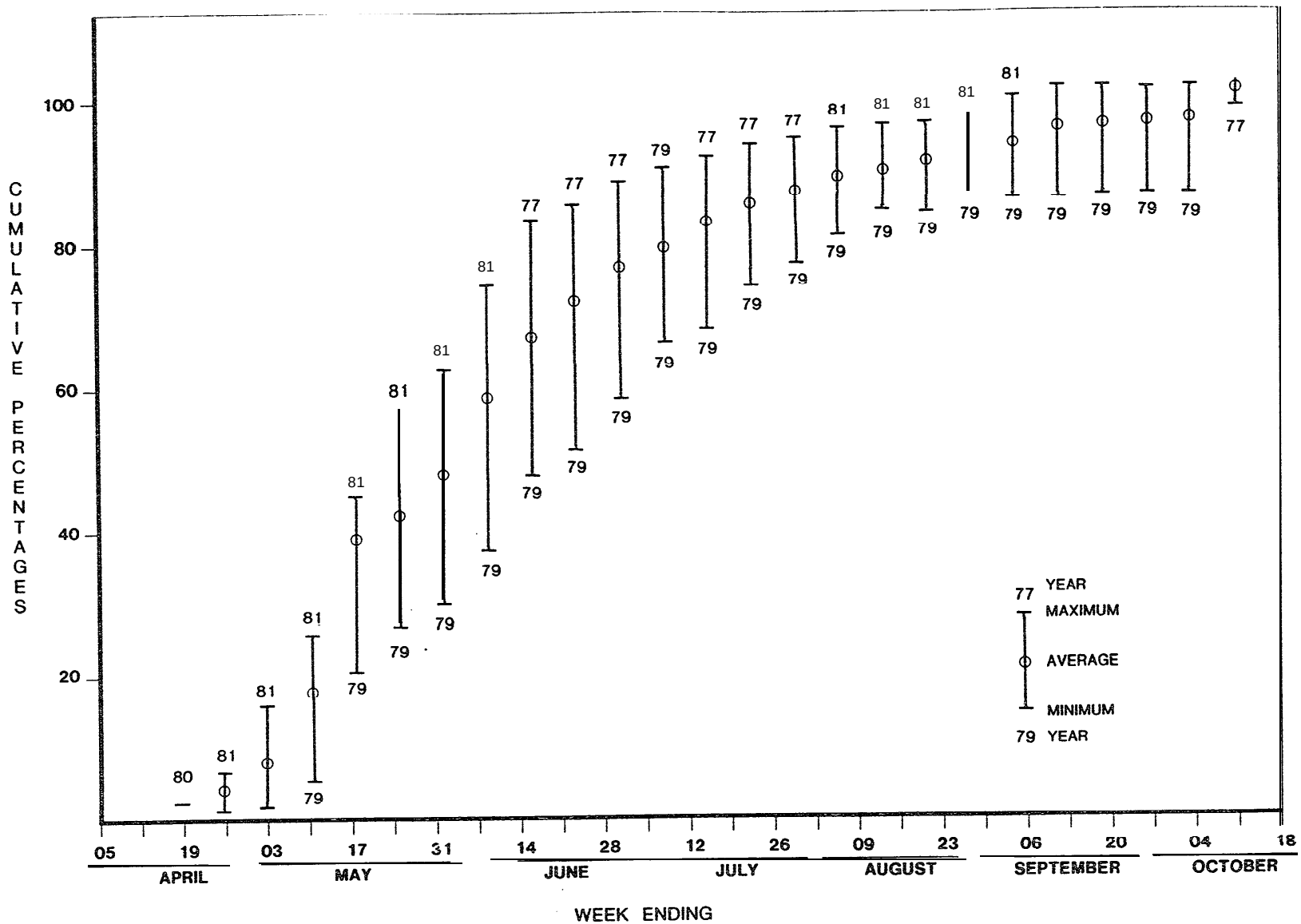

Figure 1. Cumulative percent of adult spring chinook handled at Cowlitz Hatchery, 1977-1981.

Spawning Period

Spawning extends from late August to early October with peak activity in September.

Spawning areas

Primary spawning area in the Cowlitz River is the four mile reach downstream of the Cowlitz Hatchery. In the Kalama River, most of the spawning occurs in the area from the upper Kalama Falls (river mile 36.81 downstream to the Kalama Falls Hatchery (river mile 10.51. Spawning in the Lewis River occurs primarily in the four mile reach between Lewis River Hatchery (river mile 12.1) and Merwin Dam.

Age composition

The adult run is composed of primarily four and five-year fish with a minor number of six-year-olds. Jacks (age-31 return in lesser numbers. Between 1975-1982, jacks averaged 15 percent of the Cowlitz run of three to six-year-old spring chinook and both four- and five-year-old adults averaged 42 percent. In the mid-1970's, two-year-old spring chinook, informally called minijacks, comprised a substantial portion of the Cowlitz River run. Modifications in the rearing strategy at Cowlitz Hatchery beginning with the 1977 brood substantially reduced the number of returning 'minijacks'.

Size

In 1982 fork length measurements were similar for male and female four-year-old spring chinok, whereas five-year-old males averaged about 5 cm. larger than females (Table 7). In 1982, the nadir in fork lengths between three and four-year-old Cowlitz spring chinook occurred within the 65-67 cm. range (Figure 2). The separation point between four and five-year fish was not as precise but occurred in the 80-82 cm. range.

Sex ratio

Jacks are entirely males. In 1982, Cowlitz five-year-old spring chinook were primarily females (60 percent) compared to four-year-old fish which were 50 percent females.

Fecundity

Age specific fecundity is not available.

Average fecundity at Cowlitz, Kalama Falls, and Speelyai hatcheries ranged between 3,852 to 4,270 eggs per female during 1978-1982.

Biochemical-genetic characteristics

Milner et al. (1983) measured the genetic distances between Cowlitz and Kalama Falls spring chinook. The within group variation was one of the lowest for 17 different stock group comparisons, indicating a relatively high degree of genetic homogeneity.

Table 7. Fork length (cm) according to sex and age (scale readings) of spring chinook at Cowlitz Hatchery, 1982.

	Age 2		Age 3		Age 4		Age 5	
	Male	Fema1e	Male	Female	Male	Female	Age	Female
Sample size	0	0	128	0	71	70	52	78
Average fork length (cm)	-		57.2	-	73.6	73.4	83.5	84.2
Range			45-67	-	57-97	59-83	69-105	67-100
Standard deviation			5.1	-	7.6	5.0	8.2	6.4

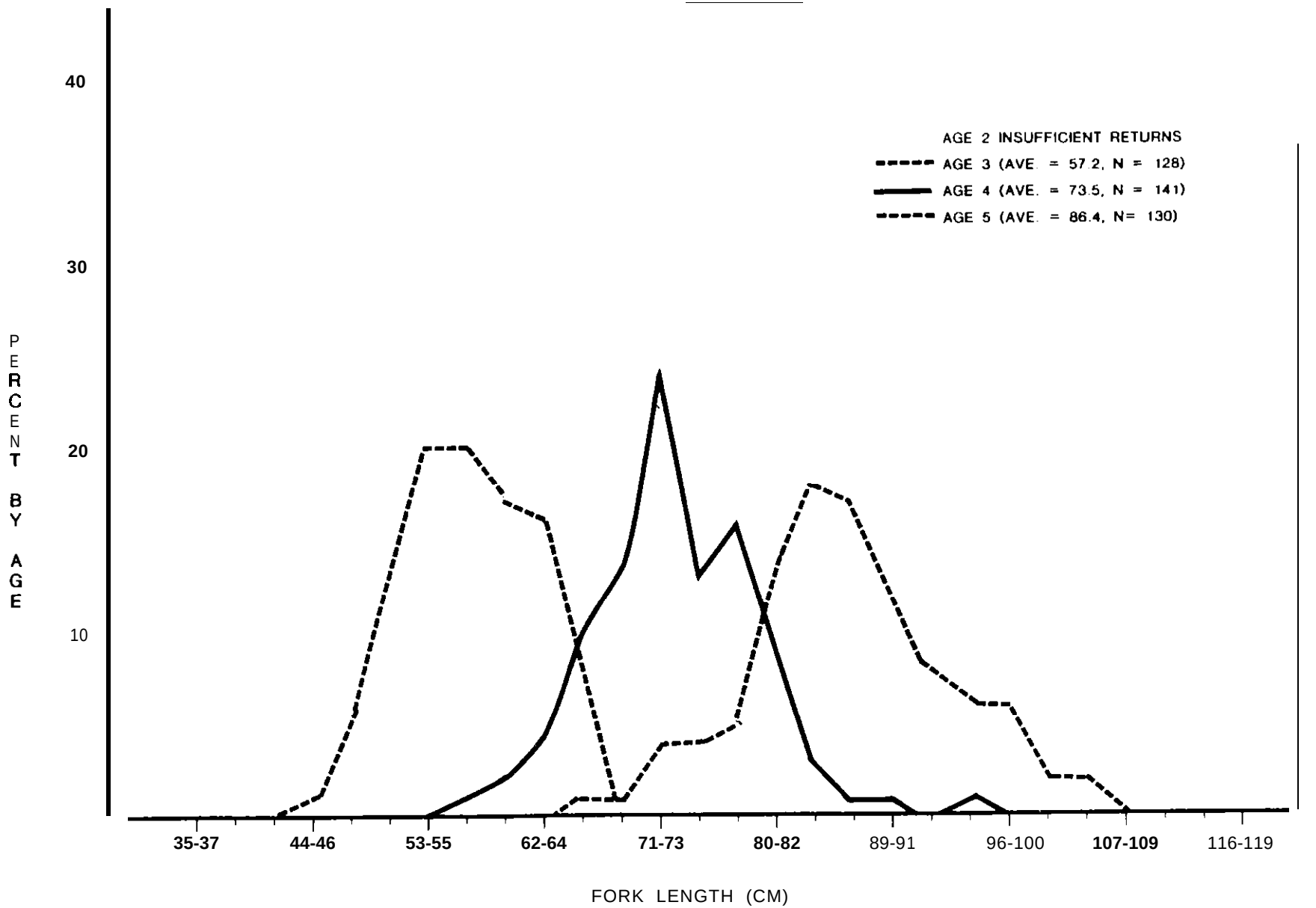

Figure 2. Length - frequency by age of spring chinook at Cowlitz Hatchery, 1982

Schreck et al. (1984) compared their samples to those of Milner et al. (1983) in order to determine if there were any genetic changes in stock between sampling dates. The results indicated a statistically significant difference in isozyme gene frequencies for one enzyme system between the current and historical profiles for both the Cowlitz and Kalama Falls samples. However, the statistical difference in the Cowlitz Hatchery comparison may have been due to the normal difficulty in interpreting the characteristics of that particular enzyme system (isocitrate dehydrogenase) and not due to any stock changes over time.

JUVENILE LIFE HISTORY

Time of emergence

No information is available on emergence of naturally produced fry.

At Cowlitz Hatchery artificial emergence occurs primarily in mid to late November.

Time, age and size at migration

Based on scale readings and coded-wire tag recoveries, most of the spring chinook spend over a year in freshwater and migrate downstream in their second spring and are called 'sub-2' age migrants.

Yearlings begin downstream smolt migration immediately after release in March and April based on tag recoveries in the Columbia estuary (Dawley et al. 1979). Fall release tagged juveniles (1976 brood code 63-17-15) were not recovered in the estuary until the following spring.

Survival rate

Survival to all catch and escapement was estimated to be 5.5 percent for Cowlitz spring chinook (B. Foster, Washington Department of Fisheries, personal communication).

DISEASE HISTORY

The viral disease infectious hematopoietic necrosis (IHN) was detected in 1984 adult spring chinook at Cowlitz Hatchery. Because of the potential catastrophic effects of this disease if it is transmitted to the juvenile production, stock transfer from Cowlitz Hatchery is presently restricted.

Bacterial kidney disease has been detected at Cowlitz, Kalama Falls, and Lewis River hatcheries (Tables 8-10). Other diseases that have occurred at some of these stations include bacterial hemorrhagic septicemia, furunculosis, columnaris, low temperature disease, red mouth, and gill disease.

Costia is the most common parasite

PRIORITY INFORMATION NEEDS

None.

Table 8. Diseases encountered by Cowlitz stock spring chinook at Cowlitz Hatchery, 1979-1983 (WDF 1984).

Type		
Bacterial:	Low temperature disease	1977-1979 brood juveniles
	Bacterial gill disease	1978, 1980-1982 brood juvenile
	Bacterial hemorrhagic septicemia	1978-1981 brood juveniles
	Bacterial kidney disease	1978-1980 brood juveniles
	Furunculosis	1979, 1980 brood juveniles
Parasitic:	Costia	1978-1982 brood juveniles
	Fungus-gills	1978 brood juveniles
Viral :	None[a/]	
Other:	None	

a/ Infectious hematopoietic necrosis (IHN) detected in 1984 adult spring chinook (K. Amos, WDF, personal communication).

Table 9. Diseases encountered by spring chinook at Kalama Falls Hatchery, 1979-1983 (WDF 1984).

Type		
Bacterial:	Bacterial kidney disease	1980 brood juveniles
	Bacterial hemorrhagic septicemia	1981 brood juveniles
	Bacterial gill disease	1981 brood juveniles
	Columnaris	1980 brood juveniles
	Furunculosis	1978 brood juveniles
Parasitic:	Costia	1978-1982 brood juveniles
	Ichthyophthirius	1978 brood juveniles
	Fungus-gills	1978 brood juveniles
Viral :	None	
Other:	None	

Table 10. Diseases encountered by spring chinook at Lewis River Hatchery, 1980 and 1983 (WDF 1984).

Type	Diseases	Infected group
Bacterial:	Bacterial kidney disease	1979 brood juveniles
	Low temperature	1982 brood juveniles
	Enteric redmouth	1979 brood juveniles
Parasitic:	Fungus	1981 brood juveniles
	Costia	1982 brood juveniles
Viral :	None	
Other:	Dropout disease	1982 brood juveniles

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Willamette River Spring Chinook (wild and hatchery)

Spring chinook are the only race of salmon native to the Willaaette River system above Willamette Falls. Prior to the construction of adequate passage facilities, fall chinook and coho were unable to pass above Willamette Falls.

Willamette spring chinook form an important component of the spring chinook run in the Columbia River system. From 1946 to 1963, Willamette stocks averaged more than 20% of the spring chinook run entering the Columbia River (Galbreath 1965). From 1982 through 1984, the Willamette run passing over Willamette Falls exceeded spring chinook counts of upper Columbia River stocks at Bonneville Dam.

PRODUCTION

Based on releases of oxytetracycline-marked fish from the 1970 brood, it was estimated that 65% of the returning adults were from hatchery releases of smolts, 10% from fingerling releases in reservoirs, and 25% from natural spawning (Bennett 1983b). Before the mid-1950s, most returning adults were the progeny of naturally spawning adults. The shift from natural to hatchery production occurred as hatcheries were built to mitigate for dam-induced losses and as hatchery practices improved.

Fry, fingerling, and smolts are currently released into the Willamette system (Tables 1 and 2).

GEOGRAPHIC LOCATION

Streams

Spring chinook occur in the mainstem and eastside tributaries of the Willamette River (Figure 1).

Hatcheries

Historically, spring chinook were trapped and spawned from nearly all major eastside tributaries of the Willamette River. Currently, adults are captured for spawning at Clackamas and Eagle Creek (USFWS) hatcheries on the Clackamas River, at Minto on the North Santiam River, at South Santiam Hatchery on the South Santiam River, at McKenzie Hatchery on the McKenzie River, and at Dexter on the Middle Fork Willamette River. Rearing facilities are indicated in Table 2.

ORIGIN

Hatchery releases are derived primarily from native Willamette stock. Hatchery-reared fish have been released in the Clackamas, Santiam, McKenzie, and Willamette rivers since the early 1900s. Broodstock were collected on the McKenzie and Middle Fork Willamette rivers and the eggs shipped to Bonneville

Table 1. Spring chinook released into the Willamette River system, 1963-1979 broods (Buckman and Warren 1983).

Brood year	Numbers released (thousands)				Pounds released (thousands)		
	ODFW hatcheries[a]	Reservoir[b]	Eagle Creek[c]	Total	ODFW hatcheries	Eagle Creek[c]	Total
1963	6,329	-	-	6,239	326	-	326
1964	6,775	-	-	6,775	312	-	312
1965	6,720	130	-	6,050	341	-	341
1966	5,162	100	-	5,262	353	-	353
1967	6,426	570		6,996	391		391
1960	4,060	240	675	4,903	340	37	305
1969	4,024	840	460	5,324	429	20	457
1970	3,469	500	75	4,124	310	8	326
1971	3,252	1,000	950	5,202	300	56	444
1972	3,050	560	550	4,160	204	30	314
1973	3,602	510	606	4,710	341	41	302
1974	4,501	600	848	6,029	414	49	463
1975	4,133	100	252	4,405	349	10	367
1976[d]	3,493	304	702	4,579	396	53	449
1977[d]	4,236	144	421	5,620	429	20	457
1970	4,447	333	402	7,071	557	28	505
1979	4,690	125	953	6,475	614	64	670

a McKenzie, Harion Forks, Oakridge, and South Santiam hatcheries; smolts were released from Clackamas Hatchery beginning with the 1970 brood.
b Estimated numbers migrating from Fall Creek, Green Peter, and Cottage Grove reservoirs resulting from fingerlings stocked earlier.
c Fish released from Eagle Creek National Fish Hatchery prior to 1960 were sub-smelts and were not included.
d Snolts from Oxbow Hatchery were released at the Clackamas Hatchery site.

Table 2. Willamette spring chinook releases by hatchery, 1976-82 brood years.

Brood year	Clackamas Fingerlings	Clackamas Smolts	Dexter Fingerlings	Dexter Smolts	Eagle Cr. Fed Fingerlings	Eagle Cr. Fed Smolts	Marion Forks Fingerlings	Marion Forks Smolts	McKenzie Fingerlings	McKenzie Smolts
1976			460,872			782,473		690,549	1,463,970[a]	752,525
1977		1,020,949		726,246[b]			2,208	1,071,763	71,763	751,940
1978	739,752	1,289,076		402,144			1,367,973[a]	1,014,871		864,898
1979	1,054,859	1,358,158		172,113		940,646	321,030	518,857		882,561
1980	983,626	999,762		252,251		589,624		497,146		840,721
					99,994[a]					
1981		1,123,189		1,132,529		540,308		524,921	41,540[a]	890,013
1982	991,563	1,842,884		66,370[a]		634,885	2,527,791[a]	559,732	33,000	953,613

Brood year	South Santiam Fingerlings	South Santiam Smolts	Willamette Fingerlings	Willamette Smolts
1976		386,334	1,012,472[a]	446,705
1977	1,840	384,238	892,436[a]	460,158
1978		321,467	853,931[a]	317,199
			889,336[a]	
1979		227,710	435,881[a]	1,010,274
1980		294,857	2,572,278[a]	1,845,203
1981		308,409	3,259,196[a]	366,959
1982		312,605	5,691,836[a]	131,314
			400,180	

[a] Fry.
[b] 304,919 were released into the Sandy river.

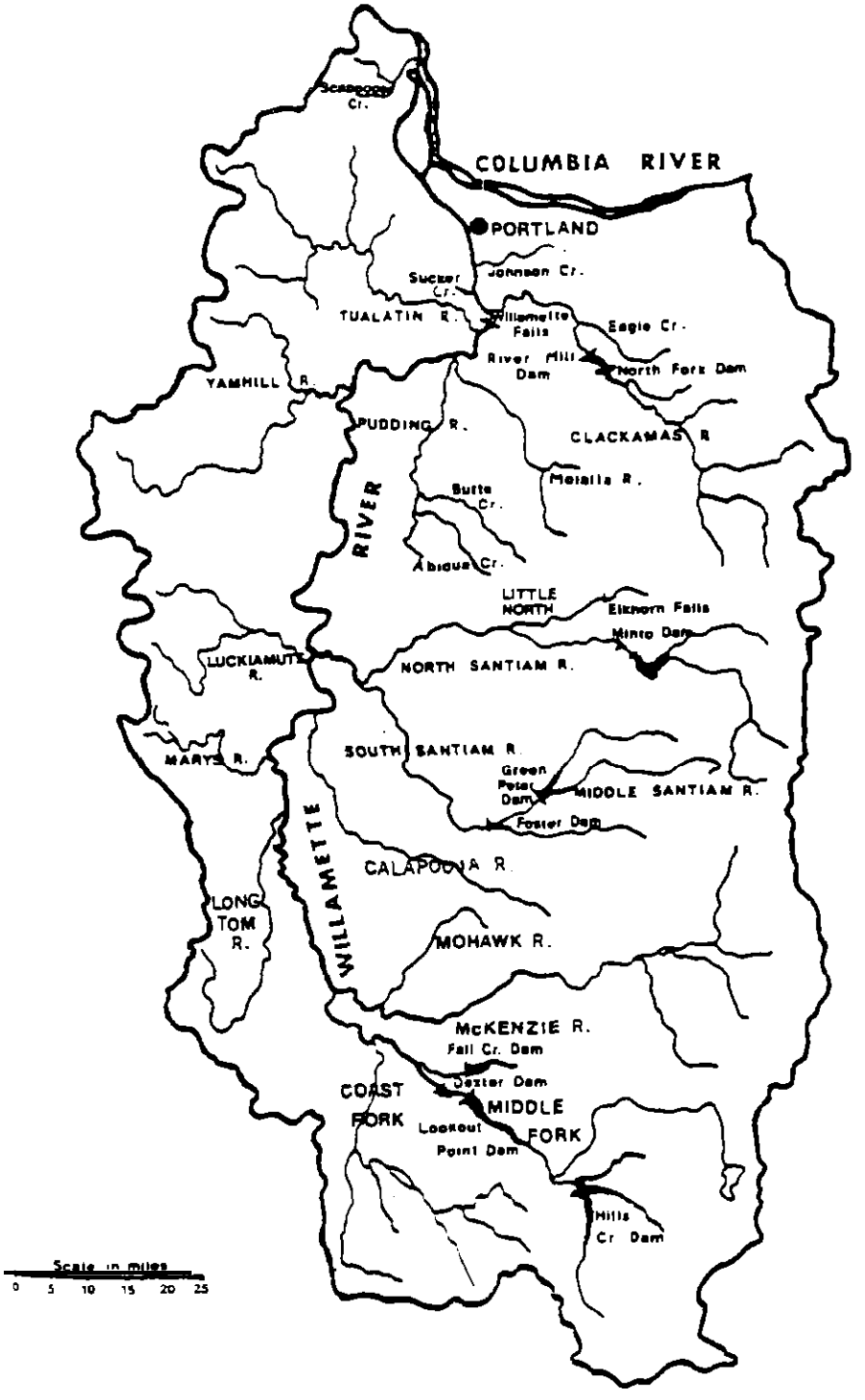


Figure 1. Willaaette River system.

for incubation and rearing from 1909-1942. It is not known whether the juveniles released back in the Willamette system were from those same egg takes or from other stocks. However, few adults returned from hatchery releases until the mid-1950s due to poor hatchery practices, such as releasing large numbers of very small fry (Wallis 1961).

Experimental groups of 1976-80 brood Carson stock spring chinook were released from Marion Forks Hatchery (Smith and Zakel 1981). Approximately 200,000 to 350,000 smolts of each brood year were released. Carson stock fish originated from upriver-bound spring chinook trapped at Bonneville Dam and transfered to Carson Hatchery on the Wind River in Washington for rearing. It was expected that these Carson stock fish would be well adapted to the environmental conditions found in the North Santiam River since upper Columbia spring chinook stocks rear in cold water and emigrate early and at small sizes. However, survival was not substantially improved and fishery contributions were much lower than that of the native Willamette stock. Releases of Carson stock were discontinued following the 1980 brood year releases. Because of differences in time of spawning and special precautions taken by fish culture personnel in handling these fish, chances of hybridization with Willamette stock are considered minimal.

Eggs and fish have been widely exchanged between rearing stations within the basin. However, since 1975, spring chinook at McKenzie Hatchery have been treated separately, although in some years up to 25% of the returning adults are strays from other releases in the Willamette (M. Smith, ODFW, personal communication). The hatchery broodstock used in the Middle Fork Willamette are trapped at Dexter and reared at Oakridge Hatchery ponds, and Clackamas and South Santiam hatcheries now use fish returning to their hatcheries as the primary broodstock for releases since the 1900 brood Hatchery fish apparently stray from the hatchery or stream of release and may spawn in the wild since only about 30% of hatchery fish passing Willamette Falls reach the hatchery of origin (Bennett 1983b).

ADULT LIFE HISTORY

Run size, catch, and escapement

The run size goal for Willamette spring chinook entering the Columbia River is 100,000 adults (hatchery and wild) (ODFW 1980). From 1970 to 1982 40,700 to 03,300 Willamette spring chinook entered the Columbia River (Table 3). The run size entering the lower Willamette River has averaged 51,700 fish since 1946 and ranged from 24,200 up to 96,000 fish. Most of these fish pass above Willamette Falls. An average of 003 and 2,419 spring chinook pass over North Fork Dam on the Clackamas River and Leaburg Dam on the McKenzie River, respectively (Tables 4 and 5).

Most of the Willamette spring chinook harvested are caught in the Columbia and Willamette River fisheries and in British Columbia fisheries (Table 6). The 2- and 3-year-old chinook contribute primarily to the British Columbia fisheries. Four-year-old chinook are harvested in Alaska, British Columbia, and freshwater fisheries. The older fish are mainly caught in freshwater. In recent years, the 4-year olds have formed the major component of the total fishery, comprising 54% of the total catch.

Table 3. Estimated run of Willamette spring chinook entering the Columbia River, Willamette River, and Clackamas River, and sport catch, 1946-1984 (from Collins 1981; Bennett 1983a; Bennett 1985).

Year	Run entering Columbia River	Lower Willamette recreational fishery harvest[a]	Willamette Falls Count	Clackamas River escapement[b]	Willamette estimated run size[c]	Percentage of run caught by recreational fishery
1946		12,600	53,000	3,000	68,600	18
1947		12,000	45,000	2,000	59,000	20
1948		8,300	30,000	1,800	40,100	21
1949		9,100	27,000	1,800	37,900	24
1950		8,800	14,500	1,500	24,800	35
		10,200	33,900	2,020	46,100	24
1951		13,300	34,300	2,000	49,600	27
1952		12,500	52,200	2,800	67,500	29
1953		16,400	76,500	4,000	96,800	17
1954		11,500	31,100	1,800	44,400	26
1955		9,000	22,000	1,500	32,500	28
		12,500	43,200	2,420	58,200	23
1956		16,000	58,600	3,000	77,600	21
1957		11,500	39,300	2,000	52,800	22
1958		15,500	45,200	2,100	62,800	25
1959		18,500	31,900	3,000	53,400	35
1960		8,000	14,400	1,800	24,200	33
		13,900	37,900	2,380	54,200	27
1961		6,400	18,900	2,200	27,500	23
1962		9,100	26,000	3,000	38,200	24
1963		13,600	30,300	4,000	48,100	28
1964		18,600	36,300	3,500	58,400	32
1965		9,000	29,100	3,000	41,100	22
		11,300	28,100	3,140	42,700	26
1966		12,800	28,200	3,000	44,000	29
1967		15,200	56,200	3,000	74,400	20
1968		13,500	31,500	2,000	47,500	28
1969		16,300	33,700	2,500	52,600	31
1970		17,900	34,200	1,500	53,600	33
		15,100	36,800	2,400	54,400	28
1971	80,900	20,200(200)	44,600	2,000	67,400	30
1972	58,400	18,700(200)	26,200	2,000	47,100	40
1973	70,700	10,200(200)	42,000	2,000	54,500	19
1974	82,400	25,200(200)	44,500	2,000	71,800	35
1975	40,700	12,500(100)	19,100	1,000	32,700	38
	66,600	17,400	35,300	1,800	54,700	
1976	45,000	16,400(200)	22,200	2,000	40,700	40
1977	64,400	15,000(1,000)	40,000	3,000	58,100	26
1978	83,300	20,800(500)	47,500	3,000	71,400	29

[a] Catches for 1946-70 includes Clackamas River. Catch in the Clackamas River for 1971-82 is in parentheses.

[b] The Clackamas River escapement is estimated on the basis of limited field observations, North Fork Dam counts, and the number of spring chinook returning to Eagle Creek National Fish Hatchery (2,792 returned to the hatchery in 1979).

[c] Includes observed or estimated losses below Willamette Falls of 113 salmon in 1962, 220 in 1963, 500 in 1968, 117 in 1969, 550 in 1971, 200 in 1972, 300 in 1973, 95 in 1974, 101 in 1975, and 100 in each year 1976-1979.

Table 4. Spring chinook counted over North Fork Dam on the Clackamas River, 1970-82 (Bennett 1983b).

Year	Adults	Jacks	Total
1970	576	76	652
1971	333	48	381
1972	184	119	303
1973	453	61	514
1974	440	64	504
1975	359	42	401
1976	433	28	461
1977	435	69	504
197.9	413	325[a]	730
1979	587	241[a]	828
1980	2,115[b]	47	2,162
1981	2,987	165	3,152
1982	2,912	209	3,121
12-year avg 1970-81	776	107	883

a Many of these were 2-year-old mini-jacks instead of the normal 3-year-old jacks.
b Ninety-one additional were hauled to Clackamas Hatchery.

Table 5. Spring chinook counted over Leaburg Dam on the McKenzie River, 1970-82 (Bennett 1983b).

Year	Adults	Jacks	Total	Percentage of Willamette Falls Counts
1970	2,857	134	2,991	0.7
1971	3,451	151	3,602	8.1
1972	1,478	69	1,547	5.9
1973	3,742	128	3,870	9.2
1974	3,657	60	3,717	0.4
1975	1,273	74	1,347	7.1
1976	1,833	66	1,899	8.6
1977	2,650	64	2,714	6.8
1978	3,020	38	3,058	6.4
1979	1,159	60	1,219	4.6
1980	1,934	46	1,980	7.3
1981	1,050	20	1,078	3.6
1982[a]	2,163	70	2,241	4.9
12-year avg. 1970-81	2,342	77	2,419	7.1

a Estimated to correct for equipment failure. Actual counts were 1,728 adults and 64 jacks.

Table 6. Willamette spring chinook catch by age and fishery (1974-76 brood years).[a]

	Age 2		Age 3		Age 4		Age 5		Age 6		Total	
	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%
Alaska			114	6	074	23	48	4	1	3	1,037	15
B.C.	46	90	1,370	77	1,405	37	44	3			2,865	41
Puget Sound	3	6	26	1	6	<1					35	1
Wash. Troll			23	1	154	4	12	1			189	3
Wash. Sport			127	7	23	1	3	<1			153	2
C.R. Gill Net					91	2	381	28	20	69	492	7
OR Troll	1	2	27	2	13	<I					41	1
OR sport			20	1	4	<I					24	<I
CA Troll			15	1							15	<I
CA Sport											0	0
River Sport	1	2	58	3	1,269	33	862	64	8	28	2,198	31
Total Catch	51	1	1,780	25	3,839	54	1,350	19	29	21	7,049	
Hatchery\[b\]			24		1,151		447		3		1,625	
Other	1		I2		261		321		4		599	

a Hatchery - 1974 brood — Tag Codes
Marion Forks — 9-3-11, 9-3-13

Hatchery - 1975 brood
Marion Forks — 9-5-4,9-5-5, 9-5-6
South Santiam — 9-5-7, 9-5-8, 9-5-10
Eagle Creek — 9-6-10

Hatchery - 1976 brood
South Santiam — 9-16-21 through 9-16-32
Eagle Creek — 9-16-58

b Hatchery returns are incomplete.

Willamette spring chinook are caught in the Willamette and Clackamas rivers by sport anglers from February through July. Most fish are caught in the lower Willamette during April and May. In 1982, the peak of the catch was in late April (Table 7). Between 10,000 and 20,000 fish are caught below Willamette Falls each year, which represents 20-40% of the run in the Willamette (Figure 2). An average of about 2,900 fish are caught annually in the tributaries above Willamette Falls (Table 8).

Time of migration

Willamette spring chinook adults enter the Columbia River from early February through May, and a substantial portion of the run enters before many upriver-bound spring chinook are present. The peak of the migration is in late March and April (Galbreath 1965). Fish bound for the McKenzie River tend to enter the Columbia River slightly earlier than other Willamette spring chinook (Figure 3). Fish are in the lower Willamette River primarily during March and April and pass Willamette Falls in May and June (Figure 4).

Mini-jack (age-21 chinook appear in the Columbia River in early June, and peak catches in the lower Willamette River occur about mid-June. Peak counts of mini-jacks at Willamette Falls fish may occur in late June (Figure 4). Most mini-jacks have migrated over Willamette Falls by mid-August, although some are occasionally counted until late September.

Passage timing at Willamette Falls appears dependent on temperature and water level. As water level drops and temperature rises above 53°F, Willanette spring chinook move over Willamette Falls. The timing of passage may have a genetic basis, since Carson stock chinook released experimentally in the upper Willamette pass over the falls earlier even though they enter the Columbia River later (M. Smith, ODFW, personal communication).

Fish arrive at the spawning tributaries or hatcheries primarily from late May through July (Table 91. Only at minto Pond on the North Santiam River are the fish collected primarily in September.

Spawning period

Spawning (hatchery and wild) normally begins in early September, peaks from mid- to late September and is completed by mid-Octoer (Table 9). In higher elevation streams spawning is completed as early as mid-September. However, spawning is delayed (sometimes into November) where dams prevent fish from reaching upriver spawning grounds (Mattson 1962).

Spawning areas

The principal spawning areas are the McKenzie, Middle Fork Willamette, North and South Santiam, and Clackamas rivers. The Molalla, Pudding, and Calapooia supported small spawning populations, at least historically. The McKenzie River is regarded as the most important remaining area for spawning and rearing of wild spring chinook in the Willamette River system (Smith and Zakel 1981); an average of 656 redds have been counted

Table 7. Spring chinook catch in the Willamette and Clackamas rivers below Willamette Falls by area and week, 1982 (Bennett 1983b).

Week ending	Willamette River: Lower river boat	Middle river boat	Upper River: Boat	Upper River: Bank	Upper River: Total	Cum. total	Cum. %	Clackamas River: Boat	Bank	Total	Cum. total	Cum. 0	Combined Will. & Clack.: CUB. total	cm. %
Jan 31	0	0	5	0	5	5	0	--	--	0	0	0	5	0
Feb 7	0	5	15	2	22	27	0	--	--	0	0	0	27	0
Feb 14	15	15	50	5	85	112	1	--	--	0	0	0	112	1
Feb 21	10	0	0	0	10	122	1	--	--	0	0	0	122	1
Feb 28	0	0	2	0	2	124	1	--	--	0	0	0	124	1
Mar 7	0	0	15	3	18	142	1	--	--	0	0	0	142	1
Mar 14	15	10	30	10	65	207	1	--	--	0	0	0	207	1
Start of Statistical Sampling[a]														
Mar 21	262	30	111	27	430	637	3	--	--	0	0	0	637	3
Mar 28	812	306	256	59	1,433	2,070	11	--	--	0	0	0	2,070	10
Apr 4	1,208	323	165	61	1,757	3,827	20	--	--	0	0	0	3,827	18
Apr 11	569	258	228	72	1,127	4,954	26	50	129	179	179	7	5,133	24
Apr 18	209	65	48	66	388	5,342	28	68	0	68	247	10	5,589	26
Apr 25	2,455	880	1,048	379	4,762	98,104	53	182	117	299	546	22	10,650	50
MaY 2	2,115	405	1,462	146	3,828	13,932	74	220	323	543	1,089	44	15,021	70
May 9	1,390	242	885	65	2,582	16,514	87	215	221	436	1,525	62	18,039	84
May 16	675	295	1,042	129	2,141	18,655	99	237	299	536	2,061	84	20,716	97
May 23	135	--	91	25	251	18,906	100	208	33	241	2,302	93	21,208	99
May 30	--	--	0	0	0	18,906	100	161	80	161	2,463	100	21,369	100
Total 1982	9,870	2,834	5,153	1,049	18,906	18,906		1,341	1,122	2,463	2,463		21,369	
1981	7,391	964	1,393	732	10,480			1,603	731	2,334			12,814	

a See Collins 1981.

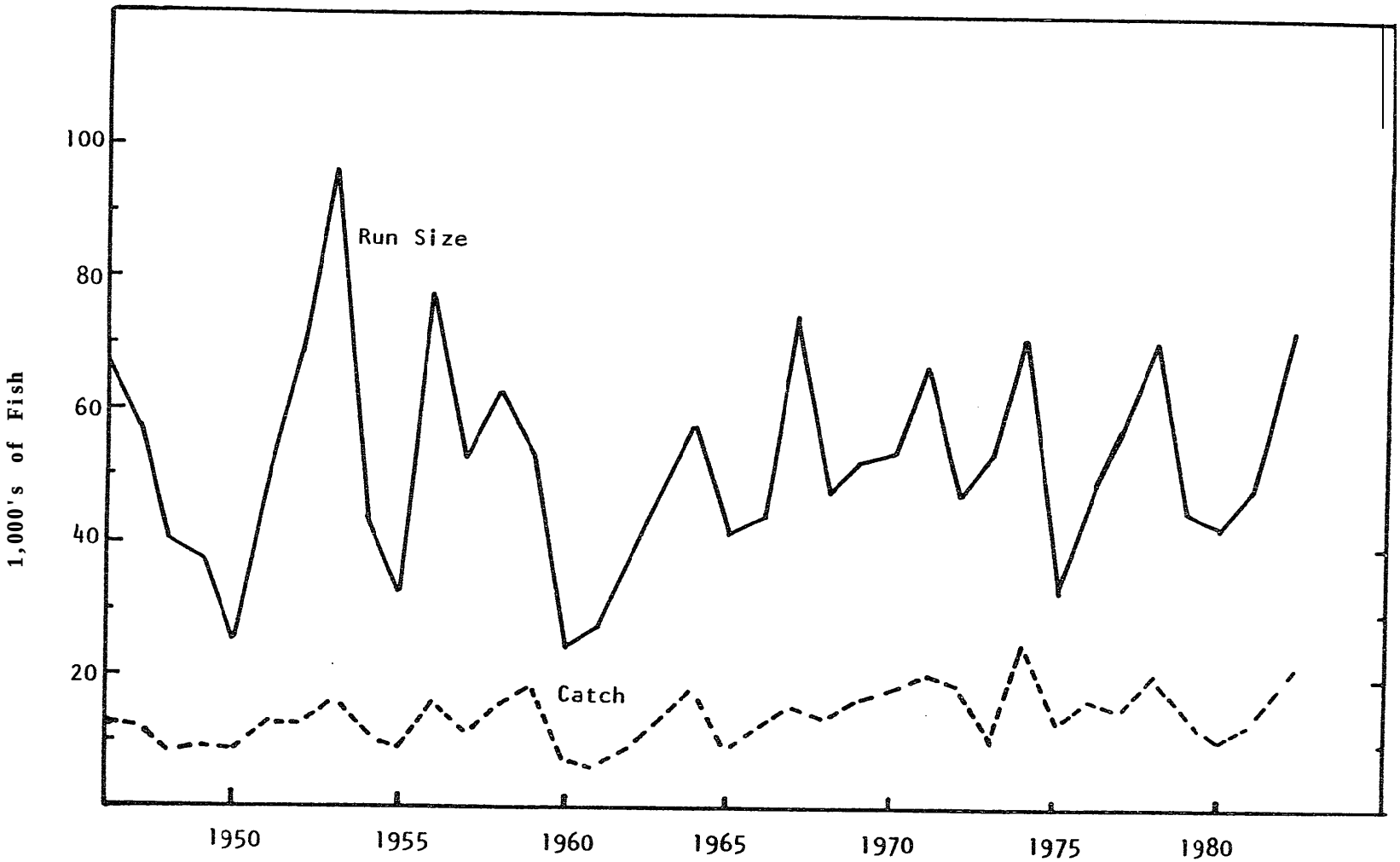


Figure 2 Number of spring chinook entering the Willamette River and catch in recreational fisheries of the Willamette and Clackamas rivers below Willamette Falls, 1946-82 (Bennett 1983b).

Table 8. Estimated sport catch of spring chinook in streams above Willamette Falls, 1963-81[a] (Bennett 1983b).

rear	Molalla	Calapooia	Santiam	McKenzie	Fall Creek	Willamette	Total
1963	67	34	633	614	--	--	1,340
1964	55	0	272	469	--	--	796
1965	47	14	313	1,571	--	--	1,945
1966	85	0	602	1,318	--	--	2,005
1967	56	0	803	1,282	--	--	2,141
1968	29	20	720	974	--	--	1,751
1969	39	0	998	a53	--	--	1,890
1970	17	33	1,582	525	--	--	2,157
1971	14	26	1,320	621	--	--	1,981
1972	30	17	597	1,125	--	--	1,769
1973	60	4	698	1,510	--	--	2,272
1974	3	11	698	1,022	--	--	1,734
1975	12	0	274	461	--	--	747
1976[b]	4	7	149	139	--	--	299
1977	107	0	1,780	1,008	131	362[c]	3,388
1978	22	0	874	924	238	2,337	4,395
1979	6	0	387	303	12	1,083	1,791
1980	3	0	835	381	15	702	1,936
1981	0	0	1,090	493	21	637	2,241
18-year Avg. 1963-80	36	9	752	839	99	1,121	2,856

a All catch data have been corrected for nonresponse bias, using the method described in "An Evaluation of the Punch Card Method of Estimating Salmon-Steelhead Sport Catch," Ronald H. Hicks and Lyle D. Calvin, Oregon State University Agricultural Experiment Station, Technical Bulletin 81, November 1964.

b An emergency angling closure of the entire Willamette June 7-July 14 eliminated almost all of the fishery above Willamette Falls.

c Previous to 1977 the upper Willamette catch was not separable from the catch below Willamette Falls and the 1977 estimate may not be complete.

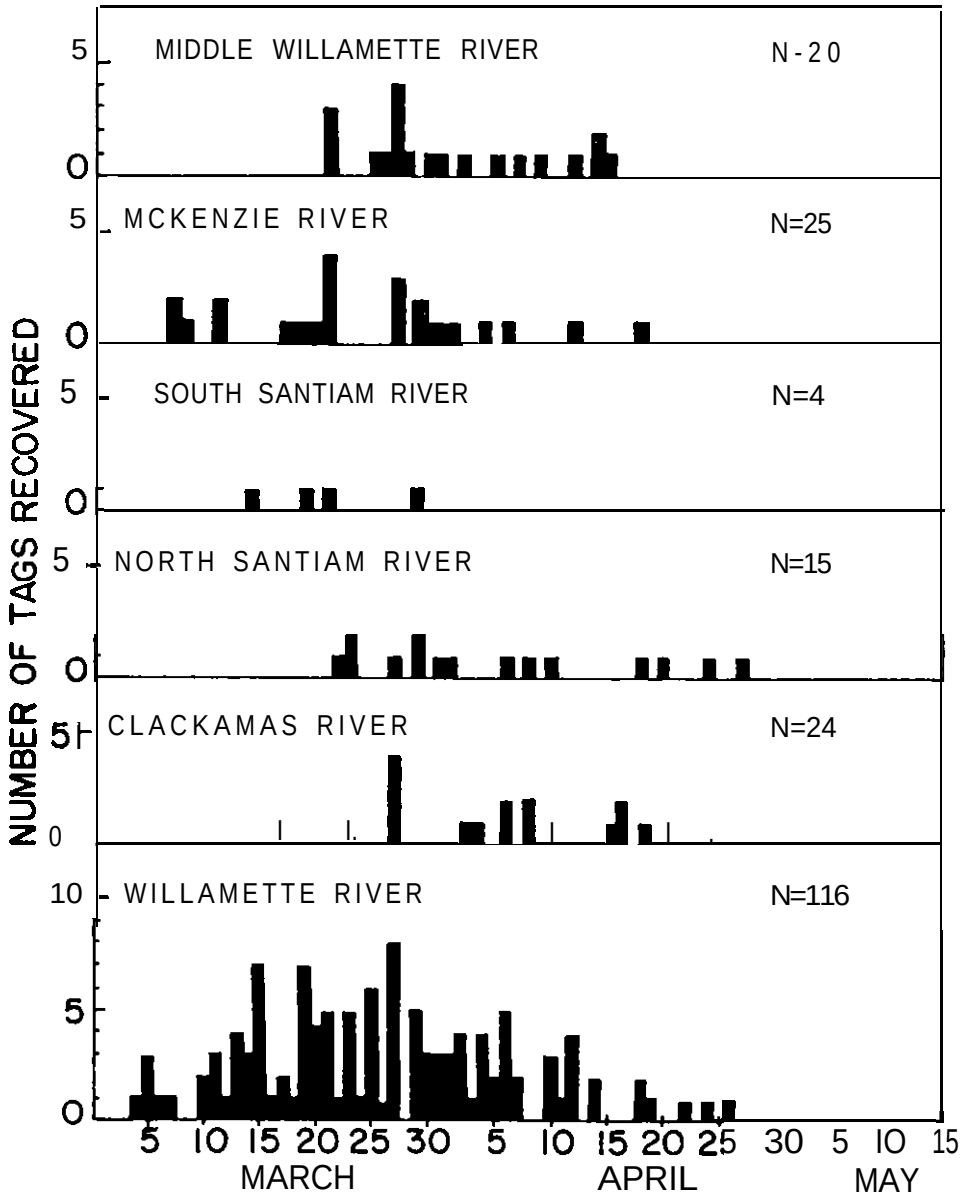
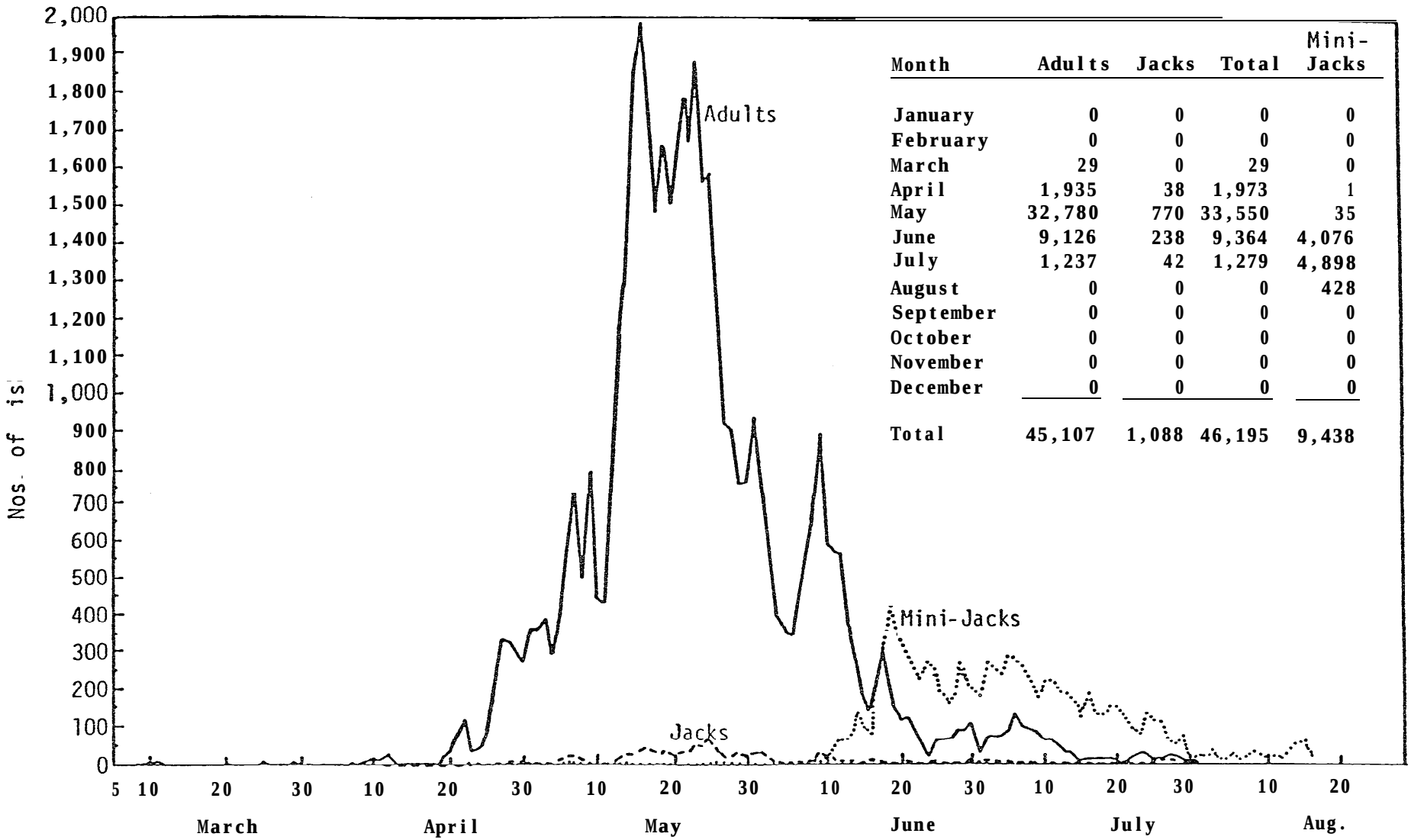


Figure 3. Tag recoveries by date of tagging in the lower Columbia River for spring chinook returning to the Willamette River and tributaries, 1946-63 (Galbreath 1965).



Month	Adults	Jacks	Total	Mini-Jacks
January	0	0	0	0
February	0	0	0	0
March	29	0	29	0
April	1,935	38	1,973	1
May	32,780	770	33,550	35
June	9,126	238	9,364	4,076
July	1,237	42	1,279	4,898
August	0	0	0	428
September	0	0	0	0
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0
Total	45,107	1,088	46,195	9,438

Figure 4. Daily and monthly counts of spring chinook passing Willamette Falls, 1982 (modified from Bennett 1983b).

Table 9. Returns of spring chinook to Willamette River hatcheries, 1978-l983.[a]

		Returns						Spawned				
Hatchery	Year	Female	Male	Jack	Total	Median date	Range	Female	Median date	Range	Eggs taken	Est. fecundity
Dexter	1978					-		773	9/28	9/21-10/10	2,288,386	2,950
	1979				2,959	7/31	6/30-9/21	570	9/30	9/21-10/26	2,187,376	3,838
	1980	1,327	1,952	140	3,419	7/31	6/30-9/26	185	10/3	9/19-10/6	679,640	3,674
	1981							134	9/25	9/18-10/6	511,560	3,818
	1983	3,585	3,704	100	7,389	7/6	6/13-12/20	20	9/23	9/23	77,000	3,842
Marion Forks	1978							339	9/23	9/9-10/9	1,500,720	4,427
	1979	49	115	19	183	9/21	6/30-10/19	49	9/28	9/14-10/19	204,280	4,169
	1980				145	9/13	7/31-9/27	56	9/20	8/20-10/4	238,050	4,251
	1981	150	449		599	9/20	6/30-10/11	132	9/20	8/31-10/18	524,705	3,975
	1983	33	59	0	92	7/13	6/28-8/23					
	1983[b]	271	164	6	441	6/28	6/28-8/19	227	9/2	8/23-9/12	983,000	4,329
	1983[b]	66	6	0	72	8/16	8/11-9/2	58	8/23	8/16-9/12	342,000	5,374
McKenzie	1978				1,454	6/30	5/31-9/30	300	9/23	9/9-10/7	1,108,000	3,693
	1979				798	6/30	5/31-10/13	254	9/29	8/31-10/13	883,700	3,479
	1980				887	6/3O	6/30-10/11	264	9/27	8/31-10/11	958,000	3,629
	1981	310	465	15	790	6/30	5/31-10/31	239	9/26	8/31-10/31	862,000	3,607
	1983	269	480	72	821	8/29	6/8-10/3	229	9/19	9/6-9/30	914,000	3,990
South Santiam	l978[c]				2,202	6/3O	5/31-9/30	450	9/30	9/8-10/20	2,039,748	4,533
	1979[c]				779	6/3O	5/31-9/28	266	10/5	9/14-10/15	1,130,210	4,249
	11980[c]				943	8/31	5/31-10/24	409	9/26	9/19-10/24	1,739,680	4,234
	1986	318	319	15	652	7/31	4/30-10/3	290	9/26	8/12-10/17	1,315,210	4,535
	1983	503	505	274	1,689	6/24	5/l-10/6	434	9/22	9/8-10/6	1,918,000	4,420
Clackamas	1980							50	10/3	9/19-10/10	233,200	4,664
	1981	532	533		1,065	6/3O	6/1-10/16	37	10/7	9/30-10/16	167,075	4,515
	1983	692	1,033	198	1,923	8/19	6/2-10/l3	110	9/30	8/10-10/11	493,000	4,479

[a] 1982 return data not available.
[b] Carson stock spring chinook.
[c] 'Hauled in.

annually in the system from 1965 to 1984 (M. Smith, ODFW, personal communication). Dams have blocked access for chinook to approximately 300 miles of streams in the Willamette River system (Bennett 1983b). Previous spawning distribution has been mapped by Fulton (19681.

Age composition

Hatchery and wild spring chinook return at ages two through six (Table 10). Four- and 5-year olds compose the majority of the returning adults. The large number of age-2 mini-jacks in 1978 and 1979 resulted from hatchery releases of large smolts in the spring (Smith and Zakel 1981). Most spring chinook caught in the lower Willamette and Clackamas sport fishery were also age-4 and age-5 fish (Tables 11 and 12), although a larger percentage of age-4 fish are caught in the Clackamas River than the Willamette River. The ocean fisheries harvest mostly age-3 and age-4 fish (Table 6).

Size

Adult age-length frequency distributions and adult age-weight frequency distributions are presented in Figures 5 and 6. There is considerable overlap in both length and weight between age groups. Age-4 and 5 fish that migrated as fingerlings tended to be larger than those that migrated as yearlings (Mattson 1963).

The average weight of fish caught in the Clackamas River is less than that of fish caught in the Willamette. This may result from the large percentage of age-4 fish (rather than age-5 fish) caught in the Clackamas River (Tables 11 and 12).

Mini-jacks of Dexter origin ranged from 22 to 35 cm in fork length in 1981. Modal size exceeded 30 cm in fork length (Smith and Zakel 1981).

Over time the mean size of adult Willamette chinook has decreased. This reduction in size appears related to progressively increasing reliance upon hatchery production as the source of adult returns to the system. Hatchery releases of large yearling smolts in the spring result in adults that return on average at a younger age and a smaller size than wild fish or fall-released hatchery smolts (Smith 1979).

Sex ratio

Of the full-size adults (age-d, -5, and -6) which are collected at hatchery facilities, the female to male ratios have varied from 0.33:l to 11.1 at individual hatcheries (Table 4), but are generally about 1:1 overall (M. Smith, ODFW, personal communication). Jacks and mini-jacks are almost exclusively males.

Fecundity

Average fecundity varies between hatchery return groups and return years (Table 9). It has ranged from 2,950 eggs/female at Dexter in 1978 to 5,374 eggs/female at Marion Forks in 1983. The values are not adjusted for age/size differences of females. Verified egg take from 3,669 females spawned at the Willamette River stations in 1983 averaged 4,258 eggs/female.

Table 10. Numbers of 2- to 6-year-old spring chinook returning to the Willanette River from parent escapements, 1955-80 (Bennett 1983b).

Parent year	Offspring returning by age 2[a]	3	4	5	6	Offspring total	Parent total[b]
1955		1,570	16,447	10,261	853	29,131	23,500
1956		2,403	11,689	12,595	306	26,993	61,600
1957		1,283	11,468	15,280	529	28,560	41,300
1958		2,585	20,704	29,004	409	52,702	47,300
1959		1,910	18,038	36,558	781	57,287	34,900
1960		529	19,330	24,907	704	45,470	16,200
1961		2,161	14,632	22,132	744	39,669	21,100
1962		781	20,592	39,953	665	61,991	29,100
1963		572	33,554	31,920	684	66,730	34,300
1964		149	13,823	25,774	375	40,121	39,800
1965		1,092	25,669	25,567	1,011	53,339	32,100
1966		421	26,746	25,275	188	52,630	31,200
1967		858	40,440	29,563	927	71,788	59,200
1968	6,036	674	15,745	28,122	2,010	46,551	33,500
1969	4,113	1,551	24,089	39,203	980	65,823	36,200
1970	1,750	1,363	29,941	14,701	525	46,530	35,700
1971	328	646	15,844	13,730	638	30,858	46,600
1972	1,734	1,110	24,893	27,781	1,000	54,784	28,200
1973	957	1,546	27,839	35,272	268	64,925	44,000
1974	773	1,682	34,558	26,180	1,105	63,525	46,500
1975	663	571	17,617	19,933	631	38,752	20,100
1976	1,084	535	21,123	23,944	624	46,226	24,200
1977	2,174	340	23,021	27,064	--	--	43,000
1978	22,433	971	42,295	--	--	--	50,500
1979	26,679	2,452	--	--	--	--	30,400
1980	9,438	--	--	--	--		32,300

a Not included in offspring or parent total.
b Willamette Falls counts and Clackamas River escapement.

Table Il. Aqe composition and average weight of Willamette River sprinq chinook samples from the recreational fishery, 1965 through 1982 (from Collins and Massey 1975, Bennett 1983b).

Year	Age 3	4	5	6	Total	Ave. Wt. (lbs.)[a]
1965						18.3
Number	4	74	126	4	208	
Percentage	1.9	35.6	60.6	1.9	100.0	
1966						15.2
Number	8	294	316	10	628	
Percentage	1.3	46.8	50.3	1.6	100.0	
1967						16.9
Number	1	189	225	4	419	
Percentage	0.2	45.1	53.7	1.0	100.0	
1968						18.5
Number	11	140	323	7	481	
Percentage	2.3	29.1	67.2	1.5	100.0	
1969						17.4
Number	5	293	294	8	600	
percentage	0.8	48.8	49.0	1.3	99.9	
1970						17.0
Number	9	276	264	4	553	
Percentage	1.6	49.9	47.7	0.7	99.9	
1971						16.9
Number	7	437	273	11	728	
Percentage	1.0	60.0	37.5	1.5	100.0	
1972						16.5
Number	28	288	541	3	860	
Percentage	3.3	33.5	62.9	0.3	100.0	
1973						16.4
Number	31	556	649	22	1,258	
Percentage	2.5	44.2	51.6	1.7	100.0	
1974						17.0
Number	16	764	999	51	1,830	
Percentage	0.9	41.7	54.6	2.8	100.0	
1975						15.8
Number	45	637	591	39	1,312	
Percentage	3.4	48.6	45.0	3.0	100.0	
1976						14.7
Number	56	901	497	19	1,473	
Percentage	3.8	61.2	33.7	1.3	100.0	
1977						14.7
Number	27	443	442	10	992	
Percentage	2.9	48.0	47.9	1.1	99.9	
1978						16. 7
Number		6 387	395	11	799	
Percentage	0.8	48.4	49.4	1.4	100.0	
1979						17.2
Number	11	349	519	5	884	
Percentage	1.2	39.5	58.7	0.6	100.0	
1980						15.9
Number	7	458	432	24	921	
1981						15.2
Number	23	552	574	15	1,164	
percentage	2.0	47.4	49.3	1.3	100.0	
1982						16.0
Number	61	1,151	777	18	2,007	
Percentage	3.0	57.3	38.7	0.9	100.0	

aData from random sample of recreational catch.

Table 12. Age composition and average weight of spring chinook from the Clackamas River recreational fishery, 1979-82[a] (Bennett 1983b).

Year	Age 3	4	5	6	Total	Average weight (lbs)
1979						
Number	2	39	14	0	55	13.3
Percentage	3.6	70.9	25.5	0.0	100.0	
1980						
Number	10	303	82	3	398	12.7
Percentage	2.5	76.1	20.6	0.8	100.0	
1981						
Number	14	210	217	1	442	14.4
Percentage	3.2	47.5	49.1	0.2	100.0	
1982						
Number	27	269	100	2	398	13.3
Percentage	6.8	67.6	25.1	0.5	100.0	
3-year Avg.						
Number	9	184	104	1	298	13.5
Percentage	3.0	61.7	34.9	0.3	100.0	

[a] Includes Eagle Creek in 1979-80.

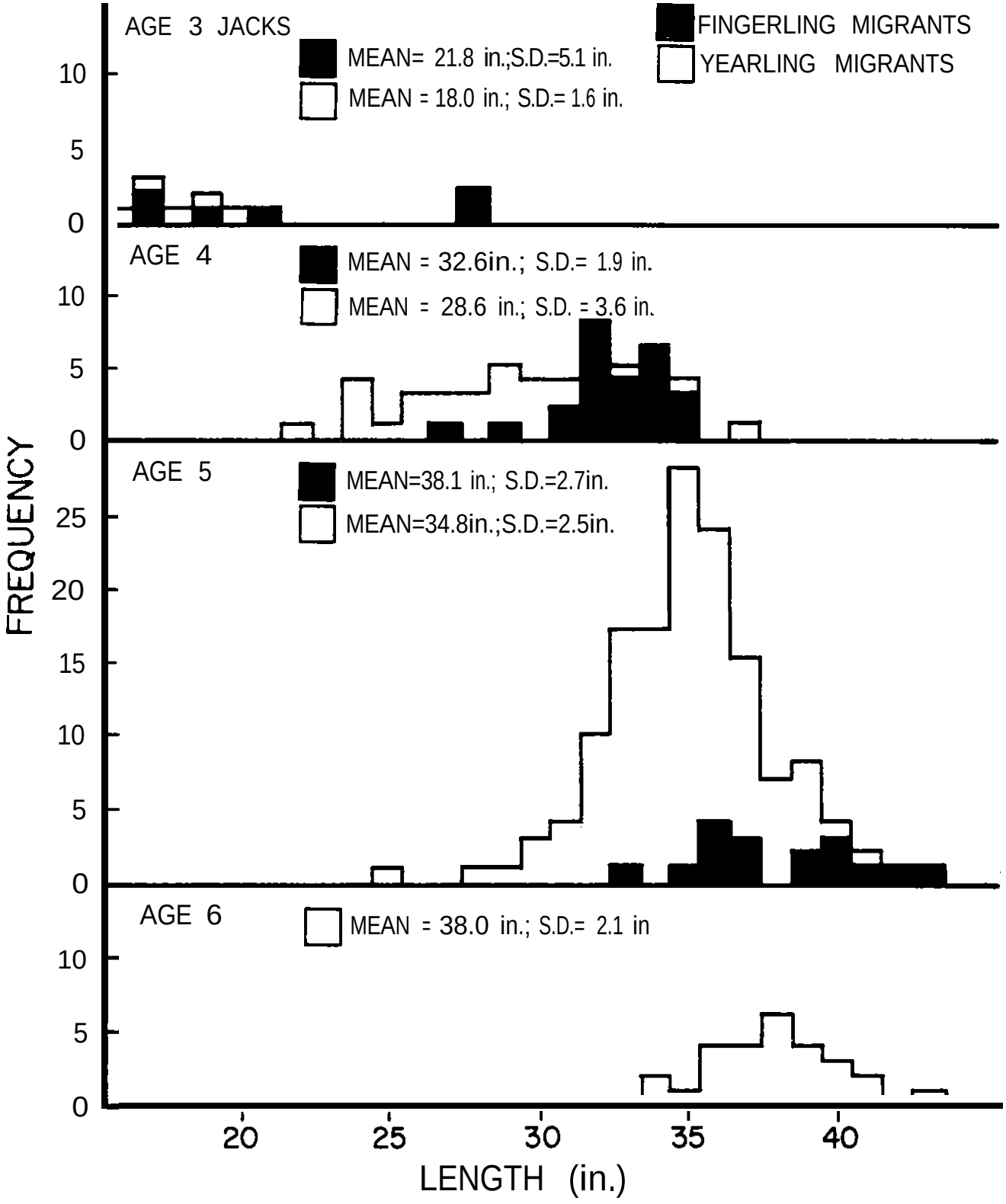


Figure 5. Adult age-length frequency distributions by type of downstream migrant, 1951 sport fishing season (Mattson 1963).

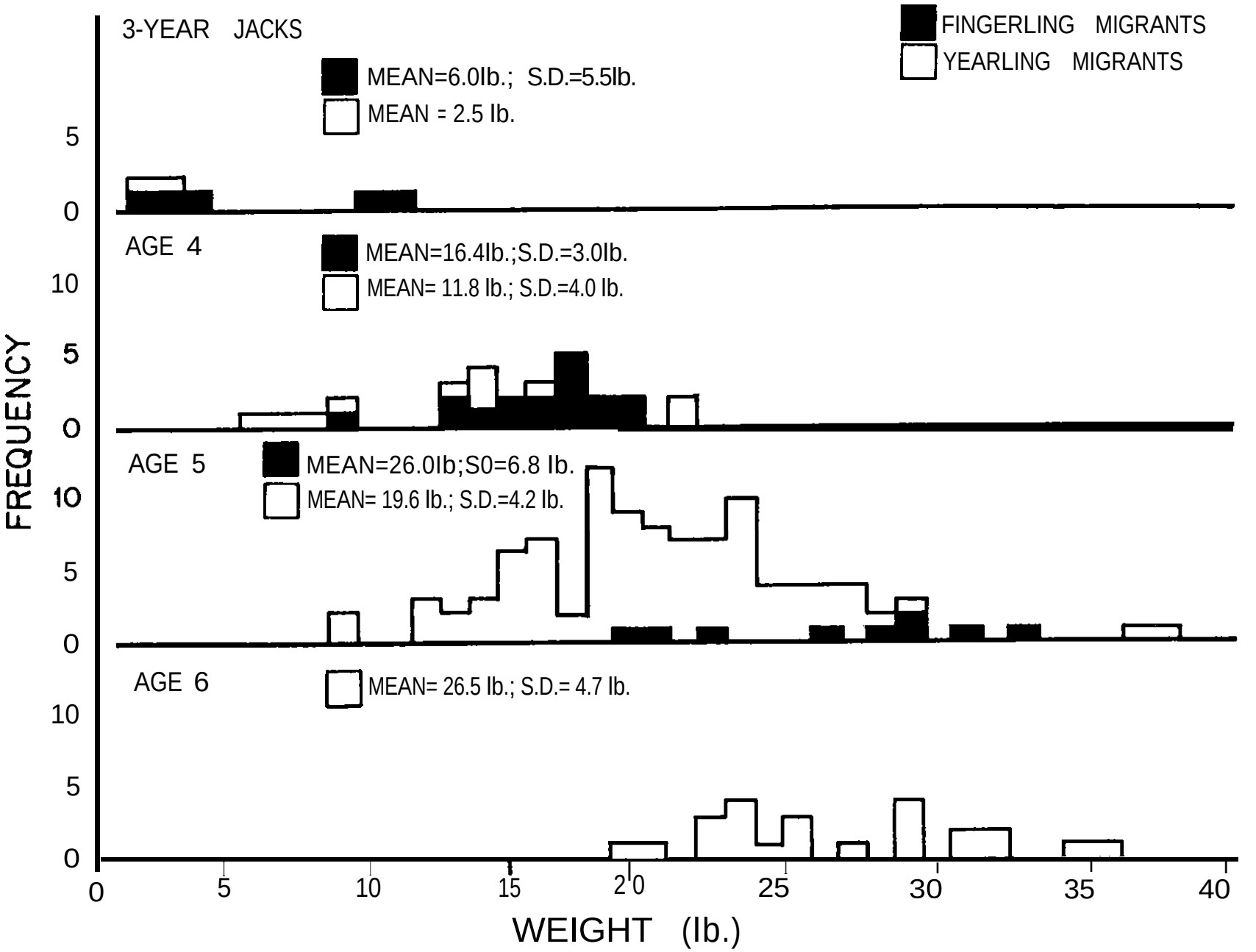


Figure 6. Adult age-weight frequency distributions by type of downstream migrant, 1951 sport fishing season (Mattson 1963).

Biochemical-genetic characteristics

Preliminary data on isozyme gene frequencies are listed in Table 13. In comparisons of Willamette spring chinook from adjacent streams or hatcheries, samples from Thomas Creek (wild) and South Santiam Hatchery had significant differences in three of eight isozyme gene frequencies examined (Table 14). Samples from other hatcheries differed in one to two enzyme systems.

JUVENILE LIFE HISTORY

Time of emergence

Eggs normally incubate from 65 to 80 days in the gravel (range = 58 to 150 days) (Mattson 1962). Fry emerge in February and March unless cold temperatures lengthen incubation time. The emergence time can vary widely. For example, the earliest capture in the Molalla during 1946-49 was 14 March and in the North Santiam the earliest catch was 5 June (possibly a result of late spawning and long incubation times from dam blockage and cold temperatures, respectively) (Mattson 1962).

Hatchery incubation times vary depending on water temperature, but the fry emerge by the end of January at most facilities.

Time, age, and size at migration

Wild juvenile spring chinook reside in fresh water from 3 to 18 months following egg deposition. Seaward migration occurs during one of three periods: (1) late winter to spring (subyearlings), (2) late fall to early winter (yearlings), or (3) spring the year following emergence (yearlings). The migrating fish are from 33-140 mm in length, and the larger fish emigrate first Mattson 1962). An accelerated growth period occurs up to two months earlier for fish in the lower main Willamette compared with fish in the upper tributaries.

Most returning adults (1946-51) migrated to the ocean as yearlings (Table 15). The proportion of yearling migrants increased with the age of the returning adults. Slower growing juveniles tended to produce adult returns comprised of a majority of age-5 fish. Faster growing juveniles produced more age-4 fish.

Table 13. Isozyme gene frequencies and sample sizes (N) as determined by electrophoresis for Willamette spring chinook stocks. Numbers at the top of each column are the relative mobilities for each allele present in the enzyme system. Minus signs indicate cathodal migration (Schreck et al. 1984).

Sample location	ACON				ADA			ADH			GPI-2			GPI 1-3H			GOT 3		
	100	86	116	N	100	83	N	-100	-52	N	100	60	N	Stand.	Vari.	N	100	90	N
Eagle Creek	0.76	0.21	0.03	87	1.00		100	0.98	0.02	100	1.00		100	1.00		100	1.00		90
South Santiam	0.72	0.27	0.01	98	1.00		65	1.00		100	1.00		100	1.00		100	1.00		90
Marion Forks	0.79	0.44	0.02	97	1.00		100	1.00		100	1.00		100	1.00		100	1.00		100
Dexter Dam	0.75	0.22	0.03	98	1.00		100	1.00		100	1.00		100	0.83	0.17	100	1.00		100
McKenzie Hatchery	0.79	0.19	0.02	98	1.00		50	1.00		100	1.00		95	0.90	0.10	95	1.00		100
Thomas Creek	0.83	0.16	0.01	95				0.98	0.02	100	1.00		100	0.80	0.20	100	1.00		100

	ICD 3 & 4				LDH-4			LDH-5			MDH-3, 4				MPI				
	100	74	127	N	100	120	N	100	70	N	100	121	70	N	100	109	95	113	N
Eagle Creek	1.88			100	1.00		100	1.00		87	0.95	0.05		100	0.61	0.38		0.01	84
South Santiam	1.00			100	1.00		100	1.00		100	0.95	0.05		100	0.50	0.50			97
Marion Forks	1.00			100	1.00		100	1.00		100	0.92	0.08		98	0.46	0.54			95
Dexter Dam	1.00			100	1.00		100	1.00		85	0.93	0.07		100	0.53	0.47			88
McKenzie Hatchery	0.98	0.02	<0.005	70	1.00		100	0.99	0.01	100	0.93	0.07		99	0.47	0.52	0.81		97
Thomas Creek	0.88	0.11	0.01	89	1.00		100	1.00		100	0.92	0.08		99	0.42	0.58			95

	PEP-GL-1			PEP-LGG				PGK				SOD		
	100	90	N	100	130	45	N	100	90	64	N	-100	-260	N
Eagle Creek	1.00		100	0.92	0.08		99	0.06	0.94		95	0.67	0.33	98
South Santiam	1.00		100	0.65	0.35		95	0.94	0.06		99	0.84	0.16	99
Marion Forks	1.00		100	0.91	0.09		98	0.98	0.02		77	0.80	0.20	100
Dexter Dam	1.00		100	0.83	0.17		100	0.90	8.10		94	0.92	0.08	100
McKenzie Hatchery	1.00		100	0.87	0.13		99	0.88	0.12		84	0.81	0.19	100
Thomas Creek	1.00		100	0.87	0.13		100	0.93	0.07		100	0.81	0.19	100

Table 14. Number of enzyme systems with similar isozyme gene frequencies and the enzyme systems with dissimilar isozyme gene frequencies between adjacent sources of Willamette spring chinook salmon (Schreck et al. 1984).

Sampling location	No. of similar isozyme gene frequencies ($P > 0.05$)	Enzyme systems with statistically significant differences in gene frequencies ($P \leq 0.05$)
Dexter and McKenzie Hatchery spring chinook (Upper Willamette River)	5	ICD SOD
Marion Forks and South Santiam Hatchery spring chinook (North and South Santiam rivers)	6	LCG
Thomas Creek (South Santiam River Tributary) and South Santiam Hatchery spring chinook	5	ACO ICD LGG

Table 15. Sport caught spring chinook by age groups classified as fingerling or yearling migrants (Mattson 1963).

Age	1946 No.	1946 %	1947 No.	1947 %	1948 No.	1948 %	1951 No.	1951 %	Total No.	Total %
3 Fingerling	4	44.5	0	-	2	66.7	5	61.4	11	55.0
Yearling	5	54.5	1	100.0	1	33.3	2	38.6	9	45.0
4 Fingerling	14	22.6	9	39.1	3	27.4	21	37.5	47	30.9
Yearling	48	10.4	14	60.9	8	72.6	35	62.5	105	69.1
5 Fingerling	10	8.9	6	13.6	4	8.9	7	5.4	27	7.1
Yearling	102	91.1	38	86.4	41	91.1	143	94.6	324	92.3
6 Fingerling	1	5.6	0	-	0		0			
Yearling	17	94.4	1	100.0	11	100.0	36	100.0	6 :	98.5
Fingerling total	30	14.9	15	21.7	9	12.8	33	13.3	87	14.0
Yearling total	172	85.1	54	78.3	61	07.2	216	86.7	503	85.2

Juveniles are either released in April through June as subyearling fry into reservoirs and streams for further rearing or are reared in the hatcheries for release as smolts (4-20 fish/lb). Currently yearling smolt releases are divided between fall and spring liberations.

Hatchery smolts released from McKenzie Hatchery in early November arrived at Jones Beach (River Mile 46) in the Columbia River between mid-November and late March. Smolts released in mid-March reached Jones Beach by the end of April (Dawley et al. 1984).

Juvenile Willamette spring chinook were collected in purse seines off the Oregon and Washington coast in May and June (Figure 7). No coded-wire tagged juveniles were captured in August and September off the northern California, Oregon, Washington, or Vancouver Island (B.C.1 coast.

Survival rate

The goal for survival of hatchery-released smolts in the Willamette system is 2% adult return to freshwater. Based on tagging studies, actual survival rates range from 0.15 to 2.51, varying depending on hatchery and rearing conditions (M. Smith, ODFW, Personal communication). There are no survival estimates for naturally produced fish.

DISEASE HISTORY

Spring chinook reared in Willamette River hatcheries are subject to a wide variety of diseases. Pathologists have documented mortalities from coagulated yolk syndrome, dropout (club-gill) syndrome, gill amoeba, Furunculosis, bacterial kidney disease, enteric redmouth, Columnaris, Ichthyopthirius, cold-water disease, external fungus and bacterial gill

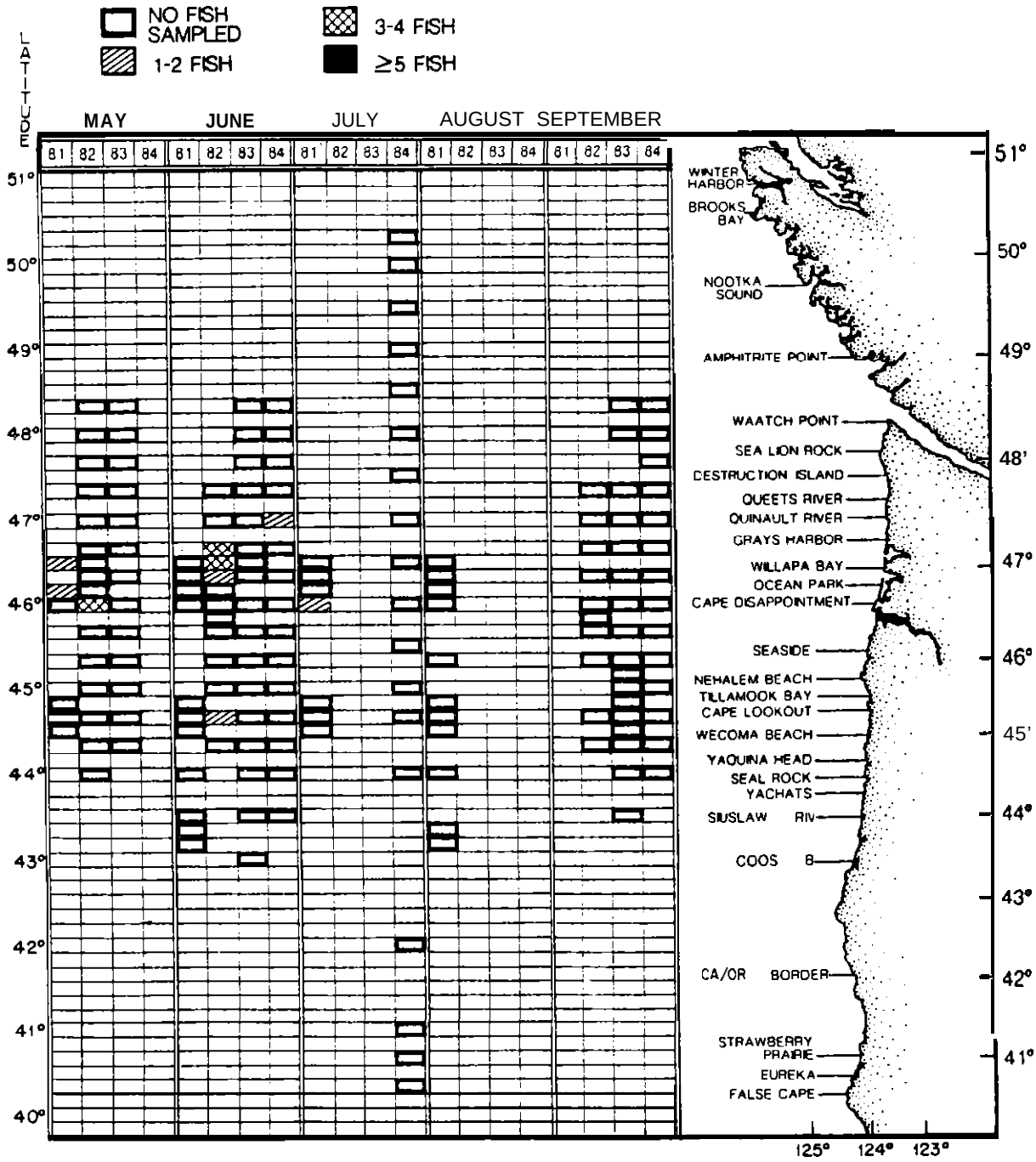


Figure 7. Recoveries of coded-wire tagged juvenile Willamette spring chinook in the Pacific Ocean, 1981-84 (Data from Wakefield et al. 1981; Fisher et al. 1983; Fisher et al. 1984; Fisher and Pearcy 1985).

disease among rearing juvenles. Adults which die in holding ponds typically sustain multiple infections of such diseases as Saprolegnia, bacterial kidney disease, Furunculosis, Columnaris, Ceratomyxa and Aeromonads. Losses of juveniles associated with viral infections have not been documented in the Willamette system (R. Holt, ODFW, personal communication).

PRIORITY INFORMATION NEEDS

1. Effects of passage facilities at Willamette Falls on juvenile migrants

2. Data base related to residual wild fish in the Willamette:
   A) Current hatchery/wild composition of the run
   B) Selective harvest of wild fish by major fisheries
   C) Use of excess hatchery stocks to supplement natural rearing in currently-underseeded streams

3. Validation of Willamette Falls fish counts (possible inflation of counts resulting from fallback)

4. Compilation of tributary sport harvest records

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Sandy River Fall Chinook (wild)

PRODUCTION

Fall chinook stocks occurring in the Sandy River system consist of naturally reproducing early spawning and late spawning stocks. This summary pertains to the native late-spawning wild stock.

GEOGRAPHIC LOCATION

Streams

Mainstem Sandy River and tributaries Trout and Gordon creeks (Figure 1)

ORIGIN

Late spawning fall chinook are a native stock in the Sandy River. Although the Tule fall chinook have not been stocked since 1977, early spawning fall chinook established from those releases and/or strays from current releases (Tule or Upriver Bright fall chinook) continue to spawn below Marmot Dam.

ADULT LIFE HISTORY

Run size, catch, and escapement

No information is available on total run size; however, spawning ground redd counts have been 0 the past three years in Trout Creek and the past two years in Gordon Creek (Table 11. No escapement data are available for late spawning wild fall chinook in the mainstem Sandy.

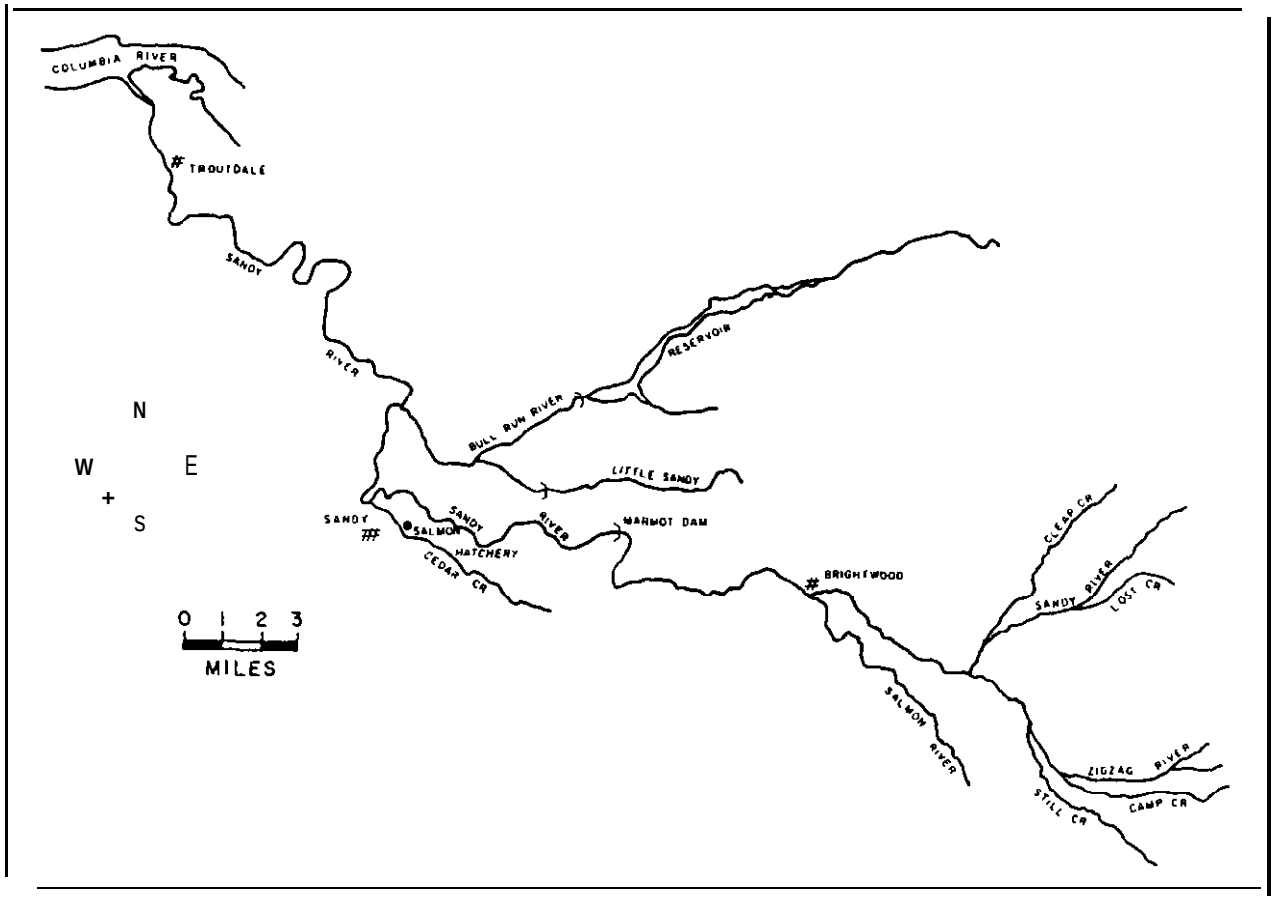

Figure 1. The Sandy River and major tributaries.

Table 1. Counts of late spawning fall chinook and redds in Trout and Gordon creeks, 1970-83 (Hirose 1982; P. Hirose, ODFW, personal communication).

Spawning year	Trout Creek		Gordon Creek	
	Fish	Redds	Fish	Redds
1970	41	32		
1971	99	8	5	5
1972	25	19		
1973	1	5	8	7
1974			1	6
1975	27	14	4	3
1976	0	0	3	14
1977	18	4	3	8
1978	15	1	1	5
1979	22	7	7	5
1980	26	17	6	11
1981	2	0	1	4
1982	0	0	0	0
1983	2	0	0	0

The sport fishery for fall chinook is concentrated in the mainstem Sandy River. The catch averaged 238 chinook per year from 1971 through 1980 (Table 2). It is not known what proportion of the catch is the late spawning stock.

Table 2. Sport catch of fall chinook by run year in the Sandy River drainage 1971-80[a] (Berry 1981).

	1971	1972	1973	1974	1975	4976	1977	1978	1979	1980
Beaver Cr.							0	0	3	0
Bull Run R.	-	-	-	-	-	-	0	0	6	0
Sandy R.	427	71	112	477	76	159	56	453	329	215

[a] Estimated from punch card returns adjusted for non-response bias. Prior to 1977 the catch in tributaries was included in the mainstem catch.

Time of migration

Tagging studies suggested that the historical time of migration of Sandy River fall chinook through the lower Columbia River may be similar to that for other lower river stocks, from August 14 through September 20 (Galbreath 1966). The two tagged fish recovered in the Sandy were tagged in the lower Columbia (zones 1 and 2) between August 25 and 30. It is not known whether or not these fish were late spawning stock; however, it is suspected that they were Tules because of the early timing (B. Bohn, ODFW, personal communication).

Spawning period

The late stock spawn in December and January after the Tule stock, which peak in early to mid-October (P. Hirose, ODFW, personal communication).

Spawning areas

This stock spawns in Trout and Gordon creeks and probably in the mainstem (P. Hirose, ODFW, personal communication).

Age composition

Adult carcasses sampled during spawning ground surveys in 1980 were predominantly age 4 and 5 (Table 3).

Table 3. Age composition of late-spawning fall chinook sampled during spawning ground surveys on Trout and Gordon creeks, Sandy River system, l/18-2/8/1980 (ODFW, unpublished data).

Age	Number
3/2	2
4/1	3
4/2	1
512	5

Size

Lengths of the male carcasses sampled in 1980 ranged from 101 to 108 cm (n=3); females were 80-92 cm (n=5).

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age, and size at migration

From the limited age composition data in Table 3, it appears that most juveniles enter the ocean as yearlings.

Survival rate

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Run size, catch, and escapement
2. Time of adult migration in the Columbia River

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Bonneville Upriver Bright Fall Chinook (hatchery)

Upriver bright or late spawning fall chinook are so named because they are brighter than Tule fall chinook at the time of migration through the lower Columbia, are primarily destined for areas above Bonneville, and spawn later than Tule fall chinook.

PRODUCTION

Bonneville Hatchery produces upriver bright fall chinook to compensate for half of an estimated loss of 30,000 adult chinook due to the construction of John Day Dam. Compensation goals call for Bonneville Hatchery to produce 15,000 adult fall chinook for Columbia River fisheries and 4,500 hatchery returns after ocean harvest (Pribble et al. 1978). Approximately l-2 million subyearling and yearling juveniles are released each year (Table 1).

GEOGRAPHIC LOCATION

Streams

Bonneville Hatchery releases upriver bright fall chinook into the Columbia River and the Umatilla River (Table 1).

Hatcheries

Bonneville Hatchery

ORIGIN

This stock was developed from upriver-bound fall chinook trapped at Bonneville Dam. Since 1981 adult returns to the hatchery and additional fish trapped at the dam have been used for broodstock. These fish may be from several different production areas above Bonneville. Consequently, the genetic characteristics of this stock may be quite mixed.

ADULT LIFE HISTORY

Run size, catch. and escapement

Based on coded-wire tag returns, more than half of the chinook from the 1977 and 1978 broods were harvested by the British Columbia fisheries (Tables 2 and 3). Alaska fisheries also harvested a significant portion of the production.

Bonneville upriver brights began returning to the Columbia River in 1980. Run size has generally increased each year (Table 4).

Table 1. Tagged and untagged 1977-82 broods of upriver bright fall chinook released from Bonneville Hatchery (Hansen 1983).

Binary code	Release date	Water supply	Number released tagged	untagged	total	Size (No/lb)
		1977 Brood				
07 16 58	10/30/78	Tanner Cr.	44,830	563,630	608,460	20.3
07 16 60	10/30/78	Well	44,430	7,233	51,663	23.8
07 16 61	3/13/79	Well	32,745	591	33,336	8.0
Brood Totals			122,005	571,454	693,459	
		1970 Brood				
07 17 35	11/20-12/5/79	Well	51,227	992,120	1,043,355	11.6
07 17 33	3/13/80	Well	49,334	--	49,334	7.0
__	3/13/80	Herman Cr.	--	240,225	248,225	8.9
Brood Totals			100,561	1,240,353	1,340,914	
		1979 Brood				
07 22 07	6/30/80	Well-Tanner	100,717	3,869	104,586	83.0
07 17 34	11/11/80	Tanner Cr.	51,274	603,404	654,678	13.6
__	12/5/80	Herman Cr.	--	154,489	154,489	12.0
__	3/13/81	Herman Cr.	--	229,455	229,455	9.9
Brood Totals			151,991	991,217	1,143,208	
		1980 Brood				
07 25 06	6/21/81	Well	99,632	2,450	102,082	64.0
07 25 07	7/30/81	Well	102,221	2,514	104,735	34.9
07 21 42	11/9/81	Well	50,702	477	51,179	11.5
07 21 41	11/9/81	Tanner Cr.	49,813	380,324	430,137	9.3
07 21 43	3/17/82	Well	50,553	308	50,861	7.2
07 21 37	3/17/82	Herman Cr.	48,052	245,046	293,898	1.4
Brood Totals			400,973	631,919	1,032,892	
		1981 Brood				
07 24 24	6/4/82	Well	105,029	847	105,876	79.0
07 24 26	8/3/82	Well	104,966	1,383	106,349	39.6
07 25 48	11/1/82	Well	50,737	204	50,941	12.1
07 25 45	11/1/82	Tanner Cr.	48,394	241,862	290,256	12.0
07 25 47	3/23/83	Well	49,918		49,910	5.9
07 27 41[a]	3/24-4/18/83	Well	99,570	994	100,564	5.9
__	4/2-5/83	Herman Cr.	--	116,765	116,765	7.2
Brood Totals			458,614	362,055	820,669	
		1982 Brood				
07 28 26[b]	5/31-6/2/83	Well	100,244	914,802	1,015,046	99.8
07 28 27	6/16/83	Well	100,259	2,301	102,560	80.0
01 28 28	8/1/83	Well	99,001	5,336	104,337	41.3

Table 2. Recoveries of coded-wire tagged adult u river bright fall chinook (1977 brood) by age class and fishery[a],

	Age 2		Age 3		Age 4		Age 5		Total	
	Catch		Catch		Catch	%	Catch	%	Catch[b]	%
Alaska	0	0	2	1	220	30	84	54	314	22
B.C	40	66	239	59	408	53	58	37	745	54
Puget Sound	0	0	9	2	0	0	0	0	9	1
Wash. troll	0	0	22	5	54	7	6	4	82	6
Wash. sport	0	0	59	15	31	4	3	2	93	7
C.R. gill net	8	13	64	16	8	1	0	0	80	6
C.R. sport	13	21	0	0	0	0	0	0	13	1
OR troll	0	0	3	1	27	4	4	3	34	2
OR sport	0	0	5	1	10	1	0	0	15	1
CA troll	0	0	0	0	0	0	0	0	0	0
CA sport	0	0	0	0	0	0	0	0	0	0
TOTAL CATCH	61	4	403	29	766	55	155	11	1,385	--
ESCAPEMENT										
Hatchery	79		121		340		132		666	
Other	0		2		19		22		43	

[a] 1977 brood released from Bonneville Hatchery. Tag codes 7-16-50, 7-16-60 and 7-16-61.

b Data for 6-year-old fish not available.

Table 3. Recoveries of coded-wire tagged adult u river bright fall chinook (1978 brood) by age class and fishery[a,b].

	1980 Age 2		1981 Age 3		1982 Age 4		Total	
	Catch	%	Catch	%	Catch	%	Catch	%
Alaska	0	0	0	0	85	19	85	11
B.C.	23	57	137	53	277	62	437	59
Puget Sound	0	0	0	0	0	0	0	0
Wash. troll	0	0	26	10	22	5	48	6
Wash. sport	0	0	57	22	31	7	88	42
C.R. gill net	11	27	0	0	0	0	11	1
C.R. sport	6	15	0	0	0	0	6	1
OR troll	0	0	18	7	18	4	36	5
OR sport	0	0	8	3	7	2	15	2
CA troll	0	0	11	4	5	1	16	2
CA sport	0	0	0	0	0	0	6	0
TOTAL CATCH	40	5	257	34	445	60	742	
ESCAPEMENT								
Hatchery	90		80		221		391	
Other	1		3		25		29	

a 1978 brood released from Bonneville Hatchery. Tag codes 7-17-33 and 7-17-35.

b Data for 5- and 6-year-old fish not available.

Table 4. Freshwater adult size for Bonneville Hatchery upriver bright fall chinook egg bank program (WDF unpublished data).

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Couercial	Ceremonial and subsistence	Commercial	Recreational	Natural	Hatchery	Total production
1980	0	0	300	0	0	0	300
1901	1,300	0	300	0	0	2,700	4,300
1982	900	1,100	700	0	0	3,600[a]	8,800[b]
1903	1,900	800	1,100	100	0	6,100[c]	14,400[b]
1984[e]	(1,300)	(240)	(3,200)	(200)	0	(3,500)d	(11,900)[b]

a Includes 319 Bonneville Hatchery egg-bank adults collected at Bonneville Dam north shore fish trap.

b Includes fish passing Bonneville Dam but unaccounted in upstream fisheries or escapement.

c Includes 211 Bonneville Hatchery egg-bank adults collected at Bonneville Dam north shore fish trap.

d Includes 125 Bonneville Hatchery egg-bank adults collected at Bonneville Dam north shore fish trap.

e Incomplete

Time of migration

Adults return to Bonneville Hatchery from late August through early November. The median time of return is mid- to late September (Table 5).

Spawning period

Most females are not spawned until late November or early December. During 1970-03 the spawning period began in early November and sometimes lasted until mid-January (Table 5).

Spawning areas

. Bonneville Hatchery

Age composition

Four-year-old fish are the predominant age class harvested in offshore fisheries and in returns to Bonneville Hatchery (Tables 2, 3, and 6).

Size

Lengths of adults returning to Bonneville Hatchery in 1983 are shown in Table 7. Adults that entered the ocean as subyearlings tended to be longer than fish that entered as yearlings.

Sex ratio

Approximately twice as many females as males returned to Bonneville from the 4- and 5-year-old classes in 1983, but four times as many males as females returned as 3-year olds (Table 7).

Fecundity

Fecundity has averaged from 4,206 eggs/female up to 4,903 eggs/female (Table 5). Fecundities for each return year were not adjusted for differences in age and lengths of the females.

Biochemical-genetic characteristics

Preliminary data on isozyme gene frequencies have been reported by Schreck et al. (1904).

JUVENILE LIFE HISTORY

Time of emergence

Eggs are incubated in 47.5-51°F well water at Bonneville Hatchery (D. Banks, ODFW, personal communication). Fertilization to eyed-egg takes approximately 4 weeks, eyed-egg to hatch about 2 l/2 weeks, and hatch to swim-up (ponded) about 6 weeks.

Table 5. Upriver bright fall chinook handled and spawned at Bonneville Hatchery, 1977-83.

	Handled						Spawned				
Year	Female	Male	Jack	Total	Median date	Range	Female	Median date	Range	Eggs taken	Est. fecundity
1977	460	114	--	574	NA	NA	260	NA	NA	1,180,000	4,530
1978	516	191	--	707	WA	NA	428	11/30	11/9-12/21	1,800,000	4,206
1979	525	la1	--	706	NA	NA	425	11129	11/8-12/27	1,904,000	4,400
1900	1,020	324	50	1,402	NA	NA	874	11127	11/6-12/16	4,285,000	4,903
1981[a]	2,008	1,150	273	3,439	9/17	8/27-11/5	1,255	11/12	11/5-11/26	5,523,000	4,401
1982[b]	3,504	1,395	1,194	6,173	9/17	9/17- 1/14	2,519	12/3	11/5- 1114	11,881,000	4,716
1983[c]	6,203	2,393	327	9,003	9/23	9/2 -11/28	4,099	12/2	12/3- 1/5	17,527,000	4,276

a First year that adults volitionally returned to Bonneville Hatchery. 1,447 were females and 1,000 were males.

b Of total adults handled, 1,502 females and 1,047 males were volitional returns to hatchery.

c Of total adults handled, 3,201 females and 300 males were trapped at Bonneville Dam, 3,002 females and 2,093 males volitionally returned to Bonneville Hatchery, and 733 females and 41 males strayed into Cascade Hatchery.

Table 6. Percentage return to Bonneville Hatchery of Ad+CWT-marked upriver bright fall chinook, 1977-80 broods (Hansen 1983).

Brood year	Number released	Size (fish/lb)	Release date	Water supply	Percentage return at each age[a] 2	3	4	5	6	Total return No.	%	Age 3-6 return No.	%
1977	44,830	20.3	10/30/78	Tanner Cr.	0.029(13)	0.136(61)	0.379(170)	0. 134(60)	0.002(1)b	305	0.680	292	0.651
1977	44,430	23.8	10/30/78	Well	0.000(0)	0.038(17)	0.070(36)	0.050(221	0.00(0)b	70	0.158	70	0.158
1977	32,745	8.0	3/13/79	Well	0.202(66)	0.1316433	0.424(139)	0.140(46)	0 .00(0)b	294	0.897	228	0.695
1978	51,227	11.6	11/20/79	Well	0.053(27)	0.109(56)	0.338(173)	0.031(16)[b]	-- (-)	272	0.531	245	0.478
1978	49,334	7.0	3/13/80	Well	0.128(63)	0.049(24)	0.101(50)	0.008(4)[b]	-- (-)	141	0.286	78	0.158
1979	100,717	83.0	6/30/80	Well-Tanner	0.037(37)	0.059(59)	0.021(21)[b]	-- (-)	-- (-)	117	0.917	80	0.080
1979	51,274	13.6	11/11/80	Tanner Cr.	0.004(2)	0.076(39)	0.197(101)[b]	-- (-)	-- (-)	142	0.277	140	0.273
1980	99,632	63.8	6/12/81	Well	0.053653)	0.022(22)[b]	-- (-)	-- (-)	-- (-)	75	0.075	22	0.022
1980	102,221	34.9	7/30/81	Well	0.114(117)	0.043(44)[b]	-- (-)	-- (-)	-- (-)	161	0.157	44	0.043
1980	50,702	11.5	11/9/81	Well	0.00(0)	0.002(4)[b]	-- (-)	-- (-)	-- (-)	1	0.002	1	0.002
1980	49,813	9.3	11/9/81	Tanner Cr.	0.000(0)	0.008(4)[b]	-- (-)	-- (-)	-- (-)	4	0.008	4	0.008
1980	50,553	7.2	3/17/82	Well	0.374(189)	0.016(8)[b]	-- (-)	-- (-)	-- (-)	197	0.390	8	0.016
1980	48,052	7.4	3/17/82	Herman Cr.	0.015(7)	0.002(1)b	-- (-)	-- (-)	-- (-)	8	0.017	1	0.002

[a] Actual return is in parentheses.

b In fall 1983 a total of 2,349 female and 2,052 male late spawning fall chinook volitionally returned to Bonneville Hatchery. An additional 733 females and 41 males which returned to Cascade Hatchery were trucked to Bonneville Hatchery for maturation and spawning. This table has been adjusted accordingly and tagged returns are only for those adults returning to Bonneville Hatchery.

Table 7. Estimated age, sex, and length of age 3 through 5 upriver bright fall chinook returning to Bonneville Hatchery in the fall of 1983[a] (Hansen 1983).

Age group	Number		% return		Mean length (cm)		Length range (cm)	
	Male	Female	Male	Female	Male	Female	Male	Female
3_1[b]	347	83	6.7	1.6	68.3	71.9	51.1- 88.8	65.4-77.6
3_2[b]	93	26	1.8	0.5	60.3	64.5	56.6- 69.1	54.3-73.5
4_1[c]	1,138	2,810	22.0	54.3	82.3	80.9	65.7-104.0	66.7-96.3
4_2[c]	31	129	0.6	2.5	76.2	75.4	70.2- 84.0	56.3-83.9
5_1[d]	119	290	2.3	5.6	93.9	86.5	86.2-183.1	69.8-98.0
5_2[d]	26	83	0.5	1.6	93.7	86.5	88.4- 98.0	83.1-91.4
Totals	1,754	3,421	33.9	66.1				

[a] A total of 4,401 adults volitionally returned to Bonneville Hatchery. An additional 774 adults that returned to Cascade Hatchery were trucked to Bonneville Hatchery and intermixed with Bonneville returns. Data are based on a random sample of 566 untagged adults.

[b] 1980 brood.

[c] 1979 brood.

[d] 1978 brood.

Time, age, and size at migration

Upriver bright fall chinook are incubated in well water and reared in Tanner Creek or well water. Juvenile fish were released as subyearlings in the summer or fall or as yearlings in the spring (Table 1). The regime resulting in the highest survival (escapement to the hatchery) is a fall release (November 10 of subyearlings at 13-20 fish/lb, reared in Tanner Creek water (Hansen 1983). Subyearling releases in the fall account for 92% of the adults returning to Bonneville Hatchery.

Juveniles were captured in purse seines in Oregon and Washington coastal waters only during May and June (Figure 1).

Survival rate

Green egg-to-fry survival at Bonneville Hatchery averages 84-85%. The smolt-to-adult survival (return to hatchery) of tagged and untagged groups at age 4 of 1977 and 1979 brood subyearlings reared in Tanner Creek and released in the fall averaged 0.335% and 0.412%, respectively. Survival to return to the hatchery and catch rates of tagged groups are listed in Tables 6 and 8, respectively.

DISEASE HISTORY

Upriver brights reared at Oxbow Hatchery in Herman Creek water have experienced cold-water disease, bacterial gill disease, and dropout syndrome in 1981. Juveniles (500/lb-80/lb) reared at Bonneville Hatchery experienced bacterial gill disease and clubbed-gill dropout syndrome until the 1983 brood year (Terry Kreps, ODFW, personal communication).

IHN, ENV, and BKD have been found in upriver bright adults at Bonneville Hatchery. In 1984-85 (fish spawned 26 December 1984 and 2 and 9 January 1985) eggs from females found to have IHN virus were destroyed. Blood samples reveal a high level of ENV in this stock (R. Holt, ODFW, personal communication).

PRIORITY INFORMATION NEEDS

1. Genetic characteristics, including comparisons with fish from upriver production areas

2. Fecundity/length relationship

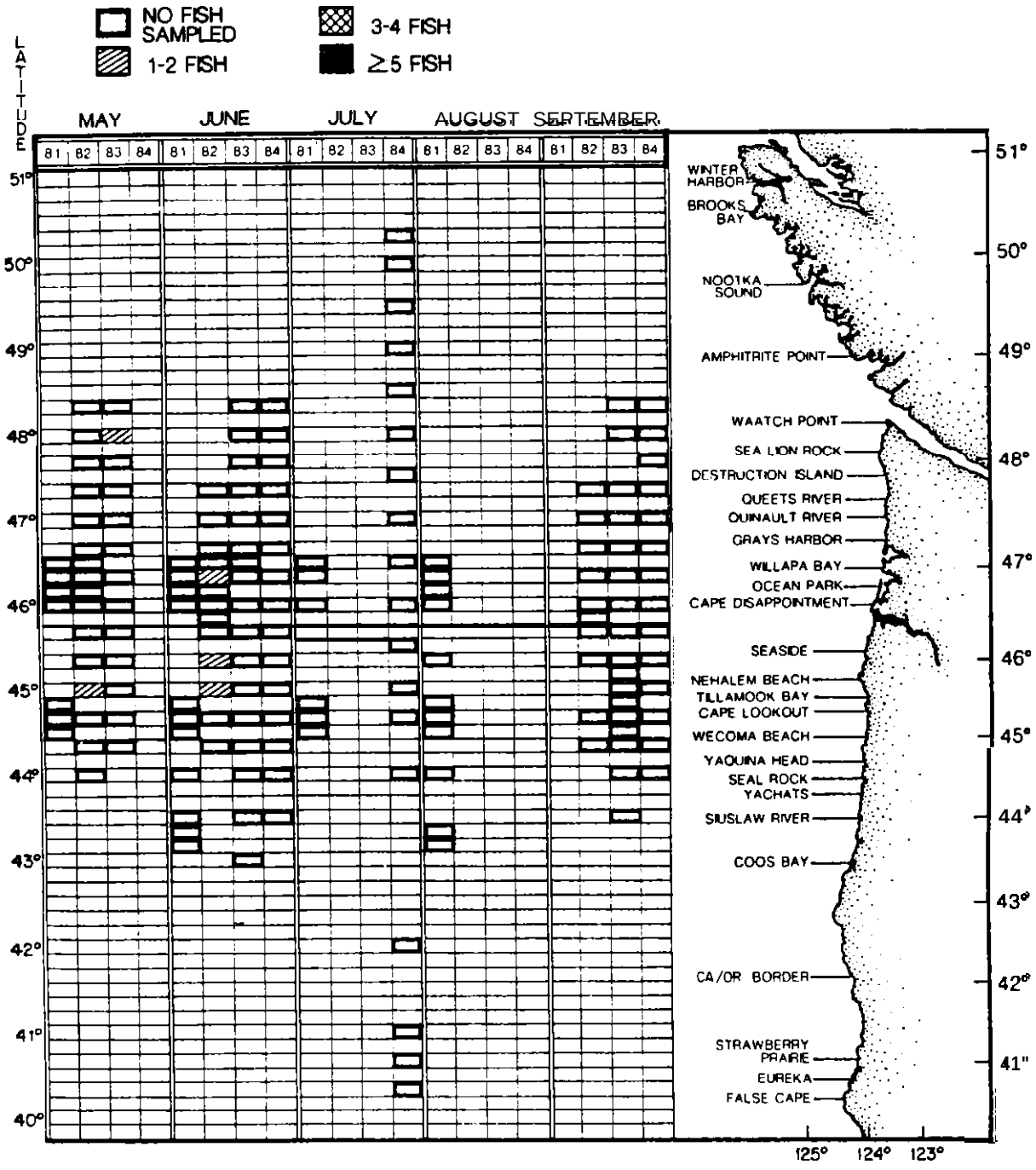

Figure 1. Recoveries in the Pacific Ocean (1981-84) of coded-wire tagged juvenile upriver bright fall chinook released from Bonneville Hatchery (data from Wakefield et al. 1981; Fisher et. al 1983; Fisher et al. 1984; Fisher and Pearcy 1985.)

Table 8. Estimated catches in Alaska, British Columbia, Washington, and Oregon of experimental 1977-brood upriver bright fall chinook released from Bonneville Hatchery (Hansen 1983).

Release group			Catch/100,000 juveniles released				
			1979	1980	1981	1982	1983
Subyearling release (Tanner Cr.)							
		Alaska	4	0	344	80	(2)
		British Col.	47	286	248	62	
1. Release date:	10/30/78	Washington	0	47	58	9	
2. No. released:	44,830	Oregon	0	0	13	0	
3. Size at release:	20.3/lb	Inland[b]	0	31	51	92	0
		Totals	51	364	714	243	
Subyearling release (well)							
		Alaska	0	2	34	16	(0)
1. Release date:	10/30/78	British Col.	16	38	158	68	
2. No. released:	44,430	Washington	0	0	20	0	
3. Size at release:	23.8/lb	Oregon	0	7	9	0	
		Inland	0	0	18	23	0
		Totals	16	47	239	107	
Yearling release (well)							
		Alaska	0	0	180	125	(12)
1. Release date:	3113179	British Col.	46	216	725	159	
2. No. released	32,745	Washington	0	208	153	15	
3. Size at release:	8.0/lb.	Oregon	0	21	83	12	
		Inland	36	122	177	43	0
		Totals	82	567	1,318	354	

a Observed catches are shown in parentheses. Blanks indicate data were not available as of 7/1/84.

b Columbia River gill-net fishery.

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CARSON STOCK SPRING CHINOOK
(including Wind River and Little White Salmon River)

This summary contains information on spring chinook produced at Carson and Little White Salmon national fish hatcheries. Data on Carson stock reared at other facilities can be found in the Grande Ronde Spring Chinook and Kooskia Hatchery Spring Chinook summaries.

PRODUCTION

During 1979-1984 releases from Carson Hatchery ranged from 1.7-2.9 million yearlings and averaged about 2.4 million. Yearling production from Little White Salmon Hatchery has numbered between 0.2-0.8 million and averaged 0.6 million for the same period. Fingerling and fall release juveniles are also planted intermittently, especially from Little White Salmon Hatchery where releases ranged from 0.1-0.7 million during 1979 and 1981-1984.

GEOGRAPHIC LOCATION

Streams

The following tributaries have been stocked either with direct transfers of Carson stock or are utilizing local returns that are considered to be of Carson ancestry:

Washington	Oregon	Idaho
Wind	Grande Ronde	Middle and North Fk. Clearwater
Little White Salmon		
Wenatchee-Icicle Crk.		
Entiat		
Methow		

Hatcheries

Carson stock spring chinook or their derivatives are commonly reared at the following hatcheries:

Washington	Oregon	Idaho
Carson	Lookingglass	Kooskia
Little White Salmon		Dworshak
Leavenworth		
Entiat		
Winthrop		

ORIGIN

Production of spring chinook at Carson Hatchery commenced in 1945 with an experimental transfer of 35,382 eggs from the Salmon River in Idaho in order

to determine the feasibility of a full production program which was scheduled to begin in 1951 (WDF and USFWS 1951). The program eventually began in 1958 and 1959 using spring chinook collected at Bonneville Dam for broodstock. The release of 1,016,500 yearlings in 1960 and 260,700 yearlings in 1961 provided the basis for establishment of a permanent program at Carson Hatchery. Carson Hatchery has subsequently spawned only Wind River returns except in 1968-1970 when Bonneville Dam adults were spawned and the eggs transferred to hatcheries in the Snake system.

Releases from Little White Salmon Hatchery began in the late 1960's utilizing Eagle Creek Hatchery stock and Little White Salmon River returns. The Little White Salmon returns were from an unknown stock but probably were the result of previous off-station releases from Willard or Carson hatcheries. In later years the Little White Salmon Hatchery utilized local returns (1972 brood to present) and/or received eggs from Carson (1972-1974 broods). South Santiam (1974 brood) and Klickitat (1966, 1974 brood) stock spring chinook were also reared and released at Little White Salmon Hatchery. Little White Salmon spring chinook are considered to be a Carson stock derivative (substock).

ADULT LIFE HISTORY

Run size, catch, and escapement

Between 1970 and 1984 the adult spring chinook minimum run has averaged 4,200 to the Wind River (Table 1) and 1,400 to the Little White Salmon River (Table 2). From a 1970-1974 average of 300 adults, returns to the Little White Salmon increased substantially beginning in 1975 (1,400). Virtually all of the escapement to the Little White Salmon River is accounted at the hatchery rack located at the head of Drano Lake. Some natural escapement occurs in the Wind River but is minor in most years, averaging 350 fish.

The catch distribution based on coded wire tag recoveries and the genetic stock identification method indicates that ocean harvest is relatively minor Survival of coded wire tagged yearlings from Carson Hatchery has consistently been poor (<O.l%), but the few recoveries that do occur are primarily in freshwater as recreational catch, incidental harvest during commercial fisheries, and hatchery escapement. Based on genetic stock identification methodology, of the 73,200 chinook salmon caught in the May 1982 troll fishery off Washington, approximately 1,700 were upper Columbia spring chinook produced from Carson, Little White Salmon, Klickitat, Warm Springs, Round Butte, Leavenworth, and Winthrop hatcheries (Miller et al. 1983).

Table 1. Minimum freshwater adult run size of Carson stock spring chinook returning to Wind River, 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial[a]/	Ceremonial and subsistence[b]/	Commercial[a]/	Recreational[c]/	Natural[d]/	Hatchery	Total production
1970	N/A	N/A	N/A	250	250	3,950	4,450
1971	N/A	N/A	N/A	300	1,950	3,500	5,750
1972	N/A	N/A	N/A	1,450	1,100	6,550	9,100
1973	N/A	N/A	N/A	450	200	2,100	2,750
1974	N/A	N/A	N/A	200	100	1,400	1,700
1975	0	N/A	0	2,450	100	4,900	7,450
1976	0	N/A	0	150	100	5,200	5,450
1977	N/A	N/A	N/A	1,600	150	2,950	4,700
1978	N/A	N/A	0	1,650	250	2,950	4,850
1979	0	N/A	0	800	150	2,550	3,500
1980	0	N/A	0	0	100	3,350	3,450
1981	0	N/A	0	0	150	2,550	2,700
1982	0	N/A	0	0	100	1,650	1,750
1983	0	N/A	0	0	250	2,500	2,750
1984	0	N/A	0	0	200	2,100	2,300
Mean	N/A	N/A	N/A	600	350	3,200	4,200

a/ Contribution from Carson stock is not available for years with a spring season (1970-1974, 1977) and assumed to be negligible for other years with a possible exception of the 1978 winter season treaty catch (2,600 chinook).
b/ Ceremonial and subsistence fishing opportunity limited to mainstem Columbia River only,
c/ Wind River only.
d/ R. Roler, WDF, personal communication.
N/A: Not available.

Table 2. Minimum freshwater adult run size Of Carson stock spring chinook returning to Little White Salmon River. 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial[a]/	Ceremonial and subsistence[b]/	Commercial[a]/	Recreational[c]/	Natural[d]/	Hatchery	Total production
1970	N/A	N/A	N/A	0	N/A	200	200
1971	N/A	N/A	N/A	0	N/A	750	750
1972	N/A	N/A	N/A	0	N/A	350	350
1973	N/A	N/A	N/A	0	N/A	150	150
1974	N/A	N/A	N/A	0	N/A	50	50
1975	0	N/A	0	0	N/A	1,400	1,400
1976	0	N/A	0	0	N/A	2,400	2,400
1977	N/A	N/A	N/A	0	N/A	3,450	3,450
1978	N/A	N/A	0	0	N/A	1,650	1,650
1979	0	N/A	0	100	N/A	900	1,000
1980	0	N/A	0	0	N/A	950	950
1981	0	N/A	0	0	N/A	2,600	2,600
1982	0	1,650[e]/	0	500	N/A	2,500	3,000
1983	0	N/A	0	100	N/A	2,600	2,700
1984	0	N/A	0	0	N/A	550	550
Mean	N/A	N/A	N/A	50	N/A	1,350	1,400

a/ Contribution from Carson stock is not available for years with a spring season (1970-1974, 1977) and assumed to be negligible for other years with a possible exception of the 1978 winter season treaty catch (2,600 chinook).

b/ Ceremonial and subsistence fishing opportunity limited to mainstem Columbia River only,

c/ Drano Lake only.

d/ Not available and limited to a few adults not trapped at barrier dam. No natural production potential in existing accessible area.

e/ Surplus hatchery returns donated to Yakima Indian Nation for personal use.

Time of migration

Spring chinook destined for areas upstream of Bonneville Dam begin entering the Columbia River in large numbers in mid-March. Counts peak at Bonneville Dam usually between April 20 and April 28 but can be earlier during abnormally low flow years or later during high run-off.

At Little White Salmon Hatchery, about one mile upstream from the confluence with the Columbia River, approximately 50 percent of the escapement has been collected by the end of May (Figure 1). Timing to Carson Hatchery is slightly later because of the possible delays at Shipperd Falls (river mile 2.0) and the additional migration distance to the hatchery (river mile

Spawning period

Peak of natural spawning in the Wind River occurs during the latter part of August. At Carson Hatchery, spawning commences about August 10 and can extend to about September 7.

Spawning areas

The principal spawning area in the Wind river is from the mouth of Paradise Creek (river mile 25.1) downstream approximately 10 miles.

Age composition

Carson stock spring chinook return to Carson Hatchery (Table 3) and Little White Salmon Hatchery (Table 4) primarily as four and five-year adults with lesser numbers of jacks (age-31.

Size

Jacks are characteristically less than about 65 cm. in fork length. In 1982 and 1984, four and five-year adults averaged about 75 cm. and 92 cm. respectively, with males slightly larger than females (Table 5). In 1982, the fork length separating most four and five-year spring chinook returning to Little White Salmon River occurred at approximately 83 cm. (Figure 2).

Sex ratio

Based on biological sampling at Carson Hatchery, females comprised an average of 66 percent of the four-year-old returns (Figure 3). The sex ratio of five year adults was closer to 1:1 with females averaging 52 percent of the age class.

Fecundity

Age and length specific fecundity is not available.

From 1968-1984, the number of eggs per female at Carson Hatchery ranged from 3,640 (1968) to 5,180 (1978) and averaged 4,300 (D. Zirjacks, USFWS, personal communication). During 1978-1982, fecundity at Little White Salmon Hatchery averaged 4,000 eggs per female and ranged from about 3,800-4,800 (C. Burley, USFWS, personal communication).

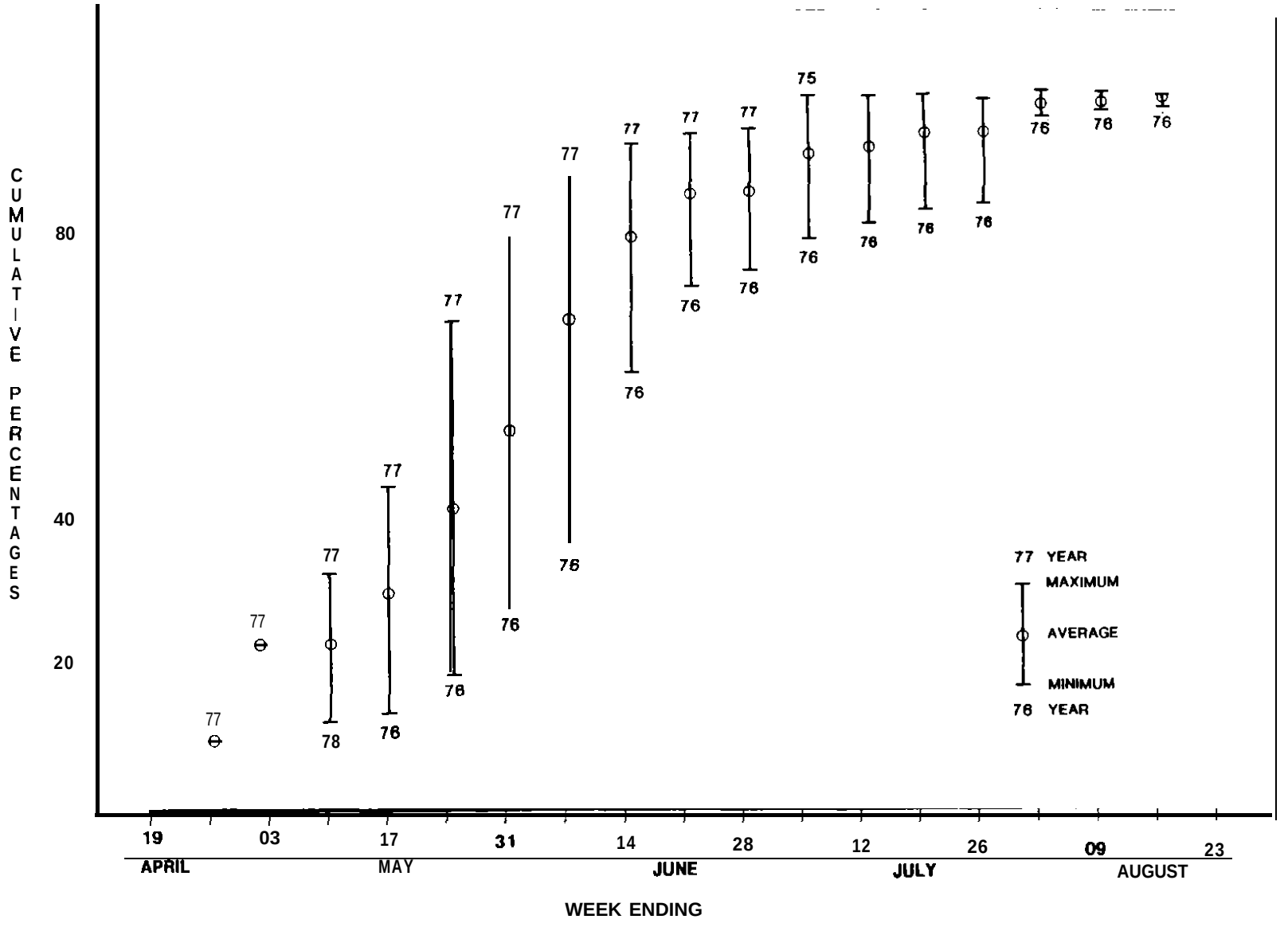

Figure 1. Cumulative percent of adult spring chinook handled at Little White Salmon Hatchery, 1975-1978.

Table 3. Age composition from scale analysis of Carson stock spring chinook returning to Carson National Fish Hatchery, 1971-1984 (T. Roth, USFWS, personal communication).

Return Year	Age 3		Age 4		Age 5		Age 6		Total
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
1971	952	22.4	2,580	60.7	718	16.9	0	0.0	4,250
1972	49	0.7	4,123	62.1	2,469	37.2	0	0.0	6,641
1973	101	4.6	1,022	46.7	1,066	40.7	0	0.0	2,189
1974	384	24.6	905	57.9	261	16.7	13	0.8	1,563
1975	10	0.2	4,630	94.4	265	5.4	0	0.0	4,905
1976	288	5.2	161	2.9	5,025	91.4	24	0.4	5,498
1977	22	0.7	2,907	97.7	46	1.5	0	0.0	2,975
1978	12	0.4	598	20.1	2,361	79.3	5	0.2	2,976
1979	4	0.2	2,328	91.6	209	8.2	0	0.0	2,541
1980	32	1.0	606	18.0	2,730	81.1	0	0.0	3,368
1981	3	0.1	901	35.4	1,609	63.1	35	1.4	2,548
1982	21	1.3	1,085	65.5	550	33.2	0	0.0	1,656
1983	9	0.4	1,072	43.0	1,413	56.7	0	0.0	2,494
1984	79	3.7	1,214	59.2	789	36.6	11	0.5	2,153
Mean	140	4.7	1,728	53.9	1,394	41.2	6	0.2	3,268

Table 4. Age composition from scale analysis of Carson stock spring chinook returning to Little White Salmon National Fish Hatchery, 1970-1984 (T. Roth, USFWS, personal communication).

Return	Age 3		Age 4		Age 5		Age 6		
Year	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Total
1970	38	15.9	40	20.1	139	58.2	14	5.9	239
1971	96	11.9	688	85.1	24	3.0	0	0.0	808
1972	24	6.0	199	50.1	175	43.9	0	0.0	398
1973	9	5.0	86	48.0	81	45.3	3	1.7	179
1974	14	19.4	16	22.2	35	50.0	6	8.3	71
1975	27	1.9	1,154	82.0	214	15.2	12	0.9	1,407
1976	664	21.8	1,067	35.0	1,321	43.3	0	0.0	3,052
1977	69	2.0	3,103	88.9	308	8.8	11	0.3	3,491
1978	206	11.1	353	19.0	1,275	68.7	22	1.2	1,856
1979	21	2.3	766	04.2	114	12.5	9	1.0	910
1980	No age analysis								1,089
1981	No age analysis								2,595
1982	31	1.2	411	13.3	2,651	85.3	8	0.3	3,107
1983	14	0.5	939	36.0	1,655	63.5	0	0.0	2,608
1984	43	7.5	256	44.3	270	40.2	0	0.0	577
Mean	97	8.2	699	40.4	650	41.9	7	1.5	1,492

Table 5. Length according to sex and age for Carson stock spring chinook at Carson Hatchery (T. Roth, USFWS, personal communication).

1982	Male	Female	Male	Female	Male	Female	Male	Female
Sample	6	0	96	207	22	81	0	0
Average fork length (cm)	57.0		77.5	75.4	92.3	88.7		
Range	49-69		67-92	66-89	86-102	04-95		
Standard deviation	6.7		5.1	5.3	3.4	2.5		
Year 1984								
Sample	14	0	83	168	17	74	2	0
Average fork length (cm)	53.8		82.1	77.3	96.3	89.2	99.0	
Range	44-63		72-94	68-89	81-106	76-98	98-100	
Standard deviation	4.9		3.8	3.1	5.7	4.5	1.4	

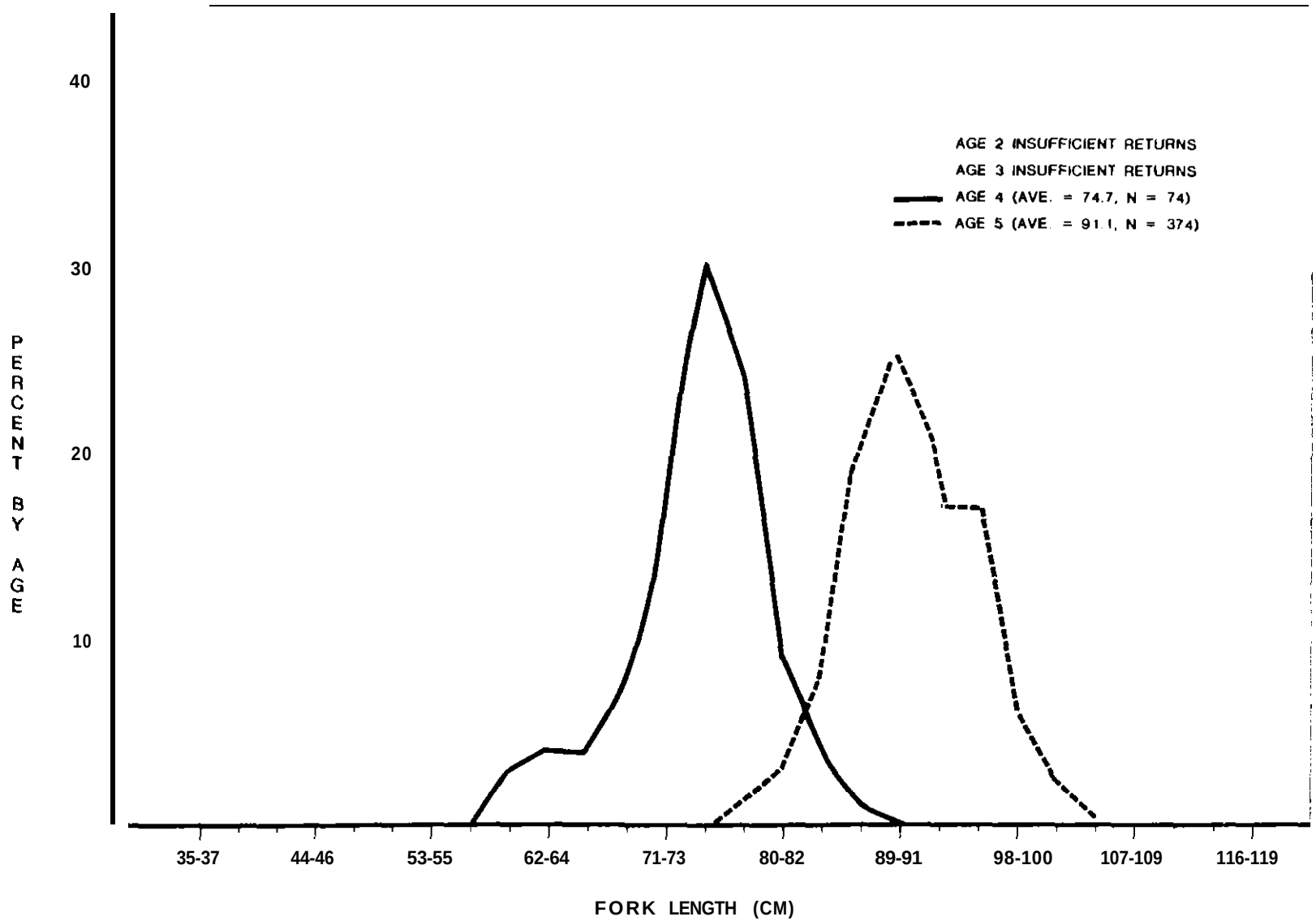

Figure 2. Length - frequency of Carson spring chinook from sampling of the Little White salmon sport fishery and surplus hatchery returns, 1982.

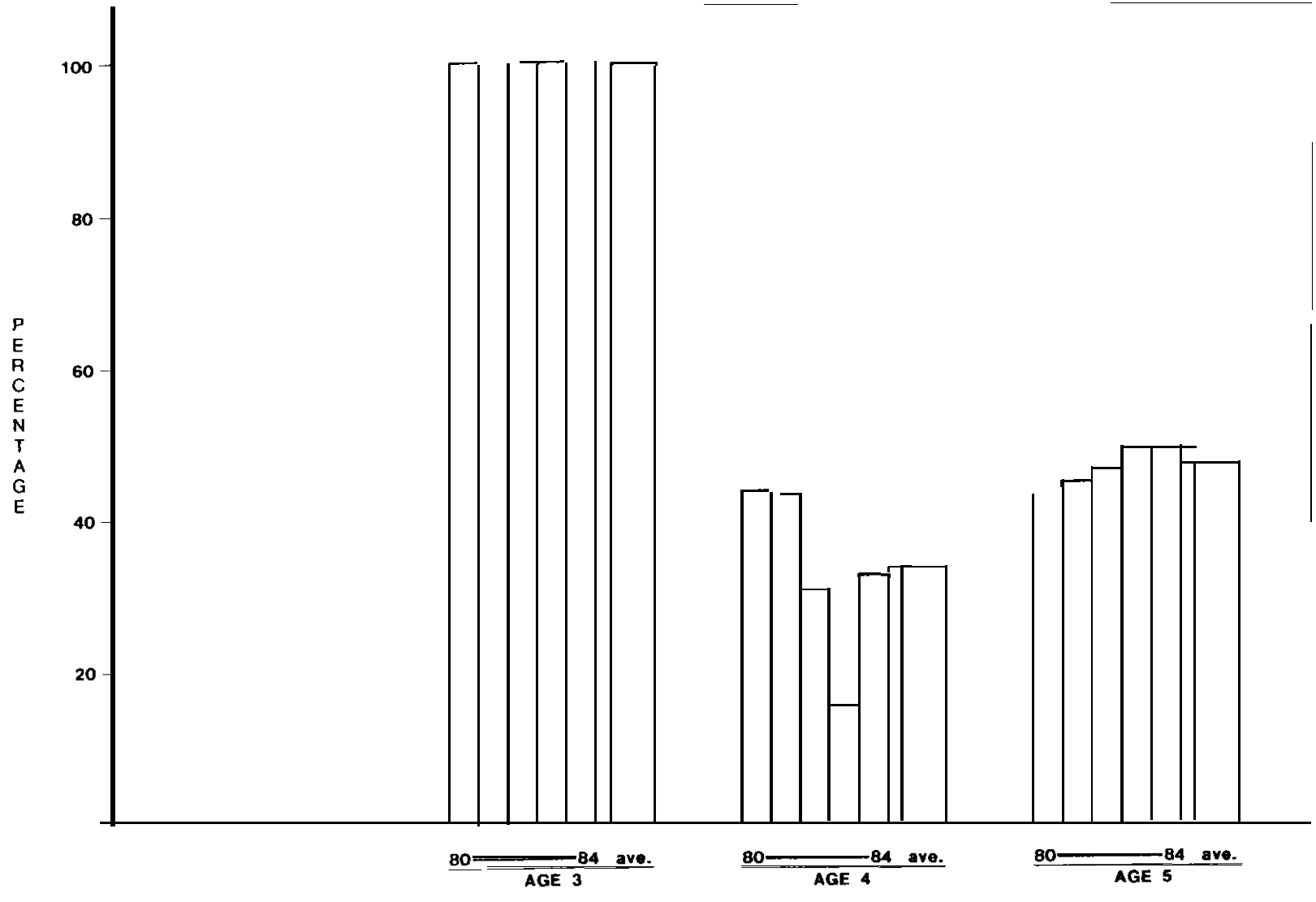

Figure 3. Percent male spring chinook returning to Carson Hatchery, 1980-1984.

Biochemical-genetic characteristics

Schreck et al. (1984) compared the electsophoretic profiles from their analysis to the historical baseline data in Milner et al. (1983) in order to evaluate the genetic stability of the isozyme gene frequencies over time. In the comparison of current vs. historical profiles for Little White Salmon spring chinook, there were no instances of statistically different isozyme gene frequencies. Based on Carson Hatchery samples, isozyme gene frequencies were statistically different for three enzyme systems. The profiles of one of the dissimilar enzymes are normally difficult to interpret and may not reflect actual genetic differentiation.

JUVENILE LIFE HISTORY

Time of emergence

No information is available on the naturally produced population

At Carson and Little White Salmon hatcheries, artificial emergence of nearly "buttoned-up" fry occurs primarily in early January to February after exposure to about 1,750 temperature units.

Time, age, and size at migration

No information is available on the naturally produced population

Juveniles are customarily released as yearling smolts in April and May at 16-25 fish/pound and 110-145 mm. in length. Smolt migration to the Columbia estuary is rapid. Coded wire tagged yearlings released on May 3, 1979 from Carson Hatchery had a median date of recovery in the estuary (river mile 47) on May 12 and 19, 1979 for beach and purse seine samples, respectively (Dawley et al. 1982). The final recoveries occurred on May 20, 1979.

Fingerlings are released in May and June at 30-60 fish/pound. Fall releases are typically 30-70 fish/pound when liberated in October. Downstream smolt migration of fingerlings and fall releases occur during the following spring based on coded wire tag recoveries in the estuary and the absence of "sub-l" age adult returns.

Survival rate

Survival rates of fingerling and fall releases are not available.

Smolt to adult survival was about 2.0 percent for two 1973 brood coded wire tagged groups of Carson stock spring chinook reared at Speelyai Hatchery and released into the North Lewis River (TAC 1984). Survival rates have been substantially lower (<O.l%) for coded wire tagged yearlings from Carson Hatchery.

DISEASE HISTORY

Infectious hematopoietic necrosis (IHN) was detected in the adults returning to Little White Salmon Hatchery in 1981. Common bacterial diseases encountered at Carson and Little White Salmon hatcheries include: kidney disease, gill disease, cold water disease, and furunculosis (Table 6).

PRIORITY INFORMATION NEEDS

A better understanding of ocean migration and catch contribution/distribution is necessary in order to assess the productivity of Carson stock spring chinook and provide useful information on determining its desirability for enhancing runs in upper Columbia River areas.

Table 6. Diseases encountered by Carson stock spring chinook at Carson and Little Salmon (E. Pelton, USFWS, personal communication).

Type	Disease	Infected group
Bacterial :	* Kidney disease	Juveniles
	* Gill disease	Juveniles
	* Cold water disease	Juveniles
	* Furunculosis	Juveniles, pre-1981
Parasitic:	* *Costia*	Juveniles
	* *Epistylis*	Juveniles
	* *Schyphidia*	Juveniles
	* *Ceratomyxa shasta*	Adults
	* *Hexamita*	Juveniles
	* *Myxobolus sp.*	Juveniles
	Cystidicola stigmatura	Juveniles
	* *Salmincola edwardsi*	Juveniles
	Dermociptidium	Juveniles
Viral :	Infectious hematopoietic necrosis (IHN)	Adults, 1981
	Viral erythrocytic necrosis (VEN)	Juveniles, 1983-1984
Other:	* Sunburn	Juveniles
	* Dropout	Juveniles
	* Phoma *herbarum*	Juveniles
	* *Saprolegnia invaderis*	Juveniles
	* Coagulated yolk	Juveniles
	* Gas bladder fungus	Juveniles
	Blue slime	Juveniles, 1981

* Commonly occurring.

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BONNEVILLE POOL HATCHERY FALL CHINOOK

The four major stocks of fall chinook in the Columbia River include:

1. Bonneville Pool Hatchery stock (BPH).
2. Lower River Hatchery stock (LRH).
3. Upriver Bright stock (URB).
4. Lower River Wild stock (LRW).

PRODUCTION

BPH fall chinook are produced almost entirely by artificial propagation. Some natural production exists in the Rlickitat, Wind, Big White Salmon and Hood rivers.

Most of the hatchery releases are reared at Spring Creek Hatchery and to a lesser extent at Rlickitat and Little White Salmon hatcheries. BPH fingerling releases from Spring Creek ranged between 12.5 - 22.5 million and averaged 16.8 million during 1979-1983. For this same period at Little White Salmon Hatchery, fingerling releases ranged between 8.4 - 11.4 million (average 9.6 million). An average of 3.6 million (range: 2.5 - 4.91 fingerlings were liberated from Klickitat Hatchery during 1979-1983. Periodically, juveniles are released in the fall in much fewer numbers In 1980 and 1981, John Day pool and Rock Creek each were stocked with approximately 1 million fingerings from Little White Salmon and Spring Creek hatcheries. In 1982 about 1 million fingerlings reared at Spring Creek Hatchery were released into the Umatilla River.

GEOGRAPHIC LOCATION

Streams

Minor numbers of BPH fall chinook are produced naturally in the Rlickitat and Wind rivers. Some negligible natural production of BPH fall chinook may occur in the Big White Salmon and Hood rivers.

Hatcheries

BPH fall chinook are reared at Klickitat, Little White Salmon and Spring Creek hatcheries. Frequently, surplus eggs from Spring Creek Hatchery have been transferred to other Columbia River hatcheries to satisfy production needs.

ORIGIN

Of the tributaries that presently flow into Bonneville pool, fall chinook were native to the Wind, Little White Salmon, Big White Salmon, and Hood rivers (Fulton 1968). Completion of Bonneville Dam in the late 1930's

resulted in the inundation of virtually all of the spawning area in the Little White Salmon River. Condit Dam blocked the Big White Salmon run of fall chinook beginning in 1912. Fall chinook were not native to the Klickitat River but were introduced there in 1946 (WDF and USFWS 1951).

Hatchery production began in 1896 from eggs collected in the Little White Salmon River (WDF and USFWS 1951). Some of the 1897 egg-take was transferred to Clackamas Hatchery. In the early years of operation, Little White Salmon fall chinook were intermittently planted in many tributaries from the Deschutes to the Sandy River.

Within several years of the establishment of the Little White Salmon program, other hatchery and egg-take facilities were constructed on the Wind River and Big White Salmon River for propagation of fall chinook (WDF and USFWS 1951). In 1901, fall chinook eggs collected from the Big White Salmon River were transferred to facilities on Spring Creek. The initial adult return in 1904 provided the basis for subsequent production, although Big White Salmon fall chinook may have periodically supplemented the Spring Creek egg-take. The Spring Creek Hatchery program was very successful and surplus eggs were readily available for transfer to other stations. This situation has continued at Spring Creek Hatchery with the exception of 1972, 1974, 1983 and 1984. Some of the Spring Creek Hatchery production in 1973 and 1975 originated from shipments of 1972 and 1974 brood LRH fall chinook eggs. Spring Creek Hatchery releases in 1973 included 8.9 million fingerlings of 1972 brood LRH fall chinook from Toutle Hatchery. The 1974 brood egg shortage was supplemented with 9.5 million LRH eggs from Bonneville Hatchery. From these 9.5 million eggs, 3.2 million fry were shipped back to Bonneville Hatchery, 3.6 million fry and fingerlings were transferred to Little White Salmon Hatchery, and 1.9 million fingerlings were released into the Big White Salmon River. Klickitat Hatchery has had a chronic problem of meeting escapement and has utilized stock from Spring Creek Hatchery and other locations (Table 1). Recent BPH fall chinook programs at Little White Salmon and Klickitat hatcheries have either received eggs directly from Spring Creek Hatchery or have utilized local returns that are considered to be derivatives of Spring Creek stock.

ADULT LIFE HISTORY

Run size, catch, and escapement

Since 1970, the BPH fall chinook run has averaged about 104,000 adults (Table 2). From 1979-1984, the harvest of BPH in the freshwater fisheries was determined primarily by expansion of coded wire tags collected during fishery sampling. Prior to 1979, catch was determined by applying the 1979 stock specific catch per escapement proportions in the fisheries to the particular stock escapement for each year. In 1980-1984, natural and hatchery escapements were adjusted, based on coded wire tag recoveries, for chinook straying to non-origin areas. The total production values in Table 1 include BPH fall chinook that migrated past Bonneville Dam but were not accounted in subsequent fisheries or escapement.

Table 1. Releases of non-BPH stock fall chinook into Klickitat River*.

Brood year	Release year	Number released	Type	Hatchery	Stock
1970	1971	1,079,900	Fingerling	Klickitat	Cowlitz
1971	1972	982,400	Fingerling	Klickitat	Cowlitz
1971	1972	496,500	Fingerling	Klickitat	Cowlitz
1972	1973	1,636,OOO	Fingerling	Klickitat	Toutle
1973	1974	1,211,600	Fingerling	Klickitat	Cowlitz
1973	1974	233,400	Fingerling	Klickitat	Toutle
1973	1975	134,100	Yearling	Klickitat	Toutle
1974	1975	106,700	Under-fed	Klickitat	Ringold
1974	1975	383,700	Fingerling	Klickitat	Cowlitz
1974	1975	626,100	Fingerling	Klickitat	Kalama
1974	1975	44,400	Fall releases	Klickitat	Cowlitz
1974	1975	45,000	Yearling	Klickitat	Cowlitz
1975	1976	1,085,500	Fingerling	Klickitat	Cowlitz
1975	1976	51,100	Fingerling	Klickitat	Kalama
1977	1978	819,200	Fingerling	Klickitat	Washougal
1977	1978	2,555,800	Fingerling	Klickitat	Bonneville Hatchery
1978	1979	3,452,800	Fingerling	Klickitat	Cascade
1979	1980	3,139,400	Fingerling	Klickitat	Bonneville Hatchery

a/ Release years 1967-1983 and complete for WDF facilities only.

Table 2. Freshwater adult run size of BPA fall chinook to Oregon and Washington, 1970-1984 (WDF 1985).

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial	Ceremonial and subsistence[a]	Commercial	Recreational	Natural	Hatchery	Total production[b]
1970	12,300	N/A	86,300	200	2,400	10,400	164,000
1971	18,500	N/A	45,700	300	3,400	12,800	115,500
1972	13,000	N/A	17,300	300	3,900	0,900	45,700
1973	17,900	N/A	53,100	400	2,200	17,200	112,800
1974	17,600	N/A	18,900	200	1,600	11,200	70,200
1975	78,000	N/A	54,700	200	3,200	35,000	184,100
1976	65,600	N/A	40,000	200	3,100	24,600	182,200
1977	19,400	N/A	41,500	100	1,300	21,500	107,700
1978	25,500	N/A	23,400	200	2,400	18,000	99,700
1979	28,800	N/A	22,300	100	1,900	18,800	95,200
1980	23,400	0	31,800	100	2,600	35,100[d]	97,000
1981	33,100	700[c]	3,400	0	1,500	32,400[e]	86,300
1982	48,900	0	35,700	300	2,500	33,200[f]	120, 800[i]
1983	7,900	0	3,600	100	1,0000	10,700[g]	20,800
1984	(19,200)	0	(5,700)	(2,300)	(700)	(10,800)[h]	(47,200)
Mean	28,600	N/A	32,200	300	2,200	20,000	103,900

a Not available but assumed to be minor.
b Includes fish passing Bonneville Dam but not accounted for in upstream fisheries or escapement.
c TAC (1983).
d Includes 8,145 Bonneville Pool Batchery stock fall chinook that strayed to other Columbia River hatcheries.
e Includes 7,311 Bonneville Pool Hatchery stock strays.
f Includes 3,800 Bonneville Pool Batchery stock strays.
g Includes 603 Bonneville Pool Hatchery stock strays.
h Includes 1,198 BPH stock strays.
i Includes minor test fishing catch.
( ) (Preliminary).
: Not available.

Between 1970-1984, natural escapement has averaged about 900 in the Big White Salmon River and 650 in the Wind and Klickitat rivers (Table 3).

Based primarily on the success of Spring Creek Hatchery releases, BPH fall chinook are one of the major contributors to chinook fisheries on the Washington coast and in the Columbia River. According to 1971 and 1972 brood coded wire tag releases, about 38 percent of the overall BPH harvest occurs off the Washington coast and 20 percent in the Columbia River commercial fisheries (Figure 1). Recreational catch upstream of Megler-Astoria Bridge is negligible.

Time of migration

Upstream migration begins in early August with greatest abundance in the Columbia River estuary in late August and early September. Counts of BPH fall chinook at Bonneville Dam generally peak between September 4 and September 9. Approximately 90 percent of the run has migrated past Bonneville Dam by September 20 (Figure 2).

Spawning period

Peak of spawning is mid-September at Spring Creek Hatchery. Natural spawning peaks in late September on the Wind River and early October on the Klickitat River.

Spawning areas

Fall chinook spawn in the lower 2 mile reaches of the Wind River downstream of Shipperd Falls and in the lower 1 mile of the Big White Salmon River downstream of Condit Dam. Spawning occurs intermittently throughout the Klickitat River downstream of the hatchery (river mile 42).

Age composition

BPH fall chinook mature primarily as three-year-old adults (Table 4). From 1970 to 1984, age-3 fish averaged 56 percent of the BPH run returning to the Columbia River. A much higher percentage of BPH fish return as three-year-old adults than for LRH (35 percent), URB (24 percent), and LRW (18 percent) fall chinook stocks. The five-year-old component has been low, typically less than 2 percent of the total returns.

Size

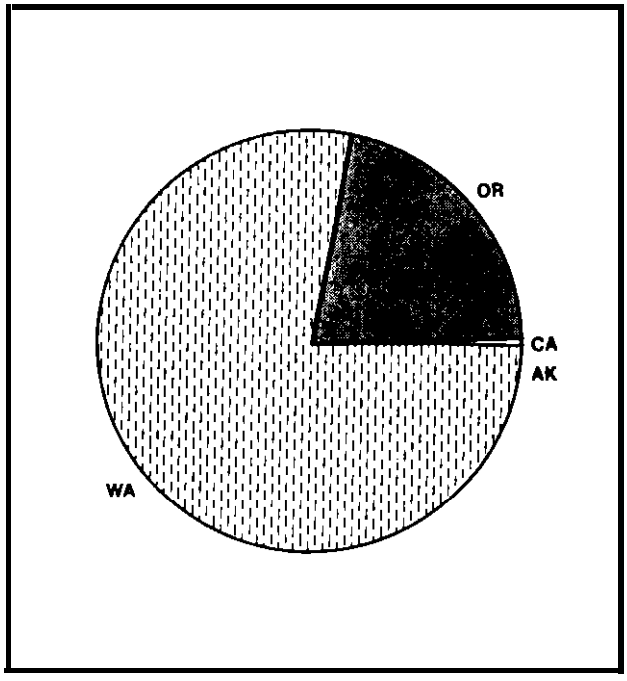
BPH fall chinook are characterized by the large jacks and large three-year-old adults. In 1981 and 1982, fork length measuremens (Figure 3) of jacks and three-year adults returning to Spring Creek Hatchery averaged approximately 62 cm. and 83 cm. respectively (Table 5), significantly larger than URB, LRW, and some LRH fall chinook.

Table 3. Estimate of naturally spawning BPH adult fall chinook in Wind River, Big White Salmon River and Klickitat River, 1970-1984s

	WIND RIVER		BIG WHITE SALMON		KLICKITAT	
Year	Peak count	Population estimate	Peak count	Population estimate	Peak count	Population estimate
1970	11	51	240	634	127	1,692
1971	368	1,801	203	712	68	096
1972	342	1,190	333	864	141	1,027
1973	135	472	336	874	64	049
1974	169	481	328	069	18	286
1975	159	556	706	1,789	64	858
1976	179	549	767	1,881	51	668
1977	269	922	86	216	7	128
1970	423	1,322	395	796	18	233
1979	262	884	154	636	9	379
1980	111	355	297	1,539	54[d]	680[b]
19.91	71	197	273	293	40[b]	525[b]
1982	101	361	587	1,562	157	550
1983	137	443	104	250	13	311
1984	37	126	NC	369[c]	55	216
Mean	185	647	344	920	59	673

a Norman (1982) for 1970-1981; otherwise WDF (1985).
b Values from Norman (1982) adjusted for spring and summer chinook coded wire tags recovered during fall stream surveys.
c Based on applying 1980-1983 ratio of Little White Salmon Hatchery return and Big White Salmon natural escapement to 1984 Little White Salmon Hatchery returns.
NC Not counted.

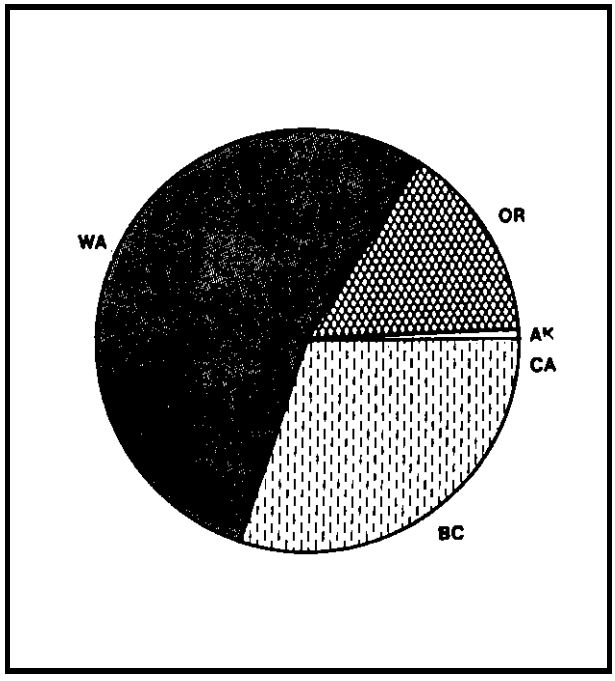
Distribution of U.S. Catch



Percentage By Fishery

Alaska Troll & Net	.31
Washington Ocean Troll	32.21
Washington Ocean Sport	22.36
Washington Coastal Net	2.50
Puget Sound Troll & Sport	5.74
Puget Sound Net	.67
Columbia River Sport & Net	26.29
Oregon Ocean Troll	3.60
Oregon Ocean Sport	4.05
California Ocean Troll	.20
California Ocean Sport	0

Distribution of Total Catch



Percentage By Fishery

Alaska Troll & Net	.22
Washington Ocean Troll	22.54
Washington Ocean Sport	15.62
Washington Coastal Net	1.74
Puget Sound Troll & Sport	4.01
Puget Sound Net	.47
Columbia River Sport & Net	19.76
Oregon Ocean Troll	2.51
Oregon Ocean Sport	2.63
California Ocean Troll	.14
California Ocean Sport	0
No. B.C. Troll, Sport. Net	1.86
So. B.C. Troll, Sport. Net	26.30

Figure 1. Harvest profile of BPH fall chinook based on coded wire tag recoveries of 1971 and 1972 fingerling releases from Spring Creek Hatchery (Buckman et. al. 1984).

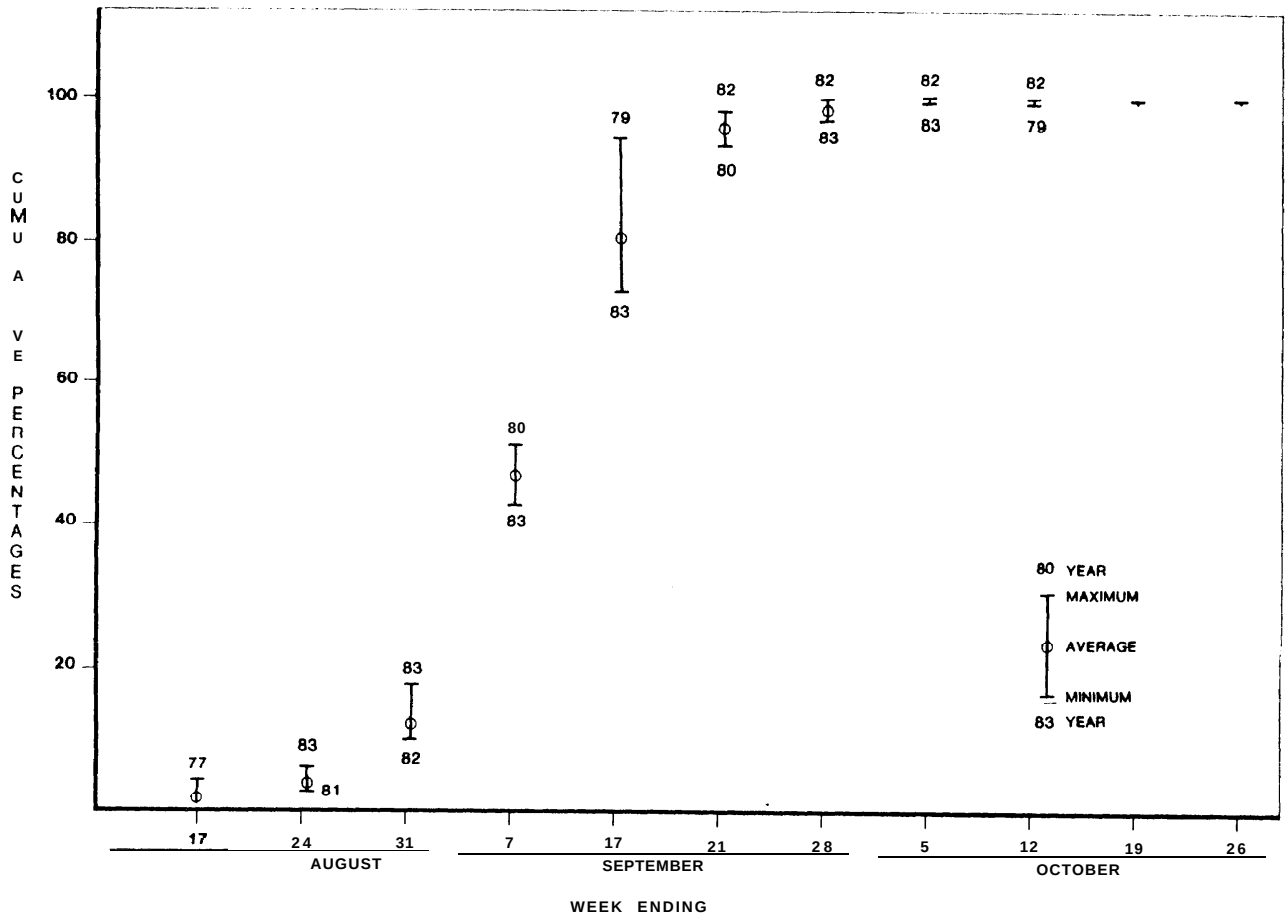
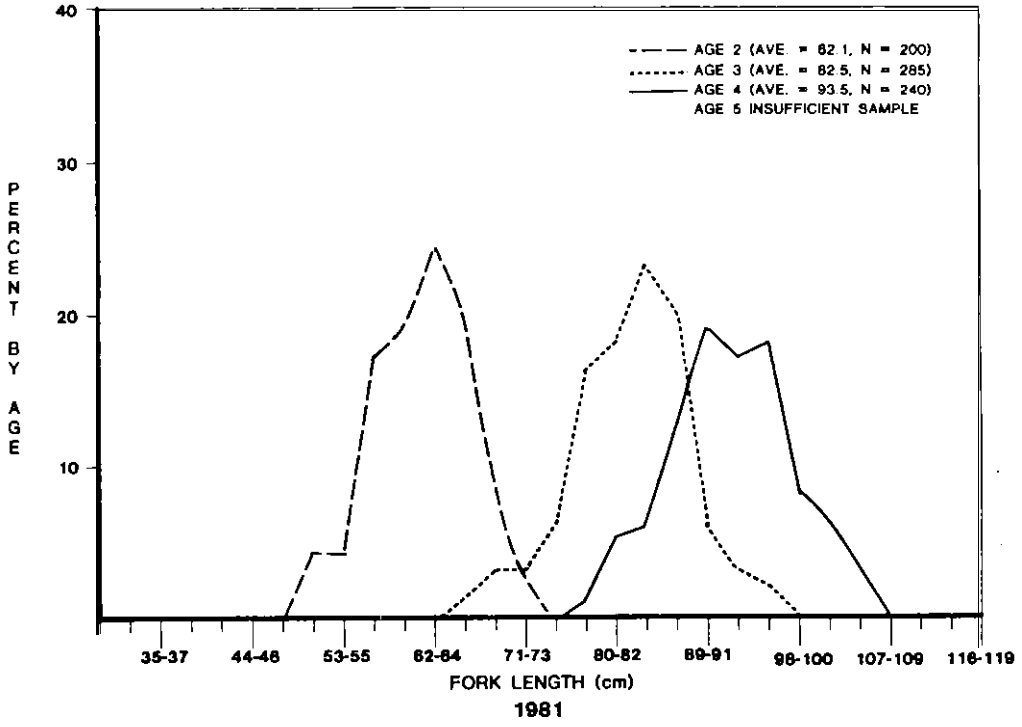


Figure 2. Cumulative percent of BPH fall chinook adults passing Bonneville Dam, 1979-1983.

Table 4. Total age specific freshwater returns to Oregon and Washington of BPR fall chinook, 1970-1984 (WDF 1985).

Year	Age 2		Age 3		Age 4		Age 5		Total
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
1970	4,500	2.7	115,600	60.4	45,500	26.9	3,300	2.0	168,900
1971	3,500	2.9	60,200	57.3	47,200	39.7	100	0.1	119,000
1972	5,700	11.1	21,700	42.2	23,400	45.5	600	1.2	51,400
1973	8,000	6.6	56,100	46.4	54,700	45.3	3,000	2.5	120,800
1974	6,200	8.1	43,100	56.4	25,200	33.0	1,900	2.5	76,400
1975	16,900	0.4	129,300	64.3	43,500	21.7	11,300	5.6	201,000
1976	15,400	7.0	43,600	22.1	129,900	65.7	8,700	4.4	197,600
1977	6,900	6.0	65,400	57.1	40,300	35.2	2,000	1.7	114,600
1978	10,200	9.3	53,300	40.5	45,700	41.6	700	0.6	109,900
1979	4,300	4.3	66,500	66.0	20,000	28.2	700	0.7	99,500
1980	7,000	6.7	57,300	54.7	40,300	30.4	200	0.2	104,800
1981	16,900	16.4	59,700	57.0	25,300	24.5	1,300	1.3	103,200
1982	1,300	1.1	94,400	77.3	26,200	21.4	200	0.2	122,100
1983	3,100	9.7	14,400	45.2	14,100	44.2	300	0.9	31,900
1984	(1,900)	(4.3)	(39,000)[a]	(79.0)	(8,000)	(16.3)	(200)	(0.4)	(49,100)
Mean	7,500	7.0	61,800	56.2	39,000	35.2	2,300	1.6	111,400

a Represents actual return in year of greatly reduced ocean harvest; 26,000 would have been expected to return from a 'normal' ocean season and would be consistent with data base.
O (Preliminary).



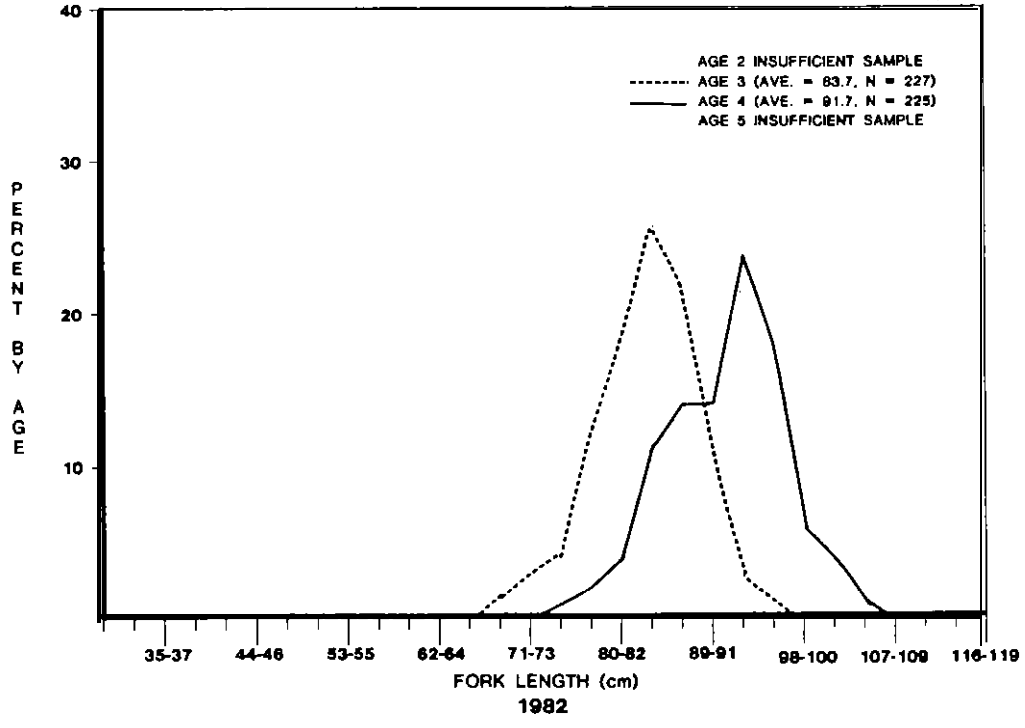


Figure 3. Length frequency of BPH fall chinook at Spring Creek Hatchery, 1981-1982.

Table 5. Length according to sex and age for BPH fall chinook at Spring Creek National Fish Hatchery, 1981-1982. (T. Roth, USFWS, personal communication).

Year 1981	Age 2		Age 3		Age 4		Age 5	
	Male	Female	Hale	Female	Male	Female	Male	Female
Sample	290	9	420	493	40	90	2	1
Average fork length (cm)	62.1	63.0	03.7	01.4	97.1	91.4	100.5	95
Range	47-77	59-70	58-100	62-97	01-112	81-102	96-105	
Standard deviation	4.6	3.7	7.4	5.4	6.5	5.0	6.4	
Year 1982								
Sample	9	0	245	396	63	139	0	1
Average fork length (cm)	62.2		05.7	02.4	95.1	90.3		95.0
Range	59-69		55-102	62-92	83-110	73-101		
Standard deviation	5.5		7.1	4.5	5.9	5.0		

Sex ratio

The periodic occurrence of female jacks at Spring Creek Hatchery is notable (Table 5). Three and four-year adults at Spring Creek Hatchery were predominantly females based on the returns during 1979-1983 (Figure 4).

Fecundity

Age specific fecundity is not available

Fecundity averaged 4,700 eggs per female at Spring Creek Hatchery from 1978-1982.

Biochemical-genetic characteristics

Schreck et al. (1984) compared isozyme gene frequencies for 11 enzyme systems from samples collected at Bonneville and Spring Creek hatcheries. No statistically significant differences were found for any of the enzymes.

In a comparison of wild fall chinook juveniles from the Sandy River and Hood River, no statistical differences in gene frequencies were determined for seven enzyme systems (Schreck et al. 1984).

JUVENILE LIFE HISTORY

Time of emergence

No information is available on the naturally produced population.

At Spring Creek Hatchery, where water temperatures during incubation are set at approximately 52°F, newly absorbed yolk-sac fry are prevalent in mid-December.

Time, age, and size at migration

BPH fall chinook are released as fingerlings primarily in March through June. Because of the controlled water temperatures at Spring Creek Hatchery, growth is rapid and a portion of the production is ready for release in March. Most of the Spring Creek production is liberated in March and April, prior to fall chinook releases from other Columbia River hatcheries. Release timing at Klickitat and Little White Salmon hatcheries is later, occurring in May through mid-June.

Size at release varies between approximately 50-150 fish/pound or 70-110 mm in length.

Based on recoveries of tagged Spring Creek juveniles, migration to the Columbia River estuary is rapid and generally occurs within 1-3 weeks after release (Table 6). From scale readings, juveniles enter the ocean in the first year of live and are considered 'sub-1' age migrants.

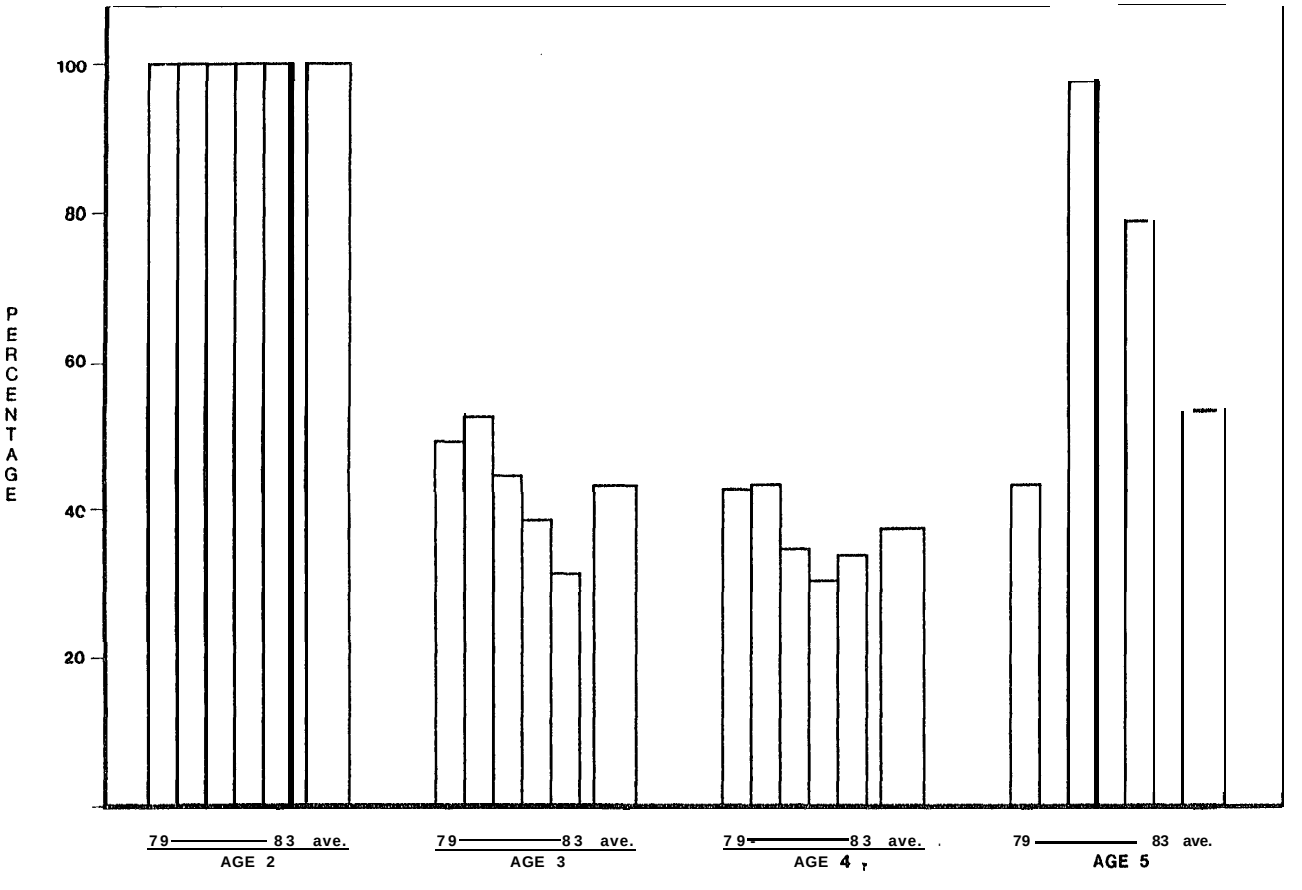


Figure 4. Percent male BPH fall chinook at Spring Creek Hatchery, 1979-1983.

Table 6. Juvenile outmigrant timing of coded wire tagged BPA fall chinook released from Spring Creek Hatchery and recovered in the Columbia River estuary at Jones Beach (River Mile 47) (Dawley et al. 1982).

Origin	Purpose	Size at release (fish/lb)	Year	Date	Percent of release recaptured	Year	Median fish	First fish	Last fish	Movement rate (RM/day)
Spring Creek Hatchery										
	Sub-yearling releases									
	Hatchery evaluation	125	1979	20 Mar	0.153	1979	8 Apr	26 Mar - 30 May		6
	Evaluation & contribution	50	1979	l8 May	0.067[a]	1979	22 May	21 May - 30 May		29
	Evaluation & contribution	19	1979	13 Aug	0.181[a]	1979	l8 Aug	17 Aug - 22 Aug		23
	Hatchery contribution	123	1980	10 Mar	0.197	1980	26 Mar	14 Mar - 23 May		8
	Hatchery contribution	a3	1980	10 Apr	0.196	1980	24 Apr	16 Apr - 17 May		8
	Hatchery contribution	51	1980	9 May	0.081[a]	1980	12 May	12 May - 11 Jun		39
	Hatchery contribution	19	1980	7 Aug	0.122[a]	1980	13 Aug	11 Aug - 15 Aug		19
	Production release	118	1981	25 Mar	0.083	1981	4 Apr	2Apr - 20 May		11
	Production release	71	1981	15 Apr	0.107	1981	29 Apr	20 Apr - 19 May		8
	Time of release	65	1981	5 May	0.165	1981	11 May	9 May - 30 May		19

a Purse seine recoveries, other groups recaptured using beach seines.

Survival rates

BPH fall chinook reared and released from Spring Creek Hachery are noted for their generally high survival rate. Spring Creek substock fall chinook reared at other stations do not experience the same high survival. A minimum survival rate (partial catch and escapement) of four groups of coded wire tagged Spring Creek Hatchery releases ranged between O-l.9 percent (1978 brood) and 0.3-2.1 percent (1979 brood) (Vreeland 1984). Survival of the 1979 brood releases was based on only two years of catches. These rates were much higher than the average of 0.2 percent for the 1978 and 1979 brood tule releases from other stations. TAC (1984) estimated a general survival rate of Spring Creek Hatchery releases at 2.0 percent which did not include mortality on juvenile outmigrants caused by Bonneville Dan.

DISEASE HISTORY

Common bacterial diseases at Spring Creek and Little White Salmon hatcheries include: kidney disease, enteric redmouth, cold water disease, and gill disease (Table 7).

Viral erythrocytic necrosis (VEN) was detected in BPH juveniles at Spring Creek Hatchery in 1984 and at Little White Salmon Hatchery in 1983-1984. In 1984, infectious hematopoietic necrosis (IHN) was diagnosed at Little White Salmon Hatchery in the URB fall chinook obtained from Bonneville Hatchery.

Periodically, bacterial hemorrhagic septicemia infects BPH fall chinook juveniles at Klickitat Hatchery.

PRIORITY INFORMATION NEEDS

A complete electrophoretic, morphometric and meristic profile of fall chinook from Spring Creek and other hatcheries is currently being developed by the Oregon Cooperative Fishery Research Unit. Completion of this study will be valuable in determining whether success of the Spring Creek Hatchery releases is a function of the rearing practices or because of genetic differences.

Table 7. Diseases encountered by BPH fall chinook at Little White Salmon National Fish Hatchery and Spring Creek National Fish Hatchery (E. Pelton, USFWS, personal communication).

Type	Disease	Infected group
Bacterial:	* Kidney disease	Juveniles
	* Enteric redmouth (ERM)	Adults, 1983-1984
	* Cold water disease	Juveniles
	* Gill disease	Juveniles
	Aeromonas sp. (BHS)	Juveniles
	Furunculosis	Adults
Parasitic:	* *Costia*	Juveniles
	* *Schyphidia*	Juveniles
	* *Epistylis*	Juveniles
	* *Hexamita*	Juveniles
	* Gill Amoeba	Juveniles
	Phylloborthrium salmonis	Adults, pre-1981
	Cryptobea	Juveniles, 1984
	Chilodon	Juveniles, once pre-198
Viral:	Viral erythrocytic necrosis (VEN)	Juveniles, 1983-1984
Other:	* Soft shell	Juveniles
	* Coagulated yolk	Juveniles
	* Gas bladder fungus	Juveniles
	* *Phoma herbarum*	Juveniles, 1983

a Commonly occurring.

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KLICKITAT RIVER SPRING CHINOOK

PRODUCTION

Primary emphasis is on hatchery production although a remnant naturally produced native run originates from the area upstream of Klickitat Hatchery. Between 1979-1983, Klickitat Hatchery yearling releases have ranged between 0.6-0.8 million and averaged 0.7 million. Fingerling and fall releases have ranged from 0.2-1.5 million and averaged 0.9 million for this same period.

GEOGRAPHIC ORIGIN

Streams

Natural production originates from the mainstem Klickitat River, primarily upstream of Klickitat Hatchery.

Hatcheries

Artificial propagation occurs at Klickitat Hatchery (river mile 41.7).

ORIGIN

Spring chinook are indigenous to the Klickitat River (Fulton 1968).

The history of hatchery production begins with the first release of 11,900 yearlings of unknown stock origin in 1950 (WDF and USFWS 1951). Klickitat Hatchery began rearing salmon in 1952 (Fulton 1968). According to the original hatchery development plan, spring chinook broodstock were to be collected at the lower fish trap on the Klickitat River (WDF and USFWS 1951). Some fingerling releases from these fish were scheduled to be made into the West Fork and upper Klickitat River. Spring chinook returning to the Klickitat River provided the original broodstock for the hatchery program (B. Foster, WDF, personal communication). Klickitat Hatchery has occasionally released non-local stock spring chinook of Carson, Willamette, and Cowlitz origin (Table 1).

ADULT LIFE HISTORY

Run size, catch, and escapement

The minimum freshwater run has averaged 1,700 fish since 1970 (Table 2). Most of the accountable portion of this run occurs as hatchery escapement. Freshwater harvest occurs primarily by recreational anglers and Yakima Indian dip net fisherman operating in the lower portion of the river.

Table 1. Releases of non-local stock spring chinook into Klickitat Basin[a]/.

Release site	Brood year	Release year	Number released	Type	Hatchery	Stock
Klickitat River	1960	1961	31,000	Fingerling	Klickitat	Carson
	1961	1962	68,600	Fingerling	Klickitat	Carson
	1962	1963	140,900	Fingerling	Klickitat	Carson
	1963	1964	236,100	Fall release	Klickitat	Carson
	1963	1964	268,700	Fingerling	Klickitat	Willamette
	1963	1965	640,000	Yearling	Klickitat	Willamette
	1975	1976	335,800	Fingerling	Klickitat	Cowlitz
	1976	1977	168,700	Fingerling	Klickitat	Cowlitz
	1977	1978	173,600	Fall release	Klickitat	Carson
	1977	1979	103,300	Yearling	Klickitat	Carson
	1979	1980	1,030,700	Fingerling	Klickitat	Cowlitz
West Fork Klickitat	1976	1977	58,000	Fingerling	Klickitat	Cowlitz
Diamond Fork Creek	1976	1977	21,700	Fingerling	Klickitat	Cowlitz

a/ Release years 1961-1965 from T. Roth, USFWS, personal communication.
Release years 1967-1983 form WDF (1985).

Table 2. Minimun freshwater adult run size profile of Klickitat River spring chinook, 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial[a/]	Ceremonial and subsistence	Commercial	Recreational[b/]	Natural[d/]	Hatchery	Total production
1970	450	N/A	N/A	500[c/]	300	1,900	3,350
1971	300	N/A	N/A	400[c/]	250	500	1,450
1972	450	N/A	N/A	650[c/]	350	1,250	2,700
1973	350	N/A	N/A	450[c/]	550	500	1,850
1974	0	N/A	N/A	250	150	1,400	1,850
1975	0	N/A	N/A	300	250	550	1,100
1976	0	N/A	N/A	150	50	500	700
1977	0	N/A	N/A	0	N/A	300	350
1978	0	600[e/]	N/A	250	150	450	1,450
1979	0	N/A	N/A	100	50	700	850
1980	0	N/A	N/A	0	150	1,550	1,700
1981	0	400[f/]	N/A	200	200	1,700	2,500
1982	0	700[f,g/]	N/A	200	50	1,350	2,300
1983	0	1,250[f,g/]	N/A	300	50	600	2,200
1984	0	(400)[g,h/]	N/A	(350)	N/A	(500)	(1,250)
Mean	100	700	N/A	250	200	900	1,700

[a/] Klickitat River dip net only.
[b/] Does not include mainstem Columbia River harvest.
[c/] May include jacks which were 18 percent of 1974-1982.
[d/] Values calculated from spawning ground surveys form R.M. 60.2 to R.M. 82.0, and based on expanding the greater of actual peak count or peak count from redd counts (2.1 fish/redd) by a factor 3.0 peak fish count expansion.
[e/] TAC (1983).
[f/] J. Hollowed. Yakima Indian Nation (YIN), personal communication.
[g/] May include jacks which comprised 45.6 percent of 1981 subsistence harvest.
[h/] E. Barth, YIN, personal communication.
( ) Preliminary
N/A: Not available.

An overall ocean and freshwater catch distribution from coded wire tag analysis is shown in Table 3. The codes chosen for analysis represent typical production releases from Klickitat Hatchery. Most of the ocean catch occurred in Alaska (26 percent) and British Columbia (45 percent). Washington and Oregon ocean harvest was relatively minor.

Time of migration

Klickitat River spring chinook enter the Columbia River primarily in March and April, generally after the lower Columbia River winter gill net season. Migration into the Klickitat River reaches a peak in May. Although somewhat flow related, subsistence catch success in the April-May period coincides with this timing (Table 4).

Spawning period

Spawning activity peaks in late August and early September. At Klickitat Hatchery spawning commences in mid-August, peaks about September 10, and is completed by the end of September.

Spawning areas

The naturally produced run spawns in the area from Parrott's Bridge (river mile 49.0) upstream to about McCormick Meadows (river mile 80.0). The primary spawning area is from Soda Ford (river mile 60.7) upstream to Castille Falls (river mile 64.2).

Fulton (1968) stated that available spawning area was increased from historical levels due to construction of fish passage facilities at Castille Falls, although presently this area is nearly barren of spring chinook.

Age composition

Age data is very limited. J. Hollowed (YIN, personal communication) stated that age composition in the 1980 subsistence dip net fishery was 15.6 percent three-year-old jacks, with four and five-year-old adults comprising 75.0 percent and 9.4 percent of the run respectively.

Based on adults and jacks reported by hatchery personnel, the percentage of two and three-year-old jacks has varied considerably, ranging between 1.0 percent and 80 percent of the returns during 1970-1982.

Size

Length information is insufficient for proper analysis.

Sex ratio

Age specific sex ratio information is not available

Fecundity

Fecundity of the natural run is not available.

Table 3. Harvest profile of Klickitat Hatchery spring chinook based on coded wire tag recoveries of 1976 brood yearling releases.

Harvest composition	Percent
Alaska :	
Troll and sport	14.2
British Columbia:	
Northern troll	1.9
Southern troll	14.0
Net and sport	8.9
Oregon :	
Troll and sport	9.7
Washington:	
Ocean troll and sport	6.4
Other net and sport	
Columbia River:	
Non-treaty commercial net	5.3
Treaty commercial net	8.3
Sport	31.3

Survival	'76 brood 63-16-I	'76 brood 63-16-2
Smolt to all adult	0.3%	0.2%
Smolt to fisheries	0.1%	0.1%
Smolt to Columbia River	0.3%	0.2%

Table 4. Yakima Indian weekly subsistence harvest of spring chinook, 1981-1983. (J. Hollowed, YIN. personal communication).

Dates		Harvest			
		1980	1981	1982	1983
April	02-06	N/A	4	0	0
	09-13	N/A	12	0	0
	16-20	N/A	24	0	0
	23-27	N/A	55	0	13
	30-May 4	N/A	88	0	89
May	07-11	N/A	105	80	146
	14-18	N/A	76	247	216
	21-25	N/A	57	248	341
	28-31	N/A	79	113	270
June	03-07	N/A	--	--	
	09-12	N/A	--	--	93
	13-20	N/A	--	--	65
	25-29	N/A	--	--	--
July	03-07	N/A	--	--	--
	12-16	N/A	--	--	--
Total		N/A	500	688	1,233

From 1978-1982 fecundity at Klickitat Hatchery averaged 4,105 eggs per female and ranged between 3,737 to 5,009 eggs per female. Age specific fecundity is not available.

Biochemical-genetic characteristics

Isozyme gene frequencies of Klickitat Hatchery spring chinook were determined by Milner et al. (1983).

JUVENILE LIFE HISTORY

Time of emergence

No information is available on time of emergence for naturally produced fry.

At Klickitat Hatchery, juvenile development that corresponds to gravel emergence occurs in late November thru early December.

Time, age, and size at migration

Naturally produced juveniles rear in the upper watershed and remain in the river the entire year migrating downstream in the spring as yearlings (Conroy 1977). No size information is available on the naturally reared population.

Production releases from Klickitat Hatchery typically occur in March as yearlings averaging about 10 fish per pound. Some fish are released as sub-yearlings in the summer and fall ranging in size from 10-300 fish per pound.

Downstream smolt migration of yearlings occurs immediately after release. Coded wire tagged hatchery spring chinook released on March 30, 1979 were recovered in the Columbia River estuary from April 6, 1979 to June 10, 1979 with a median recapture date of April 19, 1979 (Dawley et al. 1982).

Survival rate

No information is available on the naturally produced population.

Smolt to adult survival for two coded wire tag releases averaged 0.4 percent (adjusted to level of no dam mortality).

DISEASE HISTORY

No information is available on natural production.

Based on the disease profile during 1979-1983 (Table 5), enteric redmouth and bacterial hemorrhagic septicemia commonly infects Klickitat Hatchery spring chinook juveniles.

PRIORITY INFORMATION NEEDS

Biological sampling of hatchery and natural escapement is necessary in order to compile basic information (age composition, size, and sex) on stock characteristics of the spring chinook population in the Klickitat River.

Table 5. Diseases encountered by Klickitat stock spring chinook at Klickitat Hatchery 1979-1983 (WDF 1984).

Type	Disease	Infected group
Bacterial:	Septicemia	1978 brood juveniles
	Bacterial hemorrhagic septicemia (BHS) or possibly enteric redmouth (ERM)	1978 brood juveniles
	Bacterial kidney disease	1980, 1982 brood juveniles
	ERM	1980 brood juveniles
	ERM (30% loss)	1981 brood juveniles
	BHS	1980, 1981 brood juveniles
Parasitic:	None	
Viral :	None	
Other:	Sunburn	1978-1981 brood juveniles
	Coagulated yolk	1982 brood juveniles
	Saprolegnia	1982 brood juveniles

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Deschutes River Spring Chinook (wild)

PRODUCTION

Wild spring chinook production in the Deschutes River is supplemented with releases of hatchery stock from Round Butte Hatchery and Warm Springs National Fish Hatchery (WSNFH) [see "Deschutes River Spring Chinook (hatchery) "].

GEOGRAPHIC LOCATION

Streams

Deschutes River and the westside tributaries Warm Springs River and Shitike Creek (Figure 1)

ORIGIN

Spring chinook are indigenous to the Deschutes River. There has been one reported introduction of a non-native stock, a fry release of Willamette stock from the Santiam River in 1967. Some of the spring chinook reaching Sherars Falls are of non-Deschutes origin, however (Table 1).

Table 1. Origin of stray Ad+CWT-marked spring chinook recovered in the Deschutes River, 1983 (Jonasson and Lindsay 1983).

Number	Agency	Hatchery	Release site
1	IDFG	Rapid River	Columbia River below Bonneville Dam
2	ODFW	Cole Rivers	Rogue River
3	NMFS	Leavenworth	Columbia River at Dalton Point

ADULT LIFE HISTORY

Run size, catch, and escapement

Adults are harvested by offshore troll and sport fisheries, Columbia River gill net fisheries and tribal dip-net, and sport fisheries in the Deschutes River. Tagged fish have been recovered in offshore fisheries of British Columbia, Washington, and Oregon. However, the majority of chinook tagged as juveniles from 1978 through 1982 were recovered in the Columbia and Deschutes rivers (Table 21.

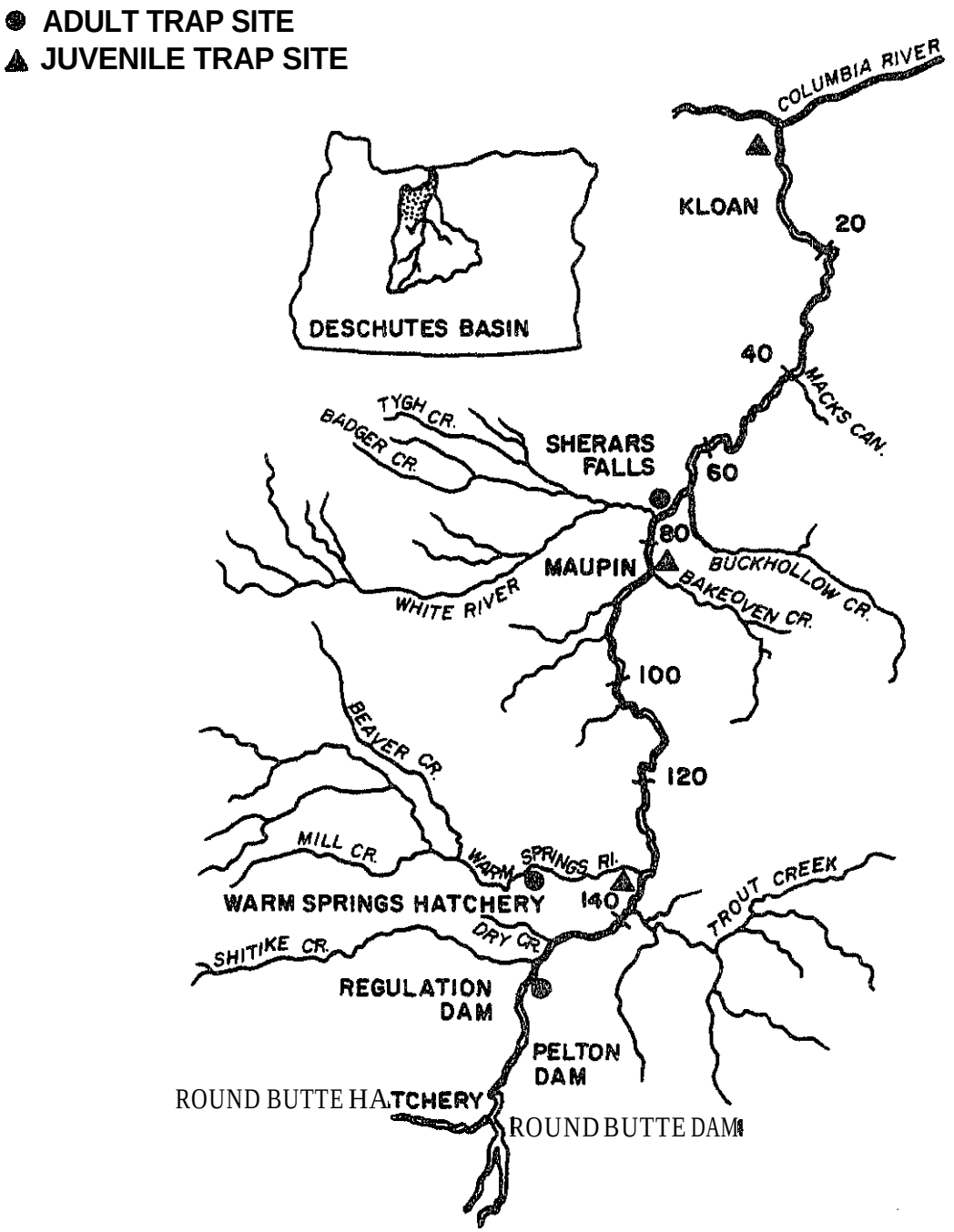

Figure 1. Map of lower 161 km of the Deschutes River (Aho1 et al. 1979).

Table 2. Expanded recoveries of coded-wire tagged wild Deschutes River spring chinook salmon, 1978-82.

Area	Catch
Alaska	0
British Columbia	10
Washington	8
Oregon	10
California	NA
Columbia River	25
Deschutes River	27

Run sizes of wild spring chinook entering the Columbia and Deschutes rivers have averaged about 2,000 fish (adults and jacks) since 1979 (Table 3). Tribal harvest at Sherars Falls from 1971-82 ranged from 0 in 1972, 1973, and 1975 to 1,500 in 1971, and has generally been declining (Table 4). Sport harvest of adult fish from 1974-82 ranged from 0 in 1975, 1976, and 1981 to 1,190 in 1977 (Table 5). The sport season was closed in 1981 in response to predicted low returns of adult fish (Lindsay et al. 1981). Harvest rates in the Deschutes River have ranged from 21% to 41% in years with open seasons (Table 3).

Table 3. Run size and exploitation rates of wild spring chinook[a] in the Deschutes River, 1977-84 (modified from Jonasson and Lindsay 1983).

Year	Run size[b] (Columbia River)	Run size[c] (Deschutes River)	Harvest (Deschutes River)	Exploitation rate (%)	Escapement
1977	5,698	4,059[d]	1,683	41	2,376
1978	3,492	3,415	723	21	2,692
1979	2,136	2,115	605	29	1,510
1980	1,628	1,628	493	30	1,135
1981	1,731	1,668	0[e]	- -	1,668
1982	2,390	2,276	729	32	1,547
1983	2,194	2,158	544	25	1,614
1984	1,647	1,610	0[e]	__	1,610

a Includes both adults and jacks.
b Estimated from catch-to-escapement ratios for upriver spring chinook in the Columbia River.
c WSNFH count plus harvest, including adults taken at the steeppass trap for broodstock at Round Butte Hatchery, and estimates from redd counts in the Shitike Creek and lower Warm Springs River.
d Redd counts were not made for Shitike Creek in 1977. Spawning escapement was estimated for Shitike Creek by using the mean redd count from 1978-80.
e No sport or Indian fishery at Sherars Falls.

Table 4. Wild spring chinook catch in the Indian dipnet fishery at Sherars Falls, 1971-83[a] (data from Jonasson and Lindsay 1983).

Year	Adults	Jacks
1971	1,500	50
1974	1,026	107
1976[b]	941	221
1977	367	8
1978	177	0
1979	203	0
1980	113	0
1982	214	13
1983[c]	167	2

a No creel in 1972, 1973, and 1975; closed to fishing in 1981.
b Includes 404 adults and 181 jacks from hook and line fishing.
c Includes 19 hatchery and 11 wild adults, and 6 hatchery and 2 wild jacks from hook and line fishing.

Table 5. Wild spring chinook catch in the sport fishery in the Deschutes River, 1974-83[a] (data from Jonasson and Lindsay 1983).

Year	Adults	Jacks
1974	332	26
1977	1,190	118
1978	541	5
1979	362	40
1980	339	41
1982	449	53
1983	330	42

a Closed to sport angling in 1975, 1976, and 1981.

Escapement is monitored at Sherars Falls, at the Warm Springs National Fish Hatchery, and by spawning ground counts in the Warm Springs River. Escapement estimates at Sherars Falls averaged 1,770 wild spring chinook during 1977-84 (Table 3). An average of 1,600 wild adults returned to WSNFH from 1977-84. The number of fish passed above the WSNFH is regulated at the hatchery and is usually about 75% of the wild adults reaching the hatchery (Table 6). Redd counts in the Warm Springs River have fluctuated between a low of 87 redds in 1972 to a high of 1,066 redds in 1976 (Table 7).

Until 1980 the adult/redd ratio above the hatchery was between 2.5 and 3.0 (Table 6). In 1980 and 1981 the ratio rose to 5.7 and 6.9, respectively. Cates (1981) suggested that increased prespawning mortality above the hatchery may have resulted from bacterial kidney disease (BKD).

Table 6. Wild spring chinook returns to WSNFH, 1977-1984 (B. Cates, USFWS, personal communication).

Year	Wild		Wild adults		Hatchery adults		Adults per redd[d]
	Adult	Jack	Kept for broodstock	Released upstream	Released upstream	Redds above WSNFN	
1977	1,505[a]		--	1,505	--	498	3.02
1978	2,584	76	569	2,015	--	788	2.56
1979	1,322	73	416	906	--	354	2.54
1980	968	34	317	651	--	114	5.71
1981	1,525	50	511	1,014		147	6.90
1982	1,408	46	91	1,317	270	421	3.77
1983	1,523	34[b]	465	1,058	193	426	2.94
1984	1,959[c]	98[c]	639"	I, 320[b]	2	415	3.19[d]

[a] Adults and jacks not separated.
[b] 1980 hatchery brood not marked.
[c] 1981 hatchery brood not 100% marked.
[d] Wild and hatchery adults released upstream of WSNFH included in ratio.

Table 7. Redd counts for wild Deschutes spring chinook in the Warm Springs River and tributaries, 1969-84, and Shitike Creek, 1976-84 (data from Cates 1980, 1981, and 1984; Stainbrook 19841.

year	Warm Springs River	Beaver Creek	Mill Creek	Total	Shitike Creek
1969	205	39	20	264	--
1970	119	41	12	172	--
1971	152	15	6	173	--
1972	75	12	0	87	--
1973	396	154	34	584	--
1974	172	31	13	216	--
1975	560	162	86	808	--
1976	834	151	71	1,066	0
1977	591[a]	68	35	694	0
1978	628	119	49	796	5
1979	255	97	1	359	3
1980	89	22	6	117	14
1981	141	9	7	157	6
1982	321	72	40	433	16
1983	305	104	30	439	15
1984	253	146	30	429	25

a One hundred ninety-nine of these redds were in the Warm Springs River below the hatchery.

Hatchery personnel began routinely innoculating all fish that were passed above Warm Springs Hatchery with Erythromycin in 1982.

Time of migration

Adults first reach Sherars Falls (RK 67) about April 15 (Aho$_2$ et al. 1979). During 1973, 26 spring chinook tagged at Bonneville Dam from April 3 to May 31 were recovered at Sherars Falls in the Deschutes River. The fish were harvested at Sherars Falls between April 18 and May 11. They took an average of 16.8 days to swim from Bonneville Hatchery to Sherars Falls (6.1 miles/day) (Newton 1973). It is not known how long the fish may have delayed at Sherars Falls before being recovered.

The number of adults passing the falls peaks in late April to mid-May depending on water conditions and other unidentified factors (Figure 2). Numbers decrease through mid-June.

Of 31 adult fish radio tagged in April and May at Sherars Falls, 28 had entered the Warm Springs River before the end of June [Aho$_1$ et al.1979). Timing of returns to Warm Springs Hatchery also reflects this pattern (Figure 3). Jacks returned toward the latter portion of the run, in June and July (Figure 4). A few returned in September. About 65% of the spring chinook tagged at Sherars Falls were recaptured at Warm Springs Hatchery within 5-15 days (Figure 5). Adults entered the trap at the Pelton Regulation Dam in mid-May (Newton 1973).

Spawning period

Wild spring chinook spawn primarily in September (Gates 1981).

Spawning areas

Virtually all wild spring chinook spawn in the Warm Springs River (RK 132) and its tributaries (Lindsay et al. 1981), including Mill and Beaver creeks (Figure 1). A few fish also spawn in Shitike Creek (Cates 1981). In 1979 an estimated 82-98% of those fish passing Sherars Falls entered the Warm Springs River and potentially spawned in Mill Creek above Potters Pond and upper areas of Beaver Creek (Cates 1981). In 1977 no carcasses of spring chinook salmon tagged at Sherars Falls were recovered in the mainstem Deschutes River (Fessler et al. 1978), indicating that little or no spawning occurs there. Access to historic spawning areas in the Metolius River, Squaw Creek, and main-stem Deschutes River to Steelhead Falls (FCO 1953; Newton 1973) was eliminated by the Pelton-Round Butte Hydroelectric Project.

Age composition

Adults return as 3-to 5-year olds. From 1974 through 1982, 4-year-old fish accounted for 57-97%. of the adults sampled at Sherars Falls and WSNFH (Table 8).

Size

Jacks (age 3$_2$) ranged in length from about 36 to 65 cm, age 4$_2$ fish from about 50 to 80 cm, and age 5$_2$ fish from about 70 to 100 cm (Figure 6).

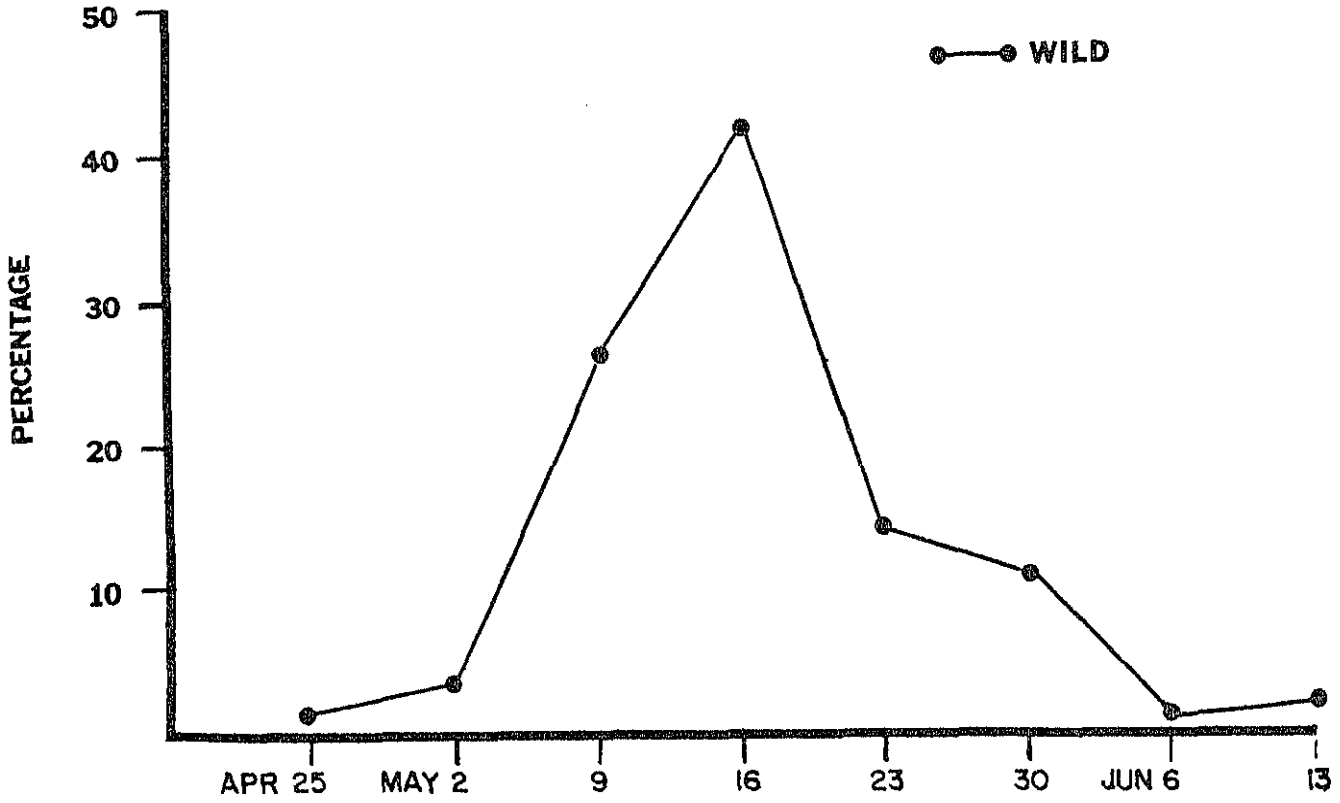

Figure 2. Migration timing of wild spring chinook past Sherars Falls, 1982 (Lindsay et al. 1982).

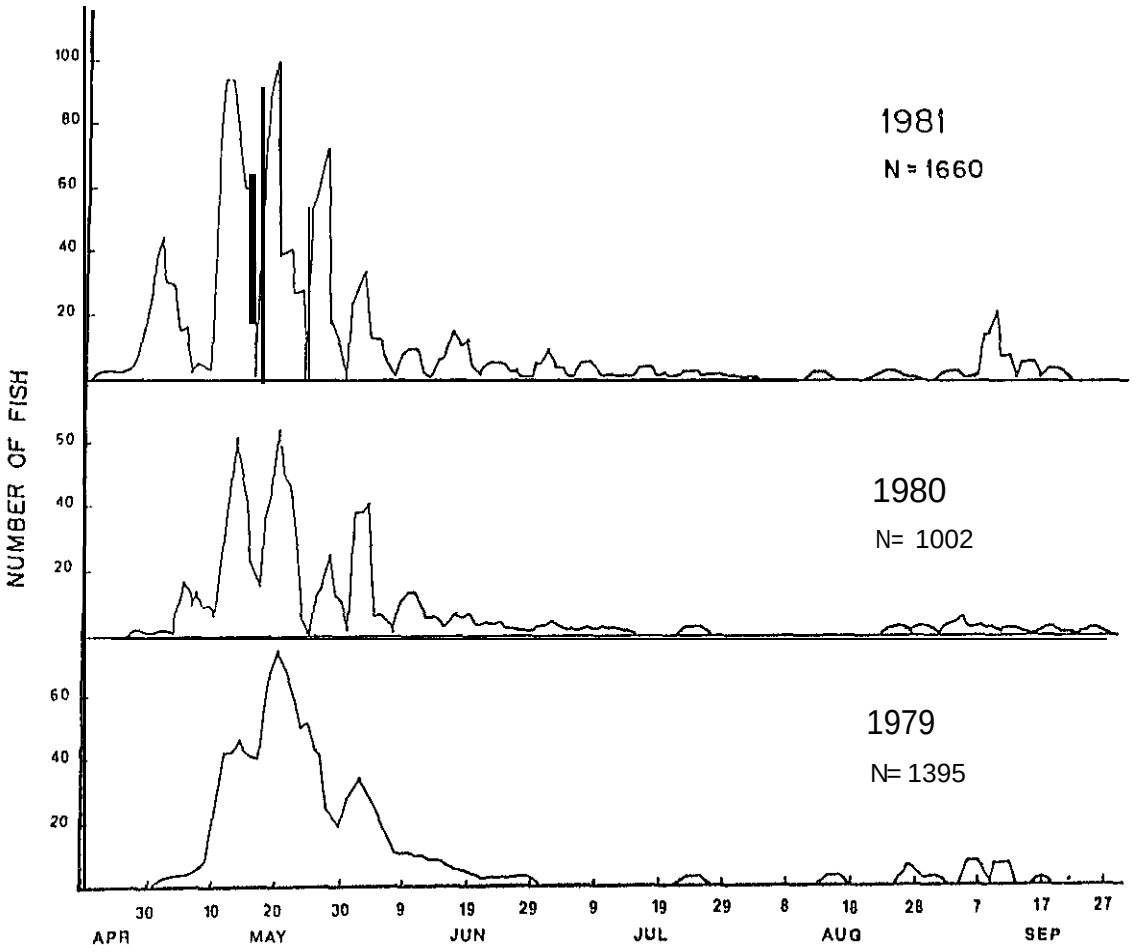

Figure 3. Run timing of spring chinook at Warm Springs NFH 1979-81 based on running 3-day averages (Cates 1984).

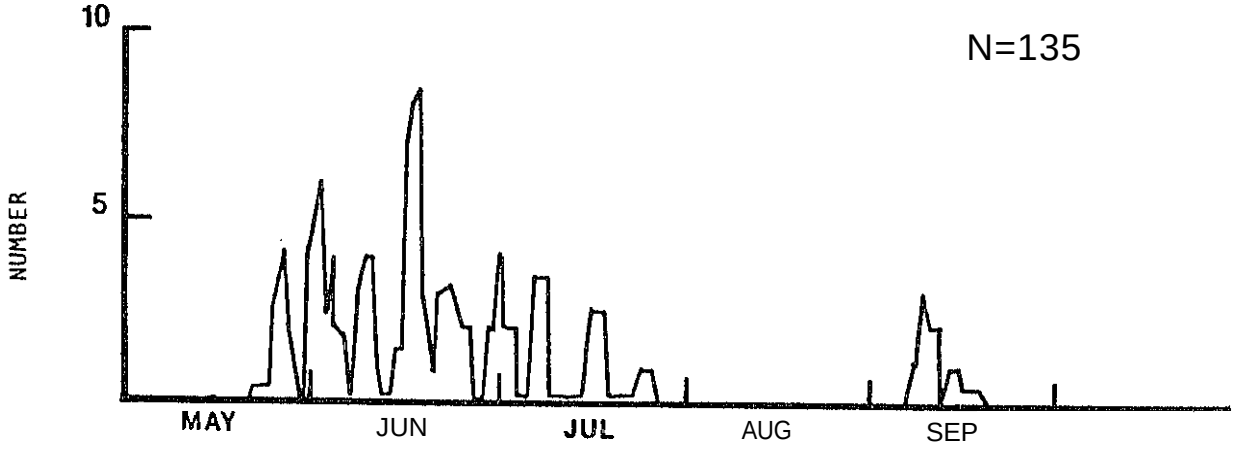

Figure 4. Run timing of spring chinook jacks arriving at Warm Springs NFH in 1981 (Cates 1984).

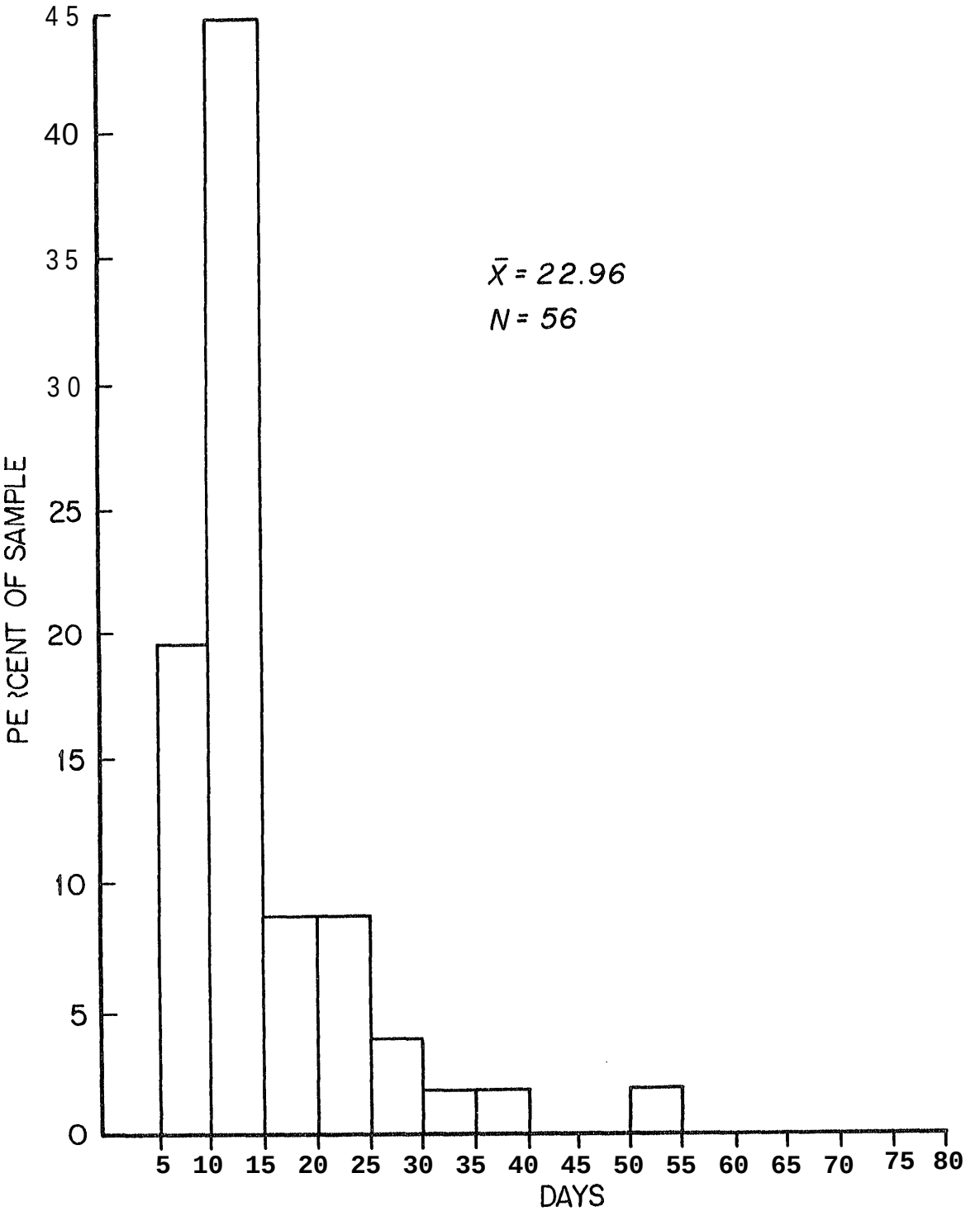

Figure 5. Time elapsed between tagging of spring chinook at Sherars Falls on the Deschutes River and their recapture at Warm Springs NFH in 1980 (Cates 1980).

Table 8. Age composition of adult spring chinook sampled at Sherars Falls and WSNFH in 1974-82, as determined from scale analyses (Fessler et al. 1978; Lindsay et al. 1982).

Year	Location	Age class (%)		
		3_2	4_2	5_2
1974	Sherars Falls	2.9	04.6	11.5
1976	Sherars Falls	2.0	74.5	23.5
1977	Sherars Falls	0.5	96.7	2.8
1977	WSNFH	0.6	96.0	3.4
1978	Sherars Falls	0.0	65.9	34.1
1978	WSNFH	0.6	56.7	42.7
1979	Sherars Falls	6.0	72.0	22.0
1980	Sherars Falls	5.0	73.0	22.0
1981	Sherars Falls	3.0	77.0	20.0
1982	Sherars Falls	5.0	76.0	19.0

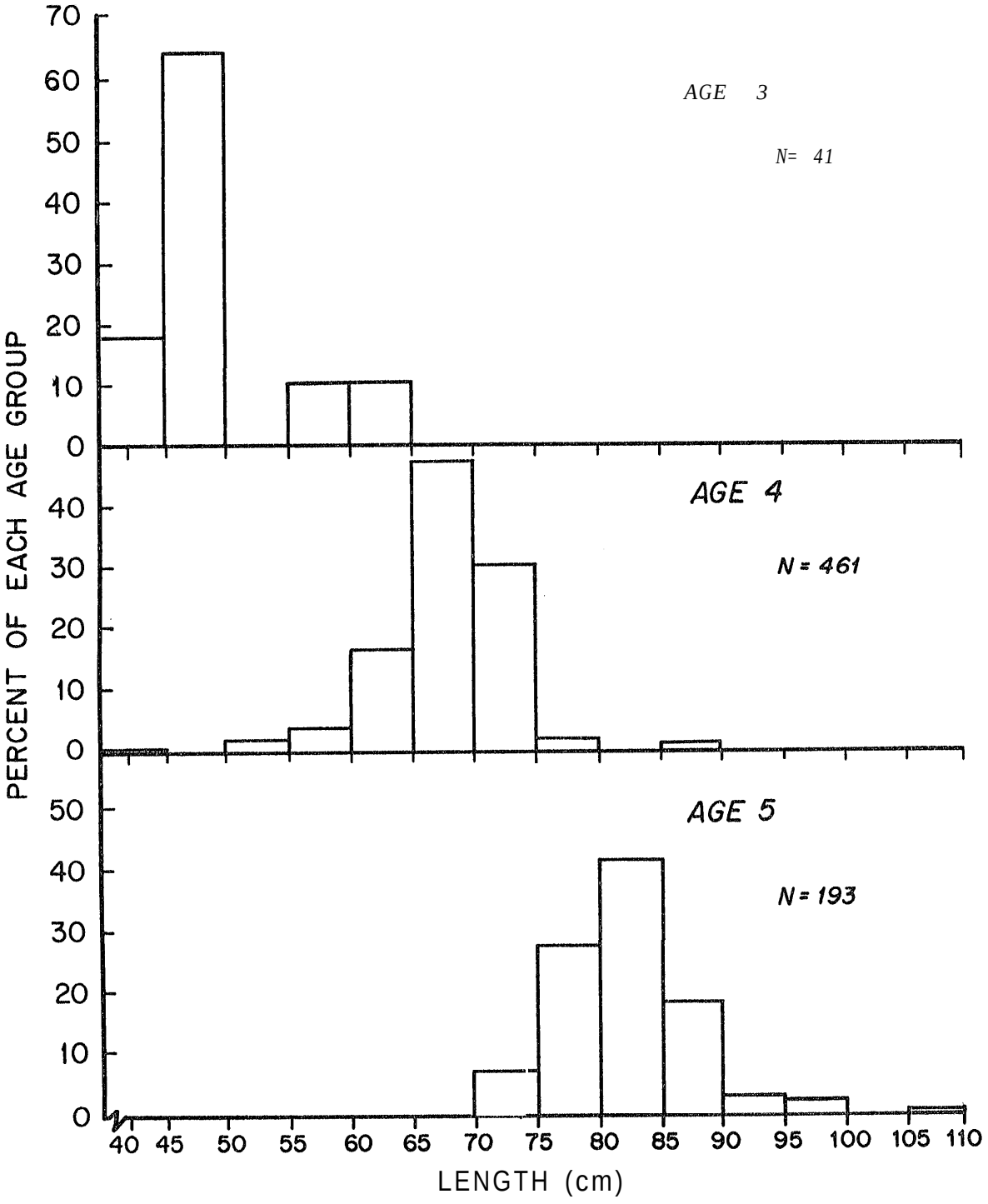

Figure 6. Length frequencies of wild spring chinook arriving at Warm Springs NFH, 1977-81 (B. Cates, USFWS, personal communication).

Weights averaged 2.0, 4.5, and 7.1 kg for the age 3_2, 4_2, and 5_2 adults, respectively (Montgomery 1952).

Sex ratio

The percentage of females among the wild adults trapped at WSNFH from 1978 to 1981 ranged from 58% to 65% (B. Cates, DSFWS, personal communication):

	Females		Males	
	No.	(%)	No.	(%)
1978	345	(0.63)	201	(0.37)
1979	259	(0.62)	157	(0.38)
1980	205	(0.65)	112	(0.35)
1981	302	(0.58)	215	(0.42)

Fecundity

Between 1978 and 1981, the average number of eggs/female in the Warm Springs River varied from 3,360-3,647 (average = 3,470) (Cates 1981). Data on fecundity by age or length are not available.

Biochemical-senetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age, and size at migration

Juvenile fish migrate downstream from the Warm Springs River in two peaks : a spring migration from February through May and an autumnal migration from September through December (Aho$_1$ et al. 1979; Cates 1980, 1981) (Figure 7). The spring migrants are almost all yearlings (age 1+) (Aho$_1$ et al. 1979) and show smolt-like coloration. The autumn migrants are subyearlings (age 0+) and usually do not show silvery coloration (Cates 1981).

Juveniles in the Deschutes River migrated primarily during April, May, and June. Migration began in the lower River and moved progressively upstream. There was little movement in summer and winter (Fessler et al. 1976).

Yearlings from the Warm Springs River appear to migrate through the Columbia River in May and June and then go to the ocean (Fessler et al. 1978). Seven tagged yearlings from the Warm Springs River were sampled in the ice-trash sluiceway at The Dalles Dam (16 km below the mouth of the Deschutes River) between April 24 and May 24. Later-migrating yearlings travel

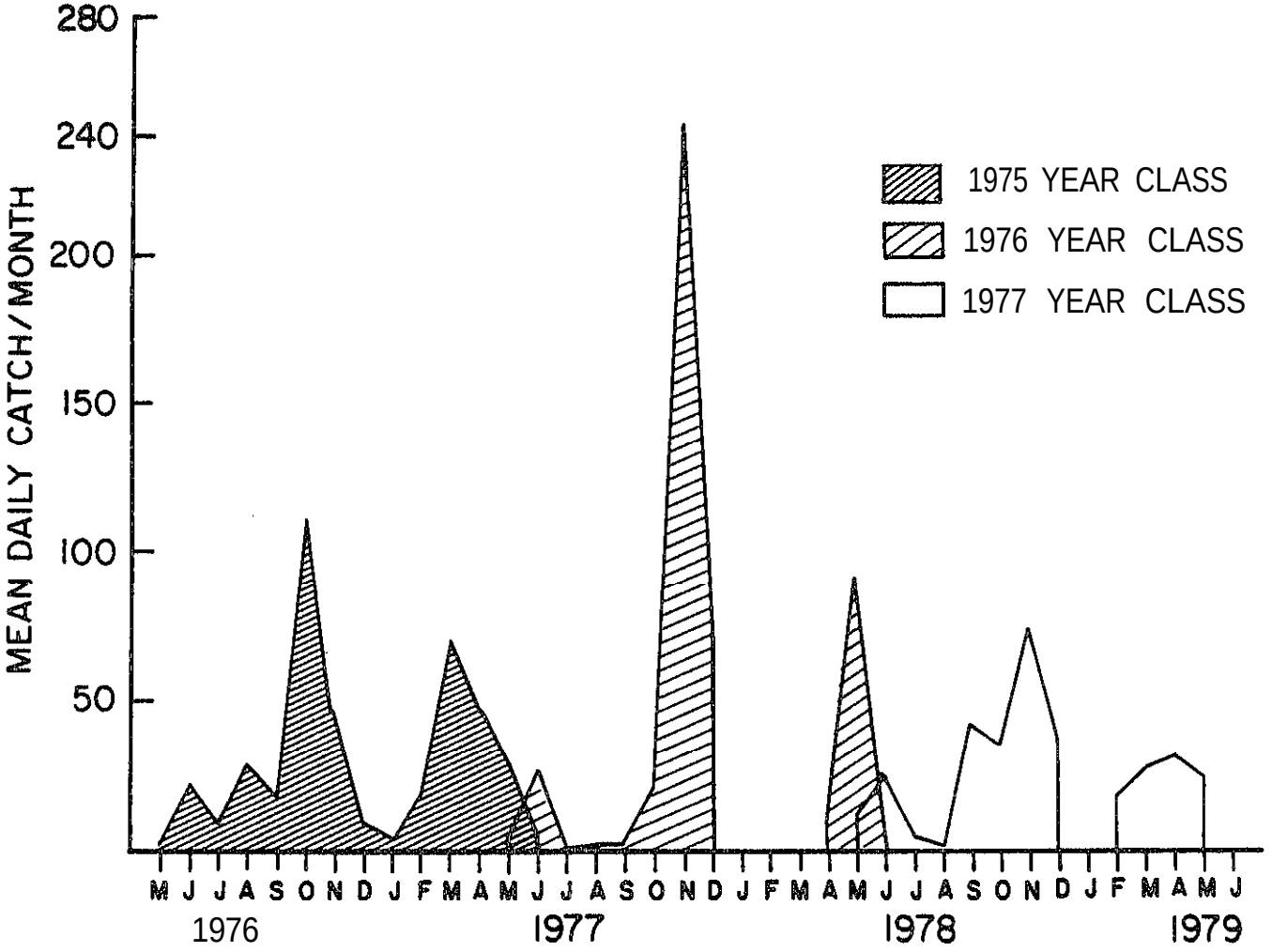

Figure 7. Migration of juvenile spring chinook from the Warm Springs River. Data collected at the migrant trap in the lower Warm Springs River (Ahol et al. 1979).

downstream up to 25 km/day, whereas earlier migrants travel more slowly (about 2 km/day) (Aho$_2$ et al. 1979) (Figure 8).

All of the adults sampled for age composition from 1974 to 1982 entered the ocean as yearlings (Table 8). Fry emigrating from the Warm Springs River in the fall may either overwinter in the Deschutes or Columbia rivers before going to the ocean in April and May of the following year (Lindsay et al. 1980; Cates 1981) or fail to survive if they enter the ocean that same fall or winter.

Age 0 fish (40-80 mm FL) first entered the Warm Springs trap in May (Figure 9). By June, few chinook greater than 100 mm were sampled, which indicated most yearlings had left the river. Mean lengths of migrants in December ranged from 8.8 cm to 10.0 cm (Figure 10). Mean lengths in April were 10.6-11.7 cm (Figure 11). Larger yearlings generally leave the river before smaller ones (Fessler et al. 1978) (Figure 12). Juveniles average 8-9 cm FL at the end of their first year in freshwater and 12-15 cm FL at ocean entry (Tables 9, 10).

Table 9. Back-calculated mean fork lengths at the end of the first year in freshwater for adult spring chinook sampled at Sherars Falls and WSNFH in 1977 and 1978 (Fessler et al. 1978).

		Fork length at end of first FW year (cm)		
Year	Location	3$_2$	4$_2$	5$_2$
1977	Sherars	8.8	8.7	0.4
1977	WSNFH	9.2	10.1	9.5
1978	Sherars	--	9.7	9.0
1978	WSNFH	9.0	9.1	8.5

Table 10. Back-calculated mean fork lengths at ocean entry for adult spring chinook sampled at Sherars Falls and WSNFH in 1977 and 1978 (Fessler et al. 1978).

		Fork length at ocean entry (cm)		
Year	Location	3$_2$	4$_2$	5$_2$
1977	Sherars	12.9	12.7	11.9
1977	WSNFH	13.9	15.4	14.7
1978	Sherars	--	14.1	13.9
1978	WSNFH	13.2	13.3	12.9

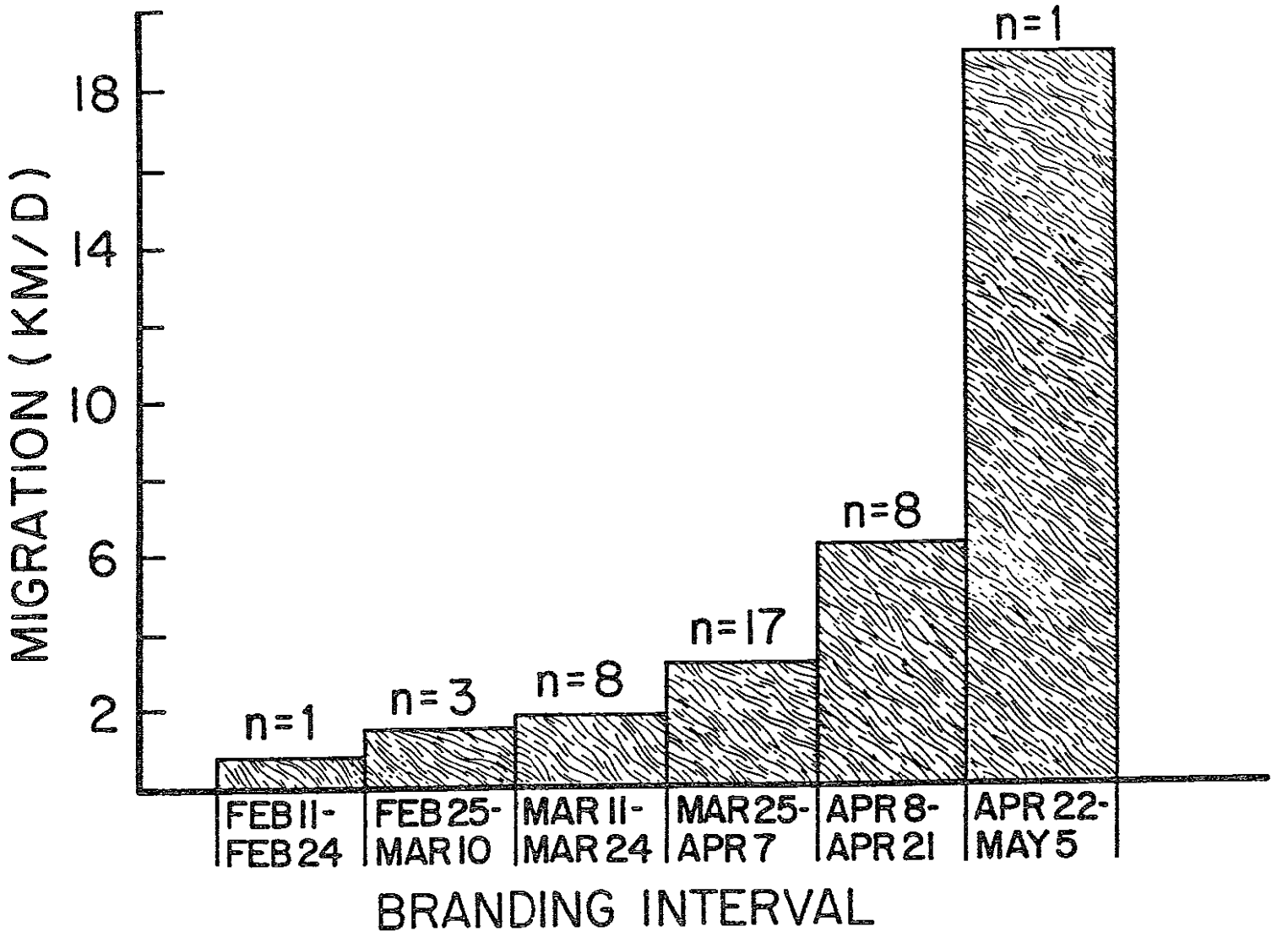

Figure 8. Rate of migration of juvenile spring chinook branded at the Warm Springs trap and recaptured in the Deschutes and Columbia rivers in 1979 (Aho$_2$ et al. 1979).

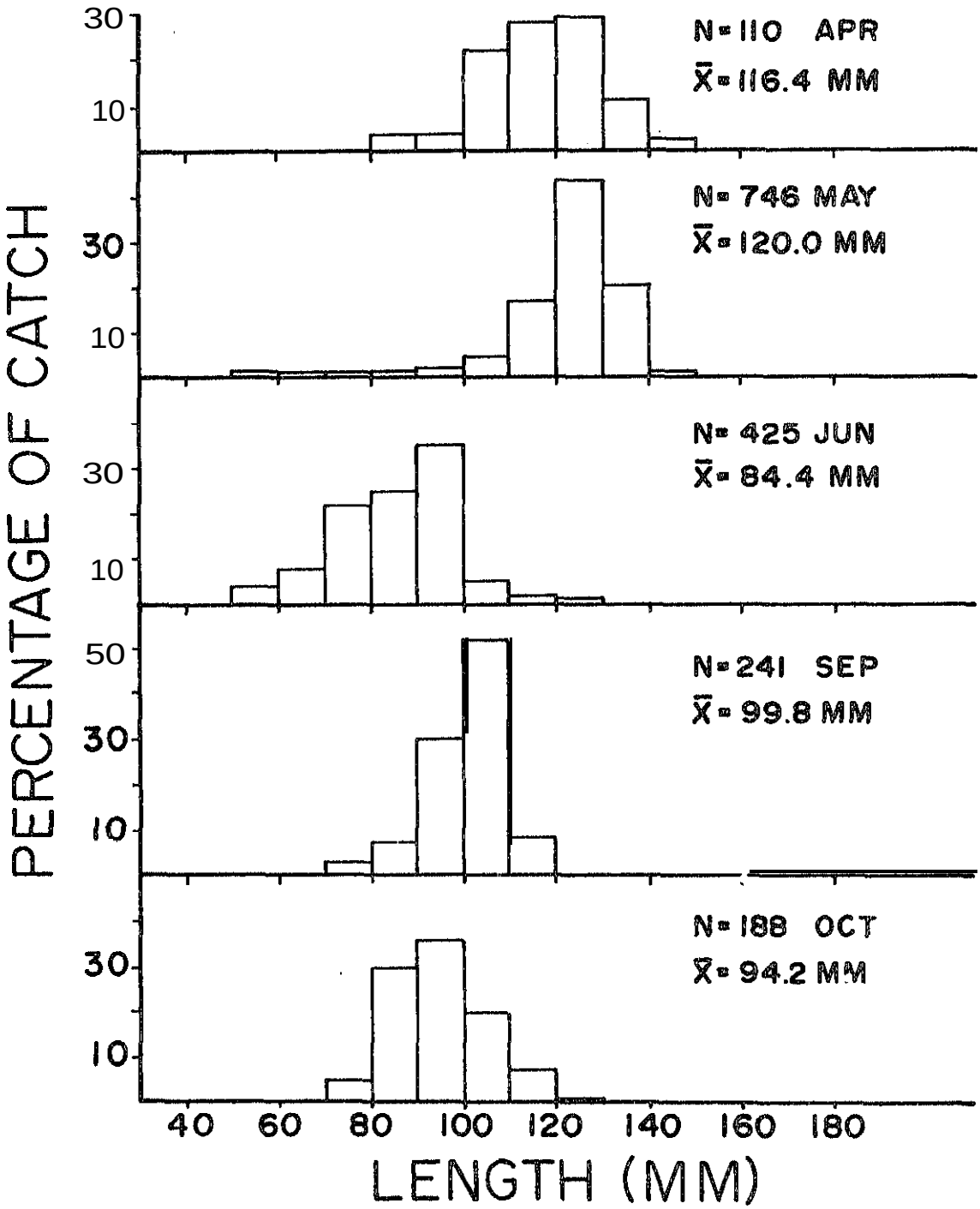

Figure 9. Monthly length frequency distribution of juvenile chinook captured by migrant trap in the Warm Springs River, April to October, 1978 (Fessler et al. 1978).

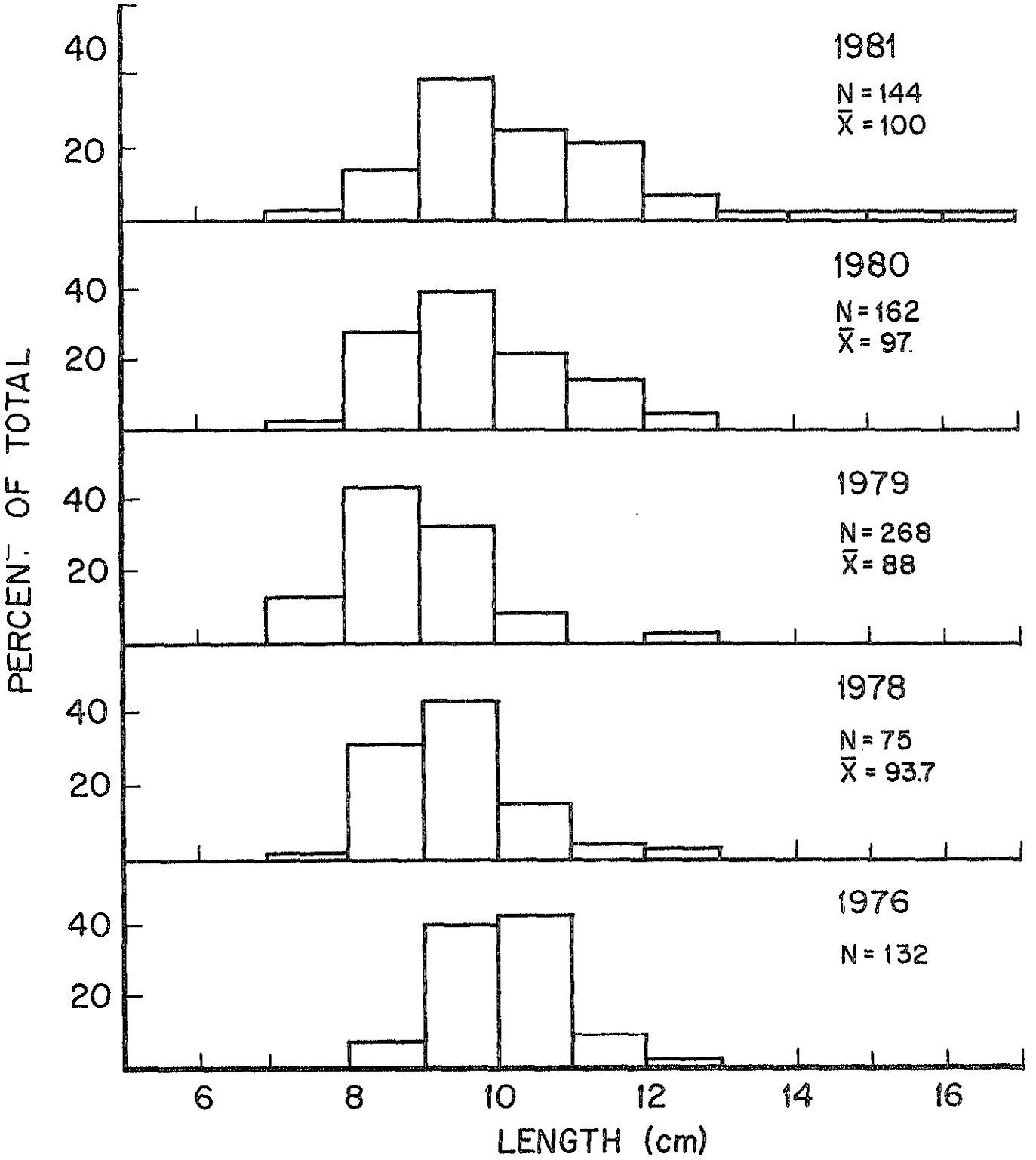

Figure 10. Length frequencies of juvenile chinook migrating from the Warm Springs River during December 1976, 1978-81 (Cates 1981).

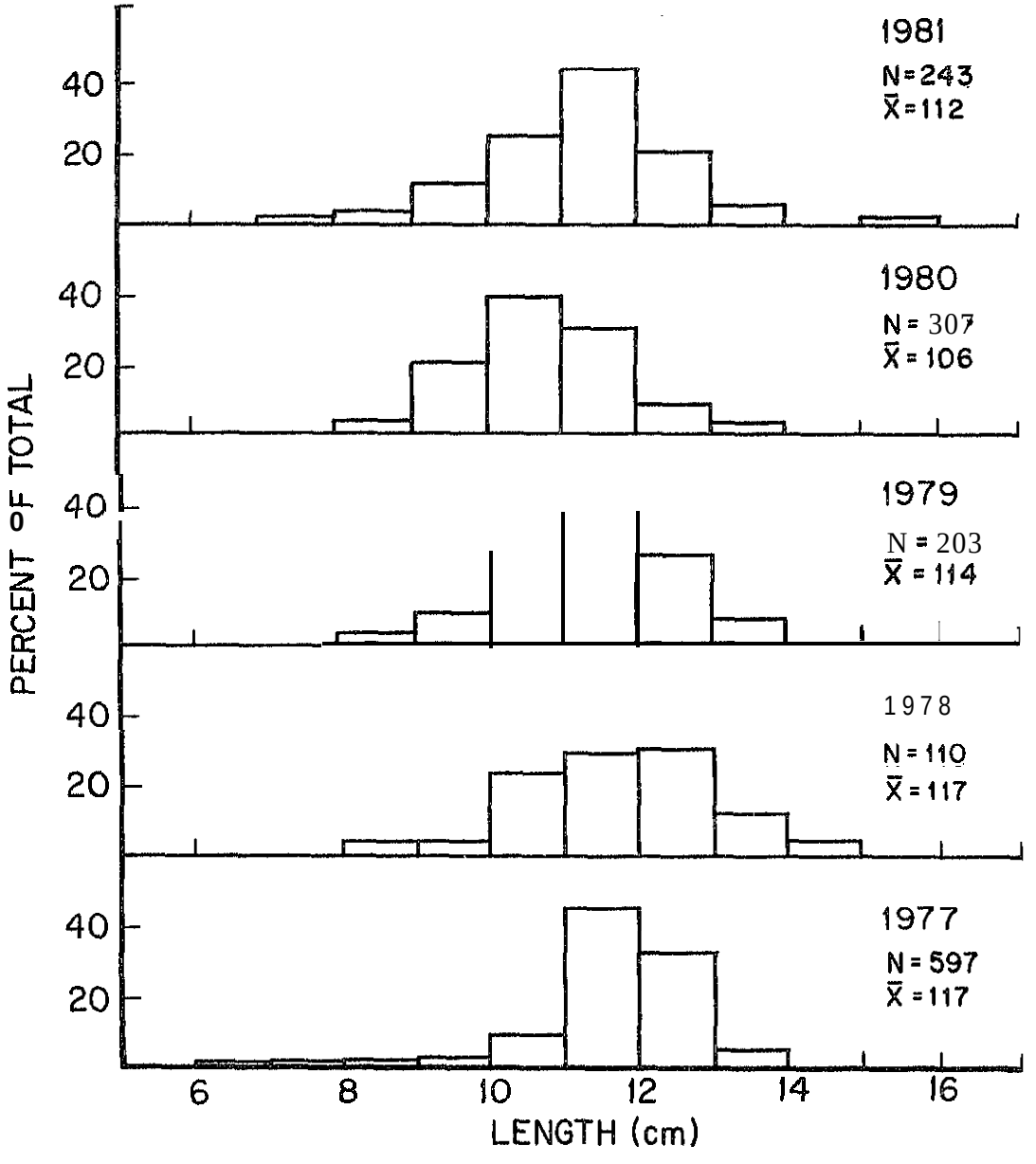

Figure 11. Length frequencies of wild juvenile spring chinook migrating from the Warm Springs River during April 1977-81 (Cates 1981).

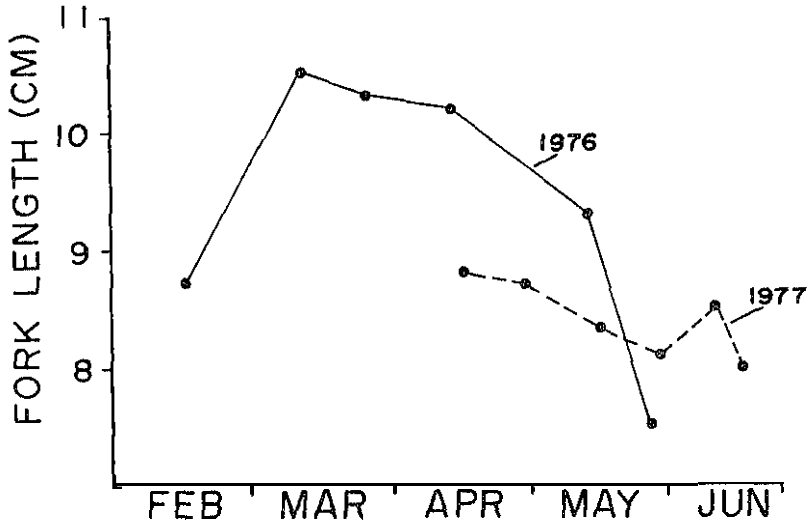

Figure 12. Back-calculated mean fork length at the end of the first year in freshwater for yearling chinook migrants sampled in the Warm Springs River during 1976 and 1977 (Fessler et al. 1978).

Survival rate

Survival of fry from egg to migrant stage ranged from 2.3-10.0%, and smolt-to-adult survival rates ranged from 1.7-3.2% (Table 11). Overall egg-to-adult survival of 1975-79 brood spring chinook averaged 0.07%, ranging from 0.04-0.09% (Table 11).

Table 11. Abundance and survival of wild spring chinook in the Deschutes River at several life history stages, 1975-83 (Jonasson and Lindsay 1983; Stainbrook 1984).

Brood year	Thousands of eggs deposited	Juvenile outmigrants[a]	Adult return[b]	Survival (%)		
				Egg to smolt	Smolt to adult	Egg to adult
1975	2,424	69,045	1,851	2.8	2.7	0.08
1976	3,198	73,084	1,445	2.3	2.0	0.04
1977	2,097	50,329	1,620	2.4	3.2	0.08
1978	2,388	131,943	2,212	5.5	1.7	0.07
1979	1,077	50,558	970[c]	4.7	1.9[c]	0.09
1980[d]	351	35,235	--	10.0	--	--
1901[e]	471	43,885	--	1.3	--	--
1982	1,299	99,142	--	--	--	--
1983	1,293	--	--	--	--	--

[a] Juveniles that migrated from the Warm Springs River in the spring and fall.
b Adult returns to the mouth of the Deschutes (estimated from catch plus escapement).
c Does not include age 5 chinook returning in 1984.
d 208,187 unmarked juveniles released from WSNFH.
[e] 223,511 externally unmarked juveniles released from WSNFH.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Rearing distribution and survival of juvenile fall outmigrants.

2. Fecundity/length relationships.

3. Overlap of spring and fall chinook runs.

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Deschutes River Spring Chinook (hatchery)

PRODUCTION

Hatchery spring chinook have been released into the Deschutes River since 1967. As many as 900,000 juveniles are currently released each year as fry, fingerlings, and smolts (Table 1).

Table 1. Deschutes spring chinook releases, 1976-82 broods. Subyearlings were released in the spring or fall following the brood year and yearlings were released in the spring two years after brood year.

Brood year	Round Butte Hatchery		Warm Springs NFH	
	Subyearlings[a]	Yearlings	Subyearlings[a]	Yearlings
1976	62,040	72,300		
1977	174,342	40,328		
1978	68,879[b]	93,614		178,890
1979	51,509[c]	85,335	54,668	358,137
1980	77,902	53,808	65,303	142,884
1981	87,656	130,682	108,472	209,856
1982	106,729	162,781	61,864	625,995

a All were larger than 44 fish/lb unless otherwise designated.
b 14,579 were 91/lb.
c 22,245 were 101.1/lb.

GEOGRAPHIC LOCATION

Streams

Spring chinook are released into the mainstem Deschutes River and Warm Springs River (Figure 1).

Hatcheries

Round Butte Hatchery on the Deschutes River and Warm Springs National Fish Hatchery (WSNFH) on the Warm Springs River

ORIGIN

The Deschutes spring chinook hatchery stock was developed from native Deschutes spring chinook stock collected in the Warm Springs River, at Sherars Falls, and in the Pelton trap.

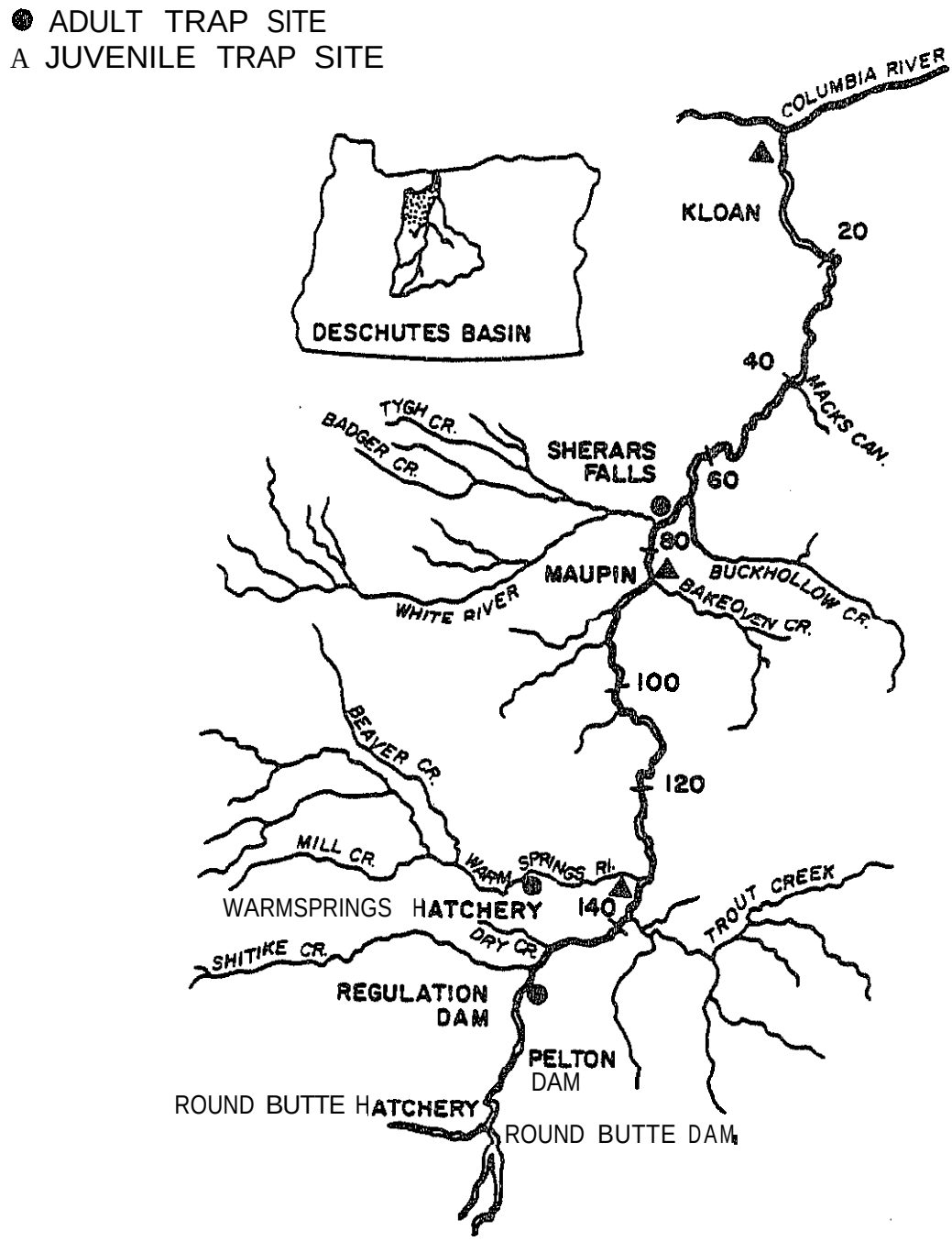


Figure 1. Map of lower 161 km of the Deschutes River (Aho et al. 1979).

ADULT LIFE HISTORY

Run size, catch, and escapement

The estimated average run size of Deschutes hatchery spring chinook entering the Columbia River in 1982 through 1984 was 1,641 fish (Table 21. The hatchery component of the spawning escapement to the Deschutes River averaged 1,262 fish during the same period (Table 2).

Table 2. Recruitment of Deschutes hatchery spring chinook[a] to the mouth of the Columbia River, 1977-84.

Year	Run size[b] (Columbia River)	Spawner escapement[c] (Deschutes River)
1977	37	27
1978	15	15
1979	26	26
1980	188	127
1981	593	571
1982	2,097	1,373
1983	1,410	1,028
1984	1,417	1,385

a Includes both adults and jacks.
b Estimated from 1) Columbia River harvest (calculated from catch:escapement ratios for upriver spring chinook), 2) Deschutes River harvest, and 3) spawner escapement to the Deschutes River system.
c Round Butte Hatchery and WSNFH returns and estimates of hatchery adults spawning naturally.

Hatchery adults and jacks composed 25% to 50% of the spring chinook catch in both the Indian dipnet fishery and the sport fishery since 1982 (Tables 3 and 4). The majority of the hatchery spring chinook are caught in the Deschutes River (Table 5). The remainder are primarily caught off California and in the Columbia River.

Table 3. Catch of Deschutes River hatchery stock of spring chinook in the Indian dipnet fishery at Sherars Falls, 1982-83[a] (Jonasson and Lindsay 1983).

	Adults		Jacks	
Year	Hatchery	Wild	Hatchery	Wild
1982	69	214	40	13
1983[b]	109	167	13	2

a No reported catch of hatchery stock prior to 1982.
b Includes 19 hatchery and 11 wild adults, and 6 hatchery and 2 wild jacks from

Table 4. Sport catch of hatchery spring chinook at Sherars Falls, 1980-83[a] (Jonasson and Lindsay 1983).

year	Adults		Jacks	
	Hatchery	Wild	Hatchery	Wild
1980	8	339	53	41
1982	309	449	205	53
1983	226	330	10	42

a No catch of hatchery stock prior to 1980.

Table 5. Preliminary expanded recoveries of adult chinook coded-wire tagged as juveniles at Round Butte Hatchery, 1978-80 (B. Jonasson, ODFW, personal communication).

Area	Catch
Alaska	0
British Columbia	0
Washington	12
Oregon	0
California	48[a]
Columbia River	63
Deschutes River	300

a Data are not available for California 1980-82.

Wild and hatchery fish are trapped at WSNFH (Table 6). A portion of both stocks are retained as broodstock; the others are passed upstream (Table 6). Hatchery adults have only been passed above WSNFH to spawn in the wild since 1982. In 1982 and 1983, 270 and 194 hatchery fish were passed above WSNFH, comprising 17% and 15% of the spawning populations above the hatchery, respectively.

Table 6. Returns of Deschutes spring chinook hatchery stock to WSNFH, 1981-84 (B. Cates, USFWS, personal communication).

	Adults			
Year	Kept for broodstock	Released upstream	Jacks	Total
1981	----	----	85	85
1982	625	270	21	916
1983	162	193	-[a]	355
1984	20[a]	2[a]	203	225

a 1980 hatchery brood not marked.
b 1981 hatchery brood not 100% marked.

Time of migration

Hatchery spring chinook pass Sherars Falls in May (Figure 2), and arrive at Pelton Trap and Warm Springs hatcheries in May, June, and July. Jacks return to WSNFH from late May through July, and a few return in September (Cates 1984).

Spawning Period

Females were spawned in late August and early September (Table 7).

Table 7. Time of spawning and fecundity of Deschutes spring chinook at Round Butte Hatchery, 1978-83.[a]

	Spawned				
Year	Females	Median date	Range	Eggs taken	Estimated fecundity
1978	56	8/31	8/18-9/15	190,402	3,400
1979	58	9/15	8/31-9/28	164,658	2,839
1980	51	9/5	8/31-8/19	154,188	3,023
1981	161	8/31	8/31-9/11	479,036	2,975
1983	266	9/1	8/22-9/14	823,000	3,094

a Data not available for 1982

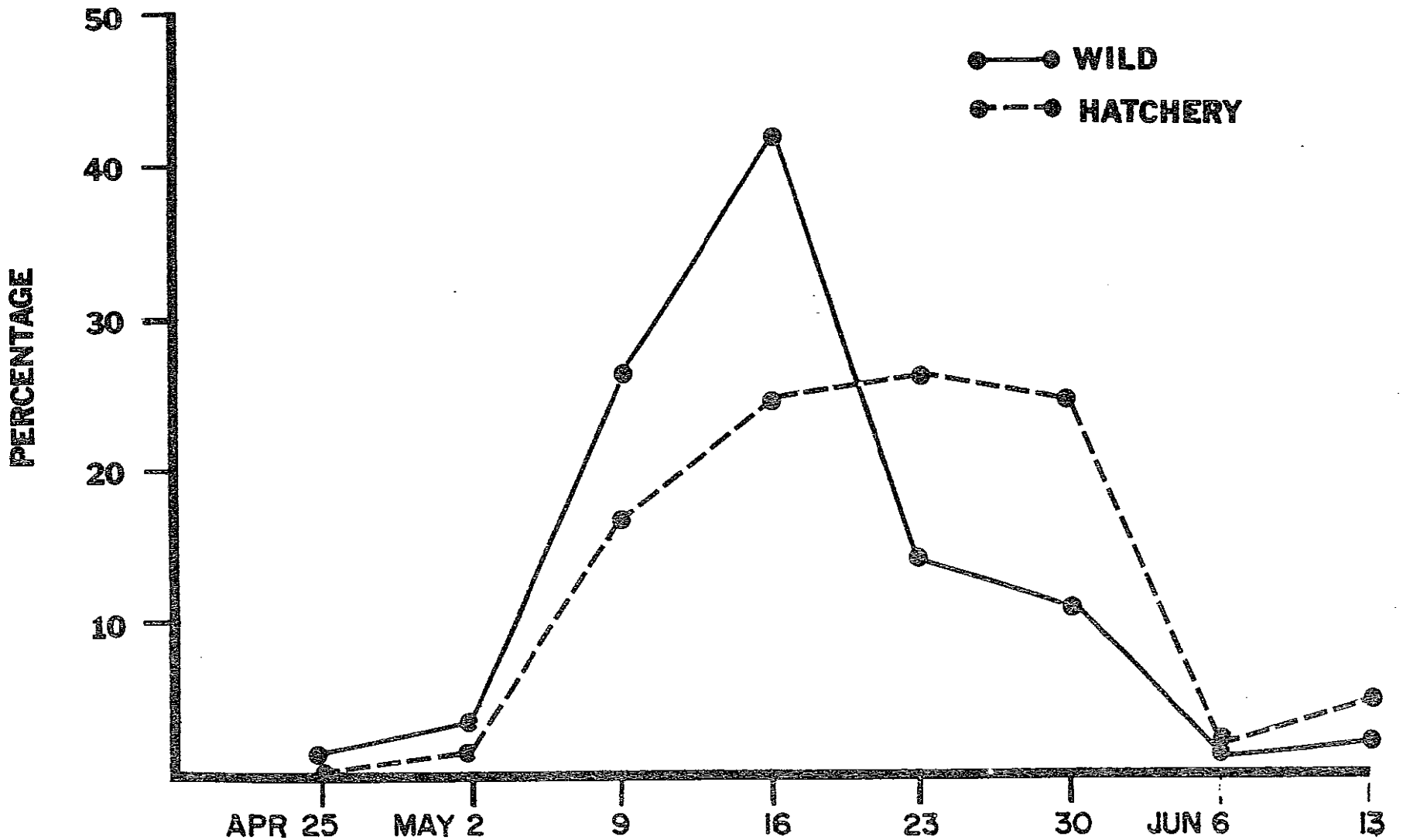


Figure 2. Migration timing of wild and hatchery spring chinook past Sherars Falls, 1982 (Lindsay et al. 1982).

Spawning areas

Adults are spawned at Round Butte Hatchery and Warm Springs NFH.

Age composition

The majority of spring chinook released from Round Butte Hatchery return as 3-year-old jacks and 4-year-old adults (Table 8). The majority (86-87%) of fish returning to WSNFH from the 1978 and 1979 broods were 4-year-old fish (Table 9). Jacks accounted for 27% and 28% of returns from 1978 and 1979 brood releases from Round Butte Hatchery compared to 6% and 7% of returns from WSNFH releases for the same brood years.

Table 8. Adjusted[a] Sherars Falls catch and returns to Pelton Trap of tagged Round Butte Hatchery spring chinook, 1975-1980 (B. Jonasson, ODFW, personal communication).

Brood	Pelton Trap						Sherars Falls						
	Age 3		Age 4		Age 5		Indian catch			Sport catch			
year	M	F	M	F	M	F	Age 3	Age 4	Age 5	Age 3	Age 4	Age 5	Total
1975	2	1	4	8									15
1976	2												2
1977	52	16	58	220									407
1978	101	23	69	213	2	3		16		11	60		498
1979	114	45	88	439	0	0	13	54	0	137	175	0	1,065
1980	31	22	32	203	-	-	25	0	-	39	0	-	352

a Adjusted to total number of juveniles released (total tagged adult fish in returns divided by % tagged fish in release group).

Table 9. Age of 1978-79 brood spring chinook released from Warm Sprins National Fish Hatchery (B. Cates, USFWS, personal communication).

Brood	Number released	Acre (%)			Total
		Jacks	4	5	
1978	178,890	93 (6)	1,269 (86)	113 (8)	1,475
1979	409,807	28 (7)	331 (87)	20 (5)	379

Size

Jacks of WSNFH origin had a modal length of 48 cm in 1981. Lengths ranged from 31 to 65 cm (Cates 1984).

Sex ratio

The 3- and 4-year-old adult population that returned to Round Butte Hatchery from 1977 to 1980 was composed of 16-44% and 76-83% females, respectively (Table 10).

Table 10. Percentage females in returning spring chinook captured at Pelton trap from releases of slow-incubated juveniles from Round Butte Hatchery, 1977-80 broods (Jonasson and Lindsay 1983).

Brood Year	Age 3	Age 4
1977	16	79
1978	27	76
1979		83
1980	44	na

Fecundity

Average fecundity ranged from 2,839 eggs/female to 3,400 eggs/female at Round Butte Hatchery during 1978-83 (Table 7).

Biochemical-genetic characteristics

Preliminary data on isozyme gene frequencies are listed in Table 11.

JUVENILE LIFE HISTORY

Time of emergence

Eggs are incubated in 42.5°F water at Round Butte Hatchery. Approximate incubation times are as follows: egg to eyed-egg--43 days, eyed-egg to hatch--28 days, and hatch to emergence--81 days.

Time, age, and size at migration

The Round Butte hatchery groups with high survival rates were slowly incubated in chilled water (42.5°C) and released from the hatchery as yearlings (at 6 fish/lb) in March and April. Experimental groups of juveniles were transferred to the Pelton Ladder as subyearlings in October and allowed to migrate volitionally beginning in March (Jonasson and Lindsay 1983). The smolts allowed to migrate volitionally left the ladder during March and early April at an average length of 14-15 cm.

Fast incubated juveniles were reared in 50°F water and released in May or October as subyearlings. Survival of these groups was very low. Subyearlings were no longer released as of the 1984 brood.

Table 11. Isozyme gene frequencies and sample sizes (N) as determined by electrophoresis for spring chinook from Round Butte Hatchery. Numbers at top of each column are the relative abilities for each allele present in the enzyme system. Minus signs indicate cathodal migration (Schreck et al. 1984).

ACON				ADA			ADH			GPI-2			GPI 1-3H			GOT 3		
100	86	116	N	100	83	N				100	60	N	Stand. Vari.		N	100	90	N
1.00			93	1.00		78	1.00		90	1.00		100	1.00		180	1.00		50

ICD 3 & 4				LDH-4			LDH-5			MDH-3 & 4				MPI				
100	74	127	N	100	120	N	100	70	N	100	121	70	N	400	109	95	113	N
0.95	0.05	<0.005	82	1.00		93	1.00		93	0.99	0.01		100	6.81	0.19			93

PEP-GL-1			PEP-LGG				PGK				SOD		
10	90	N	100	130	45	N	100	90	64	N	-100	-260	N
1.0		93	0.98	0.02		93	0.45	0.55		93	0.56	0.44	81

WSNFH releases subyearlings in the fall at a size of 6-10 fish/lb and yearlings in the spring at a size of 8-20 fish/lb. Fall releases of large juveniles and spring releases of small juveniles resulted in greater adult returns than spring releases of large juveniles.

Juveniles released from WSNFH in the spring moved out of the Warm Springs River within two months. A few juveniles released in the fall lingered in the Warm Springs River until the spring (Figure 3). Yearling smolts released in the spring migrated to the Columbia River estuary shortly after release. Lengths of spring chinook released in April and recaptured in the Columbia River estuary are presented in Figures 4 and 5. Subyearlings released in the fall migrated to the estuary in the fall, winter, and spring (Lindsay et al. 1981).

Deschutes spring chinook were captured in purse seines in Oregon and Washington coastal waters in May and June (Figure 6). Juveniles were not captured in July, August, or September in northern California, Oregon, Washington, or Vancouver Island (B.C.) coastal waters.

Survival rate

Prespawning mortality of males and females at WSNFH ranged from 13% to 53% (Table 12). Egg-to-fry survival of the 1983 brood at Round Butte Hatchery averaged 61%. Survival of the 1977-79 slow-incubated juveniles reared at Round Butte and released as yearlings ranged from 0.20% to 1.48%. The yearlings allowed to migrate volitionally had the highest survival.

The highest return rate to WSNFH resulted from a spring release of small (18-20 fish/lb) yearlings (Table 13). Survival rate of all release groups ranged from 0.017% to 0.121%.

DISEASE HISTORY

Bacterial kidney disease is the principal disease affecting adult and juvenile spring chinook at Round Butte Hatchery and Warm Springs NFH. Adult innoculations and culling have reduced the problem. IHN and IPN viruses have also been detected in spawning adults 1979-84, although no viral epizootics have been noted at Round Butte Hatchery (R. Holt, ODFW, personal communication). In addition, the young spring chinook are susceptable to *Ceratomyxa shasta*.

PRIORITY INFORMATION NEEDS

1. Run size of spring chinook entering Deschutes River and passing Sherars Falls.

2. Fecundity/length relationship.

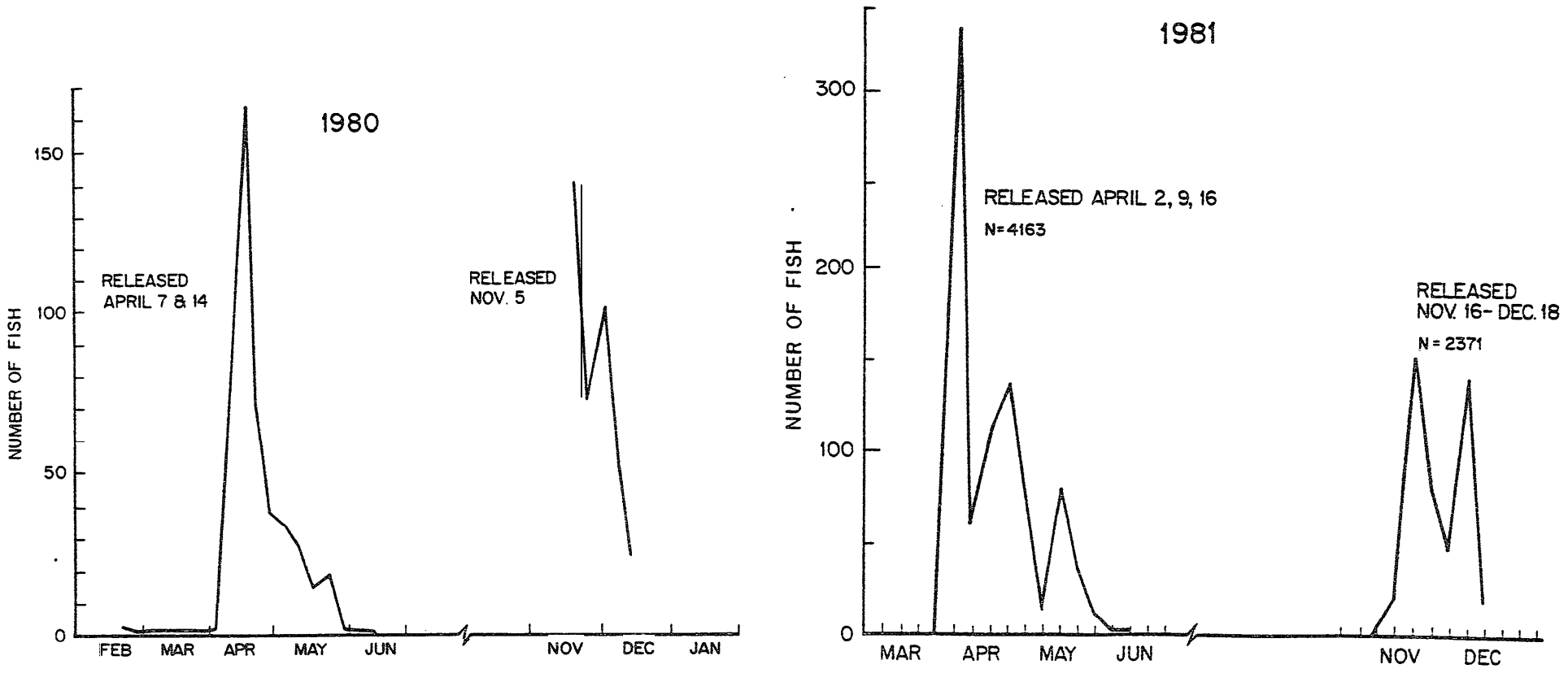


Figure 3. Mean daily catch per week of juvenile hatchery spring chinook in the Warm Springs scoop trap in 1980 and 1981 (Cates 1984).

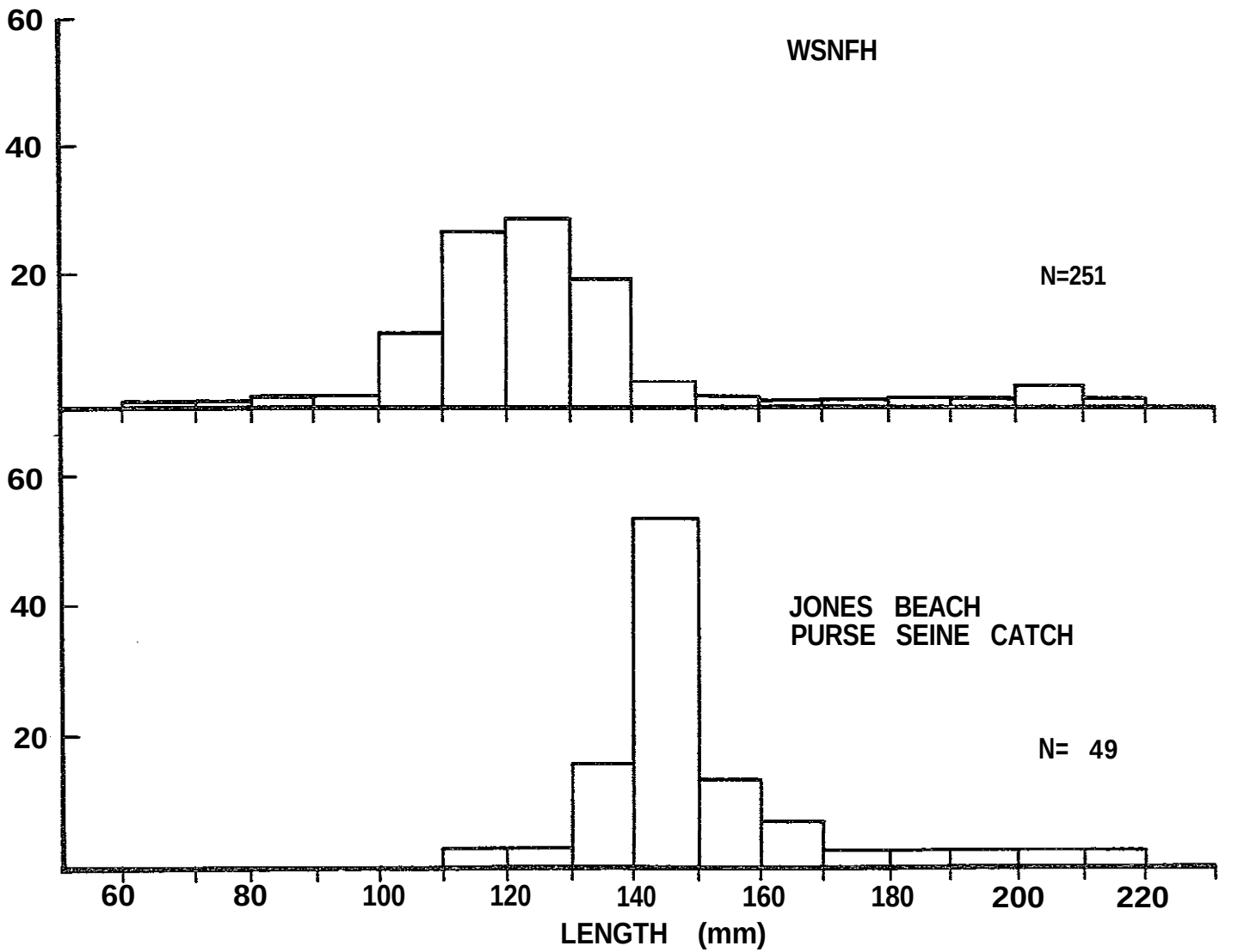
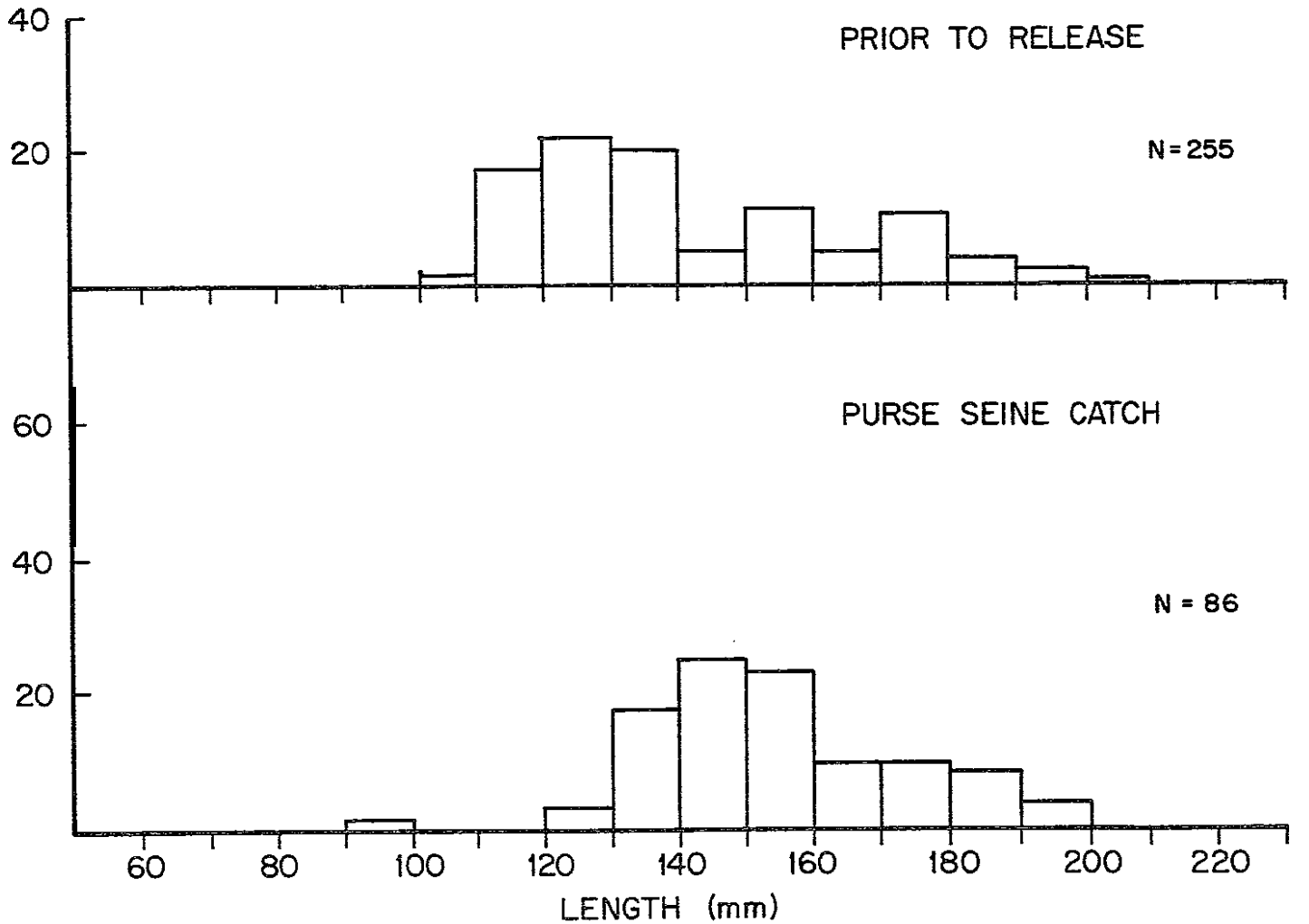


Figure 4. Length frequencies of 1978 brood chinook released from Warm Springs NFH and recaptured at Jones Beach in 1980 (Cates 1984).



igure 5. Length frequencies of 1979 brood chinook released from Warm Springs NFH and recaptured at Jones Beach in 1981 (Cates 1984).

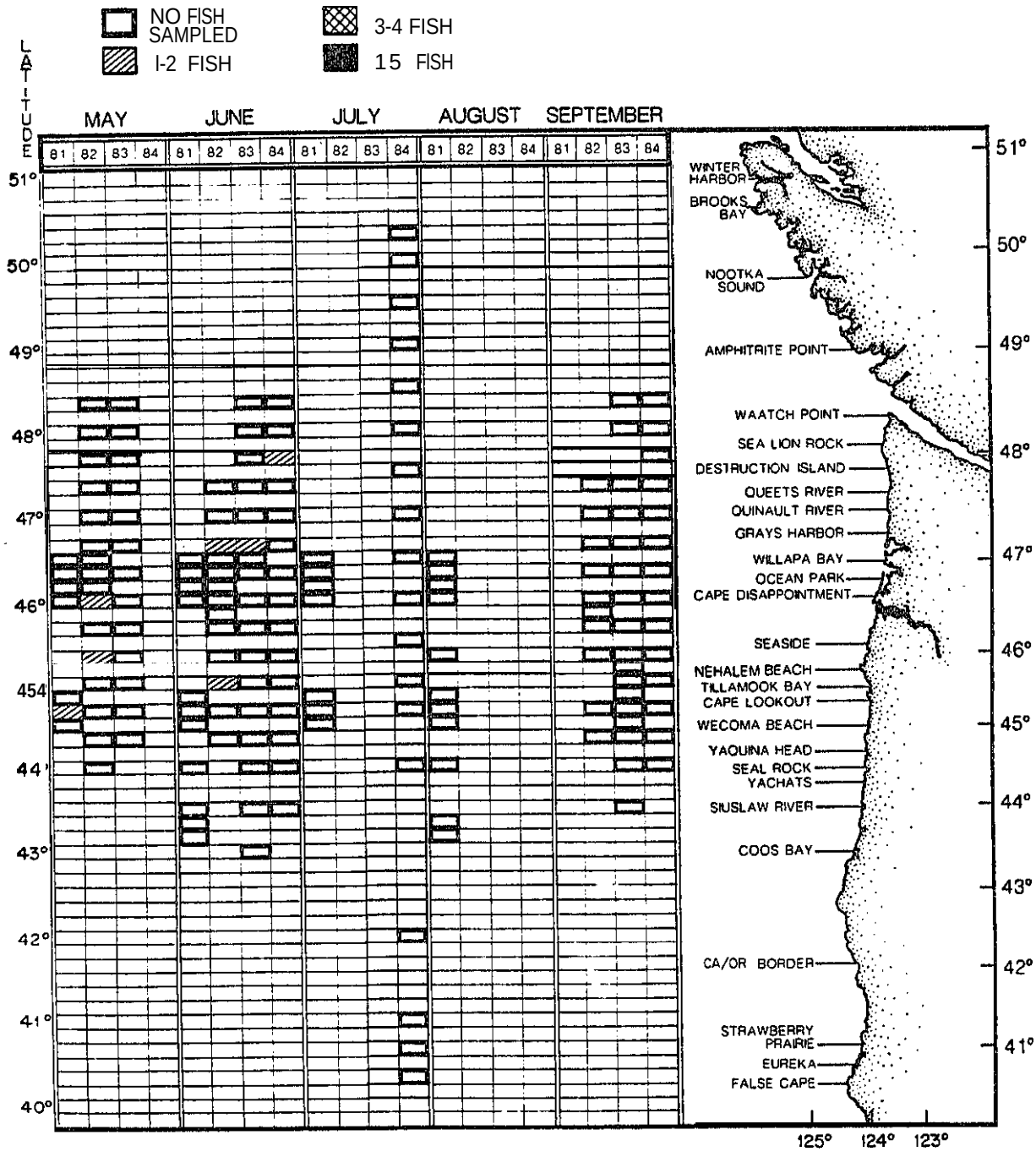


Figure 6. Recoveries of coded-wire tagged Deschutes River juvenile spring chinook in the Pacific Ocean, 1981-84 (Data from Wakefield et al. 1981; Fisher et al. 1983; Fisher et al. 1984; Fisher and Pearcy 1985).

Table 12. Disposition of spring chinook adults held for spawning at Warm Springs NFH (B. Cates, USFW, personal communication).

	Total females held	Prespawning mortality	Females spawned
1978	345	0.401 (139)	206
1979	259	0.278 (72)	187
1980	205	0.454 (93)	112
1981	302	0.464 (140)	162
1982[a]	428[b]	0.164 (70)	358
1983	362	0.169 (61)	301
1984	396	0.126 (50)	339[c]

	Total males held	Prespawning mortality	Males spawned
1978	201	0.408 (82)	119
1979	157	0.287 (45)	112
1980	112	0.518 (58)	54
1981	215	0.526 (113)	102
1982[a]	230[b]	0.226 (52)	178
1983	252	0.183 (46)	206
1984	254	0.161 (41)	161[d]

[a] First year of adult inoculations for BKD.
[b] 50 additional fish were taken by poachers from hatchery ponds - sex unknown.
[c] 7 females not spawned (gross BKD, bad eggs, etc.)
[d] 52 males not used (gross BKD, low sperm, etc.).

Table 13. Return of 1979 brood spring chinook to WSNFH (B. Cates, USFWS, personal communication).

Date released-size	Number released	Age (%) Jacks	4	5	Total	Return rate
Fall-large[a]	54,668	12 (0.26)	33 (0.70)	2 (0.04)	47	0.086%
Spring-large[b] and small[c]	358,137	16(0.05)	298(0.90)	16(0.05)	332	0.093%
Fall-large[a]	54,668	12(0.26)	33 (0.70)	2(0.04)	47	0.086%
Spring-large[b]	99,000	2 (0.12)	13 (0.76)	2 (0.12)	17	0.017%
Spring-small[c]	259,137	14 (0.04)	285 (0.98)	14 (0.04)	313	0.121%

[a] 9/lb.
[b] 8/lb.
[c] 18-20/lb.

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Deschutes River Fall Chinook (wild)

PRODUCTION

The Deschutes fall chinook stock is currently maintained solely through wild production. There was little contribution from a limited hatchery program during the 1970s which has since been discontinued (Table 1).

GEOGRAPHIC LOCATION

Streams

Deschutes River (mainstem) (Figure 1)

ORIGIN

Deschutes fall chinook are a native stock. Previous hatchery releases of fall chinook were offspring of native wild broodstock.

ADULT LIFE HISTORY

Run size. catch, and escapement

More than 6,800 fall chinook returned to the Deschutes River each year during 1977-83 (Table 21. The estimated run size of adults ($\geq$54 cm in length) for that period ranged from a low of 4,443 fish in 1980 to a high of 7,682 fish in 1977. Jack fall chinook (<54 cm) runs varied more, from 1,603 in 1983 up to 6,426 in 1979. More than 83% of the total escapement passed Sherars Falls in 1983 (Table 3). The population estimates for the portion of the run above Sherars Falls ranged from 2,009 to 3,927 adults and from 738 to 3,042 jacks during 1977-83 (Table 3).

Deschutes fall chinook are caught in ocean, river sport, and Indian dipnet fisheries. Approximately 88% of the ocean recoveries of coded-wire tagged fall chinook from the Deschutes were caught north of the Columbia River, primarily off British Columbia (Table 4).

From 1973 to 1983, the sport catch at Sherars Falls ranged from 600 to 2,200 fish (Table 5), while the Indian dipnet catch ranged from 1,600 to 3,500 fish (Table 6). Since 1973 the adult catch in both the sport and Indian dipnet fishery has been relatively stable; however, the jack catch has declined (Tables 5 and 6). The sport catch consists primarily of jacks.

Time of migration

Although this stock is referred to as a fall run, all of the fish recovered during tagging studies from 1947-65 passed Bonneville Dam during the migration period of designated summer run stocks in the Columbia, 1 June through 31 July (Galbreath 1966). Five fish recovered in the Deschutes had

Table 1. Percentage return to Pelton Trap of fast-reared fall chinook juveniles released from Round Butte Hatchery, 1976-79 (modified from Lindsay et al. 1980).

Brood year	Release date	Release site	Size (fish/lb)	Number released	Returns to Pelton Trap 1978	1979	1980	Return to trap (%)
1975	6-14-76	Regulation reservoir	28.0	61,684	0	0	0	0
1976	6-13-77	Below regulation dam	22.5	55,008	0	0	0	0
1976	6-13-77	Below regulation dam	25.9	63,349	0	0	1[a]	0
1977	5-22-78	Below regulation dam	35.5	69,948	--	2	0[b]	0.004
1977	5-30-78	Below Bonneville Dam	32.4	73,092	--	0		0
1978	5-23-79	Below regulation dam	24.8	52,109	--	--	0	0
1978	5-30/31-79	Below Bonneville Dam	22.4	53,836	--	--	2	0.004

a Two fall chinook were landed in British Columbia commercial fisheries, 1980.
b Three were caught in Indian ceremonial fisheries in the Columbia River, 1980.

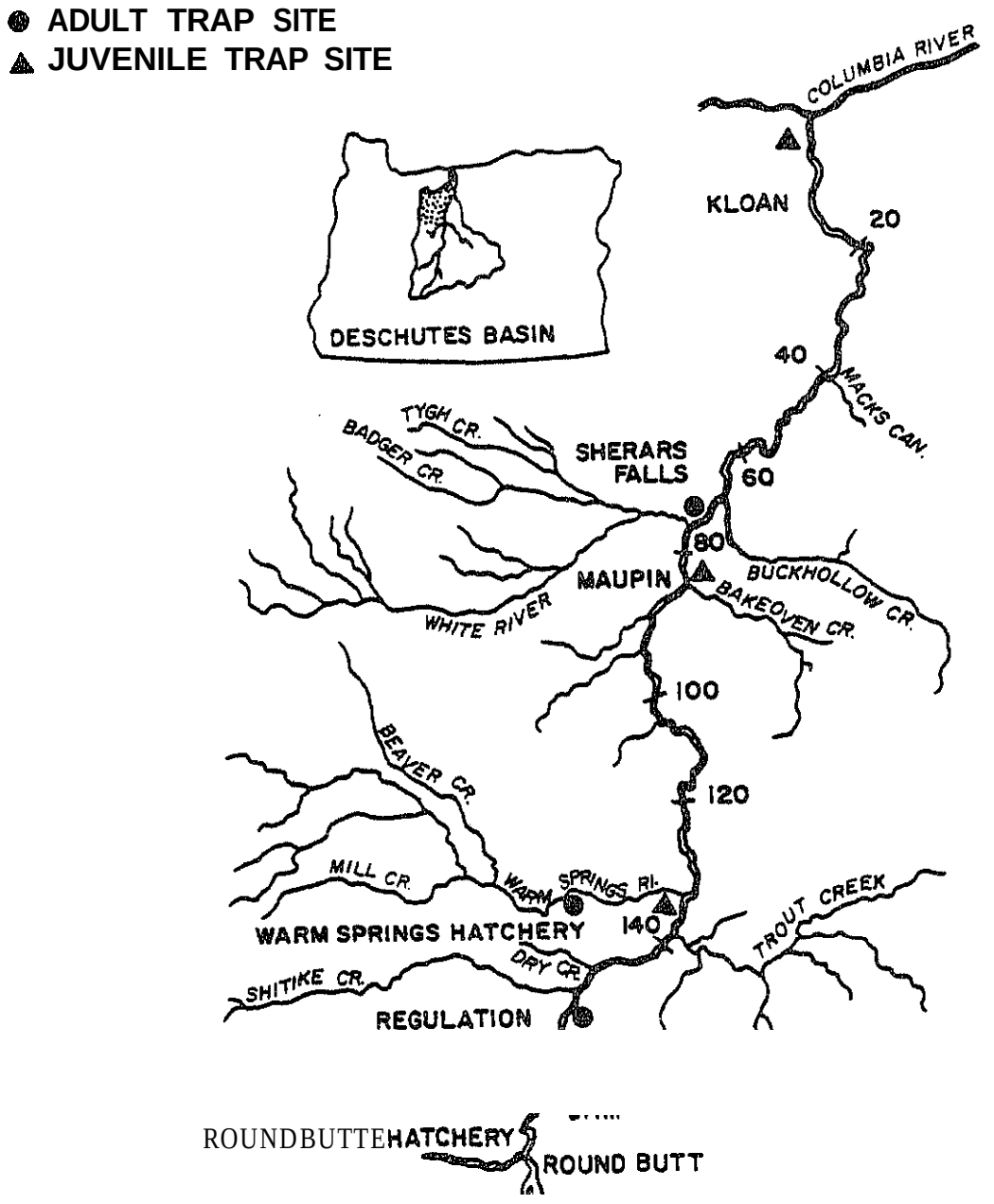

Figure 1. Map of lower 161 km of the Deschutes River (Aho et al. 1979).

Table 2. Run size of fall chinook in the Deschutes River, 1977-1983 (Jonasson and Lindsay 1983).

Year	Escapement	Harvest	Run size	Exploitation rate (%)
		Jacks and Adults Combined		
1977	8,322	3,617	11,938	30
1978	6,736	3,529	10,266	34
1979	7,665	3,647	11,312	32
1980	4,459	3,334	7,793	43
1981	7,156	3,139	10,295	30
1982	8,525	3,607	12,132	30
1983	4,664	2,199	6,863	32

Year	Escapement[a]	Harvest	Run size	Exploitation rate (%)
		Adults (>_54 cm)		
1977	6,042	1,840	7,882	23
1978	4,078	1,955	6,033	32
1979	3,307	1,579	4,866	32
1980	2,549	1,894	4,443	43
1981	3,296	1,835	5,131	36
1982	5,053	2,021	7,074	29
1983	3,779	1,481	5,260	28

Year	Escapement[a]	Harvest	Run size[b]	Exploitation rate (%)
		Jacks (<54 cm)		
1977	2,280	1,777	4,056 (34)	44
1978	2,658	1,574	4,232 (41)	37
1979	4,358	2,068	6,426 (57)	32
1980	1,910	1,440	3,350 (43)	43
1981	3,860	1,304	5,164 (50)	25
1982	3,472	1,586	5,058 (42)	31
1983	885	718	1,603 (23)	45

[a] Includes escapement below Sherars Falls estimated from redd counts. Chapman's modification of Peterson index was used to calculate escapement estimates.

[b] Numbers in parentheses are percent of total run that were jacks.

Table 3. Escapement of adult (≥ 54 cm) and jack (<54 cm) fall chinook above Sherars Falls in the Deschutes River, 1977-83 (Jonasson and Lindsay 1983).

Year, age	Population estimate (95% C.L.)	Tagged	Examined for tags	Recaptured,
1977				
Adults	3,927 (3,277-4,705)	811	560	115
Jacks	1,482 (890-2,626)	272	75	13
1978				
Adults	3,564 (3,117-4,076)	992	760	211
Jacks	2,323 (1,462-3,871)	320	122	16
1979				
Adults	2,308 (1,919-2,774)	567	454	111
Jacks	3,042 (2,062-4,680)	489	148	23
1980				
Adults	2,009 (1,640-2,461)	427	431	91
Jacks	1,505 (1,003-2,366)	398	82	21
1981				
Adults	2,495 (2,104-2,959)	542	601	130
Jacks	2,922 (1,812-4,973)	440	105	15
1982				
Adults	3,820 (2,940-4,957)	286	731	54
Jacks	2,625 (1,071-6,563)	99	104	3
1983				
Adults	3,152 (2,265-4,522)	228	467	33
Jacks	738 (301-1,844)	58	49	3

Table 4. Preliminary expanded recoveries in fisheries of wild chinook coded-wire tagged as juveniles in the Deschutes River, 1978-82 (Jonasson and Lindsay 1983).

Area	Number
Alaska	9
British Columbia	104
Washington	58
Oregon	23
California[a]	0
Columbia River	17
Deschutes River	84

[a] Recoveries from 1980-82 are not available.

Table 5. Catch statistics for the fall chinook sport fishery at Sherars Falls, 1973-83 (Jonasson and Lindsay 1983).

Year	Angler days	Hours fished	Harvest	
			Adults	Jacks
1973	4,363	25,537	363	1,524
1974	4,002	19,468	382	1,793
1975[a]	4,110	26,060	517	1,434
1976[a]	4,193	26,196	359	1,282
1977	4,675	19,971	269	797
1978	3,546	20,764	448	1,042
1979	4,001	21,707	218	1,408
1980	4,346	22,426	289	930
1981[b]	4,643	22,170	376	739
1982	5,294	26,581	489	984
1983	4,168	18,246	278	312

[a] Sport fishery closed to chinook until 1 August.
b Sport fishery closed to all angling until 22 June.

Table 6. Catch statistics for fall chinook in the Indian dipnet fishery at Sherars Falls, 1971-83[a] (Jonasson and Lindsay 1983).

Year	Angler days	Hours fished	Harvest	
			Adults	Jacks
1971	--	4,010	1,700	730
1973	610	4,550	1,628	1,945
1974	754	5,411	1,380	1.406
1975	488	3,361	1,632	1,725
1976[b]	565	3,796	1,099	773
1977	752	4,597	1,520	769
1978	935	4,283	1,507	532
1979	617	5,703	1,361	660
1980	992	7,359	1,605	510
1981[c]	600	5,024	1,423	367
1982	541	4,363	1,471	392
1983[b]	919	5,100	1,172	406

[a] No creel survey in 1972.
b Includes Indian hook and line fishery.
[c] Fishery closed until 22 June.

been tagged at Bonneville between 13 June and 15 July, and 3 fish in the Metolius River (Deschutes tributary1 were tagged 1, 21, and 22 July. No fish tagged during the fall run period, 1 August - 30 September, were recovered in the Deschutes system.

Fall chinook pass Sherars Falls from mid-June through November. The majority of fish pass over Sherars Falls in late September and the first two weeks of October (Figure 2). The run drops off sharply in late October and November.

Spawning period

Fall chinook spawn from October through December. Spawning activity peaks in November (Aho et al. 1979).

Spawning areas

Fall chinook spawn primarily in the mainstem Deschutes River. About 20% of the spawning occurs below Sherars Falls (Figure 1) (Aho et al. 1979). Most fall chinook carcasses were recovered between Maupin and Pelton Regulation Dam. It is not known what percentage of the fall chinook population spawned above the Pelton Regulation Dam prior to its construction.

Age composition

Most fall chinoook return after 2-4 years at sea (Table 7). The largest group consists of fish that migrated to sea as subyearlings and returned as 4-year olds. Fish migrating to sea as yearlings returned primarily as 5-year olds.

Table 7. Age compositon of adult fall chinook salmon sampled at Sherars Falls, 1978 and 1979 (from Aho et al. 1979).

	Percentage							
	July		August		September		October	
Age	1978	1979	1978	1979	1978	1979[a]	1918	1979[a]
3_2	0.0	3.7	0.0	1.0	2.8	----	1.1	----
4_2	2.8	4.7	8.3	2.5	0.8	-----	0.0	----
5_2	38.4	5.6	16.7	2.0	0.8	----	1.1	----
2_1	0.0	26.2	0.0	41.6	33.4	----	33.3	----
3_1	1.7	13.3	14.6	13.2	18.4	----	17.2	----
4_1	42.3	38.3	56.3	32.5	36.8	----	40.2	----
5_1	7.7	7.5	4.2	7.1	6.8	----	6.9	----
6_1	0.0	0.9	0.0	0.0	0.0	----	0.0	----
Sample size	26	107	48	197	353	----	8 7	----

[a] Analysis not completed

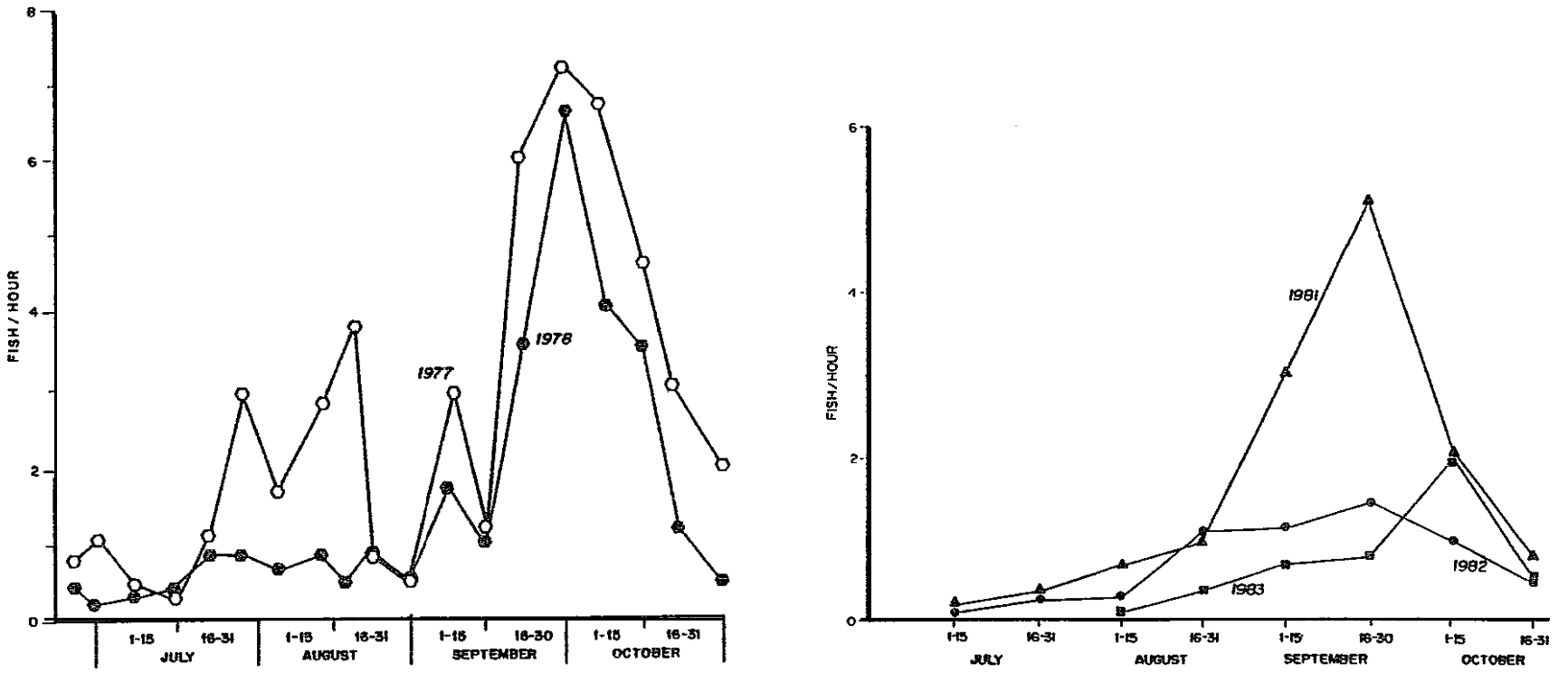

Figure 2. Catch rate (fish/hour) of fall chinook in the steeppass trap at Sherars Falls, 1978, 1979, 1981-83 (Jonasson and Lindsay 1983; Fessler et al. 1978).

Size

Length frequencies of fall chinook passing Sherars Falls in 1978 are shown in Figure 3. Based on a sample of fish collected in September and October 1978, there appears to be considerable overlap in lengths of age 3-5 adults (Figure 4).

Sex ratio

The sex ratio of fall chinook trapped for broodstock in 1976-78 in the Deschutes River varied widely (R. Robart, ODFW, unpublished data):

Brood year	% Males	% Females	% Jacks
1976	19.6	54.9	25.5
1977	57.6	38.9	3.5
1978	28.6	71.4	0.0

Fecundity

Average fecundities of fall chinook broodstock trapped in the Deschutes River during 1976-78 were the following (R. Robart, ODFW, unpublished data):

Brood Year	Estimated fecundity
1976	4,332
1977	4,620
1978	4,364

Length and age composition of broodstock may have varied between years

Biochemical-genetic characteristics

Preliminary data on isozyme gene frequencies have been reported by Schreck et al. (1984).

JUVENILE LIFE HISTORY

Time of emergence

Fall chinook emerge from the gravel in the Deschutes River between February and mid-May (Aho et al. 1979).

Time, age, and size at miora'cion

The juveniles that smolt as subyearlings rear for 2-3 months in the mainstem Deschutes before emigrating in June, July, and August (Figures 5-7).

Juvenile fall chinook in the lower river tended to migrate earlier and at a smaller size (Table 8). Most juveniles that were present through October in the upper river during 1979 migrated out of the Deschutes River in

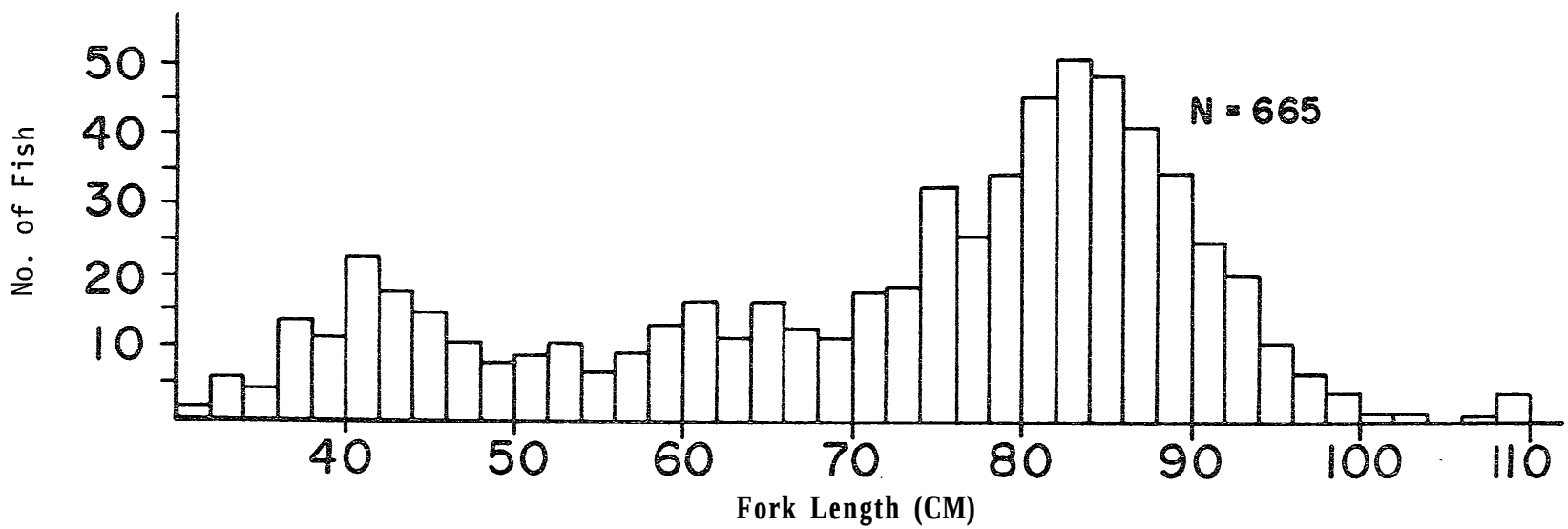

Figure 3. Length frequency of adult chinook captured by steeppass trap at Sherars Falls, June 6 to November 1, 1978 (Fessler et al. 4978).

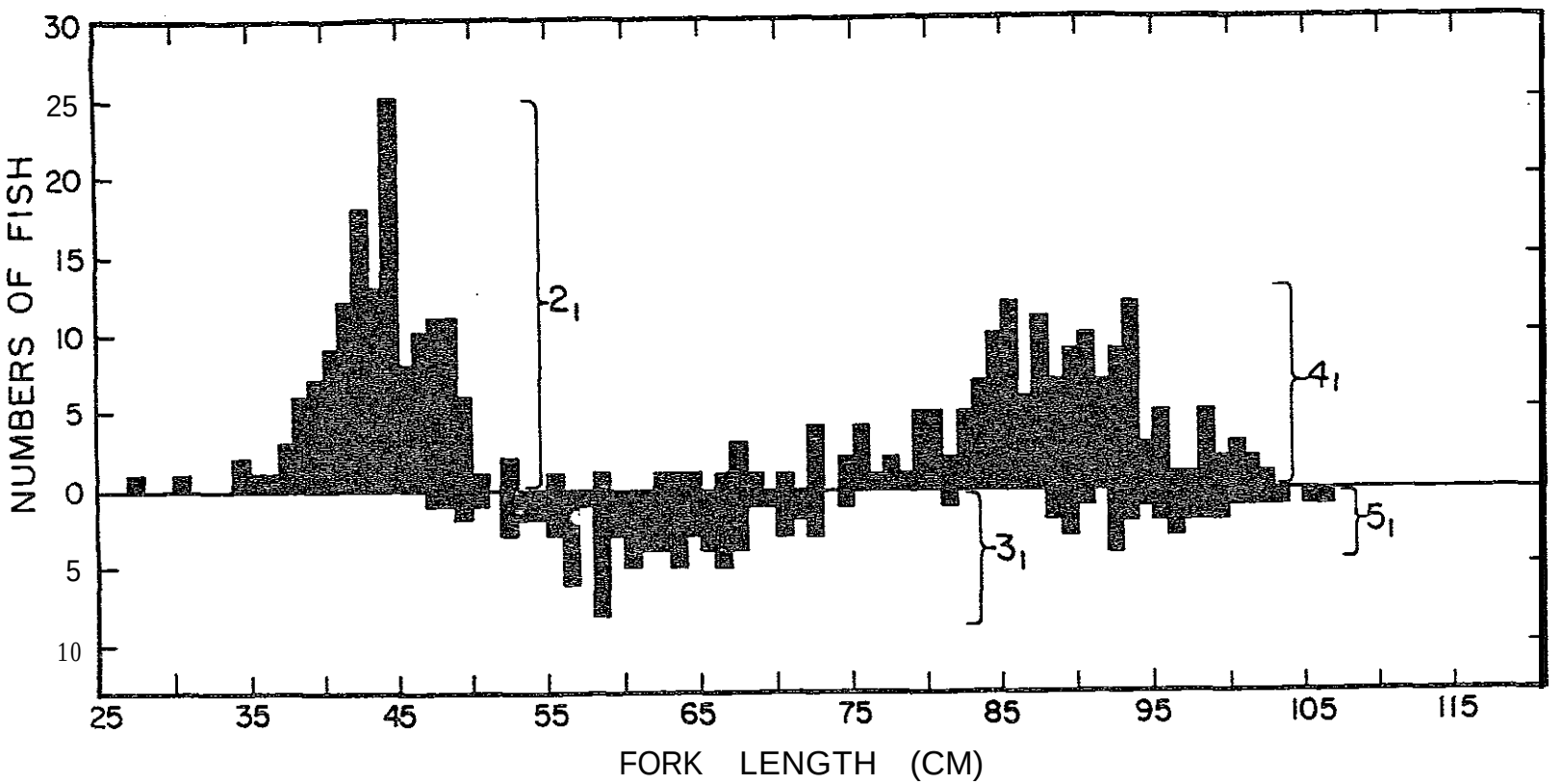

Figure 4. Length frequencies of the four most common age classes of adult fall chinoook sampled at Sherars Falls in September and October 1978. Age was determined by scale analysis (Aho et al. 1978).

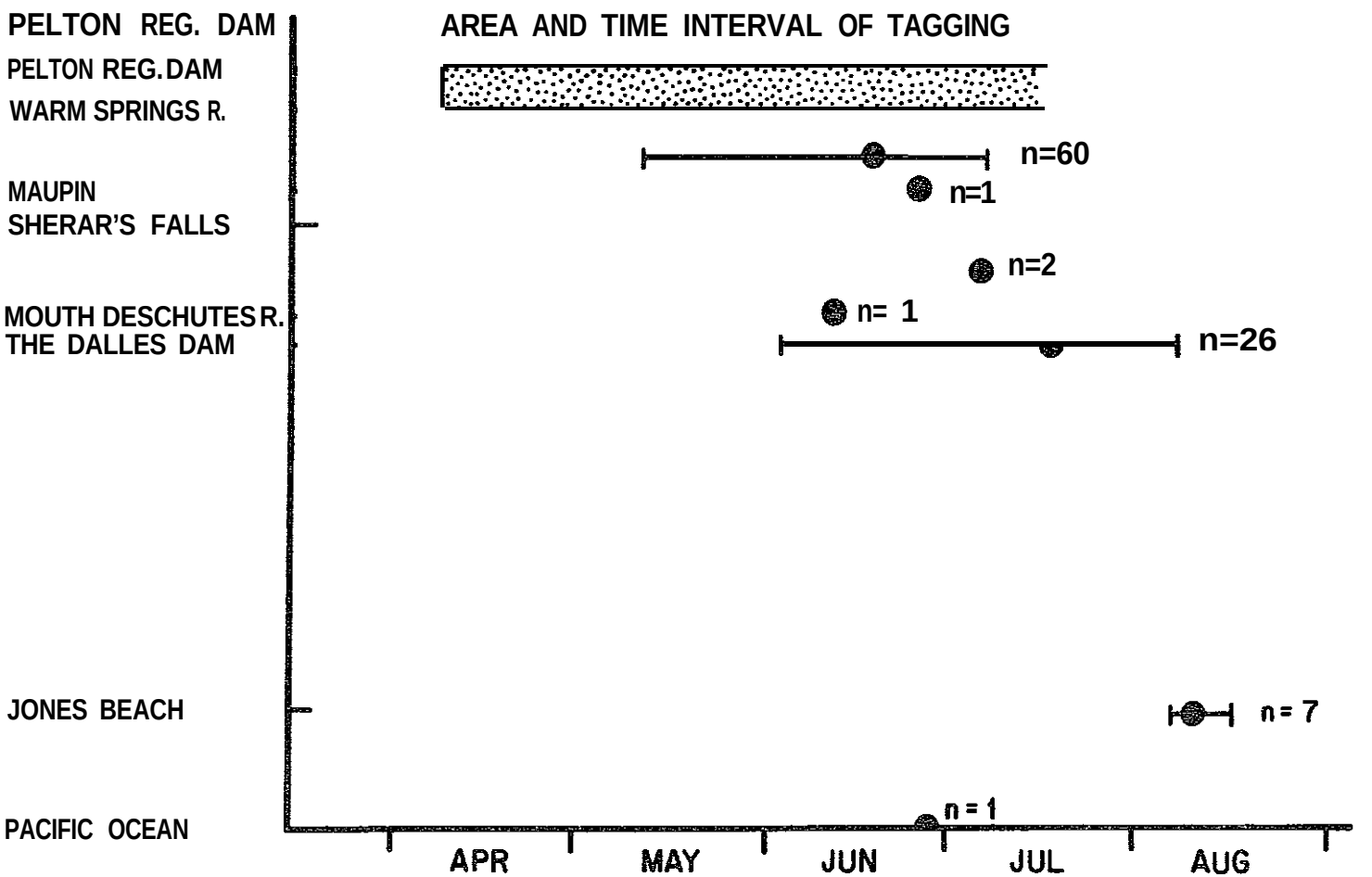

Figure 5. Location and time (mean and range) of recapture of juvenile fall chinook tagged between Pelton Reg. Dam and the Warm Springs River, 1979. (Recapture data for the upper two study sections were combined since fish in both sections were given the same coded-wire tag code. Different freeze brand codes were used, but much of the recapture information from the Columbia River was based on coded-wire tag codes) (Aho et al. 1979).

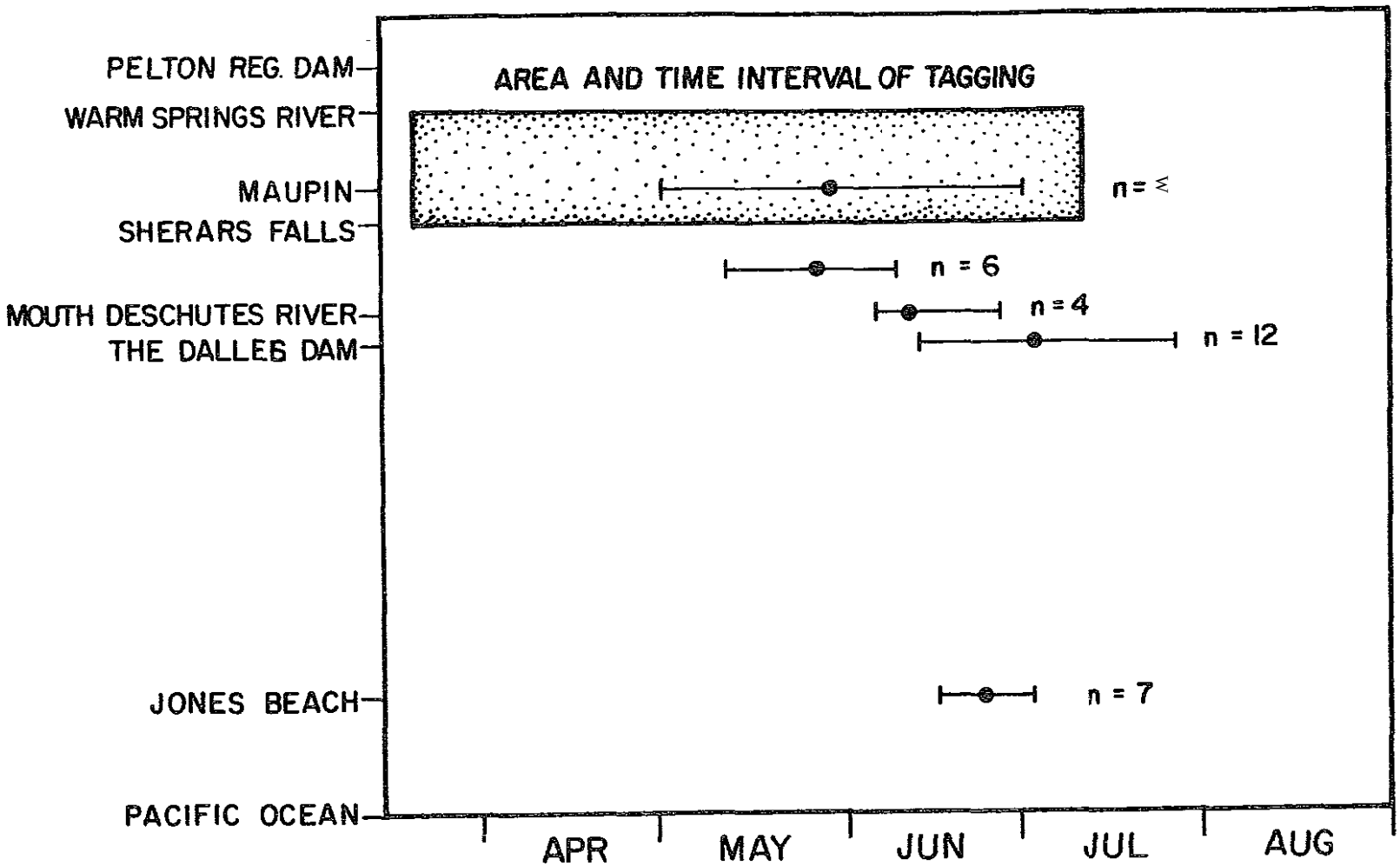

Figure 6. Location and time (mean and range) of recapture of juvenile fall chinook tagged between the Warm Springs River and Sherars Falls, 1979 (Aho et al. 1979).

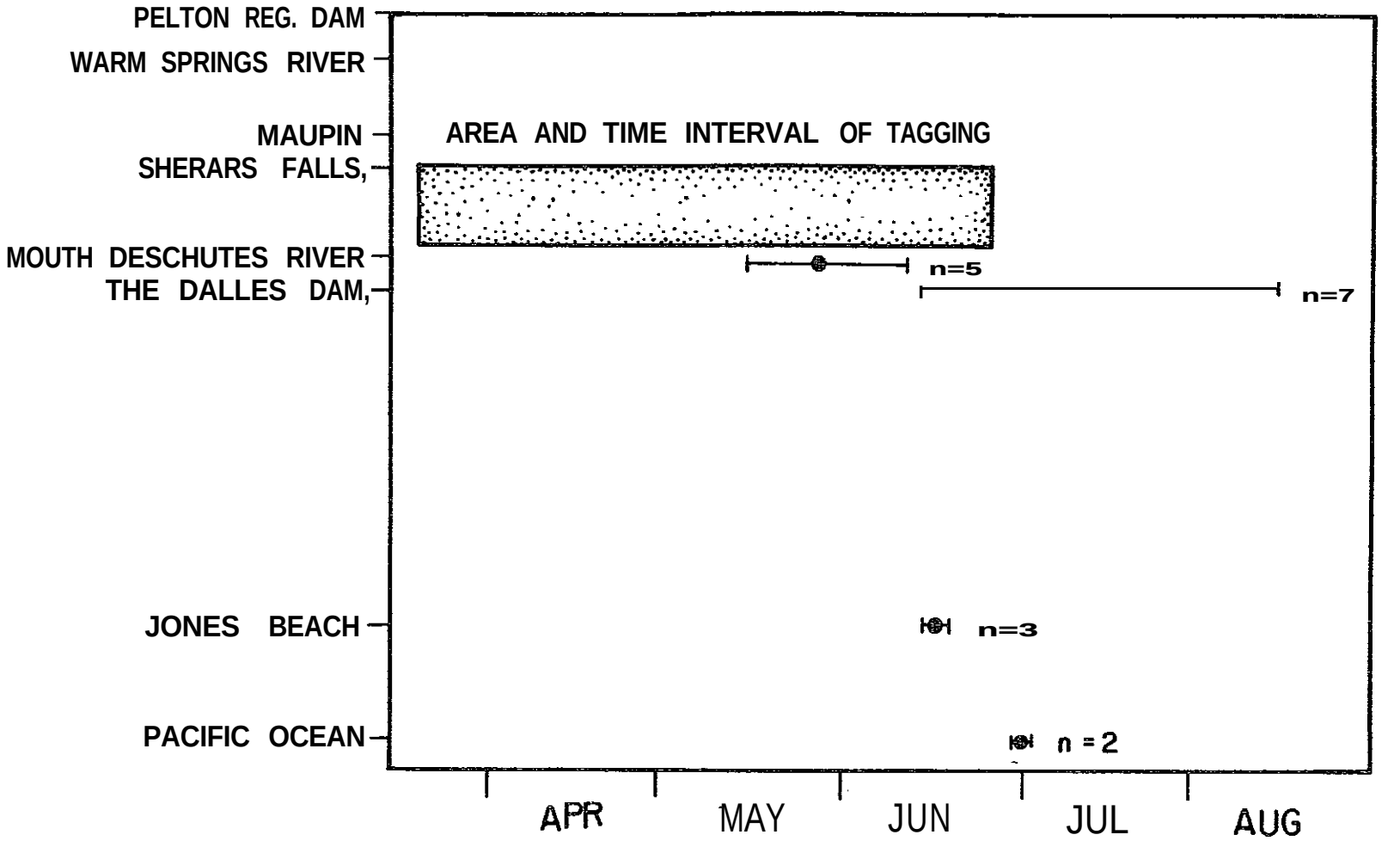

Figure 7. Location and time (mean and range) of recapture of juvenile fall chinook tagged between Sherars Falls and the mouth of the Deschutes River, 1979 (Aho et al. 1979).

the fall (Figure 8). Some juveniles remained in the upper mainstem Deschutes (above Sherars Falls) until spring and smolted as yearlings.

Table 8. Mean fork length of juvenile fall chinook during peak migration from the Deschutes River, 1979 and 1980 (from Lindsay et al. 1980).

Study section	year	Time of peak migration	Mean fork length (mm)
Pelton Reg. Dam to Dry Cr.	1979	July 7-21	85.5
	1980	July 13-26	80.6
Dry Cr. to Warm Sp. R.	1979	July 7-21	83.4
	1980	June 29-July 12	92.2
Warm Sp. R. to Sherars F.	1979	May 27-July 21	82.3
	1980	Nay 25-July 5	89.4
Sherars Falls to mouth	1979	May 13-June 9	54.6
	1980	Nay 4-17	56.1

On average, juveniles were larger further downstream from February through October (Figures 9 and 10). Also, the fish migrating out of a section at a given time were larger than those remaining in that stream section (Tables 9 and 10).

Survival rates

No information.

Table 9. Mean fork lengths of juvenile chinook in the original tagging area above Dry Creek and recaptured below Dry Creek (Aho et al. 1979).

Time interval	Mean F.L. of recaptured chinook (mm)	Mean F.L. of chinook above Dry Cr. (mm)	Calculated t
Jun 3-16	72.0	62.3	1.55
Jun 17-30	101.7	66.6	5.93**
Jul 1-14	98.6	77.1	5.16**

**$p \leq 0.01$

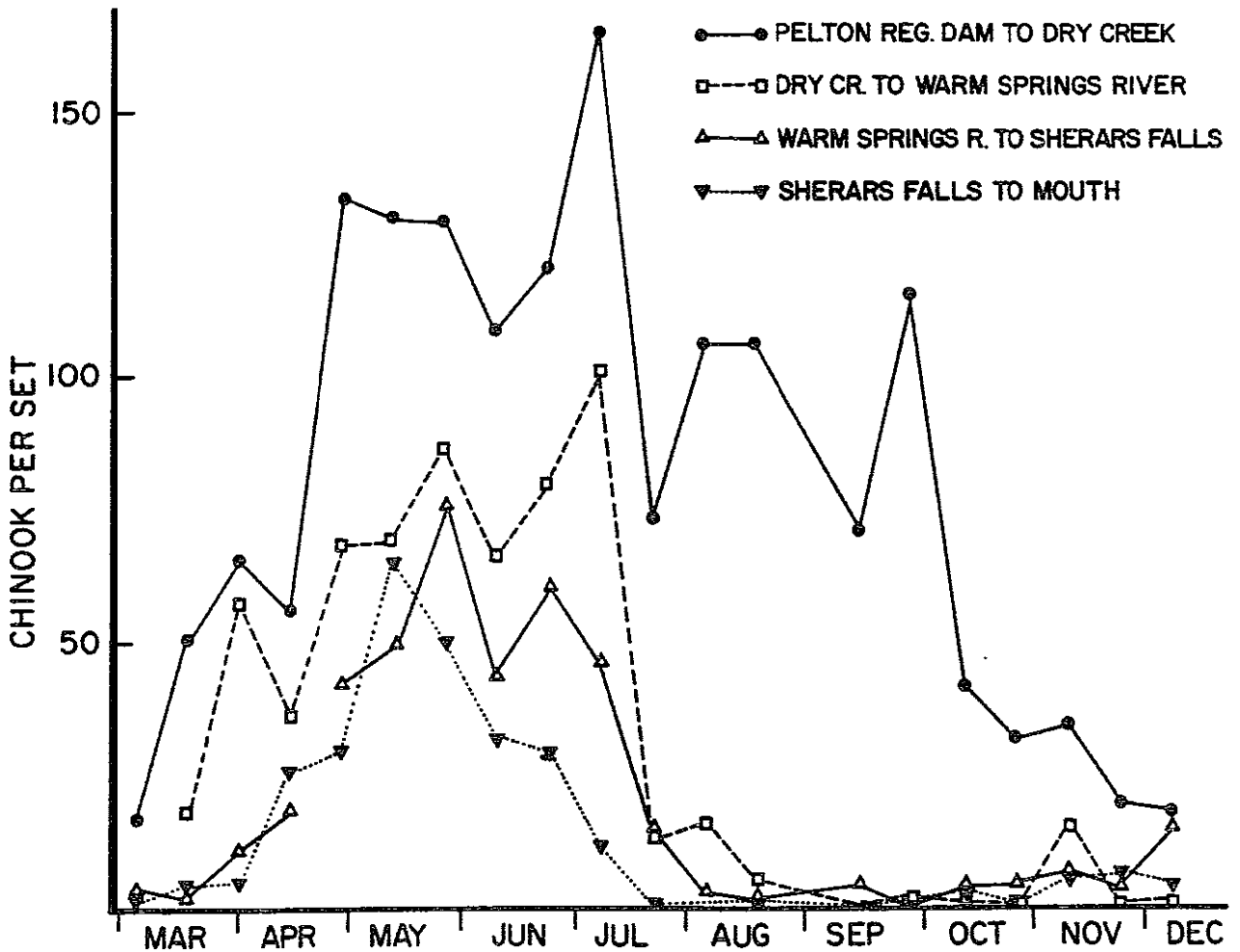

Figure 8. Catch per seine haul of 0-aged fall chinook in the Deschutes River, 1979 (Aho et al. 1979)

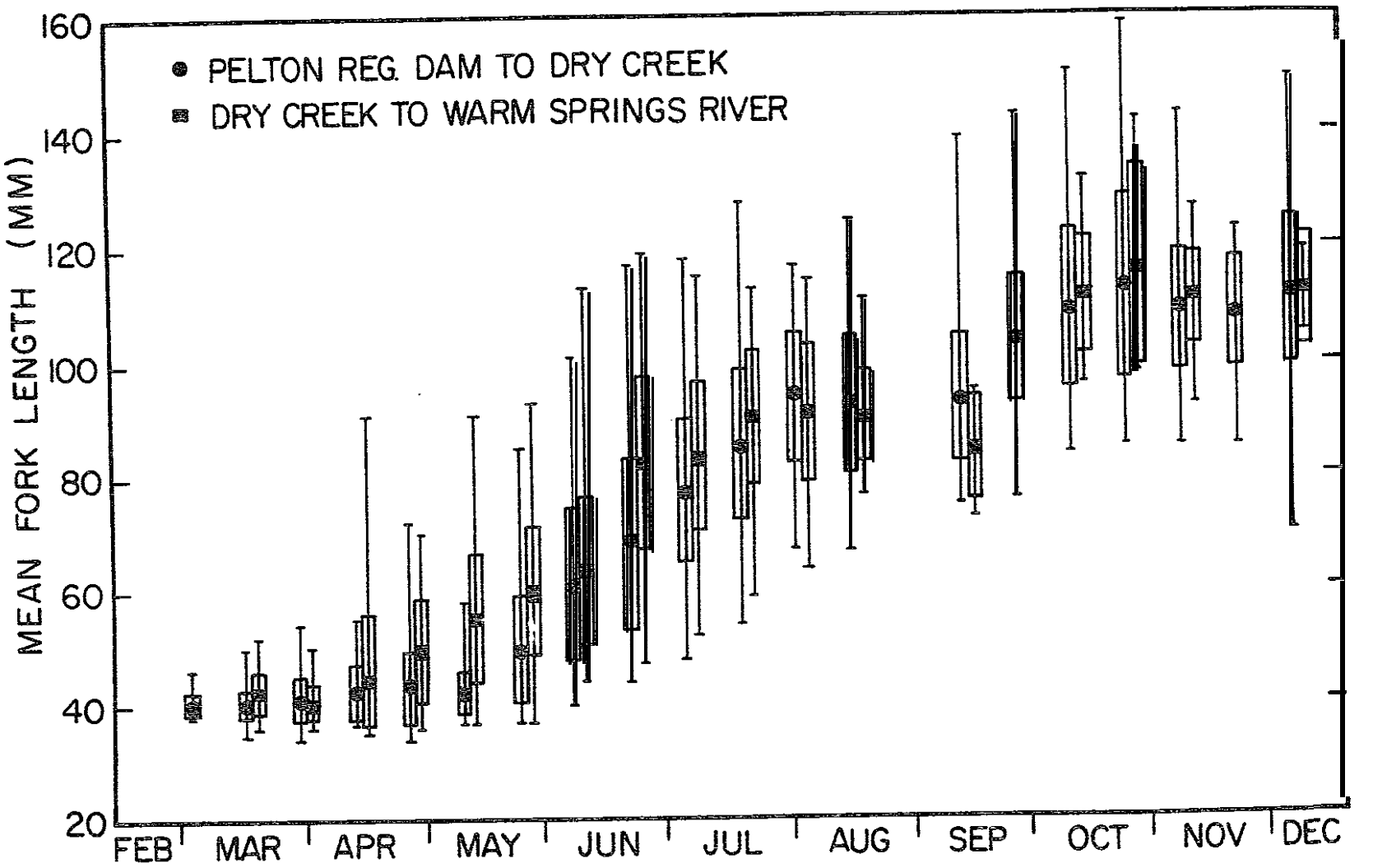

Figure 9. Biweekly mean, standard deviation, and range of fork lengths of juvenile fall chinook captured by seine in the Deschutes River above the Warm Springs River, 1979 (Aho et al. 1979).

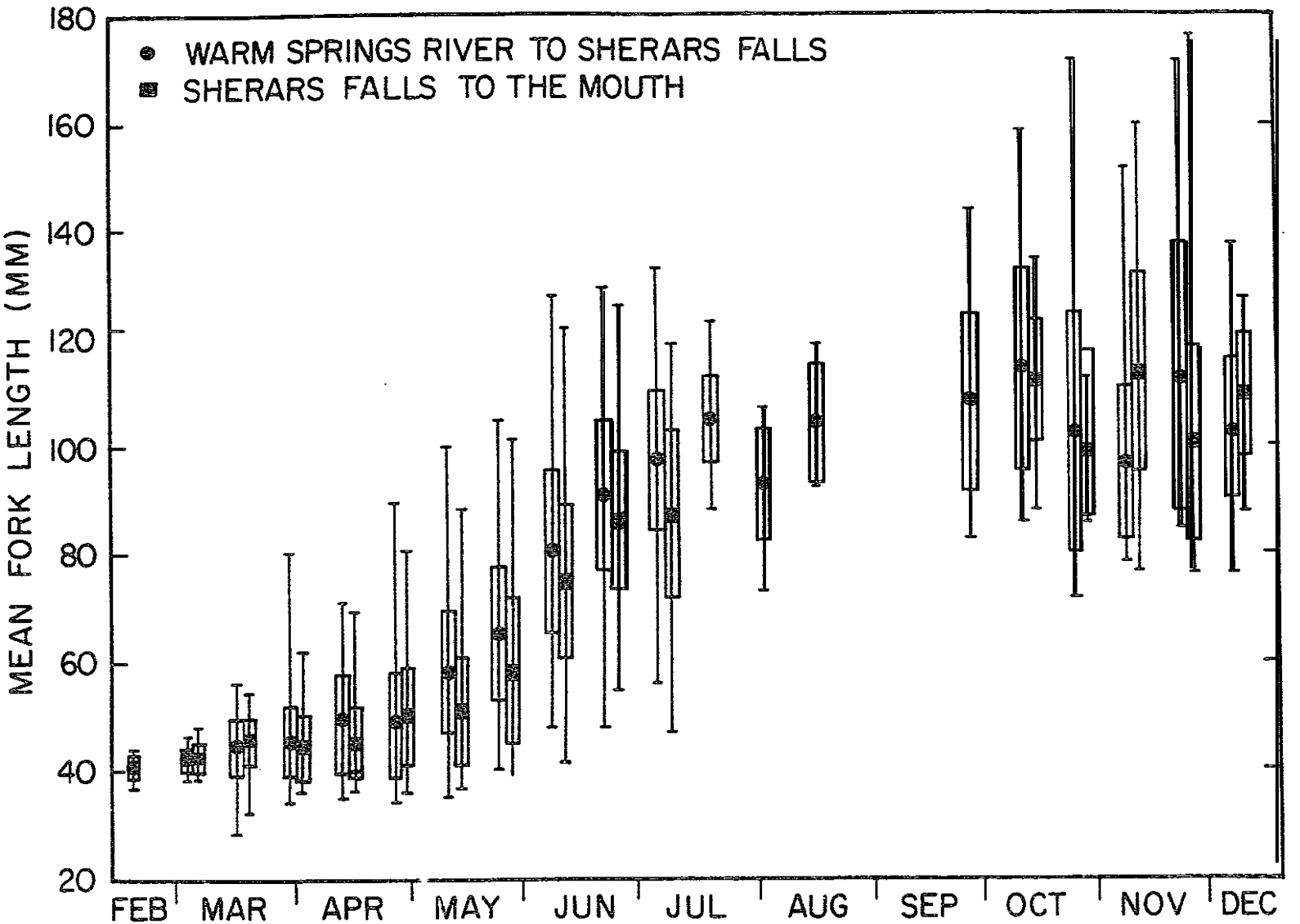

Figure O. Biweekly mean, standard deviation, and range of fork lengths of juvenile fall chinook captured by seine in the Deschutes River below the Warm Springs River, 1979 (Aho et al. 1979).

Table 10. Mean fork lengths of juvenile chinook in the original tagging area between Dry Creek and the Warm Springs River and recaptured below the Warm Springs (Aho et al. 1979).

Time interval	Mean F.L. of recaptured chinook (mm)	Mean F.L. of chinook fron Dry Creek to Warm Springs R. (mm)	Calculated t
May 6-19	69.9	51.2	4.79**
May 20-Jun 2	81.5	58.0	6.53**
Jun 3-16	84.1	65.9	3.50**
Jun 17-30	92.0	85.6	1.55
Jul l - 4	102.2	84.0	5.40'"

**p ≤0.01

DISEASE HISTORY

Ceratomyxa shasta infections increase in juvenile chinook after 1 May when the water warms (Figure 111 until July, when the susceptable individuals are eliminated from the population.

PRIORITY INFORMATION NEEDS

1. Survival rates

2. Genetic comparison with other upriver fall chinook stocks and Deschutes spring chinook stocks

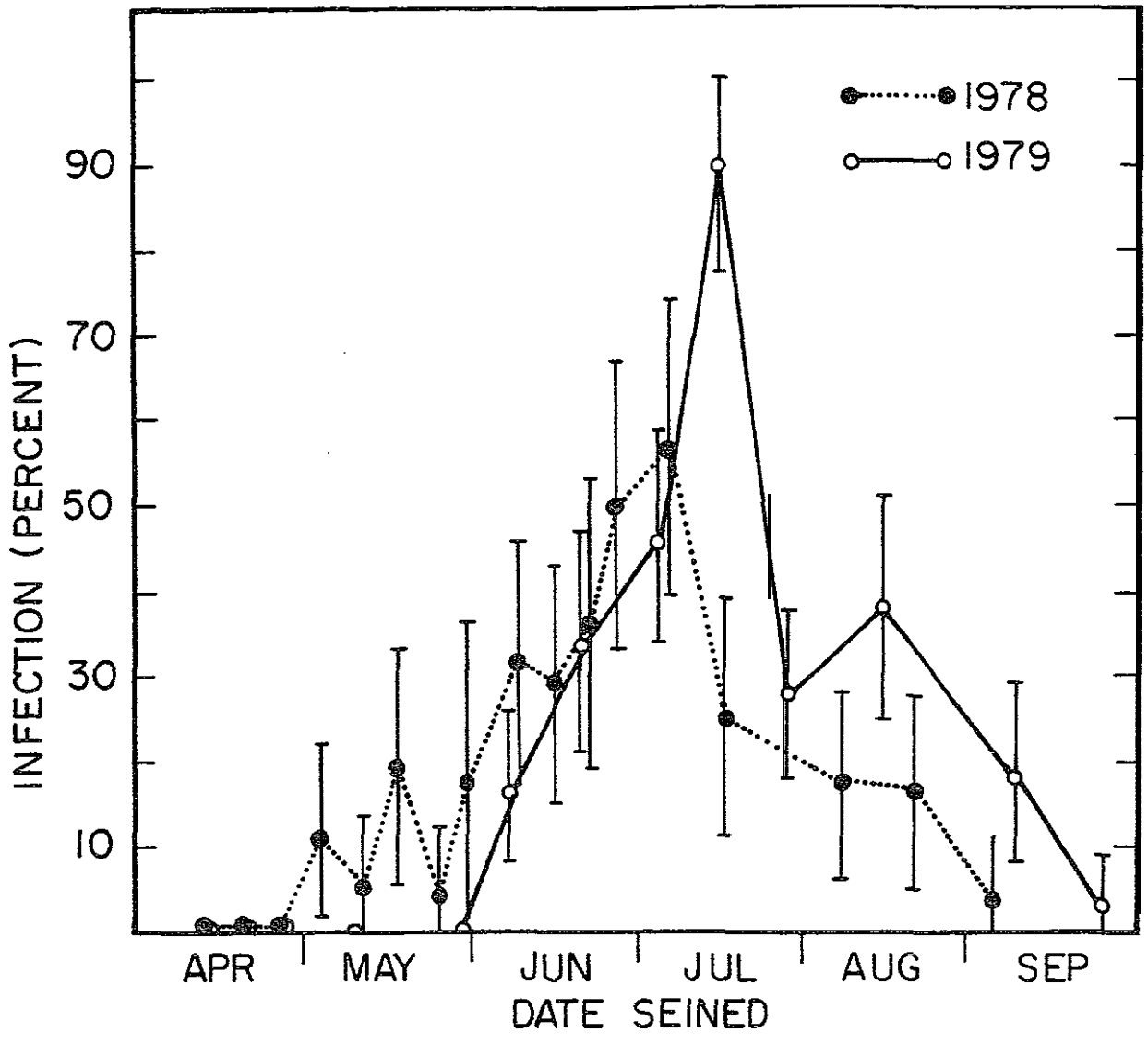

Figure 11. Estimated Ceratomyxa shasta infection of 0-age wild fall chinook in the Deschutes River (RK 156) in 1978 and 1979. Intervals represent 95% confidence limits on estimates (Aho et al. 1979).

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John Day River Spring Chinook (wild)

PRODUCTION

Spring chinook production in the John Day system is entirely from native wild stock.

GEOGRAPHIC LOCATION

Streams

Spring chinook are found in the mainstem John Day, the North and Middle Forks, and their tributaries (Burck et al. 1980; Fulton 1968) (Figure 1).

ORIGIN

John Day spring chinook are the largest remaining native wild stock of spring chinook in eastern Oregon.

ADULT LIFE HISTORY

Run size, catch, and escapement

Ocean harvest of John Day spring chinook is suspected to be small. Only one ocean recovery of coded-wire tagged John Day spring chinook has been reported. This 1978-brood chinook tagged in Granite Creek in the summer of 1979 was captured by a troller near Sitka, Alaska, on 24 June 1982 (Knox et al. 1984). Marked groups may have been too small (31,000, 21,000, and 18,000 for brood years 1978, 1979, and 1980, respectively) to accurately estimate ocean catch, however.

The historical catch of John Day spring chinook in Columbia River sport and commercial fisheries in unknown. Estimated catches based on catch:escapement ratios for all stocks of upriver spring chinook are listed in Table 1. The commercial spring season has been closed since 1977.

Spring chinook sport harvest in the John Day River drainage has been estimated from punch card returns since 1959 (Table 1). There has been no salmon sport fishery on the John Day since 1977.

No estimates of catch for Umatilla and Warm Springs tribes subsistence fisheries are available. However, effort has decreased in the last decade and has been negligible in recent years due to depressed runs (James 1984).

Redd counts in spawning ground index areas have declined from an average of 14.6 redds/mile during 1967-68 to 5.4 redds/mile for 1979-84 (Table 2). The accuracy of index counts as an estimator of spawning escapement in the Middle and North Forks of the John Day River may be affected by shifts in

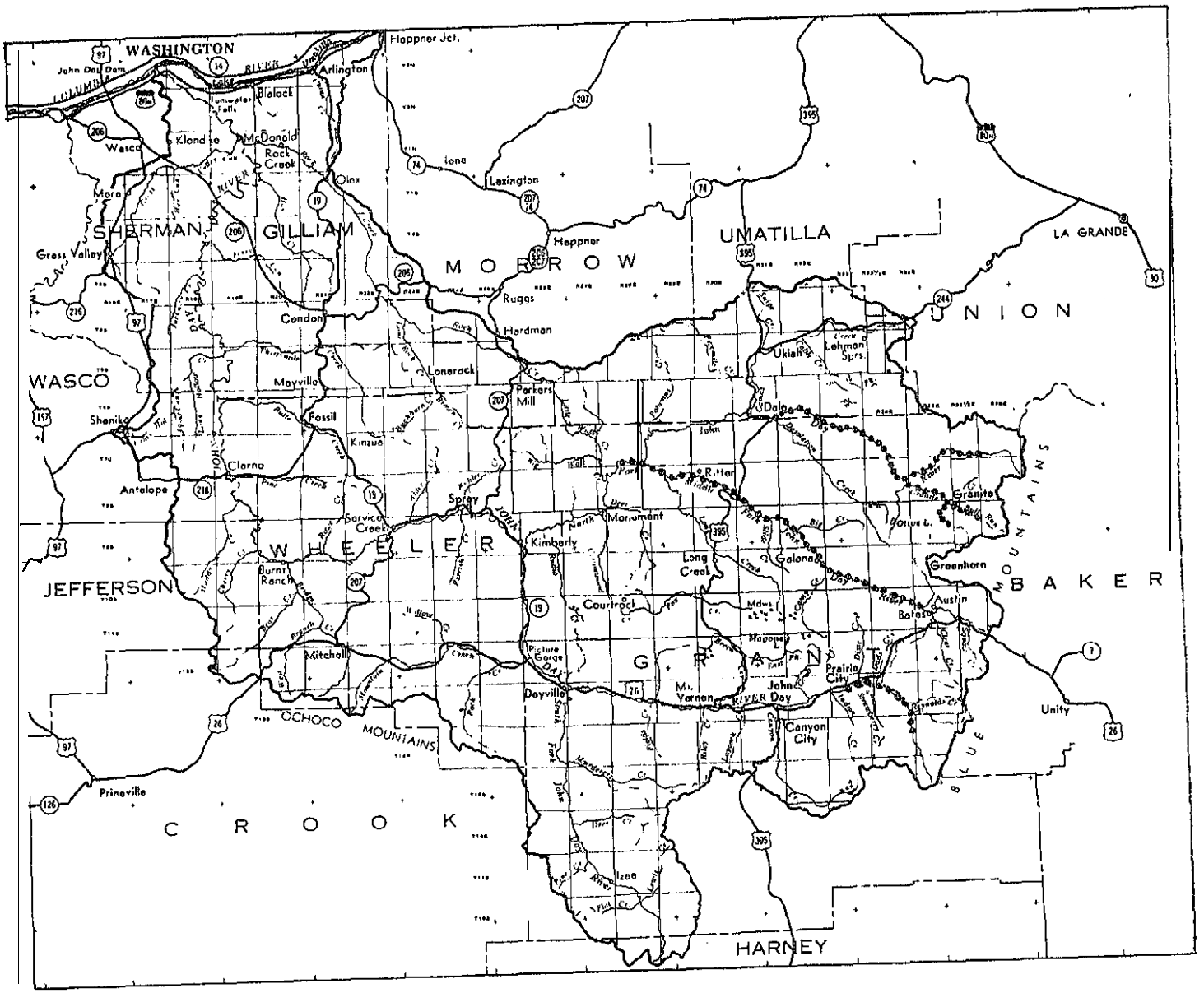

Figure 1. Spawning distribution (....) of spring chinook in the John Day River system (E. Claire, ODFW, personal communication.

Table 1. Estimated commercial, sport and tribal harvest of John Day spring chinook in the Columbia River and John Day River,[a] 1959-1978.

Year	Columbia River	John Day
1959	--	362
1960	--	364
1961	--	250
1962	--	146
1963	--	97
1964	2,878	297
1965	3,437	104
1966	1,716	247
1967	2,345	443
1968	1,709	91
1969	1,607	121
1970	2,476	113
1971	1,168	95
1972	2,751	88
1973	3,722	156
1974	1,092	98
1975	-- b	44
1976	-- b	81
1977	916	205
1978[c]	2	0

[a] Includes jacks and adults.
[b] No commercial spring season.
[c] The Columbia River spring season for upriver stocks and the John Day sport season have been closed since 1978. The incidental harvest rate in the Columbia River is unknown but assumed to be only l-2% of the population.

Table 2. Spring chinook salmon spawning density (redd/mile) in index sections of the John Day system, 1959-84 (modified from Claire 1983).

Year	Bull Run Creek	Clear Creek	Granite Creek	John Day River	Middle Fork John Day River	North Fork John Day River	Average
1959	a	4.3	6.0	0.3	0.0	a	2.6
1960	a	16.3	10.0	0.7	3.2	a	7.5
1961	a	3.3	5.3	3.0	1.1	a	3.2
1962	2.0	49.7	44.2	12.2	2.8	a	22.2
1963	7.0	29.2	26.4	0.8	0.4	a	12.7
1964	10.0	49.7	34.8	1.3	3.6	7.8	17.8
1965	7.5	16.7	24.4	5.8	3.7	8.1	11.0
1966	0.3	43.5	31.0	9.3	6.5	10.3	16.8
1967	6.0	38.5	19.4	7.4	1.7	5.5	13.0
1968	6.4	60.5	50.2	0.7	0.4	8.8	14.4
1969	15.6	13.7	16.8	9.3	4.8	20.5	13.3
1970	26.4	18.7	33.6	8.3	7.6	16.8	14.1
1971	11.6	18.8	31.2	7.0	4.1	11.8	11.5
1972	24.4	39.5	43.5	3.9[b]	5.1	10.5	14.2
1973	7.2	27.0	36.0	8.9	4.3	19.4	15.7
1974	7.6	8.0	25.5	2.5	8.1	7.2	8.2
1975	18.8	11.5	24.7	7.1	8.9	11.7	11.7
1976	9.2	7.0	20.2	4.6	6.6	6.2	7.5
1977	11.6	12.8	23.1	4.9	5.8	16.4	11.1
1978	12.4	6.3	19.8	4.5	10.7	5.9	8.3
1979	6.4	7.0	15.6	5.2	11.8	11.1	9.7
1980	1.2	7.0	8.5	1.2	5.8	4.3	4.3
1981	2.8	11.3	10.6	3.9	2.6	7.7	6.1
1982	5.2	10.8	12.0	3.8	6.2	5.5	6.4
1983	0.8	1.0	7.3	10.2	5.1	4.2	5.8
1984	3.2	2.0	5.8	5.6	6.7	3.5	4.4
Ave.	8.8	19.8	22.5	5.1	4.9	9.7	

[a] No survey.
b Count low due to rain and increased river flows which delayed survey and caused poor counting conditions.

spawner distribution related to streamflow within the upper spawning areas of each system (Lindsay et al. 1982). Peak index counts represented 74.6% of the total redd counts for 1978-84 (Table 3).

Run size and spawning escapement were estimated by expanding total redd counts by 2.75 adults/redd documented for the Warm Springs River (R. Boyce, ODFW, personal communication) and the catch:escapement ratios for upriver spring chinook in the Columbia River (Bohn and McIsaac 1984) (Table 4). Runs have generally declined since 1973, a reflection of poor recruitment beginning with the 1970 brood year (Table 5). Recruitment has been below the replacement level (i.e., returns/spawner=1) for 9 of the past 10 years for which return estimates are complete. This decline coincides with the completion of the John Day Dam and the phase-in of the turbines through 1972.

Time of migration

Adult spring chinook begin entering the John Day River in mid-April and reach spawning grounds by late June (James 1984).

Spawning period

Spawning occurs in late August through September (Lindsay et al. 1982).

Spawning areas

Spring chinook currently spawn in a total of 189 km (117 miles) of the John Day system. Spawning areas are located in the upper mainstem between Hall Hill (RK 418) and Roberts Creek (RK 443), in the Middle Fork between Armstrong Creek (RK 68) and Summit Creek (RK 116), in the North Fork between Camas Creek (RK 92) and Baldy Creek (RK 171), and in 37 km of Granite Creek, a tributary of the North Fork, and its tributaries including Dull Run and Clear creeks (Figure 1). In 1984, 79% of the chinook spawned in the Worth Fork system. Granite and Clear creeks have historically supported the greatest spawning densities of spring chinook. Spawning areas in the John Day River no longer utilized by chinook include Rock, Long Hollow, Thirtymile, bridge, Mountain, Cottonwood, and Long creeks and the South Fork (Fulton 1968) and Camas and Desolation creeks (E. Claire, ODFW, personal communication).

Recoveries of coded-wire tagged fish on the spawning grounds suggest there is little straying within the John Day system of adult returns of juveniles tagged in the North Fork system (including Granite Creek) and the Middle Fork (Table 6).

Age composition

From 1978 to 1984 age-4 fish accounted for 54-89% of the spawning adults (Table 7).

Table 3. Salmon redds counted during extensive (Ext.) and index surveys in the John Day River system, 1978-84 (Knox et al. 19841.

	Mainstem		Middle Fork		North Fork		Granite Creek[a]		Total	
Year	Ext.	Index	Ext.	Index	Ext.	Index	Ext.	Index	Ext.	Index
1978	58	58	188	107	167	108	196	165	609	438
1979	74	68	171	118	250	200	146	130	641	516
1980	15	16	97	58	104	78	89	78	306	230
1981	53	51	47	26	179	138	122	110	401	325
1982	51	49	131	62	173	107	146	122	501	340
1983	142	133	81	51	113	76	58	46	394	306
1984	80	73	150	67	82	63	63	48	375	251

a Includes Clear and Bull Run creeks.

Table 4. Estimated escapement to the mouth of the John Day and recruitment to the mouth of the Columbia River for John Day spring chinook,[a] 1964-1984.

Run Year	Escapement[b]	Columbia River catch/escapement ratio	Recruitment to the Columbia R.
1964	2,607	1.104	5.485
1965	2,002	1.717	5,439
1966	2,923	0.587	4,639
1967	2,200	1.066	4,545
1968	2,825	0.605	4,534
1969	2,975	0.540	4,582
1970	3,237	0.765	5,713
1971	2,389	0.489	3,557
1972	2,896	0.950	5,647
1973	3,220	1.156	6,942
1974	1,877	0.582	2,969
1975	2,401	0.000	2,401
1976	1,600	0.000	1,600
1977	2,443	0.475	3,359
1978	1,675	0.001	1,677
1979	1,763	0.000	1,763
1980	842	0.000	842
1981	1,103	0.000	1,103
1982	1,378	0.000	1,378
1983	1,084	0.000	1,084
1984	1,031	0.000	1,031

a Includes jacks and adults.
b Estimates were adjusted for the John Day sport fishery.

Table 5. Spring chinook spawners, returns, and returns per spawner by brood year for the John Day basin, 1964-1979.[b]

Brood year	Spawners[c]	Returns[c]	Returns/spawner
1964	2,310	4,136	1.79
1965	1,897	4,604	2.43
1966	2,676	5,082	1.90
1967	1,757	3,982	2.27
1968	2,734	5,624	2.06
1969	2,854	5,698	2.00
1970	3,124	2,929	1.94
1971	2,294	2,211	0.96
1972	2,808	1,914	0.68
1973	3,064	2,654	0.07
1974	1,779	1,793	1.01
1975	2,357	1,917	0.81
1976	1,529	1,031	0.67
1977	2,238	1,130	0.50
1978[d]	1,675	1,172	0.70
1979[d]	1,763	882	0.50

[a] Returns are to the mouth of the Columbia River.
[b] Returns from 1980-1984 broods are not yet complete.
c Includes jacks and adults.
d Spawner escapement in 1978 and 1979 is based on observed total redd counts.

Table 6. Summary of coded-wire tagging and recoveries of juvenile spring chinook in different areas of the John Day River system.

Brood year	Age	Number marked	Marking Location	Recoveries Age 3	Age 4	Age 5	Location
1978	ot	5,042	North Fork	0	2	0	North Fork
				0	2	0	Granite Creek
1978	1+	923	North Fork	0	2	0	North Fork
1978	ot	22,714	Granite Creek	0	16	4	Granite Creek
1978	ot	3,546	Middle Fork	0	1	0	Middle Fork
1978	1+	608	Middle Fork	0	2	0	Middle Pork
1979	ot	7,397	North Fork	0	1	0	North Fork
1979	1+	270	North Fork	0	0	0	
1979	ot	8,964	Granite Creek	1	1	2	Granite Creek
1979	ot	4,056	Middle Fork	0	1	1	Middle Fork
1979	1+	333	Middle Fork	0	1	1	Middle Fork
1980	ot	5,288	North Fork	0	0	0	--
1980	1+	364	North Fork	0	1	0	Granite Creek
1980	ot	7,754	Granite Creek	0	5	0	Granite Creek
1980	ot	5,438	Middle Fork	0	9	0	Middle Fork
1980	1+	46	Middle Fork	0	0	0	--

Table 7. Percentage age composition of adult spring chinook carcasses collected during spawning ground surveys in the John Day River, 1978-84 (Knox et al. 1984).

Return year	Percentage by age group 3_2	4_2	5_2
1978	2	54	44
1979	1	84	15
1980	1	56	43
1981	4[a]	79	10
1982	3	89[a]	8
1983	1	81	18
1984	9	86	5
Average	3.0	75.6	21.6

[a] Includes 0.5% that migrated during their first year (i.e., 3_1 or 4_1)

Size

Age 3, 4, and 5 spawners averaged 47.2, 68.1, and 81.6 cm in length, respectively, for 1981-83 (Table 81.

Sex ratio

No information.

Fecundity

No information.

Table 8. Fork lengths (cm) of spring chinook carcasses collected during spawning surveys in the John Day River system, 1981-83.

		Age 3			Age 4			Age 5		
Year	Stream	n	Avg. FL	Range	n	Avg. FL	Range	n	Avg. FL	Range
1981	Mainstem	1	58.0		3	68.0	67-69	2	78	77-79
	Middle Fork	0	--	--	9	68.9	56-74	3	79.3	73-84
	North Fork	5	42.2	35-46	83	67.2	47-95	23	83.4	70-90
	Granite Creek	1	59.0	--	63	66.5	55-77	9	77.7	65-83
	Combined System	7	46.9	35-59	158	67.0	47-95	37	81.4	65-90
1982	Mainstem	0	--	--	5	67.0	60-73	1	69	--
	Middle Fork	0	--	—	32	65.8	57-77	1	87	—
	North Fork	2	49.0	49	68	69.5	44-87	7	84.4	76-93
	Granite Creek	4	44.0	38-49	85	67.3	58-81	8	80.9	71-94
	Combined System	6	45.7	38-49	190	67.8	44-87	17	82.0	71-94
1983	Mainstem	0		--	21	70.0	61-75	0	—	--
	Middle Fork	1	63.0	--	38	68.1	47-79	3	79.7	76-83
	North Fork	0	--	--	46	70.9	60-81	15	82.3	74-95
	Granite Creek	1	43.0	--	25	69.6	55-83	13	81.4	76-95
	Combined System	2	53.0	43-63	130	69.7	47-83	31	81.7	74-95
Years and streams combined		15	47.2	35-63	478	68.1	44-95	85	81.6	65-95

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Seining indicated that fry emerged from late February through mid-June (Table 9). Scales from fingerlings (age 0+) chinook were also used

to develop regressions of Julian day on circuli number to be used as an index of emergence timing. Emergence timing based on seining was earliest in the mainstem, while that based on the regressions occurred earliest in the Middle Fork.

Table 9. Comparisons of emergence timing based on field sampling and mean time of scale formation in the John Day River system, 1979-81 (Knox et al. 1984).

Year and stream location	Beginning of emergence[a]	End of emergence[b]	Mean date of scale formation[c]
1979			
Mainstem	d	05/28	05/16
Middle Fork	d	05/27	04/21
North Fork	e	e	06/08
Granite Creek	04/27	06/12	06/12
1980			
Mainstem	02/25	05/04	05/15
Middle Fork	03/19	05/15	05/03
North Fork	04/22	06/03	06/01
Granite Creek	04/23	06/16	06/06
1981			
Mainstem	03/12	04/30	05/09
Middle Fork	d	05/25	04/22
North Fork	04/01	06/14	05/25
Granite Creek	04/07	06/19	06/05

a First sampling date when emergent fry were captured.
b Time when less than 5% of the fry sampled were less than 37 mm fork length.
c Estimated from intercept of regressions of Julian day on circuli number.
d Emergence underway when sampling began.
e No sampling.

Time, age, and size at migration

From 1979 through 1984 peak migration of chinook smolts past Spray occurred in April (Figure 2). Migration timing of smolts past Columbia River locations is shown in Table 10. The median recapture dates at the John Day Dam ranged from 28 April to 14 May during 1979-84, at The Dalles Dam from 5 May to 28 May during 1979-82, and at Jones Beach from 4 May to 6 June in 1979, 1980, and 1983.

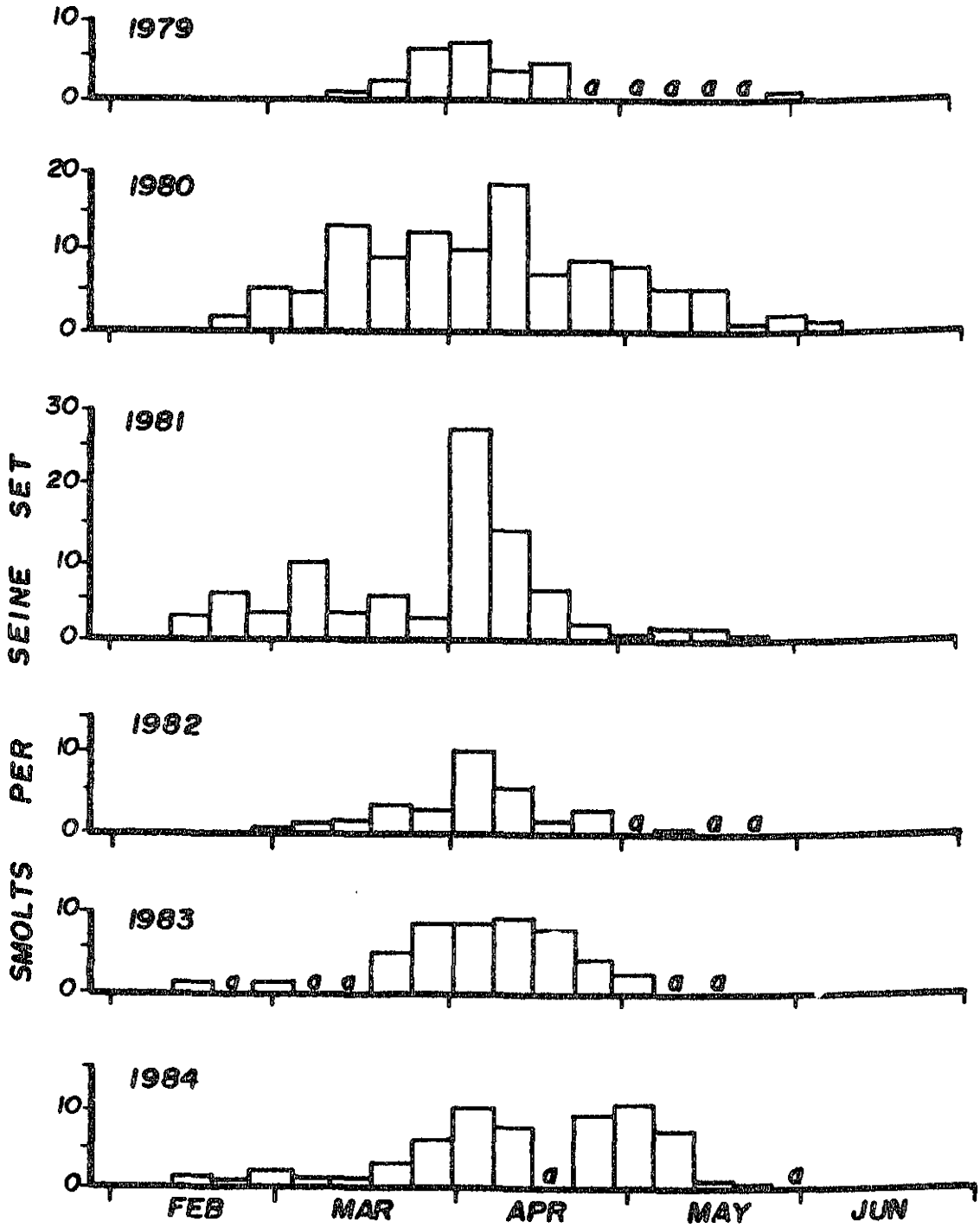

Figure 2. Timing of migration of spring chinook smolts past Spray (RK 286) in the John Day River based on seining of standard sites, 1979-84 (a indicates incomplete sampling of standard sites) (Knox et al. 1984).

Table 10. Dates that smolts marked in the John Day River were recaptured in the Columbia River, 1979-84 (Knox et al. 1984).

Location, year	Number recaptured	Range of recapture dates	Median recapture date
John Day Dam[a]	7		
1979	62	27 April-13 August	14 May
1980		21 April-22 May	1 May
1982	13	15 April-10 May	29 April
1983	18	18 April- 8 Nay	28 April
1984	123	9 April- 9 June	10 May
The Dalles Dam[b]			
1979	3	21 May-22 June	22 May
1980	6	2 May-10 June	28 May
1981	4	30 April-14 May	5 May
1982	0	--	--
Jones Beach[c]			
1979	2	27 May-17 June	6 June
1980	1	--	5 June
1981	0	--	—
1982	0	--	--
1983	5	30 April-13 May	4 May

[a] There was no sampling at John Day Dam in 1981.
[b] Smolt sampling at The Dalles Dam ended in 1982
[c] There was no sampling at Jones Beach in 1984.

Scale analysis from spawning ground surveys in 1978-83 showed nearly all (99.5%) adults had migrated to the ocean in their second year (Knox et al. 1984).

Smolts from the North Fork were generally smaller than those from the Middle Fork or upper mainstem in 1983 and 1984 (Tables 11 and 12).

Table 11. Lengths of spring chinook smolts (1981 brood) in the John Day Basin, 1983 (Smith et al. 1983).

Sampling area	Sample size	Fork length (mm) Range	Mean	95% CI
Mainstem (km 396)	255	84-130	108	± 1
Middle Fork[a]	14	96-122	108	± 7
North Fork	477	72-119	92	± 1
Spray (km 286)	397	88-140	113	± 1
Rock Creek (km 48)	18	109-140	126	± 5

[a] Middle Fork was chemically treated in 1982 which reduced the number of chinook smolts captured in 1983.

Table 12. Lengths of spring chinook smolts captured in scoop traps in the mainstem, Middle Fork, and North Fork of the John Day River, and by seining in the mainstem near Spray, February-May, 1984 (Knox et al. 1984).

Sampling area	Sample size	Fork length (mm) Range	Mean	95% CI
Mainstem (km 397)	206	82-123	99	± 1
Middle Fork (km 51)	151	77-126	104	± 2
North Fork (km 97)	386	72-117	96	± 1
Spray (km 275-293)	542	90-136	110	± 1

Survival rate

Survival rates from egg to smolt ranged from 3.6 to 8.6 percent for 1978-82 broods (Table 13). Survival from smolt to spawning adult were 0.98% and 1.43% for the 1978 and 1979 broods, respectively (Table 13).

Table 13. Estimated survival rates at various life history stages for John Day River spring chinook, 1978-82 broods (modified from Knox et al. 1984).

Brood year	Abundance ($x10^3$) Eggs	Fingerlings	Smolts[a]	Adult returns	Survival (%) Egg to smolt	Smolt to adult	Egg to adult
1978	2,510	573	169	1,650	6.7	0.98	0.07
1979	2,310	336	83 (52-113)	1,187	3.6	1.43	0.05
1980	1,090	267	94 (1-211)	--	8.6	--	--
1981	1,440	--	64	--	4.4	--	--
1982	1,750	---	78	--	4.4	--	--

[a] Numbers in parentheses indicate 95% confidence interval ($x10^3$) for smolt estimates.

DISEASE HISTORY

External parasites have been noted during low water years (E. Claire, ODFW, personal communication). In 1984, 51 smolt mortalities from traps were tested for BKD. Only 1 fish was found to have a moderate level of the disease (B. Knox, ODFW, personal communication).

PRIORITY INFORMATION NEEDS

1. Improved estimates of run size, catch, and escapement
2. Survival of fall outmigrants compared to spring outmigrants
3. Prespawning mortality of adults
4. Smolt production levels and capacities
5. Differences in survival and genetic characteristics of Middle and North Fork and upper mainstem populations
6. Fecundity/length relationships

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John Day River Fall Chinook (wild)

The John Day River basin supports a small run of fall chinook. Past escapement was estimated at approximately 450 adults in the mainstem below the confluence of the North Fo rk (RM 185) (ODFW 1980), but now is estimated at fewer than 100 adults (James 1984). Few fish have been reported in recent years. High water temperatures and gravel compaction have contributed to poor spawning success and poor juvenile rearing conditions (James 19841.

There is very little documented information on the life history characteristics of this stock. The suspected timing of life history stages is described in Figure 1. Spawning distribution extended up to RM 184 (USFWS and NMFS 1981).

PRIORITY INFORMATION NEEDS

1. Escapement

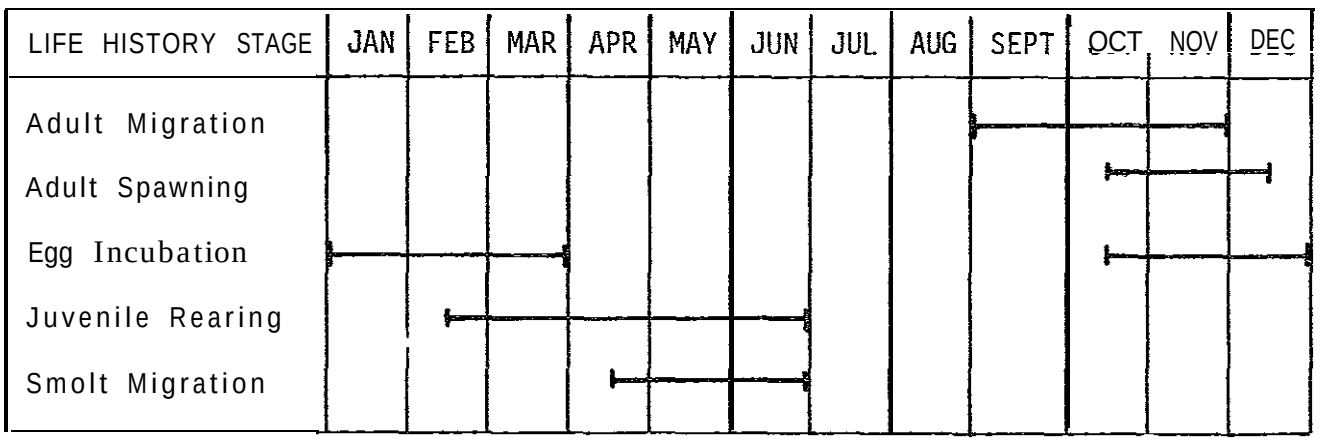

Figure 1. Periodicity chart for fall chinook life history stages in the John Day River drainage (James 1984).

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Umatilla River (Upriver Bright) Fall Chinook (hatchery)

The Umatilla River supported runs of chinook prior to extensive water use and habitat degradation in the Umatilla basin and hydroelectric projects on the Columbia River (U.S. Bureau of Reclamation 1982). Upriver bright fall chinook are being released into the Umatilla River to restore fall chinook runs in the basin. Increased flows, improved adult passage conditions, and habitat enhancement will aid the reestablishment of the runs (James 1984).

PRODUCTION

Fall chinook runs will be maintained through hatchery and natural production. At present yearling smolts are being released into the system. The first release of 100,000 yearlings was made in March and April of 1983 into Meacham Creek. In 1384, 225,000 yearlings were released. Releases of 225,000 yearlings will be maintained until facilities are developed to begin a subyearling release program. The Minthorn Springs facility (Umatilla RK 103) is expected to produce 1.25 million subyearlings.

GEOGRAPHIC LOCATION

Streams

Mainstem Umatilla River and Meacham Creek (Figure 1)

Hatcheries

Yearling upriver bright fall chinook from Bonneville Hatchery will continue to be released until adult returns to the Umatilla are sufficient for hatchery production needs. Construction of Ninthorn Springs facility will begin in 1985. This facility will be used to collect and spawn adults and rear and release fingerlings.

ORIGIN

Adults from releases of Bonneville Upriver Briqhts will begin returninq to the Umatilla River in fall of 1985. Adults trapped at Three Mile Dam will serve as the first broodstock to establish the Minthorn fall chinook fingerling program. Approximately 2,850,OOO subyearling early-spawning Tule stock fall chinook were released into the Umatilla River in 1982. Releases of Tule stock have since been discontinued.

ADULT LIFE HISTORY

No information.

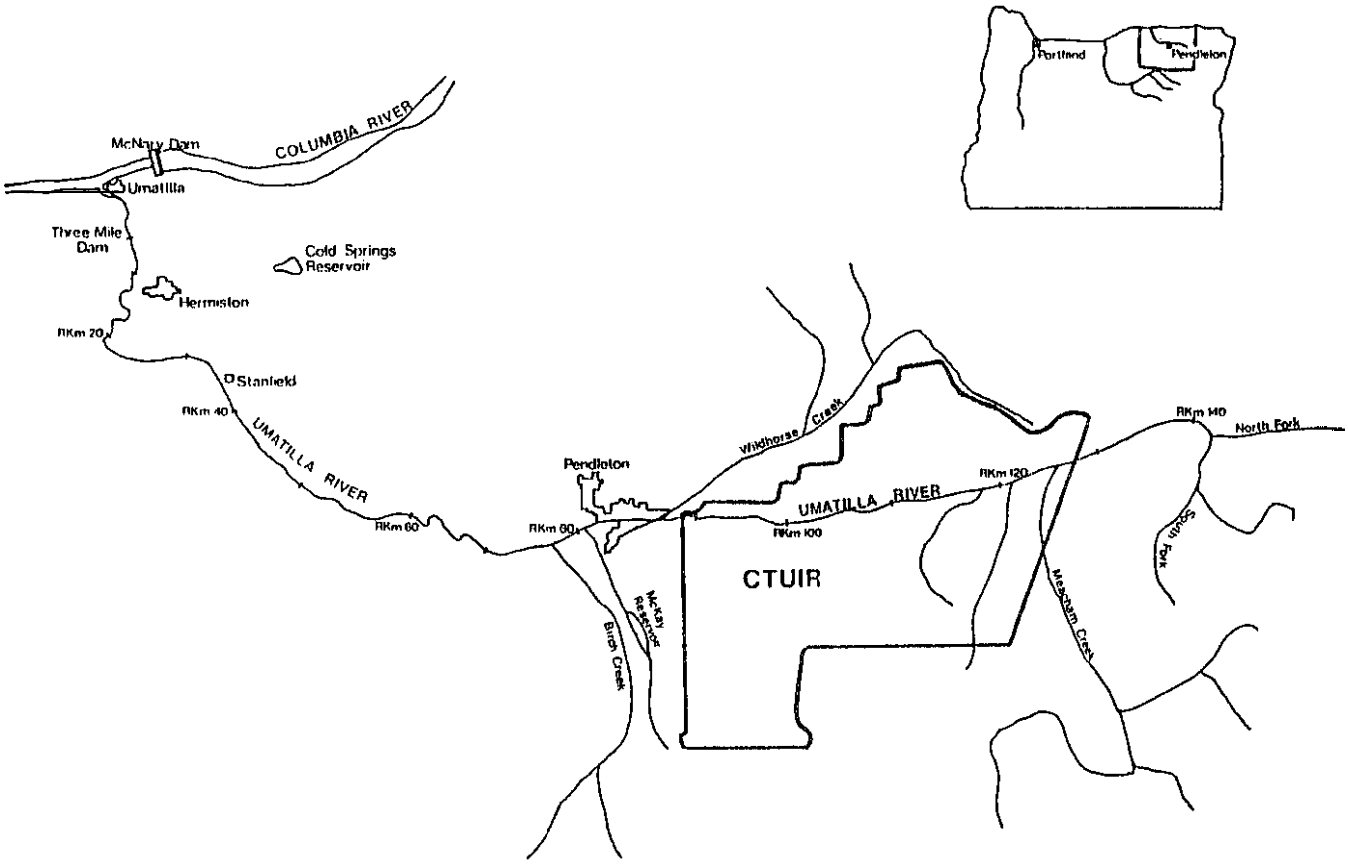

Figure 1 Umatilla River and major tributaries.

JUVENILE LIFE HISTORY

No information.

DISEASE HISTORY

See "Bonneville Upriver Bright Fall Chinook" summary.

PRIORITY INFORMATION NEEDS

1. Run size, catch, and escapement
2. Adult and juvenile life history characteristics

REFERENCES

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SNAKE RIVER FALL CHINOOK

PRODUCTION

The Snake River fall chinook run is presently a mixture of hatchery and naturally produced fish. Fall chinook hatchery propagation efforts followed the closure of Brownlee, Oxbow and Hells Canyon dams, but were unsuccessful (Richards, M., IDFG Bureau of Fisheries, pers. coma.).

The most recent artificial propagation program bad its start with the 1977 brood year and is continuing as part of the Lower Snake River Fish and Wildlife Compensation Plan at Lyons Ferry Batchery, Washington. Smolt releases have been made in the Snake River as well as in the Kalama River (lower Columbia River tributary) in an egg bank operation (Table 1).

GEOGRAPRIC LOCATION

Streams

Present distribution of Snake River system fall chinook is confined to the mainstem Snake River below Hells Canyon Dam (IDFG 1978). In pristine times, fall chinook occurred in the mainstem Snake River from its mouth to Shoshone Falls, a distance of about 600 miles (Haas 1965).

Hatcheries

Lyons Ferry Hatchery began operation with the 1984 fall chinook brood year. Returns to the Kalama Falls Hatchery egg bank program will be transferred to Lyons Ferry beginning with 1984 brood year progeny (Parrish, E., IDFG Bureau of Fisheries, pers. comm.).

ORIGIN

The Snake River stock of fall chinook is considered to be indigenous (see "Biochemical-genetic characteristics" section). There are two transfers of fall chinook to the Snake River system on record. One transfer occurred in the early 1960's when Spring Creek National Fish Hatchery stock was planted as eyed eggs in the Clearwater River drainage (Table 2, Irving and Bjornn 1981). Irving and Bjornn concluded that the program produced insignificant numbers of adults after the late 1960's.

The other transfer was of 457,000 1969 brood year Spring Creek NFH fish stocked below Hells Canyon Dam in the spring of 1970 (IDFG Bureau of Fisheries file data).

Broodstock for the Lower Snake River Compensation Plan egg bank was obtained by trapping adults at Ice Harbor Dam and by adults returning to Kalama Falls Batchery (Table 3).

Table 1. Releases of hatchery-reared Snake River fall chinook salmon.[a]

Brood year	Release year	Number released	Rearing facility
1977	Fall 1978	210,815	Tucannon
	Spring 1979	236,089	Tucannon
1978	Spring 1979	139,000	Hagerman NFH
	Spring 1980	183,034[b]	Kalama Falls
1979	Spring 1980	225,863	Hagerman NFH
	Spring 1981	267,813[b]	Kalama Falls
1980	Spring 1981	181,291	Hagerman NFH
	Spring 1982	480,000[b]	Kalama Falls
1981	Spring 1982	699,152	Hagerman NFH
	Spring 1983	664,600[b]	Kalama Falls
	Spring 1982	10,000	Dworshak NFH
1982	Spring 1983	78,900	Hagerman NFH
		NA	Kalama Falls
1983		NA	Hagerman NFH
		NA	Kalama Falls
1984		NA	Lyons Ferry

[a] Data furnished by Idaho Cooperative Fish and Wildlife Research Unit.
[b] Egg bank released into Kalama River.

Table 2. Fall chinook eyed egg plants made in the Clearwater River drainage, 1960-1967 (IDFG 1973).

Year	Number	Year	Number
1960	535,000	1964	1,000,000
1961	750,000	11965	None
1962	400,000	1966	4,500,000
1963	1,000,000	1967	1,578,000

Table 3. The numbers of fall chinook salmon taken for broodstock at Ice Harbor Dam and Kalama Falls Hatchery, 1977 to 1983[a].

Brood Year	Ice Harbor Dam	Kalama Falls Hatchery
1977	395	0
1978	368	0
1979	439	0
1980	394	33
1981	407	512
1982	473	116
1983	619	1,259

[a] Data furnished by Idaho Cooperative Fish and Wildlife Research Unit

ADULT LIFE HISTORY

Run size, catch and escapement

By the time Brownlee Dam provided a counting point for the run in 1957, and Oxbow Dam in 1958, the fall chinook had already been blocked to access above Swan Falls Dam. which removed 159 river miles from production. Counts of fall chinook were 15,160 at Brownlee Dam in 1957; 17,848 and 11,825 at Oxbow Dam in 1958 and 1959, respectively (IDFG Bureau of Fisheries file data).

When Ice Harbor Dam came on line in 1962, another counting station was provided which shows a run of 27,700 in 1962, declining to 1,000 to 2,000 in the late 1970's (Table 4).

Active Columbia River sport, commercial and Indian fisheries occur on the upriver (above Bonneville Dam) fall chinook run. Although harvest rates cannot be determined specifically for the Snake River run, they have been determined for the whole upriver run, of which the Snake run is a component. The upriver run harvest rates ranged from 24% to 71% for the 1970 to 1983 period (ODFW and WDF 19841.

Coded wire tagged Snake River fall chinook have been recovered in ocean fisheries from northern California to Alaska, but primarily in fisheries north of the Columbia River (Duke 1985, Appendix). The data shows that the run contributes to sport, commercial and Indian fisheries in the Columbia River as well as the Pacific Ocean.

Table 4. Yearly counts of fall chinook adults at Ice Harbor Dam, 1964 to 1983 (Anon. 1963; ODFW and WDF 1984).

Year	Number of fish
1962	27,700
1963	13,000
1964	9,100
1965	8,200
1966	12,800
1967	14,000
1968	19,500
1969	13,600
1970	9,000
1971	9,300
1972	7,500
1973	6,700
1974	2,400
1975	1,900
1976	1,100
1977	1,200
1978	1,100
1979	1,200
1980	1,200
1981	800
1982	1,600
1983	1,800

Time of migration

Snake River fall chinook enter the Columbia River in August, September and early October (Bjornn 1960). The peak movement of the run over Ice Harbor Dam (lower Snake River) is in September (Anonymous 1983).

Spawning period

Prior to development of the Hells Canyon Dam, fall run fish spawned in the Snake River below Swan Falls Dam in late October and November (Bjornn 1960).

Spawning areas

In pristine times it is likely that fall chinook spawned up to the migration barrier, Shoshone Falls. After Swan Falls Dam was built in 1901, the major spawning area was a 30-mile long section from Swan Falls Dam to Marsing, Idaho (Haas 1965). Spawning is now limited largely to the Snake River from Lewiston to Hells Canyon Dam.

Age composition

No information.

Size

No information

Sex ratio

Richards (1961) obtained sex ratio information throughout the spawning period and found it to be 0.5:1 male to female. He also found that the ratio varied considerably among individual surveys.

Fecundity

During egg-taking operations at Oxbow Hatchery from 1961 to 1969, a total of 2,017 females yielded 8,624,136 eggs for an average of 4,276 eggs per female (IDFG Bureau of Fisheries file data).

The more recent egg bank program has yielded an average of 4,185 eggs per female for 1,732 females spawned from the 1977 to 1983 brood years (Idaho Cooperative Fish and Wildlife Research Unit data).

Biochemical- genetic characteristics

Utter et al. (1982) electrophoretically analyzed tissues of mid-Columbia and Snake River fall chinook for allelic frequencies at 12 loci. They found strong evidence of biochemical genetic differences between the two groups, indicating a divergence time from common ancestry of a much longer duration than the few decades since dam impoundment. They concluded that the mid-Columbia River and the Snake River fall chinook salmon runs are separate, distinct and identifiable populations.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age and size at migration

Most juvenile fall chinook in the Snake River migrate to the ocean during their first year of life (Bjornn 1960).

Survival rate

Hatchery green-egg-to-smolt survival for the 1977 through 1981 brood years ranged from 53.5 to 78.5% and cumulatively was 65.1% (Idaho Cooperative Fish and Wildlife Research Unit data).

DISEASE HISTORY

Bacterial kidney disease has been noted at Hagerman NFH, but not chronic (Bruhn, D., USFWS, pers. comm.).

PRIORITY INFORMATION NEEDS

1. For naturally produced fish, determine timing of downstream migration and relate it to flow-spill patterns at lower Snake and Columbia dams.

2. For hatchery fish, determine optimum size and time of release.

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APPENDIX

DATACODE: 50420 SPECIES: FL CK HATCHERY OF RELEASE: HAGERMAN SITE OF RELEASE: L GRANITE D

RELEASE YEAR: 79 TOTAL GROUP RELEASE: 52577 TOTAL TAG RELEASE: 51000 PURPOSE OF RELEASE: IDMHTN

LOCATION	TYPE RECOVERY	NUMBER OBSERVED
Dworshak Nat	Hatch Rack	1
Tucannon Hat	Hatch Rack	1
Sitka	Troll Fish	5
Pelican	Troll Fish	1

4 OCEAN TOTAL 8

GRAND TOTAL 8

DATACODE: 50527 SPECIES: FL CK HATCHERY OF RELEASE: BAGERWAN SITE OF RELEASE: ASOTIN WA

RELEASE YEAR: 80 TOTAL GROUP RELEASE: 178131 TOTAL TAG RELEASE: 58100 PURPOSE OF RELEASE: IDRLCN

LOCATION	TYPE RECOVERY	NUMBER OBSERVED
Dworshak Nat	Hatch Rack	22
Sawtooth	Hatch Rack	2
Tucannon Hat	Hatch Rack	24
Juan De Fuca	Gill Net	1
SWVancouver	Gill Net	1
Oregon Zone 6	Indian Gill	2
Priest Rapid	Hatch Rack	1
L Granite D	Hatch Rack	103
	1 OCEAN TOTAL	156
Dworshak Nat	Hatch Rack	9
Tucannon Hat	Hatch Rack	5
North West	Troll Fish	2
South West	Troll Fish	9
Garibaldi	Troll Fish	2
Newport	Troll Fish	1
Port Orford	Troll Fish	1
Brookings	Troll Fish	1
Coos Bay	Troll Fish	1
Astoria	Troll Fish	1
High Seas	Groundfish	1
Wash Area 1	Sport Fish	3
Wash Area 2	Sport Fish	5
Wash Area 2	Troll Fish	3
Wash Area 3	Indian Troll	2
Wash Area 3	Troll Fish	1
Wash Area 4	Indian Troll	2
Wash Area 4	Troll Fish	4
Crescent CY	Troll Fish	1
Fort Bragg	Troll Fish	1
Oregon Zone 6	Indian gill	1
Priest Rapid	Spawn Gr	1
L Granite D	Hatch R	7

DATACODE: 50527 SPECIES: FL CK HATCHERY OF RELEASE: HAGERMAN SITE OF RELEASE: ASOTIN WA

RELEASE YEAR: 80 TOTAL GROUP RELEASE: 178131 TOTAL TAG RELEASE: 58100 PURPOSE OF RELEASE: IDRLCN

(Continued)

LOCATION	TYPE RECOVERY	NUMBER OBSERVED
		2 OCEAN TOTAL 64
Dworshak Nat	Hatch Rack	6
Tucannon Hat	Hatch Rack	18
North West	Troll Fish	3
South West	Troll Fish	2
South West	Gill Net	1
Northern	Net	1
Newport	Troll Fish	1
Wash Area 1	Sport Fish	1
Wash Area 2	Troll Fish	2
Wash Area 3	Troll Fish	2
Wash Area 4	Indian Troll	1
Craig	Troll Fish	1
Sitka	Troll Fish	1
Siuslw Bay	Troll Fish	1
Clearwater 2	Sport Fish	1
		3 OCEAN TOTAL 42
		GRAND TOTAL 262

DATACODE: 50528 SPECIES: FL CK HATCHERY OF RELEASE: HAGERMAN SITE OF RELEASE: BELOW BONVLE

RELEASE YEAR: 80 TOTAL GROUP RELEASE: 58102 TOTAL TAG RELEASE: 56000 PURPOSE OF RELEASE: IDRLTN

LOCATION	TYPE RECOVERY	NUMBER OBSERVED	
Tucannon Hat	Batch Rack	3	
Juan De Fuca	Gill Net	1	
Ketchikan	Seine	1	
Oregon Zone 6	Indian Gill	1	
L Granite D	Hatch Rack	2	
		1 OCEAN TOTAL	1
North West	Troll Fish	1	
South West	Troll Fish	4	
Astoria	Sport Fish	1	
Astoria	Troll Fish	1	
Wash Area 1	Sport Fish	1	
Wash Area 2	Sport Fish	2	
Wash Area 3	Troll Fish	1	
Wash Area 4	Troll Fish	1	
Oregon Zone 6	Indian Gill	3	
		2 OCEAN TOTAL	15
South West	Troll Fish	3	
South West	Gill Net	1	
Wash Area 2	Sport Fish	1	
Wash Area 4	Troll Fish	1	
Sitka	Troll Fish	1	
Oregon Zone 6	Sport Fish	I	
		3 OCEAN TOTAL	8
		GRAND TOTAL	31

DATACODE: 102210 SPECIES: FL CK HATCHERY OF RELEASE: HAGERMAN SITE OF RELEASE: L GRANITE

RELEASE YEAR: 81 TOTAL GROUP RELEASE: 120157 TOTAL TAG RELEASE: 55400 PURPOSE OF RELEASE: IDTNST

LOCATION	TYPE RECOVERY	NUMBER OBSERVED
Dworshak Nat	Hatch Rack	8
Tucannon Hat	Hatch Rack	14
Northernn	Net	1
Church Is	Sport Fish	1
Wash Area 7	Indian Gill	1
Ketchikan	Seine	2
Excursion Inlet	Seine	1
L Granite D	Hatch Rack	110
	1 OCEAN TOTAL	138
Dworshak Nat	Hatch Rack	13
Tucannon Hat	Hatch Rack	23
North West	Troll Fish	1
South West	Troll Fish	9
Northern	Troll Fish	I
Astoria	Sport Fish	1
Wash Area 1	Sport Fish	2
Wash Area 2	Sport Fish	4
Wash Area 2	Troll Fish	1
Wash Area 3	Troll Fish	1
Wash Area 4	Indian Troll	1
Wash Area 6	Sport Fish	1
Ketchikan	Troll Fish	1
Petersburg	Seine	1
Petersburg	Gill Net	1
Oregon Zone 1	Gill Net	1
Oregon Zone 6	Indian Gill	11
L Granite D	Hatch Rack	4
	2 OCEAN TOTAL	77

GRAND TOTAL 215

DATACODE: 102211 SPECIES: FL CR HATCHERY OF RELEASE: HAGERMAN SITE OF RELEASE: BELOW BONVLE

RELEASE YEAR 91 TOTAL GROUP RELEASE: 611347 TOTAL TAG RELEASE: 55700 PURPOSE OF RELEASE: IDTNMH

LOCATION	TYPE RECOVERY	NUMBER OBSERVED
Dworshak Nat	Hatch Rack	9
Tucannon Hat	Hatch Rack	24
Ringold	Hatch Rack	1
Central	Net	1
Valdes Is	Sport Fish	1
Astoria	Troll Fish	1
Ketchikan	Seine	1
Petersburg	Seine	1
Oregon Zone 1	Gill Net	1
Oregon Zone 6	Indian Gill	1
Priest Rapid	Spawn Gr	1
L Granite D	Hatch Rack	97
	1 OCEAN TOTAL	139
Dworshak Nat	Hatch Rack	6
Tucannon Hat	Hatch Rack	14
North West	Troll Fish	5
South West	Troll Fish	7
Northern	Net	1
Northern	Troll Fish	2
Central	Net	1
Central	Troll fish	4
Wash Area 1	Sport Fish	5
Wash Area 2	Sport Fish	3
Wash Area 2	Troll Fish	4
Wash Area 3	Troll Fish	1
Wash Area 4	Indian Troll	3
Wash Area 5	Sport Fish	3
Ketchikan	Troll Fish	1
Juneau	Voluntary	1
Oregon Zone 1	Gill Net	1
Oregon Zone 2	Gill Net	2
Oregon Zone 6	Indian Gill	15
Priest Rapid	Spawn Gr	1
L Granite D	Hatch Rack	1
	2 OCEAN TOTAL	81
	GRAND TOTAL	220

DATACODE: 51022 SPECIES: FL CK HATCHERY OF RELEASE: HAGERMAN SITE OF RELEASE: ASOTIN WA

RELEASE YEAR: 82 TOTAL GROUP RELEASE: 80721 TOTAL TAG RELEASE: 78300 PURPOSE OF RELEASE: INMHID

LOCATION	TYPE RECOVERY	NUMBER OBSERVED	
Dworshak Nat	Hatch Rack	11	
Tucannon Hat	Hatch Rack	24	
Northern	Gill Net	1	
Johnstone St	Net	1	
Johnstone St	Gill Net	4	
Central	Net	7	
Central	Gill Net	1	
Newport	Sport Fish	1	
Ketchikan	Seine	3	
L Granite D	Batch Rack	44	
		1 OCEAN TOTAL	97
Pahsimeroi	Hatch Rack	1	
		2 OCEAN TOTAL	1
		GRAND TOTAL	98

DATACODE: 51023 SPECIES: FL CK HATCHERY OF RELEASE: HAGERMAN SITE OF RELEASE: L GRANITE

RELEASE YEAR: 82 TOTAL GROUP RELEASE: 82907 TOTAL TAG RELEASE: 80425 PURPOSE OF RELEASE: TRNL

LOCATION	TYPE RECOVERY	NUMBEROBSERVED
Dworshak Nat	Hatch Rack	7
Tucannon Hat	Hatch Rack	32
Northern	Net	1
Johnstone St	Net	1
Johnstone St	Gill Net	1
Central	Net	4
Central	Gill Net	5
Ketchikan	Seine	1
L Granite D	Hatch Rack	12

1 OCEAN TOTAL 124

GRAND TOTAL 124

TUCANNON RIVER SPRING CHINOOK

PRODUCTION

The Tucannon River spring chinook run is maintained entirely from natural production of an indigenous stock. Currently, hatchery production utilizing local native stock is scheduled to begin in 1985 to supplement and rebuild the Tucannon spring chinook run. This plan involves collecting a minimum of 80 fish or 50 percent of the total run, up to 131 fish. The juveniles would be reared at Lyons Ferry Hatchery and released from Tucannon Hatchery. Hatchery production would initially occur as yearling smolt releases (132,000 target) with the possibility of future off-station plants of fingerlings and/or smolts.

GEOGRAPHIC LOCATION

Streams

Tucannon River drains from the Tucannon-Wenaha Wilderness Area.

Hatcheries

Artificial propagation is scheduled to begin in 1985 at Lyons Ferry Hatchery.

ORIGIN

Spring chinook are indigenous to the Tucannon River. The current run is a remnant of a formerly large population that was reduced because of obstructions and dam diversions (Fulton 1968).

ADULT LIFE HISTORY

Run size, catch, and escapement

Information is very limited on the Tucannon spring chinook run. Based primarily on spawning survey counts, the present run is estimated to be approximately 200 fish. These index area redd counts which have been conducted annually since 1954 have ranged from a low of 6 (1971) to a high of 168 (1957) (Table 1). Recent harvest of Tucannon spring chinook has been minimal. The final recreational season occurred in 1973 when 149 fish were caught (Table 2). In the current Tucannon River subsistence fishery, a maximum of 40-50 fish are annually harvested by the Umatilla Tribe and an unknown but negligible number by the Nez Perce.

Table 1. Tucannon River spring chinook salmon spawning survey redd counts (J. Easterbrooks, WDF, personal. communication).

Year	Area surveyed: Cow Camp Bridge-Tucannon CG Bridge	Area surveyed: Panjab Creek Bridge - Cow Camp Bridge	Total redds observed
1954	33	Not surveyed	33
1955	80 fish; no redd count	" "	--
1956	No survey		--
1957	168	" "	168
1958	54	" "	54
1959	27	" "	27
1960	42	" "	42
1961	102	" "	102
1962	52	" "	52
1963	21	" "	21
1964	61	" "	61
1965	24	" "	24
1966	65	" "	65
1967	40	" "	40
1968	18	" "	18
1969	61	" "	61
1970	62	" "	62
1971	6	" "	6
1972	23	" "	23
1973	24	" "	24
1974	18	" "	18
1975	37	" "	37
1976	13	" "	13
1977	19	" "	19
1978	No survey	" "	
1979	No survey		
1980	38	8	46
1981	67	8	75
1982	27	19	46
1983	40	12	52
1984	31	21	52

Table 2. Tucannon River salmon catch from punch card reports.

Year	February	March	April	May	June	July	August	September	October	November	Total March-July
1964	-	-	-	95	258	-		2			353
1965	-	-	-	91	268	-					359
1966	-	-	-	565	389	-		9	3		954
1967	-	-	-	189	139	-					328
1968	-	2	-	66	52	-		2	2		120
1969	-	-	-	60	402	-					462
1970	-	-	-	161	104	4	4	18			269
1971	-	-	-	7	61	5		2	-	2	13
1972	-	-	-	51	118	-			-		169
1973[a]	-	-	-	60	89	-		-	-		149
Average	-	-	-	135	188	1		3			323

a Last year of open season.

Time of migration

Exact timing is unknown but is expected to be similar to other upper Columbia spring chinook stocks where freshwater entry occurs primarily during mid-March through April. Peak counts of Snake River spring chinook at Lower Monumental Dam generally occurs in early to mid-May.

Spawning period

Spawning surveys are generally conducted between September 7-11. Although redd counts are the primary intent of the survey, most of the fish observed are still alive indicating further spawning activity.

Spawning areas

Spawning occurs in the 20-mile reach of the Tucannon River between approximately Cummins Creek Bridge (river mile 34.71 upstream to Bear Creek. The principal spawning area is between Camp Wooten (river mile 42.4) and the Panjab Creek Bridge (river mile 46.3). The historical index area is the short 2.4-mile distance between Camp Wooten upstream to Cow Camp Bridge. Beginning in 1980, the index area was expanded to include the river from Cow Camp Bridge to Panjab Creek Bridge. In 1984 a complete river survey was performed and index area redds comprised 50.5 percent of the total observed (J. Easterbrooks, Washington Department of Fisheries [WDF], personal communication).

Age composition

Based on limited length information, most of the Tucannon River spring chinook run is composed of four-year-old fish (J. Easterbrooks, WDF, personal communication).

Size

Based on limited fork length information, Tucannon spring chinook range between 60-87 cm (Table 3). This range is smaller than the range for Carson stock spring chinook but similar to the size distribution for populations in the Deschutes and Rapid rivers.

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

Schreck et al. (19851 determined the isozyme gene frequencies of 16 enzyme systems for Tucannon River spring chinook. The profiles from the Tucannon samples were not statistically compared to the results from any other spring chinook populations.

Table 3. Length frequency of Tucannon River spring chinook from spawning ground surveys.

Fork length (cm)	1966	1968	1969	1970	1971	1973	1974	1975	1983
36	-	1	-	-	-	-	-		
36-39	-	1	-	-	-	-	-		
40-43	-	-	1	-	-	-	-		
44-47	-	-	-	-	-	-	-		
48-51	-	-	-	-	-	-	-		
52-55	-	-	-	-	-	-	-		
56-59	-			-	-	1	-		
60-63	-	1	4	-	-	-	-		
64-67	1		17	1	-	2	-	2	1
68-71	-	1	11	1	1	-	2	1	2
72-75	1		5	1	1	1	-	1	1
76-79	2		6	4	-	-	1	3	2
80-83	1			1	-	-	-		2
84-87	1		2	-	-	1	1	1	
88-91	-			-	-	-	-		
91-94	-			-	-	-	-		
94	-	-	-	-	-	-	-		
Sample	6	4	46	9	2	5	4	a	9
Average	76	37[a],65	43[a],69	11	72	70	75	74	77
Standard deviation	6.2	1.4,5.7	0,5.9	8.8	3.5	11.2	7.5	6.6	7.8

a Assumed to be jacks.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age, and size at migration

Pre-smolts collected on February 20, 1985 ranged between 63-95 mm. and averaged 78 mm. This range is generally smaller than juveniles of the same age from other spring chinook populations.

Survival rate

No information

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

Fundamental biological information is lacking on the spring chinook population in the Tucannon River. Data needs to be collected on the following topics :

1. Magnitude of the spawning population through expanded or multiple surveys.
2. Age composition based on scale readings and length frequency.
3. Juvenile abundance. rearing, and srowth.

REFERENCES

Fulton, L. A. 1968. Spawning areas and abundance of chinook salmon (Oncorhvnchus tshawvtscha) in the Columbia River basin -- past and present. United States Fish and Wildlife Service, Special Scientific Report -- Fisheries No. 571.

Kooskia Hatchery Spring Chinook

Kooskia National Fish Hatchery (KNFH) is owned and operated by the U.S. Fish and Wildlife Service.

PRODUCTION

The KNFH spring chinook rearing program has included releases of subsmolts (age 09 up to 666,544 and smolts up to 244,083 per year (Table 1) (USPWS file data).

GEOGRAPHIC LOCATIOM

KNFH is located on Clear Creek, tributary to the Middle Fork Clearwater River near Kooskia, Idaho.

ORIGIN

KNFH has reared five upriver spring chinook stocks beginning in 1971: Rapid River, Carson, South Santiam (originally Carson), Little White Salmon (Carsons and Leavenworth (Carson) (Table 29 (pers. comm., D. Diggs, USFWS). Any adult returning to KNFH, regardless of its parentage, is considered to be "Kooskia stock'.

ADULT LIFE HISTORY

Run size, catch and escapement

The run size by age class of KNFH spring chinook returning to the hatchery since 1975 has ranged from 67 in 1900 to 2,035 in 1978 (Table 39 (pers. comm.,D. Diggs, USFWS).

KNFH chinook with coded wire tags have been harvested in the Columbia River Zone l-5 gillnet fishery, in the Zone 6 Indian gillnet fishery and in the Deschutes River sport fishery (Table 4) (Duke 1984). No harvest estimates for tbe stock have been made for any fishery.

MO coded wire tagged Kooskia spring chinook have been recaptured in ocean fisheries (Duke 1984).

The spawning escapement objective for KNFH spring chinook is 600 fish, based on a sex ratio of 60 females:40 males (pers. comm., D. Diggs, USFWS).

Time of migration

Spring chinook salmon, including KNFH stock, are generally considered to enter the Columbia River and pass Bonneville Dam during the period March 15 through May 31, peaking during the period April 16 tbrough

Nay 8. Spring chinook pass Lower Granite Dam during April through mid-June, with a peak during Way 7 through June 10.

Table 1. Number of age 1 smolts and subyearling spring chinook released from Kooskia NFH, and total and percent returns to the hatchery.

Year released	Number released		Total return	Percent return
	Subyearling	Age 1 smolt		
1971	0	151,700	52	.034
1972	75,800	96,000	67	.039
1973	0	508,500	406	.080
1974	0	303,800	394	.130
1975	0	802,200	2,369	.295
1976	71,000	972,200	1,993	191
1977	900,200	500,630	291	:021
1978	871,500	512,146	143	.010
1979	666,500	301,000	322	.033
1980	0	766,900	249	.032
1981	571,600	557,200	(440)[a]	--
1982	360,500	127,289	(81)[a]	--
1983	0	461,269	(55)[a]	--
1984	0	267,406	--	--

a Incomplete returns.

Table 2. Parental stock origin and rate of return to hatchery for spring chinook salmon released from Kooskia National Fish Hatchery, 1971-1981.

Release year	Origin of parents	% return to hatchery
1971	100% Rapid River	0.034
1972	56% Rapid River; 44% Carson (O+)	0.040
1973	100% Carson	0.080
1974	100% Carson	0.130
1975	46% Rapid River; 54% Carson	0.295
1976	93% South Santiam 7% Little White Salmon	0.190
1977	80% Carson (0+) 11% Little White Salmon 9% Kooskia	0.016
1978	66% Rapid River (0+); 34% Carson	0.012
1979	69% Kooskia; 31% Carson	0.033
1980	69% Carson (0+); 31% Kooskia	0.032
1981	72% Carson 17% Rapid River 11% Kooskia	0.030
	TEN YEAR AVERAGE RETURN RATE =	0.080

Table 3. Run size by age class and return to hatchery by Kooskia NFH spring chinook.

Year	Run size to Kooskia NFH				Total
	One-ocean	Two-ocean	Three-ocean	Four-ocean	
1972	5	--	--	--	5
1973	5	45	--	--	50
1974	16	35	2	--	53
1975	15	284	27	0	326
1976	409	286	106	0	801
1977	214	1,529	93	0	1,836
1978	23	1,676	336	0	2,035
1979	8	264	103	95	470
1980	9	55	3	0	67
1981	1	168	77	1	247
1982	3	116	136	3	258
1983	1	231	132	9	373
1984	55	80	206	0	341

Table 4. Recoveries by month of coded-wire tagged adult spring chinook salmon from Kooskia NFH, 1978-81 releases into Clear Creek (tag groups 50426, 50529, 100329, 100330, 102218, 102219, and 102220 combined).

rea and type of recovery	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dee	Total
Columbia River Below Bonn. Dam Gill net, expts.			1	1									2
Columbia Zone 6 Indian gill net			2	1									3
Indian-Cer., Treaty, Subsist.				2	1								3
Deschutes River sport							1						1
Kooskia NFH Hatchery rack				1			1	18	24				44

Recoveries of coded wire tags from KNFH spring chinook have been limited (Table 4, Duke 1984). A few tagged Kooskia fish have been taken in Columbia River fisheries during March-May and a single tag recovery was made in the Deschutes River sport fishery during July.

KNFH spring chinook enter the trap at KNFH primarily during August and September (Table 4).

Spawning period

Spawntaking has begun as early as August 13 and as late as September 1 (Table 5). The end of the spawntaking period has ranged from August 30 to October 7.

The shift to earlier spawning which occurred after 1978 corresponded to a change in spawntaking operations from KNFH to Dworsbak NFH; adult chinook are held in warmer water at Dworsbak (54°F) than at Kooskia (48°F) prior to spawning (pers. comm., B. McLeod, USFWS).

Spawning areas

Fish are spawned at Dworshak National Fish Hatchery, reared at either KNFR or Dworshak NFH and released into Clear Creek. Other upriver stocks used in the development of Kooskia stock--Rapid River, Carson, Leavenworth, Little White Salmon and South Santiam stocks--have also been released into Clear Creek and return to KNFH as adults (USFWS file records).

Age composition

KNFM spring chinook are 3 to 6 years old at maturity. A one-ocean adult has had a lifespan of 3 years, including up to 20 months in the hatchery. Two-ocean, three-ocean and four-ocean fish are 4, 5 and 6 years old, respectively.

Kooskia spring chinook primarily spend 2 years at sea. The percentage of adults returning after 2 years has ranged from 38 to 91%; percentages of one-ocean, three-ocean and four-ocean fish have ranged from 0.4-17%, l-549 and O-49, respectively (Table 6) (USFWS file records).

Size

Years in ocean related to size has been determined by USFWS as: one-ocean (jacks), (22.0 inches fork length; two-ocean, 22.1-32.0 inches; three-ocean, 32.1-39.0 inches and four-ocean, >39.0 inches. The length-frequency distribution of adult spring chinook returning to KNFH in 1984 is shown in Figure 1 (USFWS file records).

Sex ratio

The sex ratio of returning adults has averaged 60 females:40 males (pers. comm., D. Diggs, USFWS).

Table 5. Yearly spawntaking period for spring chinook reared at Kooskia NFH, 1974-1984. Spawntaking occurred at Kooskia NFH until 1978, and at Dworshak NFH in later years.

Year	Number of females spawned	Begin spawntaking	End spawntaking
1973	0[a]		
1974	0[a]	--	
1975	203	9/1	09/30
1976	34	9/1	10/07
1977	0[a]	--	--
1978	598	08/25	09/05
1979	91	0/25	09/05
1980	18	08/25	09/05
1981	101	08/25	09/11
1982	112	08/24	09/14
1983	185	08/23	09/06
1984	143	08/13	08/30

[a] All adults died before spawntaking.

Table 6. Percentage by release year of adult spring chinook returning to Kooskia NFH after 1, 2, 3, and 4 years in the ocean.

Release year	Total adult return	One-ocean (year)	%	Two-ocean (year)	%	Three-ocean (year)	%	Four-ocean (year)	%
1971	52	(1972)	9.6	(1973)	86.5	(1974)	3.8	(1975)	0
1972	67	(1973)	7.5	(1974)	52.2	(1975)	40.3	(1976)	0
1973	406	(1974)	3.9	(1975)	70.0	(1976)	26.1	(1977)	0
1974	394	(1975)	3.8	(1976)	72.6	(1977)	23.6	(1978)	0
1975	2,369	(1976)	17.3	(1977)	64.5	(1978)	14.2	(1979)	4.0
1976	1,993	(1977)	10.7	(1978)	84.1	(1979)	5.2	(1980)	0
1977	291	(1978)	7.9	(1979)	90.7	(1980)	1.0	(1981)	0.3
1978	143	(1979)	5.6	(1980)	38.5	(1981)	53.8	(1982)	2.1
1979	322	(1980)	2.8	(1981)	52.2	(1982)	42.2	(1983)	2.8
1980	249	(1981)	0.4	(1982)	46.6	(1983)	53.0	(1984)	0

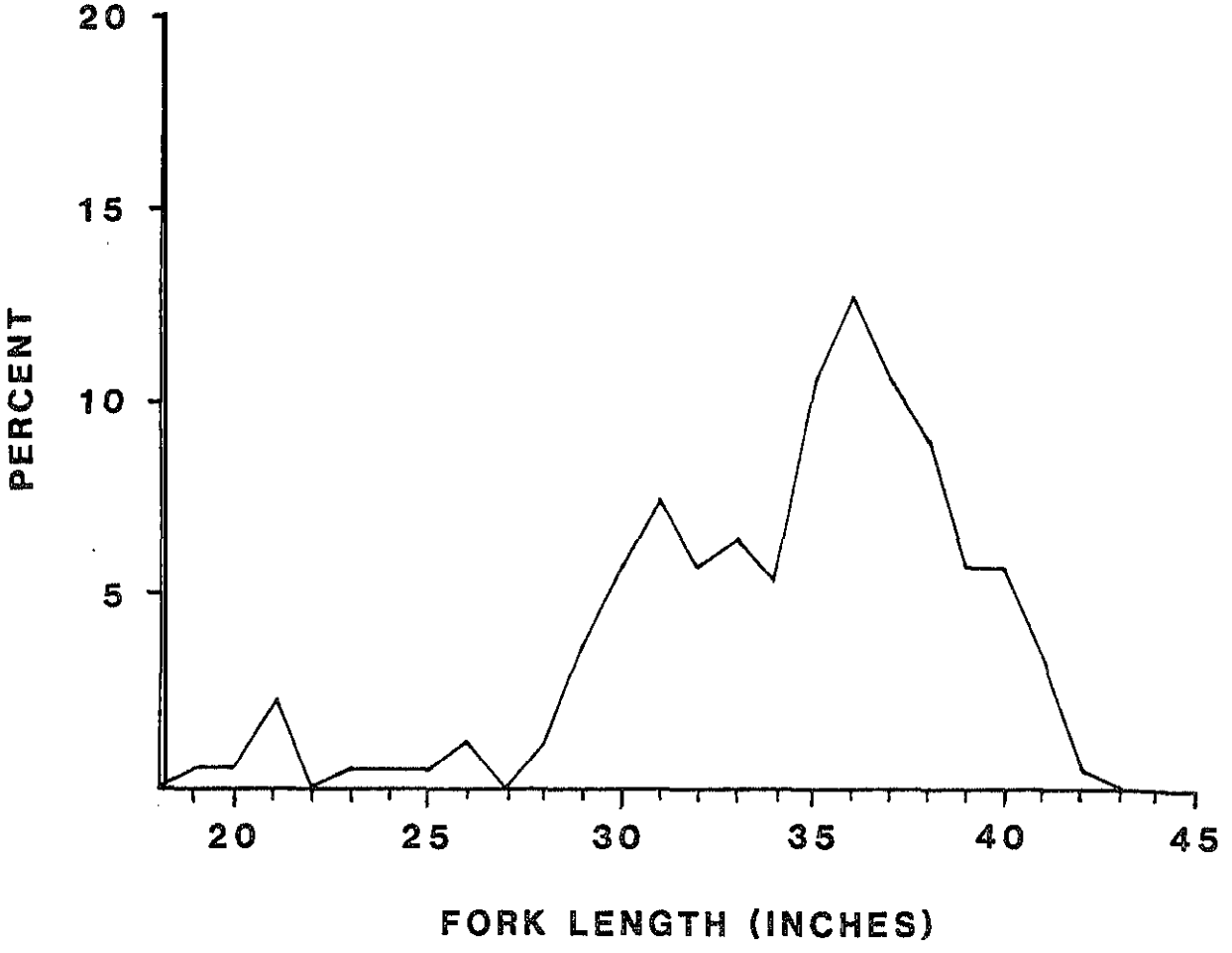

Figure 1. Length frequency of Kooskia spring chinook returning to the hatchery in 1984.

Fecundity

Adult females contain an average 4,000-4,200 eggs (pers. comm., D. Diggs, USFWS).

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age and size at migration

The KNFH stock of spring chinook has been released as age smolts and as subyearlings.

Most spring chinook smolts (age 1) averaged between 28.3/pound and 5,5/pound (4.9-8.5 inches total length) (pers. comm.; D. Diggs, USFWS). Subyearlings released in spring averaged 55.0/pound to 41.0/pound (3.8-4.1 inches).

Kooskia chinook are released as smolts during the period March 18 through May 20 (USFWS file records). Releases of age 0 chinook have occurred during late February through early June and in October.

Depending on the release dates and flow conditions in the Snake and Columbia rivers, naturally migrating spring chinook smolts (age 1) from KNFH reach the lower Columbia River at Jones Beach (Rkm 75) during late April through June, 1 to 8 weeks after release (Table 7) (Dawley et al. 1982, 1984). Subyearlings from KNFH have been recaptured in the lower Columbia River as late as July.

Survival rate

Survival from time of release to adult return to KNFH has ranged from 0.028% for the 1978 release to 0.295% for the 1975 release (Table 1) (pers. comm., D. Diggs, USFWS).

DISEASE HISTORY

Spring chinook production at KNFH has been hampered primarily by bacterial kidney disease (BKD) and *Ichthyopthirius* ("Ich") (pers. comm., J. Leintz, USFWS). KNFH has a limited source of high quality water which results in coldwater temperatures during winter and temperatures up to 80 F in summer.

Table 7. Recapture dates at Jones Beach (RKm 75) of spring chinook with coded wire tags that were released from Kooskia NFH.

Release year	Coded wire tag group	Release date [a]	Recapture date: 10 Percentile	Median	90 percentile	Number of days
1977	100218 [b]	4/26	5/31	5/31	5/31	35
	100217	4/26	5/6	5/12	5/31	10-35
1970	100330	4/14	4/25	5/10	6/9	11-55
	100329	5/13	5/30	6/15	6/30	17-48
1979	50426 [b]	4/26	5/29	6/17	7/2	33-67
1981	100519	4/7	4/29	4/29	5/14	22-37
	102219	4/7	4/23	4/24	5/7	16-30
	102220	4/8	4/29	5/3	5/15	22-37
	102218 [b]	5/21	5/31	6/19	7/10	IO-50

[a] Duke (1984).
[b] Subyearlings.

Minor disease problems reported for KNFH include:

1. Costia.
2. Bacterial gill disease.
3. Epithelial cystis.

PRIORITYINFORMATION WEEDS

1. Determination of the comparative effectiveness of rearing spring chinook for release at age 0 or age 1.

REFERENCES

Dawley, E. M. R. D. Ledgerwood, T. H. Blahm and A. L. Jensen. 1982. Migrational characteristics and survival of juvenile salmonids entering the Columbia River estuary in 1981. Annual report to BPA by NMFS, 2725 Montlake Blvd. E., Seattle, WA 98112.

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Duke, R. C. 1984. Anadromous fish marking and recovery. Federal Aid in Fish Restoration, Job Performance Report, Project F-73-R-5, Idaho Department of Fish and Game.

Grande Ronde River Spring Chinook (wild)

PRODUCTON

Spring chinook currently are produced in the Grande Ronde system primarily by wild stock. Survival from hatchery releases to date has been poor. Consult "Grande Ronde Spring Chinook (hatchery)" for information on the hatchery stock.

GEOGRAPHIC LOCATION

Streams

Grande Ronde River and tributaries (Figure 1)

ORIGIN

Spring chinook are native in the Grande Ronde system. Since 1978 Rapid River and Carson Hatchery stocks have been released in Lookingglass and Catherine creeks as part of the Lower Snake River Compensation Plan. Objectives of the plan include maintaining native stocks of wild spring chinook in the Minam and Wenaha rivers and restoring and maintaining natural spawning populations of spring chinook throughout the Grande Ronde system with supplementary hatchery releases.

ADULT LIFE HISTORY

Run size, catch, and escapement

Due to depressed runs, no in-river commercial seasons for upriver spring and summer chinook have been open since 1977 and 1963, respectively. The Grande Ronde River system has been closed to salmon sport fishing since 1974. Sport catch of chinook from 1959 through 1973 is summarized in Table 1. Total catch declined from a high of 1,175 fish in 1966 to a low of 122 fish in 1972.

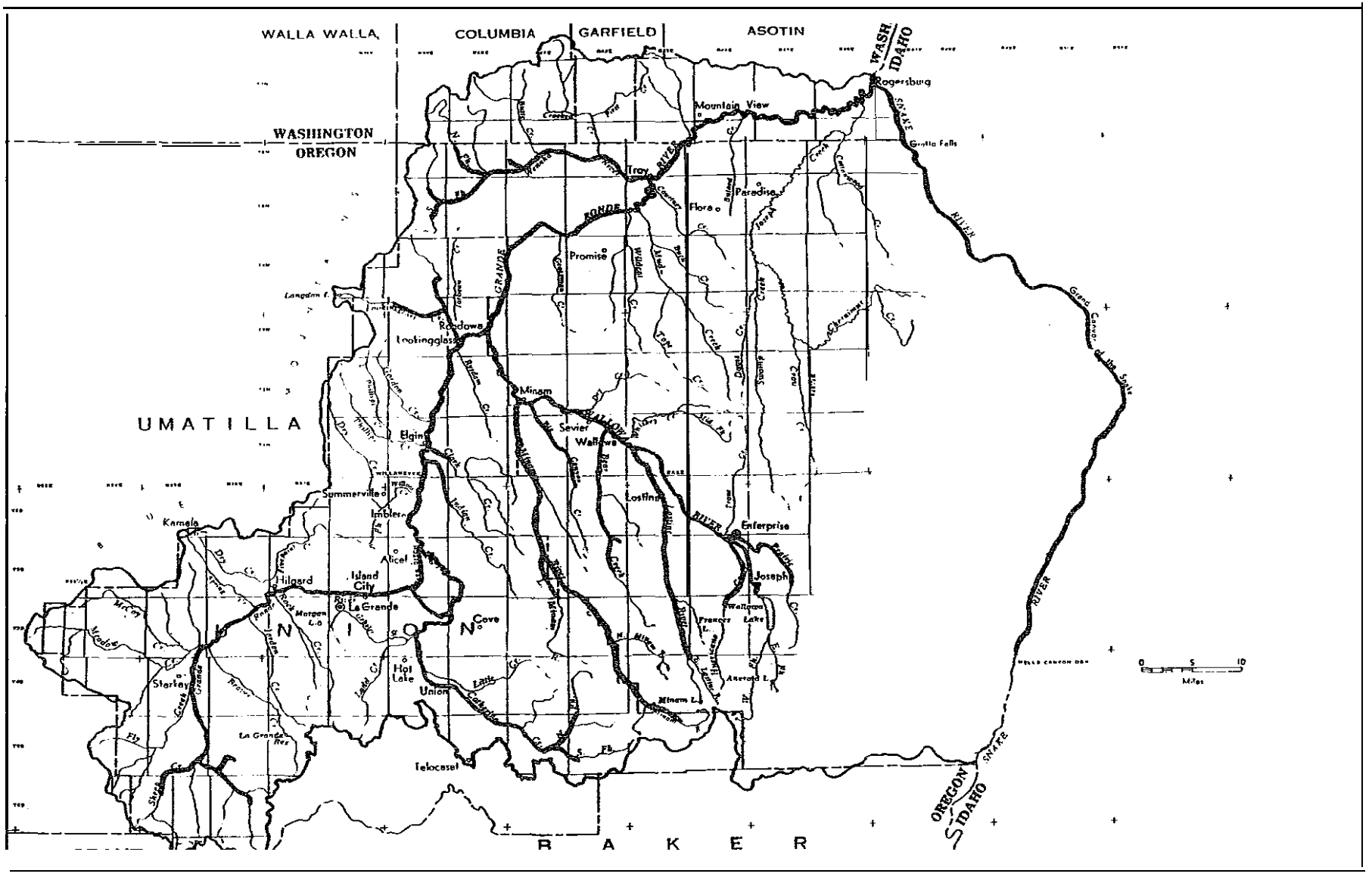

Figure 1. Spring chinook salmon distribution, Grande Ronde Basin (Smith 1975).

Table 1. Punch-card estimates of salmon sport harvest in the Grande Ronde River and tributaries 1959-1973[a].

Year	Harvest
1959	503
1960	552
1961	221
1962	762
1963	345
1964	444
1965	361
1966	1,175
1967	489
1968	431
1969	645
1970	237
1971	91
1972	34
1973	186

a Estimates prior to 1971 are not adjusted for non-response bias and include total reported salmon catch during all months. Consequently, they may include other species and contain identification errors.

The Umatilla and Nez Perce tribes have historically fished for salmon in the Grande Ronde Basin. The largest reported harvest was 300 fish caught in the upper Grande Ronde in 1968 (West 1968). No current estimates of subsistence harvest are available, but effort has decreased in recent years. The Umatilla Tribes closed the Grande Ronde to subsistence fishing in 1982 and 1983 (James 1984), and the Nez Perce Tribe closed the Snake River and its tributaries including the Grande Ronde to subsistence fishing in 1984.

The Grande Ronde historically produced large runs of spring chinook. Van Cleave and Ting (1960) estimated the spawning escapement was more than 20,000 fish in 1956, prior to the construction of dams on the Snake River. This estimate was based on the availability of spawning gravel, but the specific method used for this estimate was not described. In 1957 the run size to the mouth of the Grande Ronde was estimated at 12,200 fish (USACE 1975). This was calculated from the McNary Dam count (222,100), the proportion of that run that would have passed Ice Harbor based on counts in later years (55%), and the estimated proportion of the run passing Ice Harbor Dam destined for the Grande Ronde (10%). The accuracy of these estimates is unknown

Chinook spawning ground surveys have been conducted since the late 1940s. Since 1967 chinook redd counts have declined by more than 70% (Table 2 and Figure 2) despite large reductions in harvest. Estimates of total escapement for the past 5 years are presented in Table 3. Construction of hydro-electric dams on the Columbia and Snake rivers has been tied to the

Table 2. Annual spring chinook redd counts in the Grande Ronde River basin, 1964-1984.

stream	e	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
		Year																		
Bear Creek	6.5	24	15	12	11	40	23	25	30	55	16	21	33	17	12	25	4	4	2	12
Sheep Creek	6.0		4		24	13	106	74	58	69	21	19	22	18			0	8	8	18
Little Minam River	1.5						7	8	11	19	9	22	13							
Hurricane Creek	3.0	28	17	1	3	20	9	17	23	18	10	11	2	0	0	11	0	0	1	9
Wallowa River	4.5	35	32	14	15	11	17	14	12	5	11	7	1	15	2	18	0	1	0	1
Spring Creek	1.0	20	6	6	4	1	1	0	0	4	2	0	0							
South Fork Wenaha	6.0	167	79	278	185	128	254	279	164	71	205	49	30	20	60	77	5	24	20	27
Lostine River	3.0	335	102	187	177	128	108	80	82	127	138	117	35	77	25	120	21	18	8	58
Lookingglass Creek	6.2	141	101	210	92	92	165	188	149	63	101	27	28	40	32	25	13	29	7	26
Catherine Creek	7.5	41	47	15	27	51	85	51	121	85	116	70	21	78	6	47	36	66	16	42
North Fork Catherine Creek	3.0				31	15	43	19	28	38	73	17	9	39	4	7	0	3	3	14
South Fork Catherine Creek	2.0				17	7	19	3	86	21	33	19	12	21		26	5	0	3	7
Grande Ronde River	8.5[a]	172	128	143	216	304	194	51	129	110	52	61	42	75	92	42	7	32	39	29
Lower Minam River	7.5	108	75	69	25	67	82	102	71	91	70	15	25	28	14	65	9	3	2	9
Upper Minam River	6.0	68	78	77	32	30	106	82	49	66	48	36	25	24		72	6	7	12	13
Indian Creek	3.0					10	2	10	0	19	7	1	0	9		11				

[a] 14 miles surveyed in 1964, 7.5 miles in 1966, 18 miles in 1967, 21 miles in 1968, and 10 miles in 1971.

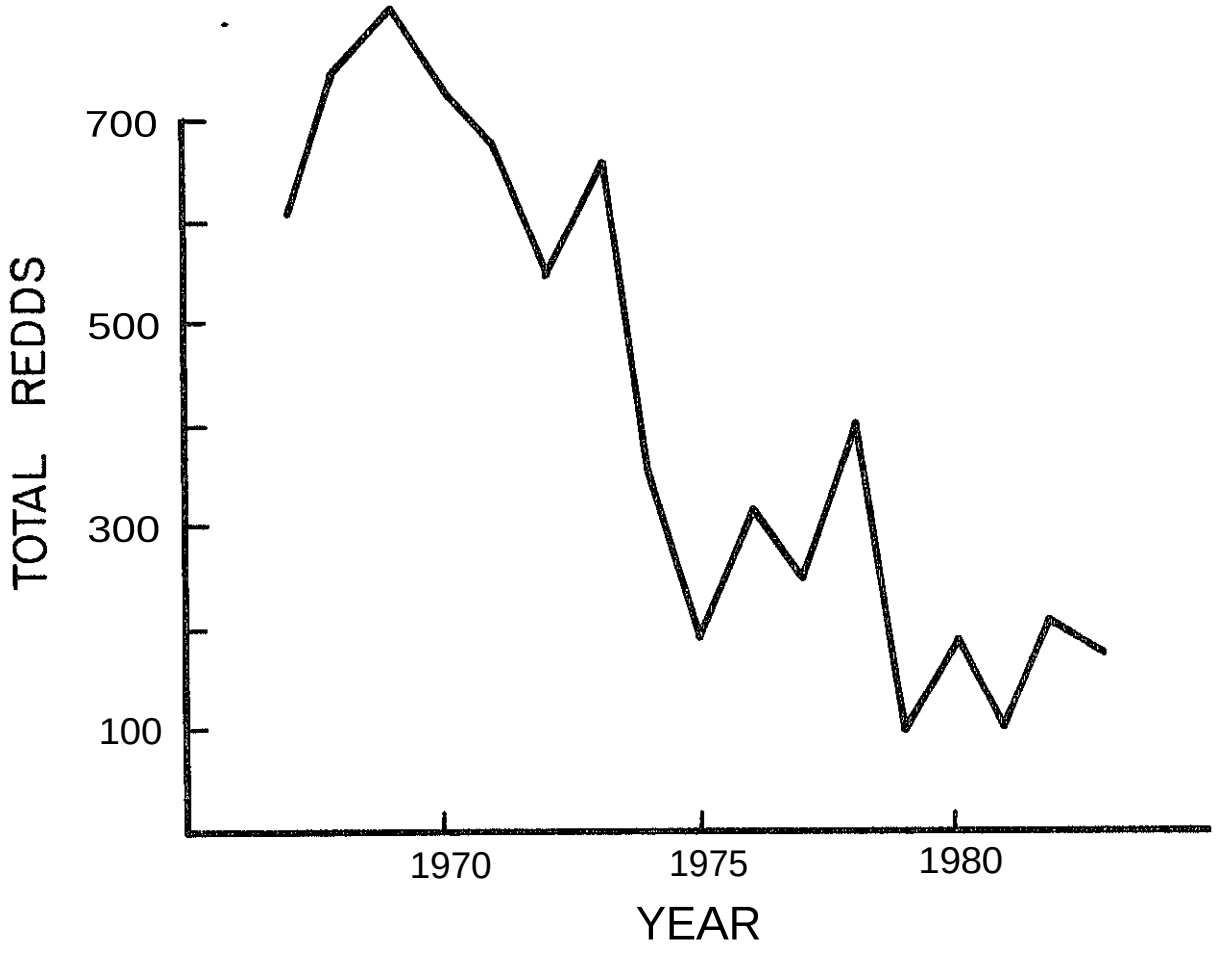

Figure 2. Trend in the spawning escapement of spring chinook in the Grande Ronde River (modified from James 1984).

continuing downward trend in chinook abundance in the Crande Ronde and other Snake River tributaries (Hirose 1984). Redd counts in Wenaha and Minam rivers have continued to decline even though the habitat of these streams has remained essentially unaltered.

Table 3. Spring chinook escapement estimates for the Grande Ronde River and tributaries for 1979-1984. Estimates based on redd counts expanded for unsurveyed areas and 2.75 fish/redd (R. Boyce, ODFW, personal communication).

Stream	E timated escapement 1979	1980	1981	1982	1983	1984	Redd count expansions
SF Wenaha	14	26	22	29	25	13	1.18
Wallowa River	0	3	0	3	14	33	1.10
Lostine River	72	63	28	192	181	195	1.25
Bear Creek	11	11	6	36	17	11	1.00
Hurricane Creek	0	0	3	25	19	0	1.00
Minam River	41	28	39	61	58	63	1.00
Grande Ronde River	33	146	113	132	223	118	1.65
Lookingglass Creek	51	88	22	120	40	39	1.00
Sheep Creek	0	22	22	50	14	50	1.00
Catherine Creek	322	589	143	374	385	215	3.25
NF Catherine Creek	0	8	8	39	30	3	1.00
SF Catherine Creek	14	0	8	19	11	11	1.00
Total escapement Grande Ronde Basin	558	984	474	1,080	1,017	751	

Time of Migration

Most chinook destined for the Grande Ronde pass Bonneville in April and May. Six of the seven tagged adults recovered in the Grande Ronde in 1974 were tagged at Bonneville between 4/14 and 5/18. One of the recoveries was classified as a summer chinook having been tagged at Bonneville between 6/23 and 6/29. Six tagged fish were trapped at Little Goose Dam between 4/28 and 6/l (Gunsolus et al. 19751.

There were only three recoveries of tagged fish in the Grande Ronde system (one each from the Wenaha, Wallowa, and Minam rivers) from chinook tagging programs on the Columbia from 1947 to 1965. These fish were classified as summer chinook, having been tagged between 6/18 and 6/22 (Galbreath 1966). Recoveries of Grande Ronde chinook tagged near Lewiston, Idaho, indicated that those fish passed through the lower Snake River primarily during late May through mid-July (Table 4).

Peak immigration of adults in Lookingglass Creek, a tributary of the Grande Ronde, occurred during June (Table 51. Most of the fish were thought to enter Catherine Creek the last three weeks of June and early July (Loeffel 1959).

Table 4. Number of recoveries of tagged adult chinook in the Grande Ronde River system by date of tagging, 1954-56 (Thompson et al. 1958). Fish were tagged in the Snake River near Lewiston, Idaho.

1954 Weekly tagging period ending:

	May		June					July				Aug.
Tributary	19	26	2	9	16	23	30	1	14	21	28	4
Wenaha			1			1						
Wallowa							1		1		1	
Minam		1	1				1					
Lostine						2		1				
Lookingglass Cr.							1					
Catherine Cr.		1	2	1								
Upper Grande Ronde	1											

1955 Six-day tagging period ending:

	May	June					July					Aug.
Tributary	31	6	12	18	24	30	6	12	18	24	30	5
Wenaha		1		4	1							
Wallowa						1						
Minam				1		1	1	1				
Lostine				1								
Catherine Cr.	1											
Upper Grande Ronde				1	2							

1956 Eight-day tagging period ending:

	May			June			July				Aug.	
Tributary	15	23	31	8	16	24	2	10	18	26	3	11
Wenaha		1		2			15	3	1			
Wallowa							2					
Minam			2	1	1	1	5	2				
Lostine							1	1				
Lookingglass Cr.					1		4					
Catherine Cr.		1	1		2		2					
Upper Grande Ronde						1	1	1				

Table 5. Numbers of adult chinook trapped in Lookingglass by month, 1964-74 (Burck, 1974a).

Dar	May	June	Julv	Auaust	September	Total
1964	1	41	27	1	1	71
1965[a]	0	19	13	6	0	38
1966	104	209	15	21	0	349
1967	4	153	74	9	4	244
1968	75	257	49	5	1	387
1969	11	545		24	2	664
1970	1	433	2%	18	5	727
1971	0	153	242	12	1	408
1972	0	162	114	1	–	277
1973[b]	131	134	13	0	–	278
1974	0	30	47	1	–	78
Percentage	9	61	27	3	<1	

a Trap placed in operation on May 16, 1964.
b Gates removed and trap left open after August 4 because of heavy poaching activity.

Spawning Period

Spawning ground surveys were conducted throughout most of the spawning period on Lookingglass Creek from 1964 to 1974 (Burck 1974a). Spawning usually began prior to the first surveys in early August and peaked the last week of August. Figure 3 describes time of spawning in 1966, which is similar to timing in other years. There are no specific data comparing spawning times of spring vs. summer chinook in the Grande Ronde system.

Spawning areas

The distribution of spring chinook in the Grande Ronde system (c. 1975) is depicted in Figure 1. Fulton (1968) listed the spawning areas as follows:

Grande Ronde River
upper half of mainstem and tributaries

Wenaha River
middle and upper mainstem and tributaries

Wallowa River
40+ km section below Wallowa Lake and upper tributaries

Minam River
middle mainstem and lower Little Minam River

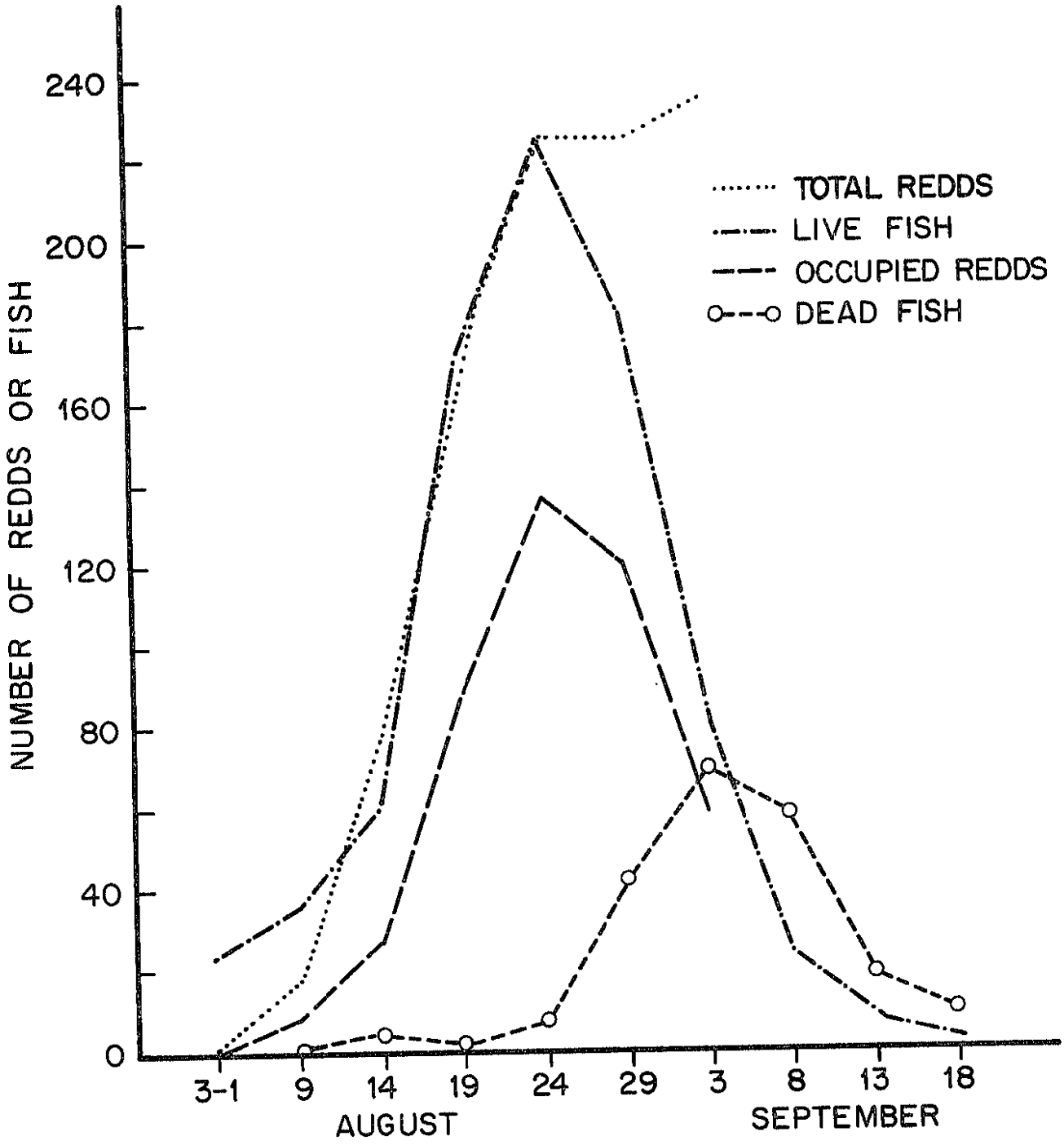

Figure 3 Number of total redds, occupied redds, live fish, and dead fish counted on Lookingglass Creek during 1966 spawning ground surveys, by survey date (Burck 1967a).

Bear Creek
12 km section in lower creek.

Lostine River
upper and middle mainstem areas from near mouth to forks

Catherine and Lookingglass creeks are other important spawning areas.

Age composition

Grande Ronde chinook generally return at ages 3-6 years. Four-year-old fish are the dominant age class overall, especially in Lookingglass and Catherine creeks (Table 6). The Lostine and Minam rivers had higher percentages of older fish. In the Lostine River, 5-year olds averaged more than one-third of the run.

Size

In Lookingglass Creek adults were distributed in three size groups: 21 in., 21-30 in., and 30 in. (Figure 4). Most of the fish were 21-30 in. (Burck 1973; 1974a). Length-frequency distributions of carcasses recovered from other streams in the Grande Ronde system can be found in annual Northeastern Oregon spawning ground survey reports published by the Fish Commission of Oregon.

Sex ratio

The female:male ratios for wild adults trapped for hatchery broodstock in 1982 and 1983 were 1.2:1 and 1.9:1, respectively. This may not be representative of the spawning population since the trap only sampled a portion of the total run.

Sex ratios based on carcasses recovered during spawning ground surveys are available from spawning ground counts prior to 1965. However, carcass recoveries may indicate a higher percentage of females than actually occur in the spawning population. Females die near their redds after spawning, whereas males tend to drift downstream out of the survey area before they die (Burck 1971).

Fecundity

Total egg deposition was estimated for Lookingglass Creek during 1964-74 based on average fecundity of 3,577 eggs (Burck, 1974b). Fecundities were not directly measured but were derived from length-fecundity relationships developed for Columbia River chinook by Galbreath and Ridenhour (1964) that were not stock-specific.

The average fecundity of 18 wild females trapped for broodstock in 1984 was 3,462 eggs. Average fecundity of wild broodstock in 1983 was 3,715 eggs/female.

Table 6. Percentage age composition of chinook salmon found dead on spawning ground surveys of Grande Ronde River tributaries, 1961-76 (modified from Bennett 1975).

	Lostine River				Minam River			Lookingglass Creek[a]			Catherine Creek[b]				Average				
	Age				Age			Age			Age				Age				
Year	3	4	5	6	3	4	5	3	4	5	2	3	4	5	2	3	4	5	6
1961	13	63	25	0	33	50	17	0	100	0	-	---	--	--	0	15	71	14	0
1962	30	55	15	0	11	64	25	0	90	10	0	0	100	0	0	14	77	13	0
1963	10	53	37	0	0	60	40	50	50	0		---		--	0	20	54	26	0
1964	8	76	16	0	23	65	12	17	77	6	-	---	--		0	16	73	11	0
1965	9	64	27	0	0	83	17	12	86	2	0	33	67	0	0	14	75	12	0
1966	18	60	22	1	0	55	45	6	93	1	0	0	75	25	0	6	71	23	<1
1967	11	46	42	1	8	67	25	21	53	26	0	0	75	25	0	IO	60	30	<1
1968	2	50	48	0	20	73	7	47	51	2		00	100	0	0	17	69	14	0
1969	3	61	36	0	7	82	11	24	75	1	3	3	94	0	1	9	78	12	0
1970	0	77	23	0	12	69	19	9	89	3		00	89	11	0	5	81	14	0
1971	18	64	18	0	13	60	27	13	63	4		05	95	0	0	12	76	12	0
1972	5	15	80	0	8	78	14	16	76	8		03	75	22	0	8	61	31	0
1973	0	46	54	0	7	47	47	3	88	9		00	83	17	0	3	66	32	0
1974	0	50	50	0	6	56	38	8	85	7		00	74	26	0	4	66	30	0
1975	0	36	64	0	0	50	50	0	33	67	0	0	0	100	0	0	30	70	0
1976	0	44	56	0	10	76	14	36	50	14	0	2	95	2	0	12	66	22	0
Average	8	54	38	0	10	65	26	16	74	10	0	4	79	17	0	10	67	23	0

[a] From 1971-74 scales were taken from every fish passing through upstream migrant trap.
b No scales were taken in 1961, 1963, or 1964.

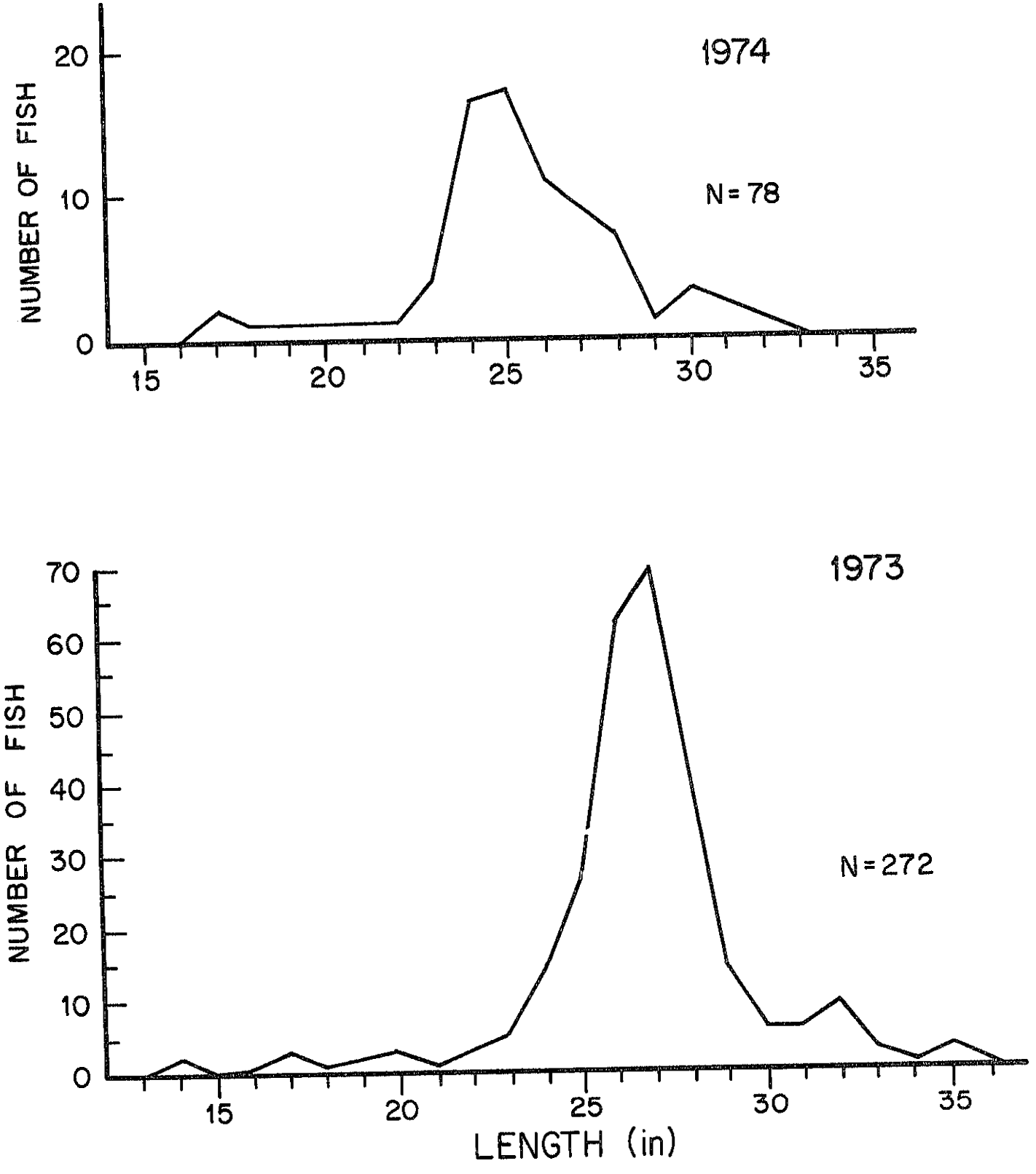

Figure 4. Length-frequency distribution of adult spring chinook trapped in Lookingglass Creek during 1973 and 1974 (Burck 1973; 1974a).

JUVENILE LIFE HISTORY

Time of emergence

In Lookingglass Creek, chinook fry emerged in January and February (Burck 1974b).

Time, aae, and size at migration

Downstream migration timing of 1965-69 brood chinook was monitored in Lookingglass Creek. Few 0-age fish migrated downstream before June. Peak movements occurred in July and August (Figure 5). At least 50% of the O+ migrants had moved out of Lookingglass Creek into the Grande Ronde by the end of August and 90% of the 0+s emigrated by the end of November. In 1965 and 1966 lower peaks occurred again in October. In 1968 downstream migration continued at about the same level from June until October. Based on scale analysis, most of these fish continued to rear in freshwater prior to smolting the following spring (Burck 1974b). Migration of 1+ smolts in Lookingglass Creek peaked in March and April.

Lengths of 0-age chinook were sampled in Lookingglass Creek from 1964-70 (Burck 1966a; 1966b; 1967; 1970). Figure 6 illustrates length-frequency distributions and growth of 0-age chinook in 1970.

Survival rate

Estimates of egg-to-downstream migrant survival of 1965-69 chinook broods in Lookingglass Creek are contained in Table 7. It should be noted that these are not estimates of egg-to-smolt survival since most of the fish were age 0+ when they migrated out of Lookingglass Creek. Additional mortality in the Grande Ronde and Snake Rivers prior to smolting (age l+) could not be determined.

Table 7. Estimated egg deposition, downstream migrants, and survival from egg deposition to outmigration for 1965-69 brood spring chnook in Lookingglass Creek (Burck 1974b).

Brood year	Estimated egg deposition	Estimated number of migrants	95% confidence limits		Per cent survival
1965	354,225	48,800	42,250	55,330	13.8
1966	940,545	97,750	73,300	121,950	10.4
1967	494,430	40,950	33,900	48,000	8.3
1968	482,125	42,200	37,450	46,950	8.8
1969	991,830	63,400	51,650	72,100	6.4

DISEASE HISTORY

No information

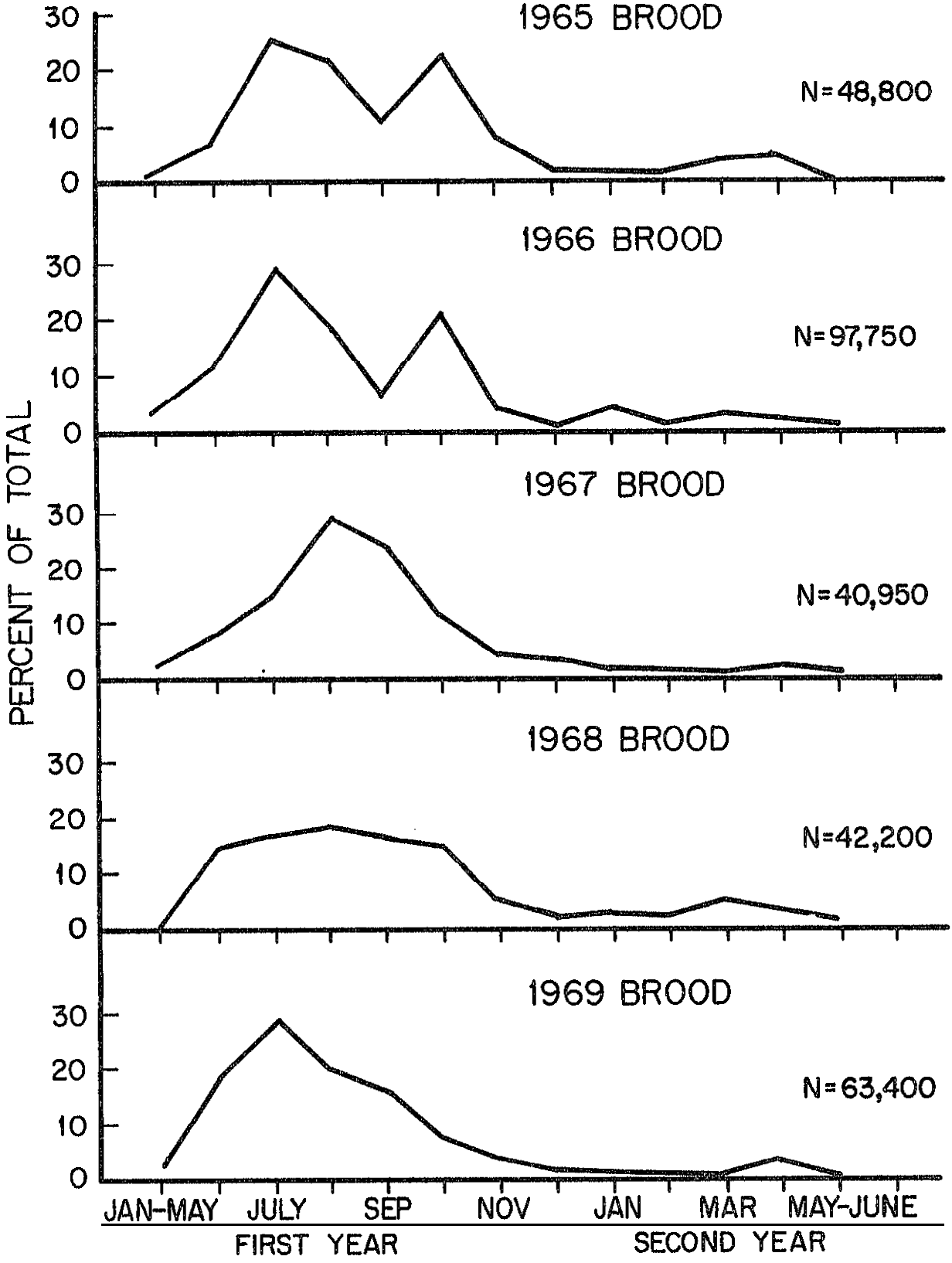

Figure 5. Monthly pattern of downstream migration for five broods of juvenile spring chinook in Lookingglass Creek (Burck 1974b).

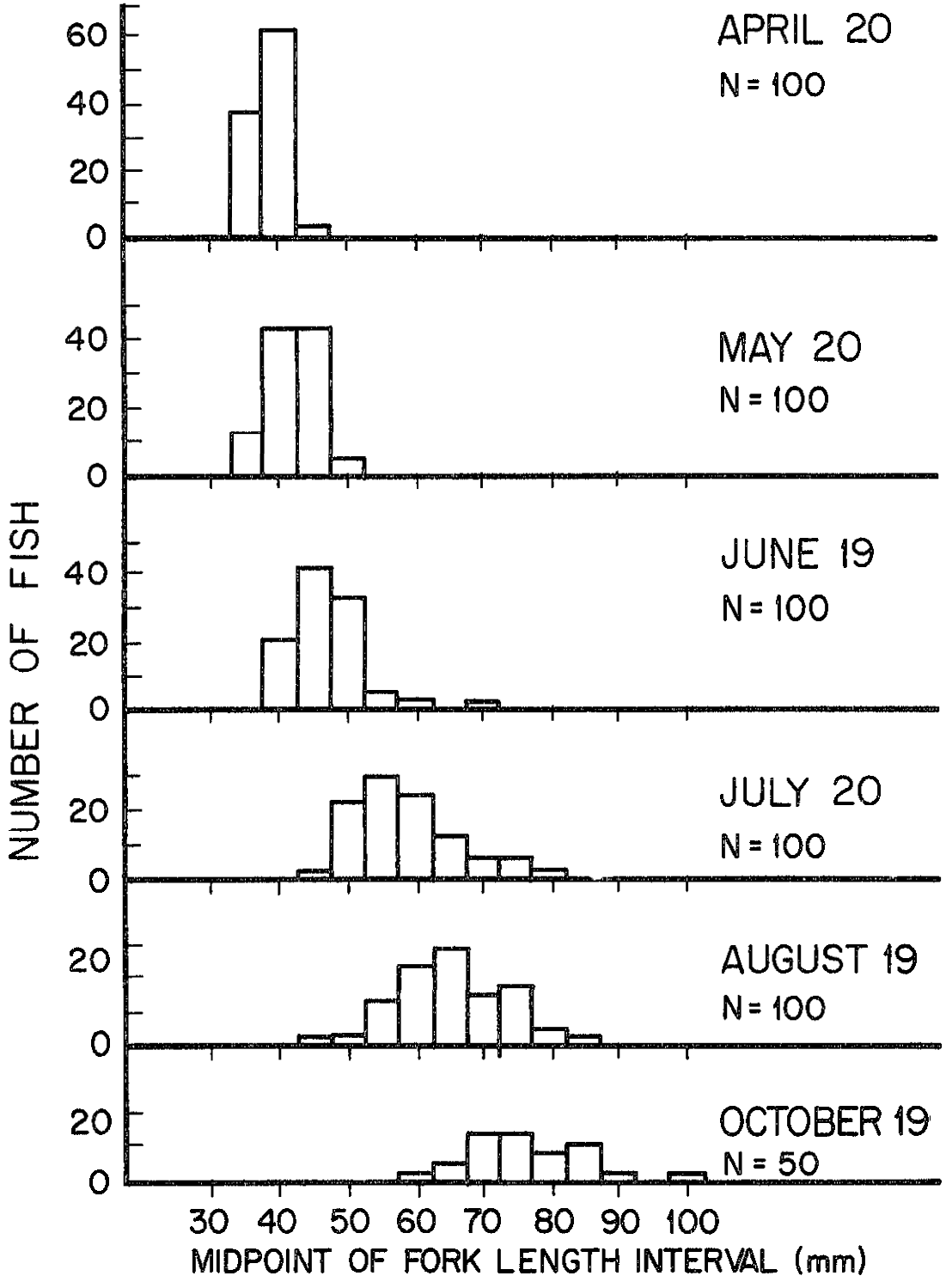

Figure 6. Growth of the 1969 brood spring chinook in Lookingglass Creek, April to October, 1970 (Burck 1970).

PRIORITY INFORMATION NEEDS

1. Improved estimates of run size, catch, and escapement

2. Smolt production levels and capacities, including parr rearing in the mainstem Grande Ronde, Snake, and Columbia

3. Possible genetic differences among tributary populations (suggested by age composition data)

4. Interactions of wild and introduced hatchery stocks

5. Imprinting patterns of juvenile migrants rearing in the mainstem Grande Ronde, Snake, and Columbia rivers

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Grande Ronde River Spring Chinook (hatchery)

PRODUCTION

The Grande Ronde spring chinook hatchery stock is being developed as part of the Lower Snake River Compensation Plan to help maintain and restore the chinook runs in the Grande Ronde system (Carmichael 1984). Approximately 900,000 smolts will be released each year when facilities reach full production (Table 1). Annual releases of presmolts began in 1984 (Table 2).

Table 1. Proposed release sites for spring chinook smolts in the Grande Ronde River system (Carmichael 1984).

Release site	Stock	No. to be released	Type of release
Lookingglass Creek	Carson	400,000	Hatchery ponds
Wildcat Creek	Carson	50,000	Stream
Beaver Creek	Carson	100,000	Stream
Catherine Creek	Carson	100,000	Stream
Big Canyon Creek	Carson	125,000	Advanced rearing ponds
Upper Wallowa	Carson	125,000	Stream
	Total	900,000	

GEOGRAPHIC LOCATION

Streams

Grande Ronde River system (Lookingglass Creek, Wildcat Creek, Beaver Creek, Catherine Creek, Big Canyon Creek, and the upper Wallowa River) (Figure 1)

Hatcheries

Lookingglass Hatchery will produce all spring chinook for release into the Grande Ronde River system. Oxbow and Carson hatcheries have produced other hatchery stocks used to develop the Grande Ronde broodstock (Table 2).

ORIGIN

Since adequate native broodstock was not available, Rapid River (Idaho) stock was initially released into Lookingglass Creek in 1980 (1978 brood) to provide adult returns to the hatchery (Table 2). Because of disease concerns and an inadequate supply of Rapid River eggs, Carson stock fish were released in Catherine Creek and Lookingglass Creek beginning in 1982. Adult trapping at Lookingglass Hatchery began in 1982. The first release of smolts from a

Table 2. Spring chinook releases in the Grande Ronde River system (Carmichael 1984).

Brood year	Stock	Hatchery of rearing	Number released	Date of release	Location of release	Size (fish/lb)
18	Rapid River	Oxbow	418,488	03/11-03/27/80	Lookingglass Creek	8.4
80	Carson	Carson	100,000	04/06/82	Catherine Creek	20.0
80	Carson	Oxbow	460,144	04/04-04/12/82	Lookingglass Creek	9.4
81	Carson	Lookingglass	434,640	04/03/83	Lookingglass Creek	20.0
a2	Carson	Lookingglass	710,621	12/22/83	Lookingglass Creek	31.0
a2	Lookingglass	Lookingglass	9,955	12/22/83	Lookingglass Creek	31.0
82	Lookingglass	Lookingglass	29,650	04/05/84	Lookingglass Creek	31.0
82	Carson	Lookingglass	68,940	12/22/83	Lookingglass Creek	25.0
a2	Carson	Carson	101,870	04/17/84	Catherine Creek	16.7
83	Carson	Oxbow	150,960	05/16/84	Grande Ronde River	148.0
83	Carson	Lookingglass	351,682	06/l8-07/17/84	Grande Ronde River	85.5-141.0
83	Carson	Lookingglass	243,535	07/12-07/13/84	Lookingglass Creek	76.7- 79.1
83	Carson	Lookingglass	382,500	06/13-06/14/84	Catherine Creek	187.5
83	Carson	Oxbow-Lookingglass	171,600	09/11/84	Big Canyon Creek	16.3
83	Carson	Oxbow-Lookingglass	411,400	09/15-09/29/84	Lookingglass Creek	23.5- 32.8
83	Carson	Oxbow-Lookingglass	112,097	11/01/84	Lookingglass Creek	28.3

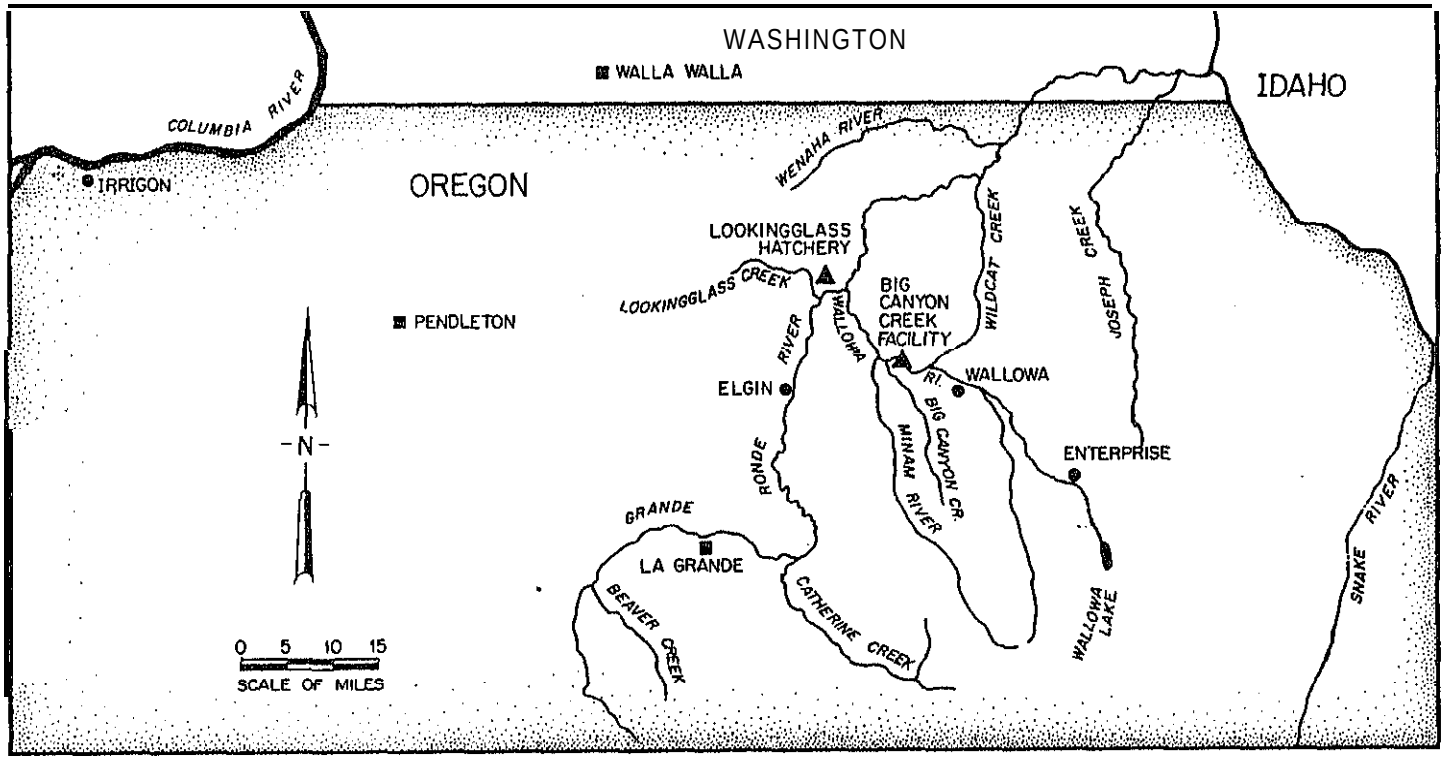

Figure 1. Grande Ronde River, major tributaries, and location of hatchery production facilities.

mixture of eggs from returning Rapid River stock and wild Lookingglass Creek adults was made in 1983. Releases of Carson stock will continue until returns to Lookingglass Hatchery can supply an adequate number of eggs.

ADULT LIFE HISTORY

Run size, catch, and escapement

Returns to Lookingglass Hatchery to date have been negligible. In 1982 and 1984, 44 and 43 adults were trapped; however, the majority of these fish were wild (R. Carmichael, ODFW, personal communication). The first group of spring chinook reared at Lookingglass Hatchery will return as 4-year olds in 1985.

Time of migration

Adults return during June, July, and August.

Spawning period

Grande Ronde spring chinook are spawned in late August through early September.

Spawning areas

Lookingglass Hatchery

Aae composition

No information.

Size

No information.

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Eggs are incubated at Lookingglass Hatchery in 41°-54°F creek and/or well water. Incubation from egg to eyed-egg stage takes 28 days (54°F), eyed-egg to hatch takes 22 days (47°F), and hatch to emergence takes 15 days (41°F).

Time, age, and size at migration

The fry are reared in 50°F water (creek water supplemented with well water). Smolts (l+) have been released from Lookingglass Hatchery in the spring except for the 1982 brood, which were released prematurely due to icing problems in the hatchery (Table 2).

Survival rate

Egg-to-fry survival of 1983 brood spring chinook averaged 92% at Lookingglass Hatchery. Smolt-to-adult survival is unknown.

DISEASE HISTORY

The principal disease affecting spring chinook in Lookingglass Hatchery is BKD (R. Holt, ODFW, personal communication). BKD has been transmitted to chinook in Lookingglass Hatchery through transfer of spring chinook from Oxbow and Bonneville hatcheries. Costia and ENV are also present. ENV is especially common in Carson stock. Eggs are held for viral tests at Lookingglass Hatchery.

PRIORITY INFORMATION NEEDS

1. Disease problems (IHN, IPN) affecting potential stock transfers, particularly Rapid River stock

2. Run size, catch, and escapement

3. Smolt-to-adult survival rate

4. Evaluate performance of the Carson stock in the wild, including smolt production and the migrational pattern of the progeny of Carson stock that spawn in the wild

5. Interactions of hatchery and wild stocks, including monitoring of straying of the Grande Ronde hatchery stock into the Minam and Wenaha rivers, which are being managed for wild production

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Grande Ronde River Fall Chinook (wild)

PRODUCTION

Wild

GEOGRAPHIC LOCATION

Streams

Grande Ronde River and tributaries (Figure 1)

ORIGIN

Fall chinook are indigenous to the Grande Ronde system. A hatchery operating below Minam from 1903 to 1907 produced fall chinook (Thompson and Hass 1960), but there have been no recent releases of hatchery stocks of fall chinook in the Grande Ronde.

ADULT LIFE HISTORY

Run size. catch. and escapement

Early hatchery records indicate that there were once "large numbers" of fall chinook in the Wallowa River. Stout (1957) also reported "good" runs in Joseph Creek in the past. Since that time the stock has been reduced to remnant levels at most, but there appears to be high potential for reestablishment (James 1984).

Suspected fall chinook spawning areas have been inventoried since 1965. No fish or redds have been observed. Dam counts generally describe the decline of fall chinook in the Snake River basin (Table 1).

The Grande Ronde has been closed to all salmon fishing since 1974

Time of migration

Smith (1975) indicated that fall chinook enter the lower Grande Ronde in late October through mid-November and enter the lower Minam early to mid-November.

Spawning period

Smith (19751 reported that spawning occurs from mid- to late November. However, early hatchery records indicate that chinook collected and spawned in the early 1900s attained sexual maturity between September 15 and late October (Thompson and Haas 1960). In 1957 freshly spawned carcasses were found on October 28 and November 1. Redds and carcasses were observed on the Minam on September 22 and October 1, 1958 (Thompson and Haas 1960).

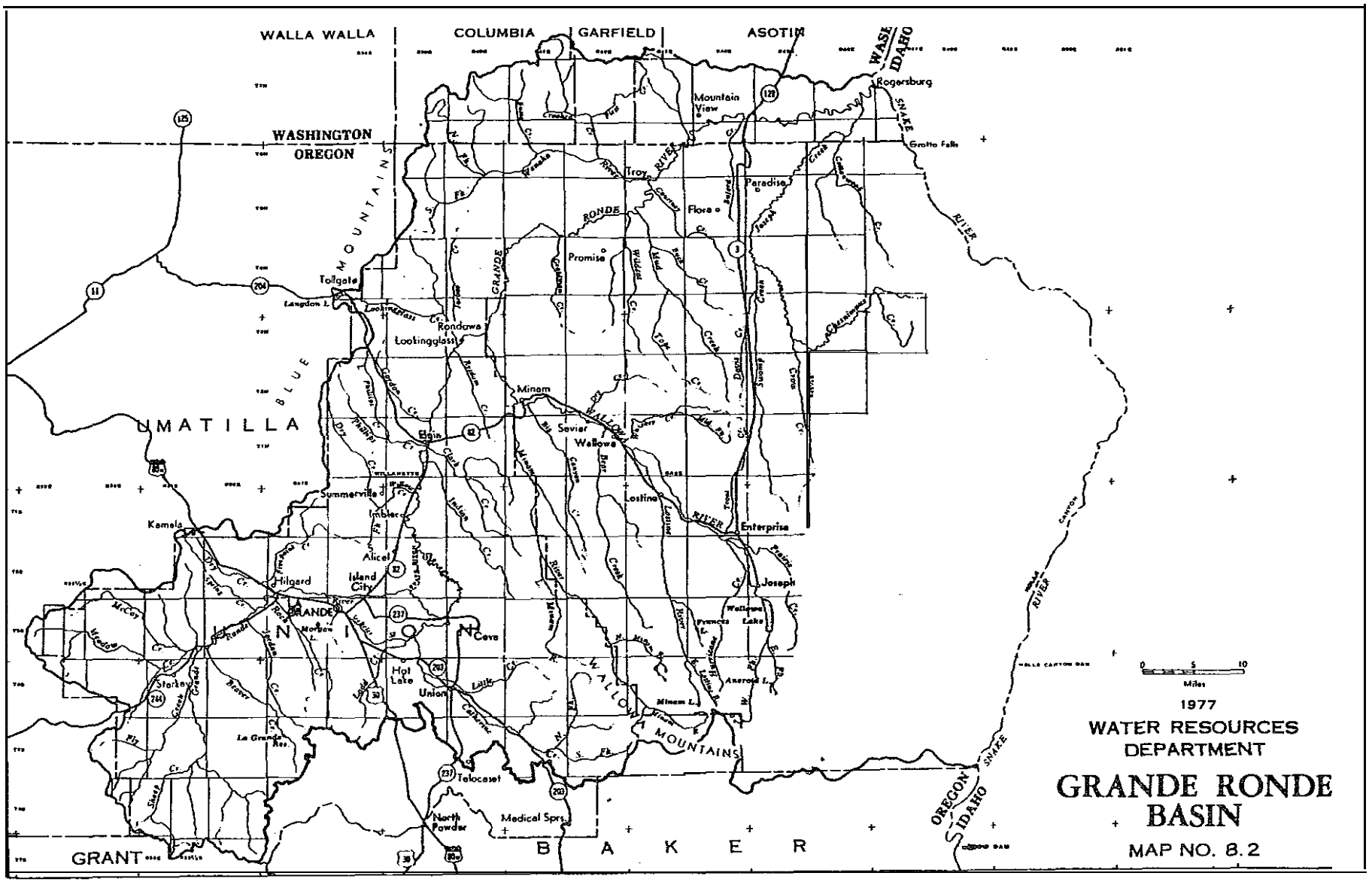

Figure 1. Grande Ronde River Basin.

Table l. Adult and jack counts of fall chinook at four Snake River dams (Jensen 1984).

Year	Ice Harbor		Lower Monumental		Little Goose		Lower Granite	
	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks
1964	9,100	2,000						
1965	8,200	4,200						
1966	12,800	2,200						
1967	14,000	5,000						
1968	19,500	4,900						
1969	13,600	3,900	6,200	1,400				
1970	9,000	1,400	5,300	2,000	4,500	1,800		
1971	9,300	1,700	7,800	2,400	4,700	1,400		
1972	7,500	1,900	4,100	1,100	1,800	530		
1973	6,700	1,600	3,800	1,700	2,400	760		
1974	2,400	410	2,200	860	900	380		
1975	1,900	620	1,800	1,300	900	710	1,000	1,200
1976	1,100	360	1,100	1,000	430	630	470	830
1977	1,200	540	870	1,100	420	840	600	1,300
1978	1,100	500	500	520	490	780	640	850
1979	1,200	810	620	660	550	640	500	940
1980	1,200	590	570	340	500	200	450	330
1981	770	1,300	490	1,100	420	970	340	1,400
1982	1,600	1,900	930	1,400	---[a]	---	720	1,500
1983	1,800	960	800	720	---[a]	---	540	980

[a] After 1981 counts at Little Goose Dam were not differentiated by species.

Spawning areas

Previous spawning areas included the Lostine and Minam rivers, Joseph Creek, and possibly the mainstem Wallowa River (Thompson and Haas 1960).

Age composition

No information.

Size

No information.

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic charactistics

No information.

JUVENILE LIFE HISTORY

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Suitable hatchery stock to reestablish run

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Rapid River Spring Chinook Salmon (Hatchery)

The Rapid River Hatchery spring chinook salmon production program is part of Idaho Power Company's mitigation for the Brownlee, Oxbow and Bells Canyon dams on the mid-Snake River. All facilities and costs of the Program are provided by Idaho Power Company.

PRODUCTION

Rapid River Hatchery's production objective is to stock yearly 2 million smolts into Rapid River at the hatchery and 1 million smolts into the Snake River below Hells Canyon Dam. This satisfies Idaho Power Company's mitigation requirement.

Added value of the hatchery has been to supply spring chinook for other programs. Eggs, fingerlings, or smolts exported from Rapid River Hatchery are listed in the Appendix.

GEOGRAPHIC LOCATIOW

Hatcheries

Rapid River Hatchery, a second order tributary to Salmon River near Riggins, Idaho.

ORIGIN

Transplanted from mid-Snake River at Hells Canyon Dam beginning in 1964. These fish formerly occupied waters above Hells Canyon Dam such as Powder River, Eagle Creek, and Weiser River.

ADULT LIFE HISTORY

Run size, catch, and escapement

This run has the potential for being harvested heavily in the Columbia River as it passes through Zones 1 to 6 in late February to late May. The potential has not been realized, while fisheries were restricted during the 1970's and 1980's.

Tag recoveries from ocean fisheries are sparse, indicating that harvest has been light for the period of 1977 to present.

Locally, the run has been utilized by the Nez Perce Indian Tribe in many years. In the mid to late 1970's the run provided a significant sport fishery on the Little Salmon River.

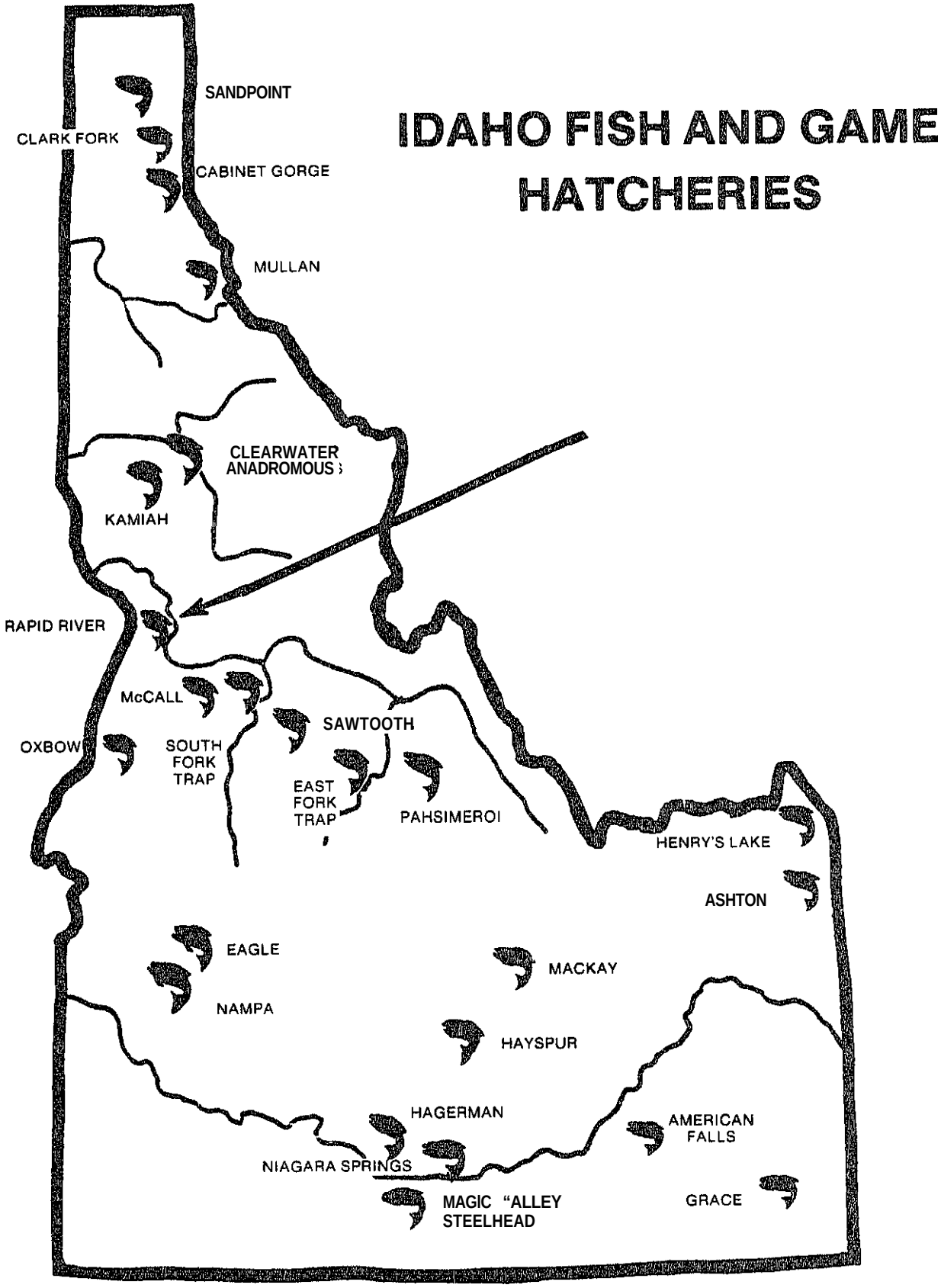

Figure 1. Location of spring chinook hatchery on Rapid River, Idaho.

Time of migration

In the Columbia River there were 63 coded-wire tagged Rapid River spring chinook recovered from 1978 through 1983. These tags were recovered primarily in treaty Indian fisheries in Zone 6 (Bonneville to McNary dams) and in the Oregon-Washington experimental fishery below Bonneville Dam.

Timing of tagged fish recovered below Bonneville (N=27) ranged from February 25 to Nay 24. In Zone 6 tagged fish (N=36) were taken from March 17 to Nay 23 (also, one fish with apparently disoriented homing was taken on September 3, 1981). Although the data are too sparse to demonstrate any peak of timing in the Columbia, we can generalize that the run enters the Columbia in late February through early May and has crossed Bonneville Dam at the end of Nay. Timing through the river below Bonneville Dam appears to precede Zone 6 by about 2 weeks. Data for this analysis were found in Duke (1979, 1982, 1984).

Arrival time at Rapid River Hatchery is earlier in low flow years, such as 1973 and 1977, and later in high flow years such as 1974 and 1975 (Table 1). The extremes of first arrival have been April 25 in 1973 and May 27 in 1975 (Parrish et al. 1974; Parrish 1976). The run has peaked as early as May 23 and as late as July 16 (Parrish et al. 1975; Parrish 1978).

Spawning period

Spawn taking at Rapid River Hatchery has commenced as early as August 7 (Parrish and Wimer 1978; Parrish 1980) and has been completed as late September 18 (Parrish et al. 1973).

Spawning areas

The run is artificially propagated at Rapid River Hatchery (Fig. 1) which is maintained by Idaho Power Company as part of its mitigation program involved with the development of Brownlee, Oxbow, and Hells Canyon dams.

Age composition

Returning adults of the 1966 through 1978 brood years averaged 10.7% 3 years old, 70.7% 4 years old, and 18.6% 5 years old (Table 2). All brood years returned primarily as 4-year-old, 2-ocean fish (range = 55.25 to 88.2%). Data for this analysis were taken from Irizarry (197la, 197lb), Parrish and Hays (1972), Parrish et al. (1973, 1974, 19751, Parrish (1976, 1977, 1978), Parrish and Wimer (1978), Parrish (1980), and Levendofske et al. (1980, 1981, 1983).

Size

Weights of returning adult chinook are not available. Length frequency data of adults for 1974 to 1981 are listed in Table 3.

Sex ratio

The sex ratio of returning adults was recorded for runs in 1978 through 1982. The percentage of females yearly ranged from 53.4 to 58.7; the

Table 1. Timing of arrival of spring chinook salmon adults at Rapid River Hatchery, 1971 to 1980.

Year	Duration of run: First fish	Duration of run: Last fish	Peak of run	Source
1971	05/25	07/25	07/14	Parrish and Rays 1972
1972	05/04	07/17	06/30	Parrish et al. 1973
1973	04/25	07/09	06/07	Parrish et al. 1974
1974	05/25	07/27	07/16	Parrish et al. 1975
1975	05/27	07/28	07/11	Parrish 1976
1976	05/10	07/13	06/22	Parrish 1977
1977	04/30	06/30	05/23	Parrish 1978
1970	05/12	07/18	06/29	Parrish and Wimer 1978
1979	05/15	07/19	06/12	Parrish 1980
1980	05/12	07/23	06/09	Levendofske et al. 1980

Table 2. Age composition of adult spring chinook salmon returning to Rapid River Hatchery, brood years 1966 through 1978.

Brood	Age composition: 3_2	(%)	4_2	(%)	5_2	(%)	Total	(%)
1966	1,090	(15.3)	5,654	(79.6)	362	(5.1)	7,106	(100.0)
1967	888	(16.4)	2,993	(55.2)	1,544	(28.5)	5,425	(100.1)
1960	1,754	(10.4)	10,766	(63.6)	4,403	(26.0)	16,923	(100.0)
1969	943	(6.1)	12,654	(82.4)	1,759	(11.5)	15,356	(100.0)
1970	286	(12.3)	1,654	(71.1)	306	(16.6)	2,326	(100.0)
1971	582	(10.3)	3,973	(70.0)	1,120	(19.7)	5,675	(100.0)
1972	642	(9.9)	5,222	(80.4)	634	(9.8)	6,498	(100.1)
1973	1,765	(16.5)	7,110	(66.3)	1,845	(17.2)	10,720	(100.0)
1974	437	(6.6)	3,807	(57.2)	2,413	(36.2)	6,657	(100.0)
1975	34	(5.0)	590	(88.2)	46	(6.8)	678	(100.0)
1976	350	(20.6)	1,211	(71.1)	142	(8.3)	1,703	(100.0)
1977	432	(11.0)	2,945	(74.9)	557	(14.2)	3,934	(100.1)
1978	176	(4.1)	3,089	(72.0)	1,026	(23.9)	4,291	(100.0)
Average		(10.7)		(70.7)		(18.6)		(100.0)

Table 3. Length frequencies of spring chinook entering Rapid River trap, 1974-81 (Levendofske et al 1981).

Fork length cm	in	1974	1975	1976	1977	1978	1979	1980	1981
33.0	13	0	0	0	0	1	0	1	1
35.6	14	0	0	0	0	0	0	0	0
30.1	15	11	5	4	1	2	4	4	8
40.6	16	27	21	50	12	7	11	19	25
43.2	17	80	93	114	28	1	30	52	47
45.7	18	91	114	311	77	4	61	103	56
48.3	19	75	139	463	115	4	93	120	23
50.8	20	53	114	445	110	2	88	95	14
53.3	21	32	41	233	58	9	39	35	2
55.9	22	59	15	75	19	4	18	18	25
58.4	23	37	31	30	7	16	6	78	54
60.9	24	117	69	40	IO	67	7	178	154
63.5	25	70	126	143	04	240	57	311	455
66.0	26	250	317	361	292	655	69	376	172
68.6	27	379	736	069	079	1,025	75	290	764
71.1	28	423	1,106	1,324	1,848	895	47	137	428
73.7	29	273	920	1,224	2,138	512	40	57	174
76.2	30	159	521	858	1,221	242	88	25	58
70.7	31	100	187	443	648	238	214	7	61
81.3	32	146	110	232	245	362	414	11	58
83.8	33	260	96	217	122	483	525	10	43
86.4	34	376	17	215	92	458	485	11	28
88.9	35	358	51	176	74	303	455	8	10
91.4	36	290	27	151	38	136	291	4	2
94.0	37	190	13	70	26	63	131	0	1
96.5+	38+	131	12	51	37	40	112	2	0
Total run		3,995	5,001	8,107	8.181	5,769	3,360[a]	1,960	3,263

a Total run actually 3,404 fish with 43 fish that died in the trap, which were not measured.

percentage of males (excluding jacks) ranged from 41.3 to 46.6. The combined run for the 5 years contained 56.2% females and 43.8% males (Parrish and Wimer 1978; Parrish 1980; Levendofske'et al. 1980, 1981, 1983).

Fecundity

The number of eggs per female ranged from 3,235 to 4,950 during the 1965 to 1983 period; weighted average fecundity was 3,894 eggs per female (Levendofske et al., 1984).

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Eggs hatch at Rapid River Hatchery in late September through December; swim-up is in late January to early April (Parrish, E., IDFG Bureau of Fisheries, pers comm.).

Time, age, and size at migration

Spring chinook smolt at Rapid River Hatchery are allowed to exit the rearing ponds at their own volition Current. practice is to let emigration occur naturally until mid-April when the remaining smolts are forced from the ponds. The emigration periods from 1969 brood year to 1977 brood year have been in March and April (Table 4).

The average size at release following about 20 months of egg-to-smolt life has ranged from 117 to 138 mm fork length and 28 to 15 per pound (Table 5).

Survival rate

Rapid River Hatchery was designed to rear 3 million smolts. This was achieved first in 1970 (1968 brood year).Stocking was done directly from the hatchery into Rapid River during the period 1966 to 1979. Beginning 1981, 1 million smolts yearly are scheduled to be stocked in the Snake River at Hells Canyon Dam, which reduces the objective for stocking directly into Rapid River to 2 million smolts yearly.

Smolt-to-adult return rates for the 1964 to 1978 brood years ranged from 0.02% to 0.87% (Table 6) (Levendofske et al., in press). Environmental conditions, primarily the size of spring freshet and passage conditions at downriver dams are primary influence on the rate of adult returns.

DISEASE HISTORY

Bacterial kidney disease (BKD) has been a chronic problem with Rapid River spring chinook. Two million smolts were lost to BKD in 1970. The

Table 4 . Emigration periods of Rapid River spring chinook salmon, 1969 to 1977 brood years.

Brood year	Emigration period	Data source
1969	03/21/71- 04/22/11	Parrish and Hays (1972)
1970	03/09/72- 04/28/72	Parrish et al. (1973)
1971	03/23/73- 04/25/73	Parrish et al. (1974)
1972	03/14/74- 04/19/74	Parrish et al. (1975)
1973	03/05/75- 04/17/15	Parrish (1976)
1974	03/06/76 - 04/15/76	Parrish (1977)
1975	03/07/77- 04/19/77	Parrish (1978)
1976	03/13/78- 04/14/78	Parrish and Wimer(1980)
1977	03/12/79- 04/24/79	Parrish (1980)
1978	NA	--
1979	NA	--
1980	NA	--
1981	NA	--

Table 5 . Average size at release for Rapid River Hatchery spring chinook, 1967 to 1981 brood years.

Brood year	Mean fork length (mm)	No/lb.	Data source
1967	118	NA	Irizarry (1971a)
1968	117	24	Irizarry (1971b)
1969	123	21	Parrish and Hays (1972)
1970	128	19	Parrish et al. (1973)
1971	129	17	Parrish et al (1974)
1972	132	18	Parrish et al. (1975)
1973	137	15	Parrish (1976)
1974	125	18	Parrish (1977)
1975	134	16	Parrish (1978)
1976	136	16	Parrish and Wimer (1978)
1977	138	15	Parrish (1980)
1978	136	15	Levendofske et al. (1980)
1979	136	18	Levendofske et al (1981)
1980	111	28	Levendofske et al (1983)
1981	118	22	Levendofske et al. (1984)

Table 6. The percentages of smolts released from Rapid River Hatchery that returned as adults, for brood years 1964 through 1978.

Brood year	Year released	Smolts released (x 1,000)	Total brood year return	% brood year return
1964	1966	588	4,658	0.79
1965	1966-67	480	4,234	0.87
1966	1968	1.460	7,003	0.48
1967	1969	900	5,416	0.60
1968	1970	3,172	16,923	0.53
1969	1971	2,719	15,356	0.56
1970	1972	2,809	2,370	0.08
1971	1973	2,908	5,864	0.20
1972	1974	2,708	6,429	0.24
1973	1975	3,314	10,720	0.32
1974	1976	3,359	6,740	0.20
1975	1977	3,171	678	0.02
1976	1978	2,414	1,978	0.08
1977	1979	2,867	4,057	0.14
1978	1980	2,812	4,291	0.15

procedure used to reduce BKD at Rapid River is to inject adults with erythromycin and water-harden eggs in 2 ppm erythromycin solution.

Next in severity is the malady termed “spring thing,” which is thought to be nutritionally related and reduces survival of early rearing fry.

Other diseases noted at the station include coldwater disease, bacterial gill disease, cataracts, and sunburn (Levendofske et al. 1980, 1983).

Nitrogen bubble damage acquired in the Columbia and Snake rivers has been common with adult fish (2% with evidence in 1977, 23% with evidence in 1978) (Parrish 1980).

Losses due to infectious hematopoetic necrosis (IHN) have not been known or identified. Seven of 31 adults tested positive for IHN virus in ovarian fluid in 1982 (Levendofske et al. 1983).

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Appendix. Summary of eggs, fingerlings and smolts planted from Rapid River Hatchery, 1964-1983.

964 Brood:	887,000	eggs taken.
	580,000	smolts released into Rapid River, 1966.
	22.6/lb.	
1965 Brood:	604,000	eggs taken.
	480,000	smolts released into Rapid River, 1967.
	23.2/1b.	
1966 Brood:	2,296,000	eggs taken.
	1,460,000	smolts released into Rapid River, 1967.
	25.0/lb.	
1967 Brood:	2,055,000	eggs taken.
	900,000	smolts released into Rapid River, 1969.
	24.0/lb.	
1968 Brood:	6,540,000	eggs taken.
	757,376	eyed eggs shipped to Clearwater River drainage batching channels. Nearly 2,000,000 smolt-sized fish were lost to Kidney Disease in early 1970.
	3,172,000	smolts released into Rapid River, 1970.
	20.0/lb.	
1969 Brood:	5,171,697	eggs taken.
	497,000	eyed eggs shipped to Dworshak Nat'1 Hatchery to start Kooskia Nat'1 Hatchery.
	4,300,000	eggs kept at Rapid River.
	2,718,720	smolts released into Rapid River, 1971.
	21.0/lb.	
1970 Brood:	14,560,280	eggs taken.
	4,417,454	green eggs shipped to Sweetwater Eyeing Station for Clearwater reintroduction.
	2,224,119	green eggs shipped to Kooskia Nat'1 Hatchery.
	526,516	green eggs shipped to Hayden Creek Hatchery.
	2,473,983	eyed eggs shipped to Clearwater River drainage hatching channels.
	9,642,072	eggs shipped.
	4,607,736	eggs kept at Rapid River.
Fingerling Plants, 1971:	200,520	planted in the Lemhi River.
	353,970	planted in Decker Pond.
	100,000	transferred to Sandpoint Hatchery.
	654,584	fingerlings planted or transferred.

Appendix (Continued).

Smolts Planted, 1972:	91,800	planted in the Lochsa River.
	2,809,200	released into Rapid River. 19.4/lb.
1971 Brood:	6,038,785	eggs taken.
	600.496	eyed eggs shipped to Hayden Creek Hatchery.
	5,438,289	eggs kept at Rapid River.
Fingerling Plants, 1972:	53,562	planted in the Lemhi River.
	104,300	planted in Red River.
	29,800	planted in Ten Mile Creek (Clearwater).
	44,700	planted in American River.
	14,900	planted in Papoose Creek.
	59,600	planted in Brushy Fork.
	44,700	planted in Fish Creek.
	14,900	planted in Post Office Creek.
	44,700	planted in Squaw Creek (Lochsa).
	61,500	planted in Lochsa River.
	60,000	planted in Ten Wile Creek (Clearwater).
	200,880	transferred to Sandpoint Hatchery.
	174,300	transferred to Decker Pond.
	74,700	transferred to Decker Pond.
	152,305	transferred to Decker Pond.
	1,134,847	total fingerlings planted or transferred.
Smolt Plants, 1973:	197,303	planted in the South Fork of the Clearwater River drainage
		2,908,425 released into Rapid River. 17.0/lb.
1972 Brood:	15,072,604	eggs taken.
	5,256,662	green eggs shipped to Sweetwater Eyeing Station (Clearreintroduction).
	1,881,024	green eggs shipped to Hayden Creek Hatchery.
	1,131,334	eyed eggs shipped to Hayden Creek Hatchery.
	1.293.592	eyed eggs shipped to Red River Hatching Channel.
	9,562,612	total eggs shipped.
	4,878,017	eggs kept at Rapid River.
Fingerling Plants, 1973:	None.	

Appendix (Continued).

Smolt Plants, 1974:	2,707,917	released into Rapid River. 17.5/lb.
1973 Brood:	13,510,464	eggs taken.
	3,915,900	green eggs shipped to Sweetwater Eyeing Statin (Clearwreintroduction).
	1,295,424	green eggs shipped to Hayden Creek Hatchery.
	104,760	green eggs shipped to Hagerman Hatchery.
	502,200	eyed eggs shipped to Crooked River Hatching Channel.
		702,000 eyed eggs shipped to Kooskia National Hatchery.
	806,400	eyed eggs shipped to Hayden Creek Hatchery.
	504,000	eyed eggs shipped to Minnesota for walleye trade.
	7,830,684	total eggs shipped.
	5,302,677	eggs kept at Rapid River.
Fingerling Plants, 1974:	210,734	transferred to Sandpoint Hatchery.
	206,360	transferred to Kooskia National Hatchery.
	36,400	planted in Ten Mile Creek.
	52,080	planted in Ten Mile Creek.
	18,200	planted in Newsome Creek.
	633,000	planted in Lemhi River.
	10,428	planted in Capehorn Creek.
	1,167,202	total fingerlings planted or transferred.
Smolt Plants, 1975:	117,000	planted in the S.F. of the Clearwater River.
	3,373,700	released into Rapid river. 14.8/lb.
1974 Brood:	6,890,186	eggs taken.
	809,400	eyed eggs shipped to Hayden Creek Hatchery.
	407,012	eyed eggs shipped to Indian Creek Hatching Channel.
	1,216,412	total eggs shipped.
	5,203,276	eggs kept at Rapid River.
Fingerling Plants, 1975:	203,500	transferred to Sandpoint Hatchery.
	21,840	planted in Capehorn Creek.
	59,962	planted in Red River.
	30,750	planted in Newsome Creek.
	10,250	planted in Ten Mile Creek.
	1,140,300	planted in the Lemhi River.
	1,466,602	fingerlings planted or transferred.

Appendix (Continued).

Smolt Plants, 1976:	205,700	planted in the S.F. of the Clearwater River.
	3,564,640	released into Rapid River. 18.4/lb.
1975 Brood:	8,503,606	eggs taken.
	2,363,200	green eggs shipped to Sweetwater Eyeing Station (Clearreintroduction).
	252,200	eyed eggs shipped to Mullan Hatchery.
	255,000	eyed eggs shipped to Hayden Creek Hatchery.
	280,659	eyed eggs shipped to Indian Creek Hatching Channel.
	3,151,059	eggs shipped.
	4,906,492	kept at Rapid River.
Fingerling Plants, 1976:	34,000	planted in Ten Mile Creek.
	156,000	planted in the Lemhi River.
	65,960	planted in the S.F. of the Clearwater River.
	206,400	planted in Decker Pond.
	206,400	planted in Decker Pond.
	209,950	transferred to Sandpoint Hatchery.
	36,143	planted in Bear Valley Creek (upper Hayden Creek drain
	914,844	total fingerlings planted or transferred.
Smolt Plants, 1977:	249,750	planted in the S.F. of the Clearwater River.
	3,170,922	released into Rapid River. 15.9/lb.
1976 Brood:	11,492,878	eggs taken.
	1,161,608	green eggs shipped to Mullan Hatchery.
	2,937,994	green eggs shipped to Sweetwater Eyeing Station (Clearreintroduction).
	261,900	eyed eggs shipped to Hayden Creek Hatchery.
	261,900	eyed eggs shipped to Sandpoint Hatchery.
	1,267,208	eyed eggs shipped to Mackay Hatchery.
	6,344,610	total eggs shipped.
	5,009,482	kept at Rapid River.
Fingerling Plants, 1977:	47,008	shipped to the University of Idaho, Fisheries Co-op Unit
	311,850	shipped to Mackay Hatchery.
	104,500	planted in Lo10 Creek.
	501,600	transferred to Red River Pond.
	80,600	planted in the S.F. of the Clearwater River.
	1,045,558	fingerlings planted or transferred.

Appendix (Continued).

Smolt Plants, 1970:	2,413,678	released into Rapid River. 15.7/lb.
1977 Brood:	14,160,330	eggs taken.
	2,633,400	green eggs shipped to Sweetwater Eyeing Station (Clearwater reintroduction).
	2,287,800	green eggs shipped to Kooskia Nat'1 Hatchery.
	2,439,000	green eggs shipped to Mullan Hatchery.
	250,200	eyed eggs shipped to Mullan Hatching.
	288,000	eyed eggs shipped to Hayden Creek Hatchery.
	20,700	eyed eggs shipped to the University of Idaho.
	1,007,340	eyed eggs shipped to the Crooked River Hatching Channel.
	8,926,440	total eggs shipped.
	5,098,587	eggs kept at Rapid River.
Fingerling Plants, 1978:	723,000	transferred to Mackay Hatchery.
	50,800	transferred to Decker Pond.
	200,025	transferred to Red River Pond.
	265,600	planted in the Lemhi River.
	1,239,425	total fingerlings transferred or planted.
Smolts Planted, 1979:	44,373	planted in Newsome Creek.
	156,362	planted in White Sands Creek.
	200,735	total smolts planted.
	3,018,448	released into Rapid River. 15.0/lb.
1978 Brood:	10,026,888	eggs taken.
	767,322	green eggs shipped to Hayden Creek Hatchery.
	970,728	green eggs shipped to Mackay Hatchery (500,000 eyed eggs to be shipped to Oregon).
	1,540,282	green eggs shipped to Sweetwater Eyeing Station (Clearwater reintroduction).
	706,936	green eggs shipped to Dworshak Nat'1 Hatchery.
	38,160	eyed eggs shipped to the University of Idaho.
	10,864	eyed eggs shipped to the University of Idaho (Hayden Creek).
	1,250,010	eyed eggs shipped to the Crooked River Hatching Channel.
	249,969	eyed eggs shipped to Sweetwater Eyeing Station (Clearwater reintroduction).
	5,534,271	total eggs shipped.
	4,219,846	eggs kept at Rapid River.

Appendix (Continued).

Fingerling Plants, 1979:	232,500	transferred to Red River Pond.
	10,000	planted in Ten Mile Creek.
	242,500	total fingerlings planted or transferred.
Smolts Planted, 1980:	157,440	planted in White Sands Creek.
	2,811,593	released into Rapid River. 15.0/lb.
1979 Brood:	5,646,722	eggs taken.
	806,440	eyed eggs shipped to Hayden Creek atchery.
	330,880	eyed eggs shipped to Dworshak Nat,'l Hatchery.
	1,137,280	total eggs shipped.
	4,511,442	eggs kept at Rapid River.
Fingerling Plants, 1980:	293,240	planted in Red River Pond.
Smolt Plants, 1981:	1,001,700	planted in the Snake River at Hells Canyon Dam. 21.0/lb.
	2,375,715	released into Rapid River. 17.9/lb.
	3,377,415	total smolts planted or released.
1980 Brood:	1,756,827	eggs taken.
Fingerling Plants, 1981:	None.	
Smolt Plants, 1982:	1,473,733	released into Rapid River. 28.0/lb.
1981 Brood:	6,122,273	eggs taken.
	608,384	eyed eggs shipped to Pahsimeroi Hatchery.
	256,608	eyed eggs shipped to Oxbow Hatchery (Oregon).
	449,280	eyed eggs shipped to Dworshak Nat'1 Natchery .
	1,314,272	total eggs shipped.
	4,409,036	eggs kept at Rapid River.
Fingerling Plants, 1982:	None.	
1982 Brood:	7,420,450	eggs taken.
	493,346	green eggs shipped to Lookingglass Hatchery (Oregon). These were later shipped to Dworshak Mational Hatchery.
	1,332,000	eyed eggs shipped to Pahsimeroi Natchery.
	375,028	eyed eggs shipped to Dworshak National Hatchery.
	125,055	eyed eggs shipped to Hagerman National Hatchery.
	2,325,429	total eggs shipped.
	4,614,863	eggs kept at Rapid River.

RAPID RIVER SUMMER CHINOOK

PRODUCTION

Rapid River contains a population of wild summer chinook.

GEOGRAPHIC LOCATION

Rapid River, tributary to the Little Salmon River. Rapid River enters the Little Salmon River four river miles south of Riggins, Idaho. The Little Salmon River enters the Salmon River at Riggins. The main stem Rapid River is 21 miles long (Mallet 1974).

ORIGIN

The summer chinook run is indigenous to Rapid River. A spring chinook fish cultural station, Rapid River Hatchery, exists on Rapid River three miles from the mouth. The spring and summer runs of chinook have been maintained separately by segregating fish at the Rapid River weir and fish trap. The timing and appearance of fish are tbe basis for segregation. Spring chinook are retained at the hatchery while summer chinook are allowed to proceed upriver for natural spawning (Parrish E., IDFG, Bureau of Fisheries, pers. comm.).

Early reports referred to the natural Rapid River run as spring chinook. However, Reingold (1966) found that the run had typical summer chinook timing.

ADULT LIFE HISTORY

Run size, catch and escapement

Periodically, run sizes have been estimated or determined by trapping and have ranged from under 100 to over 400 (Table 1).

The spawning escapement objective for the Salmon River subbasin from the mouth to and including the Little Salmon River is 500 natural spawning summer chinook (IDFG 1985). An objective specifically for Rapid River is not identified.

Time of migration

Generally, Idaho summer chinook enter the Columbia River in June and July (Bjornn 1960). Trapping in Rapid River shows the run arriving in July, August and September (Table 1).

Spawning period

Bjornn (1960) reports Idaho summer chinook spawning occurring in September. No information is available specific for the Rapid River run.

Spawning areas

No information.

Age composition

Age groups were recorded for the 1965 and 1969 runs as they were counted through the hatchery's upstream trap. Jacks and four-year-old fish predominated (Table 2).

Size

Reingold (1966) used the following criteria for the age:size relationship:

3_2, under 24 in. fork length
4_2, 24 to 33 in. fork length
5_2, over 33 in. fork length

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age and size at migration

No information.

Survival rate

No information.

DISEASE HISTORY

No information

PRIORITY INFORMATION NEEDS

1. Electrophoretic analysis and comparison to the hatchery-reared Rapid River spring chinook.

2. Juvenile life history information.

Table 1. Rapid River summer chinook run size and spawning escapements.

Year	Run Size	Reported duration of run	Data sources
1952	294[a]	ND	Annon. (1953)
1953	87[a]	ND	Hauck (1954)
1965	437	7/1 to 9/15	Reingold (1966)
1969	215	7/23 to 8/31	Irrizarry (1971a)
1970	426	7/23 to 8/31	Irrizarry (1971b)
1974	200	7/27 to 8/16	Parrish et al. (1975)
1975	112	7/29 to 8/20	Parrish (1976)
1976	322	7/13 to 8/1	Parrish (1977)
1977	186	6/30 to 8/1	Parrish (1978)
1982	62	8/10 to 8/25	Levendofske et al. (1983)
1983	86	7/29 to 8/19	Levendofske (1984)

a Sport harvest reduced the spawning escapement estimate to 144 and 27 in 1952 and 1953, respectively. In other years, run size equals spawning escapement.

Table 2. Summer chinook salmon age composition at the Rapid River trap, 1965 and 1969.

Age	Number of fish 1965[a]	Number of fish 1969[b]	Total	(%)
3_2	223	77	300	(46.0)
4_2	177	75	252	(38.7)
5_2	37	63	100	(15.3)
Totals	437	215	652	100.0

a Reingold (1966).
b Irrizarry (1971a).

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RED RIVER REARING POND SPRING CRINOOK

Red River Rearing Pond is a low technology rearing facility located on the grounds of the USDA, Forest Service, Red River Ranger Station. It is a two-acre pond with a uniform five-foot depth, constructed in 1976 as a cooperative project of the Pacific Northwest Regional Commission, Forest Service and Idaho Department of Fish and Game. Mitchell Act funds have supported the operation in most years.

The pond uses water diverted from Red River. It is operated as a "finishing" pond, with early rearing being done at other facilities. Fish have usually been liberated as pre-smolts in the fall; however, the comparative ability and effectiveness of overwintering fish for release in the spring is being evaluated.

PRODUCTION

Yearly releases have ranged from 40,000 to 350,000 fish (Table 1).

GEOGRAPHIC LOCATION

Red River Rearing Pond is located at the confluence of the mainstem and South Fork of Red River. Red River is a second-order tributary to the Clearwater River, Idaho.

ORIGIN

Rapid River spring chinook have been used in six of the seven years of operation of the rearing pond. Carson National Fish Hatchery stock was used for the 1980 brood year (Lindland 1984).

ADULT LIFE HISTORY

Run size, catch and escapement

No definitive data for the size of adult runs are available yet. Returning adults have been mixed with a natural run.

Coded-wire tag recoveries to date indicate a light harvest in Columbia River fisheries (Table 2). No fisheries in Idaho have been authorized since adults have been returning to this project.

Time of migration

The few tag recoveries to date show typical timing for Columbia River upriver spring chinook (Table 2).

Spawning period

Artificial spawn taking in 1984 occurred from August 7 to September 5. Only 49 females were spawned and there was no discernible peak period of ripeness (IDFG Bureau of Fisheries file data). The fish spawned were a mixture of natural and pond-reared fish.

Table 1. Production of spring chinook at Red River Rearing Pond, 1977 to 1984 (Lindland 1984).

Brood year	Release year	Number released	Date released	Number/ lb
1976	1977 (fall)	350,000	8/20	ND
1977	1978 (fall)	200,000	9/21	ND
1978	1979 (fall)	225,000	9/28	27
1979	1980 (fall)	265,000	9/18	25
1980	1981 (fall)	268,000	9/10	17
1981	1982 (fall)	0	NA	NA
1982	1983 (fall)	260,000	10/20	21
1982	1984 (spring)	40,000	4/17	ND

Table 2. Columbia River coded wire tag recoveries for Red River rearing pond spring chinook [Duke 1984, Duke personal communication).

Brood year	Recovery location	Recovery date	Tag code
1918	Section 8	3/16/82	102112
1978	Zone 6	4/13/82	102112
1978	Zone 6	5/01/82	102112
1978	Zone 1	2/28/83	102112
1978	Zone 6	4/01/83	102112
1918	Zone 4	4/28/83	102112
1979	Zone 1	2/22/84	102127
1979	Zone 2	3/04/84	102127

Spawning areas

When donor stocks have been used spawning has been at those hatchery locations. Fish of the 1983 brood year were progeny of adults returning to the Red River facility. It is planned that the facility will utilize only such "Red River" stock.

Aae composition

No information.

Size

No information

Sex ratio

No information.

Fecunditv

Forty-nine females, spawned artificially in 1984, yielded an average of 4,432 eggs per female (IDFG Bureau of Fisheries file data.) (These were a mixture of natural and pond-reared fish).

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Incubation and early rearing has usually been done at. Rapid River Hatchery, where swim-ups are ponded in April or May (personal communication Neil DeGuilio, IDFC Bureau of Fisheries).

Time, age and size at migration

See Table 1 for all release dates and pound counts for four release groups. No information is available on age at migration although it may mirror that of the donor stocks.

Survival rate

Estimated in--pond survival rates range from 70 percent to nearly 100 percent (Lindland 1904). Smolt-to-adult survival estimates are not available

DISEASE HISTORY

Fish ponded in 1977 developed a heavy infestation of Ichthyophthirius sp. which may have been aggravated by unusually low flow and high temperatures that occurred in 1977 in Red River.

PRIORITY INFORMATION NEEDS

1. Establish best time for release.

2. Determine carrying capacity of pond, including in-pond survival in relation to loading density.

3. Determine smolt-to-adult survival.

4. Obtain a health profile of fish during rearing and at release.

5. Determination as to whether a different stock of chinook (e.g., summer chinook) may be more effective or desirable for this program.

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South Fork Salmon River Summer Chinook

PRODUCTION

The summer chinook population of the South Fork Salmon River (SFSR) is a mixture of hatchery and natural production. Summer chinook for stocking the SFSR are reared at McCall Hatchery (Fig. 1). McCall Hatchery was constructed and is operated as a part of the Lower Snake River Fish and Wildlife Compensation Plan. The hatchery was completed in 1980 and designed to provide a yearly release of 1 million smolts at a total poundage of 61,300 (Partridge 19841. The number of smolts released yearly has ranged from 122,200 to 269,900 (Table 11. Rearing of the 1984 brood year is the first to reach the designed capacity of the hatchery.

GEOGRAPHIC LOCATION

Streams

Summer chinook are native to the SFSR drainage. The principal streams in the system are the mainstem South Fork, the East Fork of the South Fork, Johnson Creek and the Secesh River. The South Fork enters the Salmon river 215 km above the Snake River (Fig. 2).

Hatcheries

Supplemental hatchery rearing is done at McCall Hatchery, approximately 50 road miles from the South Fork.

ORIGIN

The stock is virtually native to the SFSR; however, some transfers of outside stocks occurred in the first 3 years of the hatchery program, as follows :

1. Brood year 1978 - brood stock was trapped at Little Goose Dam on lower Snake River.

2. Brood year 1979 - brood stock was trapped at Lower Granite Dam on lower Snake River.

3. Brood year 1980 - brood stock was obtained 50% at Lower Granite Dam and 50% from SFSR.

4. Brood year 1981 and later - brood stock taken entirely from SFSR.

ADULT LIFE HISTORY

Run size, catch and escapement

Runs into the SFSR drainage in the early 1960's ranged from about 5,600 to 10,200. Sport harvest reached a maximum of nearly 4,000, and spawning escapement peaked at over 6,200 in 1960 (Table 2).

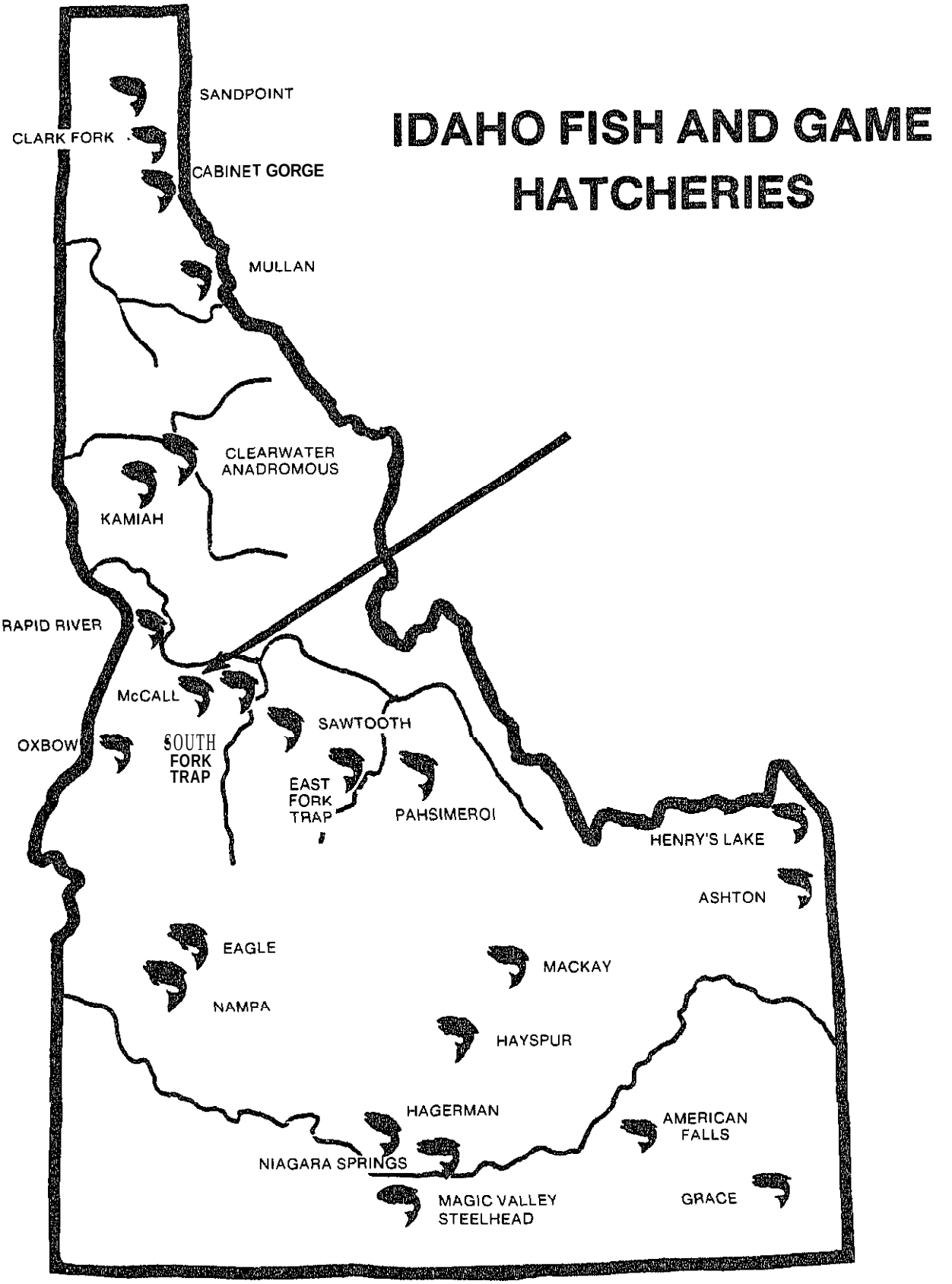

Figure 1. Location of the McCall Hatchery.

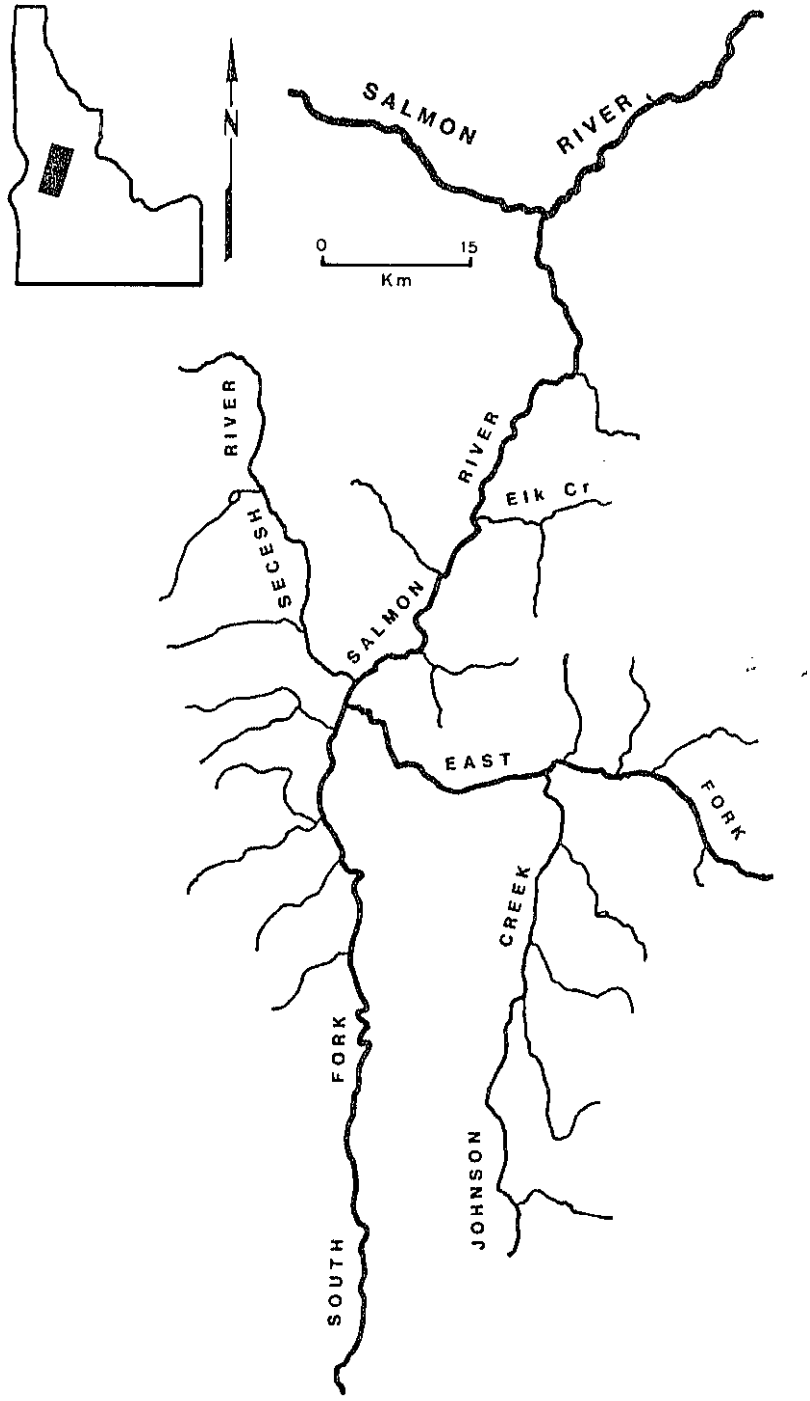

Figure 2. South Fork Salmon River drainage, Idaho.

Table 1. Yearly numbers of summer chinook reared at McCall Hatchery and released into the South Fork Salmon River (Partridge 1984).

Brood year	Number of smolts released	Number/lb
1978	124,800	13.0
1979	248,926	17.5
1980	122,247	17.8
1981	183,896	20.3
1982	269,880	15.6

Redd counts available for the drainage since 1957 show that the run peaked in the late 1950's and early 1960's and reached a low in 1979 (Table 3) (Pollard 1985).

The spawning escapement objectives for the SFSR drainage are 1,500 for hatchery requirements and 7,000 for natural spawning (IDFG 1984).

Coded-wire tag returns from brood years 1976 and 1982 show some fish taken in the Columbia River sport and Indian fisheries, as well as the British Columbia troll fishery (Table 4).

Time of migration

Columbia River fishery coded-wire tag recoveries have occurred from March 31 to July 7 (Table 4).

At a counting weir located approximatelp mid-length on the SPSR from 1964 through 1967 the first fish of the run were seen to arrive as early as June 29 and as late as July 19. Peak daily counts occurred during the first 2 weeks of the run (Ortmann 19681.

Adult salmon tagged at Bonneville Dam from June 6 to July 7, 1966 were later recovered at the SFSR weir (N=23). In 1967, chinook tagged at McNary Dam from May 20 to July 16 later appeared at the SFSR weir. Mean travel time was 33 days from Bonneville Dam and 26 days from McNary Dam (Ortmann 1968).

Spawning period

Ortmann and Richards (1964) reported spawning in the Stolle Meadows area of the upper SFSR peaking the last few days of August, while below Stolle Meadows spawning peaked in mid-September.

Artificial spawning at the egg-taking facility in 1981 occurred from August 11 to September 15 (Hutchinson 1982).

Spawning areas

Major spawning areas are present in the South Fork proper above the mouth of the East Fork, in the upper Secesh River and Lake Creek (tributary to the Secesh River) and in the lower portion of Johnson Creek (tributary to the East Fork) (Richards 1963).

For the McCall Hatchery operation, adults are held for spawntaking at a weir and trap on the mainstem SFSR near Warm Lake. Some spawners are not trapped for spawntaking but allowed to proceed into the upper SFSR for natural spawning. Also, major spawning areas exist downstream of the trapping facility.

Age composition

Yearly age composition of the population can be extremely variable (Fig. 3) (Ortmann 1968).

Table 2. Estimated run size, harvest and spawning escapement for South Fork Salmon River drainage [a] summer chinook, 1960 to 1964.

Year	Harvest	Spawning escapement	Estimated run
1960 [b]	3,937	6,259	10,169
1961 [c]	1,746	3,903	5,649
1962 [d]	2,853	4,420	7,273
1963 [e]	1,753	3,924	5,677
1964 [f]	1,709	NA	NA

a Includes mainstem SFSR, Secesh River, East Fork of South Fork and Johnson Creek.
b Richards 1961.
c Ortmann and Richards 1964[a].
d Ortmann and Richards 1965.
e Ortmann 1964.
f Ortmann 1966.

Table 3. Summer chinook redd counts for South Fork Salmon, Secesh River, Lake Creek and Johnson Creek, 1957 to 1984.

Year	Number of redds	Year	Number of redds
1957	3,505	1971	684
1958	1,983	1972	884
1959	1,884	1973	931
1960	3,347	1974	346
1961	1,463	1975	317
1962	2,176	1976	326
1963	1,486	1977	334
1964	1,615	1978	455
1965	906	1979	171
1966	1,230	1980	160 [a]
1967	700	1982	224 [a]
1968	700	1982	213 [a]
1969	1,013	1983	346 [a]
1970	720	1984	203 [a]

[a] Reduced by trapping for spawntaking.

Table 4. Coded-wire tag recoveries for McCall Hatchery summer chinook (excluding SFSR hatchery rack returns) (Duke 1984).

Brood year	Recovery location	Recovery date	Tag code
1976	Dworshak NFH	9/ - /80	100323
1976	Dworshak NFH	9/18/80	100323
1976	Zone 6	6/10/80	100323
1976	Zone 6	6/12/80	100323
1976	Zone 6	6/18/80	100323
1976	Zone 6	6/18/80	100323
1976	Zone 6	6/22/80	100323
1976	Cowlitz Hatchery	8/27/80	100323
1976	B.C. troll	6/13/80	100323
1976	B.C. troll	6/23/80	100323
1976	Zone 6	3/31/81	100323
1976	Sherars Falls	7/10/81	100323
1976	Pelton Dam	7/23/81	100323
1976	Pelton Dam	8/31/81	100323
1976	Pelton Dam	8/31/81	100323
1976	Pelton Dam	9/09/81	100323
1982	Col. R. sport	5/29/83	102412
1982	Col. R. sport	7/07/83	102412
1982	Col. R. experimental	5/27/82	102413
1982	Col. R. experimental	6/08/82	102413
1982	Col. R. sport	6/21/83	102413
1982	Col. R. sport	6/08/83	102413

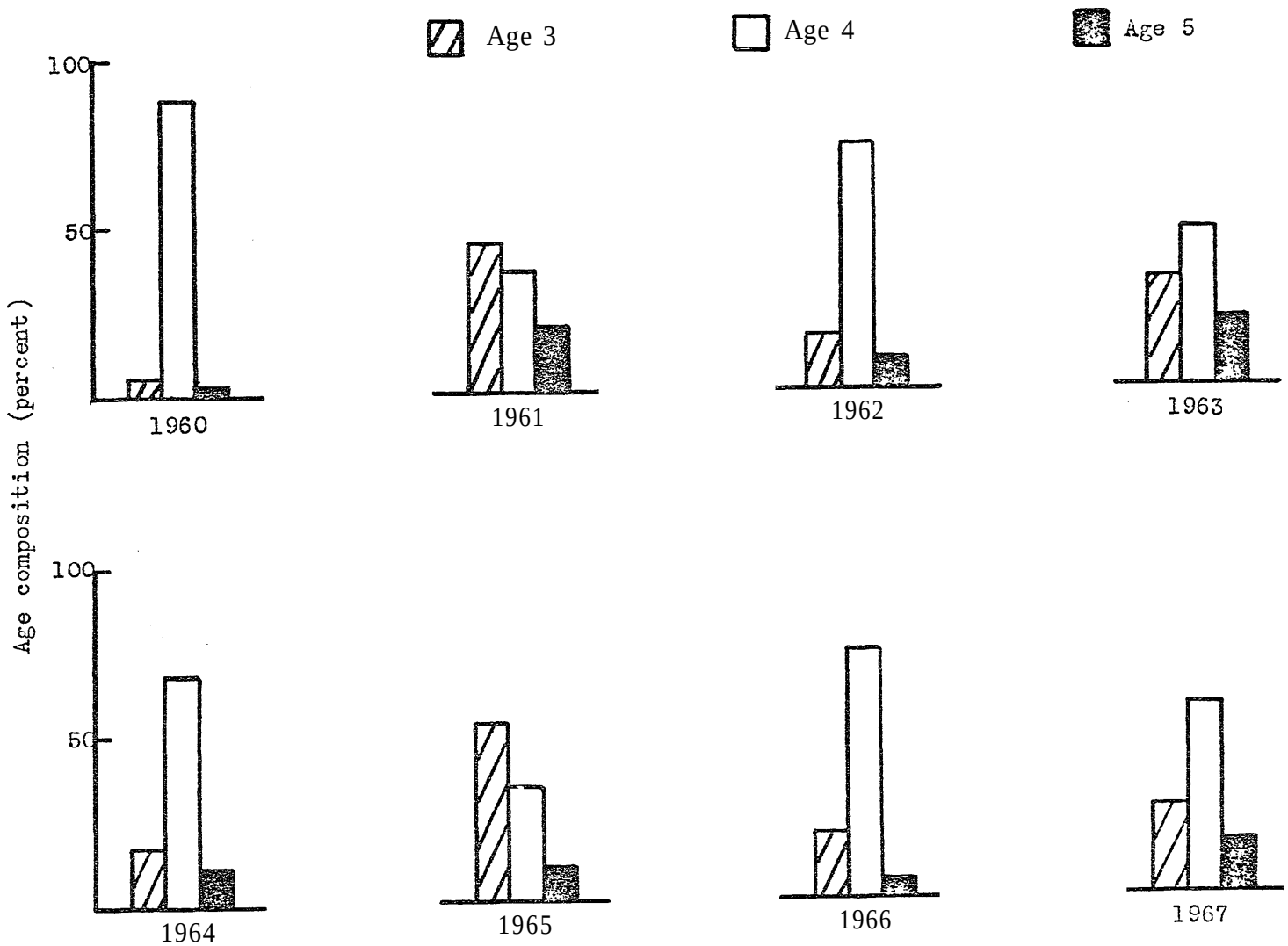

Figure 3. Percentage age composition of summer-run chinook salmon according to spawning ground surveys, South Fork of the Salmon River, 1960-1967.

Size

Wimer (1980) and Hutchinson (1982) report length frequency of chinook trapped at the spawntaking facility in 1981 and 1982 (Fig. 4, 51.

Sex ratio

SFSR chinook are principally a 4-year-old spawning race. Sex ratios lean heavily toward males due to the presence of jacks (Table 5) (Ortmann 1968).

Fecundity

3,685 eggs/female in 1980 (Wimer 1980)
3,895 eggs/female in 1981 (Hutchinson 1982)
4,412 eggs/female in 1982 (Hutchinson 1983)
4,170 eggs/female in 1983 (Hutchinson 1984)
4,338 eggs/female in 1984 (IDFC file data)

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Chinook in the SFSR emerge from the gravel in April and May (Ortmann 1968).

Time, age, and size at migration

No information is available for the naturally-produced population. With hatchery releases these factors are artificially controlled.

Survival rate

In-hatchery survival rates are presented in Table 6. Hatchery smolt-to-adult survival rate information is not available.

No information is available for survival rates of SFSR naturally-produced chinook.

DISEASE HISTORY

An as-yet undiagnosed malady termed “spring thing” has been a chronic problem with summer chinook at McCall Hatchery (Hutchinson 1984). Spring thing was responsible for the loss of about 20% of the 1982 brood year.

Bacterial kidney disease was found in the 1982 brood year. Although no serious losses occurred due to BKD, it is considered a serious threat (Hutchinson 1984).

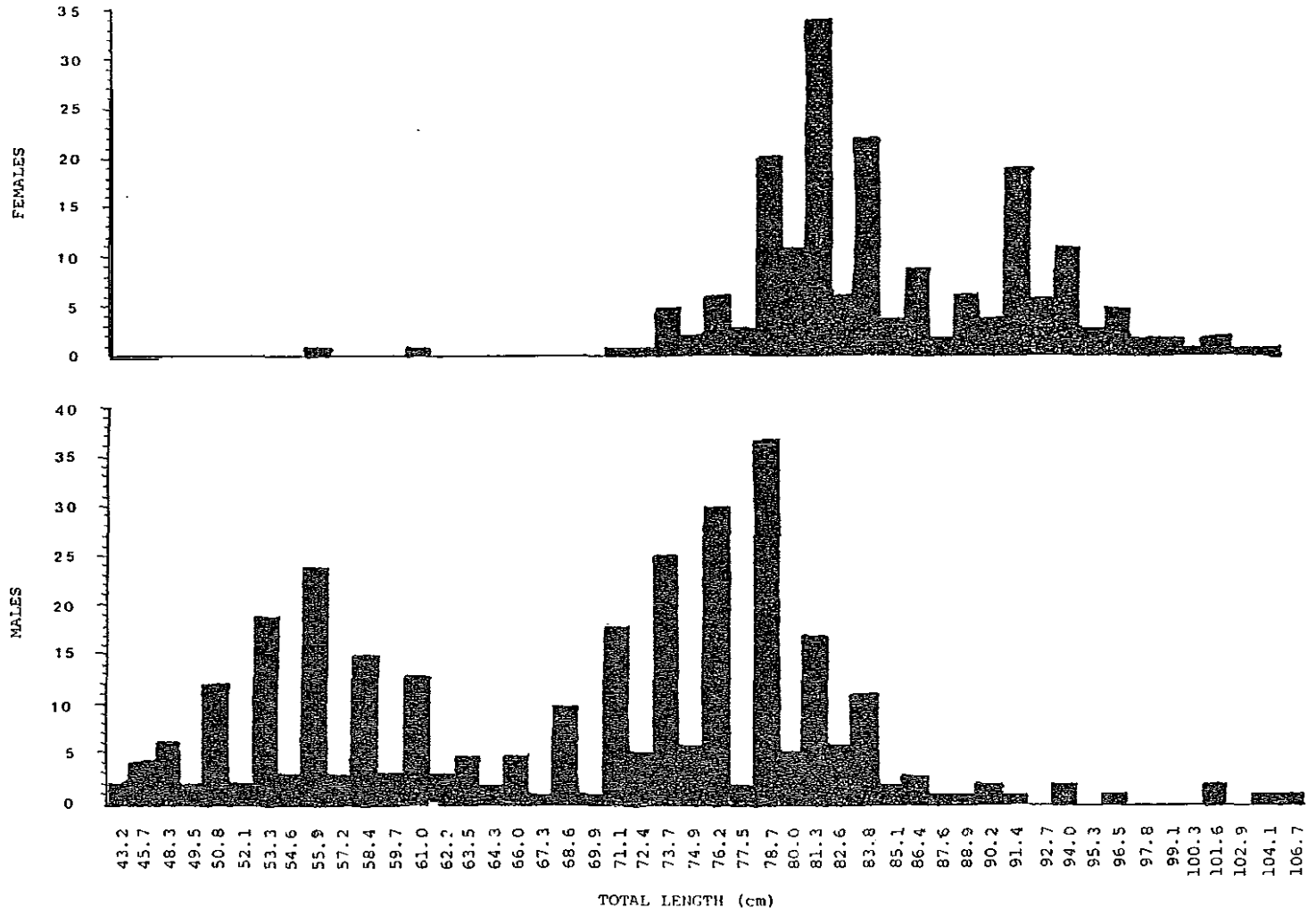

Figure 4. Length frequency of adult chinook trapped at South Fork Salmon River, 1981.

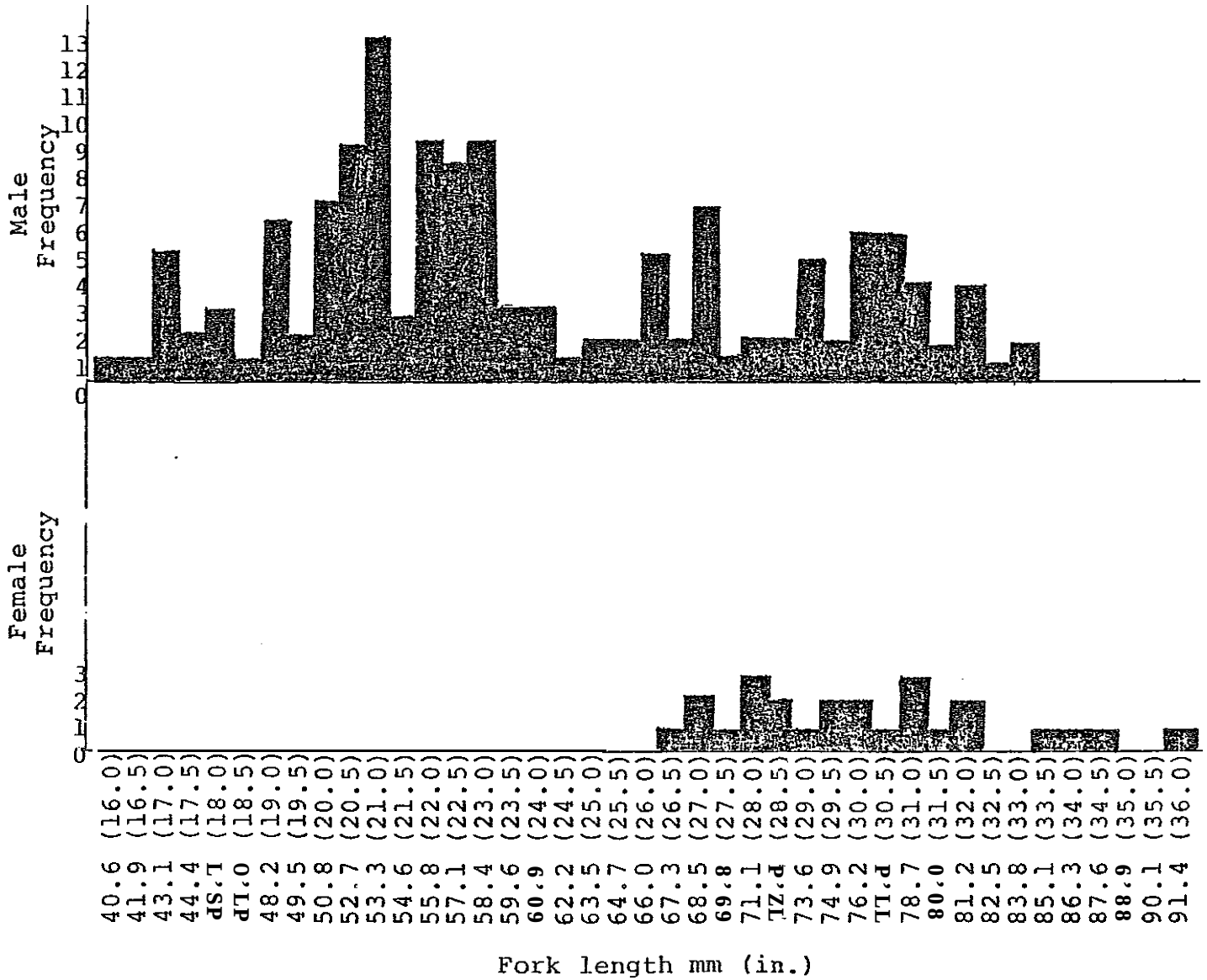

Figure 5. Length frequency of salmon spawned, salvaged, or released after ponding.

Other diseases of record with McCall Hatchery summer chinook are:

Trichophvra sp.
Pseudomonas sp.
Bacterial gill disease
Nutritional gill disease
Costia sp.
Gas bubble disease
Bexamita sp.
Aeromonas sp.

PRIORITY INFORMATION NEEDS

Hatchery

1. "Spring thing" disease diagnosis and control.
2. Smolt-to-adult survival rate.

Natural

1. Egg-to-smolt survival rate.
2. Smolt-to-adult survival rate.
3. Spawning escapement requirements

Table 5. Sex ratios reported tor South Fork Salmon River summer chinook.

Year	Males (%)	Females (%)
1964	60	40
1965	78	22
1966	62	38
1967	59	41

Table 6. In-hatchery survival rates for South Fork Salmon River summer chinook, McCall Hatchery [a].

Brood year	Eye-up (%)	Green egg to smolt (%)
1980	67	NA
1981	73	38
1982	82	42
1983	92	NA
1984	76	NA

a IDFG file data.

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Middle Fork Salmon River Spring Chinook

PRODUCTION

The Idaho Department of Fish and Game (IDFG) Draft Anadromous Fish Management Plan requires that the Middle Fork of the Salmon River be managed for natural production of wild indigenous stocks of chinook (IDFG 1984).

GEOGRAPHIC LOCATION

Streams

Located in central Idaho, the Middle Fork enters the main Salmon River at river mile 198.5. The drainage area encompasses 2,830 square miles and is largely included within the Frank Church River of No Return Wilderness area (Annon. 1965).

The mainstem Middle Fork is 106 miles long, all of which is used by spring chinook for some phases of its life cycle (Mallet 19741.

Mallet (1974) lists 28 middle Fork tributaries that contain chinook.

Hatcheries

None.

ORIGIN

The Middle Fork spring chinook stock is native, no transfers of fish into the drainage have occurred. A minor amount of spring chinook were transferred to the Selway River in the early 1960's. The numbers of females trapped for spawntaking were: 89 in 1961, 34 in 1962 and 69 in 1963 (Welsh 1961, 1963; Welsh et al. 1964).

ADULT LIFE HISTORY

Run size, catch and escapement

No data are available on run size. Estimated harvests for the IO-year period ending in 1978 are listed in Table 1. No fishing season for chinook has been provided since 1978.

Redd counts are made annually in selected stream reaches as a spawning escapement trend indicator. Redd counts are on record since 1957 and range from 98 in 1982 to 2,261 in 1957 (Table 2).

Table 1. Estimated sport harvest of spring chinook salmon from Middle Fork of the Salmon River, 1969 to 1970.

Year	Harvest	Data source
1969	1,906	Keating (1970)
1970	802	Keating (1971)
1971	687	Mallet (1972)
1972	937	Mallet (1973)
1973	1,216	Ortmann (1974)
1974	349	Ortmann (1975)
1975	0	Ortmann (1978)
1976	0	Ortmann (1977)
1977	404	Ortmann (1978)
1978	1,724	Ortmann (1979)

Table 2. Middle Fork Salmon River drainage spring chinook redd counts, 1957-1984 (Pollard 1985).

Year	Bear Valley Creek	Elk Creek	Marsh Creek Drainage	Sulphur Creek	Upper Big Creek	Totals
1984	55	27	60	0	42	184
1983	56	38	33	8	27	162
1982	39	9	40	3	1	98
1981	60	23	63	7	22	175
1980	15	8	9	2	4	38
1979	69	49	47	15	5	195
1978	1984	208	270	64	95	a21
1977	129	86	98	5	9	327
1976	76	61	48	14	22	221
1975	215	169	201	50	77	712
1974	130	108	210	30	20	506
1973	387	369	518	78	96	1,448
1972	221	212	312	71	60	876
1971	108	173	281	58	32	652
1970	334	302	456	93		1,185
1969	356	349	235	138	90	1,168
1968	574	483	466	142	90	1,755
1967	445	420	650	134	67	1,716
1966	534	525	406	142	127	1,734
1965	301	203	404	43	75	1,026
1964	576	425	709	97	51	1,858
1963	460	654	372	332	181	1,999
1962	484	426	345	169	231	1,655
1961	675	384	546	239	382	2,226
1960	386	346	316	79	159	1,206
1959	381	516	95	100	96	1,188
1958	341	410	262	131	140	1,284
1957	791	398	450	381	233	2,261

Time of migration

By the first week of July, chinook are usually seen jumping at Dagger Falls at the head of the Middle Fork (Ortmann, D., IDFG Bureau of Fisheries, pers. comm.1.

Spawning period

Ortmann and Richards (1964) report spawning peaking in Middle Fork tributaries in late August and finishing by early September.

Spawning areas

Spawning is documented in the following Middle Fork drainage streams (Mallet 1974):

1. Middle Fork mainstem
2. Big Creek
3. Rush Creek
4. Cabin Creek
5. Monumental Creek
6. Snowslide Creek
1. West Fork Monumental Creek
8. Crooked Creek
9. Beaver Creek (Big Creek)
10. Camas Creek
11. Loon Creek
12. Warm Spring Creek
13. East Fork Mayfield Creek
14. Marble Creek
15. Indian Creek
16. Pistol Creek
17. Little Pistol Creek
18. Rapid River
19. Sulphur Creek
20. Marsh Creek
21. Beaver Creek (Marsh Creek)
22. Cape Horn Creek (Marsh Creek)
23. Knapp Creek
24. Bear valley Creek
25. Elk Creek

Age composition

Middle Fork drainage spring chinook spawners appear to have 4-year-old males and 5-year-old females predominating (Fig. 10 (Bjornn et al. 1964).

Size

Kelt measurements in 1961 and 1962 show the following approximate breakdown by age and sex (Figs. 2 and 3) (Bjornn et al. 19641:

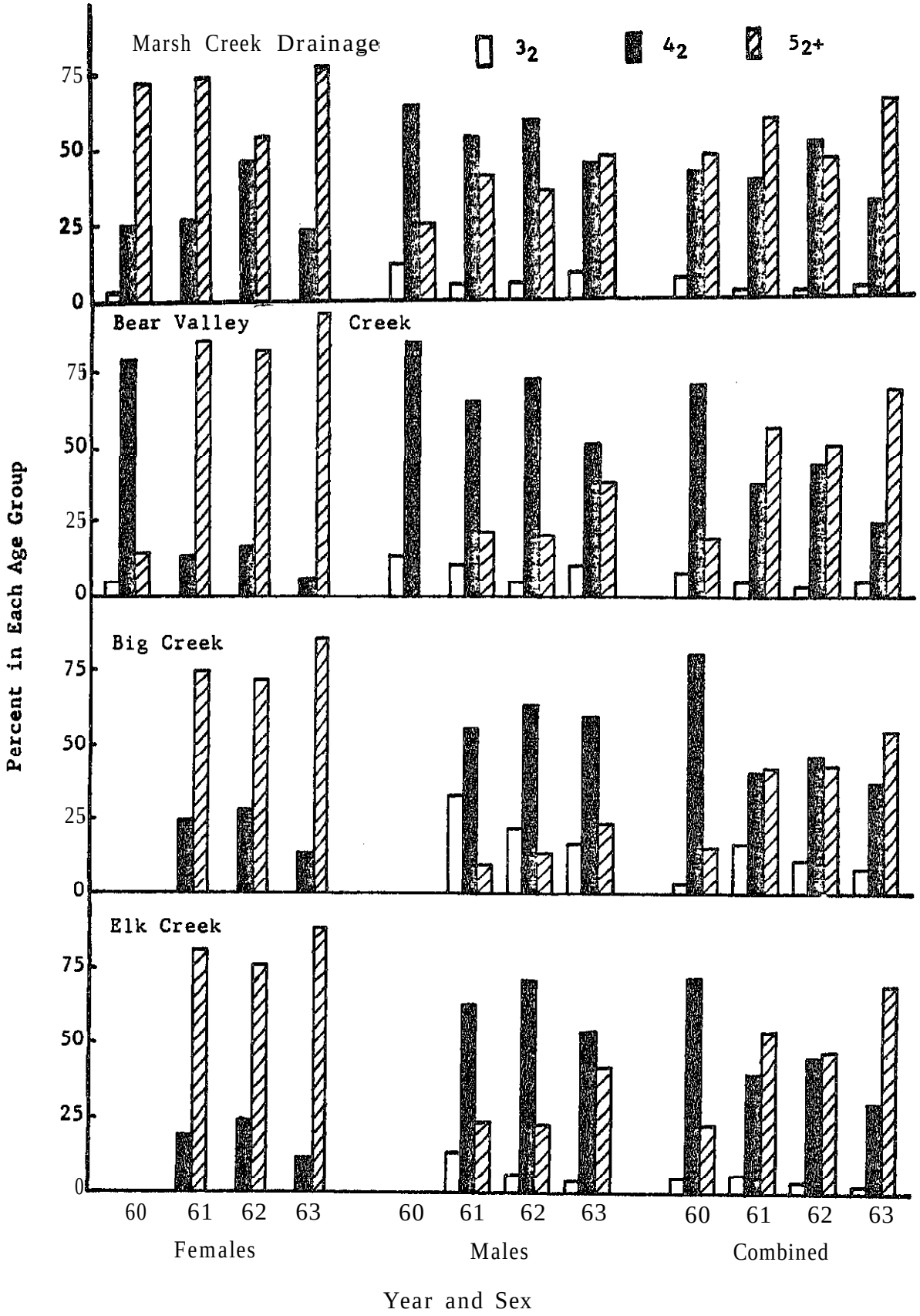

Figure 1. Age composition of Middle Pork Salmon River drainage kelts, 1960 to 1963 (Bjornn et el. 1964).

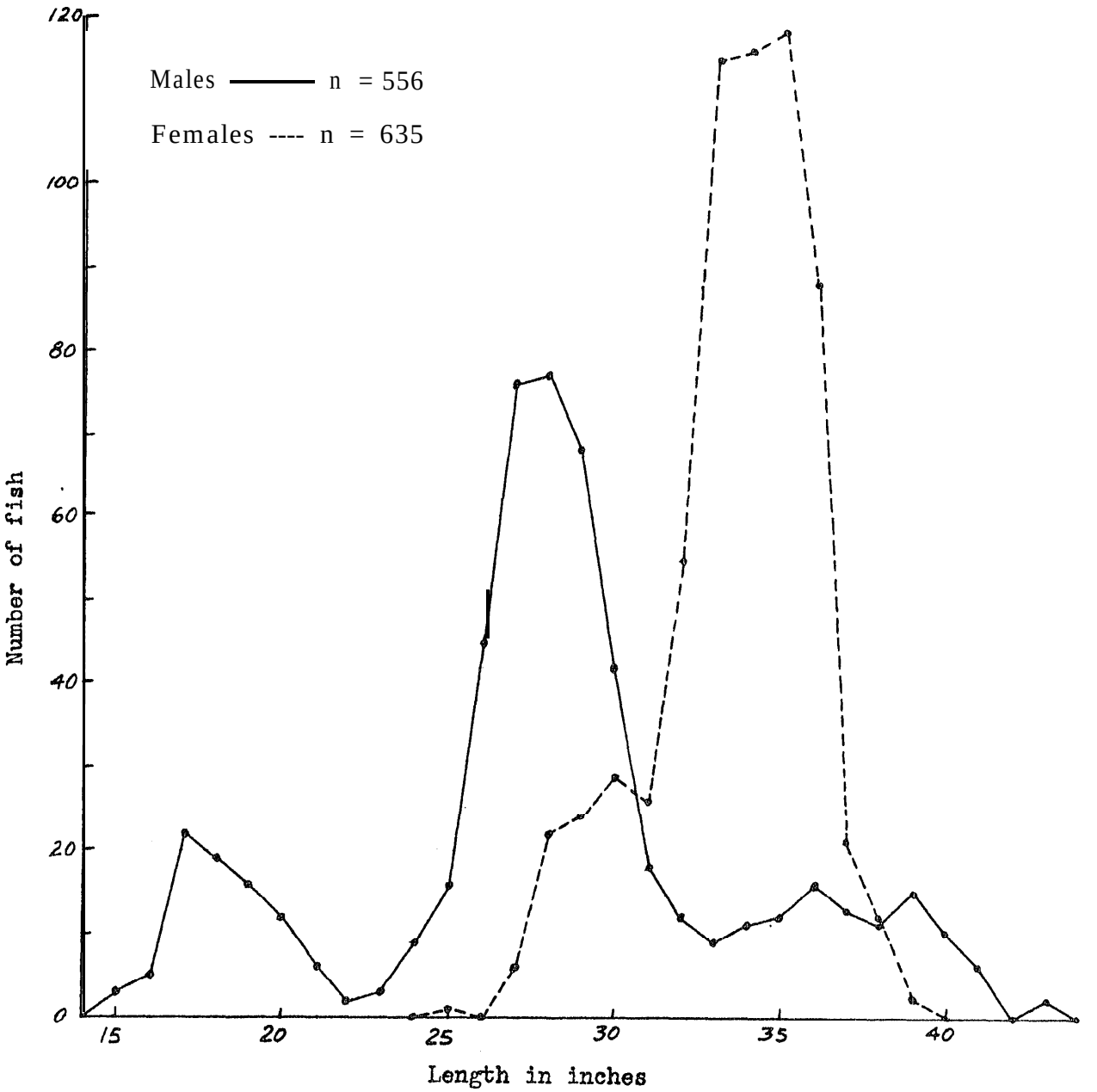

Figure 2. Fork length distribution of chinook found dead on spawning grounds, by sex, Bear Valley, Upper Big and Elk creeks combined, 1961, (Bjornn et al. 1964).

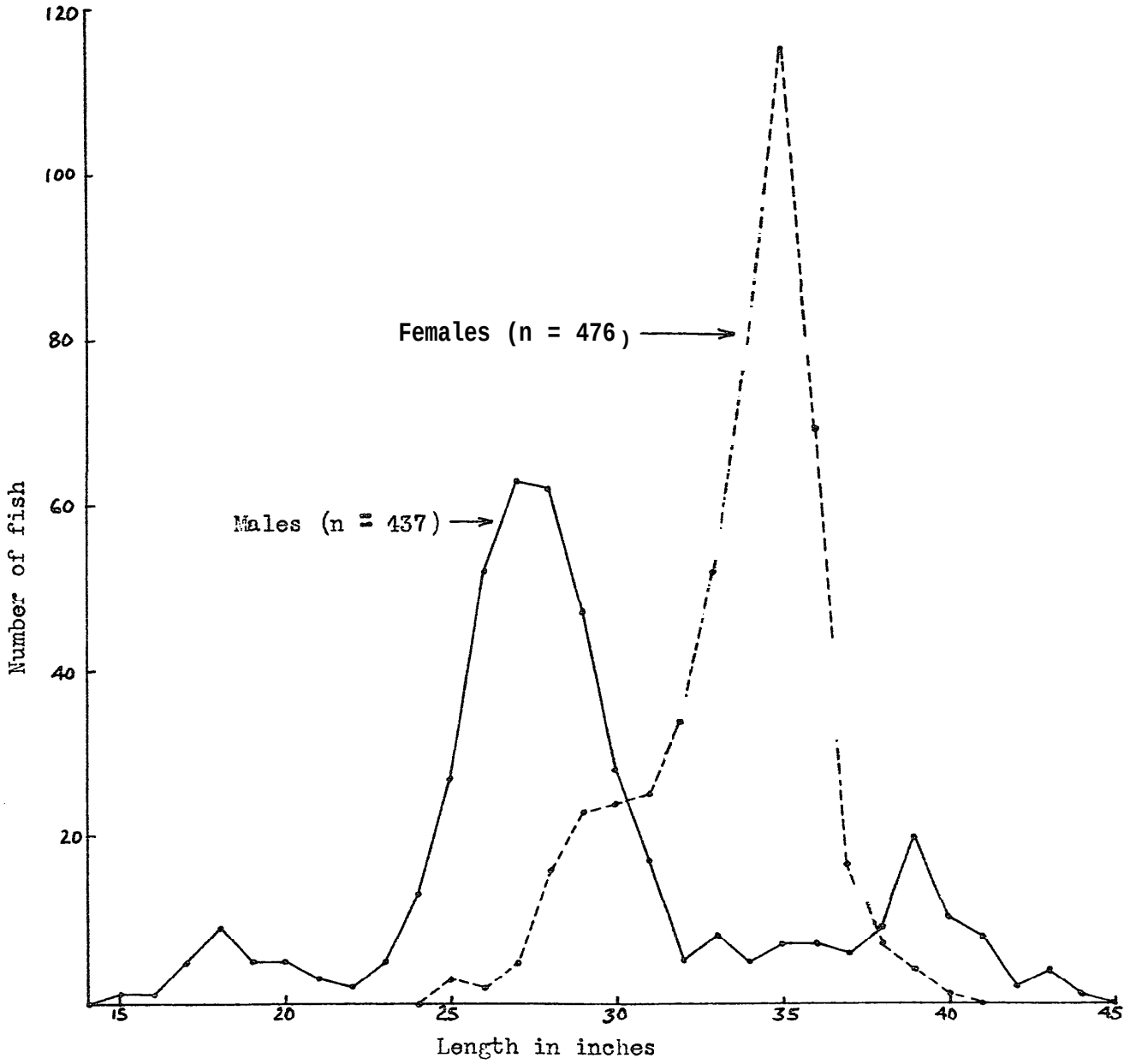

Figure 3. Fork length frequency distribution 0% chinook found dead on spawning grounds, by sex, Bear Valley, Big and Elk creeks, 62 (Bjornn et al. 1964).

	Males	Females
3^2	16-22 in.	
4^2	22-32 in.	25-32 in.
5^2	32-44 in.	32-40 in.

Sex ratio

Spawning ground sampling in 1961 through 1964 indicated male-to-female sex ratios ranging from 0.7:1 to 1.0:1 (Table 3) (Bjornn et al. 1964).

Fecundity

In spawntaking operations, Welsh et al. (1963) reported 5,511 eggs per female for 34 females and Welsh (1964) reported 5,839 eggs per female for 69 females. These were Bear Valley Creek and Elk Creek fish .

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time. age and size at migration

Migration to the ocean is in the spring of the second year of life at a length of 4 to 5 inches (Bjornn 1960).

Survival rate

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Continued monitoring of status of the stock.

2. Continued monitoring of the effectiveness of habitat rehabilitation projects being done under the Northwest Power Planning Council's Fish and Wildlife Program.

Table 3. The ratio of male to female chinook salmon examined on spawning grounds of the Salmon River drainage 1961, 1962, 1963 and 1964 (Bjornn et al. 1964).

Stream area	1961	1962	1963	1964
Harsh Creek Drainage				
Age-class 3_2	--	--	--	--
Age-class 4_2	0.5:1	1.1:1	0.4:1	0.4:1
Age-class 5_2	0.9:1	0.6:1	0.6:1	0.5:1
	. :	0.9:1	. :	. :
Bear Valley Creek				
Age-class 3_2	males	males	males	males
Age-class 4_2	3.8:1	4.3:1	6.7:1	2.1:1
	0.2:1	0.2:1	0.3:1	0.4:1
Age-class 5_2	0.8:1	1.0:1	0.8:1	0.9:1
Big Creek				
Age-class 3_2	males	males	males	males
Age-class 4_2	2.3:1	2.3:1	3.7:1	1.7:1
			0.3:1	0.1:1
Age-class 5_2	0.1:1	0.2:1	1.0:1	0.7:1
	1.0:1	1.0:1		
Elk Creek				
Age-class 3_2	males	males	males	males
Age-class 4_2	3.1:1	2.3:1	3.5:1	2.4:1
Age-class 5_2	0.3:1	0.2:1	0.3:1	0.3:1
	0.9:1	0.8:1	0.7:1	0.8:1

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Upper Salmon River Spring Chinook

Beginning in 1985 with the completion and start-up of Sawtooth Hatchery, spring chinook in the upper Salmon River area (East Fork Salmon river and waters upstream) will be managed as a natural stock supplemented with hatchery production of that same stock. Sawtooth Hatchery was constructed in 1984 as part of the Lower Snake River Fish and Wildlife Compensation Plan.

PRODUCTION

The stock will be mixed hatchery and natural. The planned production at Sawtooth Hatchery is 2.3 million smolts and 1.1 million fingerlings (Table 1).

Some preliminary hatchery production has occurred in anticipation of the development of Sawtooth Hatchery (Table 2).

GEOGRAPHIC LOCATION

Naturally produced spring chinook occur in streams throughout the upper Salmon River drainage.

For purposes of management, the Salmon River drainage from the headwaters downstream to and including the East Fork constitutes this unit.

Hatchery stocking has been done from Mackay and McCall hatcheries (Table 2). Future stocking will be done from Sawtooth Hatchery, located 6 miles south of Stanley, Idaho, on the mainstem Salmon River.

ORIGIN

Except for stocking of Rapid River stock in three areas in 1977 through 1979, spring chinook in the upper Salmon River area are native fish (Table 2).

ADULT LIFE HISTORY

Run size, catch and escapement

Redd counts since 1957 on important spawning streams provide an index to run size and spawning escapement (Table 3).

The spawning escapement objectives for this portion of the Salmon River Basin are for 2,400 hatchery and 7,200 natural spawners (IDFG 1985).

Spring chinook catch data for the 1970 to 1978 period are available for the mainstem Salmon River from the East Fork upstream. This river reach encompasses the heart of the Salmon River fishery and provided catches up to about 2,000 per year in that period (Table 4). No open fishing season for salmon has been provided since 1978.

Tabl e 1. Proposed distribution summary for Sawtooth Hatchery spring chinook (IDFG 1985).

Stream	Number of smolts	Number of fingerlings
Upper Salmon River	1,300,000	0
East Fork Salmon River	700,000	200,000
Valley Creek	100,000	0
Yankee fork	200,000	200,000
Slate Creek	0	100,000
Stanley Basin tributaries	0	600,000
Total	2,300,OOO	1,100,000

Table 2. Spring chinook stocking summary for Sawtooth Hatchery production area, 1977 to 1984.

Brood Year	Year released	Receiving stream	No. of smolts	No. of fingerlings	Rearing facility	Stock origin	Reference
1977	1977	E. Fk. Salmon R.		100,170	Rapid R. Hatchery	Rapid River	Ortmann (1979a)
1916	1977	W. Fk. Yankee Fk.		56,700	Rapid R. Hatchery	Rapid River	Ortmann (1979a)
1977	1978	Upper Salmon R.	985,400	607,750	Mackay Hatchery	Rapid River	Ortmann (1980)
1978	1979	Upper Salmon R.	1,012,300		Mackay Hatchery	Rapid River	Ortmann (1981)
	1980	No releases made					
	1981	No releases made					
	1982	No releases made					
1981	1983	Redfish Lake Cr.	167,900		McCall Hatchery	Upper Salmon R.	IDFG file data
1982	1984	Redfish Lake Cr.	230,550		McCall Hatchery	Upper Salmon R.	IDFG file data

Table 3 . Upper Salmon River drainage spring chinook redd counts, 1957-1984 (Pollard 1985).

Year	Alturas Lake Creek	Upper East Fork	Upper Salmon River	Upper Valley Creek	Upper Yankee Fork	Totals
1984	3[a]	NC[b]	71a	6	NC	80
1983	27[a]	121	161a	8	0	317
1982	9[a]	28	42[a]	1	0	80
1981	4[a]	76	363[a]	2	16	461
1980	7	7	47	6	0	67
1979	29	56	205	25	18	333
1978	303	841	1,707	141	60	3,052
1977	85	168	698	NC	6	975
1976	16	75	370	189	40	509
1975	60	348	509	127	60	1,166
1974	42	346	338	127	54	907
1973	153	665	414	125	104	1,461
1972	143	448	740	182	115	1,636
1971	50	370	619	89	89	1,217
1970	68	468	432	202	67	1,237
1969	41	174	313	350	53	931
1968	110	622	637	330	234	1,933
1967	74	614	943	253	250	2,134
1966	119	511	699	219	112	1,660
1965	101	138	472	204	77	992
1964	80	405	706	199	146	1,536
1963	86	646	638	141	128	1,639
1962	138	334	638	157	60	1,327
1961	30	818	813	227	192	2,080
1960	33	122	720	83	43	1,001
1959	18	223	502	24	10	777
1958	107	427	535	75	38	1,182
1957	110	572	1,118	225	47	2,072

[a] Reduced by trapping at Sawtooth.
[b] Reduced by trapping at East Fork weir.

Table 4. Estimated yearly sport catches of spring chinook in mainstem Salmon River upstream of East Fork, 1970 to 1978.

Year	Catch	Data source
1970	1,963	Keating (1971)
1971	1,013	Mallet (1972)
1972	1,175	Mallet (1973)
1973	2,263	Ortmann (1974)
1974	431	Ortmann (1975)
1975	season closed	NA
1976	season closed	NA
1971	525	Ortmann (1978)
1978	1,782	Ortmann (1979b)

Time of migration

Salmon River spring chinook enter the Columbia River in March, April and Way (Bjornn 1960).

Sawtooth Hatchery trapping records show chinook arriving at the hatchery in June through August (IDFG Bureau of Fisheries file data).

Spawning period

Spring chinook spawning in the Salmon River occurs in August and early September (Bjornn 1960). The peak of artificial spawning at the Sawtooth weir in 1982 was August 23 (IDFG Bureau of Fisheries file data).

Spawning areas

Wallet (1974) refers to chinook spawning in the following streams:

Salmon River mainstem
East Fork Salmon River
Rerd Creek
Big Lake Creek
Big Boulder Creek
Germania Creek
Chamberlain Creek (tributary to Germania Creek)
West Pass Creek
West Fork of East Fork
Squaw Creek
Slate Creek
Warm Springs Creek
Yankee Fork
West Fork of Yankee Fork
Lightning Creek
Jordan Creek
Eight Wile Creek
Eleven Mile Creek
Big Casino Creek
Valley Creek
McKay Creek
Basin Creek
Stanley Creek
Elk Creek
Trap Creek
Redfish Lake Creek
Fourth of July Creek
Alturas Lake Creek
Beaver Creek
Smiley Creek

Age composition

Spawning ground kelt sampling in the early 1960's showed 5-year-old fish predominating, especially among female fish (Fig. I).

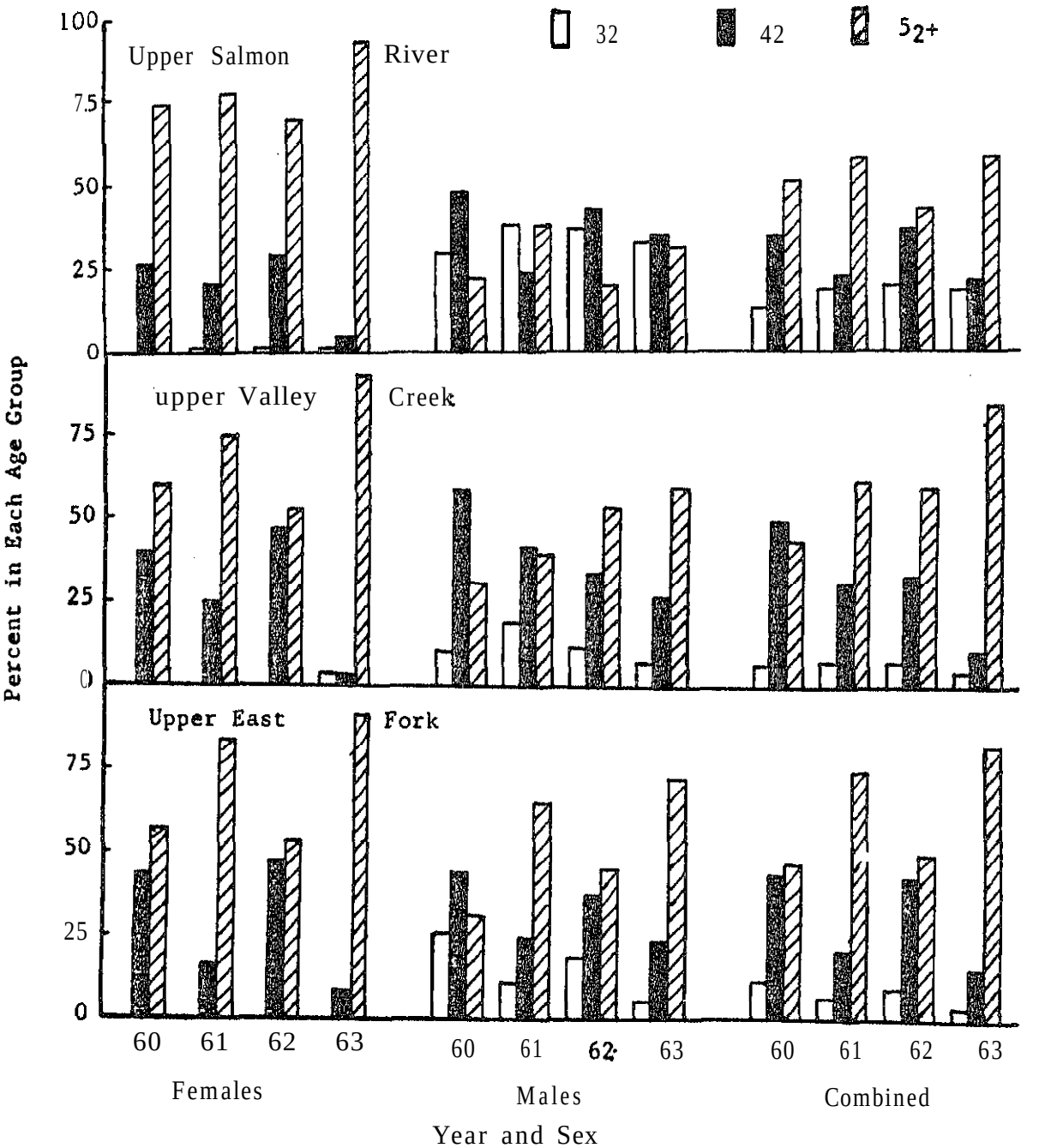

Figure 1. Percent age composition of upper Salmon River Basin spring chinook kelts, 1960 to 1963 (Bjornn et al. 1964).

Size

The length-at-age breakdown used by IDFG for upper Salmon River Basin spring chinook is:

Age	Fork Length
3_2	<24 in.
4_2	24 to 32 in.
5_2	>32 in.

The length frequencies of kelts in 1963 and 1964 are listed in Tables 5 and 6.

Sex ratio

Se% ratio samples for upper Salmon River Basin kelts in 1961 to 1964 were generally near equal (Table 7).

Fecundity

For 369 females spawned at the Sawtooth weir from 1981 through 1984, fecundity was 5,894 eggs per female (IDFG Bureau of Fisheries file data).

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Salmon River spring chinook usually hatch in December and emerge from the gravel in February or March (Bjornn 1960).

Time. age and size at migration

Most naturally reared Salmon River spring chinook migrate to the ocean in the spring during their second year of life at a length of 4 to 5 inches (Bjornn 1960).

Sawtooth Hatchery smolts will be released while in their second year of life during March or April. The size of Sawtooth smolts is targeted at 20 per pound (Parrish, E., IDFG Bureau of Fisheries, pers. comm.).

Survival rate

No information.

DISEASE HISTORY

The eye fluke, Diplostomum spathaceum became a serious problem while experimentally rearing chinook in an earth& pond at the present Sawtooth Hatchery site in the 1970's. The pathology of the eye fluke was studied by

Heckmann (1982) and prophylactic measures were incorporated into the Sawtooth Hatchery design (Parrish, E., IDFG Bureau of Fisheries, pers. comm.).

Table 5. Length frequency distribution of upper Salmon River Basin spring chinook kelts, 1963 (Bjornn et al. 1964).

Fork length (inches)	Upper Salmon River			Upper Valley Creek			Upper East Fork		
	Female	Male	Combined	Female	Male	Combined	Female	Male	Combined
16		1	1					1	1
17		5	5					2	2
18	1	4	5					2	2
19		14	14					1	1
20	1	21	22						
21		11	11						
22		15	15	1	1	2		2	2
23	—	16	16	—	—	—	—	1	1
Subtotal	2	87	89	1	1	2	0	9	9
24		11	11		2	2		1	1
25		11	11				1	7	0
26		9	9		1	1	2	6	8
27	1	10	11				1	6	7
28	2	10	12		1	1	2	7	9
29	1	18	19				2	4	6
30	2	17	19				4	3	7
31	3	9	12	1	—	1	4	3	7
Subtotal	9	95	104	1	4	5	16	37	53
32	6	4	10	1		1	5		5
33	12	4	16	1		1	6		6
34	26	4	30	4		4	26	2	28
35	40	8	48	10		10	48	7	55
36	37	6	43	9		9	34	3	37
37	36	7	43	2		2	17	9	26
38	20	8	28	4	2	6	26	18	44
39	10	5	15		1	1	5	22	27
40	2	9	11		3	3	3	32	35
41	1	15	16		2	2		11	11
42		5	5		1	1		9	9
43		6	6		1	1		3	3
44	—	4	4	—	—	—	—	—	—
Subtotal	190	85	275	31	10	41	170	116	286
Grand Total	201	267	468	33	15	48	186	162	348

Table 6. Length frequency distribution of upper Salmon River Basin spring chinook kelts, 1964 (Platts et al. 1966).

Fork length (inches)	Upper Salmon River			Upper Valley Creek			Upper East Fork		
	Female	Male	Combined	Female	Male	Combined	Female	Male	Combined
15		1	1						
16					2	2			
17		6	6					2	2
18		15	15		1	1		4	4
19		1	1		1	1		2	2
20		12	12						
21		4	4						
22	1		1						
23									
Subtotal	1	39	40		4	4		8	8
24		9	9						
25		2	2						
26	2	6	8		2	2	1	3	4
21	1	5	6	2	2	4		2	2
28		3	3	1	4	5		2	2
29	2	5	7	1	1	2	1	5	6
30	7	9	16	1	2	3	1	6	7
31	5	3	8	1	2	3	5	4	9
Subtotal	17	42	59	6	43	19	8	22	30
32	8	11	19				2	1	3
33	4	1	5	4		4	4		4
34	19	4	23	8	4	12	44	3	17
35	13	4	17	6	3	9	7	2	9
36	65	4	69	6	2	8	28		28
37	11	1	12		2	2	17	3	20
38	24	7	31		2	2	12	4	16
39	13	3	16				8	4	12
40	9	6	15		4	4	2	16	18
41		3	3					11	11
42		13	13					5	5
43		3	3					3	3
44		3	3					2	2
Subtotal	166	63	229	24	17	41	94	54	148
Grand Total	184	144	328	30	34	64	102	84	186

Table 7. The ratio of male to female chinook salmon examined on spawning grounds of the Salmon River drainage 1961, 1962, 1963 and 1964 (Platts et al. 1966).

Stream area	1961	1962	1963	1964
Upper Salmon River				
Age-class 32	38.01:1	32.0:1	43.0:1	39.0:1
Age-class 42	1.0:1	1.7:1	10.5:1	2.5:1
Age-class 52	0.4:1	0.3:1	0.4:1	0.4:1
	0.9:1	1.1:1	1.3:1	0.8:1
Upper Valley Creek				
Age-class 32	--	--	1.0:1	--
Age-class 42	0.9:1	1.1:1	0.3:1	2.2:1
Age-class 52	0.3:1	1.1:1	0.3:1	0.7:1
	0.6:1	1.4:1	0.4:1	1.1:1
Upper East Fork				
Age-class 32	--	--	--	--
Age-class 42	1.8:1	0.8:1	2.3:1	2.1:1
Age-class 52	0.9:1	0.9:1	0.7:1	0.6:1
	1.1:1	1.0:1	0.9:1	0.0:1

PRIORITY INFORMATION NEEDS

1. The proper ratio and quantity of hatchery/wild stocking for individual stocking areas in the Sawtooth Hatchery fish distribution program.

2. Green egg-to-smolt survival rates for Sawtooth Hatchery fish.

3. Smolt-to-adult survival rates for Sawtooth Hatchery and upper Salmon River Basin natural spring chinook.

4. Fishery contribution of Sawtooth Hatchery and upper Salmon River Basin natural spring chinook.

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Upper Salmon River Summer Chinook

PRODUCTION

Wild.

GEOGRAPHIC LOCATION

Streams

Summer chinook are documented in the upper mainstem Salmon River between the towns of Challis and Stanley and in the lower portions of the East Fork and Valley Creek (Welsh et al. 1978, Mallet 1974).

Hatcheries

None.

ORIGIN

Native.

ADULT LIFE HISTORY

Run size, catch and escapement

Redd counts in the mainstem Salmon River are available from 1957 to 1984 as an index to run size and spawning escapement (Table 1).

No catch data are available that distinguish this stock from other mixed stocks in the fishery.

Time of migration

Adults enter the Columbia River from May through July and the Snake River in June and July (Corps of Engineers 1939-78, ODFW and WDF 1978).

Spawning period

Spawning occurs in late August to mid-September (Pollard, H. A. II, IDFG, pers. comm.).

Spawning areas

Primary spawning areas are Valley Creek from its mouth to Stanley Lake Creek, East Fork Salmon River from its mouth to one mile above Lake Creek and the mainstem Salmon River from Hell Roaring Creek downstream to Yankee Fork (Ball, K., IDFG, pers. comm.).

Table 1. Upper Salmon River summer chinook redd counts, 1957 to 1984 (Pollard 1985).

Year	Number of redds	Year	Number of redds
1957	2,406	1971	220
1958	362	1972	412
1959	336	1973	224
1960	818	1974	200
1961	356	1975	45
1962	467	1976	44
1963	195	1977	94
1964	415	1978	349
1965	201	1979	ND
1966	390	1980	11
1967	365	1981	75
1968	223	1982	39
1969	120	1983	111
1970	150	1984	51

Ase composition

No information.

Size

No information.

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age and size at migration

Juveniles migrate to the ocean mainly in their second year of life (Bjornn 1960).

There is no information on time and size at migration.

Survival rate

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Spawning escapement requirements.

2. Improved definition of geographical habitat, including spawning areas and juvenile rearing areas.

3. Egg-to-smolt and smolt-to-adult survival rates.

4. Genetic profile compared to other Columbia Basin chinook stocks.

5. Sex and age structure of the adult population.

6. Fecundity.

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Imnaha River Spring/Summer Chinook (wild)

PRODUCTION

Currently, adult production is entirely from wild stock. Hatchery producton will increase under the Lower Snake River Compensation Plan [see "Imnaha River Spring Chinook (hatchery)"].

GEOGRAPHIC LOCATION

Streams

Imnaha River and tributaries (Figure 1)

ORIGIN

Spring/summer chinook (hereafter referred to as spring chinook) are indigenous to the Imnaha River system. The only recorded introduction of non-native stocks occurred in 1966, when 119 chinook adults trapped at Hells Canyon Dam were released into the Imnaha River and Lick Creek (Gaumer 1968). Hatchery broodstock now used are native Imnaha stock.

ADULT LIFE HISTORY

Run size, catch, and escapement

Parkhurst (1950) reported that "the Imnaha formerly supported good runs of chinook salmon and steelhead trout, but the present runs were reported to be very small." Thompson and Haas (1960) described the Imnaha River as "the most consistently productive chinook salmon stream in eastern Oregon." The estimated size of the run entering the Imnaha in 1957, when the redd counts were the highest recorded (Table 1), was 6,700 fish (USACE 1975). This estimate was based on the maximum McNary Dam count for 1954-67 (222,100), the proportion of that run that would have passed Ice Harbor Dam (55%), and the proportion of the run at Ice Harbor destined for the Imnaha (5.5%). Smith (1975) estimated the escapement for the highest runs durinq the early 1970s:

	Spring chinook	Summer chinook
Imnaha River	3,270	1,630
Big Sheep Creek	1,122	562
Total	4,392	2,192

The accuracy of these estimates is unknown.

Spawning ground surveys conducted by ODFW generally indicate a decline in the number of spawners since the early 1970s (Table 1). These redd counts correlate with the number of chinook passing Snake River dams (Figure 2). The estimated escapement since 1979 has averaged 463 fish (Table 2).

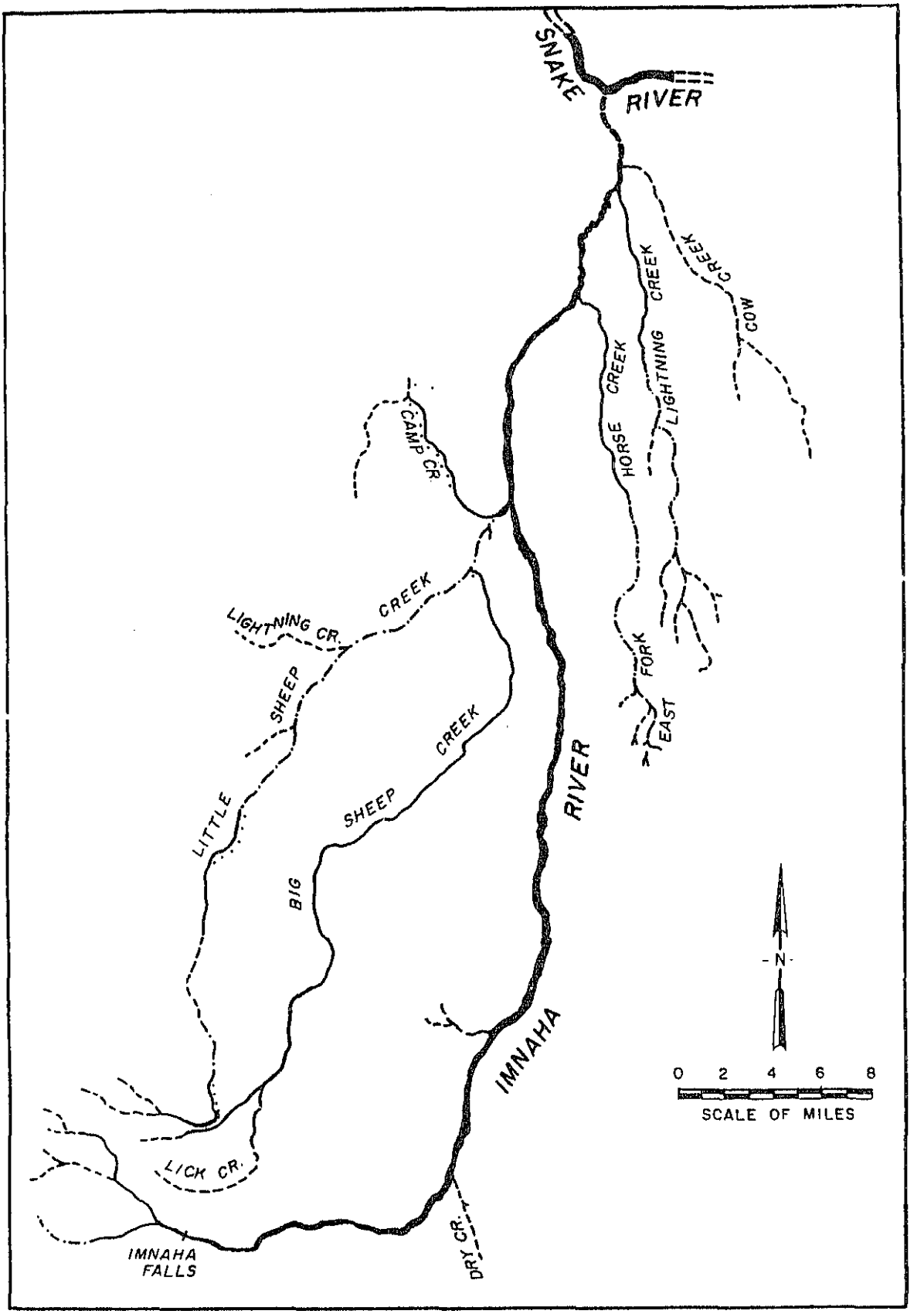

Figure 1. Imnaha River Basin.

Table 1. Counts of spring chinook in spawning index areas of the Imnaha River system, 1949-1983.

Location	Year	Redds	Miles	Redds/ mile	Location	Year	Redds	Miles	Redds/ mile
Imnaha R.	1949[a]	256	15.0	17.1	Big Sheep Cr	1964	40	4.0	10.0
	50[a]	122	15.0	8.1		65	26	4.0	6.5
	51	- -	- -	--		66	61	4.0	15.3
	52	426	13.0	32.8		67	30	4.0	7.5
	53	348	13.0	26.8		68	36	4.0	9.0
	54	314	13.8	26.4		69	30	4.0	7.5
	55	698	10.0	69.8		70	55	4.0	13.8
	56	206	5.8	35.5		71	57	4.0	14.3
	51	147	10.0	74.7		72	28	4.0	7.0
	58	129	9.7	13.3		73	31	4.0	7.8
	59	115	8.0	14.4		74	8	4.0	2.0
	60	323	9.7	33.3		75	14	4.0	3.5
	61	221	9.7	22.8		76	24	4.0	6.0
	62	248	9.7	25.6		17	5	4.0	1.3
	63	133	9:7	13.7		78	14	4.0	3.5
	64	250	9.1	25.8		79	0	4.0	0.0
	65	189	9.7	19.5		80	0	4.0	0.0
	66	223	9.7	23.0		81	2	4.0	0.5
	67	215	9.7	22.2		82	9	4.0	2.3
	68	241	9.7	24.8		83	11	4.0	2.8
	69	302	9.1	31.1					
	70	176	9.7	18.1	Lick Cr.	64	14	4.0	3.5
	71	366	9.7	37.7		65	25	4.0	6.3
	72	336	9.1	34.6		66	42	4.0	11.8
	73	520	9.7	53.6		67	30	4.0	7.5
	74	217	9.7	28.6		68	34	4.0	8.5
	75	149	9.7	15.4		69	4	4.0	1.0
	76	103	7.7	13.4		70	50	4.0	12.5
	77	143	1.7	18.6		71	13	4.0	3.3
	18	319	7.7	41.4		72	27	1.0	6.8
	79	52	7.7	6.7		73	16	4.0	4.0
	80	33	7.7	4.3		74	12	4.0	3.0
	81	82	7.7	10.6		75	11	4.0	2.8
	82	92	7.7	11.9		76	17	4.0	4.3
	83	71	7.7	9.2		17	5	4.0	1.3
						78	32	4.0	8.0
						79	4	4.0	1.0
						80	4	4.0	1.0
						81	2	4.0	0.5
						82	0	4.0	0.0
						83	0	4.0	0.0

[a] Counts in 1949 and 1950 were conducted prior to peak spawning.

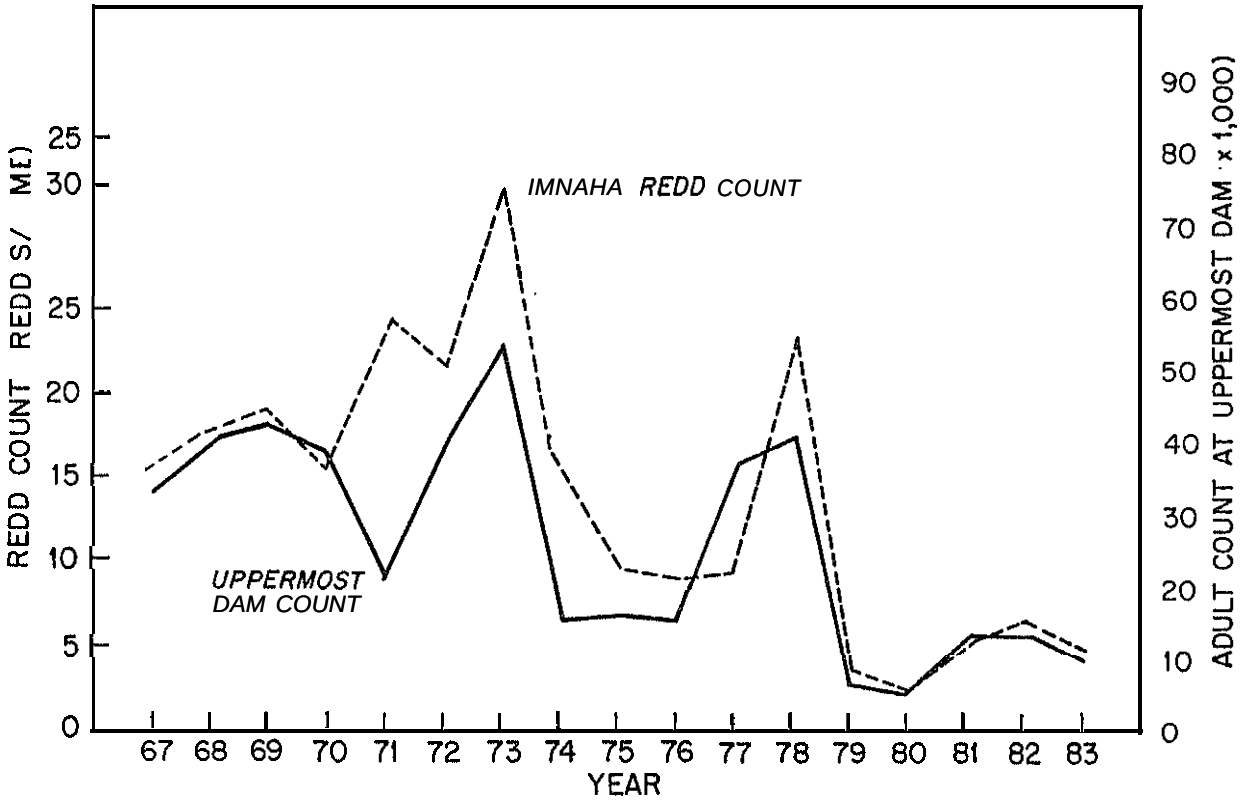

Figure 2. Relationship of the counts of adult spring chinook at the uppermost Snake River dam to the combined spring chinook redd count in Imnaha River index streams (upper Imnaha River, Big Sheep Creek, and Lick Creek), 1967-83.

The decline has been attributed primarily to increased adult and juvenile mortality resulting from the eight dams on the Snake and Columbia rivers between the Imnaha and the ocean (Hirose 1984). The habitat of the Imnaha Basin is largely unaltered since the mid-1950s (James 1984).

Table 2. Estimated escapement of spring/summer chinook in the Imnaha River system, 1979-84.

Year	Redd counts	Expanded redd count[a]	Number collected for broodstock	Estimated escapement (2.75 fish/redd)
1979	56	64	0	176
1980	44	54	0	147
1981	103	128	0	352
1982	138	173	28	504
1983	106	133	64	430
1984	128	160	37	477

[a] Imnaha River and Big Sheep Creek redd counts expanded by 1.25 for unsurveyed areas.

The contribution of Imnaha spring chinook to ocean and Columbia River commercial fisheries is unknown. In-river commercial seasons for spring and summer chinook have been closed since 1977 and 1963, respectively. sport catches in the Imnaha from 1959 to 1973 ranged from about 26 to 387 fish (Table 3). Non-Indian sport fishing has been prohibited since October 1974. Although the Imnaha once supported substantial subsistence fishing by the Nez Perce and Confederated Umatilla tribes, fishing effort has declined in recent years as runs have declined. No estimates of catch by Indians are available. The Nez Perce Tribe closed the Snake River and tributaries including the Imnaha to subsistence fishing in 1984.

Table 3. Punch-card estimates of salmon sport harvest in the Imnaha River, 1959 to 1980.[a]

Year	Catch
1959	315
1960	387
1961	125
1962	54
1963	45
1964	19
1965	46
1966	60
1967	45
1968	162
1969	46
1970	48
1971	26
1972	45
1973	96
1974	0
1975	0
1976	0
1977	44
1978	22
1979	0
1980	0

a Catch estimates prior to 1971 not adjusted for non-response bias and include total reported salmon catch during all months. Consequently, they may include other species and contain identification errors.

Time of migration

Early runs of chinook in the Imnaha have been classified as both spring and summer races. In tagging programs conducted from 1947 to 1965, seven tags were recovered in the Imnaha: one spring chinook tagged in the lower Columbia 10 April and six summer chinook tagged from 14 June through 8 July at Bonneville (Galbreath 1966). There were 11 recoveries in the Imnaha of fish tagged in the Snake River near Lewiston, Idaho from mid-June through early July (Thompson et al. 19581. The chinook run in the Imnaha begins in early May and extends through early August (Smith 1975). Spawning ground surveys have not indicated two distinct spring and summer chinook populations.

Spawning period

Spawning takes place in August and early September. On spawning ground surveys conducted during the last week in August, which generally coincides with the time of peak spawning, unspawned live fish, spawned out carcasses, and redds are found (Bennett 1975).

Spawning areas

The two principal spawning areas are Big Sheep Creek from Coyote Creek (RM 20.4) to 0.25 miles above Lick Creek (RM 31.9) (12 miles) and the upper Imnaha mainstem from Freezeout Creek (RM 29.4) to the Blue Hole (RM 59.5) (30 miles) with the largest concentration of spawners in the spawning ground index area between Blue Hole and Mac's Mine (RM 49.8) (10 miles) (Thompson and Hans 1960). In Big Sheep Creek the highest spawning densities were from Lick Creek to Carroll Creek (7.5 miles). Fish also spawn in the lower 2.8 miles of Lick Creek. It is estimated that spawning survey index areas are currently used by 80% of the fish spawning in the upper Imnaha and Big Sheep Creek and by 100% of the fish spawning in Lick Creek (K. Witty, ODFW, personal communication).

Age composition

From 1961 through 1976, the average age composition of carcasses sampled from the Imnaha was 5% age 3, 44% age 4, and 50% age 5 (Table 4). Spawning fish in the Imnaha are generally older than fish in the neighboring Grande Ronde system. From 1961 through 1974, age 5 fish accounted for only 12% and 6% of the spawners sampled in Catherine and Lookingglass creeks, respectively, in the Grande Ronde system (Bennett 1975).

Table 4. Percentage age composition of chinook carcasses sampled during spawning ground surveys on the Imnaha and Grande Ronde rivers, 1961-76 (data from Bennett 1975; ODFW, unpublished data).

	Imnaha River					Grande Ronde River				
	Age					Age				
Year	2	3	4	5	6	2	3	4	5	6
1961	0	14	32	54	0	0	15	71	14	0
1962	0	5	57	38	0	C	14	77	13	0
1963	0	18	32	50	0	0	20	54	26	0
1964	0	5	56	38	1	0	16	73	11	0
1965	0	10	60	30	0	0	14	75	12	0
1966	0	13	36	52	0	0	6	71	23	<1
1967	0	3	64	31	1	0	10	60	30	<1
1968	0	1	39	59	1	0	17	69	14	0
1969	0	4	58	38	0	1	9	78	12	0
1970	0	0	41	57	2	0	5	81	14	0
1971	0	10	59	30	1	0	12	76	12	0
1972	0	1	23	76	0	0	8	61	31	0
1973	0	0	24	76	0	0	3	66	32	0
1974	0	0	44	53	3	0	4	66	30	0
1975	0	0	19	81	0	0	0	30	70	0
1976	0	0	57	43	0	0	12	66	22	0
Average	0	5	44	50	<1	0	10	67	23	0

Size

Five-year-old fish sampled in 1972 averaged 35 in. (range = 29-44 in.); 4-year olds were 29-30 in. (range = 24-34 in.).

Sex ratio

No information.

Fecundity

The average fecundities of wild females trapped for broodstock in 1983 and 1984 were 5,286 and 4,709 eggs, respectively.

Biochemical-senetic characteristics

Preliminary data on isozyme gene frequencies have been reported by Schreck et al. (1984).

JUVENILE LIFE HISTORY

Time of emergence

Young of the year first appear in the Imnaha in February (Gaumer 1968).

Time, age, and size at migration

The Imnaha stock has evolved a life history pattern in which juveniles utilize most of the Imnaha and Snake rivers at some stage during their development. The large spawning stock originally present in the upper river produced fry in excess of habitat available nearby for rearing. Displaced fry move downstream into the lower river and the Snake River as they grow and as suitable habitat becomes scarce. Timing of downstream movement is constrained by high water temperatures in the lower Imnaha and Big Sheep Creek during late summer.

Few 0-age fish moved through the lower river in spring. From July to September, fingerlings (modal size 6.0 cm) migrated extensively through the upper Imnaha, but few moved through lower Big Sheep Creek or the lower Imnaha apparently because of high water temperatures in the lower reaches. From October to December, as water temperatures decreased, young of the year (modal size 7.5 cm) migrated through the lower Imnaha and Big Sheep Creek and into the Snake River, where they reared until the following spring. Based on samples of juveniles collected from small tributaries, Gaumer (1968) speculated that juvenile chinook may move into many smaller tributaries in the lower river to rear, even though adults do not spawn in them because of low water.

From March through June, yearlings (10.5-11 cm) migrated through both the upper and lower Imnaha. Few yearling chinook were left in the river by late summer. Most of the larger fish trapped in lower Big Sheep Creek were precocious males (Gaumer 1968).

Imnaha juvenile chinook primarily emigrated past Ice Harbor and McNary dams in April and May. Most of these fish were yearlings; however, 35% (13 of 37 recoveries of marked fish) were 2-year olds.

Unlike juveniles of the Grande Ronde stock, juveniles in the Imnaha have parr marks and fin characteristics similar to coho salmon.

Survival rate

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Improved estimates of run size, catch, and escapement
2. Smolt production levels and capacity, particularly from juveniles rearing in the Snake and Columbia rivers
3. Imprinting patterns of parr migrating in the summer and fall
4. Adult and juvenile migration timing in the Columbia and Snake rivers

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Imnaha River Spring Chinook (hatchery)

PRODUCTION

Hatchery production of Imnaha spring chinook was initiated under the Lower Snake River Compensation Plan. Approximately 490,000 smolts are scheduled to be released annually in the Imnaha system (Table 1) to attain a goal of 3,200 adult returns each year. The first releases were made in spring 1984 (Table 2). Hatchery-reared juveniles will return as adults beginning in 1986.

Table 1. Proposed releases of spring chinook in the Imnaha River system (Carmichael 1984).

Release site	No. to be released	Type of release
Horse Creek	140,000	Stream
Upper Imnaha	250,000	Advanced rearing ponds or stream
Upper Imnaha	100,000	Stream
Total	490,000	

Table 2. Spring chinook releases in the Imnaha River (Carmichael 1984).

Brood year	Stock	Hatchery of rearina	Number released	Date of release	Location of release	Size (fish/lb1
82	Imnaha	Lookingglass	24,920	3/22/84	Imnaha River	32.0
82	Lookingglass	Lookingglass	4,258	3/22/84	Imnaha River	31.0
83	Imnaha	Lookingglass	56,235	9/14/84	Imnaha River	24.4
83	Imnaha	Lookingglss	29,184	3/22/84	Imnaha River	32.0

GEOGRAPHIC LOCATION

Streams

Imnaha River system (mainstem and Horse Creek) (Figure 11

Hatcheries

Imnaha stock are spawned, incubated, and reared at Lookingglass Hatchery. The Imnaha River facility will be used for adult collection and possibly an advanced rearing site.

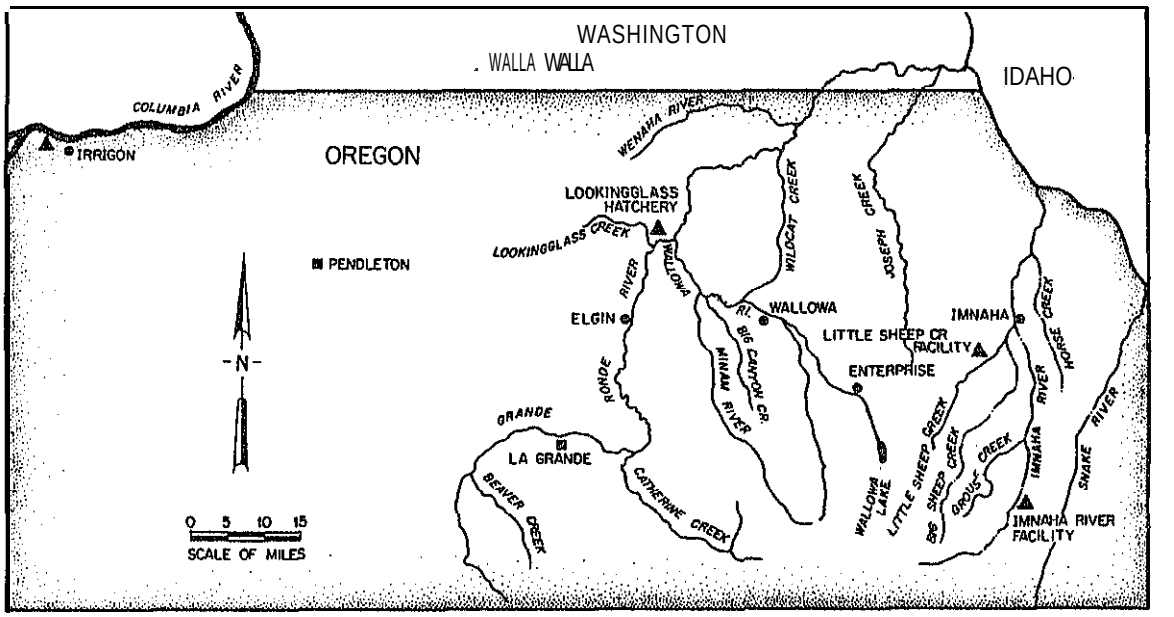

Figure 1. Imnaha River, major tributaries, and hatchery production facilities.

ORIGIN

Native Imnaha spring chinook have been trapped in the upper Imnaha River since 1982 for broodstock (Table 3). Wild adults will be trapped until hatchery adults return in 1986. One release of 1982 brood Lookingglass stock (approximately 4,000 smolts) was made in March 1984.

Table 3. Imnaha spring chinook broodstock collected at the Imnaha River trap, 1982-84(Carmichael1984).

Return year	Total number	Number females	Number males	Jacks	Number females spawned
1982	28	14	14	0	10
1983	64	35	21	8	31
1984	36	17	9	10	11

ADULT LIFE HISTORY

Run size, catch, and escapement

Three-year-old adults will return in 1986.

Time of migration

No information.

Spawning Period

No information.

Spawning areas

Imnaha spring chinook are spawned at Lookingglass Hatchery.

Age composition

No information.

Size

No information.

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

Imnaha spring chinook are incubated in 41-54°F creek and/or well water at Lookingglass Hatchery. The eggs require 28 days (54°F) of incubation to eye-up, 22 days (47°F) to hatch, and 15 days (41°F) to emerge.

Time, age, and size at miaration

Imnaha spring chinook are reared in 50°F water (creek water supplemented with well water) and released in March as yearlings at a size of 24-32 fish/lb (Table 2).

Survival rate

Egg-to-fry survival of Imnaha spring chinook averaged 75% at Lookingglass Hatchery in 1983.

DISEASE HISTORY

Spring chinook reared at Lookingglass Hatchery are occasionally infected with bacterial kidney disease. The disease was transmitted to fish in Lookingglass Hatchery through spring chinook reared at Oxbow and Bonneville hatcheries and transported to Lookingglass Hatchery (R. Carmichael, ODFW, personal communication). No viruses have been detected in Imnaha spring chinook (R. Holt, ODFW, personal communication).

PRIORITY INFORMATION NEEDS

1. Run size, catch, and escapement
2. Smolt-to-adult survival rate
3. Natural production from hatchery releases
4. Interactions of hatchery and wild stocks

REFERENCES

Carmichael, R.W. 1984. Evaluation of the lower Snake River compensation plan facilities in Oregon. Project proposal by the Oregon Department of Fish and Wildlife.

YAKIMA RIVER SPRING CHINOOK

The Yakima Basin spring chinook population is composed of two segments, the Naches substock and the upper Yakima substock.

PRODUCTION

The run is almost exclusively maintained from natural production, although non-local stock hatchery releases ranging from 2,500 yearlings to 402,000 yearlings have occurred periodically since 1970.

GEOGRAPHIC ORIGIN

Streams

Production areas for the Naches substock include the Bumping River, American River, Little Naches River, Rattlesnake Creek, and mainstem Naches River (Figure 1).

For the upper Yakima substock, the primary production areas are the Cle Elum River and mainstem Yakima. A minor level of natural production occurs in the Teanaway and Tieton rivers.

Hatcheries

Non-local hatchery stock spring chinook are released from Nile Springs pond on the Naches River. Out-plants have been made from Leavenworth, Klickitat, Carson, and Entiat hatcheries.

ORIGIN

Spring chinook are indigenous to the Yakima River (Fulton 1968) and have numbered as high as 12-15,000 fish since the 1950's (Figure 2).

Hatchery releases of spring chinook from upper Columbia River hatcheries have occurred with regularity since the mid-1970's (Table 1). In 1984, approximately 20 percent of the returns were considered to be of hatchery origin from substantial releases in 1981 and 1982 (E. Barth, YIN personal communication).

ADULT LIFE HISTORY

Run size, catch, and escapement

Since 1970, the minimum freshwater run size has averaged 1,350 adults (Table 2). Escapements, based on index area redd count expansions, have been increasing during this period and exceeded 2,000 in 1984.

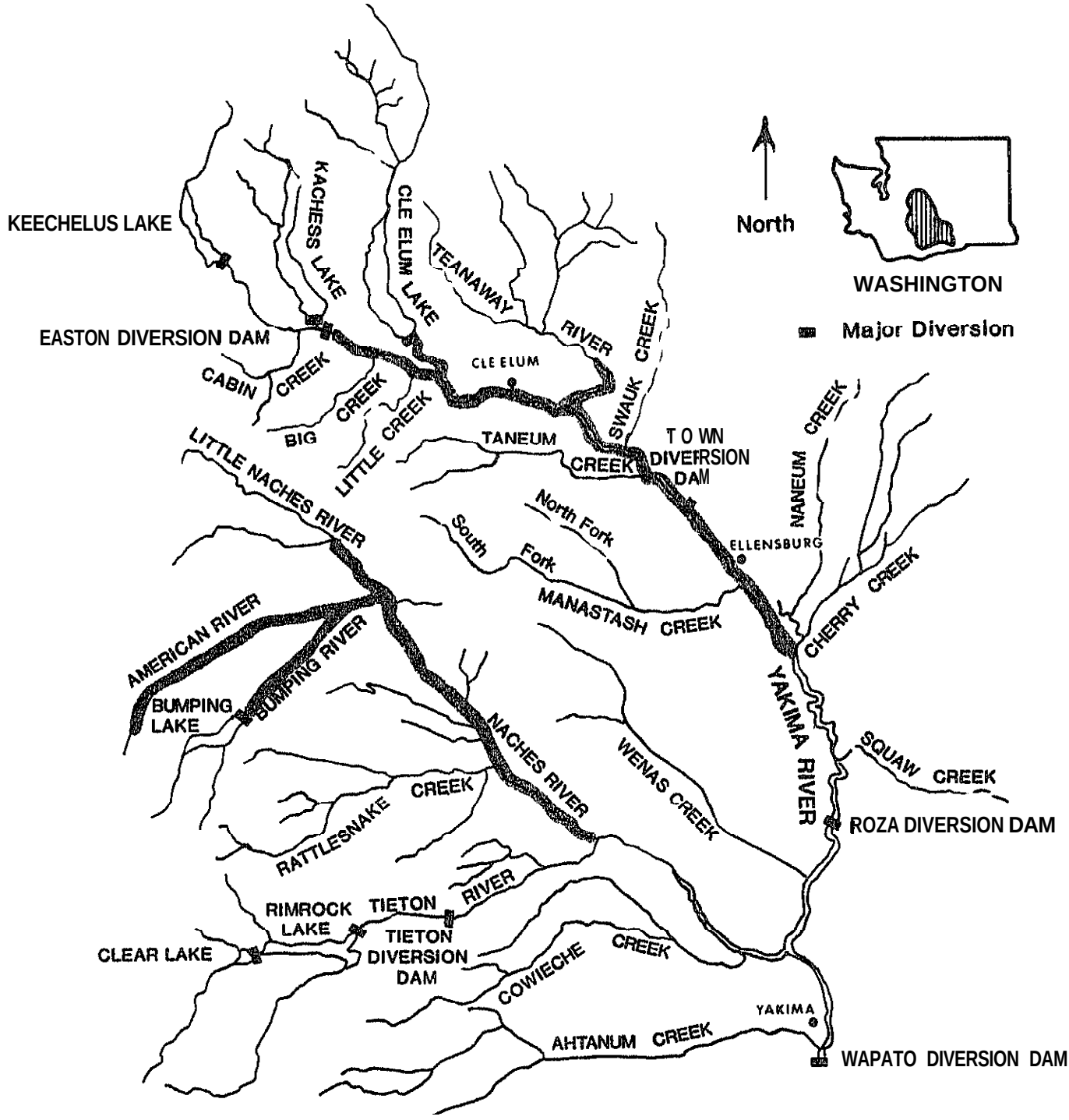

Figure 1. Major spring chinook spawning areas in the Yakima Basin (Malm 1984).

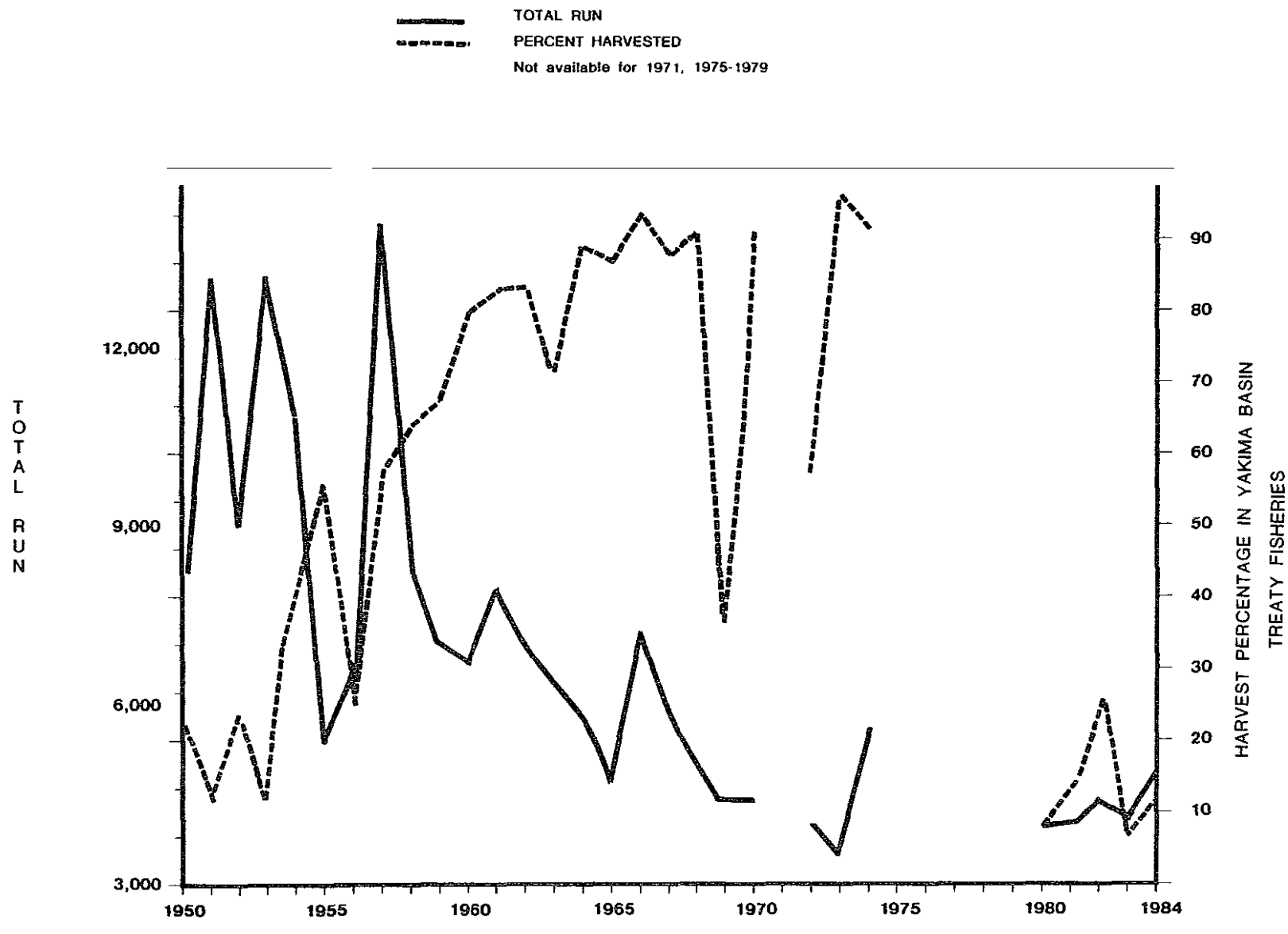

Figure 2. Run size and harvest rates by Yatima Indian Nation for Yakima Basin spring chinook, 1950-1975 (Mongillo and Falconer 1980).

Table 1. Releases of non-local stock spring chinook into Yakima Basin

Stream	Brood year	Release year	Number released	Type	Hatchery	Stock
Mainstem Yakima R.	1958	1959	20,000	Fingerling	Easton Pond	Unknown
	1958	1959	20,000	Fingerling	Klickitat	Klickitat[b]/
	1959	1960	62,000	Fingerling	Cle Elum Pond	Unknown
	1959	1960	92,000	Fingerling	Easton Pond	Unknown
	1960	1961	18,000	Fingerling	Leavenworth	Icicle[c]/
	1960	1961	18,500	Fingerling	Cle Elum Pond	Unknown
	1961	1962	5,000	Fry	Leavenworth	Icicle[c]/
	1962	1962	5,000	Egg/Fry	Leavenworth	Icicle[c]/
	1963	1964	60,000	Fingerling	Cle Elum Pond	Unknown
	1963	1964	25,300	Fingerling	Easton Pond	unknown
	1975	1977	13,300	Yearling	Nile Pond	Klickitst
	1977	1979	50,000	Yearling	Carson	Carson
	1978	1980	30,300	Yearling	Leavenworth	Carson[b]/
	1979	1981	400,200	Yearling	Leavenworth	Leavenworth
	1980	1982	401,700	Yearling	Leavenworth	Leavenworth
	1981	1983	97,000	Yearling	Leavenworth	Leavenworth
	1982	1984	42,600	Yearling	Entiat	Carson[b]/
	1983	1984	102,800	Fingerling	Leavenworth	Carson[b]/
	1983	1984	102,800	Fall releases	Leavenworth	Carson[b]/
	1983	1984	108,300	Fall releases	Leavenworth	Carson[b]/
American River	1972	1973	162.400	Fingerling	Klickitat	Klickitat
Marion River	1974	1976	20,600	Yearling	Klickitat	Klickitat
Naches River	1972	1973	162,400	Fingerling	Klickitat	Klickitat
	1977	1979	25,000	Yearling	Nile Pond	Cowlitz[b]/
Nile Springs	1974	1976	8,600	Yearling	Nile Pond	Klickitat
	1974	1976	7,200	Yearling	Ringold	Ringold[b]/
	1976	1978	2,500	Yearling	Nile Pond	Cowlitz[b]/
	1978	1980	23,900	Yearling	Nile Pond	Klickitat
	1973	1981	39,900	Yearling	Nile Pond	Klickitat
	1980	1982	100,100	Yearling	Nile Pond	Leavenworth
	1981	1983	94,500	Yearling	Leavenworth	Leavenworth
	1982	1984	29,600	Yearling	Entiat	Carson[b]/

a/ information for release years 1967-1983 from WDF (1985) unless noted otherwise.
b/ E. Barth, YIN (Yakima Indian Nation), personalcommunication.
c/ T. Roth, United States Fish and Wildlife Service (Personal communication).

Table 2. Minimum freshwater adult run size of Yakima Basin spring chinook, 1970-1984.

Return year	HARVEST				ESCAPEMENT		Total production
	Treaty		Non-treaty				
	Commercial[d]/	Ceremonial and subsistence&k/	Commercial[c]/	Recreational[a]/	Natural-&c/	Hatchery	
1970	1,500	N/A	N/A	0	150	0	1,650
1971	1,250	N/A	N/A	0	N/A	0	1,250
1972	500	N/A	N/A	0	350	0	850
1973	3,200	N/A	N/A	0	150	0	3,350
1974	1,750	N/A	N/A	0	150	0	1,900
1975	0	600	N/A	0	N/A	0	600
1976	0	N/A	N/A	0	350	0	350
1977	0	N/A	N/A	0	300	0	300
1978	0	N/A	N/A	0	950	0	950
1979	0	N/A	N/A	0	550	0	550
1980	0	100	N/A	0	1,100	0	1,200
1981	0	200	N/A	0	1,100	0	1,350
1982	0	450	N/A	0	1,250	0	1,700
1983	0	100	N/A	0	1,250	0	1, 350
1984	0		N/A	0	2,050	0	2 ,700[b,f,g]/
Mean	650	200 (4 yr)	N/A	0	650	0	1,350

a/ Does not include mainstem Columbia River harvest.
b/ E. Barth, YIN, personal communication.
c/ Based on run timing, Yakima River spring chinook would primarily be harvested in the April-May fisheries of 1970-1974 and 1977. February-March (winter season) catch would be very minor.
d/ Yakima River only.
e/ Based on index area redd count expansions of 1.13 and 2.5 for Upper Yakima and Naches systems, respectively for 1970-1980, and complete area redd counts in 1981-1984. These values expanded by a fish per redd factor from Roza Dam counts.
f/ Prosser Dam count plus dip net harvest downstream of Prosser Dam.
g/ Approximately 20 percent estimated to originate from hatchery releases in 1981 and 1982 (E. Barth, YIN, personal communication).
N/A: not available.

An ocean and freshwater catch distribution profile is not available for Yakima Basin spring chinook. If the catch profile of Yakima spring chinook mirrors other upper Columbia River stocks, than the ocean harvest is minor.

Time of migration

Spring chinook begin to enter the Yakima River in mid-April. Fish counts at Prosser Dam (river mile 47.21 peak in late May. More than 50 percent of the run is past the dam in late May or early June (Figure 3). In recent years a portion of the run was able to pass the dam without being counted due to flooding of the counting station. The counting structures were modified in 1984 and should permit total enumeration of the run.

Spawning period

Spawning occurs in the Naches system earlier than in the upper Yakima (Figure 4). In the Naches system redds are first observed in the American River in early August. Peak of spawning occurs in mid-August in the American River and late August or early September in the remaining Naches system. The majority of spawning on the upper Yakima occurs during the last 20 days of September. Spawning begins in the colder water areas and progresses to the warmer locations (E. Barth, YIN, personal communication).

Spawning areas

Present spawning areas are shown in Figure 1. About 65 percent of the spawning occurs in the upper Yakima between Ellensburg and Easton (Mongillo and Falconer 1980). Between 1970 and 1984, index area redd counts in the upper Yakima River averaged 91 annually or 66 percent of the total index redd counts for the Yakima Basin (Table 3).

Age composition

Hollowed (1983) determined from length frequencies and scale analysis that four-year-old spring chinook dominated the 1980-1983 returns, averaging 77 percent of the run (Table 4). Age composition from the spawning grounds showed a greater percentage of five-year-old chinook in the Naches system versus the upper Yakima (Table 5). This concurs with the results by Major and Nighell (1969) and the traditional belief that Naches fish are predominately five years old, whereas upper Yakima spring chinook are primarily four-year-old fish.

Size

During 1980-1983, fork length measurements of spring chinok carcsses from the Naches system averaged 79,8 cm., compared to 68.2 cm. for upper Yakima fish (Table 6).

Sex ratio

Preliminary data from the 1980-1983 subsistence fishery showed that three-year-old fish were predominately males and females comprised most of the four and five-year-old spring chinook (Table 7).

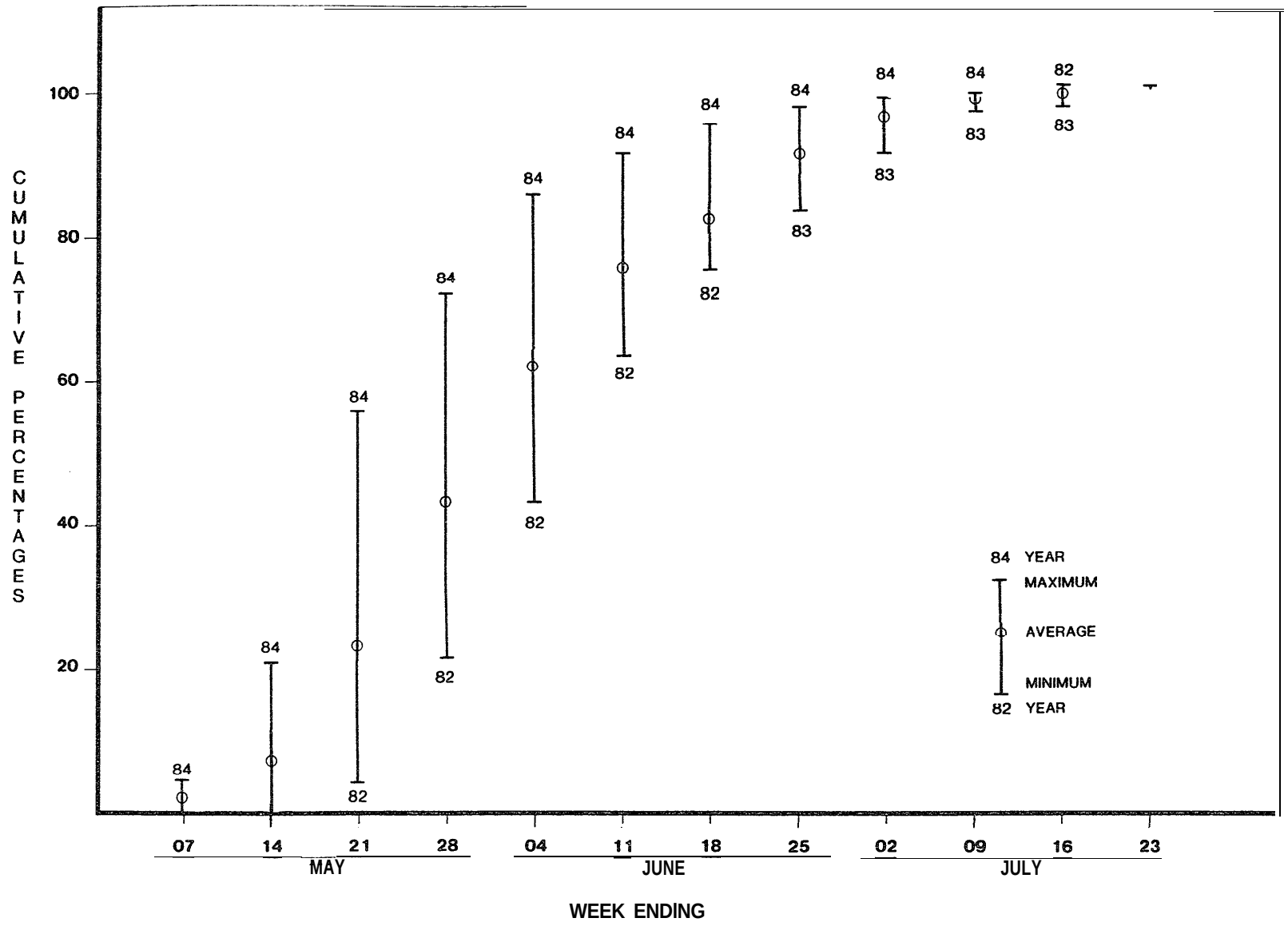

Figure 3. Cumulative percentage of adult spring chinook passing Prosser Dam, 1983-1984 (3. Easterbrooks, Washington Department of Fisheries, personal communication)

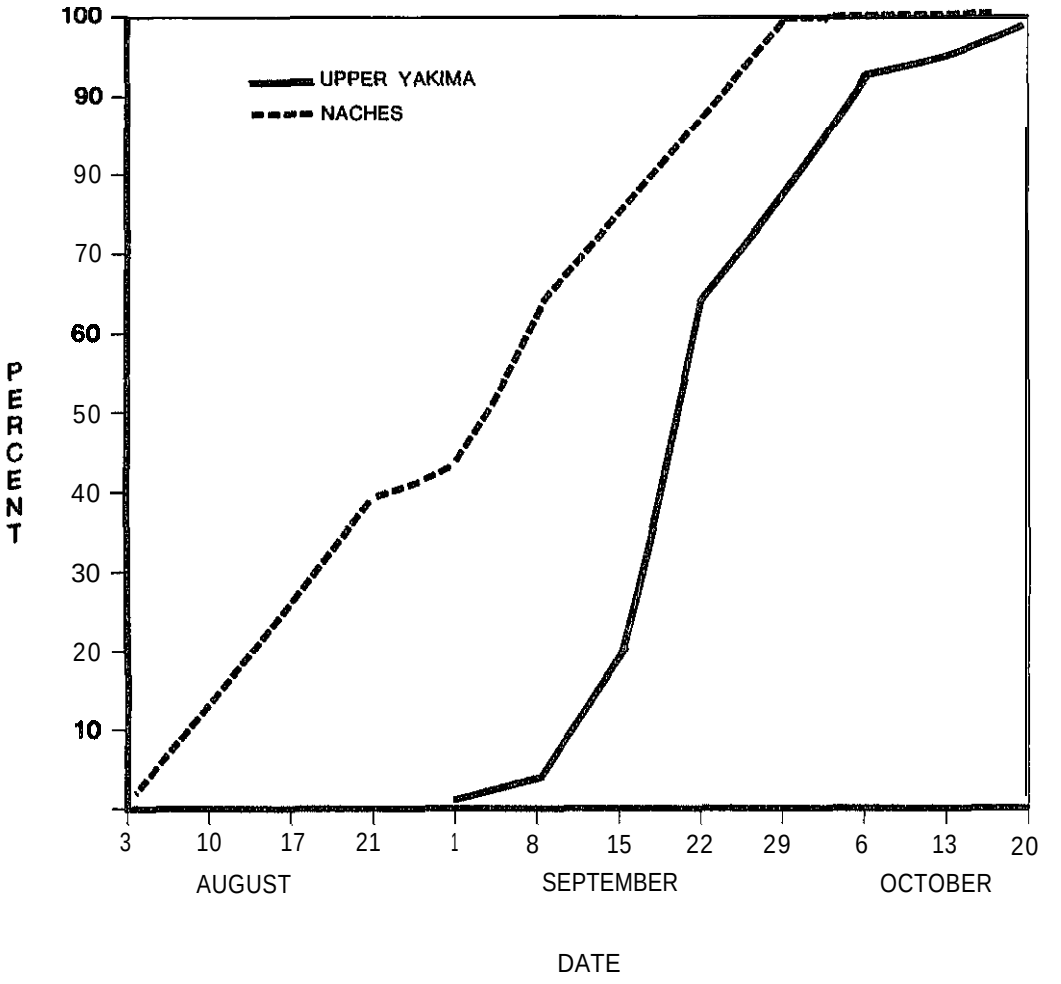

Figure 4. Cumulative percent spawned by date of spring chinook in the upper Yakima and Naches systems, 1983. (Hollowed 1984).

Table 3. Index area redd counts of spring chinook in Yakima River Basin (J. Easterbrooks, Washington Department of Fisheries, personal communication)

Year	Upper Yakima[a]/	Naches System			
		Mainstem[b]/	Little Naches	American	Bumping
1970	13	14	NC	5	NC
1971	54	NC	NC	NC	NC
1972	56	13	NC	9	NC
1973	23	I I	0	0	NC
1974	22	10	2	2	NC
1975	58	21	NC	NC	NC
1976	60	13	1	1	34
1977	67	4	0	0	2
1978	171	34	4	4	17
1979	48	45	8	20	13
1980	196	14	NC	20	8
1981	90	35	NC	32	4
1982	249	5	NC	4	0
1983	94	13	2	12	1
1984	169	7.0	41	28	10
Mean	91	18	7	11	10

a/ Historical index from Easton Dam (R.N. 202) to Twin Bridges (R.M. 191).
b/ Historical index from confluence of Bumping and American rivers downstream to Cliffdale on the Naches River.
c/ Some unresolved discrepancies occur between these redd counts and the values used by E. Barth (YIN) to determine spawning population in Table 1.

NC: No counts.

Table 4. Yakima Basin sample of spring chinook salmon percent age class composition. 1980-1983 (Hollowed 1983).

Season	Sample size	Percent Age 3	Age 4	Age 5
1980	172	11.3	78.6	10.1
1981	96	8.3	70.1	21.6
1982	72	4.2	86.1	9.7
1983	179	8.6	74.3	17.1
1980-1983	519	8.8	76.7	14.5

Table 5. Yakima Basin spawning ground survey samples of spring chinook age class composition by system 1980-1983 [Hollowed 1983).

Season	System	Sample size	Percent Age 3	Age 4	Age 5
1980	Yakima	61	23.6	76.4	0.0
	Naches	9	0.3	58.7	41.0
1981	Yakima	25	17.1	79.3	3.6
	Naches	34	6.2	66.9	26.9
1982	Yakima	12	2.9	94.6	2.5
	Naches	6	4.6	72.8	22.6
1983	Yakima	95	7.4	79.4	13.2
	Naches	26	8.2	56.8	35.0
1980-1983	Yakima	169	14.2	83.1	2.7
	Naches	75	6.1	62.8	31.1

Table 6. Yakima Basin spawning ground survey samples of spring chinook salmon average size (cm) by system, 1980-1983 (Hollowed 1983).

Season	System	Mean	Standard deviation	Sample size
1980	Yakima	64.8	7.3	61
	Naches	81.9	8.0	9
1981	Yakima	61.7	12.0	25
	Naches	79.0	12.0	34
1982	Yakima	70.0	5.2	12
	Naches	76.7	14.0	6
1983	Yakima	71.1	7.1	69
	Naches	80.8	11.5	26
1980-1983	Yakima	68.2	8.4	167
	Naches	79.8	11.7	75

Table 7. Age composition of spring chinook salmon by sex from the Yakima River subsistence fishery, 1980-1983 (Hollowed 1983).

Season	Sex	Sample size	Total catch	Percent Age 3	Age 4	Age 5
1980	Male	42	106	9.6	83.3	7.1
	Female	49		2.0	89.8	8.2
1981	Male	0	216			
	Female	0				
1982	Male	20	434	10.0	80.0	10.0
	Female	33		3.0	87.9	9.1
1983	Male	4	84	0.0	100.0	0.0
	Female	3		0.0	33.3	66.7
1980-1983	Male	66	840	9.2	83.1	7.7
	Female	85		2.3	81.1	10.6

a/ Ageing data has not been verified (January 15, 1984).

Fecundity

Major and Mighell (1969) reported a fecundity of 5,245 eggs per female for Naches spring chinook and 3,523 eggs per female in the upper Yakima for the 1957-1961 brood years.

Biochemical-genetic characteristics

Isozyme gene frequency profiles were determined from juvenile spring chinook from the mainstem Yakima in 1984 (Schreck et al. 1985). Juveniles from the Naches system will be obtained in 1985 for electrophoretic analysis (R. Hjort, Oregon Cooperative Fisheries Research Unit, personal communication).

JUVENILE LIFE HISTORY

Time of emergence

In 1983, Wasserman and Hubble (1984) trapped emerging fry at one site on the American River at Hells Crossing Campground and at another site on the Yakima River near Ellensburg. Fry were collected on the first day of trap operation on March 28th, suggesting that emergence occurs prior to this date. All fry had barely absorbed their yolk sacs. Peak fry capture date was May 5, 1983 on the American River. On the Yakima River, peak capture occurred on April 6, 1983, shortly before the trap became inoperable on April 20th.

Time, age, and size at migration

Wasserman and Hubble (1984) collected smolts at Wapatox on the Naches (river mile 9.7) and at Prosser. Peak of migration at both sites occurred in mid-April (Figure 5 and 6). Size of the yearling age smolts averaged 126 mm. and 141 mm. for wild and hatchery fish, respectively. For both types, sizes ranged from about 100 mm. to 180 mm.

Survival rate

Egg to smolt survival was 6.0 percent in 1983 (Wasserman and Hubble 1984). Major and Mighell (1969) estimated survival using the same method at 10.7 percent for the 1957-1961 broods.

No information is available on smolt to adult survival.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

Separation of Yakima River spring chinook into two segments has been based on differences in spawning period and the apparent adult age composition

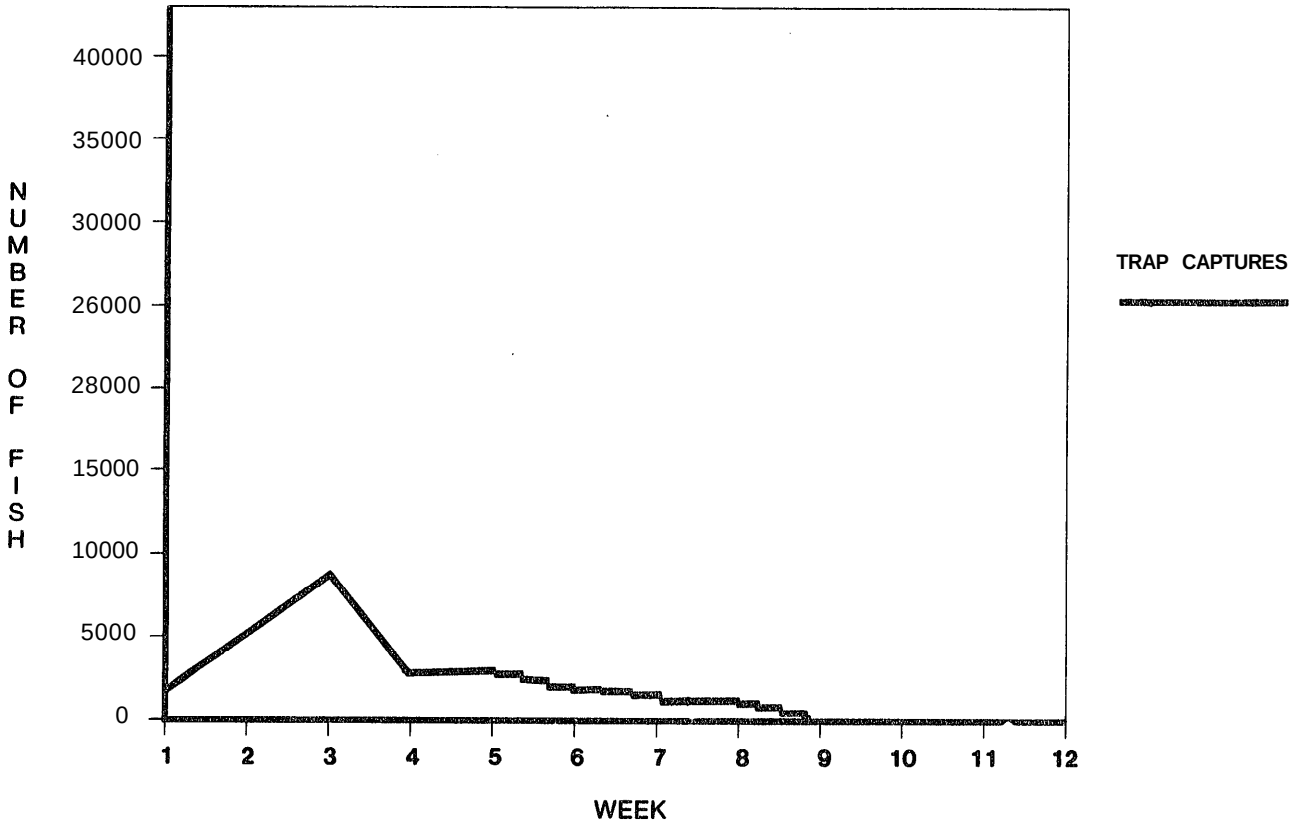

Figure 5. Captures of wild spring chinook smolts at Prosser, 1983. Week one begins on April 4 (Wasserman and Huble, 1984).

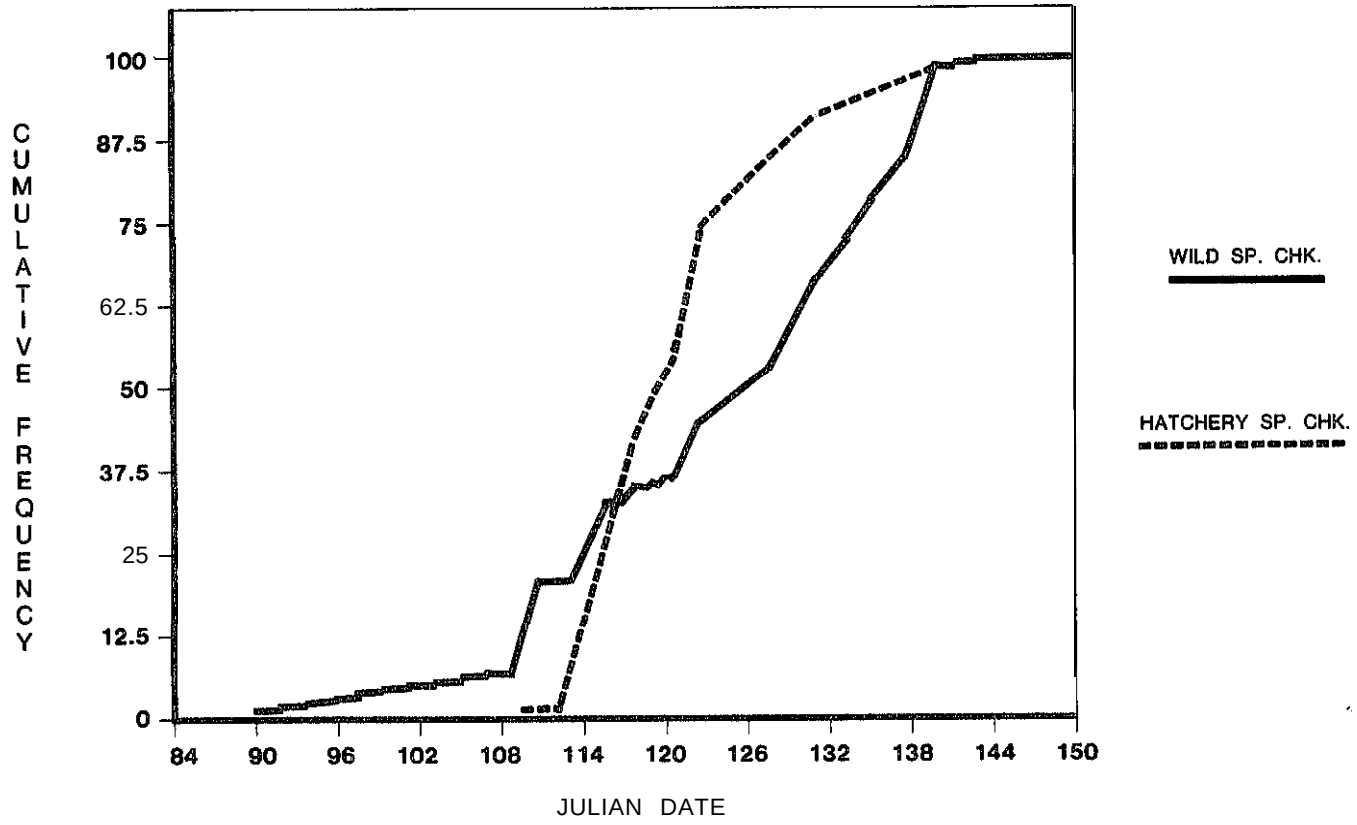

Figure 6. Spring chinook smolt captures at Wapatox smolt trap, 1983. April 12 is Julian date 102 (Wasserman and Huble, 1984).

between the populations in the upper Yakima and Naches systems. The spawning period difference is well known and easily verified. The age profile difference was described in Major and Mighell (1969). Others have determined a similar age structure based on length designation or from small sample sizes of scale readings. Some recent age information from scale age readings appears to contradict the expected age composition of each population (E. Barth, YIN, personal communication I. Additional carcass sampling is needed in the upper Yakima and Naches systems in order to determine the age structure based on a larger sample of scale age readings. From this information we can better understand Yakima Basin spring chinook and confidently identify all of the discrete substocks.

Compared to many other systems, the Yakima River has not been extensively supplemented with hatchery releases of nonlocal stock. Potential enhancement measures in the Yakima Basin include out-planting of spring chinook juveniles in areas considered to be below carrying capacity. Because these releases will originate from local brood stock, the capability to artificially propagate this wild population needs to be investigated.

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UPRIVER BRIGHT FALL CHINOOK

The four major stocks of fall chinook in the Columbia River include:

1. Upriver Bright stock (URB).
2. Lower River Wild stock (LRW).
3. Bonneville Pool Hatchery stock (BPH).
4. Lower River Hatchery stock (LRH).

Within the current URB stock, there is the primary stock which originates from natural and hatchery production areas in the mainstem Columbia between McNary and Priest Rapids dams, several substocks of smaller magnitude from Bonneville Hatchery, the Deschutes, Snake, and Yakima rivers, and a remnant substock from the John Day River basin. This summary will contain some information on all of these groups. Additional specific information on the Bonneville Hatchery, Snake, Deschutes, John Day, and Grande Ronde (historical) substocks is contained in separate summaries.

PRODUCTION

URB production is primarily from natural spawning. Hatchery programs on the Snake and Columbia rivers supplement the production, heavily in recent years. Hatchery releases into the Columbia Basin from all stations upstream of John Day Dam averaged about 3.0 million during 1971-1981 and then increased to 7.2 million in 1982, 12.8 million in 1983 and 18.5 million in 1984.

GEOGRAPHIC LOCATION

Streams

Rivers containing URB fall chinook include: Mainstem Columbia, Deschutes, Snake, Yakima, John Day, Kalama (hatchery production), and Umatilla (hatchery production).

Hatcheries

Hatcheries producing URB fall chinook include: Priest Rapids, Hagerman, Bonneville, Kalama Falls, Ringold Springs (intermittently), Rocky Reach (1984-1985), Spring Creek (1983-1985), Little White Salmon (1983 and 1984), and Lyons Ferry (1985). The Bonneville Hatchery program was originally developed to provide an URB source for a variety of enhancement programs upstream of Bonneville Dam. The Kalama Falls program was established to provide an “egg-bank” of Snake River URB's for the eventual permanent program at the newly constructed Lyon's Ferry Hatchery. The final URB release from Kalama Falls Hatchery occurred in 1984. Eggs will probably be transferred to Lyons Ferry Hatchery until the last of the 1984 releases return to Kalama Falls Hatchery.

ORIGIN

Fulton (1968) reported that historical runs of fall chinook migrated as far as the San Poil, Spokane, pend Oreille, and Kootenay rivers. Grand Coulee Dam construction blocked these runs. As dam construction continued, additional mainstem Columbia and Snake River spawning areas were blocked or inundated and the runs were reduced. A substantial shift in the Columbia River fall chinook upriver migration pattern occurred in 1957 with the completion of The Dalles Dam. McNary Dam adult fall chinook counts ranged between 5-8,000. With the filling of The Dalles pool and the inundation of Celilo Falls, the McNary Dam count skyrocketed to almost 50,000 in 1957. Since 1957, adult counts at McNary Dam have only once fallen below 25,000 (1981) and typically have numbered between 30-45,000.

Native fall chinook populations in the Columbia River and major tributaries upstream of The Dalles Dam provide the basis of the current URB stock with most of the population produced naturally in the free-flowing Columbia River upstream of McNary Dam.

The original URB broodstock for the current hatchery programs have come from a variety of locations, but generally have been collected at Columbia and Snake River dams (Table 1). Broodstock for the Bonneville Hatchery program continues to be collected at Bonneville Dam in order to supplement the voluntary returns of URBs to the hatchery.

Hatchery releases of non-URB stock fall chinook into traditional URB areas have been infrequent and few in number (Table 2).

ADULT LIFE HISTORY

Run size, catch, and escapement

Excluding the Bonneville and Kalama Falls hatchery production, the URB adult run has averaged about 100,000 since 1970 (Table 3). The run in 1984 (129,300-preliminary) was the second largest in this period and the third largest since 1964 (136,000). The adult run from Bonneville Hatchery production has ranged from 300-14,400; while at Kalama Falls the run has ranged from 600-3,300 during 1980-1984 (Table 4).

For all four major fall chinook stocks, harvest (except Tribal ceremonial and subsistence) has been estimated using two methods. The first method was used for 1979-1984 where harvest was determined primarily by expansion of the coded wire tags recovered during fishery sampling. Prior to 1979, catch was determined by applying the 1979 stock specific catch per escapement proportions in the various fisheries to the particular stock escapement for each year.

Tribal ceremonial and subsistence harvest was based on a combination of Tribal reports, fishery monitoring, and analysis of radio tagging studies conducted by National Marine Fisheries Service.

Table 1. Broodstock origin for URB hatchery programs.

Hatchery	Original URB broodstock collection site	Initial year of release	(Brood)
Priest Rapids Hatchery	Priest Rapids Dam trap	1971	(1970)
Ringold Springs Pond	Priest Rapids Dam/Hatchery	1980	(1979)
Bonneville Hatchery	"Bright" stock - Bonneville Dam	1977	(1978)
Hagerman NFH	Ice Harbor Dam	1979	(1978)
Kalama Falls Hatchery	Priest Rapids Hatchery	1976	(1974)
	Little Goose Dam via Bonneville Hatchery	1977	(1976)
	Ice Harbor Dam via Tucannon and Klickitat hatcheries	1978	(1977)
Lyons Ferry Hatchery	Kalama Falls Hatchery (Snake River stock transfer)	1985	(1983)
	Ice Harbor Dam	1985	(19831
Spring Creek NFH	Bonneville Hatchery voluntary returns and Bonneville Dam trapped	1983	(1982)
Little White Salmon NFH	Bonneville Hatchery voluntary returns and Bonneville Dam trapped	1983	(1982)

Table 2. Releases of non-URB stock fall chinook into Coluabia River Basin upstream of John Day Dam. [a]

Stream	Brood Year	Release Year	Number Released	Type	Hatchery	Stock
Wainstem Columbia River (John Day)	1979	1980	200,000	Fingerling	Little White Salmon	Little White Salmon (BPH)
	1979	1980	96,000	Fingerling	Little White Salmon	Little White Salmon (BPH)
Rock Creek	1979	1980	700,000	Fingerling	Little White Salmon	Little White Salmon (BPH)
	1980	1981	149,800	Fingerling	Spring Creek	Spring Creek (BPH)
	1980	1981	876,000	Fingerling	Spring Creek	Spring Creek (BPH)
Umatilla River	1980	1982	200,200	Yearling	Bonneville	Bonneville (LRH)
	1981	1982	978,300	Fingerling	Spring Creek	Spring Creek (BPH)
	1981	1982	2,560,000	Fingerling	Bonneville	Bonneville (LRH)
Marion River (Yakima Basin)	1975	1976	138,400	Fingerling	Klickitat	Kalama (LRH)
Wainstem Columbia River (Ringold)	1966	1967	132,100	Unfed-fry	Klickitat	Klickitat (BPH)
	1966	1967	401,000	Unfed-fry	Klickitat	Spring Creek (BPH)
	1967	1968	43,900	Unfed-fry	Ringold	Klickitat (BPH)
	1973	1974	1,747,500	Fingerling	Ringold	Spring Creek (BPH)
Wainstem Columbia River (Rocky Reach)	1974	1975	41,600	Fall releases	Rocky Reach	Simpson (Grays Harbor)
	1979	1981	296,100	Yearling	Rocky Reach	Elokomin (LRH)
Entiat River	1974	1975	673,300	Fingerling	Wells Dam	Simpson (Grays Harbor)

[a] Data complete for release years 1967-1983 for WDF facilities and for other agencies during 1980-1983.

Table 3. Freshwater adult run size of Upriver Bright stock fall chinook to Oregon, Washington and Idaho, 1970-1984 (WDF 1985) a/.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial	Ceremonial and subsistence	Commercial	Recreational	Natural c/	Hatchery	Total production b/
1970	22,500	N/A	44,200	2,900	41,700	1,580	126,900
1971	32,400	N/A	31,400	3,500	44,700	4,308	115,700
1972	26,000	N/A	19,800	3,400	36,800	800	86,700
1973	39,100	N/A	58,300	3,700	43,300	3,300	447,600
1974	33,500	N/A	15,200	2,500	31,600	3,000	89,800
1975	44,300	N/A	21,900	2,400	27,800	1,800	412,500
1976	55,900	N/A	28,000	2,100	27,700	1,100	115,100
1977	26,900	2,100e/	28,800	1,100	37,000	600	95,100
1978	30,700	1,900e/	16,300	1,300	25,200	2,100	85,300
1979	31,100	1,400e/	17,700	1,000	28,700	2,500	89,200
1980	9,000	1,800e/	5,100	900	28,800	2,200	76,800
1981	13,200	1,900e/	2,400	700	23,900	3,000d,f/	66,200
1982	2,800	4,200	4,500	200	34,100	5,600d,f/	78,980
1983	12,200	5,900	4,300	700	48,300	9,200d,f/	86,000
1984	(29,000)	(6,000)	(21,900)	(4,200)	(47,300)	(17,500d,f/	(129,300)
Mean	23,200	3,200	24,300	2,000	35,100	3,900	100,100

a/ Excludes egg bank adults returning to Bonneville Hatchery and Kalama Falls Hatchery.
b/ Includes fish passing Bonneville Dam but unaccounted in upstream fisheries or escapement.
c/ McNary Dam count minus Priest Rapids and Ringold Hatchery returns for 1970-1979, Deschutes River escapement included in 1980-1983.
Includes minor number of adults that strayed to other Columbia River areas.
e/ TAC (1983).
f/ includes Upriver Bright adults collected at Bonneville Dam north shore fish trap.
() (Preliminary).
N/A: Not available

Table 4. Freshwater adult run size for the Bonneville Hatchery and Kalama Falls Hatchery egg bank programs (WDF 1985).

Return year	HARVEST				ESCAPEMENT		Total prodiction
	Treaty		Non-treaty				
	Commercial	Ceremonial and subsistence	Commercial	Recreational	Natural	Hatchery	
			BONNEVILLE HATCHERY				
1980	0	0	300	0	0	0	300
1981	1,300	0	300	0	0	2,700	4,300
1982	900	1,100	700	0	0	3,600[a]/	8,800[b]/
1983	1,900	800	1,100	100	0	6,100[c]/	14,400[b]/
1984	(1,300)	(240)	(2,900)	(200)	0	(3,500)[d]/	(11,600)[b]/
			KALAMA FALLS HATCHERY				
1980	0	0	200	0	100	300	600
1981	0	0	200	100	1,000	500	1,800
1982	0	0	100	400	800	800	2,100
1983	0	0	400	800	800	1,300	3,300
1984	0	0	(1,300)	(500)	(500)[e]/	(500)	(2,800)

a/ Includes 319 Bonneville Hatchery egg-bank adults collected at Bonneville Dam north shore fish trap.
b/ Includes fish passing Bonneville Dam but unaccounted in upstream fisheries or escapement.
c/ Includes 211 Bonneville Hatchery egg-bank adults collected at Bonneville Dam north shore fish trap.
d/ Includes 125 Bonneville Hatchery egg-bank adults collected at Bonneville Dam North shore fish trap.
e/ Includes 210 straying to other Columbia River areas.
0 (Preliminary).

Most of the harvest of URB fall chinook occurs in British Columbia (51 percent) and Alaska (33 percent) (Figure 1). Only a minor percentage of the harvested run occurs in the Oregon and Washington coastal fisheries. Treaty and non-treaty commercial fisherman harvest most of the freshwater catch.

Time of migration

The main portion of the run begins entering the Columbia River about the third week of August. Passage over Bonneville Dam generally reaches a peak between September 4 and September 10. Without extensive downstream fisheries, the maximum count at McNary Dam would probably occur about a week later than the peak count at Bonneville Dam. A critical in-river harvest management period occurs from about September 1 through September 14 when most of the run migrates past Bonneville Dam (Figure 2).

Spawning period.

Peak of spawning in the mainstem Columbia River occurs in mid-November, and ranges from late October to late December.

Spawning areas

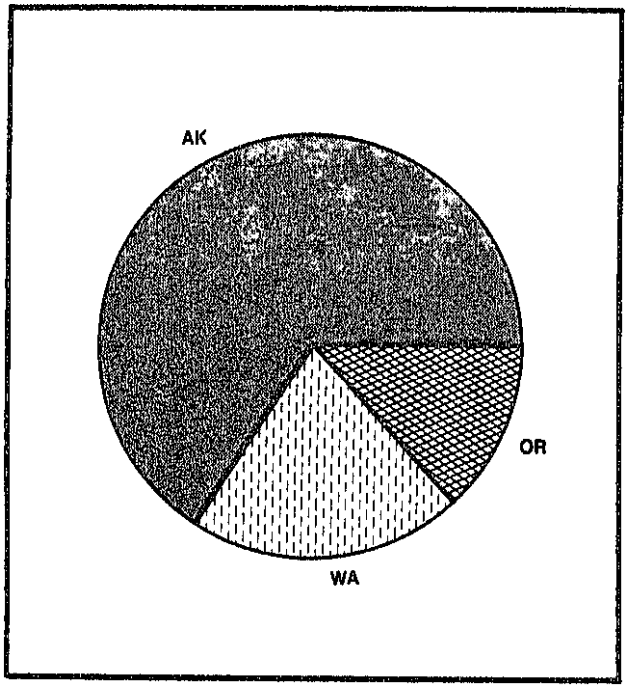
The primary natural spawning area is in the mainstem Columbia from Priest Rapids Dam (river mile 395.0) downstream about 45 miles to the upper end of McNary pool. This area, called the Hanford Reach, has had adult spawning populations ranging from about 15-44,000 during 1971-1984 (Table 5, WDF 1985). Since 1970, Hanford Reach redd counts have ranged from 728 to 7,310 (Table 6).

Much smaller natural spawning populations exist in the Deschutes, Snake and Yakima rivers. The John Day River supports a negligible run of fall chinook. Historically, fall chinook were present in the Grande Ronde River, but this system currently contains few, if any, fall chinook. Refer to the Snake, Deschutes, John Day, and Grande Ronde fall chinook summaries for more information. The Yakima River fall chinook population is split into two segments; one spawns in the lower 32 miles of the mainstem Yakima and the other utilizes the 17-mile long Marion Drain (E. Barth, Yakima Indian Nation [YIN], personal communication). The Marion Drain population is a sustaining run of tule fall chinook from the 1975 brood LRH release, because fall chinook were not known to occur in this area. The Prosser Dam adult fall chinook count, which enumerates the Marion Drain population, was 264 in 1983 and 694 in 1984 (E. Barth, YIN, personal communication). The lower mainstem Yakima population size is unknown but probably is less than 2,000 adults (J. Easterbrooks, Washington Department of Fisheries, personal communication).

Age composition

Age specific accountability of URB fall chinook, excluding Bonneville and Kalama Falls production, is presented in Table 7. Based on returns of the 1962-1979 broods, age-2 fall chinook (jacks) comprised about 34.1 percent of the year class, three-year-olds 23.8 percent, four-year-olds 34.6 percent, and

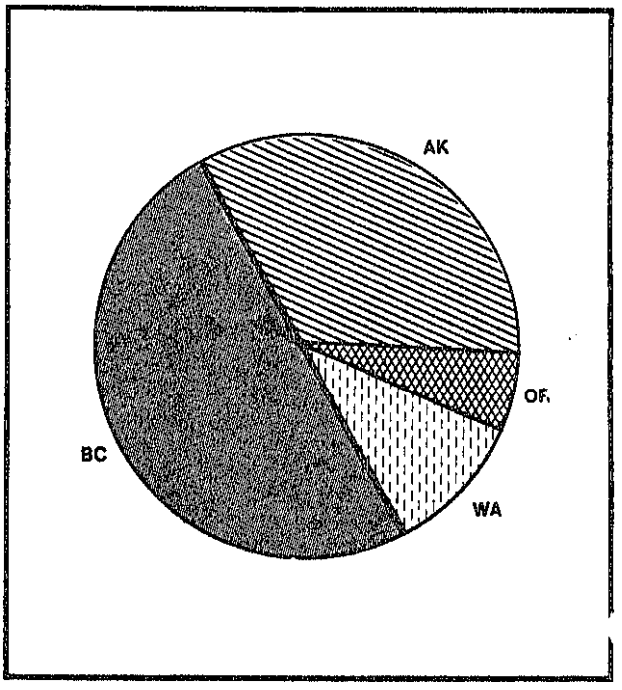
Distribution of U.S. Catch



Percentage By Fishery

Alaska Troll & Net	66.47
Washington Ocean Troll	3.02
Washington Ocean Sport	5.46
Washington Coastal Net	.02
Puget Sound Troll & Sport	2.52
Puget Sound Net	.04
Columbia River Sport & Net	21.59
Oregon Ocean Troll	.12
Oregon Ocean Sport	.75
California Ocean Troll	0
California Ocean Sport	0

Distribution of Total Catch



Percentage By Fishery

Alaska Troll & Net	32.66
Washington Ocean Troll	1.46
Washington Ocean Sport	2.66
Washington Coastal Net	.01
Puget Sound Troll & Sport	1.24
Puget Sound Net	.02
Columbia River Sport & Net	10.61
Oregon Ocean Troll	.06
Oregon Ocean Sport	.37
California Ocean Troll	0
California Ocean Sport	0
No. B.C. Troll, Sport, Net	25.95
So. B.C. Troll, Sport, Net	24.91

Figure 1. Harvest profile of URB chinook based on coded-wire tag releases of 1974-1977 brood fingerlings released from Priest Rapids Hatchery (Buckman et al. 1984).

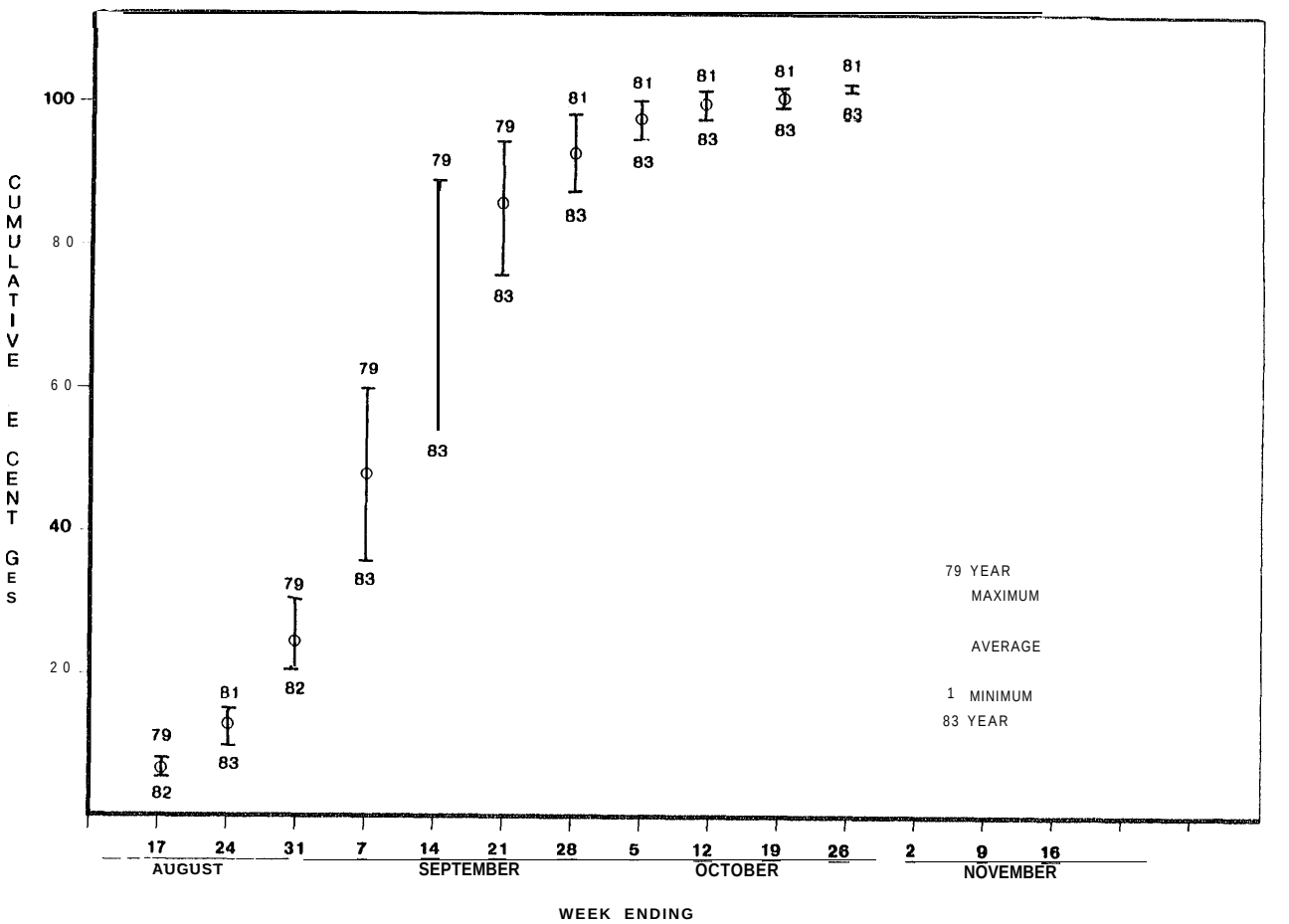


Figure 2. Cumulative percentage of adult URB fall Chinook passing Bonneville Dam, 1979-1983.

Table 5. Adult Upriver Bright fall chinook escapement to Hanford Reach, 1971-1984 (WDF 1985)[a].

Return year	Age 3 Number	Age 3 Percent	Age 4 Number	Age 4 Percent	Age 5 Number	Age 5 Percent	Total Number	Total Percent of McNary Dam count
1971	10,398	36.0	17,168	61.0	866	3.0	28,832	59.0
1972	9,109	37.0	14,698	59.7	812	3.3	24,619	65.4
1973	19,395	58.3	13,008	39.1	865	2.6	33,268	71.5
1974	4,227	16.5	20,241	79.0	1,153	4.5	25,261	74.0
1975	8,137	35.8	12,819	56.4	1,773	7.8	22,729	76.7
1976	9,852	45.7	10, 499	48.7	1,207	5.6	21,558	74.8
1977	8,799	27.8	21,713	68.6	1,139	3.6	21,651	84.2
1978	2,429	11.8	17,164	83.4	988	4.8	20,581	75.5
1979	2,563	10.9	19,377	82.4	1,576	6.7	23,516	75.3
1980	3,836	17.5	5,852	26.7	12,321	55.8	2'1,919	73.2
1981	1,473	9.6	11,078	72.2	2,793	18.2	15,344	72.5
1982	7,768	38.1	8,230	40.3	4,421	21.6	20,419	70.7
1983	9,985	27.0	21,745	58.8	5,252	14.2	36,982	75.9
1984	(8,914)	20.3	(26,344)	59.8	(8,777)	19.9	(44,035)	72.1

Hanford Reach escapement[a] = McNary Dam - Ice Harbor Dam - Priest Rapids Dam - Priest Rapids Hatchery volunteers - Ringold Hatchery

[a] Includes fall chinook spawning in Yakima River.

() (Preliminary).

Table 6. Hanford Reach (approximately River Mile 351.0 to 395.0) fall chinook redd counts 1973-1984[a]/.

Year	Number
1970	3,825
1971	3,600
1972	876
1973	2,965
1974	728
1975	2,683
1976	1,951
1977	3,240
1978	2,892
1979	2,978
1980	4,746
1981	3,510
1982	4,988
1983	5,873
1984[b]/	7,310

a/ Fiscus (1980) for 1970-1972, and Fiscus (1984) for 1973-1983.
b/ D. Watson, Battelle Pacific Northwest Laboratories, personal communication.

Table 7. Total age specific freshwater returns to Oregon, Washington and Idaho of URB chinook, 1970, 1984 (WDF 1985).

Return year	Age 2		Age 3		Age 4		Age 5		Total
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
1970	50,000	28.2	67,000	37.9	49,400	27.9	10, 500	6.0	176,900
1971	51,100	30.6	45,300	27.2	65,500	39.3	4,900	2.9	166,800
1972	42,300	32.8	31,900	24.7	50,100	38.8	4,700	3.7	129,000
1973	64,000	30.3	90,400	42.7	51,500	24.3	5,700	2.7	211,600
1974	60,500	40.2	16,400	10.9	65,500	43.6	7,900	5.3	150,300
1975	55,900	33.2	39,600	23.5	53,500	31.8	19,400	11.5	168,400
1976	98,600	46.2	59,900	28.0	38,700	18.1	16,500	7.7	213,700
1977	78,100	45.1	39,300	22.7	48,000	27.7	7,800	4.5	173,200
1978	50,400	37.1	17,900	13.2	57 , 500	42.4	9,900	7.3	135,100
1979	46,800	34.4	9,400	6.9	64,500	47.4	15,300	11.3	136,000
1980	23,300	23.3	11,900	11.9	29.200	29.2	35,700	35.6	100,100
1981	42,700	39.2	7,700	7.0	45,600	41.9	13,000	11.9	108,900
1982	61,700	43.9	35,200	25.0	29,100	20.7	14,600	10.4	140,600
1983	50,000	36.8	28,400	20.9	47,800	35.1	9,800	7.2	136,000
1984	(97,900)	(43.4)	(35,800)	(15.9)	(75,000)	(33.21	(17,000)	(7.5)	(225,700)a/
Mean	58,300	36.8	35,800	22.6	51,400	32.5	12,800	8.1	158,300

a/ Does not include 1,500 Age 6 adults.
() (Preliminary).

five-year-olds 7.5 percent. Percentage of the brood year returning as age-5 adults has been as high as 18 percent for the 1962-1979 broods and is substantially higher than the five-year-old component for LRH and BPH fall chinook. Periodically, six-year-old fish are observed in negligible numbers.

Size

Fork length according to age and sex of carcasses sampled on the Hanford Reach in 1981 and 1982 is listed in Table 8.

Based on diagramming the 1981 and 1982 length frequencies, separation points for the four age groups existed at about 55 cm. (age 2 vs. 3), 79 cm. (age 3 vs. 4), and 93 cm. (age 4 vs. 5) (Figure 3).

Sex ratio

Jacks are entirely males. Three-year-old adults are predominately males (83 percent average in 1979-1983) and four and five-year fish are mostly females (62 and 71 percent respectively in 1979-1983) (Figure 4).

Fecundity

Age specific fecundity is not available.

Mathews and Meekin (1971) determined from a sample of 385 females that mean fecundity was 5,015 for fall chinook from spawning channels in the upper Columbia at Rocky Reach, Priest Rapids, and McNary

Based on hatchery reports, fecundity at Priest Rapids Hatchery ranged from 4,454 to 5,212 eggs per female and averaged 4,704 during 1978-1982.

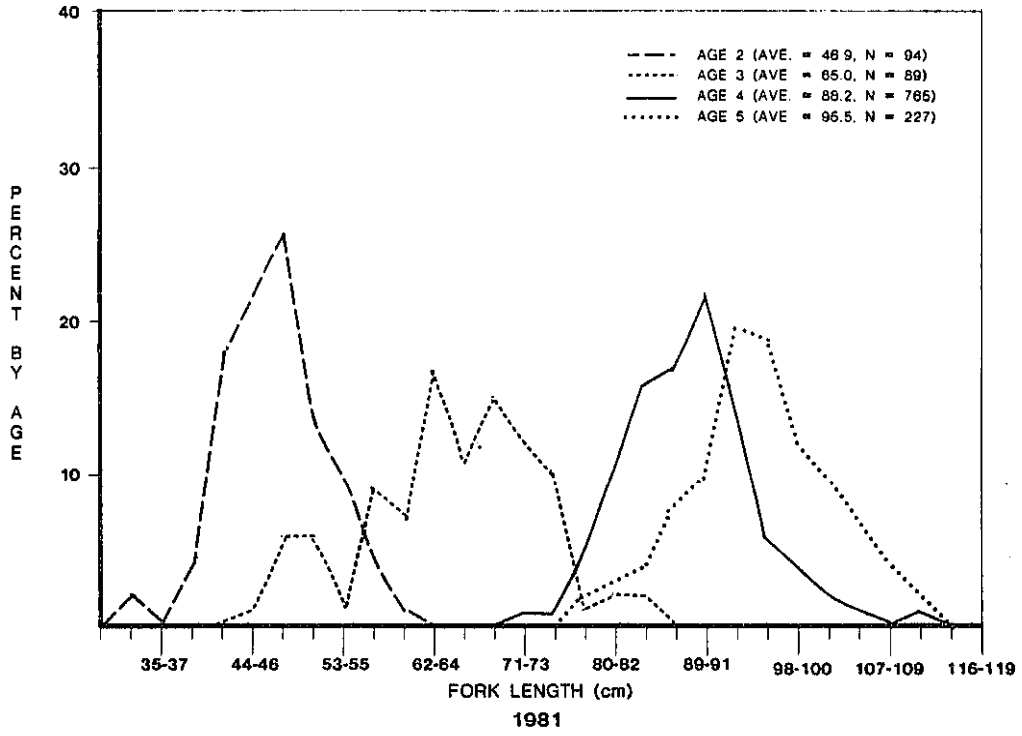
Biochemical-genetic characteristics

Schreck et al. (1984) determined from electrophoresis tkat Priest Rapids Hatchery fall chinook and Hanford Reach fall chinook each had eight enzyme systems with similar isozyme gene frequencies and one enzyme system with dissimilar frequencies. However, the electrophoretic profile of the dissimilar enzyme is characteristically difficult to interpret and the statistical difference may not be the result of genetically isolated populations.

Enzyme profiles from three separate URB populations, upper Columbia, Snake River and Deschutes River, were used as indicators to determine the relative contributions of each of these populations in the 1982 May troll fishery (Milner et al. 1983).

Table 8. Pork length (cm) according to sex and age for URB fall chinook sampled on the Hanford Reach, 1981 and 1982.

Year	Age 2		Age3		Age 4		Age 5	
	Male	Female	Male	Female	Male	Female	Male	Female
1981								
Sample size	95	0	93	17	203	207	46	182
Average fork length (cm)	47.1		65.7	69.5	93.5	87.2	104.2	93.2
Range	33-68		46-85	56-76	64-112	70-98	90-118	77-109
Standard deviation	5.5		8.6	4.5	a.3	5.1	5.4	5.9
1982								
Sample size	155	0	122	103	a9	174	49	182
Average fork length (cm)	49.4		70.1	74.3	92.0	85.2	107.9	96.2
Range	33-67	-	52-86	62-84	70-115	67-101	90-118	81-108
Standard deviation	7.5	-	7.0	4.2	9.9	6.1	6.6	5.9



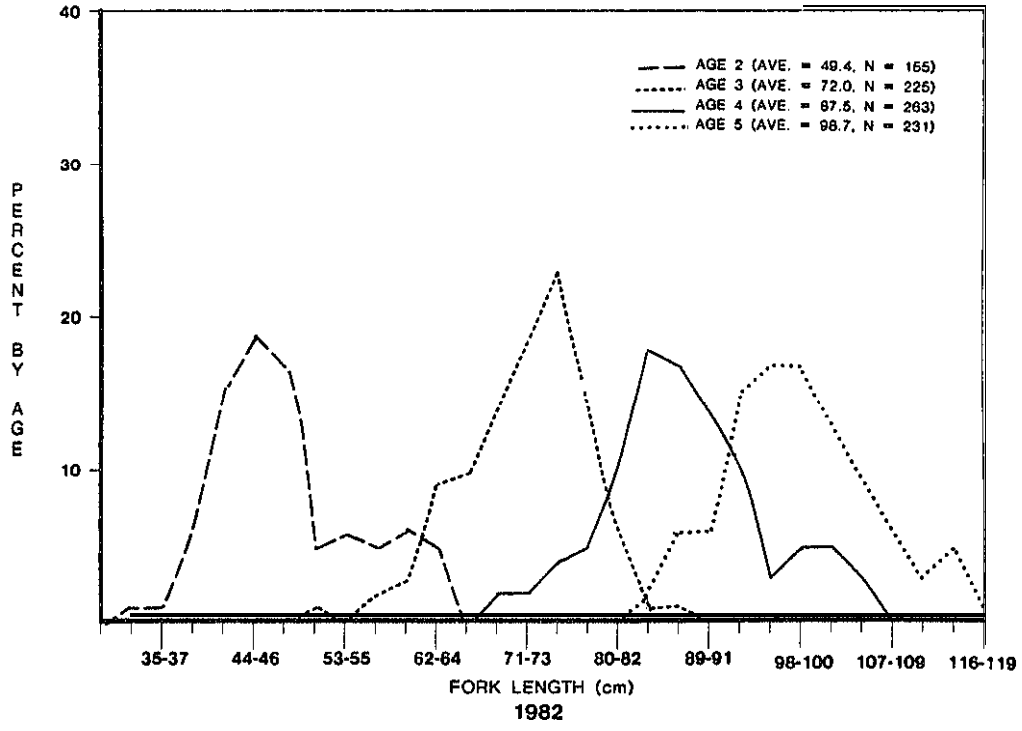


Figure 3. Length frequency of URB fall chinook sampled from Hanford Reach, 1981-1982.

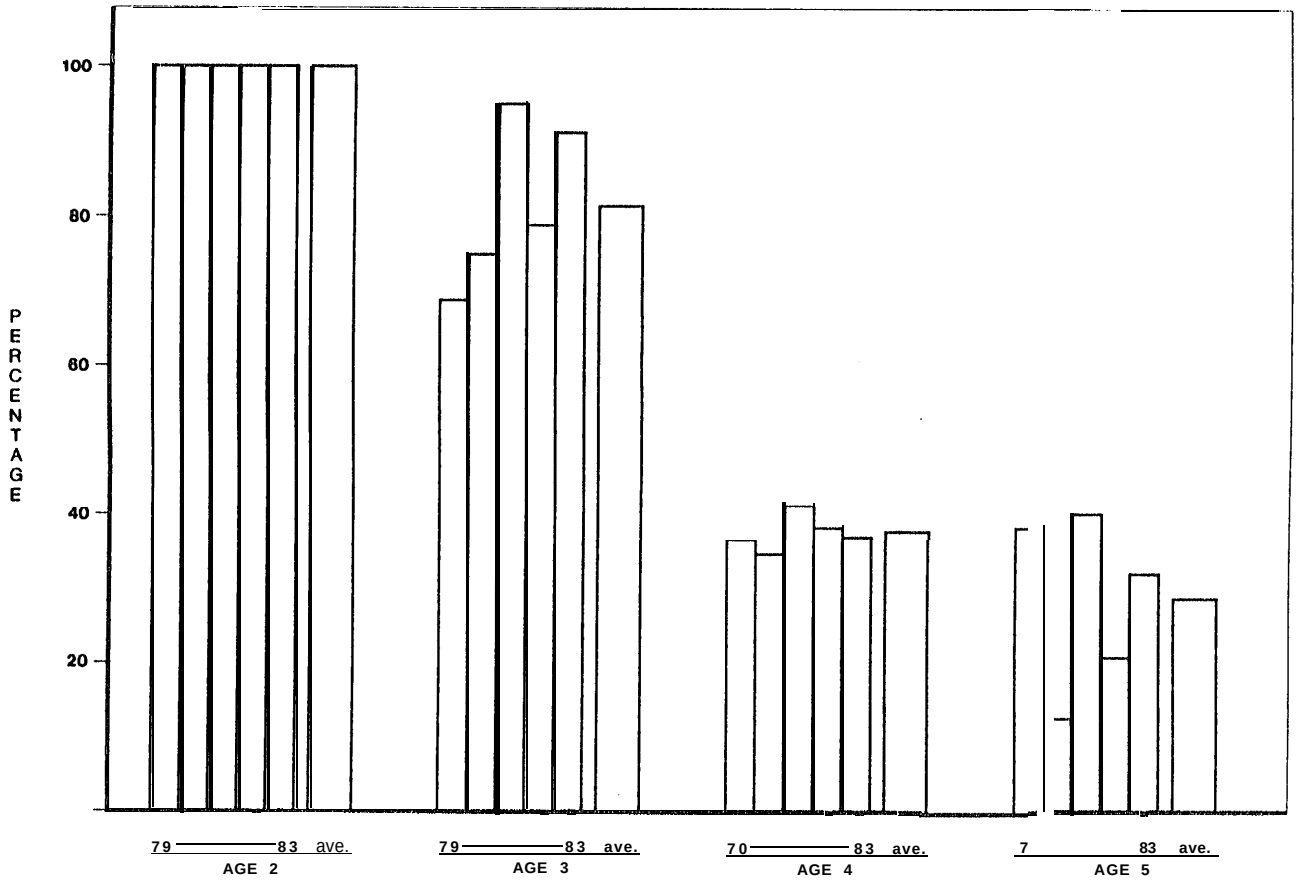


Figure 4. Percent male URB fall chinook at Priest Rapids Hatchery, 1979-1983.

Table 8. Fork length (cm) according to sex and age for URB fall chinook sampled on the Hanford Reach, 1981 and 1982.

Year	Age 2		Age 3		Age 4		Age 5	
	Male	Female	Male	Female	Male	Female	Male	Female
1981								
Sample size	95	0	93	17	203	207	46	182
Average fork length (cm)	47.1	-	65.7	69.5	93.5	81.2	104.2	93.2
Range	33-68		46-85	56-76	64-112	70-98	90-118	77-109
Standard deviation	5.5	-	8.6	4.5	8.3	5.1	5.4	5.9
1982								
Sample size	155	0	122	103	89	174	49	182
Average fork length (cm)	49.4	-	70.1	74.3	92.0	85.2	107.9	96.2
Range	33-67		52-86	62-84	70-115	67-101	90-118	81-108
Standard deviation	7.5	-	7.0	4.2	9.9	6.1	6.6	5.9

JUVENILE LIFE HISTORY

Time of emergence

For the 1963-1967 brood years at the Priest Rapids Hatchery spawning channel, eyed-egg stage was most prevalent during late December to early January and emergence occurred primarily in late April and early May (Allen et al. 1969).

Time, age, and size at migration

Allen and Meekin (1973) reported that marked 1965, 1968 and 1969 brood URB sub-yearlings released at Priest Rapids Hatchery in May and June did not arrive at McNary Dam until July and early August, with some arrivals continuing into September. Nichols (1979) showed that peak abundance of fall type chinook juveniles occurred in late July. In 1984, downstream passage indices at McNary Dam indicated a somewhat earlier migration pattern with peak passage during late June and early July (WBC 1984). The 1984 migration may be skewed to an earlier timing because of the increased hatchery releases upstream of McNary Dam (15 million) over the historical levels of l-5 million during 1971-1982. Collectively, the information indicates that peak migration occurs in July with lesser numbers migrating in June, August, and September. Based on coded wire tagged Priest Rapids Hatchery releases, median date of recovery in the Columbia River estuary was about a month after release (Table 9). Although most URB fall chinook migrate downstream as sub-yearlings, some juvenile URB fall chinook rear in freshwater for one year and migrate downstream to the ocean the following spring based on scale analysis and coded wire tag recovery information.

Fingerling smolts released from Priest Rapids Hatchery in May to July average 60-100 fish/pound and 100-130 mm in length.

Releases from Kalama Falls and Bonneville Hatchery generally occur in the fall as sub-yearlings or the following spring as yearlings. Size is correspondingly larger ranging from about 7-20 fish/pound.

Survival rate

IDFG (1984) utilized a smolt to adult survival rate of 2.0 percent in the analysis of long term objectives for natural and wild production in the Snake River. The rate for hatchery production was 1.0 percent.

Smolt to adult survival (all catch and escapement) averaged 0.8 percent for three coded wire tag groups (codes: 13-12-2, 13-11-1 of 1975 brood; and 63-16-62 of 1976 brood) released from Priest Rapids Hatchery.

DISEASE HISTORY

A disease profile for URB fall chinook at Priest Rapids and Ringold Springs hatcheries is presented in Table 10 and for Kalama Falls Hatchery in Table 11.

Table 9. Juvenile out-migrant timing of coded-wire tagged upriver bright fall chinook released from Priest Rapids Hatchery and recovered at Jones Beach (River Mile 47) in the Columbia River estuary (Dawley et al. 1982).

Origin	Purpose	Size at release (fish/lb)	Release Year	Release Date	Percent of release recaptured	Year	Median fish	First fish	Last fish	Movement rate (RM/day)
Priest Rapids Hatchery										
	Sub-yearling release									
	PNRC Upper Columbia River evaluation	96	1977	27 June	0.002	1977	29 Aug.	22 Aug. - 30 Aug.		5
	Columbia River fall chinook evaluation	74	1977	23 May	0.047	1977	17 July	17 June - 1 Aug.		6
	Columbia River fall chinook evaluation	77	1979	28 June	0.027	1979	30 July	21 July - 17 Aug.		11
					0.002	1980	23 April	23 April		21
	5 percent evaluation	67	1981	18 May	0.002	1981	1 July	18 June - 21 July		7

Table 10. Diseases encountered by upriver bright stock fall chinook at Priest Rapids and Ringold hatcheries, 1979-1983 (WDF 1984).

Type	Disease	Infected Group
Bacterial:	Columnaris	1979, 1981 adults
	Gill disease	1981 juveniles
	Enteric redmouth	1982 juveniles
Parasitic:	*Ichthyophthirus*	1978-1980 brood juveniles
	Eye fluke	1978, 1980 brood juveniles
	Trichodina	1980 brood juveniles
	Costia	1981 juveniles
Viral:	None	
Other:	Soft shell	1978 juveniles
	Saprolegnia invaderis	1980 juveniles
	Coagulated yolk	1980 eggs
	Clubbed gills	1981 juveniles

Table 11. Diseases encountered by egg-bank stock fall chinook at Kalama Falls Hatchery, 1979-1983 (WDF 1984).

Type	Disease	Infected Group
Bacterial:	Bacterial kidney disease	1979-1981 brood juveniles
	Low temperature disease	1981 juveniles
	Bacterial hemorrhagic septicemia	1981 juveniles
Parasitic:	*Costia*	1979 brood juveniles
	Fungus	1980 brood juveniles
Viral :	None	
Other:	None	

The viral disease infectious hematopoietic necrosis (IHN) was detected in 1984 brood URB fall chinook at Bonneville Hatchery.

PRIORITY INFORMATION NEEDS

The foremost information need for URB fall chinook is an assessment of the life history characteristics of the juvenile fall chinook population on the Hanford Reach and mainstem Columbia impoundments. This study should be designed so that separate profiles could be determined for the juveniles produced from natural spawning and for the hatchery releases that must pass through the Hanford Reach and pool areas possibly impacting the natural production due to intraspecific competition for food or preferred habitat.

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UPPER COLUMBIARIVER SPRING CHINOOK
(including Wenatchee, Entiat, and Methow basins)

The upper Columbia River spring chinook run is composed of one major wild substock in the upper Wenatchee and three hatchery influenced substocks in the Entiat River, Methow River, and lower Wenatchee River (Icicle Creek). Cowlitz stock spring chinook have been released from Ringold Springs Hatchery on the mainstem Columbia River upstream of McNary Dam. Information on this production segment can be found in the Cowlitz spring chinook summary.

PRODUCTION

Natural production is emphasized in the Wenatchee, Methow, and Entiat basins. An extensive federal hatchery program on each of these systems supplements the natural run. Leavenworth Hatchery on Icicle Creek annually released an average of 2.3 million (range: 1.7-2.8) yearling spring chinook from 1979 to 1983. For the same period, yearling releases from Winthrop and Entiat hatcheries have averaged 0.9 million (range: 0.4-1.2) and 0.7 million (range: 0.4-1.0) respectively.

GEOGRAPHIC LOCATION

Hatcheries

The hatcheries in the upper columbia that release spring chinook include Leavenworth, Winthrop, and Entiat federal facilities.

Streams

Wenatchee, Methow, and Entiat basins are the major production areas for upper Columbia spring chinook.

ORIGIN

Hydroelectric and diversion dam construction reduced the abundant populations of native spring chinook in the upper Columbia tributaries (Fulton 1968). The earliest hatcheries in this area were operated by state and county agencies at the turn of the century and reared ‘early’ chinook and ‘silversides’ (coho)(Mullan 1984a). Success of these hatchery programs was poor and they were only operational for a few years. The federal hatcheries were developed in the 1940's as mitigation for salmon and steelhead losses from Grand Coulee construction (Mullan 1982). Spring chinook stocking history for the federal hatcheries is divided into two periods. Beginning in the 1940's, spring chinook broodstock were intercepted at Rock Island Dam or occasionally obtained from lower Columbia hatcheries (J. Mullan, USFWS, personal communication). Commencing in 1969, Carson stock spring chinook were reared at Leavenworth Hatchery, although Cowlitz stock spring chinook were

released in 1976 and 1978. Entiat Hatchery released Klickitat stock spring chinook in 1975 and Cowlitz stock in 1976 (Table 1). The current spring chinook releases are considered to be a derivative of Carson stock.

Currently, the natural spawning populations in the Entiat and Methow rivers may be genetically linked to the adjacent hatchery production. The upper Wenatchee spring chinook population is considered, by some, to be a true wild run, but some minor influences from Leavenworth Hatchery strays may occur,

ADULT LIFE HISTORY

Since 1970, the average adult freshwater run has averaged 5,250 in the Wenatchee River (Table 2), 1,200 in the Entiat (Table 3) and 2,350 to the Methow River (Table 4). Natural escapement was calculated using fish count differences at Rocky Reach, Rock Island and Wells dams and subtracting any tributary harvest and hatchery returns.

Catch distribution information based on coded wire tag recoveries shows a low ocean catch similar to other Columbia River spring chinook populations upstream of Bonneville Dam (Table 5). In the May 1982 chinook troll fishery off northern Oregon and Washington, all upper Columbia spring chinook (Carson, Little White Salmon, Klickitat, Warm Springs, Round Butte, Leavenworth, and Winthrop hatcheries) comprised only 2.4 percent of the catch using the Genetic Stock Identification method (Miller et al. 1983).

Time of migration

Freshwater migration begins in mid-March. Counts of all upriver spring chinook stocks peaks at Bonneville Dam in mid to late April. An average of 50 percent of the Wenatchee, Entiat and Methow spring chinook run migrated past Priest Rapids Dam by mid-May during 1977 and 1979-1982 (Figure 1).

Spawning Period

Spawning commences in mid-August and continues into September.

Spawning areas

Redd counts from the Wenatchee (Table 6), Entiat (Table 7), and Methow (Table 8) systems shows the dominance of the Wenatchee naturally spawning population.

Age composition

Age information is not available for the natural spawning population.

From length-frequency samples at Leavenworth Hatchery in 1980-1982, most of the returns are five-year-olds averaging 65 percent of the hatchery escapement (Table 9). Jacks (age-3) averaged only 2 percent of the returns.

Table 1. Releases of non-local stock (excluding Carson) spring chinook into Columbia River (T. Roth, USFW, personal communication).

Stream	Brood Year	Release Year	Number released	Type	Hatchery	Stock
Entiat River	1974	1975	50,000	Fingerling	Entiat	Klickitat
	1974	1976	436,000	Yearling	Entiat	Cowlitz
Icicle Creek	1974	1976	771,600	Yearling	Leavenworth	Cowlitz
	1976	1978	217,000	Yearling	Leavenworth	Cowlitz

a/ WDF (1985)

Table 2. Estimated freshwater adult run size of spring chinook destined for Wenatchee Basin. 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial[a]	Ceremonial and subsistence[b]	Commercial[a]	Recreational[c]	Natural[d]	Hatchery[e]	Total production
1970	N/A	N/A	N/A	0	1,500	150	0,650
1971	N/A	N/A	N/A	0	1,850	50	1,900
1972	N/A	N/A	N/A	0	3,150	0	3,150
1973	N/A	N/A	N/A	0	3,700	0	3,700
1974	N/A	N/A	N/A	0	3,200	1,700	4,900
1975	0	N/A	0	<50	2,700	50	2,750
1976	0	N/A	0	200	2,100	2,000	4,300
1977	N/A	N/A	N/A	1,900	7,600	3,000	12,500
1978	N/A	N/A	0	1,500	8,650	1,550	11,700
1979	0	N/A	0	0	2,550	1,750	4,300
1980	0	N/A	0	<50	2,200	2,350	4,550
1981	0	N/A	0	150	1,600	2,400	4,150
1982	0	N/A	0	100	2,250	2,750	5,100
1983	0	250[f]	0	250	2,850	3,050	6,150
1984	0	350[f]	0	(350)	4,250	3,450	8,050
Mean	N/A	N/A	N/A	300	3,350	1,600	5,250

a/ Contribution is not available for years with spring season (1970-1974, 1977) and assumed to be negligible for other years with possible exception of 1978 winter season treaty catch (2,600 chinook).

b/ Limited to opportunity in mainstem Columbia River only.

c/ Tributary only.

d/ Difference between counts at Rocky Reach and Wells dams less any hatchery escapement. Actual natural escapement may vary because of interdam mortality, incorrect cut-off dates for dam counts, and unresolved differences in dam counts depending on data source.

e/ Fiscus (1984) for 1970-1983.

f/ Wells Dam count minus sport harvest and hatchery escapement. Actual natural escapement may vary because of interdam mortality, incorrect cut-off dates for dam counts, and unresolved differences in dam counts depending on data source.

N/A: not available.

Table 3. Estimated freshwater adult run size of spring chinook destined for Rntiat River. 1970-1984.

Return year	HARVEST				ESCAPEMENT		Total production
	Treaty		Non-treaty				
	Commercial[a]	Ceremonial and subsistence&	Commercial[a]	Recreational[c]	Natural[d]	Hatchery[e]	
1970	N/A	N/A	N/A	0	1,600	0	1,600
1971	N/A	N/A	NIA	0	1,100	0	1,100
1972	N/A	N/A	N/A	0	1,100	0	1,100
1973	N/A	N/A	N/A	0	800	0	800
1974	N/A	N/A	N/A	0	800	0	800
1975	0	N/A	0	0	1,100	0	1,100
1976	0	N/A	0	0	400	0	400
1977	N/A	N/A	N/A	0	1,900	0	1,900
1978	N/A	N/A	0	0	3,100	0	3,700
1979	0	N/A	0	0	1,050	0	1,050
1980	0	N/A	0	0	600	300	900
1981	0	N/A	0	0	1,500	250	1,750
1982	0	N/A	0	0	250	250	500
1983	0	N/A	0	0	<50	650	650
1984	0	N/A	0	0	<50	750	750
Mean	N/A	N/A	N/A	0	1,050	150	1,200

a/ Contribution is not available for years with spring season (1970-1974, 1977) and assumed to be negligible for other years with possible exception of 1978 winter season treaty catch (2,600 chinook).
b/ Limited to opportunity in mainstem Columbia River only.
c/ Tributary only.
d/ Difference between counts at Rocky Reach and Wells dams less any hatchery escapement. Actual natural escapement may vary because of interdam mortality, incorrect cut-off dates for dam counts, and unresolved differences in dam counts depending on data source.
e/ Fiscus (1984) for 1970-1983.
N/A: not available.

Table 4. Estimated freshwater adult run size of spring chinook destined for Methow River, 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial[a]	Ceremonial and subsistence[b]	Commercial[c]	Recreational[d]	Natural[e]	Hatchery[f]	Total production
1970	N/A	N/A	N/A	0	2,000	0	2,000
1971	N/A	N/A	N/A	0	2,250	0	2,250
1972	N/A	N/A	N/A	0	3,300	0	3,300
1973	N/A	N/A	N/A	0	2,400	0	2,400
1974	N/A	N/A	N/A	0	3,000	0	3,000
1975	0	N/A	0	0	2,000	0	2,000
1976	0	N/A	0	0	1,400	0	1,400
1977	N/A	N/A	N/A	0	3,900	0	3,900
1978	N/A	N/A	0	0	3,550	50	3,600
1979	0	N/A	0	0	900	100	1,000
1980	0	N/A	0	<50	800	100	900
1981	0	N/A	0	0	1,300	400	1,700
1982	0	N/A	0	0	1,700	550	2,250
1983	0	N/A	0	0	1,950	750	2,700
1984	0	N/A	0	0	2,550	500[d]	3,050
Wean	N/A	N/A	N/A	0	2,200	150	2,350

a/ Contribution is not available for years with spring season (1970-1974, 1977) and assumed to be negligible for other years with possible exception of 1978 winter season treaty catch (2,600 chinook).
b/ Limited to opportunity in mainstem Columbia River only.
c/ Tributary only.
d/ Adults actually handled totaled 511, another 400 fish escaped the holding facility during construction.
e/ Fiscus (1984) for 1970-1983.
f/ Wells Dam count minus sport harvest and hatchery escapement. Actual natural escapement may vary because of interdam mortality, incorrect cut-off dates for dam counts, and unresolved differences in dam counts depending on data source.
N/A: not available.

Table 5. Harvest profile of upper Columbia River spring chinook (Wenatchee, Entiat and Methow rivers) from Leavenworth Hatchery coded wire tag releases.

Harvest component	Percent
Alaska:	
Troll and sport	–
British Columbia:	
Northern troll	–
Southern troll	34.8
Net and sport	3.8
Oregon:	
Troll and sport	–
Washington:	
Ocean troll and sport	–
Other net and sport	–
Columbia River:	
Non-treaty commercial net	6.5
Treaty commercial net	25.0
Terminal sport	29.9

Survival.	'76 brood 63-17-2	'74 brood 13-7-11
Smolt to all adult	0.10%	0.14%
Smolt to fisheries	0.01%	0.09%
Smolt to Columbia River	0.10%	0.13%

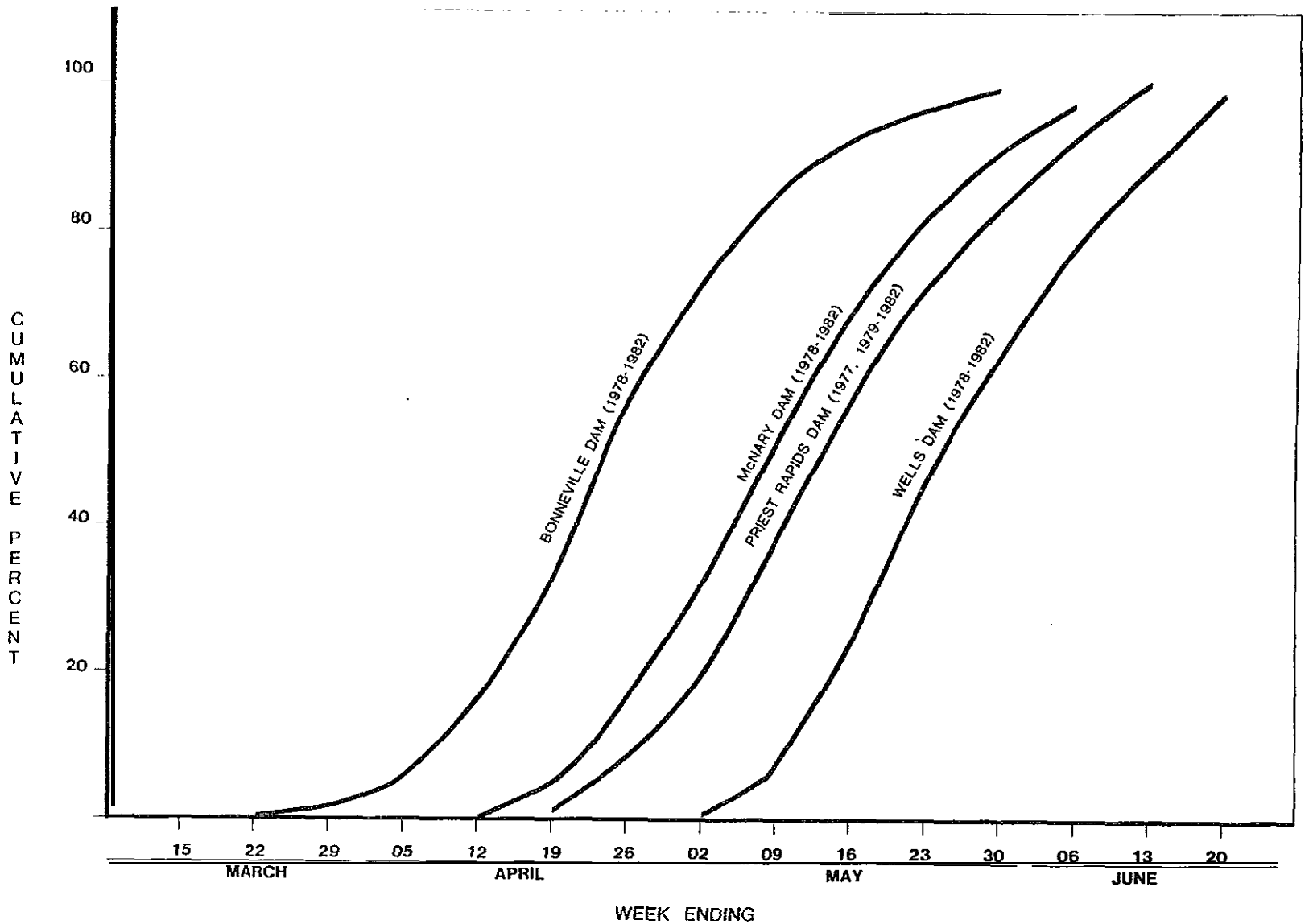

Figure 1. Cumulative percentage of spring chinook adults passing four Columbia River dams.

Table 6. Redd counts and minimum natural spawning population estimates of spring chinook in the Wenatchee Basin, 1970-1984.

	Redds[a]								
Year	Nason Creek (53.61	Chiwawa River (48.4)	White River (58.6)	Little Wenatchee River (58.6)	Icicle Creek (25.6)	Pehastin Creek (17.9)	Mainstem Wenatchee	Total redds	Total population
1970	158	276	6	11	2	NC	NC	453	1,404
1971	113	114	48	20	30	NC	16	341	1,057
1972	37	215	40	32	20	NC	61	405	1,256
1973	368	427	51	78	11	NC	48	983	3,041
1974	183	87	37	20	120	3	1	451	1,398
1975	254	229	22	14	178	NC	NC	697	2,161
1976	103	220	36[c]	19	138	NC	18[c]	534	1,655
1977	94	293	39	0	15	NC	46[c]	487	1,510
1978	233	279	44	27	55	NC	39[c]	677	2,099
1979	70	59	NC	0	89	NC	27[c]	245	760
1980	66	119	NC	17	91	NC	11[c]	304	942
1981	69	84	18	36	18	5	22	252	781
1982	93	97	19	40	21	1	1	272	843
1984[d]	139	165	69	51	15	3	3	445	1,370
	71	181	49	64	43	0	13	421	1,305
Mean	137	190	37	29	56	2	24	464	1,439

a/ Fiscus (1984) for 1973-1983, Fiscus (1980) for 1970-1972.
b/ Redds times a 3.1 fish per redd factor from Meekin (1967).
c/ Poor visibility.
d/ J. Easterbrooks, WDF, personal communication.
NC: Not counted.
() Wenatchee river mile.

Table 7. Redd counts and minimum spawning population estimates of spring chinook in Entiat River, 1970-1974.

Year	Redd count[a]	Total population[b]
1970	70	217
1971	136	422
1972	61	189
1973	229	710
1974	88	273
1975	156	484
1976	47	146
1977	171	530
1978	326	1,011
1979	NC	NC
1980	107	332
1981	95	295
1982	107	332
1983	107	332
1984[c]	85	264
Mean	128	396

a/ Fiscus (1984) for 1973-1983: Fiscus (1980) for 1970-1972.
b/ Redds times 3.1 fish per redd factor from Meekin (1967).
c/ J. Easterbrooks, WDF, personal communication.

Table 8. Redd counts and minimum natural spawning population estimates of spring chinook in Methow Basin, 1970-1984.

Year	Redds[a] Lost River (73.0)	Chewack River (50.1)	Twisp River (40.2)	Mainstem Methow	Total redds	total population[b]
1970	101	46	75	150	372	1,153
1971	70	33	97	113	313	970
1972	69	97	97	65	328	1,017
1973	65	89	247	95	496	1,538
1974	11	52	129	49	241	747
1975	59	98	177	39	373	1,157
1976	12	22	53	34	121	375
1977	14	107	174	65	360	1,116
1978	50	59	265	67	441	1,367
1979	26	13	40	12	91	282
1980	13	14	27	25	79	245
1981	20	6	24	39	89	276
1982	29	8	17	56	110	341
1983	18	29	58	63	168	521
1984[c]	54	15	48	43	160	496
Mean	41	46	102	61	250	773

a/ Fiscus (1984) for 1973-1983: Fiscus (1980) for 1970-1972.
b/ Redds times 3.1 fish per redd factor from Meekin (1967).
c/ J. Easterbrooks , WDF, personal communication.
0 Methow River Mile.

Table 9. Age of hatchery spring chinook salmon escapement to Leavenworth Hatchery based on leng samples (Mullan 1982).

Length	[illegible]	[illegible]	[illegible]	[illegible]	Winthrop [illegible]	Entiat [illegible]
Age 3						
< 24	79 (3%)	26 (1%)	81 (3%)	2%	49 (8%)	4 (2%)
Age 4						
24-32	)	1,016 (42%)	812 (29%)	33%	315 (53%)	171 (69%)
Age 5						
> 32	1,699 (69%)	1,388 (57%)	1,906 (68%)	65%	234 (39%)	72 (29%)

Scale samples collected in 1984 from an early returning portion of the Leavenworth escapement showed a dramatic shift to predominately four-year-olds (87 percent), but is considered atypical. Age specific length intervals for the 1984 samples were similar to those utilized by Mullan (1982).

Size

Size information is not available on the natural spawning population.

Length-weight relationships in 1981 and 1982 revealed that five-year-old spring chinook were greater than about 15 pounds and four-year-olds ranged between 6-15 pounds each (Figures 2,3).

Sex ratio

Information is limited to hatchery escapements.

Jacks are entirely males. Four-year-old adults are predominately females and age-5 adults mostly males.

Fecundity

Fecundity ranged from 4,200-4,600 eggs per female at Leavenworth Hatchery during 1978-1981 (Mullan 1982).

Biochemical-senetic characteristics

Schreck et al. (1984) determined a statistically significant difference existed for one enzyme system in the returns to Leavenworth between their samples and the historical profile from Milner et al. (1983).

JUVENILE LIFE HISTORY

Time of emergence

No information is available on the naturally produced population

Artificial emergence (absorbed yolk-sac) at the hatcheries occurs in late November.

Time. age, and size at migration

Hatchery reared juveniles are customarily released as yearlings in April and May at 10-18 fish/pound and 120-150 mm. in length. Median recapture date in the Columbia estuary for two coded wire tagged releases (1978 and 1979 brood) occurred about one month after release (Table 10).

Survival rate

Survival rate based on all catch and escapement is not available.

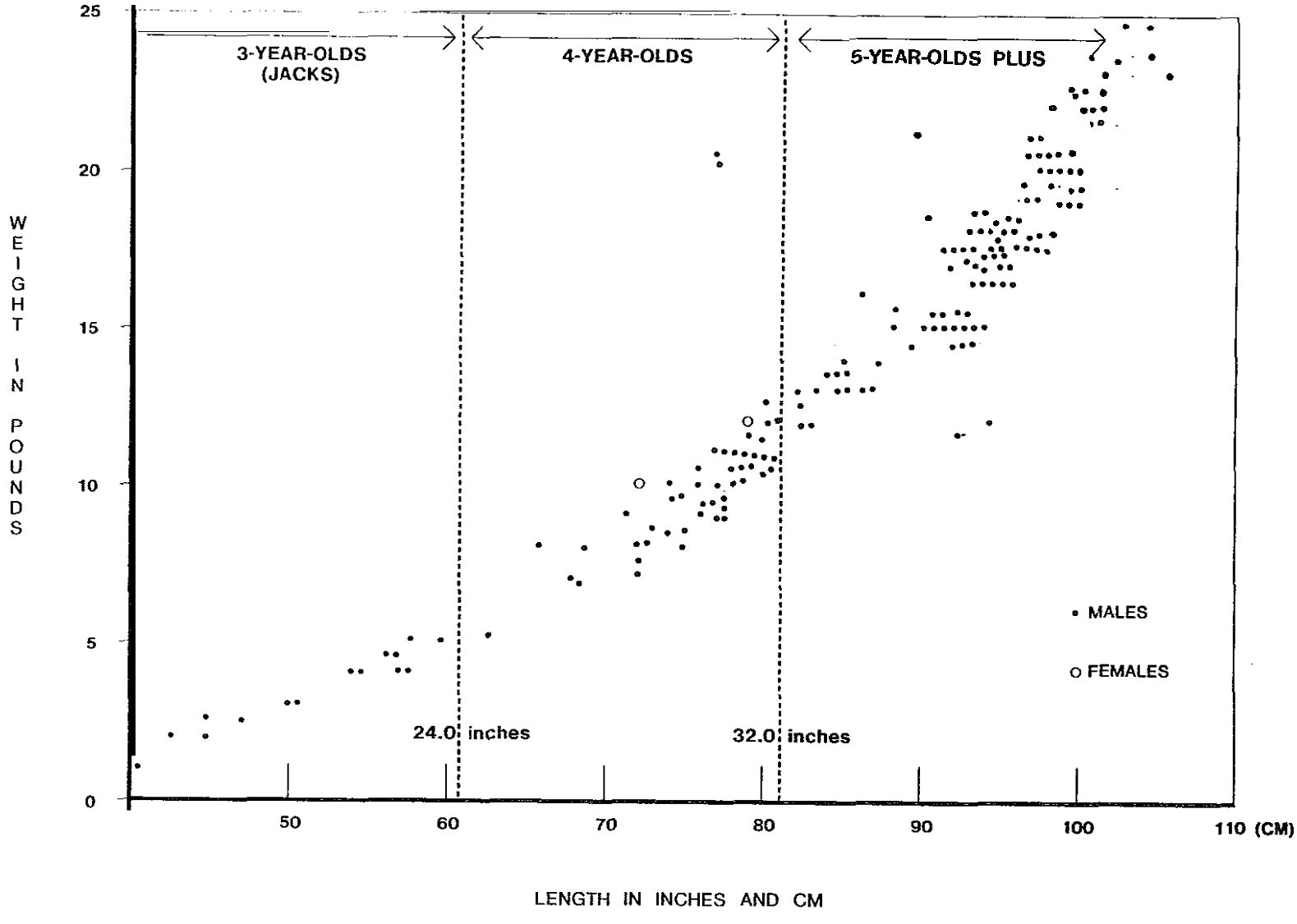

Figure 2. Length-weight of spring chinook, Leavenworth Hatchery, August 1982 (Mullan 1982).

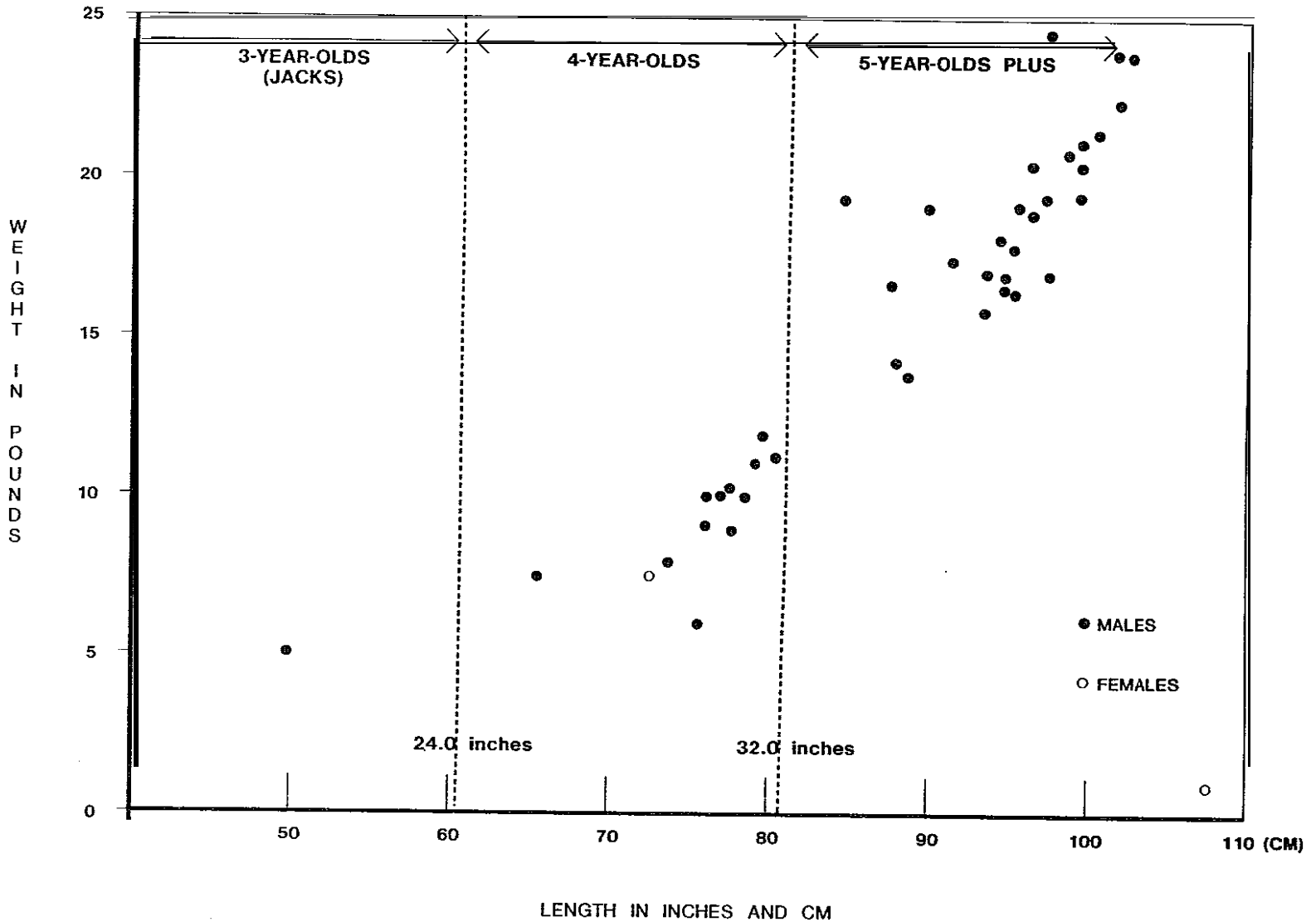

Figure 3. Length-weight of spring chinook, Leavenworth Hatchery, August, 981.

Table 10. Juvenile outmigrant timing of coded wire tagged Leavenworth Hatchery yearling spring chinook based on recoveries in the Columbia estuary at Jones Beach (River Mile 47) (Dawley et al. 1982).

Orioin	Purpose	Size at release (fish/lb)	Release Year	Release Date	Percent of release recaptured	Median fish Year	Median fish	First-Last fish	Movement rate (RM/day)
Leavenworth Hatchery									
	Yearling Release								
	Production evaluation	15	1978	25 Apr.	0.090	1978	22 May	28 Apr. - 28 Jun	16
	Hatchery evaluation	15	1979	26 Apr.	0.140	1979	29 May	12 May - 8 Jun	13

Survival to hatchery escapement average 0.22 percent and ranged from 0.05-1.51 percent for the 1968-1978 brood on-station releases from Leavenworth Hatchery (Mullan 1984b).

DISEASE HISTORY

For hatchery reared juveniles, bacterial kidney disease can be a major problem with furunculosis and redmouth present occasionally. Infectious hematopoietic necrosis (IHN) has been detected in smolts released from Entiat Hatchery but has not been a source of significant loss. IHN was diagnosed in a small number of adults in 1982 and 1983 (G. Taylor, USFWS, personal communication). Catastrophic losses of spawners due to columnaris has occurred in Icicle Creek in drought (warm water) years (Mullan 1982).

PRIORITY INFORMATION NEEDS

Virtually no biological information is available on the natural spawning populations in this area. Life history and electrophoretic profiles of the adult and juvenile natural populations should be compared to the hatchery production in order to determine the genetically based stock segments in this area.

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UPPER COLUMBIA RIVER SUMMER CHINOOK
(including Wenatchee, Entiat, Methow, and Okanogan basins)

Columbia River summer chinook are produced in the Snake River basin and in the upper Columbia system upstream of Rock Island Dam. This summary will contain information on summer chinook from the upper Columbia River.

PRODUCTION

Upper Columbia summer chinook are produced naturally in the following rivers: Wenatchee, Methow, Okanogan, and Similkameen (Okanogan tributary). Although managed primarily for natural production, summer chinook are released annually from Wells Dam Hatchery and intermittently at Rock Reach and Winthrop (Methow River) hatcheries. Wells Dam Hatchery fingerling releases ranged from 1.4 million to 2.3 million and averaged 2.2 million between 1979 and 1983. Wells Dam Hatchery also released about 314,000 yearlings in 1980. During 1979-1983, yearling summer chinook were released from Winthrop Hatchery in 1979 (236,800) and 1982 (268,100) and from Rocky Reach Hatchery in 1982 (101,500 and 1983 (175,600).

GEOGRAPHIC LOCATION

Streams

Rivers containing summer chinook include: Wenatchee, Methow, Okanogan, Similkaeeen, and a negligible number in the Entiat (remnant?). Redds are also observed in the mainstem Columbia near the Chelan Dam outlet but it is not known whether this population is a summer, fall or mixed race. The time of spawning extends l-3 weeks later than the tributary summer chinook populations.

Hatcheries

Hatcheries rearing summer chinook include: Wells Dam, Rocky Reach, and Winthrop.

ORIGIN

Prior to hydroelectric dam development, summer chinook migrated as far as Windermere Lake in British Columbia (Fulton 1968). Immediately prior to the completion of Grand Coulee Dam in 1941, the summer chinook runs destined for the upper most reaches of the Columbia River were intercepted at Rock Island Dam (1939-1941) and transplanted into the Wenatchee, Entiat, Methow, and Okanogan rivers. Native summer chinoolc runs in these tributaries, if they existed, were virtually eliminated by the time of the relocation program. Historical affidavits and other records indicate a negligible native run returned to the Wenatchee system and possibly the Methow River (J. Mullan,

USFWS, personal communication). The existence of a native summer chinook run in the Entiat River is disputed. The Okanogan system contained native summer chinook (Fulton 1968).

Initial artificial propagation of summer chinook began in the early 1940's at Leavenworth, Entiat, and Winthrop hatcheries. Nearly all releases were fry and varied in number from one thousand to almost a million. Most were released into the Entiat River and showed some success based on the cumulative adult returns of 11,365 between 1953-1961 (J. Mullan, USFWS, personal communication). The Entiat River presently contains few, if any, summer chinook (J. Easterbrooks, WDF, personal communication). Releases from these federal hatcheries were terminated in the 1960's but were reestablished at Winthrop Hatchery on an intermittent basis in the mid-1970's.

In 1967, a permanent artificial propagation program began at the Wells Spawning Channel facility. Broodstock originated from voluntary entries to the channel or from adults trapped at Wells Dam. For the first four years of operation, the facility utilized an average of 29 percent of the total summer chinook run at Wells Dam. Conventional hatchery rearing began with the 1978 brood when the spawning channel program was discontinued.

Broodstock for Rocky Reach and Winthrop hatcheries (mid-1970's) originated from fish collected at Wells Dam or from voluntary returns to Wells Hatchery. Winthrop Hatchery released local stock yearlings in 1982.

ADULT LIFE HISTORY

Run size, catch, and escapement

Since 1970, the freshwater adult run has averaged 14,000 (Table 1). Because of the extremely depressed status of upper Columbia summer chinook, harvest has been limited to incidental commercial and recreational catch (50-4,450 combined) or to tribal ceremonial and subsistence fisheries (200-1,050 documented). Snake River summer chinook are also severely underescaped.

Based on total area redd count expansion, the upper Columbia summer chinook population returns primarily to the Wenatchee system, comprising about 58 percent of the run during 1970-1984 (Table 2).

A harvest profile for two brooods (1974 and 1976) of coded wire tag fingerling releases from Wells Dam Hatchery, revealed that 78 percent of the overall catch occurred in Alaska and British Columbia (Figure 1). A comparison of the number of recoveries in the ocean fisheries to those in the Columbia River reveals a relatively high ocean harvest rate. Upper Columbia summer chinook comprised 0.3 percent of the May 1982 harvest of chinook in the troll fishery off northern Oregon and Washington (Miller et al. 1983). This low catch percentage reflects the low relative abundance of upper Columbia summer chinook in the ocean.

Table 1. Minimum freshwater adult run size of upper Columbia River summer chinook, 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial [b]	Ceremonial and subsistence [c]	Commercial	Recreational	Natural [e]	Hatchery	Total production
1970	1,800	N/A	700	800	11,000	1,750	16,050
1971	2,050	N/A	900	1,300	13,250	4,800	19,300
1972	1,800	N/A	850	750	11,000	1,700	16,100
1973	700	N/A	50	750	8,000	2,100	11,600
1974	50	N/A	0	0	6,850	2,900	9,800
1975	0	N/A	0	0	11,250	3,300	14,550
1976	0	N/A	0	0	11,150	2,500	13,650
1977	0	500	0	0	9,650	3,000	13,000
1978	0	500	0	0	17,450	2,200	19,950
1979	0	900	0	0	17,650	2,100	20,150
1980	0	950	0	0	13,200	1,850	16,000
1981	0	1,050	0	0	7,950	1,200	10,200
1982	0	850	0	0	6,300	700	7,850
1983	0	200	0	0	5,900	850	6,950
1984	0	250	0	0	13,200	(1,100)	(14,550)
Nean	1,300 [d]	650	650 [d]	900 [d]	10,900	1,950	14,000

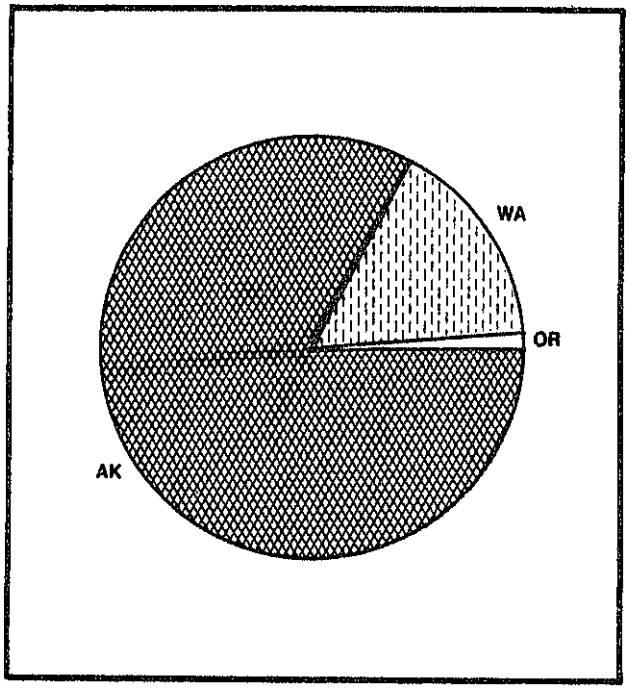
a/ Mainstem Columbia River harvest only and adjusted by percent escapement over priest Rapids Dam versus Harbor Dam (Snake River summer chinook).
b/ ODF&W-WDF (1984).
c/ Bowers (1985).
d/ 1970-1973 only.
e/ Wells Dam count plus Wenatchee River escapenent (Rock Island Dam minus Rocky Reach counts in 1973-1983 or Wenatchee River redd count expansion in 1970-1972).
0 (Preliminary).
N/A: Not available.

Table 2. Minimum natural spawning escapement based on redd counts for upper Columbia River summer chinook, 1970-1984[a/].

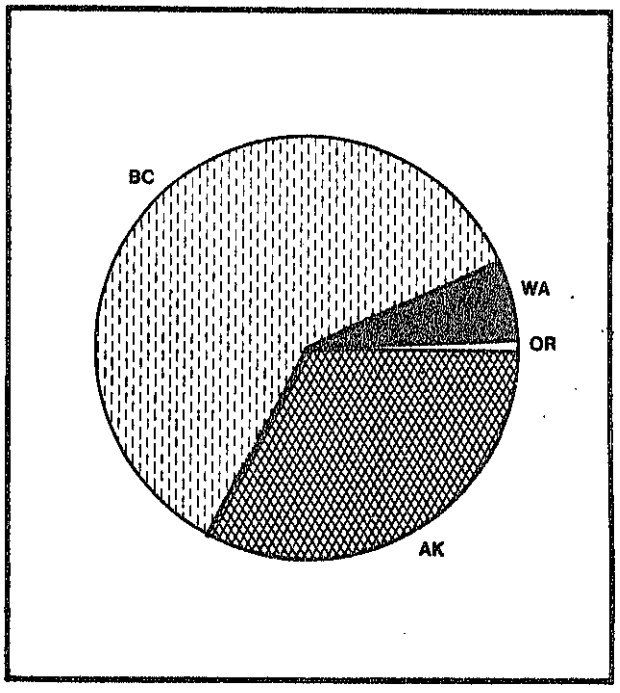
Year	Wenatchee River [b/]	Methow River [c/]	Okanogan River [d/]	Similkameen River [e/]	Total
1970	4,163	2,186	2,034	1,107	9,490
1971	4,399	1,742	961	651	7,753
1972	4,228	1,008	564	171	5,971
1973	3,546	1,135	428	198	5,307
1974	3,581	691	350	403	5,025
1975	2,868	1,339	846	623	5,676
1976	2,458	592	332	415	3,797
1977	3,091	1,132	856	431	5,510
1978	3,670	1,606	605	831	6,712
1979	2,424	1,928	536	428	5,316
1980	3,494	1,070	366	533	5,463
1981	2,737	605	171	406	3,919
1982	1,714	440	71	183	2,408
1983	1,711	202	112	177	2,202
1984	2,920	502	729	933	5,084
Mean	3,134	1,079	597	499	5,309

a/ Total production area redd counts times a 3.4 fish per redd factor from Meekin (1967).
b/ Total spawning area River Mile 0.5 to 46.0.
c/ Total spawning area River Mile 2.0 to 50.0.
d/ Total spawning area River Mile 26.2 to 77.4.
e/ Total spawning area River Wile 3.0 to 5.0.

Distribution of U.S. Catch



Distrubution of Total Catch



Percentage By Fishery

Alaska Troll & Net	62.44
Washington Ocean Troll	6.23
Washington Ocean Sport	7.65
Washington Coastal Net	0
Puget Sound Troll & Sport	2.68
Puget Sound Net	0
Columbia River Sport & Net	0
Oregon Ocean Troll	.93
Oregon Ocean Sport	.07
California Ocean Troll	0
California Ocean Sport	0

Percentage By Fishery

Alaska Troll & Net	32.86
Washington Ocean Troll	2.48
Washington Ocean Sport	3.05
Washington Coastal Net	0
Puget Sound Troll & Sport	1.07
Puget Sound Net	0
Columbia River Sport & Net	0
Oregon Ocean Troll	.37
Oregon Ocean Sport	.03
California Ocean Troll	0
California Ocean Sport	0
No. B.C. Troll, Sport, Net	28.6 1
So. B.C. Troll, Sport, Net	31.54

Figure 1. Harvest profile of upper Columbia River summer chinook from 1974-1977 brood coded wire tagged releases from Wells Dam Hatchery (Buckman et al. 1984).

Time of migration

Summer chinook migration begins in late May or early June with peak counts at Bonneville Dam during early July. Approximately 50 percent of the upper Columbia run has migrated past Priest Rapids Dam in mid-July and past Wells Dam in late July (Figure 2). Frequently, summer chinook do not enter the Okanogan River until September because of warm water in contrast to the Wenatchee and Methow rivers where migration is not delayed (J. Easterbrooks, WDF, personal communication).

Spawning period

Spawning occurs during late September through early November. During 1965 and 1966, peak redd counts from the Methow, Okanogan and Similkameen rivers occurred between October 20 and October 30th (Meekin et al. 1966; Meekin 19671. At Wells Dam Hatchery spawning commences in late September with a peak in late October or early November.

Spawning areas

In the Wenatchee River, most of the spawning occurs downstream of Tumwater Dam (river mile 32). This reach contained an average of 94 percent of the total redds observed in 1973-1978 (J. Easterbrooks, WDF, personal communication). Spawning in the mainstem Okanogan occurs from Lake Osooyoos (river mile 77) downstream to the town of Okanogan (river mile 26). Summer chinook in the Similkameen River spawn in the two mile area downstream of E nloe Dam. Methow summer chinook spawn in the mainstem between mile 2.0-50.0.

Age composition

No information is available on the naturally produced population.

Age composition from hatchery production is limited to returns of coded wire tagged summer chinook. From four different tag codes ('74 brood 13-5-11, '75 brood 13-9-10,,'76 brood 63-16-42, '77 brood 63-17-6?), an average of 4 percent of the brood returned as two-year-olds, 16 percent age-3, 48 percent age-4, 30 percent age-5, and 2 percent as six-year fish.

Size

No information is available on the naturally produced population.

Average fork-lengths for ages 2-6 for the four codes listed previously were 41 cm., 56 cm., 80 cm., 88 cm., and 92 cm. respectively.

Sex ratio

No information.

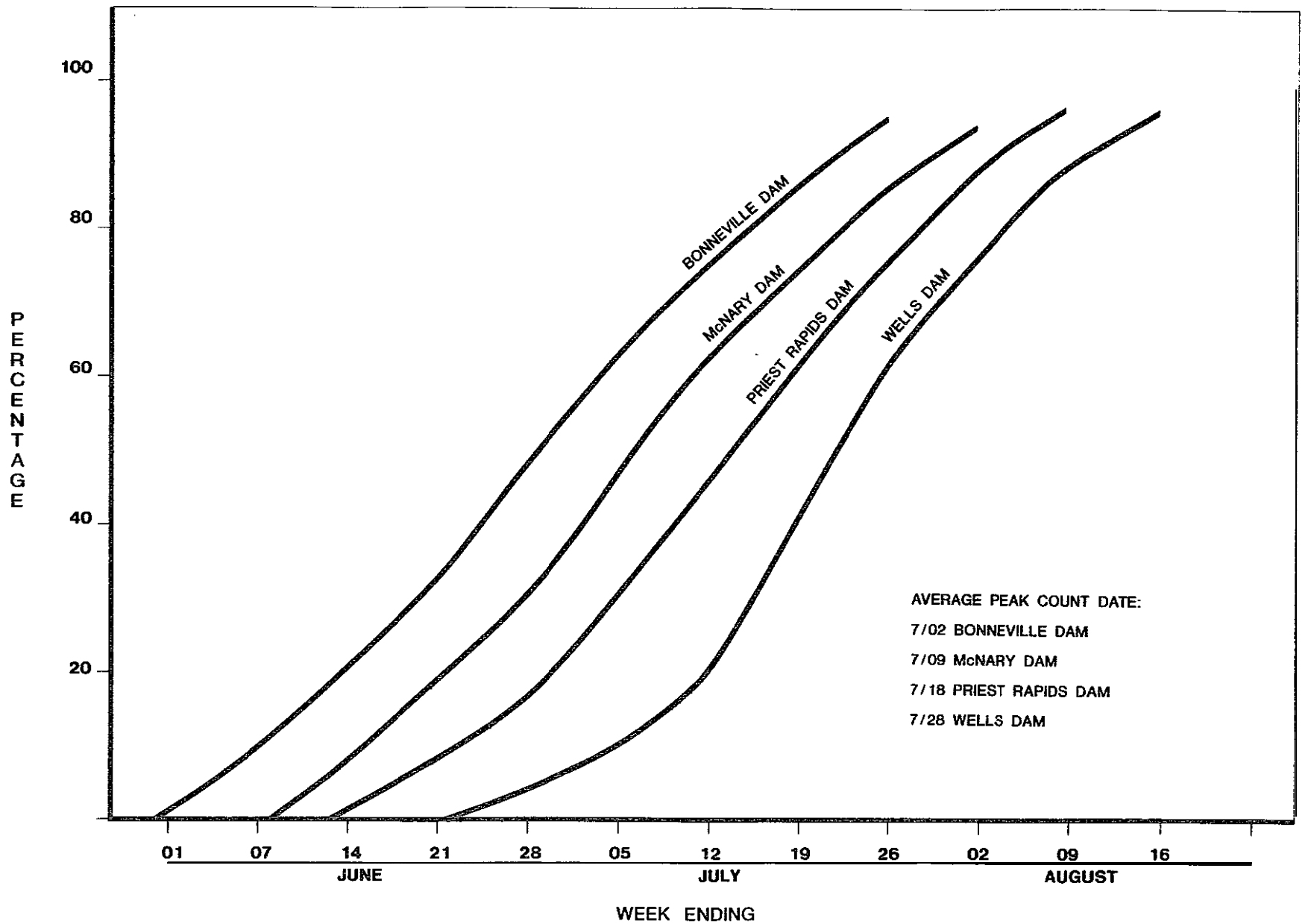


Figure 2. Cumulative percentage of the upper Columbia River summer chinook run passing four Columbia River dams for years 1978-1982.

Fecundity

No information is available on the naturally produced population.

Based on Wells Dam Hatchery spawning reports, average fecundity was 4,935 eggs per female during 1978-1982.

Biochemical-genetic characteristics

Schreck et al. (1984) compared isozyme gene frequencies of seven enzyme systems from Wells Hatchery production samples to natural production samples collected in the Wenatchee, Methow, and Okanogan systems. In paired statistical comparisons, gene frequency profiles were similar for all seven enzyme systems between Wells Hatchery production and the natural production in the Wenatchee and Methow rivers. For the Wells - Okanogan comparison, a statistically significant difference in isozyme gene frequencies was determined for two enzyme systems, indicating genetically distinct populations.

JUVENILE LIFE HISTORY

Time of emergence

No information is available on the naturally produced population.

At the Wells spawning channel, fry emergence occurred from January through April during 1968-1971 (Allen et al. 1968, 1969, 1971; and Allen 1970).

Time, age, and size of migration

Juvenile summer chinook in the Wenatchee system migrate downstream during June through October of their first year (J. Easterbrooks, WDF, personal communication).

Sub-yearlings are released from Wells Dam Hatchery in May and June at 30-75 fish/pound. Hatchery yearlings are planted in March-May at 7-15 fish/pound. Coded wire tagged sub-yearlings (1978 brood) migrated downstream about 8 miles/day compared to 23 miles/day for the yearling release (Table 3). Median date of recovery in the Columbia estuary occurred in early August for the sub-yearlings released in June and in early June for the yearlings released in mid-May.

Survival rate

No information is available on the naturally produced population.

Survival rate to all fisheries and escapement averaged 0.3 percent for 10 coded wire tagged sub-yearlings released from Wells Dam Hatchery (WDF 1984a).

Table 3. Juvenile outmigrant timing of coded wire tagged Wells Dam Hatchery summer chinook based on recoveries in the Columbia estuary at Jones Beach (River Wile 47) (Dawley et al. 1982).

Orisin	Purpose	Size at release (fish/lb)	Release Year	Release Date	Percent of release recaptured	Year	Median fish	First - Last fish	Movement rate (RM/day)
Wells Spawning Channel									
Sub-yearling release									
	Production evaluation	52	1978	13 June	0.005	1978	6 Aug	26 Jul - 7 Aug	8
Yearling Release									
	Production evaluation	9	1978	16 May	0.051	1978	5 Jun	30 Way - 30 Jun	23

DISEASE HISTORY

Bacterial diseases encountered at Wells Dam Hatchery includes columnaris (adults and juveniles) and clubbed gills (Table 4). Parasites include eye fluke, Costia and Ichthyophthicius.

PRIORITY INFORMATION NEEDS

Basic juvenile and adult life history information is almost completely unknown for naturally produced summer chinook. Priority information that needs to be collected includes the following:

1. Adult age and size composition from natural spawning areas.
2. Juvenile rearing and growth data from tributary areas.

Increased sampling of Wells Dam Hatchery adults is needed to supplement the age and size data base which is currently inadequate.

Table 4. Diseases encountered by Wells Dam Hatchery stock summer chinook at Wells Dam Hatchery, 1979-1983 (WDF 1984b).

Type	Disease	Infected Group
Bacterial:	Clubbed gills	1978 brood juveniles
	Columnaris	1978 brood juveniles
	Columnaris	1979 adults
	Gill Disease	1981 brood juveniles
Parasitic:	Eye fluke	1978 brood juveniles
	Costia	1979 adults
	Icthyophthirius	1978 brood juveniles
Viral:	None	
Other:	Coagulated yolk	1979, 1982 eggs

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Lower Columbia River (Oregon) Coho (wild)

PRODUCTION

Coho populations in the lower Columbia are now primarily supported by hatchery production. This summary presents available information on the few native wild stocks that may still exist. Consult the "Early Run Coho (hatchery)' summary for information on the hatchery stock released in lower Columbia tributaries in Oregon.

GEOGRAPHIC LOCATION

Streams

Columbia River tributaries in Oregon below Bonneville (Appendix Figure 1) except the Clackamas River, which is discussed in a separate summary, and other Willamette River tributaries, which are discussed in the "Early Run Coho" summary

ORIGIN

Coho are native primarily to tributaries of the lower Columbia, including the lower Willamette River below Willamette Falls. These streams are now routinely stocked with about 6 million smolts 2 million presmolts, and up to about 7 million fry of the Early Run stock.

ADULT LIFE HISTORY

Run size. catch. and escapement

There are no specific estimates of the harvest of these wild stock in commerical or sport fisheries. Combined sport catch of wild and hatchery stocks is listed in Table 1.

Spawning ground surveys have been conducted on lower Columbia tributaries since 1949 (Tables 2 and 3). From 1949 to 1969, counts fluctuated widely around average peak count of 31 fish/mile (Figure 1). From 1969 to 1982 the counts declined about 17%/year (ODFW, undated). The count in 1982 was 1.8 fish/mile despite the best return of coho adults to the Columbia River since 1974 and the best escapement past the gill-net fisheries since 1971 (Figure 21 (Hirose 1983). Even with recent presmolt releases to boost natural production, wild coho are virtually extinct in the lower Columbia. Experimental presmolt releases reduced wild coho juvenile populations in coastal streams by about 50% (Solazzi et al.1983) and failed to increase spawner abundance (ODFW, unpublished data).

Table 1. Sport catch of coho salmon (wild and hatchery) in Oregon tributaries of the lower Columbia River except the Willamette River system 1971-80[a] (Berry 1981).

	Run year									
Stream	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Bear Creek	4	0	0	0	0	0	2	0	0	--
Big Creek	198	170	95	230	98	137	58	99	222	702
Bullrun River		--	--	--	--	--	6	0	3	15
Clatskanie River	63	29	74	66	56	19	69	101	6	6
Columbia River, Lower	2,662	3,287	1,491	536	447	517	430	a57	135	210
Gnat Creek	75	33	32	11	a	0	14	3	0	12
Klaskanine River	a6	144	322	122	274	283	244	93	84	34
Klaskanine River, N.F.	--		--	--	--	--	18	209	99	52
Klaskanine River, S.F.	--	--	--	--		--	3	19	6	0
Lewis and Clark River	4	6	19	8	16	3	21	21	18	24
Milton Creek	--	--	--	--	--	--	--	3	0	0
Salmon River	--	--	--	--	--	--	--	25	0	6
Sandy River	635	818	740	477	1,115	1,801	956	1,967	1,127	816
Scappoose Creek	4	19	12	0	0	0	8	3	0	0
Tanner Creek		--	--	--	--	--	--	6	0	3
Youngs River & Bay		--		--	--	--	--	19	15	0
Total	3,731	4,506	2,785	1,450	2,014	2,760	1,829	3,425	1,715	1,880

a 1977 is the first year to list catch in all open streams; in prior years catch in most tributary streams was included in the main stem catch.

Table 2. Spawning ground counts of coho salmon in supplemental index areas in the lower Columbia River, 1949~69[a] (modified from Bohn 1970).

Stream	Miles surveyed	Year '49	'50	'51	'52	'53	'54	'55	'56	'57	'58	'59	'60	'61	'66	'67	'68	'69	1949-69 average
Lewis and Clark River																			
Sweeash Creek	0.5	-	-	-	51	6	9	_	-	61	10					1	0	-	20
Tide Creek	1.0	-	-	-	-	-	14		3	32	0					1	-	-	10
Clatskanie River																			
Page Creek	0.5	-	14	15	-	1	6		8	14	5			_	_	29		7	12
Milton Creek																			
Salmon creek	0.4	-	-	-	0	10	0	22	3	5	6			_	_	14	23	44	13
North Scappoose Creek																			
South Fork	1.0	-	-	4	0	0	15	5	10	43	7					1		2	9
South Scappoose Creek																			
Raymond Creek	1.0	-	-	-	29	18	6	-	11	4	5			-	-	20	8	19	13
Clackamas River																			
Deep Creek	2.1	-	15	8	20	15	14	8	57	12	27			-	12	8	-	10	17
Tickle Creek	1.4	-	13	79	25	19	3	5	42	10	18	9	20	-	16	6	0	17	19
Clear Creek	1.6	1	8	0	0	4	0	_	_	4	6			_	-	0	-	-	3
Trestle Creek	0.4	16	20	26	0	18	1	3	40	39	18	21	16	7	4	18	2	7	15
Abernathy Creek	0.3	8	0	28	0	16	8	6	30	6	1				4	4	1	-	9
Holcomb Creek	0.3	-	27	9	0	3	4	3	16	3	4			-	10	0	0	1	6
Kellogg Creek	1.0	-	13	0	-	5	-		8	4	-	2			8	1		3	5
Johnson Creek	0.7															8		5	6
Sandy River																			
Beaver Creek	0.7							_	_	32	6					7		2	12
Trout Creek	0.2	-	-	-	-	-	_	-	11	70	1			_	_	5		2	18
Average fish/mile		11	14	20	14	12	8	9	25	27	10	11	20	17	10	10	8	12	13

[a] Maximum counts are listed when several surveys of the same unit were wde during the same spawning season.

Table 3. Spawning ground counts of coho salmon in standard index streams of the lower Columbia River, 1967-82[a] (Hirose 1983).

Year	Youngs River	Little Creek	Willark Unit	Carcus Creek	Milton Creek	Salmon Creek	Sierkes Creek	Raymond Creek	Deep Creek	Trickle Creek	Total fish
1967	3	3	7	43	1	14	60	20	8	6	165
1968	19	25	9	25	4	23	31	8	5	0	149
1969	32	43	33	45	6	44	75	10	19	17	324
1970	13	16	5	33	5	49	103	15	4	5	248
1971	19	5	6	3	0	11	33	6	3	8	94
1972	7	9	4	18	2	8	42	8	3	2	103
1973	4	8	3	2	1	1	7	0	5	0	31
1974	12	0	2	0	0	9	1	1	1	2	28
1975	6	1	4	10	2	7	10	2	0	1	43
Base Index	12	8	5	18	2	11	33	8	4	2	103
1976	9	8	0	0	0	0	0	0	0	0	17
1977	3	1	0	1	0	1	3	4	2	0	15
1978	2	4	0	4	0	0	0	3	0	2	15
1979	3	3	0	3	0	0	3	2	1	0	15
1980	0	6	1	10	2	4	46	7	5	0	81
1981[a]	4	0	(0)	0	(0)	2	1	1	(0)	(8)	16
1982[a]	1	3	(3)	0	(0)	0	4	(0)	(3)	(3)	17

a Counts that are influenced by hatchery presmolt releases are in parentheses.

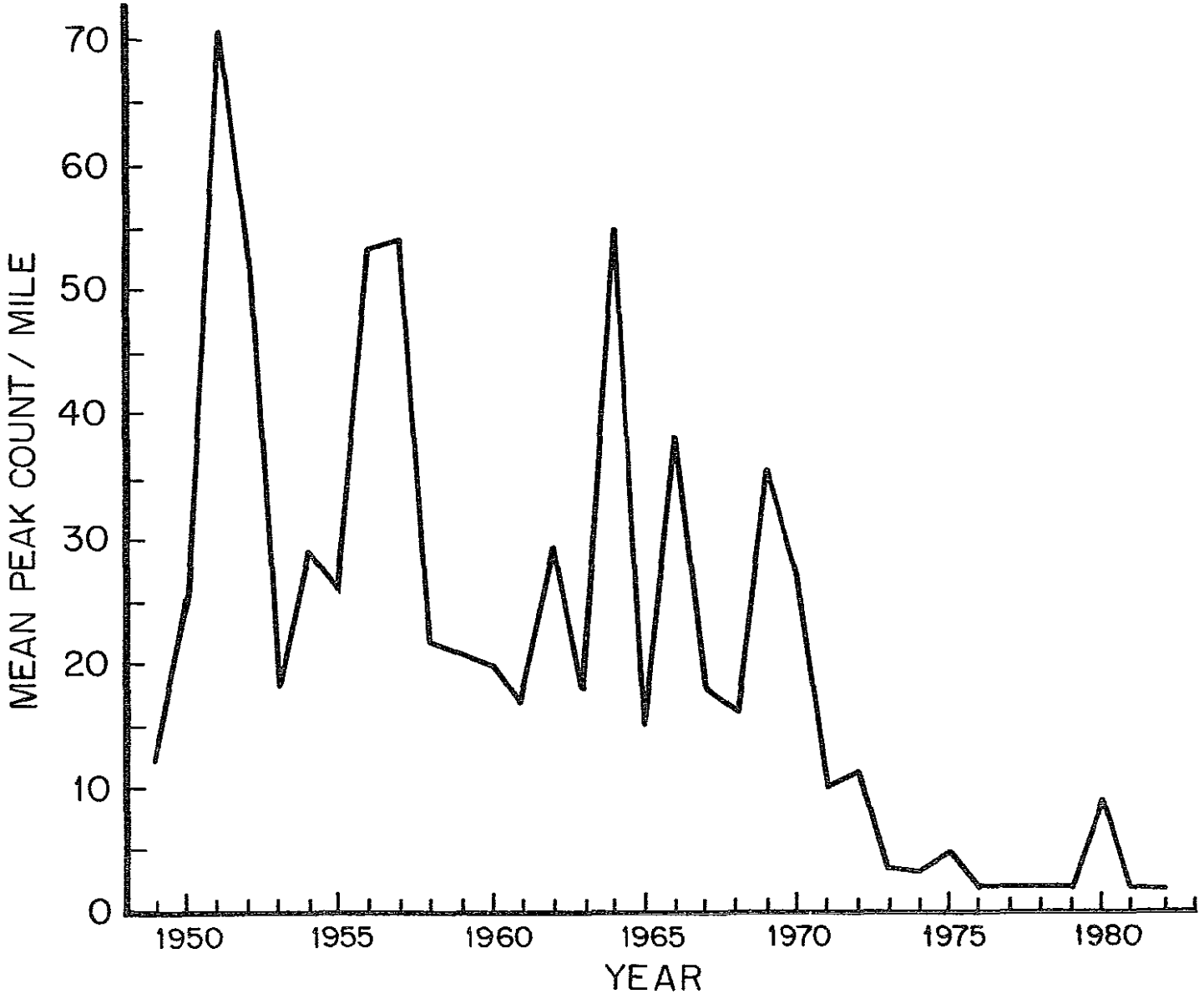

Figure 1. Trends in the escapement of coho salmon in the lower Columbia River tributaries, 1949-82.

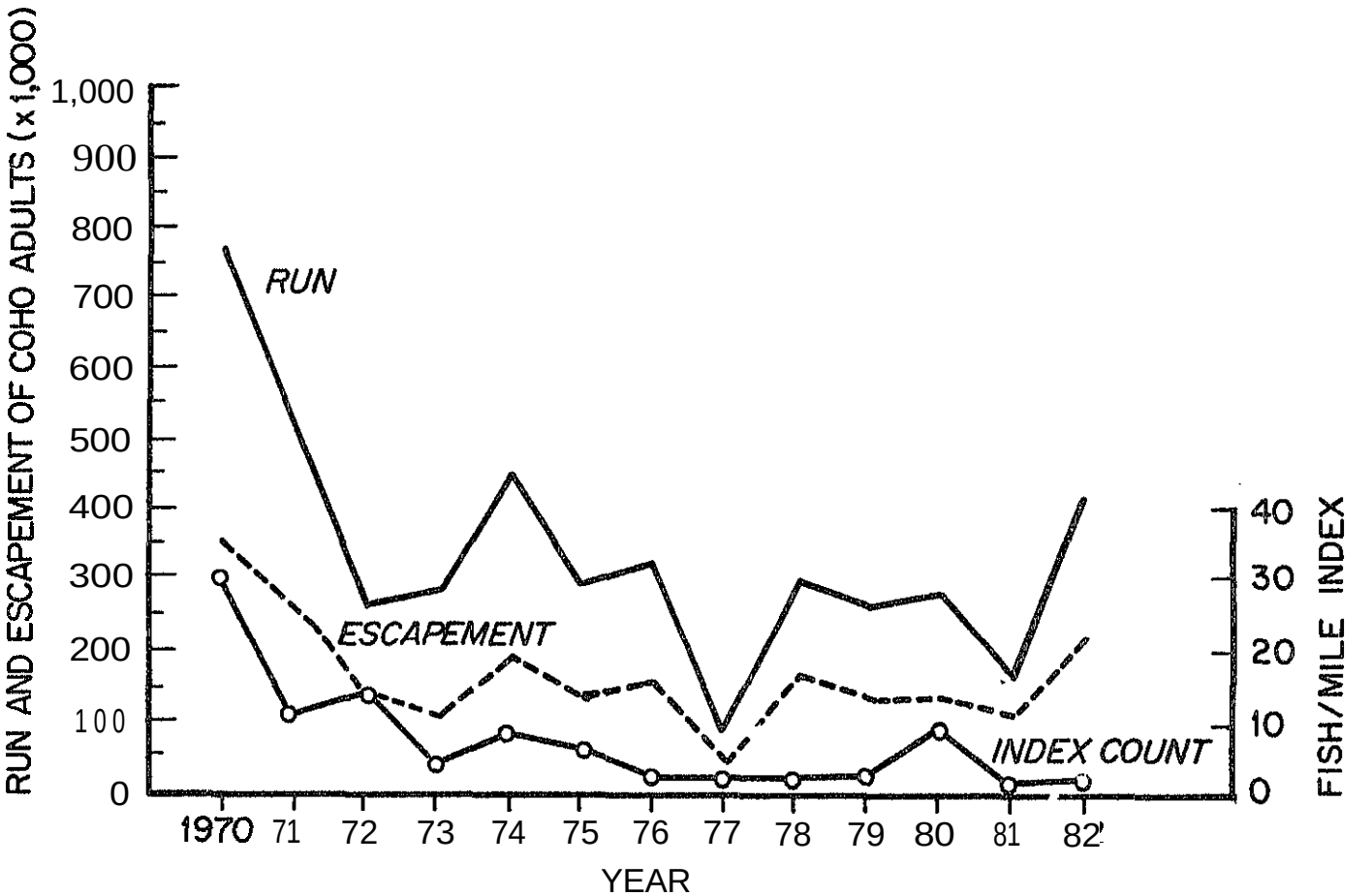

Figure 2. Adult coho run into the Columbia River, escapement past the lower Columbia River gill-net fishery, and (fish/mile) spawning ground survey index counts in standard index streams, 1970-82 (Hirose 1983).

Time of migration

Coho arrived at Gnat Creek as early as mid-September and as late as mid-February (Figure 3) (Willis 1962). Although the migration peaked in late October, large numbers of fish continued to return through mid-December. The peak migration past Marmot Dam on the Sandy River also occurs in October (Table 4); however, the percentage of the run passing Marmot Dam in September has increased from about 2% to 25% while November counts have decreased from 44% to 24%.

Table 4. Monthly counts of coho (jacks and adults) past Marmot Dam, Sandy River, 1960-70 and 1977-84.

	Month						
year	August	Sentember	October	November	December	January	February
1960-61	0	38	1,091	252	288	1	0
1961-62	0	10	1,107	436	158	20	2
1962-63	0	16	399	990	50	3	0
1963-64	0	43	993	1,135	28	0	0
1964-65	0	14	83	759	270	0	0
1965-66	-	—	--	801	213	4	--
1966-67	-	--	96	132	1		--
1967-68	-	—	343	234	71	21	—
1968-69	-	108	855	236	67	15	--
1969-70	-	122	363	143	82	0	1
1977-78	-	78	--	--	205	--	--
1978-79	0	0	111	308	3	0	0
1979-80	0	102	241	2	20	3	1
1980-81	0	0	219	373	27	7	310
1981-82	0	170	393	57	0	23	3
1982-83	1	493	197	11	35	0	0
1983-84	0	53	7	--			--
1960/61-64/65							
Mean %	0.0	1.5	44.9	43.6	9.7	0.3	0.0
1978/79-82/83							
Mean %	0.0	24.6	37.6	24.1	2.7	1.1	10.1

Spawning period

Hirose (1983) reported that the spawning season for wild coho in the lower Columbia extends from late November through early January. Most of the females in Gnat Creek were not ripe prior to November 20 (Willis 1962). By contrast, the median date of spawning of Early Run coho in Oregon hatcheries is November 4.

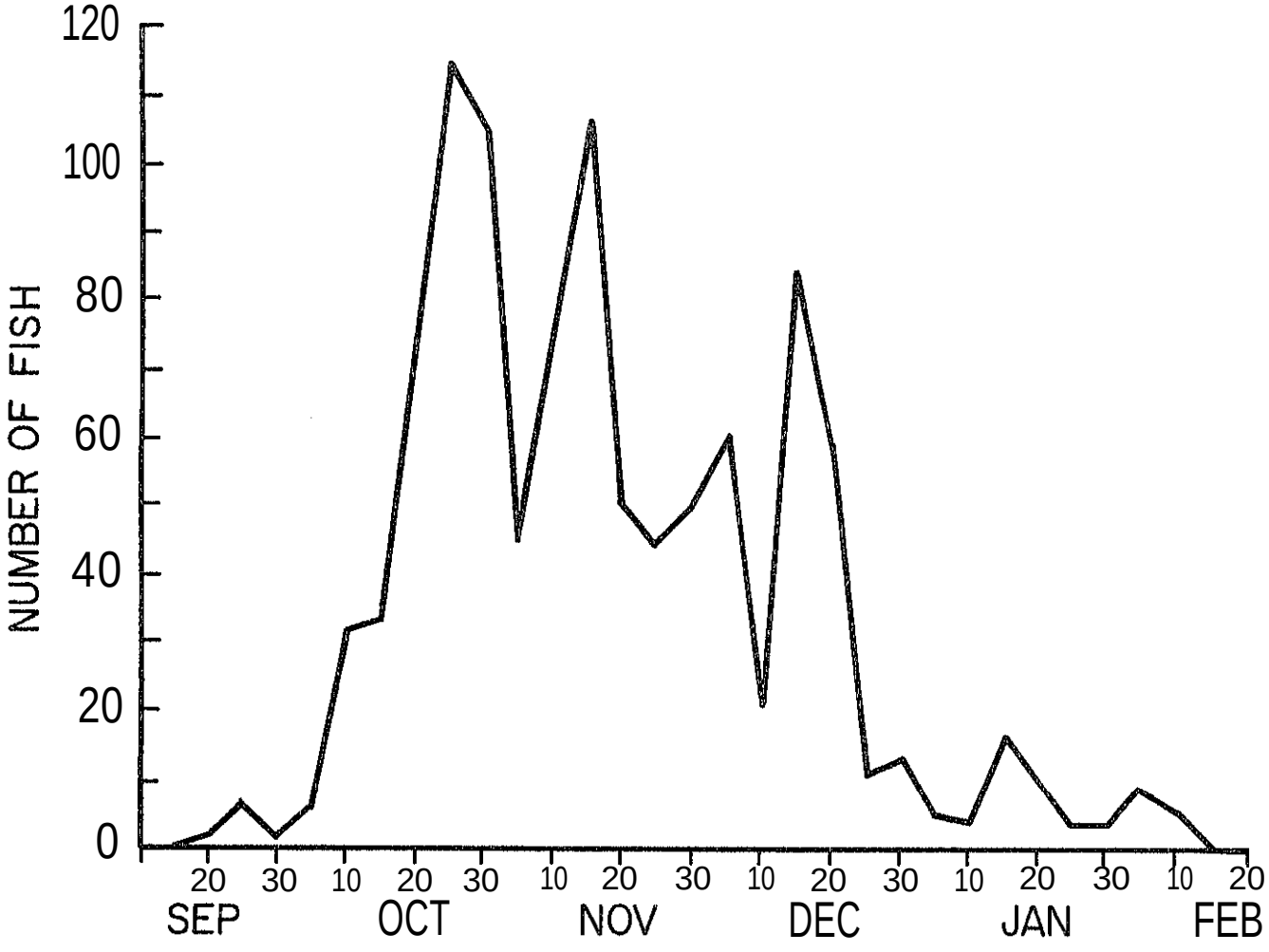

Figure 3. Time of return for coho jacks and adults in Gnat Creek, 1955-62 (data from Willis 1962).

Spawning areas

Detailed maps illustrating previous spawning distribution of coho in the lower Columbia are contained in basin investigations reports for the North Coast Basin (Thompson and Fortune 1968) and the lower Willamette Basin (Hutchison and Aney 1964). General spawning locations are listed below:

Lewis and Clark River
Youngs River
Klaskanine Creek
Bear Creek
Big Creek
Gnat Creek
Plympton Creek
Clatskanie River
Milton Creek
Scappoose Creek
Johnson Creek
Mount Scott Creek
Sandy River
Latourell Creek
Bridal Veil Creek
Multnomah Creek
Oneonta Bell Creek
McCord Creek
Moffett Creek

Age composition

In Gnat Creek, where all returning coho were counted, the proportion of jacks averaged 56% over a 7-year-period (Willis 1962).

Size

Adults trapped at Gnat Creek weir were generally 25-30 inches in fork length (Figure 4).

Sex ratio

The returning wild adults in Gnat Creek averaged 50% males and 50% females (Willis 1962).

Fecundity

The length/fecundity relationship of coho taken in the lower Columbia gill-net fishery is described in Figure 5. However, the stocks included and the proportion of wild fish in the sample is unknown.

Biochemical-genetic characteristics

No information.

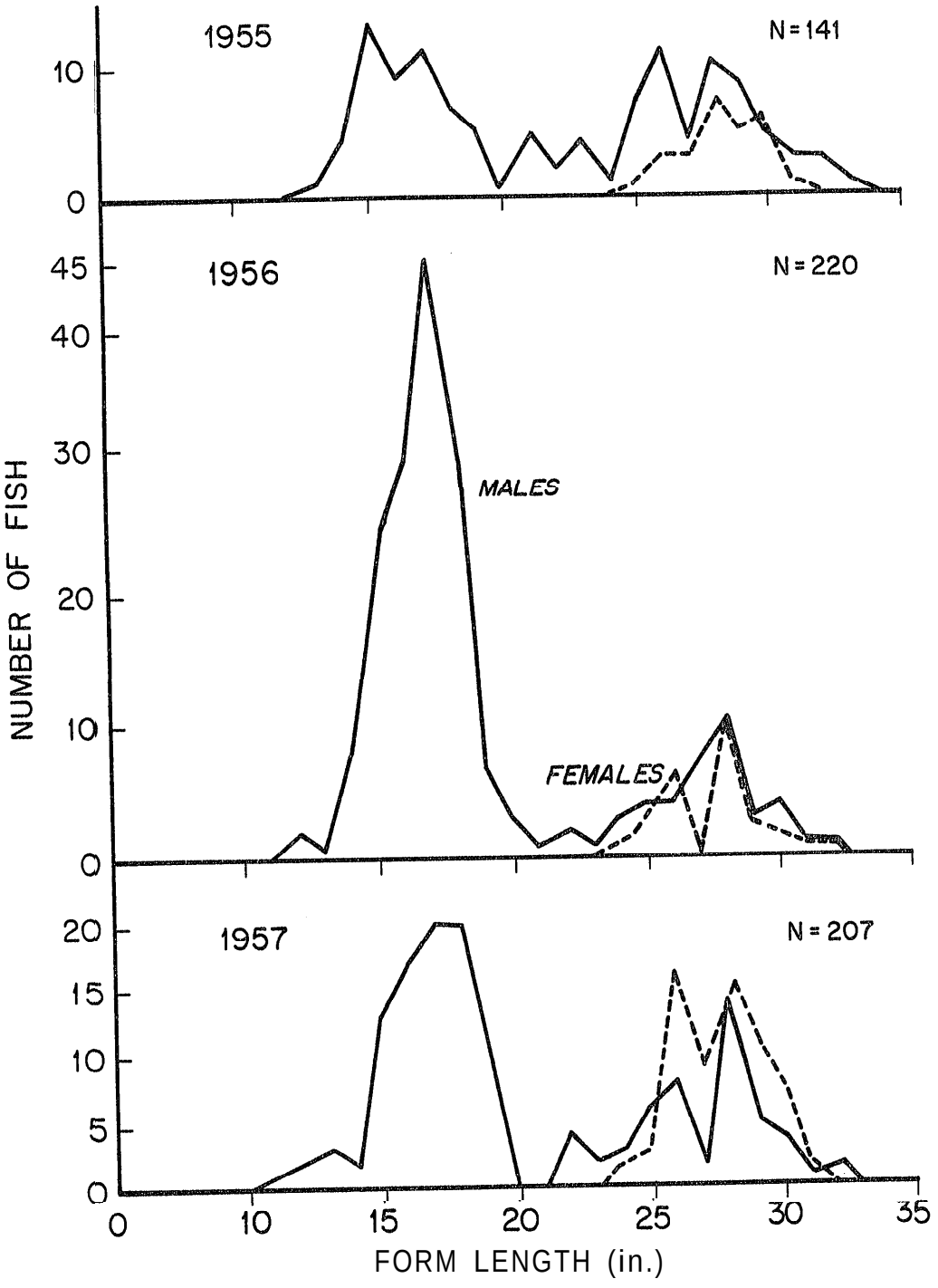

Figure 4. Length frequencies of adult coho captured at the Gnat Creek weir, 1955-57. Fish were measured to nearest one-half inch and grouped in the next lower inch (Kruse, undated).

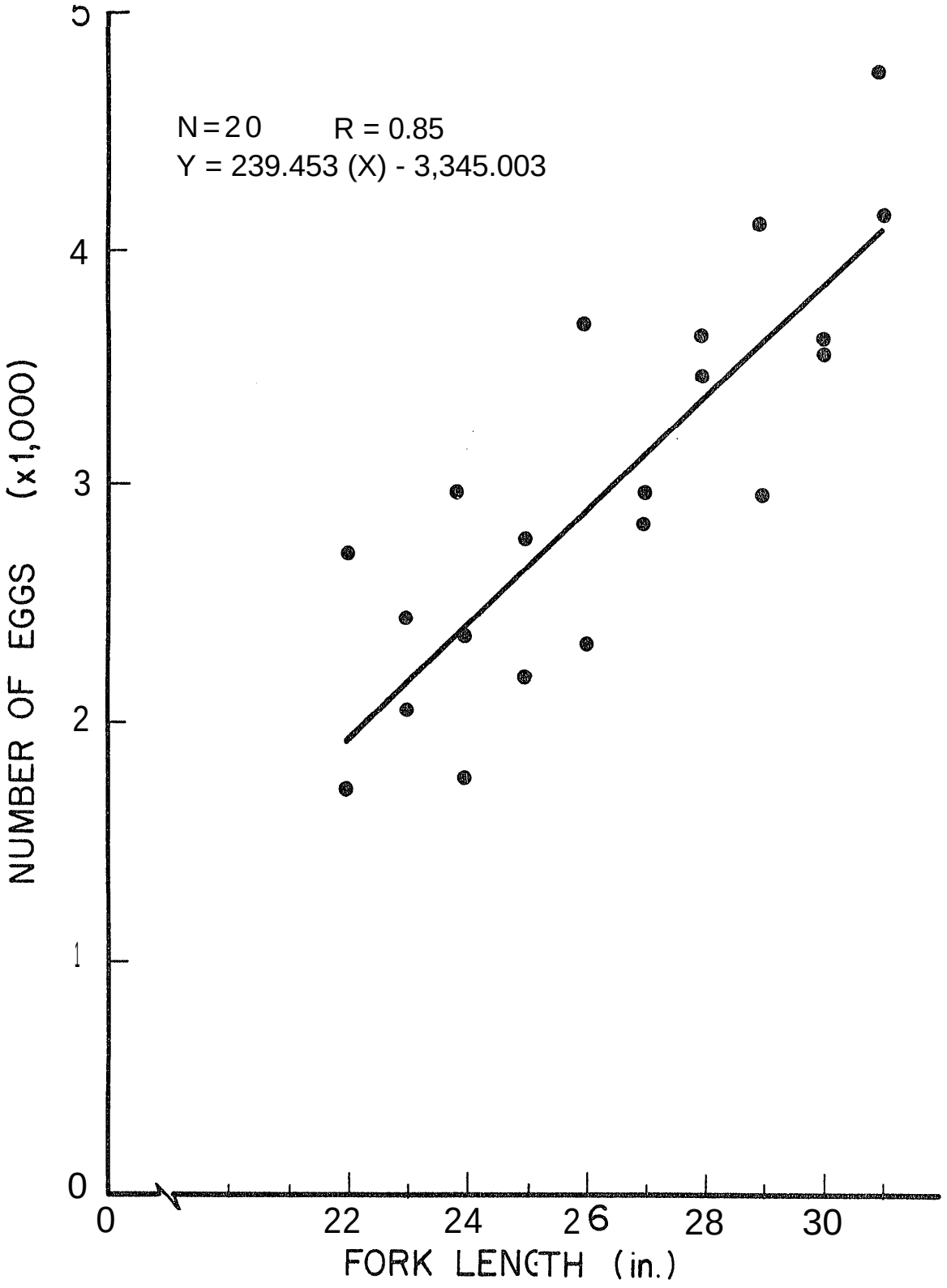

Figure 5. Relationship of fecundity to length for Columbia River coho, 1961 (Willis 1962).

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time. aae. and size at migration

In Gnat Creek 71% of the smolts migrated in May and 90% migrated in April and May combined (Table 5). Timing of smolt outmigration in Cedar and Big creeks was similar (Figures 6 and 7).

The average length of naturally reared smolts trapped in Big Creek and North Fork Klaskanine was 113-116 mm (Table 6). Cedar Creek smolts were significantly smaller, averaging 94-103 mm. In Gnat Creek, smolts averaged 115 mm over a 6-year period (Table 7).

Survival rates

Estimates of egg-to-smolt survival for wild coho were as follows (Niska and Willis 1963; Willis 1962):

Cedar Creek	4.6%
Big Creek	0.5
N. Fk. Klaskanine	1.4
Gnat Creek	1.5 (range = 0.5-3.3)

DISEASE HISTORY

No information

PRIORITY INFORMATION NEEDS

1. Determination of the existence and distinctiveness of wild stocks
2. Suitability of using Early Run hatchery stock to enhance natural production
3. Interactions of wild and hatchery stocks
4. Smolt production levels and capacities
5. Run size, catch (including distribution), and escapement

Table 5. Counts of wild juvenile coho downstream migrants at the Gnat Creek weir by 5-day periods[a] from November 16 to end of migration year, 1954-59 brood years (Willis 1962).

5-day period ending		Brood year							
Month	Day	1954	1955	1956	1957	1958	1959	Total	6-year average
Nov.	20	0	170	29	3	10	101	313	52
	25	2	62	9	11	3	33	120	20
	30	5	64	5	2	6	33	115	19
Dec.	5	4	4	23	5	6	9	51	9
	10	3	5	17	4	2	12	43	7
	15	b	27	8	0	3	4	42	7
	20	b	6	10	3	4	1	24	4
	25	1	3	9	0	1	5	19	3
	30	3	3	5	1	0	3	15	3
Jan.	5	11	0	2	0	0	0	13	2
	10	4	0	2	0	2	0	8	1
	15	13	0	18	3	11	3	48	8
	20	5	0	13	0	13	0	31	5
	25	6	0	5	0	11	1	23	4
	30	0	0	2	8	6	1	17	3
Feb.	5	7	0	4	1	2	1	15	3
	10	0	7	5	0	1	3	16	3
	15	9	5	6	16	0	8	44	7
	20	0	2	11	0	0	5	18	3
	25	7	9	3	0	3	2	24	4
	30	26	17	2	0	24	0	69	12
Mar.	5	16	6	6	2	3	2	35	6
	10	2	22	0	1	5	2	32	5
	15	10	3	1	1	3	4	22	4
	20	19	5	3	1	3	2	33	5
	25	7	10	9	1	1	14	42	7
	30	8	46	8	2	9	11	84	14
Apr.	5	14	41	16	3	13	43	130	22
	10	18	31	13	2	6	129	199	33
	15	43	4	40	4	26	72	189	32
	20	28	62	54	47	30	91	312	52
	25	60	92	17	36	40	185	430	72
	30	168	221	12	216	72	69	758	126
May	5	245	295	20	37	75	355	1,027	171
	10	509	544	312	48	155	487	2,055	343
	15	351	320	235	188	181	396	1,671	279
	20	542	515	399	128	271	442	2,297	383
	25	516	216	341	108	3	256	1,440	240
	30	332	124	143	81	34	257	971	162
June	5	106	45	22	46	15	150	384	64
	10	33	9	5	2	8	29	86	14
	15	11	1	2	2	0	4	20	3
	20	2	0	0	0	0	1	3	1
	25	0	0	0	0	0	0	0	
	30	0	0	0	0	0	0	0	
July	5	0	0	0	0	0	0	0	

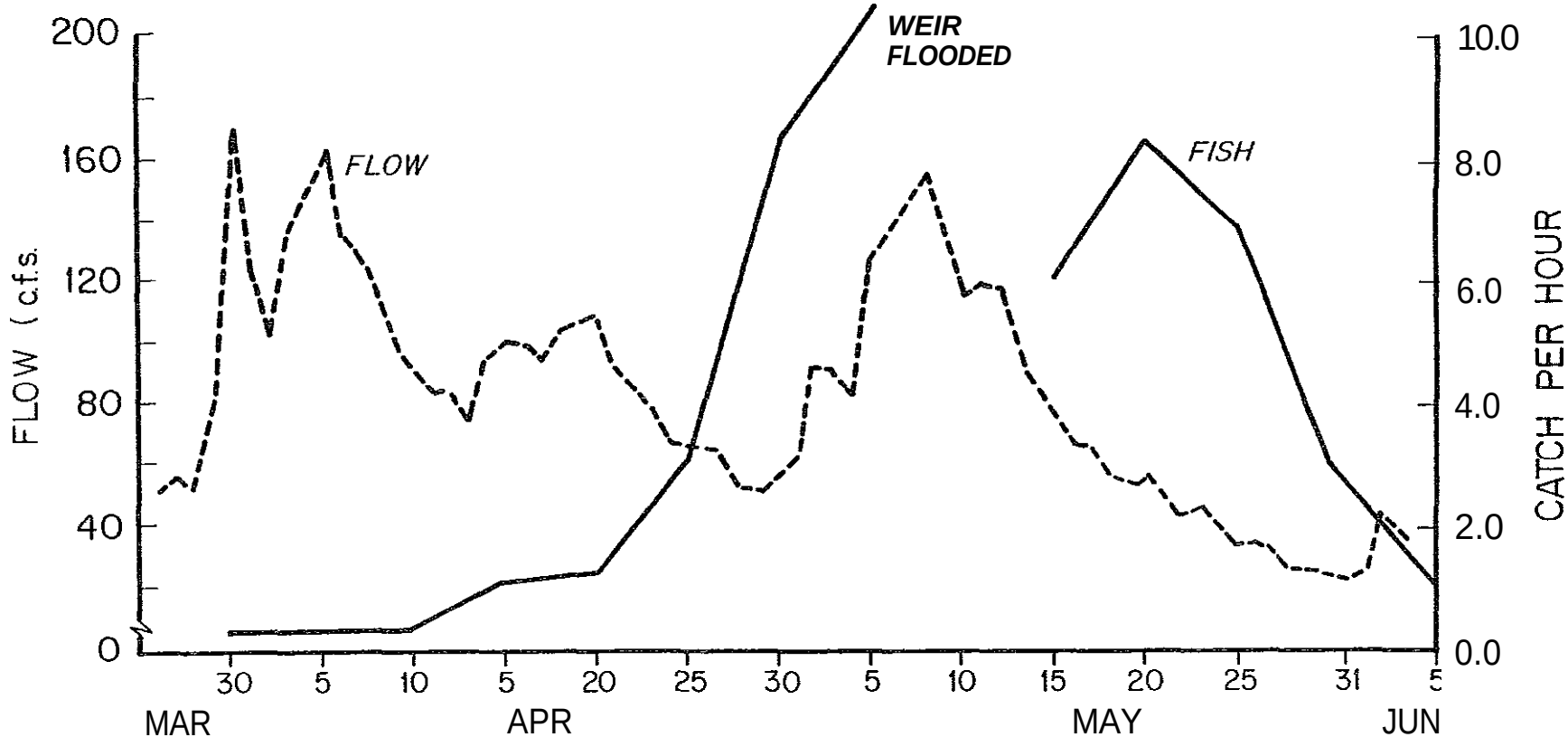

Figure 6. Coho smolt catches per hour and stream flows in 5-day intervals at the Cedar Creek weir, Sandy River, March 25-June 5, 1963 (Niska and Willis 1963).

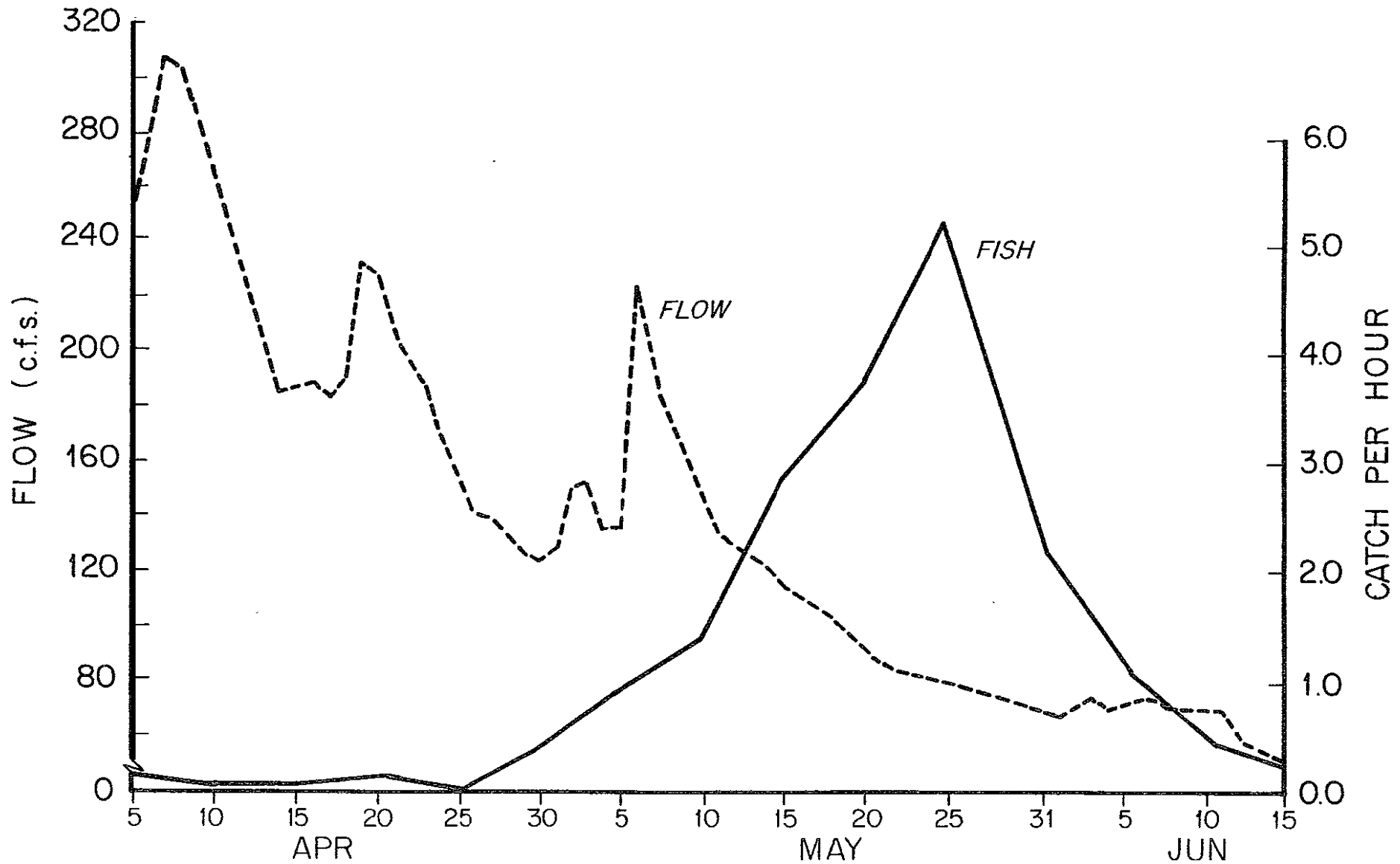

Figure 7. Coho smolt catches per hour and stream flows in 5-day intervals in Big Creek, April 5-June 15, 1963 (Niska and Willis 1963).

Table 6. Length-frequency distributions of 1961-brood yearling coho salmon from Cedar and Big creeks and the North Fork Klaskanine River, by sampling gear type, March-June 1963 (Niska and Willis 1963).

Fork length (mm)		Cedar Cr.			Big Cr.	N.F. Klaskanine R.		
Interval	Midpoint	scoop A and B	Weir	Total	Fyke net	Fyke net	Scoop	Total
65- 70	68	1		1	--	--	--	--
71- 75	73	10		10	--	--	--	--
76- 80	78	23	4	27	2	--	--	--
81- 85	83	31	19	50	0	1	--	1
86- 90	88	39	23	61	4	0	1	1
91- 95	93	60	51	111	9	5	2	7
96-100	98	41	66	107	8	5	3	8
101-105	103	43	82	125	25	23	5	28
106-110	108	24	76	100	85	95	59	154
111-115	113	10	47	57	141	175	49	224
116-120	118	3	22	25	159	171	47	218
121-125	123	1	7	8	100	84	14	98
126-130	128	--	4	4	44	39	3	42
131-135	133	--	0	0	13	11	1	12
136-140	138	--	1	1	2	4	--	4
141-145	143	--	--	--	--	1	--	1
Total		286	402	688	595	614	184	798
Mean		93.8	102.5		115.7	115.8	113.0	
Standard Deviation			±8.63		±8.34	±7.35	±5.91	

Table 7. Length frequency data by brood year for juvenile coho that outmigrated from Gnat Creek between November 15, 1956 and June 30, 1961 (Willis 1962).

Fork lengths		Frequencies Brood year								Cumulative frequency	Cumulative frequency
Interval	Midpoint	1954	1955	1956	1957	1958	1959	Total	Average	average	(%)
51- 55	53	0	1	0	0	0	0	1	0.2	0.2	---
56- 60	58		1	9	0	0	0	11	1.8	2.0	0.002
61- 65	63	4	0	8	0	0	0	12	2.0	4.0	0.003
66- 70	68	8	0	15	0		2	26	4.3	8.3	0.006
71- 75	73	21	5	36	2	0	5	69	11.5	19.8	1.505
76- 80	78	13	6	27		3	17	67	11.5	31.3	2.379
81- 85	83	37	21	31	6	2	33	130	21.7	53.0	4.028
86- 90	88	27	40	25	4	8	28	132	22.0	75.0	5.700
91- 95	93	25	37	19	10	16	42	149	24.9	99.9	7.592
96-100	98	50	70	33	20	25	79	277	46.3	146.2	11.111
401-105	103	77	97	30	44	55	233	536	89.5	235.7	17.913
106-110	108	116	123	44	102	414	460	959	160.2	395.9	30.088
111-115	613	329	100	41	173	172	695	1,510	252.2	648.1	49.255
116-120	118	417	130	26	151	171	661	1,556	259.9	908.0	69.007
121-125	123	486	104	38	138	128	453	1,047	174.8	4,082.8	82.292
126-130	128	59	76	28	125	69	268	625	104.4	1,187.2	90.226
131-135	133	14	37	22	87	82	101	343	57.3	1,244.5	94.581
136-140	138	2	10	8	55	70	45	190	31.7	1,276.2	96.990
141-14s	143	2	5	3	23	68	23	124	20.7	1,296.9	98.564
146-150	148	2	4	1	7	40	13	67	11.2	1,308.1	99.415
151-155	153	0	1	0		17	8	27	4.5	1,312.6	99.757
156-160	158	0	0	0	0	6	6	12	2.0	1,314.6	99.909
161-165	163		0	0	0	3	2	6	0.8	1,315.4	99.970
166-170	168	0	0	0	0	0	1	1	0.2	1,315.6	99.985
171-175	173	0	0	0	0	0	1	1	0.2	1,345.8	100.000
Total (n)		1,391	868	444	949	1,050	3,176	7,878	1,315.8		
Average length		112	111	101	120	121	115		114.9		
Variance		155.40	177.66	423.99	133.95	238.42	103.70		190.90		
Standard deviation		12.5	13.3	20.6	11.6	14.8	10.2		13.8		
95% confidence limits		88-136	85-137	61-141	97-143	92-150	95-135		87.8-142.0		

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Early Run Coho

The two primary stocks of coho in the Columbia River are the early coho, sometimes called Toutle stock coho, and the late coho or Cowlitz stock coho. Both are considered hatchery stocks.

PRODUCTION

In Oregon and Washington adult production of early coho is almost exclusively from hatchery releases, although natural production also occurs. Except for a few instances, adult production from natural escapement is unknown. A factor of 10 percent might be considered reasonable for the percent of the total Columbia River coho production originating from naturally spawning fish (D. McIsaac, Washington Department of Fisheries [WDF], personal communication).

Between 1979 and 1983, annual Washington early coho yearling releases have averaged 5.7 million from lower Columbia River stations, 2.8 million from federal hatcheries adjacent to Bonneville Pool, and 0.4 million from Rocky Reach Hatchery in the upper Columbia River. Varying levels of fingerling/fry releases have also occurred.

The Oregon hatchery program utilizes early stock exclusively. Since 1980, about 6 million yearling smolts and 2 million pre-smolts have been produced annually in Oregon. Eagle Creek National Fish Hatchery releases another 1 million smolts annually into Eagle Creek in the Clackamas River system. Fry are also released.

Following passage improvement at Willamette Falls, coho were introduced into the upper Willamette River. Releases peaked in the mid-1960's and early 1970s at 1.4 million yearlings, 0.9 million fingerlings, and 9.8 million fry. From 1974-1980 coho releases were restricted to the Tualatin system (Williams 1983). Currently, fry and smolts are being released in many westside tributaries to increase the coho production in the Willamette. Based on survival rates of tagged hatchery releases in Scoggins Creek, it was estimated that natural production contributed an average of 87 percent of the adult escapement to Willamette Falls during 1977, 1979, and 1980 (Williams 1983).

GEOGRAPHIC LOCATION

Streams

Early coho are planted into most of the lower Columbia River tributaries as well as the Wind River (pre-1982), Little White Salmon River, Klickitat River (pre-1979, 1984) and the mainstem Columbia River upstream of Bonneville Dam (Table 1).

Table 1. Columbia River locations receiving regular plants of early coho.

Oregon	Willamette System
Big Creek	Long Tom River
Tanner Creek	Luckiamute River
Bandy River	Mary's River
Eagle Creek	Pudding River
Klaskanina River	Mollala River
	North Yanhill River
	South Yamhill River
	Yamhill River
	Tualatin River

Washington [a]

Grays River
Elokomin River (usually)
Toutle River (pre-1980)
Kalama River
Lewis River
Washougal River
Little White Salmon River
Klickitat River (pre-1979, 1984)
Yakina River
Mainstem Columbia River (Rocky Reach area)
Wenatchee River (pre-1975)
Entiat River (pre-1976)
Hethow River (pre-1969)

[a] Periodic releases made into other tributaries, also.

Hatcheries

Hatcheries releasing early coho during 1979-1983 are listed below:

Oregon	Washington
Big Creek	Sea Resources [a]
Gnat Creek	Grays River
Bonneville	Elokomin
Cascade	Toutle [a]
Klaskanine	Lower Kalama [a]
Oxbow	Kalama Falls [a]
Sandy	Lewis
CEDC (Clatsop Economic Development Commission)	Speelyai
Eagle Creek National Fish Hatchery	Washougal
	Carson National Fish Hatchery [a]
	Little White Salmon National Fish Hatchery
	Yakima Indian [a]
	Rocky Reach

[a] Did not release early coho every year.

ORIGIN

Most existing early coho hatchery programs are considered to be linked, in varying degree, to native Toutle River stock coho. These fish provided the basis for the coho rearing program, beginning in 1952, at the Toutle hatchery on the Green River, a tributary of the North Fork Toutle River. The hatchery program was very successful and, consequently, surplus eggs were readily available for transfer to other stations. Early run coho programs at Oregon facilities were the result of Toutle stock transfers to Bonneville Hatchery. Bonneville Hatchery returns of Toutle stock coho were used to develop early coho programs at the other Oregon stations. Washington stations either received Toutle stock eggs or utilized local native early run coho. Other lower Columbia River tributaries in Washington reported to have native populations of early coho include the Kalama River, Washougal River, and Lewis River (WDF and USFWS 1951).

In the Willamette system, some coastal Oregon stocks were introduced and during 1974 to 1979, several groups of Cowlitz late stock coho were released. Currently, only Columbia River early stock coho are planted in the Willamette system.

Mullan (1983) reported that native stocks of early coho were historically abundant in the Yakima River (50-70,000), Wenatchee River (6-7,000), Entiat Rive r (9-13,000), Methow River (23-31,000), and Spokane River (32-45,000). Even prior to Grand Coulee completion in 1941, the runs to these upper Columbia River tributaries were severely reduced or eliminated because of irrigation diversions, mill dam construction, and overharvest. Beginning in the 1940's, the coho runs to the Wenatchee River, Methow River, and Entiat rivers were heavily supplemented with releases of non-local hatchery stock early coho (Table 2). Currently, minor numbers of lower Columbia origin early coho are released into the Yakima River. Releases into the Wenatchee, Entiat, and Methow rivers have been discontinued. Exact status of the runs to these upper Columbia streams is unknown, but probably minor based on upriver dam counts.

Because of extensive transferring of eggs between most Columbia River facilities, releases considered to be of Toutle River ancestry are probably a mixture of various early run coho populations.

ADULT LIFE HISTORY

Run size, catch, and escapement

Since 1970, the freshwater run has averaged 2113,700 adults (Table 3). This value should be considered a minimum number because it excludes natural escapement in the tributaries and some recreational harvest during several years. Adult escapement over Willamette Falls averaged 2,345 fish du ring 1973-1982 (Table 4). Punch card estimates of sport harvest in specific tributaries are available from WDF and Oregon Department of Fish and Wildlife (ODFW).

Table 2. Releases of non-local stock coho into tributaries of the upper Columbia River (Mullan 1983)

Stream	Brood Year	Release year	Number released	Type	Hatchery	Stock
Wenatchee River	1949	1950	230,000	Fingerling	Leavenworth	Lewis River
	1965	1966	4,170,000	Fingerling	Leavenworth	Cascade
Icicle Creek	1942	1943	110,000	Fingerling	Leavenworth	Lewis River
	1943	1944	112,300	Fingerling	Leavenworth	Lewis River
	1944	1945	29,000	Fingerling	Leavenworth	Lewis River
	1950	1952	98,800	Yearling	Leavenworth	Lewis River
	1951	1953	47,600	Yearling	Leavenworth	Lewis River
	1952	1954	93,900	Yearling	Leavenworth	Lewis River
	1954	1955	11,800	Fingerling	Leavenworth	Quilcene
	1954	1956	12,500	Yearling	Leavenworth	Quilcene
	1962	1963	455,700	Fingerling	Leavenworth	Eagle Creek
	1963	1964	871,000	Fingerling	Leavenworth	Eagle Creek
	1964	1965	769,000	Fingerling	Leavenworth	Cascade
	1964	1966	656,000	Yearling	Leavenworth	Cascade
	1965	1966	1,734,000	Fingerling	Leavenworth	Little White Salmon River
	1965	1967	536,000	Yearling	Leavenworth	Cascade
	1966	1968	1,375,000	Yearling	Leavenworth	Little White Salmon River
	1967	1969	701,000	Yearling	Leavenworth	Little White Salmon River
	1968	1970	908,000	Yearling	Leavenworth	Little White Salmon River
	1969	1970	2,001,000	Fry	Leavenworth	Willard
	1969	1971	1,457,000	Yearling	Leavenworth	Willard x Icicle
	1972	1974	156,000	Yearling	Leavenworth	Willard
	1974	1975	659,000	Fingerling	Leavenworth	Eagle Creek
Entiat River	1943	1944	29,000	Fingerling	Entiat	Lewis River
	1944	1945	99,500	Fingerling	Entiat	Lewis River
	1963	1965	106,400	Yearling	Entiat	Lower Columbia River
	1964	1965	367,500	Fingerling	Entiat	Lower Columbia River
	1965	1966	275,000	Fingerling	Entiat	Lower Columbia River
	1966	1967	703,100	Fingerling	Entiat	Lower Columbia River
	1967	1968	2,102,700	Fry	Entiat	Lower Columbia River
	1967	1968	452,900	Fingerling	Entiat	Lower Columbia River
	1960	1969	588,700	Fingerling	Entiat	Lower Columbia River

Table 2 (cont.). Releases of non-local stock coho into tributaries of the upper Columbia River (Mullan 1983).

Stream	Brood Year	Release year	Number released	Type	Hatchery	Stock
Methow River	1944	1945	40,100	Fingerling	Winthrop	Carson
	1950	1952	149,600	Yearling	Winthrop	Lewis River
	1951	1953	90,000	Yearling	Winthrop	Lewis River
	1952	1954	94,500	Yearling	Winthrop	Lewis River
	1958	1959	183,700	Fingerling	Winthrop	Quilcene
	1959	1960	638,000	Fingerling	Winthrop	Eagle Creek
	1961	1962	327,700	Fingerling	Winthrop	Eagle Creek
	1962	1963	1,448,400	Fingerling	Winthrop	Eagle Creek
	1963	1964	824,000	Fingerling	Winthrop	Big Creek
	1964	1965	1,306,900	Fingerling	Winthrop	Eagle Creek
	1965	1966	449,400	Fry	Winthrop	Little White Salmon River
	1965	1966	1,623,200	Fingerling	Winthrop	Little White Salmon River
	1966	1967	382,200	Fry	Winthrop	Little White Salmon River
	1966	1967	600,300	Fingerling	Winthrop	Little White Salmon River
	1967	1968	418,800	Fingerling	Winthrop	Little White Salmon River
	1967	1968	400,800	Fingerling	Winthrop	Little White Salmon River
	1968	1969	113,800	Fingerling	Winthrop	Little White Salmon River

Table 3. Minimum freshwater adult run size of early stock coho in Washington and Oregon, 1970-1984.

Return year	HARVEST				ESCAPEMENT		Total production
	Treaty		Non-treaty				
	Commercial [hj]	Ceremonial & subsistence [h]	Commercial [dhi]	Recreational [ab]	Natural [f]	Hatchery [e]	
1970	15,500	N/A	396,300	2,100 [g]	N/A	268,200	682,100
1971	13,100	N/A	166,200	2,500 [g]	19,700	179,000	380,500
1972	8,700	N/A	70,300	2,500 [g]	19,300	87,200	188,000
1973	11,100	N/A	144,300	7,800 [b]	8,600	54,300	266,100
1974	6,800	N/A	120,100	15,400	8,900	132,300	283,500
1975	5,700	N/A	89,100	9,800	7,600	82,900	195,100
1976	4,000	N/A	71,200	10,400	14,300	85,900	185,800
1977	1,000	N/A	17,200	5,700	4,600	25,400	53,900
1978	3,700	N/A	62,400	8,600	16,300	106,100	197, 100
1979	3,800	N/A	69,200	9,800	14,800	84,700	182,300
1980	300	N/A	68,800	8,400	1,500	77,900	156,900
1981	1,800	N/A	21,900	7,200	9,800	59 , 600	400,300
1982	3,100	N/A	42,200	(20,800) [ci]	3,400	940,800	(220,300)
1983	200	N/A	4,700	(3,400) [ci]	2,100	30,600	(41,000)
1984	(1,500)	N/A	(79,800)	(41,300) [ci]	(4,500)	(61,500)	(187,700)
Mean	5,400	N/A	94,900	10,400	10,400	98,400	218,700

a/ Mainstem Columbia River (upper-August through October: lower-July through September 30) and Washington and Oregon tributaries (August through October).
b/ Does not include Elokomin, Grays, Green, Klickitat, Little White Salmon tributary catches.
c/ Does not include Sandy, Willamette, Clackama s, and Klaskanine tributary catches.
a/ Includes 100 percent of lower Columbia River gill net harvest from August through week ending nearest to September 20 and 50 percent of coho harvest thereafter through October 10.
e/ Used on subjective cut-off between early and late stock weekly hatchery handling reports but generally those fish disposed of prior to the first week in November. Variations from this were applied when yearling releases were from only early stock.
f/ Bonneville Dam count of adults through September 30 minus subsequent hatchery escapement, treaty commercial harvest and recreational catch upstream of Bonneville Dam. Exception for 1970, 1971, 1972 where run passing Bonneville Dam considered to be all early stock from hatchery release information.
g/ Sandy River, Lower Willamette River, Clackamas River only.
h/ G. Norman, WDF, personal communication.
i/ Includes sport harvest from Megler-Astoria Bridge to Buoy 10 . Years 1982, 9983 calculated from stock composition in 1984 Buoy 10 fishery.
j/ Includes a negligible number of jacks.
N/A: Rot available.

Table 4. Calculated escapement of coho adults and jacks over Willamette Falls, 1955-60 and 1965-83 (Bennett 1984).

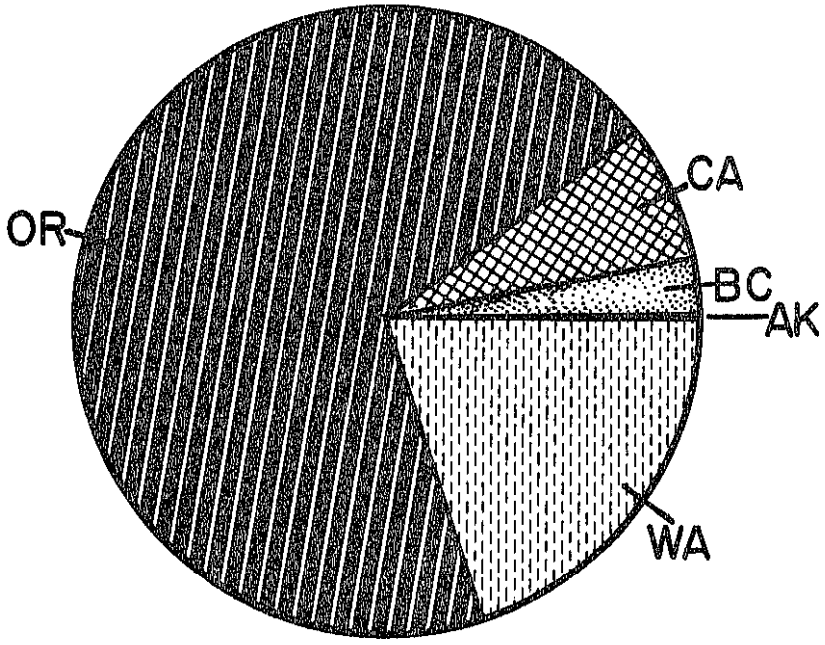
Year	Coho Adults	Coho Jacks	Coho Total[a]
1955	340	1,810	2,150
1956	2,600	6,035	8,635
1957	2,950	1,200	4,150
1958	394	976	1,370
1959	2,065	840	2,905
1960	512	458	970
1965	7,000	2,184	9,264
1966	4,071	2,247	6,318
1967	7,084	1,614	8,698
1968	12,400	5,300	17,700
1969	3,260	14,032	17,292
1970	17,902	19,453	37,355
1971	17,410	6,670	24,080
1972	9,983	7,157	17,140
1973	5,174	1,583	6,757
1974	1,501	3,941	5,442
1975	5,922	6,927	12,849
1976	2,333	2,217	4,550
1977	1,007	2,120	3,127
1978	1,711	3,891	5,602
1979	1,788	1,691	3,479
1980	1,276	1,365	2,641
1981	1,032	2,417	3,449
1982	1,702	3,517	5,219
1983	949[b]	2,840[b]	3,689
10-Year Avg. 1973-82	2,345	2,967	5,312

a/ Totals through 1960 are corrected for 8-hour daytime passage. They are expanded to include 24-hour passage since 1965.

b/ Counts as recorded at Willamette Falls Fishway. Corrected estimates of adults and jacks from scale analysis are 1,586 and 2,103, respectively.

Early coho are primarily harvested off the Oregon coast (Figure 1). The Oregon troll fishery accounts for the highest percentage of the overall catch. Most of the freshwater recreational harvest occurs in the Washington tributaries.

Distribution of Total Catch



Percentage By Fishery

Alaska Troll G Net	0
Washington Ocean Troll	8.9
Washington Ocean Sport	11.2
Washington Coastal Net	0
Puget Sound Troll & Sport	0.1
Puget Sound Wet	0.1
Columbia River Sport & Net	14.8
Oregon Ocean Troll	39.0
Oregon Ocean Sport	15.9
California Ocean Troll	5.7
California Ocean Sport	1.2
MO. B.C. Troll, Sport, Net	0.1
So. B.C. Troll, Sport, Wet	3.1

Figure 1. Harvest profile of early coho based on recoveries of 1976-1978 brood coded-wire tagged yearling releases (Buckman et al. 1984).

Production from the Willamette system contributed from 0.5-3.5 percent of the ocean catch and 0.75-6.0 percent of the Columbia River catch during the 1965-1980 period (Figures 2 and 3).

Time of migration

Early coho enter the Columbia River by mid-August and begin returning to the lower Columbia hatcheries in early September. In the mainstem Columbia River early coho predominate from August to mid-September. Stock composition shifts to late coho in late September and October.

Half of the coho have returned by mid to late September at Bonneville Hatchery and by late October to early November at other Oregon facilities (Table 5). The earlier overall time of return at Bonneville Hatchery is the result of an early pulse of fish returning in August and September. This early segment of the run has persisted at Bonneville Hatchery even though the adults are not used for broodstock because of difficulties holding them until maturity (R. Sheldon, ODFW, personal communication).

Adults and jacks pass Willamette Falls from early September through the end of October (Figure 4).

Spawning period

The median date of spawning at state facilities in Oregon is early to mid-November (Table 5). At lower Columbia hatcheries in Washington, the median date is somewhat earlier occurring in late October.

Based on index area spawning surveys in Washington (Table 6), early coho natural spawning peaks between October 20 and November 1 (H. Fiscus, WDF, personal communication).

Spawning areas

Successful natural spawning in the upper Willamette system has been documented in the Mohawk, Mary's, Luckiamute, South Santiam, North Santiam, Mill, Calapooia, Long Tom, Coast Fork Willamette, Middle Fork Willamette, North Yamhill, Pudding, Molalla, and Tualatin systems during stream surveys conducted during 1970-1977 (Williams 1983).

In Washington, spawning occurs in nearly all of the major tributaries downstream of the Klickitat River. Upstream of the Klickitat River, natural spawning populations are negligible.

Age composition

Coho return as two-year-old jacks and three-year-old adults. The age composition of the run entering the Columbia River is not available due to incomplete escapement information and the differential trapping of adults and jacks at many collection facilities. Age composition based on Oregon hatchery returns is presented in Table 7. Jacks comprised from 8-45 percent of the returns to Oregon hatcheries forised from 8-45 percent of the d years. Hatchery age composition would tend to overestimate the true jack proportion of the run entering the Columbia primarily because of size selectivity in the gill net fishery.

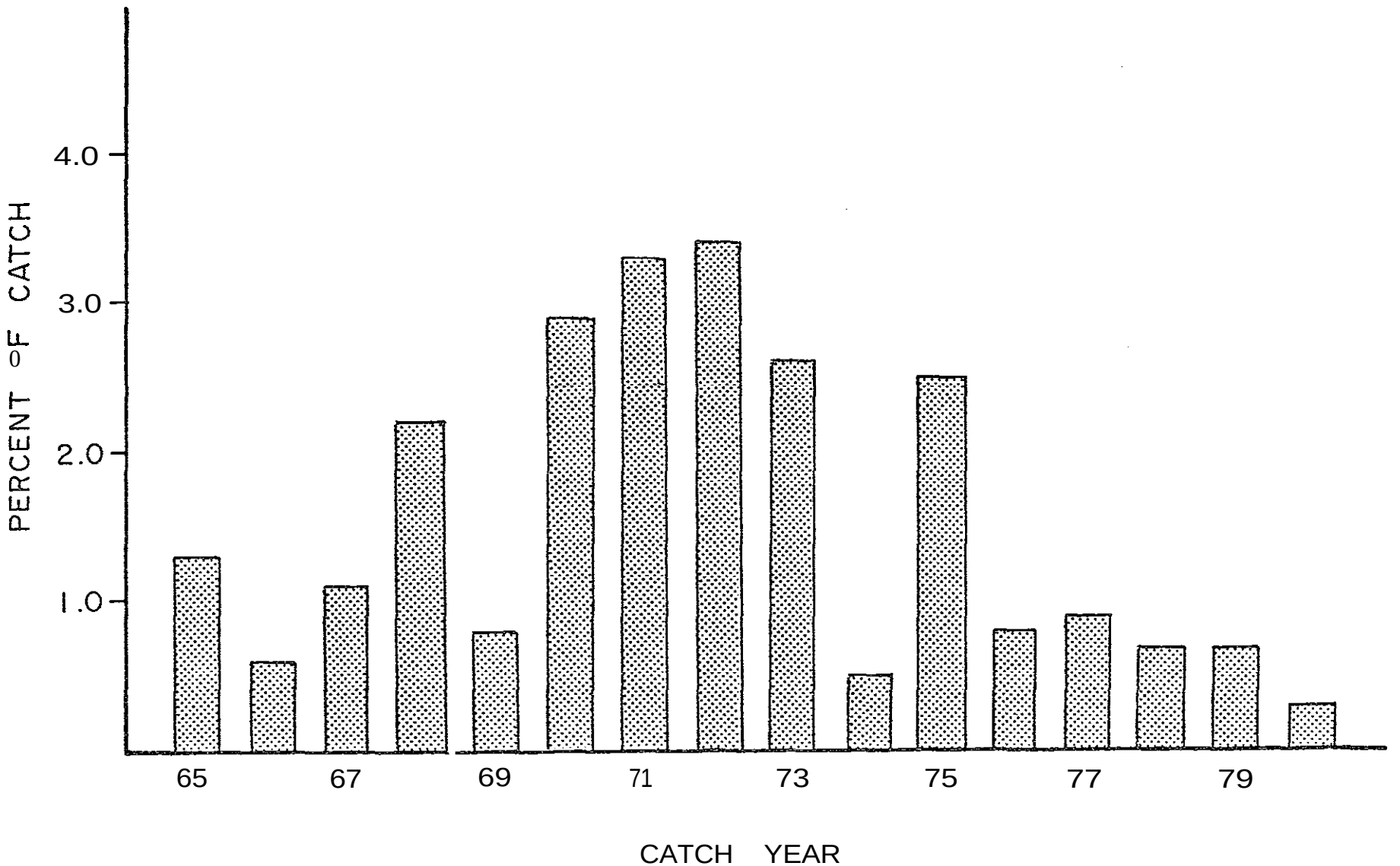


Figure 2. Proportion of the ocean catch estimated to have originated from the upper Willamette coho program (Williams 1983a).

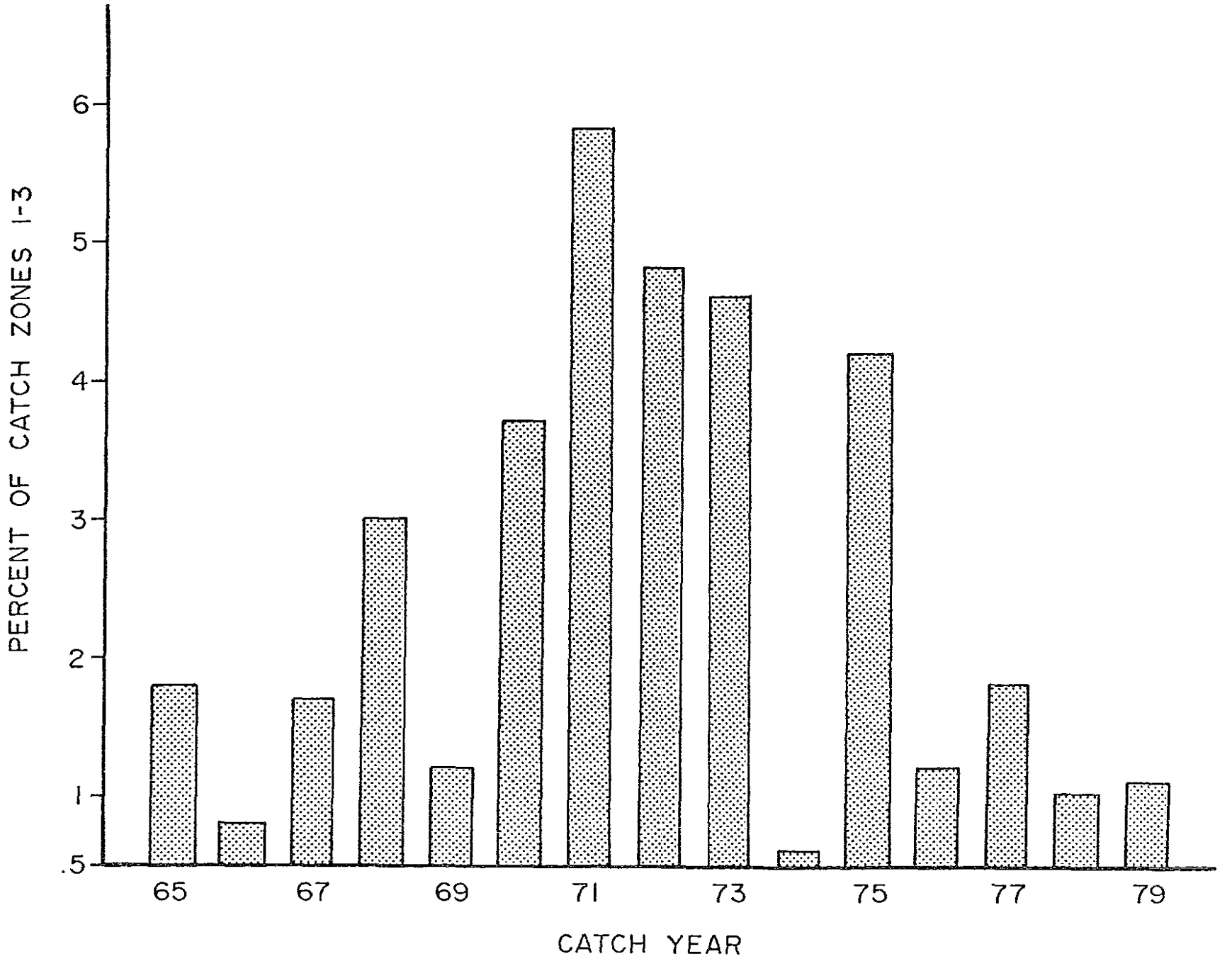
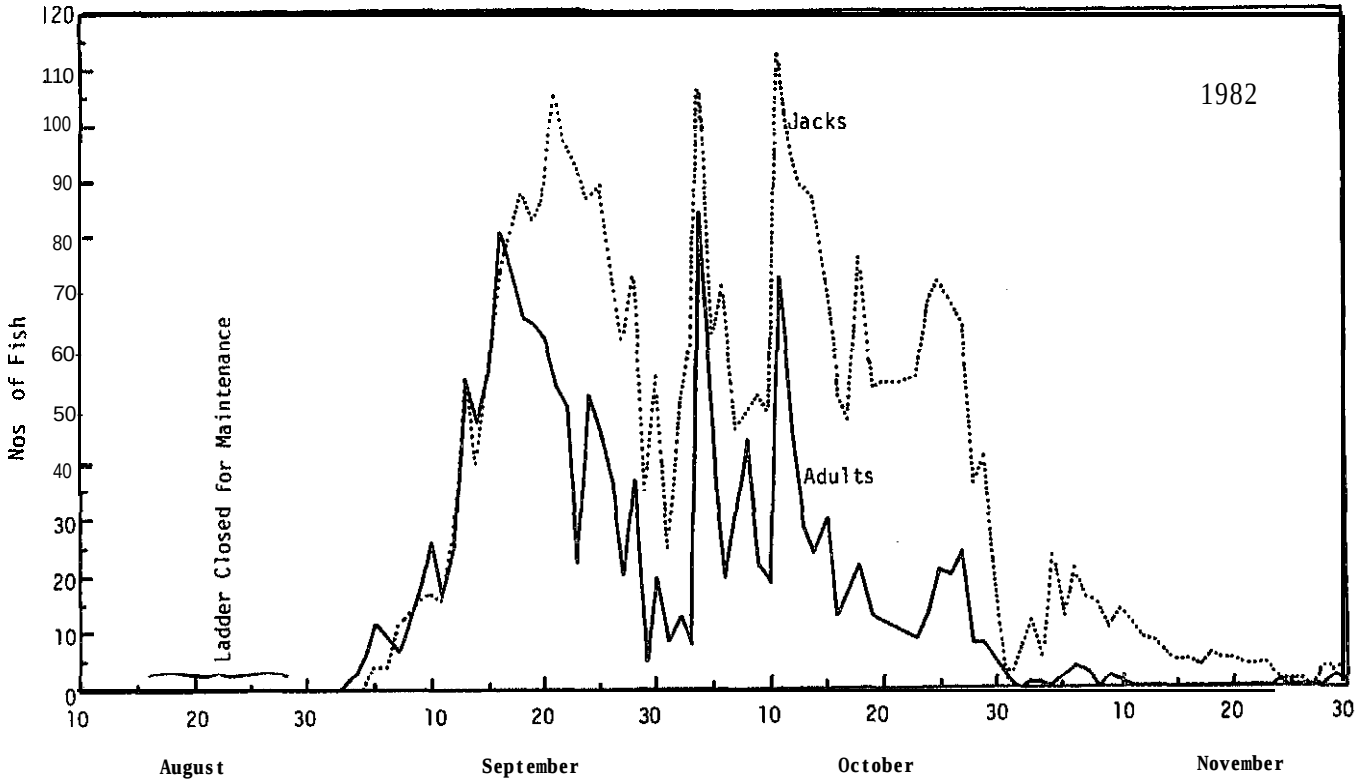


Figure 3. Proportion of upper Willamette River coho estimated in the Columbia River catch (Williams 1983a).



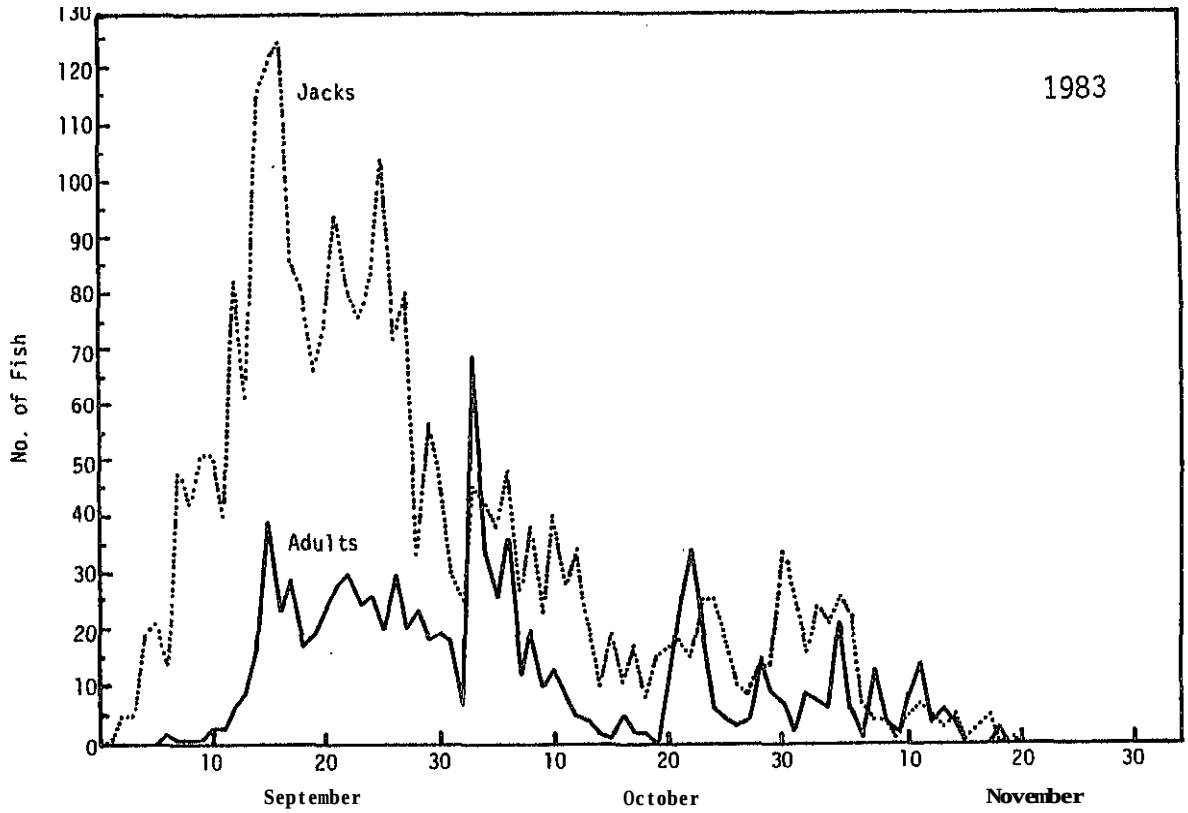


Figure 4. Daily counts of coho passing Willamette Falls 1982 and 1983 (Bennett 1983 and 1984)..

Table 5. Time of return and spawning of early run coho at Oregon hatcheries.

Coho		Returns						Spawned				
Hatchery	Year	Female	Wale	Jack	Total	Median date	Range	Female	Median date	Range	Eggs taken	Est. fecundity
Big Creek	1978	-	-	-	-	-		542	11/11	11/4-11/18	1,321,138	2,438
	1979	-	-	-	-	-		297	11/10	11/10-12/1	961,325	2,237
	1980	-	-	-	-	-		886	11/15	11/8-41/45	2,461,060	2,778
	1981	-	-	-	-	-		1,265	11/14	11/7-11/30	3,534,900	2,794
	1982	1,179	1,157	160	2,496	10/29	9/17-12/31	535	11/05	10/29-l2/31	1,364,000	2,550
	1983	477	659	329	1,465	10/31	9/9-12/1	416	11/07	10/28-11/30	797,000	1,916
Bonneville	1978	3,455	1,553	-	5,008	-		3,213	11/9	10/39-11/16	7,136,000	2,220
	1979	2,741	594	-	3,335	-		2,605	10/25	10/18-11/8	6,680,000	2,948
	1980	-	-	-	-	-		2,838	11/13	10/29-11/27	7,038,000	2,480
	1981	4,487	4,051	2,403	10,941	9/24	8/27-11/12	457	11/5	10/22-11/12	1,269,450	2,778
	1982	17,867	15,911	5,843	39,621	9/17	? -11/21	1,427	10/29	10/22-12/31	3,717,000	2,605
	1983	3,698	5,105	1,209	10,012	9/23	9/02-12/03	----------None----------				
Cascade	1978							1,257	11/3	10/20-11/17	3,264,500	2,575
	1979	587	1,120	1	1,808	10/19	10/12-11/9	1,042	10/26	10/19-11/9	3,035,500	2,913
	1980	769	799	122	1,690	11/7	10/31-11/28	807	11/14	10/31-11/28	1,963,500	2,433
	1981	125	135	104	364	10/16	10/16-11/13	115	10/30	10/23-11/13	296,500	2,578
	1982	1,298	503	285	2,086	11/12	10/8-12/3	1,866	11/12	10/22-11/12	5,319,000	2,850
	1983	97	249	33	379	10/24	10/17-12/12	2,940	11/15	10/17-12/12	6,527,000	2,220
Klaskanine	1978	-	-	-	-		-	922	11/9	10/26-11/30	185,000	2,270
	1979	-	-	-	-	–		1,326	11/1	11/l-11/8	3,080,000	2,699
	1980	-	-	-	-	–		518	11/13	11/6-11/13	1,250,000	2,281
	1981	547	393	792	1,732	11/5	10/8-11/19	474	11/5	10/22-11/19	936,000	2,495
	1982	1,004	767	1,447	3,218	11/5	before 9/17-12/3	888	11/19	10/29-12/3	2,002,000	2,576
	1983	734	755	1,701	3,190	11/3	10/24-11/21	681	11/14	10/28-11/28	4,400,000	1,738
Sandy	1978	3,728	5,023	324	9,075	11/9	9/21-12/14	2,817	11/96	11/2-12/7	6,394,046	2,270
	1979	3,127	5,565	590	9,282	10/25	9/13-41/29	2,615	11/l	10/18-11/15	7,058,600	2,699
	1980	4,132	5,366	204	9,702	11/13	9/25-12111	2,880	11/20	11/6-11/27	6,570,950	2,281
	1981	3,089	3,790	265	7,144	10/16	10/2-12/11	2,445	11/13	10/30-11/20	6,100,750	2,495
	1982	5,681	8,263	1,234	15,178	10/1	before 9/17-12/3	3,351	10/29	10/22-11/19	8,634,000	2,576
	1983	1,883	2,873	705	5,461	11/7	10/25-12/12	1,842	11/23	10/25-12/19	3,203,000	1,738

Table 5 (cont.). Time of return and spawning of early run coho at Oregon hatcheries.

Coho		Returns						Spawned				
Hatchery	Year	Female	Male	Jack	Total	Median date	Range	Female	Median date	Range	Eggs taken	Est. fecundity
Eagle Creek (USFWS)	1978	1,493	997	0	2,490	-		-	-			
	1979	3,720	3,322	708	7,760	-		-	-			
	1980	6,000	-	1,859	7,860	-		-	-			
	1981	1,707	3,113	1,867	6,687	-		-	-			
	1982	4,973	5,163	1,027	11,163			542			1,612,000	2,974
	1983	907	1,709	128	2,826	-		-	-			

Table 6. Peak fish counts for Washington early coho index tributaries, 1972-1983.

	Johnson Creek[a]/		Cedar Creek[a]/		Chelatchie Creek&/		Lawton Creek		Spirit area	
Year	Niles surveyed	Number	Niles surveyed	Number	Miles surveyed	Number	Wiles surveyed	Number	Wiles surveyed	Number
1972	1.5	716	0.3	7	0.8	0	0.8[f]/	9	2.0[e]/	18
1973	1.5	44	0.3	38	0.8	43	NS		2.0	252
1974	1.5	29	0.3	8	0.1	26	0.8	1	2.0	280
1975	1.5	634	0.3	164	0.8	292[c]/	NS		2.0	38
1976	1.5	26	0.3	0	0.8	32	0.8	1	2.0	79
1977	1.5	17	1.9	58	0.8	121	0.8	2	2.0	20
1978	1.5	6[d]/	7.3	830	0.5	54	0.8	13	2.0	96
1979	1.5	423	11.9	637	1.7	172	0.8	3	2.0	9
1980	1.5	a4	12.9	574	0.8	0	0.8	1	NS	
1981	1.5	9	13.3	194	1.6	51	0.8	0	MS	
1982	1.5	92	a.9	545	1.6	27	NS		NS	
1983	1.5	12	0.3	4	0.8	6	NS		NS	

a/ Tributary to North Lewis River.
b/ Tributary to Cedar Creek.
c/ Late count.
d/ Late count.
e/ 1969 escapement blocked by rock slide.
f/ Partial migration block.

Table 7. Age composition of early stock coho returns to Oregon hatchery facilities, 1970-1983a/ (S. King, ODFW, personal communication).

Return year	Age 2 Number	Age 2 Percent	Age 3 Number	Age 3 Percent	Total
1970	38,409	33.0	77,885	67.0	116,294
1971	21,782	26.8	59,349	73.2	81,131
1972	15,236	36.7	26,224	63.3	41,460
1973	32,933	61.8	20,330	38.2	53,263
1974	7,227	11.9	53,470	88.1	60,697
1975	22,392	49.1	23,187	50.9	45,579
1976	6,740	13.3	43,890	86.7	50,630
1977	26,051	70.4	10,972	29.6	37,023
1978	13,496	18.3	60,302	81.7	73,798
1979	9,568	17.7	44,355	82.3	53,923
1980	7,822	13.6	49,628	86.4	57,450
1981	5,326	19.9	21,398	00.1	26,724
1982	9,711	13.5	61,965	86.5	71,676
1983	4,771	20.8	18,184	79.2	22,955
Average	15,818	28.3	40,081	71.9	55,899

a/ Based on report of adults and jacks by hatchery personnel at Big Creek, Bonneville, Klaskanine, Sandy and Eagle Creek hatcheries.

Size

Fork length measurements generally range from 30-45 cm. for jacks (Washington hatchery sampling) and 55-70 cm. for adults (commercial fishery sampling).

Sex ratio

Because of a suspected differential catch rate between adult males and females in the commercial fisheries, the exact sex ratio of the run returning to the Columbia River is unknown. For the 1978-1981 brood years the percentage of females of the adults returning to Oregon hatcheries varied from 28-72 percent. Females comprised 47 percent, 42 percent, and 36 percent of the adults returning to Washington stations in 1981-1983, respectively.

Fecundity

Fecundity estimates in Oregon and Washington were based on the number of eggs fertilized divided by the number females killed for spawning. Any unripe females killed would result in a underestimate of the true fecundity. Fecundities were not adjusted for length differences.

Average fecundity of coho returning to Oregon hatcheries ranged from 1,738 eggs per female at Sandy Hatchery in the El Nino year of 1983, up to 3,237 eggs per female at Big Creek Hatchery in 1979. The average fecundity at all Oregon stations during the 1978-1983 period was 2,409 eggs per female (Table 5).

In Washington, fecundity of early coho averaged 2,606 eggs per female at lower Columbia hatcheries during 1978-1982.

Biochemical-genetic characteristics

Hjort and Schreck (1982) compared phenotypic characters (isozyme gene frequencies, life history and morphology) of coho salmon from Oregon, Washington and California using agglomerative and divisive cluster analyses, Early coho from Bonneville, Big Creek and Sandy River hatcheries were profiled along with Cowlitz Hatchery late coho. Although Columbia River coho tended to cluster together within broad comparisons, further segregation into early and late stocks did not occur.

JUVENILE LIFE HISTORY

Time of emergence

No information is available on natural production in specific streams.

Emergence time depends primarily on the temperature of the water in the stream. At 50°F, fertilization to eyed-egg stage takes about 3.5 weeks, eyed-egg to hatching about 2.5 weeks, and hatching to emergence about 8 weeks.

Time, age, and size at migration

Normal hatchery rearing extends for about 14 months. Yearling smolts are commonly released in early Way and sometimes in late Way, June, or July (informally called “delayed release”). Smolts are typically 15-20 fish/pound and 125-140 mm in length.

Downstream migration to the estuary commences immediately upon release. Releases of coded wire tagged early coho from Cascade Hatchery were recovered at Jones Beach and McGowan in the Columbia River estuary about l-4 weeks after release (Table 8). Sampling for other years and release groups is summarized by Dawley et al. (1985).

Juvenile early run coho have been caught in the ocean primarily off Oregon in May through July and off southern Washington in September during their first summer in the ocean (Figure 5).

Survival rate

Survival rates (catch plus escapement) of all marked coho releases for brood years 1964-1979 ranged from 0.95 percent to 8.49 percent (Table 9). Time of release studies indicate that June and July smolt releases produced

Table 8. Hatchery release groups and migration rates of juvenile early coho to Jones Beach (JB) and to McGowan (MG)[a] (Bottom et al. 1984).

Hatchery (km from river mouth)		Tag code	Release date	Migration rates (km/day) to JB	to MG	Median date of arrival at JB	at MG
Toutle	(160)	631911	May 07 79	7	10	May 30	May 23
		632058	May 07, 80	9	11	May 25	May 22
Cascade	(230)	LB B4 3	May 03, 78	16	10	May 17	May 26
Sandy	(235)	091645	May 02, 78	18	22	May 1 5	May 13
Eagle Creek	(247)	091657	April 23, 78	6	8	July 03	May 24
		071746	May 22, 79	10	14	June 16	June 09
Willard	(286)	WHRDLB	May 23, 78	16	21	June 09	June 05
Carson	(347)	RP ID 1	May 23, 78	34	22	June 02	June 08

[a] Jones Beach is RK 75 and McGowan is RK 16.

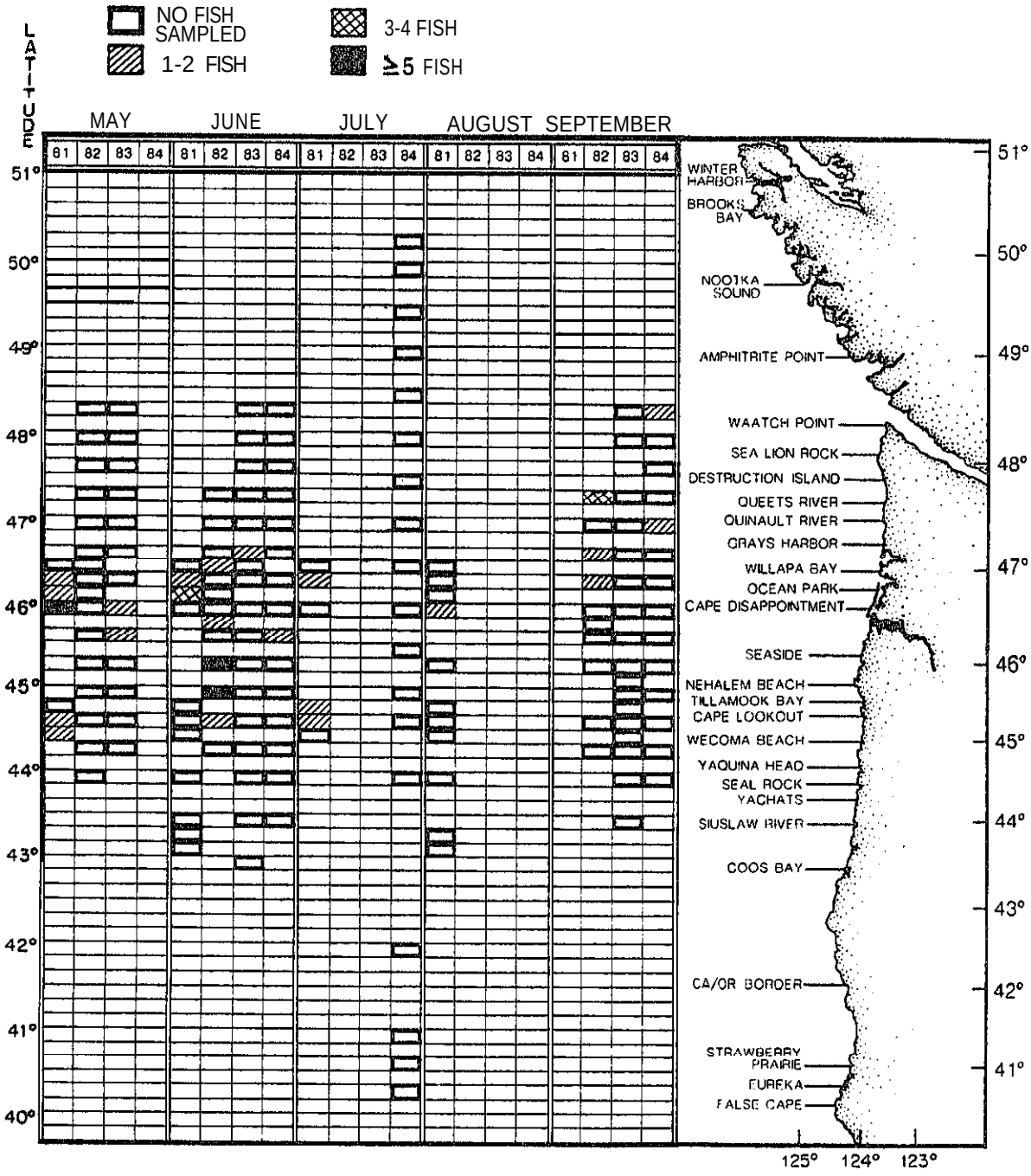


Figure 5. Ocean distribution of coded-wire tagged early run juvenile coho salmon sampled with purse seines during 1981-84 (Data from Wakefield et al. 1981; Fisher et al. 1983; Fishr et al. 1984; Fisher and Pearcy 1985).

Table 9. The mean percent survival (catch + escapement) of Columbia River marked coho released in February-July for brood years 1964-79. Number of release groups in parentheses. (Johnson 1982 and ODFW unpublished data).

Brood year	Month of Release					
	Feb.	Nar	Apr.	May	Jun.	Jul.
1964		1.60(2)				
1966		3.95(5)				
1967			3.73(2)			
1968			5.91(2)			
1969		1.10(2)	2.38(4)			
1970			1.08(7)			
1971			4.19(3)			
1972		3.55(1)	2.30(15)	2.25(17)	4.20(2)	0.95(1)
1973	6.2(1)		4.54(5)			
1974		0.60(1)	1.07(28)	1.06(5)		
1975			3.23(18)	4.21(7)		
1976			4.01(9)			
1971				2.80(8)	3.78(8)	2.55(8)
1978				1.66(4)	4.97(4)	8.49(4)
1979				2.16(4)	4.81(4)	3.41(4)

the highest survival rates for the 1977-1979 brood years (Table 10). Return of coho to ODFW hatcheries for adults and jacks combined, is generally 0.52-2.0 percent (Johnson 1982). Smolt to adult survival for 1975-1977 brood releases in Scoggins Creek, tributary of the Willamette River, averaged 0.9% (Smith et al. 1982).

DISEASE HISTORY

Diseases encountered at hatchery facilities may only be the result of the particular hatchery techniques or environment and should not necessarily be considered “stock specific”.

Common diseases found in coho in Oregon hatcheries are bacterial kidney disease, furunculosis, cold water disease, bacterial gill disease, and ectoparasitic infections (Table 11). ENV has been found in coho at Bonneville and Big Creek hatcheries. This virus appears to cause anemia and predisposes fish to secondary infections of fungi and bacteria. IPN virus was also found in coho at Bonneville and Cascade hatcheries in 1971 and 1972 (R. Holt, ODFW, personal communication).

A similar disease profile occurs at Washington facilities.

Table 10. Estimates of catch and escapement for coho salmon time of release experiments at Columbia River hatcheries (Johnson 1982 and ODFW unpublished data).

Release site	Brood year	Release date	Release size (g)	Percent return a/ Jacks Hatch	Adults Hatch	Adults Catch	Other b/	Total
Klaskanine	1973	2/28/75	31.7	--	0.36	5.85	0.00	6.21
		4/30/75	31.1	--	0.49	1.33	0.00	7.02
Klaskanine	1974	3/01/76	30.9	--	0.04	0.56	0.00	0.60
		4/01/76	32.9	--	0.08	0.37	0.00	0.45
		5/01/76	31.5	--	0.06	0.75	0.00	0.01
Big Creek	1977	5/07/79	24.2	0.01	0.26	1.69	0.00	1.23
		6/07/79	24.7	0.01	0.64	2.93	0.00	3.57
		7/05/79	23.8	0.00	0.44	1.78	0.00	2.22
Cascade	1977	5/07/79	20.5	0.01	0.33	0.89	0.01	1.24
		6/07/79	20.1	0.00	0.74	1.57	0.01	2.32
		7/06/79	20.2	0.00	0.61	0.86	0.00	1.47
Toutle	1977	5/01/79	24.0	0.01	0.08	3.07	0.58	4.54
		6/01/79	24.2	0.00	0.10	5.92	0.77	6.79
		7/01/79	25.0	0.00	0.05	2.82	0.44	3.31
Washougal	1977	5/01/79	27.5	0.03	0.65	3.07	0.00	3.75
		6/01/79	23.4	0.00	0.64	2.83	0.03	3.50
		7/01/79	22.9	0.00	0.68	2.46	0.03	3.12
Big Creek	1978	05/07/80	25.5	0.02	0.48	1.46	0.00	1.96
		06/06/80	23.9	0.00	0.76	3.04	0.00	3.80
		07/07/80	24.4	0.00	1.12	3.32	0.00	4.44
Washougal	1978	05/08/80	25.2	0.02	0.19	1.35	0.02	1.58
		06/09/80	25.2	0.00	0.82	4.36	0.12	5.30
		07/07/80	24.7	0.00	1.89	7.47	0.26	9.62
Big Creek	1979	05/05/81	23.5	0.01	0.28	0.76	0.00	1.05
		06/03/81	24.5	0.02	1.11	2.85	0.02	4.00
		07/02/81	23.6	0.00	0.93	1.67	0.01	2.61
Cascade	1979	05/06/81	26.4	0.02	1.40	1.89	0.01	3.32
		06/08/81	27.4	0.01	2.40	3.20	0.03	5.64
		07/06/81	26.55	0.00	1.95	2.19	0.04	4.18

a/ Preliminary California catch data incorporated into return estimates for years 1977-79.

b/ Includes spawning ground counts, Quinault coastal net catches, NMFS and OSU juvenile sampling, etc.

Table 11. Disease history of coho in Oregon hatcheries[a]/ (Terry Kreps, unpublished data).

Date/Year Release	Diseases Certifiable						Diseases Noncertifiable						
				Virus:			Bacterial						
	BKD	Furunc.	E. Redmouth	IHN, IPN VEN	Myxo-sporidian	Misc. Cert. Pathology	CWD	Columnaris	Gill Disease	Ectoparasites *Costia*, etc.	Gill Amoeba	ICH	Misc. Bact.
1958	+	+					+			+			
1959	+	+					+			+			
1970	+	+					+			+	+		
1971	+		+	+			+		+	+			
1972	+	+		+			+		+	+			
1973		+					+		+	+			
1974	+	+					+			+			+
1975	+	+					+		+	+			+
1976	+	+					+		+				
1977	+	+					+						+
1978	+						+		+				
1979	+						+						+
1980	+	+	+				+						
1981													

a Big Creek, Bonneville, Cascade, Klaskanine, Herman Creek, Oxbow, and Sandy.

PRIORITY INFORMATION NEEDS

Spawning ground surveys and juvenile population estimates are needed to determine the production from hatchery releases and to evaluate the impacts of hatchery releases on the naturally produced populations.

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LATE RUN COHO

The two primary stocks of coho in the Columbia River are the early coho, sometimes called Toutle stock coho, and the late coho or Cowlitz stock coho. Both are considered hatchery stocks.

PRODUCTION

Most of the Columbia River late stock coho are produced at lower river hatcheries in Washington. Oregon hatcheries do not currently rear late stock coho.

Some natural production of late stock coho exists but probably does not exceed IO-15 percent of the overall Columbia River returns (D. McIsaac, WDF, personal communication). See "Clackamas River Coho (wild)" and "Lower Columbia River (Oregon) Coho (wild) for more information on wild stock coho in Oregon.

Annual hatchery production of late coho averaged 12.6 million yearling smolts during 1979-1983. Fingerlings and fry are released in varying numbers to supplement natural production and utilize available habitat.

GEOGRAPHIC LOCATION

Streams

Late coho are stocked annually in the Elokomin, Kalama, Lewis, Washougal River basins and in most recent years in the Klickitat River. Periodic releases have also been made into the Gray's River, Yakima River and mainstem Columbia River at Ringold Springs, Rocky Reach, and Wells Dam.

Hatcheries

Late coho are released from the following hatcheries: Elokomin, Cowlitz, Lower Kalama and/or Kalama Falls, Lewis, Washougal, and in most recent years, Klickitat. Other hatcheries that have occasionally released late coho include Gray's River, Speelyai, Toutle (prior to Wt. St. Helens eruption), Ringold Springs, Rocky Reach, Wells Dam, and Yakima Indian Nation rearing pond.

ORIGIN

Late stock coho are informally considered synonymous with Cowlitz River stock coho. Late stock hatchery programs were developed utilizing Cowlitz River stock, their derivatives, or native late runs. Late coho used in most of the current programs are probably a blend of all of these, although egg transfers from Cowlitz Hatchery occur most frequently.

Other streams reported to have native late stocks include the Gray's, Elokomin, Kalama, Lewis, and Washougal rivers (WDF and IJSFWS 1951).

ADULT LIFE HISTORY

Run size, catch, and escapement

Since 1970, the freshwater run, excluding most natural escapement, has averaged about 115,000 adults (Table 1). Values shown in Table 1 include a negligible number of late timed native coho harvested in mainstem Columbia fisheries. (e.g. Clackamas River wild stock coho). Returns during even numbered years appears to be significantly greater than during odd years, averaging 148,000 versus 76,000. This odd-even phenomenon also occurred with the ocean fishery harvests (G. Norman, WDF, personal communication).

Based on coded wire tagged releases of 1976-1978 brood late coho, most of the harvest occurs in the Oregon and Washington ocean fisheries (Figure 1). Late coho have a more northerly migration pattern than early coho (Buckman et al. 1984). This is reflected in the catch distribution where the Washington coastal catch comprised 40 percent of the total harvest compared to 20 percent for early coho during 1979-81. Late coho also contribute significantly to the lower Columbia River commercial gill net fishery. Freshwater recreational catches occur primarily in the Cowlitz, Lewis, Kalama and Washougal rivers. In 1984, a recreational fishery in the Columbia River estuary downstream of the Megler-Astoria Bridge harvested 23,500 late coho or 32 percent of the area catch (ODFW and WDF 1985).

Time of migration

Typically, the late coho run begins entering freshwater in mid to late September with mid-October considered the main migratory period in the mainstem Columbia River. Arrival at the hatchery racks occurs primarily from about November 1st through November 25th, similar to the situation at Cowlitz Hatchery presented in Figure 2.

Spawning period

Spawning occurs over a wider time frame than early coho, extending from late November through March in some instances. Peak of spawning at the hatcheries is in December and early January.

Spawning areas

Spawning occurs in nearly all areas of the lower Columbia streams accessible to coho.

Age composition

Coho return as two-year-old jacks and three-year-old adults. The age composition of the late coho run entering the Columbia River is not available because of incomplete escapement information and the differential

Table 1. Minimum freshwater adult run size of late stock coho to Oregon and Washington, 1970-1984.

	HARVEST				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial a/	Ceremonial and subsistence a/	Commercial a,b/	Recreational a,c/	Natural e/	Hatchery a,d/	Total production
1970	0	0	124,200	N/A	0	49) 500	173,700
1971	0	0	98,100	N/A	0	29,000	127,100
1972	0	0	61,000	N/A	0	10,200	71,200
1973	0	0	39,400	1,000	1,100	18,500	60,000
1974	0	0	140,900	1,400	5,500	30,500	178,300
1975	0	0	67 , 500	3,700	2,600	19,200	93,000
1976	0	0	97,200	6,600	3,600	45,800	153,200
1977	0	0	21,800	1,100	1,600	13,600	38,100
1978	0	0	70,300	1,500	2,400	33,100	107,300
1979	0	0	58,400	2,000	3,300	24,000	87,700
1980	0	0	81,300	2,800	6,200	45,800	136,100
1981	0	0	37,900	2,400	900	27,500	68,700
1982	1,200	0	157,500	(8,400) f/	3,900	45,700	(216,700)
1983	0	0	2,400	(3,300) f/	3,800	45,200	(54,700)
1984	0	0	(68,300)	(26,000) f/	(3,500)	(46,800)	(144,600)
Mean	100	0	75,100	5,000	2,600	32,300	114,000

a/ G. Norman, WDF personal communication.

b/ Includes 50 percent of those coho harvested between week ending nearest September 20 to October 10 and all fish thereafter.

c/ Lower Columbia River harvest October 1 to December 31; Cowlitz River October 1 through January and other tributaries excluding Willamette, Clackamas, Sandy and Klaskanine November 1 through January.

d/ Based on subjective cut-off between early and late stock weekly hatchery handling reports but generally those fish disposed of after first week of November. Variations from this were used when yearling releases were from only-late stock.

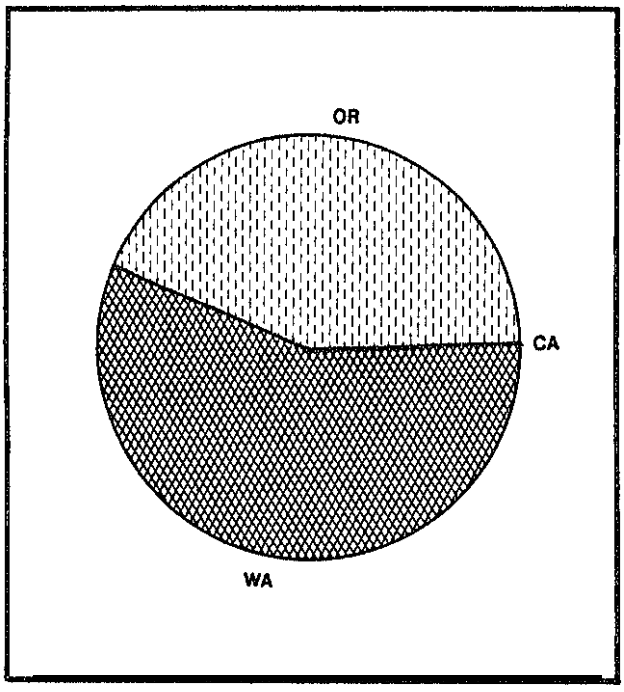
e/ Bonneville Dam count of adults after September 30th minus subsequent hatchery escapement, treaty harvest, and recreational catch. Exceptions in 1970, 1971, 1972 where hatchery release information indicates exclusively early stock to return above Bonneville Dam.

f/ Includes Megler-Astoria Bridge to Buoy 10 sport harvest; stock composition in 1984 used for 1982 and 1983.

0 (Preliminary).

N/A: Not available.

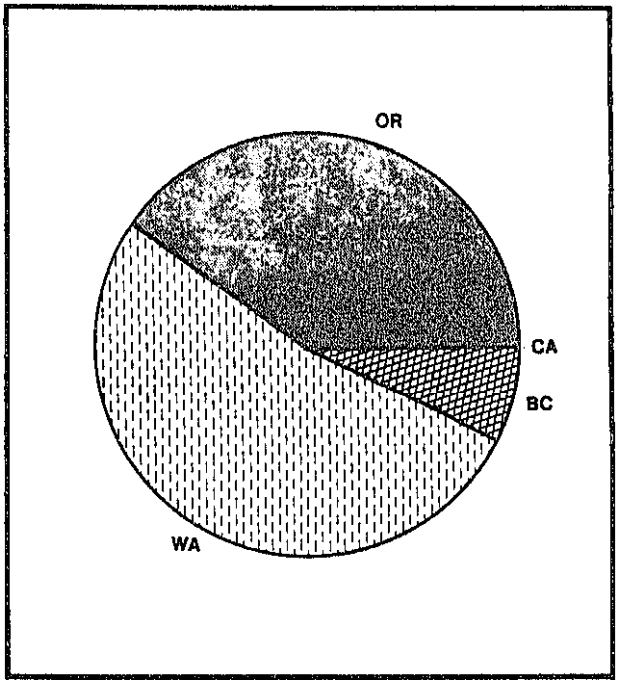
Distribution of U.S. Catch



Percentage By Fishery

Alaska Troll & Net	0
Washington Ocean Troll	16.90
Washington Ocean Sport	23.64
Washington Coastal Net	0
Puget Sound Troll & Sport	.50
Puget Sound Net	.27
Columbia River Sport & Net	26.26
Oregon Ocean Troll	16.38
Oregon Ocean Sport	13.71
California Ocean Troll	.20
California Ocean Sport	.13

Distribution of Total Catch



Percentage By Fishery

Alaska Troll & Net	0
Washington Ocean Troll	17.62
Washington Ocean Sport	22.04
Washington Coastal Net	0
Puget Sound Troll & Sport	.47
Puget Sounds Net	.25
Columbia River Sport & Net	24.50
Oregon Ocean Troll	15.27
Oregon Ocean Sport	12.76
California Ocean Troll	.19
California Ocean Sport	.12
No. B.C. Troll, Sport, Net	.16
So. B.C. Troll, Sport, Net	6.62

Figure 1. Harvest profile of late coho based on recoveries of coded-wire tagged 1976-1978 brood yearling releases (Buckman et al. 1984).

trapping of adults and jacks at many collection facilities. For brood years 1967-1980, jacks comprised about 55 percent of the returns to Cowlitz Hatchery. This value exceeds the true jack proportion of the returning run due mainly to the selective harvest of adults in the lower Columbia gill net fishery.

Size

Based on sampling of the lower Columbia River commercial fishery during 1980-1982, adult fork length measurements ranged from about 50-70 cm. Gill net selectivity may tend to skew the catch towards fish in this size interval.

Late stock coho were sampled at the hatcheries in 1982 in order to determine the fork length measurement suitable for separating adults and jacks. Dammers (1983) reported that a considerable degree of overlap existed in the 44-50 cm. range but suggested 47 cm. was a likely separation point at Lower Kalama Hatchery and 43 cm. at Washougal Hatchery. From 841 scale samples and fork lengths, the largest jack measured 50 cm. and the smallest adult was 39 cm.

Sex ratio

Accounting for the differential harvest of adult males and females in the gill net fishery, the adult run entering the Columbia River was estimated to be 46 percent females in 1982 and 30 percent females in 1983 (LaVoy 1984). Hatchery adult returns were 33 percent females in 1982 and 34 percent females in 1983.

Fecundity

Fecundity, based on hatchery documents, averaged 2,575 eggs per female during 1978-1982 at lower Columbia hatcheries in Washington.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information is available on the naturally produced population.

Time of emergence depends primarily on the water temperature in the stream. At 50°F, fertilization to eyed-egg stage takes about 3.5 weeks, eyed-egg to hatching about 2.5 weeks, and hatching to emergence about 8 weeks.

Because water temperatures vary between hatcheries, the time required to reach each stage of development will be somewhat different for each station. The following rearing profile at Lewis River Hatchery was

provided in order to present an example of the time intervals at various early life history stages.

1. Spawning to eyed-egg stage - 45 days.
2. Eyed-egg to hatching - 42 days.
3. Hatching to yolk-sac absorption - 28 to 40 days.
4. Yolk-sac absorption to raceway transfer and initial feeding - 12 to 20 days.

(R. Nicolay, WDF, personal communication)

Because spawning of late coho occurs after early coho, late coho emergence would be expected to occur later than early coho emergence.

Time, age, and size at migration

Freshwater rearing generally lasts for about 14 months. Hatcheries typically release yearlings either in early May or as 'delayed releases' in late May, June or July. Average size ranges from about 125 to 148 mm. in length and 15 to 20 fish/pound.

Based on coded wire tag recovery studies by Dawley et al. (1982), arrival in the Columbia River estuary occurs soon after hatchery release. For example, median date of recovery in the Columbia River estuary for tagged late coho from Washougal Hatchery was about one to two weeks after release (Table 2).

Survival rate

No stock specific information is available.

A generalized recent year smolt to adult survival rate for coho was estimated to be 2.5 percent (TAC 1983).

DISEASE HISTORY

Diseases encountered by late coho at Cowlitz Hatchery and Klickitat Hatchery are presented in Tables 3 and 4.

PRIORITY INFORMATION NEEDS

Estimates of natural spawning escapement and subsequent juvenile production are needed to complete run size and natural production profiles for Columbia River late coho.

An electrophoretic comparison of the dominant late coho populations would help guide current stock transfer issues.

Table 2. Juvenile outmigrant timing of late coho released from Washougal Hatchery and recovered at Jones Beach (River Mile 47) in the Columbia River estuary (Dawley et al. 1982).

Origin	Purpose	Size at release (fish/lb)	Year	Date	Percent of release recaptured	Year	Median fish	1st fish	Last fish	Movement rate (RM/day)
Washousal Hatchery										
Cowlitz Type N										
	Timing evaluation	18	1980	8 May	0.102	1980	17 May	13 May - 14 June		10
	Timing evaluation	18	1980	8 May	0.108	1980	17 May	12 May - 28 May		10
	Timing evaluation	18	1980	9 June	0.076	1980	15 June	13 June - 18 June		14
	Timing evaluation	18	1980	9 June	0.096	1980	14 June	13 June - 19 June		17
	Timing evaluation	19	1980	7 July	0.251	1980	12 July	10 July - 15 July		17
	Timing evaluation	18	1980	7 July	0.242	1980	12 July	18 June - 25 July		17

Table 3. Diseases encountered by late stock coho at Cowlitz Hatchery, 1979-1983 (WDF 1984).

Type	Diseases	Infected group
Bacterial:	Low temperature disease	1977-1981 brood juveniles
	Bacterial kidney disease	1977, 1979 brood juveniles
	Furunculosis	1978 brood juveniles
Parasitic:	Costia	1977-1981 brood juveniles
	Trichophera	1978, 1981 brood juveniles
	Epistylis	1981 brood juveniles
Viral :	None	
Other:	None	

Table 4. Diseases encountered by late stock coho at Klickitat Hatchery, 1979-1983 (WDF 1984).

Type		
Bacterial:	Low temperature disease	1977, 1980-1982 brood juveniles
	Bacterial kidney disease	1979 brood juveniles
	Septicemia	1979 brood juveniles
Parasitic:	None	
Viral:	None	
Other:	Coagulated yolk	1980, 1982 brood eggs

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Clackamas River Coho (wild)

PRODUCTION

Coho production in the Clackamas River system consists of wild and hatchery stocks. This summary covers information on the native wild stock. consult the "Early Run Coho (hatchery)" summary for information on the hatchery stock.

GEOGRAPHIC LOCATION

Streams

Clackamas River and tributaries (Figure 4)

ORIGIN

The Clackamas River is the only major tributary of the Willamette River in which coho are native. Early Run hatchery stock have been released in the system, Hatchery releases are now restricted to areas below North Pork Dam to prevent further dilution of the wild late-spawning stock above North Fork Dam (J. Massey, ODFW, personal communication).

ADULT LIFE HISTORY

Run size, catch, and esapement

From 1971 to 1980, the sport harvest of coho (hatchery and wild) in the mainstem Clackamas has ranged from 200 to 1,700 fish per year (Table 1). Eagle Creek has a large run and fishery as a result of releases of Early Run hatchery stock from Eagle Creek National Fish Hatchery.

Table 1. Clackamas River coho sport catch by run-year, 1971-80" (Berry 1981).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Clackamas R.	1,685	1,607	232	200	402	788	485	425	522	1,059
Clear Cr.	-	-	-	-	-	-	0	0	3	6
Collowash R.	-	-	-	-	-	3	0	0	0	3
Deep Cr.							3	0	21	3
Eagle Creak	-	-	1,330	149	461	1,265	327	650	1,427	1,863
Total	1,685	1,607	1,562	349	863	2,056	815	1,075	1,673	2,934

a Estimated from punch-card returns adjusted for non-response bias. Prior to 1977 the catch in tributaries was included in the mainstem catch.

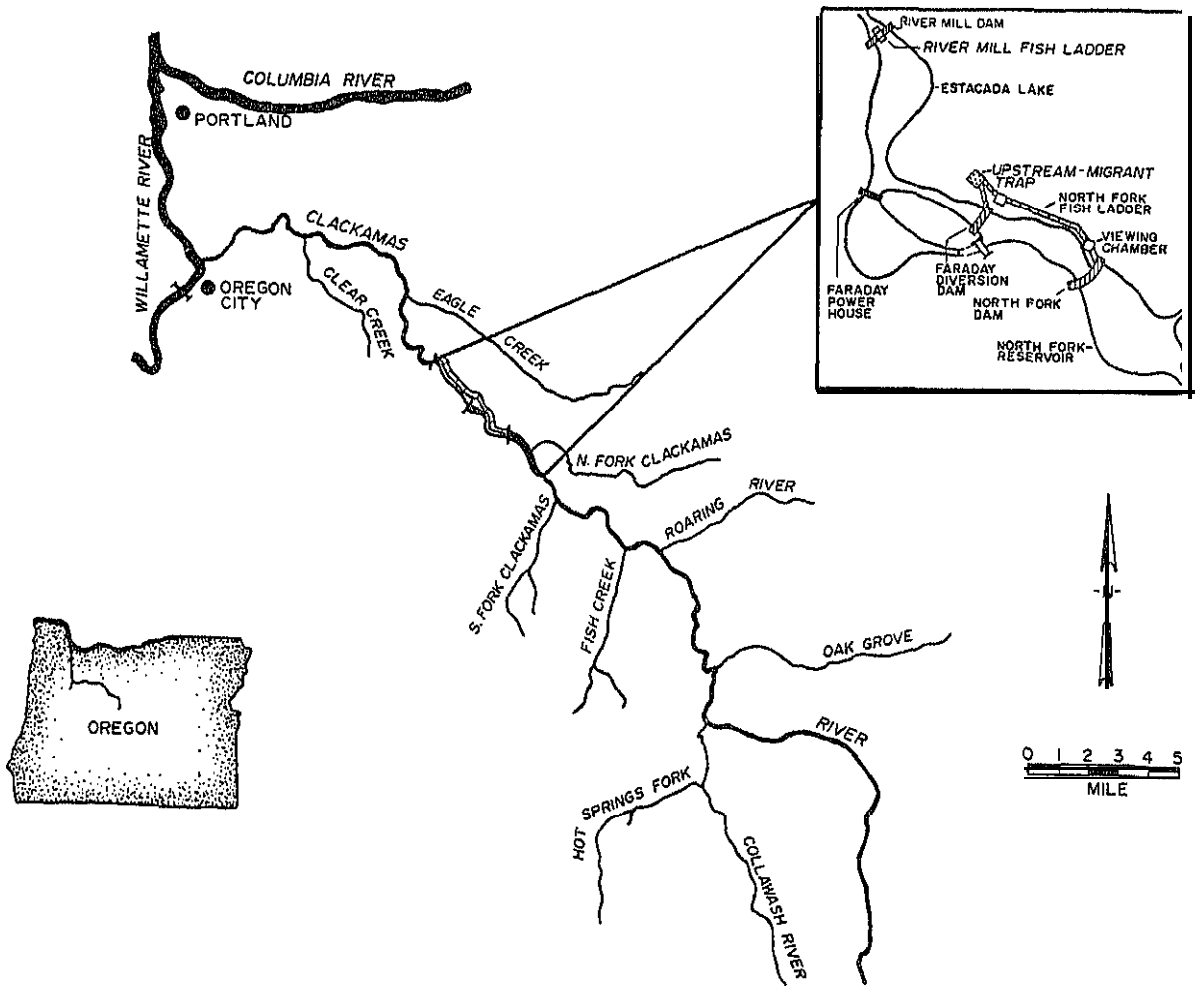

Figure 1. Clackamas River and tributaries, including the river Mill-Faraday-North Fork Dam complex.

Since 1949 spawning ground counts have been made on lower tributaries of the Clackamas River (Table 2). Although there have been some large fluctuations, counts have generally declined. Adults have been counted at North Fork Dam on the upper Clackamas since 1959. The average annual run of coho above North Fork during the 1960s was about 2,400 (Table 3). The run declined to about 1,000 during 1975-80. Since then, the count has averaged about 2,500.

The escapement goal for the Clackamas River is 9,000 spawners: 3,000 above North Fork, 4,000 to Eagle Creek Hatchery, and 2,000 to lower tributaries (ODFW 1980).

Time of migration

Based on counts at North Fork Dam, the coho run in Clackamas begins in August and extends as late as March. The time of migration has changed markedly since the counts began. From 1959 to 1969 the migration peaked rather sharply in November (Figure 2). Since 1970 the counts have been fairly evenly distributed from September through January (Table 3). The early portion of the run has become much more pronounced. From 1957/58 to 1960/61, August through October counts were only 4% of the adult run. From 1979/80 to 1982/83, counts for those months have increased to 39% of the adult run (Figure 3). This change in timing may be related to releases of Early Run stock of hatchery stock coho (Figure 4) and possible declines in late-run native fish.

Spawning period

Redds and live fish have been counted on spawning ground surveys of index streams in the lower portion of the sub-basin from late October through early January.

Spawning areas

Most of the late-spawning stock are thought to spawn above Worth Fork Dam (RW 301 (J. Massey, ODFW, personal communication). Coho also spawn in some of the lower river tributaries.

Age composition

No information.

Size

No information.

Sex ratio

No information.

Fecundity

No information.

Table 2. Spawning ground counts of coho salmon in tributaries of the Clackamas River, 1949-82 (data from Hirose 1983; Bohn 1970).

	Clear Creek	Deep Creek	Trestle Creek	Tickle Creek
1949	1	--	16	--
1950	8	15	20	13
1951	0	8	26	79
1952	0	20	0	25
1953	4	15	18	19
1854	0	14	1	3
1955	-	8	3	5
1956		57	40	42
1957	4	12	39	10
1958	6	27	18	18
1959		--	21	9
1960	-	--	16	20
1961	-	--	7	--
1966		12	4	16
1967	0	8	18	6
1968		5	2	0
1969	-	19	7	17
1970	-	4	--	5
1971	-	3	--	8
1972	-	3	--	2
1973	-	5	--	0
1974	-	1	--	2
1975	-	0	--	1
1976	-	0	--	0
1977	-	2	--	0
1978	-	0	--	2
1979	-	1	--	0
1980	-	5	--	0
1981"	-	0	--	8
1982[a]	-	3	--	3

[a] Counts that are influenced by hatchery presmolt releases.

Table 3. Counts of coho (jacks and adults) at North Fork Dam, Clackamas River, 1959 to 1983.

	Aua.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1959-60	0	0	25	609	394	126	176	0	1,330
1960-61	0	0	433	1,227	155	278	91	1	2,185
1961-62	0	1	95	699	855	226	312	1	2,189
1962-63	0	0	235	1,612	933	123	217	0	3,119
1963-64	0	1	189	1,032	246	337	74	0	1,079
1964-65	0	25	234	749	1,043	228	197	0	2,476
1965-66	0	40	563	2,137	423	718	58	0	3,939
1966-67	0	1	174	308	245	39	11	0	770
1967-60	1	0	441	274	421	271	88	2	1,498
1968-69	0	91	979	2,163	1,047	192	216	8	4,696
Average	0.1	15.9	336.7	1,081.0	576.2	253.8	144.0	1.2	
%	0.0	0.7	14.0	44.9	23.9	10.5	6.0	0.1	
1969-70	3	194	255	587	650	42	11	0	1,854
1970-71	0	242	1,053	843	341	257	16	0	2,752
1971-72		River Mill Ladder closed August 1 - November 5							
1972-73	7	238	102	436	205	86	17	5	1,096
1973-74	3	146	92	154	245	75	23	0	739
1974-75	0	38	67	464	304	61	3	0	937
1975-76	2	73	481	271	219	123	20	0	1,189
1976-77	3	111	119	130	137	394	308	27	1,229
1977-76	0	57	46	189	219	341	93	2	945
1970-79	0	214	159	56	143	7	266	0	847
1979-80	3	434	248	80	--	338	88		1,191
1980-81	0	122	130	943	1,422	585	40	0	3,242
1981-82	1	549	218	232	111	171	0	0	1,282
1902-83	46	916	602	123	384	739	137	2	2,949
Average	5.2	256.5	274.0	355.3	365.0	247.6	70.6	2.0	
%	0.3	16.1	17.3	22.4	23.0	15.6	5.0	0.2	

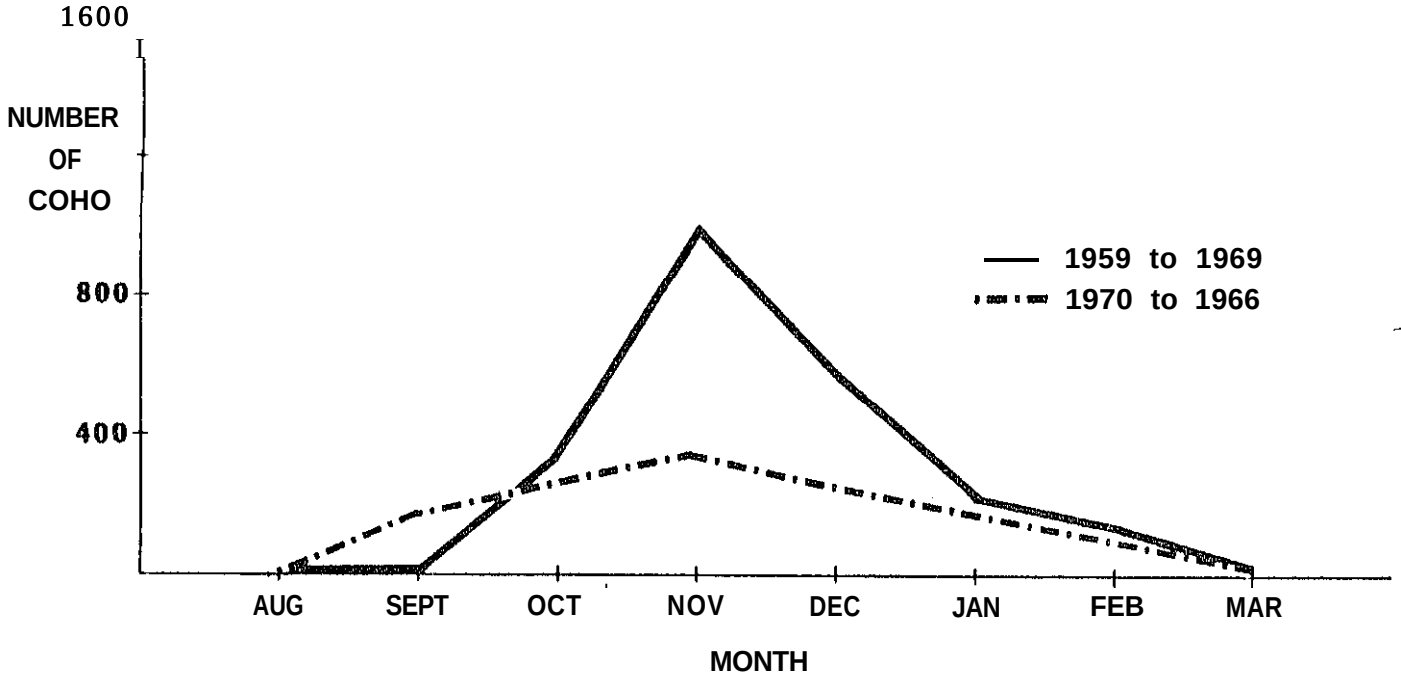

Figure 2. Counts of upstream coho at North Fork Dam, Clackamas River, 1959-1969 and 1970-1980 (Everest and Sedell 1983).

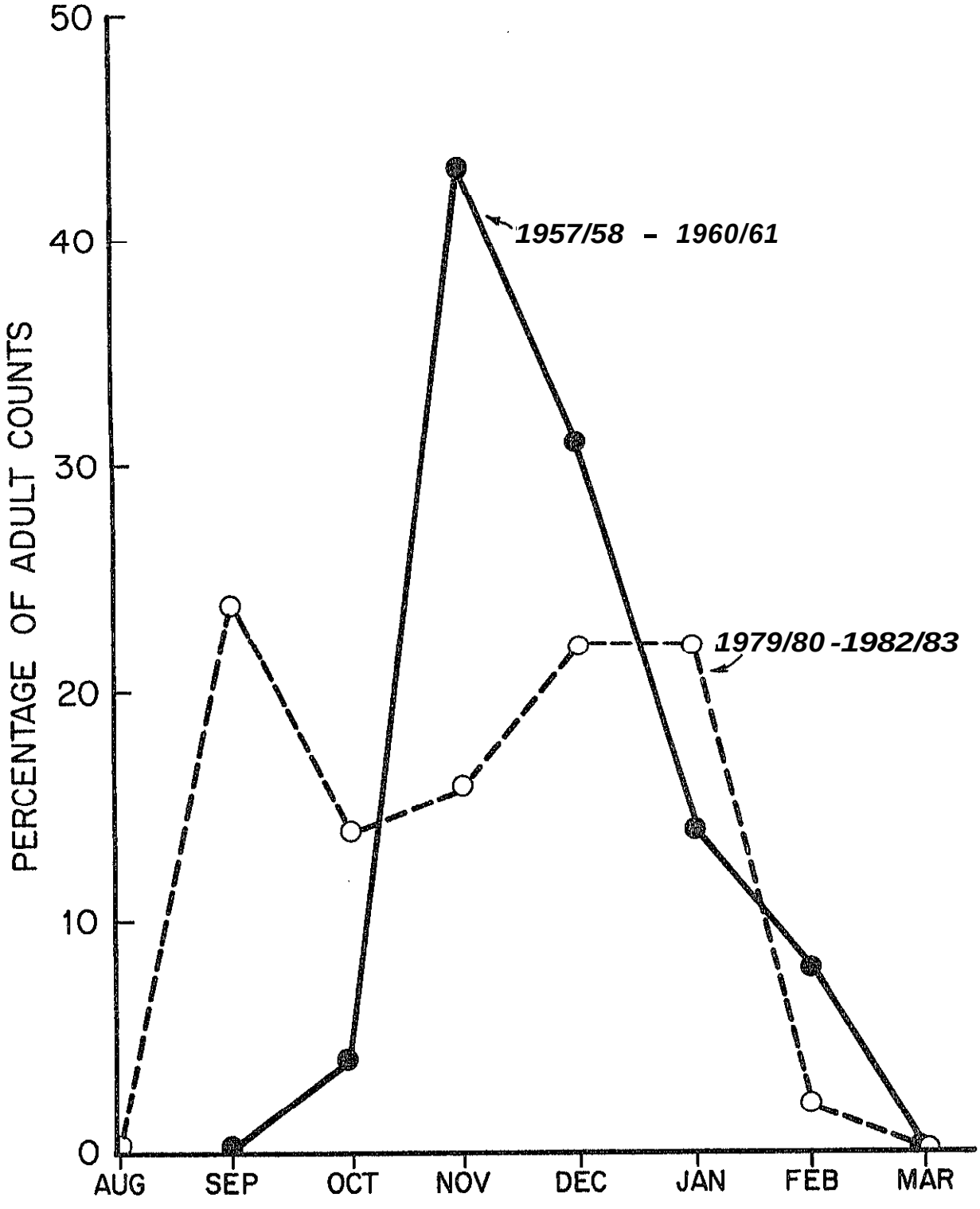

Figure 3. Timing of adult coho migration past North Fork Dam, Clackamas River, 1957/58 - 1960/61 and 1979/80 - 1982/83.

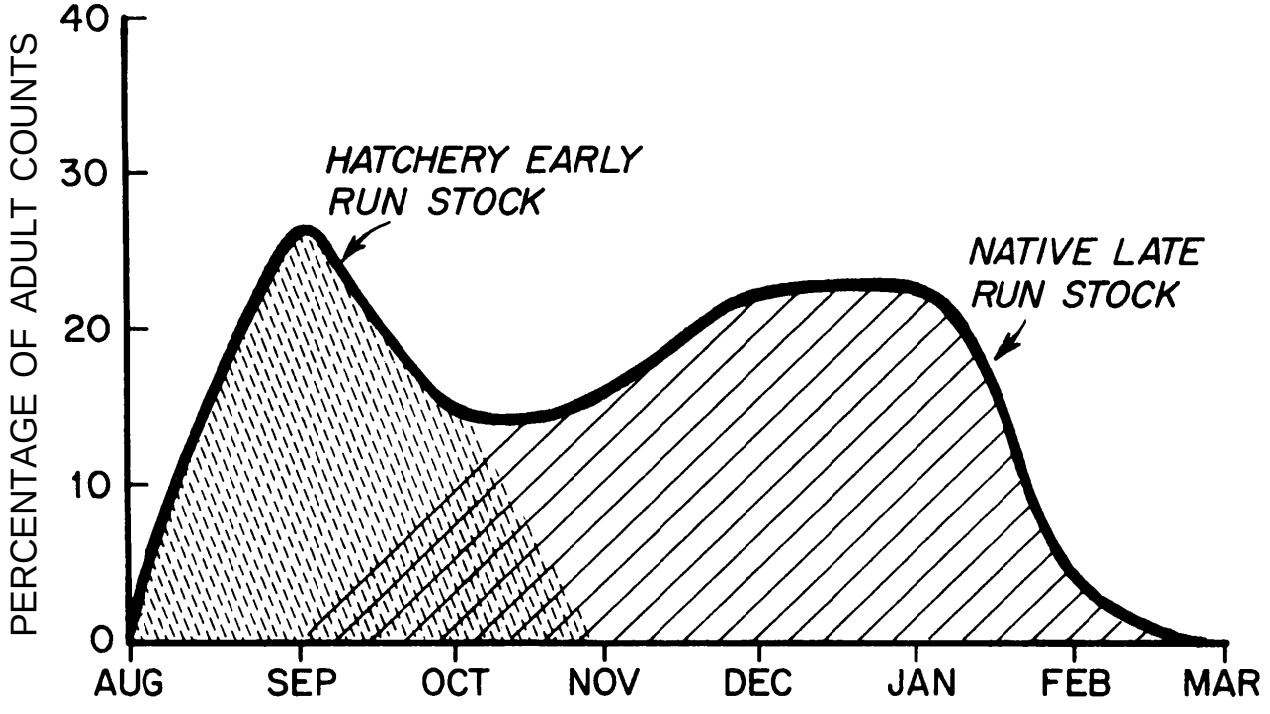

Figure 4. Possible coho stock differentiation based on timing of adult migration past North Fork Dam, Clackamas River, 1979/80 - 1982/83

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age, and size at migration

Downstream migration of juveniles past North Fork Dam occurs primarily during May and June (Table 4). A comparison of outmigrant counts for 1960-64 and 1979-83 shows little change in migration timing or total numbers of smolts (Table 4). More than half of the smolts migrated during May. May and June combined accounted for 86% and 94% of the juvenile migration for the two 5-year periods, respectively.

Survival rates

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Run size, catch (including distribution), and escapement
2. Comparison of genetic characteristics of Clackamas wild and Early Run hatchery stocks.
3. Interactions of wild and hatchery stocks
4. Smolt production levels and capacity

Table 4. Time of migration of juvenile coho past North Fork Dam, Clackamas River, 1960-64 and 1979-83.

	Month												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec	Total
1960-64	**1,449**	**4,922**	**11,361**	**2,945**	**160,335**	**111,790**	**7,846**	**272[a]**	**43[a]**	**778**	**10,346**	**5,195**	**316,935**
%	**0.5**	**1.6**	**3.6**	**0.9**	**50.6**	**35.3**	**2.5**	**-**	**-**	**0.2**	**3.3**	**1.6**	
1979-83	**414**	**1,552**	**2,742**	**10,674**	**217,041**	**114,273**	**3,713**	**54**	**8**	**91**	**441**	**1,465**	**352,968**
%	**0.1**	**0.4**	**0.8**	**3.0**	**61.5**	**32.4**	**1.1**	**0.0**	**0.0**	**0.0**	**0.3**	**0.4**	

[a] incomplete counts, excluded from total.

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Hood Basin Coho (wild)

PRODUCTION

Coho are produced from wild stocks in Hood Basin streams.

GEOGRAPHIC LOCATION

Streams

Hood River system and other Columbia tributaries located within the Hood Basin (Figure 1).

ORIGIN

Some small wild runs of coho still persist in Hood Basin, where coho are native. Coho adults and fry were previously released in the Hood River system. However, there have been no releases of hatchery fish in basin streams since the mid-1970s. Early Run coho produced at Cascade and Oxbow hatcheries, located on Eagle and Herman creeks, respectively, are released in Tanner Creek below Bonneville Dam. However, some of these fisb do return to Eagle Creek. Straying of releases from Bonneville Hatchery facilities to other streams in the basin is suspected to occur, but the extent is unknown.

ADULT LIFE HISTORY

Run size, catch, and escapement

From 1977 to 1979, the in-river sport catch has averaged only 5 fish/year (Table 1)..A number of these reported catches may be errors from punch-cards (J. Newton, ODFW, personal communication).

Table 1. Hood River coho sport catch by run-year, 1971-79[a] (Berry 1981)

1971	1972	1973	1974	1975	1976	1977	1978	1979
29	27	18	30	46	52	4	6	6

[a] Estimated from punch-card returns adjusted for non-response bias.

There are no estimates of ocean or in-river commercial harvest of this wild stock.

From 1962 to 1970 coho numbers were monitored at Powerdale ladder (Table 2). No current information on abundance is available. Estimated escapement in the early '60s is indicated in Table 3.

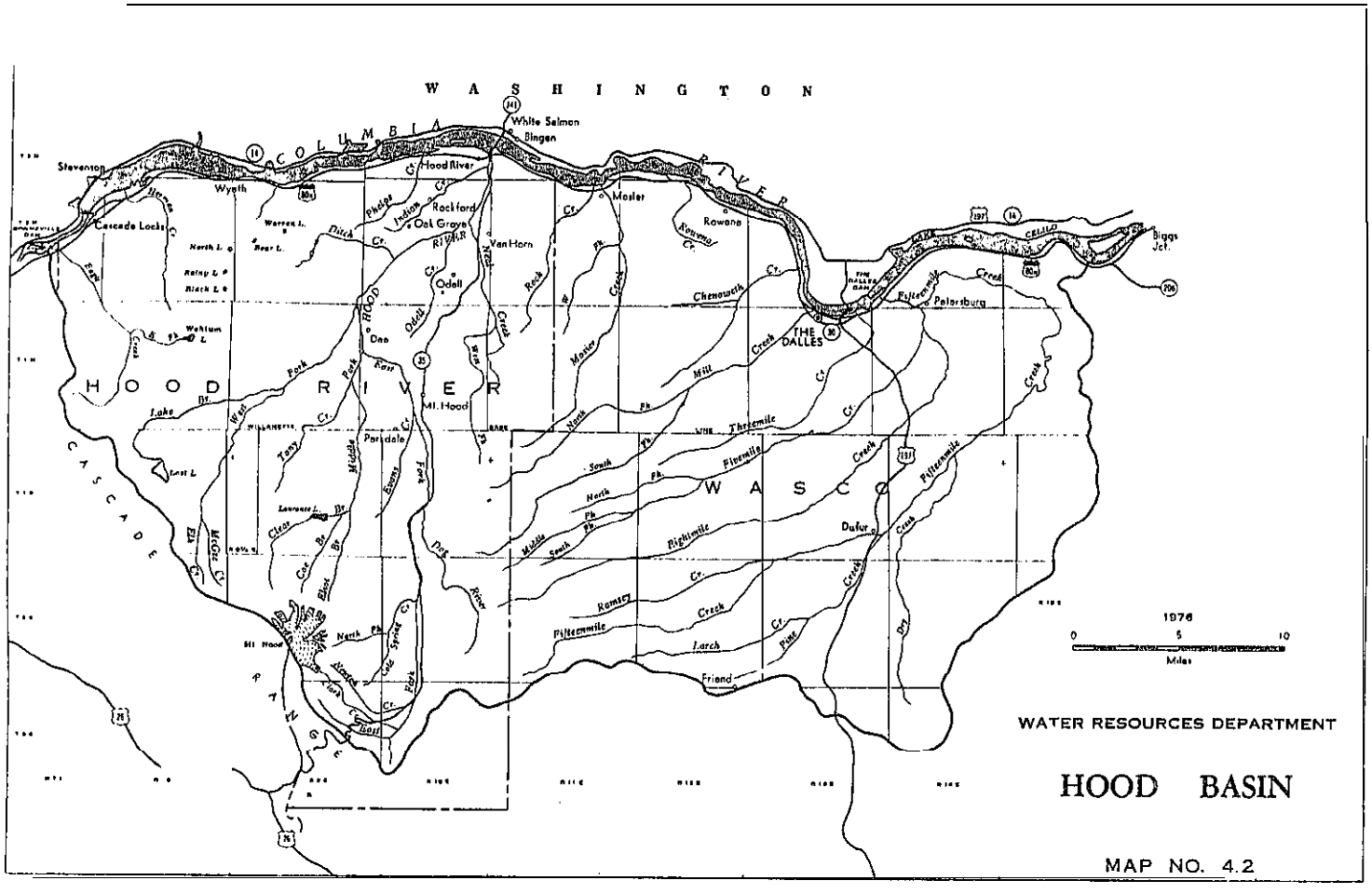

Figure 1. Hood Basin.

Table 2. Number of coho passing Powerdale ladder by month, Hood River, 1962-70.

Year	Trap Catch Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Total[a]
1962/63	1[b]	105[b]	121[b]	20[b]	8	0	255
1963/64	0	74	43	26	0	0	143
1964/65	5[b]	233	79	27	2[b]	0	346
1965/66	-[c]	--[c]	66[b]	59	5	1	131 (20)
1966/67	0	112	162	55	0	0	329 (145)
1967/68	0	89	149	19	0	0	257 (162)
1968/69	1	98	144	38	4	0	285 (100)
1969/70	0	128	30	14	1	0	173[d] (107)
1970	4	137	111	30	0	-	282 (161)
Mean %[e]	0.3	43.4	43.4	12.4	0.3	0.1	

a Total includes jacks and adults; jack count is in parentheses.
b Incomplete.
C Ladder closed.
d Includes 1 fish counted in July.
e Includes 1963/64 and 1966/67 through 1970,

Table 3. Estimated number of coho salmon spawning in Hood Basin streams (OSGC 1963).

Stream system	Coho
Eagle Creek	3,000
Herman Creek	250
Lindsey Creek	200
Hood River (Main stem and unlisted tributaries)	1,158
West Fork Hood R.	14
East Fork Hood R.	96
Middle Fork Hood R.	34
Hood River system total	1,302
Mill Creek	0
Fifteenmile Creek	0
Total	4,752

Time of migration

Peak migration in Hood River past Powerdale Dam occurred in September and October (Table 2).

Spawning period

Spawning occurs during October and November (OSCG 1963).

Spawning areas

Spawning adults have been regularly observed in the following streams (J. Newton, ODFW, personal communication):

Neal Creek (Hood River)
Lindsey Creek
Mosier Creek
Chenowith Creek
Mill Creek
Viento Creek

Previously known or suspected occurrence of coho is listed in Table 4.

Table 4. Occurrence of coho salmon in streams in the Hood River Basin (modified from OSGC 1963).

Stream	Documented coho use	Suspected coho use	Relative abundance
Eagle Cr.[a]	X		Moderate
Herman Cr.[b]	X		Moderate
Lindsey Cr.	X		Mod. -high
Hood R.	X		Moderate
Neal Cr.	X		Mod.-high
Middle Fork		X	
Clear Cr.	X		
West Fork	X		Low
Dog R.		X	

a Location of Cascade Hatchery.
b Location of Oxbow Hatchery.

Age composition

No information.

Size

No information.

Sex ratio

No information..

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Run size, catch, and escapement
2. Extent of straying of hatchery fish

REFERENCES

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Grande Ronde River Coho (wild)

PRODUCTION

The Grande Ronde River system was historically the major production area for coho in the Snake River Basin. However, hydro-electric development, harvest, and habitat degradation reduced the run in the Grande Ronde to remnant levels (Witty 1984). Coho are now considered extinct in the Grande Ronde Basin (K. Witty, ODFW, personal communication).

In 1983 a program was undertaken by the Oregon Department of Fish and Wildlife to develop a hatchery broodstock from native Snake River coho to restore the run in the Grande Ronde. Adult coho were to be trapped at Ice Harbor Dam and the juveniles reared and initially released at Wallowa Hatchery to establish a hatchery run. It was felt that the migratory characteristics of the Early Run hatchery stock used in the lower Columbia would make the stock unsuited for use in the Grande Ronde and that mixing the early run and native stocks would produce progeny with some lower river life history characteristics, thus reducing the fitness of the Grande Ronde stock (Witty 1984). No broodstock were trapped in 1983 or 1984 (see "Run size, catch, and escapement").

GEOGRAPHIC LOCATION

Streams

Grande Ronde River and tributaries (Appendix Figure 1)

ORIGIN

Coho were indigenous in the Grande Ronde system. Until their demise, the Grande Ronde was the farthest existing inland distribution of coho in the Columbia Basin (Fulton 1970).

ADULT LIFE HISTORY

Run size, catch, and escapement

The Grande Ronde was formerly an important producer of coho salmon. The largest egg take reported in early records of the Oregon Fish Commission was 7.5 million eggs from 2,655 adults trapped in 1902 at a rack on the lower Grande Ronde near the mouth of the Wenaha (Parkhurst 1950).

There are no recent trend data available specifically for the coho run in the Grande Ronde system. However, counts at dams on the Snake River below the mouth of the Grande Ronde generally describe the decline in abundance (Table 1). Problems encountered in the broodstock trapping effort at Ice Harbor in 1983 and 1984 indicate that counts at that facility were probably inflated because of identification errors. There were no coho counted at Lower Granite Dam in 1984. Since the Grande Ronde was the only reported production area for coho in the Snake River Basin (Fulton 1970), all

Table 1. Counts of adult and jack coho at four Snake River dams, 1964-83 (Jensen 1984).

Year	Ice Harbor			Lower Monumental		Little Goose		Lower Granite	
	Adults	Comb	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks
1964[a]		2,100							
1965[a]		320							
1966[a]		880							
1967	2,000		1,800						
1968	3,800		2,400						
1969	2,300		3,000	4,000	2,500				
1970	1,800		1,900	1,600	1,300	1,200	1,300		
1971	1,600		1,300	1,400	760	1,700	960		
1972	1,400		1,100	490	240	520	280		
1973	1,300		1,200	860	470	770	380		
1974	580		760	520	290	280	240		
1975	710		850	320	250	400	300	440	470
1976	840		1,200	210	150	320	410	440	460
1977	230		1,300	40	80	110	330	50	220
1978	160		490	90	130	150	160	25	125
1979	130		270	120	80	210	190	50	110
1980	50		8	60	10	90	35	30	13
1981	25		60	19	45	8	110	1	16
1982	160		190	47	37			31	28
1983	220		240	66	45			25	26

a Differential counts were not conducted for these years.

of the coho counted at Ice Harbor Dam should have been destined for the Grande Ronde. Consequently, counts at all four dams would be expected to be about the same. However, counts in most years at Snake River dams decreased progressively moving upstream; and in other years (e.g. 1975), counts increased at upstream dams (Table 1).

Time of migration

In tagging studies conducted on the Snake River near Lewiston, Idaho, from 1953 through 1956 only six coho were captured, all during September (Thompson et al. 1958).

Spawning period

Smith (1975) reported that coho enter the Wallowa River in late September and October and spawn in late November. Surveys conducted on the Wallowa River in 1957 indicated that spawning commenced sometime between October 7 and 18 (Table 2). Spawning activity peaked in late October and early November. Spawning was believed to be completed by November 20 on the Lostine River (Thompson and Haas 1960).

Table 2. Spawning ground counts of coho salmon in the Wallowa River, 1957 (Thompson and Haas 1960).

Rate	Location	Number of fish Live	Dead	Redds
October 7	West branch, 3.5 to 4 miles below Joseph	0	0	0
October 18	West branch, 3.5 to 4.75 miles below Joseph	4	0	8
October 28	2 to 3.5 miles below Joseph downstream	26	0	24
October 28	East branch, 3.5 miles below Joseph downstream 0.5 mile	5	0	13
October 30	West branch, 3.5 to 5.5 miles below Joseph to lower limit of Enterprise	20	1	37
November 20	Joseph downstream 1 mile	0	0	1 (possible)
November 21	1 to 2 miles below Joseph	0	0	1 (possible)

Spawning areas

Lower Grande Ronde River--Coho were observed spawning in 1940 (Thompson and Haas 1960).

Wenaha River--The Wenaha formerly supported a "fair run" of coho (Parkhurst 1950). In 1903 eggs were taken from 483 coho trapped in the Wenaha.

Wallowa--In 1960 the Wallowa River was one of the two rivers in eastern Oregon known to have a run of coho salmon (Thompson and Haas 1960). The principle spawning area at that time extended from 2 to 4.5 miles below Joseph. Smith (1975) reported that coho were present in the following tributaries of the Wallowa River: Hurricane, Prairie, Spring, and Bear creeks.

Minam River--One coho was reportedly caught by a sport fisherman in the lower river (Thompson and Baas 1960).

Catherine Creek--At one time Catherine Creek produced more coho than chinook (Thompson and Haas 1960). Coho fingerlings were collected in Catherine Creek in 1953.

Age composition

No information.

Size

No information.

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age, and size at migration

Juvenile coho were collected in traps at irrigation diversion screens along the Wallowa River from the time the screens were installed, usually in late April, until July. The peak movement occurred in May and June (Thompson and Haas 1960).

Survival rate

No information.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Suitability of using another coho stock to restablish run

REFERENCES

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Lower Columbia River Chum Salmon

Chum, formerly a dominant Columbia River salmonid species, has dwindled to a point of minor importance. Commercial harvest peaked in 1928 with about 700,000 fish (Chaney and Perry 1976). Since 1978 commerical harvest has not exceeded 2,000 fish (ODFW and WDF 1981).

Dramatic declines in run size have been attributed to siltation and stream blockages from deforestation and innundation of spawning areas following construction of Bonneville Dam (Fulton 1970). There has been a similar coastwide decline in chum production. The outlook for Columbia River chum is not good (Chaney and Perry 1976) since the runs have not responded to reduced fishing exploitation (Fulton 1970).

PRODUCTION

Natural production is emphasized in Washington, and some natural production also occurs in Oregon tributaries. However, chum salmon production in Oregon is largely maintained by hatchery programs. Oregon hatcheries released 33,836 to 913,873 fry annually from 1977-82 broods. During 1979-82 Sea Resources, a private cooperative hatchery in Washington, released between 6,500 and 160,300 fry (average = 56,000).

GEOGRAPHIC LOCATION

Streams

Chum salmon are found in the lower sections of tributaries flowing into the Columbia River below Bonneville Dam (Appendix Figure 1). Wild production areas include Grays Basin and Hardy and Hamilton creeks.

Hatcheries

Chum salmon are reared primarily in Big Creek and Klaskanine hatcheries and released into lower Columbia River and Youngs Bay tributaries. They are occasionally raised at facilities of the CEDC (Clatsop Economic Development Commission) and Astoria High School. Sea Resources, a private hatchery, releases chum in Washington.

ORIGIN

Chum salmon are native to lower Columbia River tributaries. Oregon hatcheries primarily use broodstock developed from native chum stocks. However, in 1984 George Adams (Hood Canal) stock was transferred to Big Creek Hatchery. Introduced stocks have also been used for experimental egg box and fry release programs in Washington (Table 1). Based on subsequent spawning ground surveys, success of these programs seems to be minor (H. Fiscus, WDF, personal communication).

Table 1. Releases of non-Columbia River stock chum salmon by Washington and Oregon hatcheries into lower Columbia tributaries[a] (modified from WDF 1985).

Stream	Brood year	Release year	Number released	Type	Hatchery	Stock
Abernathy Creek	1981	1982	625,000	Unfed fry	Egg-box	Hood Canal x Ellsworth
Chinook River	1969	1970	50,300	Fed-fry	coop Sea Resources	Neeah (Willapa Bay)
	1972	1973	74,900	Fed-fry	coop Sea Resources	Bear River (Willapa Bay)
Elokomin River	1978	1979	376,000	Unfed fry	Egg-box	George Adams (Hood Canal)
	1979	1980	475,000	Unfed fry	Egg-box	Hood Canal
Germany Creek	1981	1982	60,000	Unfed fry	Egg-hox	Rood Canal x Ellsworth
	1982	1983	65,000	Unfed fry	Egg-box	Ellsworth
Grays River	1971	1972	638,500	Fed fry	Grays River	Hood Canal
West Fork Grays R.	1972	1973	563,600	Fed fry	Grays River	Quilcene (Hood Canal)
	1973	1974	612,300	Fed fry	Grays River	Quilcene Wood Canal)
	1975	1976	1,126,800	Fed fry	Grays River	Hokkaido (Japanese1
Bull Creek	1979	1980	90,000	Unfed fry	Egg-box	Hood Canal
Skanokawa Creek	1980	1981	38,300	Unfed fry	Egg-box	Hood Canal
	1981	1982	80,000	Unfed fry	Egg-box	Rood Canal
	1982	1983	60,000	Unfed fry	Egg-box	Ellsworth
Clear Creek	1977	1978	50,000	Unfed fry	Egg-box	George Adams
Cripper Creek	1979	1980	90,000	Unfed fry	Egg-box	Rood Canal
	1982	1983	100,000	Unfed fry	Egg-box	Finch Creek x Forks
Little Creek	1980	1981	69,700	Unfed fry	Egg-box	Rood Canal
Hamilton Creek	1979	1980	360,000	Unfed fry	Egg-box	Quilcene
Tucker Creek	1984	1985	955,594	Fed fry	Big Creek/CEDC	George Adams

[a] Data complete for release years 1967-1983 for WDF facilities and for other agencies during 1980-1983. Information for 1967-1979 is incomplete for non-WDF releases.

ADULT LIFE HISTORY

Run size, catch, and escapement

Estimates of adult run size including freshwater harvest and escapement are presented in Table 2. Chum are not generally harvested in ocean troll or sport fisheries. A few fish have been caught off of central Alaska (Johnson et al. 1976). Commercial harvest occurs as incidental catch during late fall gill-net seasons targeting on coho. Chum are sometimes mixed with other species on fish landing tickets; consequently values presented may not accurately represent chum catch (ODFW and WDP 1981).

Spawning surveys are conducted annually on Hamilton Creek, Hardy Creek, and in chum production areas in the Grays River system (Table 3). Total counts have averaged 399 fish per year in these systems from 1973 through 1964.

Time of migration

Chum enter the Columbia River in mid-October through November (Chaney and Perry 1976). Adults return to Big Creek and Klaskanine hatcheries in November and December (Table 4).

Spawning Period

Peak spawner counts generally occur in late November in Grays River and mid-December in Hamilton and Hardy creeks. In many instances surveys are hampered by conditions during freshets, and peak count dates may not necessarily indicate peak of spawning activity. The median period of spawning for hatchery fish is mid- to late November.

Spawning areas

Important spawning areas are located in the Grays River system (RM 20.8), Hardy Creek (RM 141.8) and Hamilton Creek (RM 142.3) in Washington and Big Creek (RM 23.0) and Milton Creek (RM 89.5) in Oregon. Fulton (1970) indicated the following streams and rivers were used by chum for spawning:

Washinston	Oregon
Grays River	Lewis and Clark River
Skamokawa Creek	Youngs River
Elokomin River	Klaskanine River
Mill Creek	Bear Creek
Abernathy Creek	Big Creek
Germany Creek	Gnat Creek

Table 2. Minimum freshwater adult run size of lower Columbia River chum salmon to Oregon and Washington, 1970-1984.

	Harvest				ESCAPEMENT		
	Treaty		Non-treaty				
Return year	Commercial	Ceremonial and subsistence	Commercial[a]	Recreational	Naturalb	Hatcheryc	Total Production
1970	0	0	600	0	900	0	1,500
1971	0	0	500	0	1,350	0	1,850
1972	0	0	1,300	0	2,550	0	3,850
1973	0	0	1,400	0	950	0	2,350
1974	0	0	900	0	600	0	1,500
1975	0	0	500	0	800	0	1,300
1976	0	0	1,200	0	700	0	1,900
1977	0	0	200	0	1,450	0	1,650
1978	0	0	1,500	0	1,050	0	2,550
1979	0	0	100	0	350	0	450
1980	0	0	200	0	600	50	850
1981	0	0	1,400	0	100	50	1,550
1982	0	0	1,800	0	2,800	100	4,700
1983	0	0	200	0	750	50	1,000
1984	0	0	(1,200)d	0	1,250	(50)[d]	(2,500)[d]
Mean	0	0	850	0	1,100	0	1,950

a ODFW and WDF (1985).
b Total population estimates for all Washington tributaries only. Based on expanding peak fish counts in Grays System, Hardy and Hamilton creeks (2.3 factor for Grays, I.53 for Hardy and Hamilton creeks) then applying 1.2 for unsurveyed streams.
c Sea Resources Hatchery, Chinook, Washington.
d Preliminary.

Table 3. Peak counts of chum salmon from spawning surveys of Grays River (Columbia River Mile 20.8) system, Hardy Creek (Columbia River Mile 141.0) and Hamilton Creek (Columbia River Mile 142.31, 1973-1984 (modified from Fiscus 1984).

	Grays River		Hardy Creek		Hamilton Creek	
Year	Miles surveyed[a]	Fish count	Miles surveyed[b]	Fish count	Miles surveyed[c]	Fish count
1973	1.8	220	1.0	130	0.7	53
1974	4.0	191	1.0	86	0.7	111
1975	4.0	236	1.0	14	0.7	72
1976	4.3	230	1.0	6	0.7	31
1977	4.3	400	1.0	137	0.7	56
1978	4.3	285	1.0	42	0.7	89
1979	4.0	126	1.0	1	0.7	3
1980	4.3	112	1.0	131	0.7	33
1981	1.6	11	1.0	7	0.7	35
1982	4.4	756	1.0	210	0.7	161
1983	3.1	168	1.0	112	0.7	37
1984	4.1	372	1.0	76	1.3	47
Average	3.7	259	1.0	79	0.8	61

a Survey area includes mainstem Grays River (RM 9.5 to RM 13.0) and West Fork Grays (lower 1.4 miles and 0.5 miles Crazy Johnson Creek).
b Survey area includes creek mile 0.2 to 1.2.
c Survey area includes creek mile 0.6 to 1.3.

Table 4. Time of return and spawning, and average fecundity for chum salmon in Oregon hatcheries, 1978-83.[a]

Return year	Hatchery	Return				Spawning			Average f ecunditv
		Number		Date		Number	Date		
		Male	Female	Median	Range	Female	Median	Range	
1978	Big Creek					2	11/18	11/18	2,900
1980	Big Creek					19	11/30	11/30	2,673
1981	Big Creek					15	11/30	11/30-12/31	2,700
1981	Klaskanine	8	6	12/10	12/10	6	12/10	12/10	1,667
1983	Big Creek	18	35	11/15	11/7-11/25	35	11/21	11/07-11/25	2,425

[a] None spawned in 1979; no data available for 1982.

Washington	Oregon
Coal Creek	Clatskanie River
Cowlitz River	Milton Creek
Coweeman River	
Kalama River	
Lewis River	
East Fork Lewis River	
Salmon Creek	
Washougal River	
Hardy Creek	
Hamilton Creek	

Most of the former spawning areas above Bonneville Dam were innundated following dam construction.

Age composition

Scale analysis indicates that 3- and 4-year-old fish are the dominant age classes, depending on the relative brood year strength of previous years (Dammers 1979; 1981; 1982). A few chum return as 5-year olds but do not return as 2-year-old jacks (W. Dammers, WDF, personal communication).

Size

Length-weight relationships from chum sampled in the 1981 gill net fishery are diagrammed in Figure 1. In 1980, fork lengths of 38 carcasses measured during spawning surveys ranged from 60-68 cm (Roler 1981).

Sex ratio

Based on spawning ground surveys in 1981 and 1982, males comprised about 44% of the 3- and 4-year-old adults examined from Grays River, Hardy Creek, and Hamilton Creek.

Fecundity

Average fecundity of Oregon hatchery fish ranged from 1,667 eggs per female to 2,900 eggs per female during 1978-83 return years (Table 4). In Washington, fecundity averaged 2,241 eggs per female and ranged between 2,028 to 2,534 eggs per female at Sea Resources Hatchery during 1980-84.

Age or length-specific fecundity is not available.

Biochemical-genetic characteristics

No information.

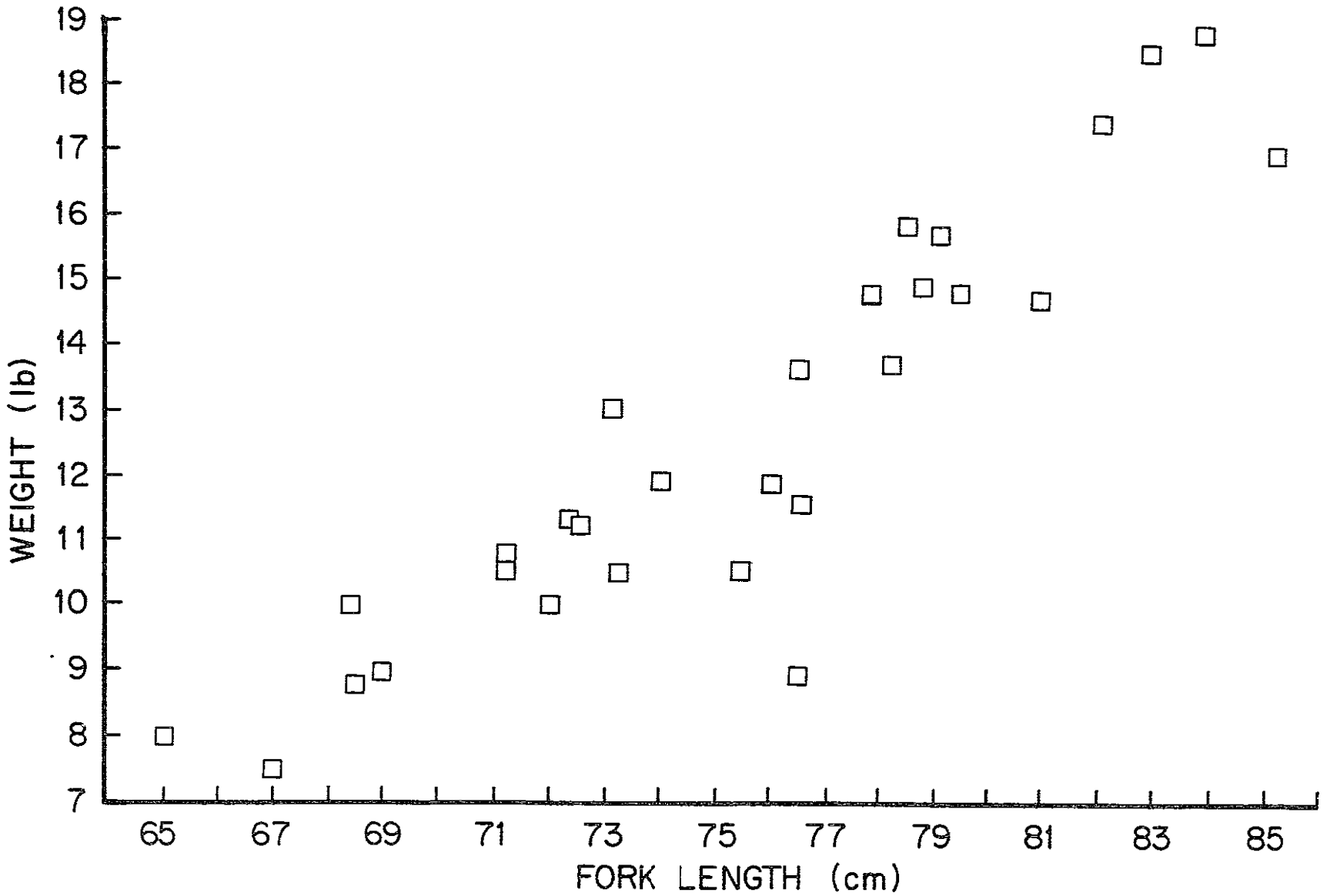

Figure 1. Length-weight relationship for chum salmon sampled during the 1981 fishery.

JUVENILE LIFE HISTORY

Time of emergence

Chum eggs are incubated at Big Creek Hatchery in 47°F spring water. Eggs incubate for 38 days before eye-up, eyed-eggs incubate for 22 days before hatching, and alevins incubate for 33 days before emerging.

Time, age, and size at migration

Juveniles are reared at Big Creek Hatchery in spring water (47°F) or Big Creek water (mid-40s°F). Fry are released in February and March.

The peak chum catch during seining of juvenile salmon in Grays River from March 16 to May 18, 1979 occurred on April 5th (Bluestein 19791. The fry averaged 41 mm and ranged from 35-45 mm in length. Juveniles migrate to sea as zero-age smolts (Hart 1973).

Survival rate

No information.

DISEASE HISTORY

There are no major disease problems affecting chum in Oregon's Big Creek Hatchery (Terry Kreps, ODFW, personal communication). Ectoparasites, cold-water disease, and miscellaneous bacteria have been noted however. Information is limited but no viruses have been detected in Oregon hatchery chum (R. Holt, ODFW, personal communcation). No disease information is available for wild Columbia River chum.

PRIORITY INFORMATON NEEDS

1. Survival of native Columbia River stocks and introduced stocks
2. Causes of population decline

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MACKAY HATCHERY SOCKEYE

In the late 1970's, the National Marine Fisheries Service reached an agreement with the Government of Canada, Department of Fisheries and Oceans in Vancouver, British Columbia, and the Idaho Department of Fish and Game, that would enable a project of sockeye restoration in Idaho to begin. That agreement called for Canada to supply one million eyed eggs to Idaho Fish and Game for stocking in four oligotrophic lakes in the Stanley Basin. The eggs were to be supplied from Canada's Fulton River Salmon Project and shipped to Idaho's Mackay State Hatchery.

PRODUCTION

The limited availability of suitable sockeye eggs (long freshwater migration, disease-free) has kept the program below the one million egg level. Fry releases have ranged from 174,000 to 631,000 yearly (Table 1).

GEOGRAPHIC LOCATION

The rearing program was initiated at American Falls Hatchery, near Pocatello, Idaho. The program was moved to Mackay Hatchery in 1982 (Fig. 1)

Stocking locations have been Stanley Lake (approximately 385 river miles from mouth of Salmon River) and Alturas Lake (approximately 400 river miles from mouth of Salmon River), both of which are Salmon River headwaters that formerly contained native runs of sockeye.

ORIGIN

Eyed eggs have been obtained yearly from the Canadian Department of Fisheries and Oceans station on the Fulton River near Granisle, British Columbia,

ADULT LIFE HISTORY

Run size. catch and escapement

As of this writing (April 1985), no adults have been seen returning to the stocking waters.

Time of migration

No information

Spawning period

No information. In the Fulton River, the donor stock spawns in October.

Age composition

No information.

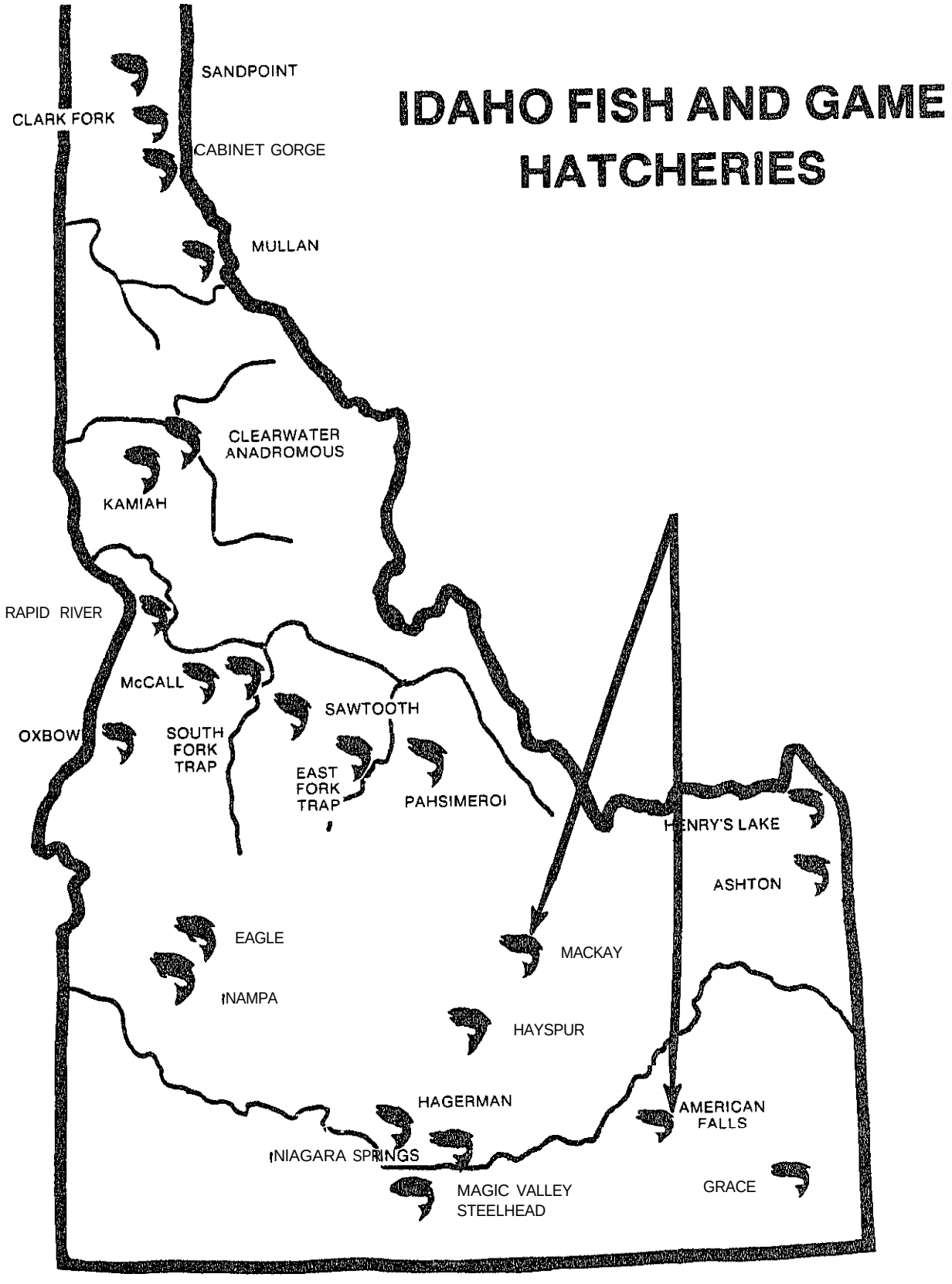

Figure 1. Location of Mackay and American Falls hatcheries.

Size

No information.

Sex ratio

No information.

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information.

Time, age and size at migration

Age 0 fry have been released into the receiving lakes at 73.0 to 41.1 per pound (Table I). The extent to which these fish become migrating smolts is not known, nor are there data relating to migratory characteristics.

Survival rate

In-hatchery eyed eggs to fry survival has ranged from 32.4 to 83.9 percent (Table 1).

DISEASE HISTORY

Deficient nutrition was noted early in rearing the first (1980) brood year and was corrected by Oregon Moist Pellet, Formula II.

Costia sp. and bacterial gill disease have also been noted (Evan Parrish, IDFG Bureau of fisheries, personal communication).

PRIORITY INFORMATION NEEDS

1. Determine the extent to which sockeye stocked as fry survive to become migrating smolts

2. Investigate the effectiveness of rearing smolt sockeye compared to fry.

3. Obtain genetic analysis of donor stock compared to native Redfish Lake stock.

4. Determine migratory characteristics of smolts.

5. Continued monitoring for returning adults is required. Any adults reariny to Alturas Lake will be intercepted at the Sawtooth Hatchery weir beginning in 1985.

Table 1. Rearing and stocking history for Mackay Hatchery sockeye, brood years 1980 to 1983a.

Brood year	No. of eyed eggs	No. of fry stocked	Survival (%) eyed egg to fry	Stocking date	No./ lb.	Stocking location	Hatchery rearing
1980	536,000	113,880	32.4	6/23/81	41.4	Stanley Lake	American Falls
1981	604,350	260,393	43.1	6/24/82	48.9	Stanley Lake	American Falls
1982	752,000	150,015	83.9	6/20/83	73.0	Stanley Lake	Mackay
		480,800	83.9	6/20/83	65.0	Alturas Lake	Mackay
1983	259,356	63,000	81.0	6/6/84	70.0	Alturas Lake	Mackay
		147,000	81.0	6/6/84	70.0	Stanley Lake	Mackay

[a] IDFG Bureau of Fisheries file data.

REDFISH LAKE SOCKEYE

PRODUCTION

Wild.

GEOGRAPHIC LOCATION

Bjornn et al. (1968) reported Redfish Lake, at the headwaters of the Salmon River, to be the only lake in Idaho still used by searun sockeye salmon. The lake is at an elevation of 6,500 feet and is 897 miles from the Pacific Ocean.

ORIGIN

Native. The stock may not be genetically identical to the original stock since passage to the lake was interrupted by Sunbeam Dam on the Salmon River in the early 1900's (Bjornn et al. 1968). A natural reestablishment of the run occurred following the removal of the dam (Bjornn 1960).

ADULT LIFE HISTORY

Run size, catch and escapement

Evermann (1895) reported the lakes at the headwaters of the Salmon River to be some of the most important spawning grounds for sockeye, but could not quantify the population size.

A weir on Redfish Lake Creek was used to count sockeye into Redfish Lake from 1955 to 1966. Annual counts ranged from 11 to over 4,300 (Table 1) (Bjornn et al. 1968).

The estimated numbers of sockeye spawning in Redfish Lake since 1981 are:

1981 - 26	1983 - 0
1982 - 50	1984 - 22

IDFG's escapement objectives are for 6,000 sockeye spawners for the group of lakes at the Salmon River headwaters. An objective specifically for Redfish Lake is not identified (IDFG 1984).

Time of miaration

At the Redfish Lake Creek weir, the first fish of a run usually appeared after the middle of July and most of the run passed during August (Table 1) (Bjornn et al. 1968).

Spawning period

Bjornn et al. (1968) reported spawning in October with the peak activity near the middle of the month.

Table 1. The number of adult sockeye salmon enumerated at the Redfish Lake Creek weir, and the dates of weir operation (Bjornn et al. 1968).

Month	Year												
	1954	1955[a]	1956[a]	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
July	1			41	2	5	7	1	1	28	3		4
August	884			443	53	224	61	7	37	357	307	17	57
September	95			39	0	62	7	3	1	8	25	0	0
October	18									2			
Total	998	4,361	1,381	523	55	291	75	11	39	395	335	17	61
Date of peak count	8/16			8/25	8/18	8/16	8/8	8/9	8/10	8/4	8/13	8/17	8/5, 10
Date trap installed	7/30			7/6	7/11	7/4	7/1	7/14	7/24	7/15	7/15	8/11	7/8
Date trap removed	10/29			9/10	9/8	9/29	9/23	9/11	9/12	10/21	10/8	9/17	9/20

a Daily count records for these two years were lost.

Spawning areas

Spawning during the 1950-60's studies took place in shoreline areas of the lake and in Fishhook Creek (Bjornn et al. 1968).

Age composition

Only generalized age composition data is available for the 1953 to 1965 period which indicates that most fish had spent two winters at sea (Bjornn et al. 1968).

Size

Most of the fish collected at the weir during the 1953 to 1965 period were 508 to 621 cm fork length (Table 2) (Bjornn et al. 1968).

Sex ratio

The sex ratio of the run enumerated at the weir was virtually 1:1 for all fish sampled during the years 1953 to 1965 (Table 2) (Bjornn et al. 1968).

Fecundity

No information.

Biochemical-genetic characteristics

No information.

JUVENILE LIFE HISTORY

Time of emergence

No information

Time, age and size at migration

Seaward migrant sockeye departed Redfish Lake from late April through May in the 1955 to 1966 studies (Bjornn et al. 1968).

Smolts left Redfish Lake at the beginning of their second or third summer of life. The percentages of the two age classes in the migration each year varied from 2 to 98 percent (Table 3) (Bjornn et al. 1968).

Yearly average smolt length for 1953 to 1964 year classes ranged from 67 to 117 mm and appeared to be inversely related to density (Table 4) (Bjornn et al. 1968).

Survival rate

No data are available for egg-to-smolt survival.

Table 2. Length-frequency distribution of adult sockeye salmon sampled at the Redfish Lake Creek weir, 1953-1965 (Bjornn et al. 1968).

Fork length (centimeters)	Males	Females
431-444		1
445-456	1	
457-469	1	
470-482	1	1
483-494	1	7
495-507	2	12
508-520	8	29
521-532	16	59
533-545	28	106
546-558	47	118
559-571	80	76
572-583	107	44
584-596	88	20
597-609	47	4
610-621	31	1
622-634	8	
635-644	9	
645-660	1	
Total	476	478

Table 3. Number of sockeye salmon and percentage of each age class in the migration from Redfish Lake,1955 to 1966 (Bjornn et al. 1968).

Year	Total migrants	Percentage age class I	Percentage age class II	Number of age class I	Number of age class II
1955	54,000				
1956	38,029	34.2	65.8	13,006	25,023
1957	65,000	59.9	40.1	38,935	26,065
1958	41,000	2.1	97.9	861	40,139
1959	13,000	24.2	75.8	3,146	9,854
1960	2,133	32.4	67.6	691	1,442
1961	21,600	97.1	2.9	20,974	626
1962	23,000	91.4	8.6	21,022	1,978
1963	23,320	98.0	2.0	22,854	466
1964	6,492	66.5	33.5	4,317	2,175
1965	19,000	46.2	53.8	8,778	10,222
1966	15,500	76.6	23.4	11,873	3,627

Table 4. The number and length of Redfish Lake smolts 1954 to 1964 year classes (Bjornn et al. 1968).

Year class	No. of smolts	Average length (mm)
1954	39,071	67.4
1955	79,074	76.7
1956	10,715	70.7
1957	4,588	87.1
1958	1,317	117.4
1959	22,952	105.4
1960	21,488	102.5
1961	25,029	93.3
1962	14,539	82.1
1963	12,405	87.5
1964	ND	100.2

Bjornn et al. (1968) estimated smolt-to-adult survival (to the weir) at 0.14 to 1.83 percent and attributed a major influence to the Columbia River harvest.

DISEASE HISTORY

No information.

PRIORITY INFORMATION NEEDS

1. Yearly spawning escapement data.

2. Genetic comparison of native kokanee with Redfish Lake searun sockeye.

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UPPER COLUMBIA RIVER SOCKEYE
(including Okanogan and Wenatchee rivers)

Sockeye originate from three distinct areas. One population returns in negligible numbers to the Redfish Lake area on the Snake River and the other two groups are destined for Lake Osooyoos on the Okanogan system or Lake Wenatchee in the Wenatchee basin. This summary will contain information on the Wenatchee and Okanogan substocks.

PRODUCTION

Okanogan and Wenatchee sockeye are exclusively maintained by natural production.

GEOGRAPHIC LOCATION

Streams

Sockeye are produced in the lake-stream systems of Lake Wenatchee and Lake Osooyoos (Okanogan River). Mullan (1984) reported that negligible numbers (<300) of sockeye were produced from riverine spawning in the Wenatchee, Entiat, Methow and Similkameen rivers. These riverine populations were not associated with nursery lakes and may have utilized mainstem Columbia impoundments for rearing.

Hatcheries

Sockeye are presently only reared at McKay Hatchery in the Snake River basin, and are not of Okanogan or Wenatchee origin.

ORIGIN

Major lake-tributary systems in the Columbia River producing sockeye have declined from eight in the early 1900's to the present three (Mullan 1984). With construction of Grand Coulee Dam in the 1930's, sockeye production was almost completely limited to the Okanogan and Wenatchee systems. Beginning in 1939, sockeye were collected at Rock Island Dam and either transferred to Lake Wenatchee and Lake Osooyoos for natural propagation, or to three recently constructed hatcheries on the Wenatchee, Entiat, and Methow rivers. Sockeye production at the Leavenworth, Entiat and Winthrop hatcheries occurred from 1941 to 1962. Frequently, sockeye stocks were interchanged between the Wenatchee (Table 1) and Okanogan systems (Table 2). Lake Quinault stock (1941 brood) was also released from Entiat and Leavenworth hatcheries.

Table 1. Releases of non-local stock sockeye into Wenatchee River Basin (Mullan 1984).

Release site	Brood year	Release year	Number	Fish/lb.	Hatchery	Stock
Lake Wenatchee	1940	1941	414,000	95.0	Leavenworth	Rock Island Dam
	1941	1942	12,500		Leavenworth	Rock Island Dam
	1942	1943	246,300	117.0	Leavenworth	Rock Island Dam
	1943	1944	1,454,000	106.0	Leavenworth	Rock Island Dam
	1944	1945	237,400	104.0	Leavenworth	Rock Island Dam
	1945	1946	40,500	129.0	Leavenworth	Carson Hatchery
	1948	1949	9,900	80.0	Entiat	Entiat River
	1949	1950	395,000	45.0	Leavenworth	Methow River
	1951	1952	7,100		Leavenworth	Entiat River
	1952	1953	61,200	63.0	Leavenworth	Entiat River
	1953	1954	139,000	96.0	Winthrop	Methow River
	1953	1954	323,600	159.0	Leavenworth	Methow River
	1953	1954	23,200	103.0	Entiat	Rock Island Dam
	1953	1954	202,600	159.0	Leavenworth	Entiat River
	1954	1955	42,500	159.0	Winthrop	Methow River
	1954	1955	291,100		Leavenworth	Entiat River
	1955	1956	234,600		Leavenworth	Entiat River
	1957	1958	267,700		Leavenworth	Entiat River
	1958	1959	394,900	67.0	Leavenworth	Methow River
	1958	1959	482,200	67.0	Leavenworth	Entiat River
	1959	1960	295,900	40.0	Leavenworth	Methow River
	1959	1960	358,900	40.0	Leavenworth	Entiat River
	1960	1961	79,500	38.5	Leavenworth	Methow River
	1960	1961	360,800	38.5	Leavenworth	Entiat River
	1961	1962	5,300	51.0	Leavenworth	Methow River
	1961	1962	164,400	51.0	Leavenworth	Entiat River
Icicle Creek	1940	1942	25,000		Leavenworth	Rock Island Dam
	1941	1942	1,900	35.0	Leavenworth	Lake Quinault

Table 2. Releases of non-local stock into Okanogan River Basin (Mullan 1984).

Release site	Brood year	Release year	Number	Fish/lb.	Hatchery	Stock
Lake Osoyoos	1940	1940	569,300	95.0	Leavenworth	Rock Island Dam
	1941	1942	395,400	87.5	Entiat	Lake Quinault and Rock Island Dam mixture
	1942	1943	84,500	117.0	Leavenworth	Rock Island Dam
	i942	1943	534,200	90.0	Leavenworth	Leavenworth Hatchery
	1942	1944	36,400	52.0	Leavenworth	Leavenworth Hatchery
	1943	1944	510,900	106.0	Leavenworth	Rock Island Dam
	1943	1944	577,200	90.0	Winthrop	Leavenworth Hatchery
	1946	1947	337,600	95.0	Winthrop	Methow River
	1948	1949	524,400	45.9	Winthrop	Methow River
	1957	1958	627,500	32.0	Winthrop	Lake Wenatchee
	1951	1958	466,700	26.0	Winthrop	Lake Wenatchee

ADULT LIFE HISTORY

Run size, catch, and escapement

Since 1970, sockeye runs to the Wenatchee (Table 3) and Okanogan (Table 4) basins have averaged about 32,300 and 45,450 respectively. In both systems the runs have fluctuated dramatically, ranging from 8,100 (1978) to 70,150 (1983) in the Wenatchee and 10,200 (1978) to 107,150 (1984) in the Okanogan basin. Although some spawning area fish counts are available (Table 5), dam counts are considered a better measure of the natural escapements. The difference between sockeye counts at Rocky Reach and Rock Island dams represents Wenatchee escapement and the Wells Dam count is the Okanogan River escapement.

Sockeye are not harvested in significant numbers in the ocean. Freshwater harvest occurs primarily in the mainstem Columbia River commercial fisheries and in the tribal ceremonial and subsistence catch. Since 1972, target commercial fisheries have only occurred in 1983 (treaty only) and 1984. In 1984, a successful recreational fishery in Lake Wenatchee harvested about 1,800 fish (Fiscus 1985).

Time of migration

Upstream migration commences in late May and early June with counts at Bonneville Dam increasing sharply in late June. Approximately 50 percent of the run has migrated past Bonneville Dam by early July (Figure 1) and past Priest Rapids Dam about 10 ten days later. Sockeye reach Lake Wenatchee and Lake Osooyoos in July and August (Mullan 1984). In 1972, sockeye initially passed Tumwater Dam on the Wenatchee River on July 29 and reached a peak count on August 9 (Allen and Meekin 1973.) Sockeye entering the Okanogan River can be delayed when water temperatures exceed 70" F (Allen and Meekin 1973) and the fish may mill up to Chief Joseph Dam (Fiscus 1984).

Spawning period

Spawning activity peaks in the Wenatchee River about the third week of September and about a month later in the Okanogan River (H. Fiscus, Washington Department of Fisheries, personal communication).

Spawning areas

Principal spawning areas for Wenatchee River sockeye is in the lower 3.5 mile reach of the Little Wenatchee River and in the lower 5 miles of the White River at the upper end of Lake Wenatchee (river mile 58.6). Some incidental spawning occurs in Napeequa River (White River tributary).

Sockeye spawn in the mainstem Okanogan from the head of Lake Osooysso (river mile 90.0) upstream to the outlet of Vaseux Lake (river mile 106.0). The primary spawning area is the approximately nine mile reach between the town of Oliver and the Vaseux Lake outlet (Allen and Meekin 1973). Spawning in Lake Osooyoos occurs in some years (Allen and Meekin 1973).

Table 3. Minimum freshwater adult run size of Wenatchee River sockeye, 1970-1984.

Return year	HARVEST[a] Treaty: Commercial	HARVEST[a] Treaty: Ceremonial and subsistence	HARVEST[a] Non-treaty: Commercial	HARVEST[a] Non-treaty: Recreational	ESCAPEMENT: Natural[c]	ESCAPEMENT: Hatchery	Total production[d]
1970	950	N/A	3,000	0	17,600	0	22,150
1971	6,400	N/A	16,500	0	21 ,000	0	45,200
1972	9,800	N/A	19,450	0	16,500	0	46,300
1973	400	N/A	650	0	19,800	0	17,600[e]
1974	0	N/A	0	0	12,900	0	16,650
1975	0	N/A	0	0	26,400	0	28,650
1976	0	N/A	0	0	8,300	0	9,950
1977	50	1,300[b]	0	0	64,600	0	70,950
1978	0	50[b]	0	0	6,400	0	8,100
1919	0	50[b]	0	0	21,700	0	22,500
1980	0	250[b]	0	0	22,800	0	25,408
1981	0	550[b]	0	0	16,500	0	19,500
1982	0	400[b]	0	0	23,700	0	28,800
1983	(1,400)	1,300[b]	0	0	60,300	0	70,050
1984	(8,400)	1,200[b]	(2,500)	(1,850)	35,900	0	53,050
Mean	1,850	650	2,800	100	25,000	0	32,300

a/ Based on applying escapement area ratios of Okanogan, Wenatchee, Snake River sockeye to total season catch.
b/ Bowers (1985).
c/ 1970-1983 from Mullan (1984)
a/ Proportionment of "Total Colmbia River Sockeye Run" from ODF&W and WDF (1984); by applying escapement area ratios in Mullan (1984) to commercial catch and counts at Priest Rapids (1970-1972 or Bonneville dam (1973-1984). The difference between "Total Sockeye Run' and sum of Okanogan and Wenatchee production represents Snake River sockeye.
e/ In 1973, Rock Island and Ice Harbor dam counts exceeded Bonneville counts (the basis for total production estimates).
N/A: not available.
( ) (Preliminary).

Table 4. Minimum freshwater adult run size of Okanogan River sockeye, 1970-1984.

Return year	HARVEST[a] Treaty: Commercial	HARVEST[a] Treaty: Ceremonial and subsistence	HARVEST[a] Non-treaty: Commercial	HARVEST[a] Non-treaty: Recreational	ESCAPEMENT: Natural[e]	ESCAPEMENT: Hatchery	Total production
1970	3,100	1,600[b]	9,850	0	55,500	0	72,150
1971	14,750	1,000[b]	38,000	0	47,900	0	104,250
1972	16,050	1,300[b]	31,850	0	25,700	0	75,900
1973	1,000	4,600[b]	1,650	0	44,300	0	43,550[g]
1974	50	1,300[b]	0	0	19,700	0	27,000
1975	0	500[b]	0	0	26,500	0	29,350
1976	50	500[b]	100	0	26,800	0	32,800
1977	50	1,050[d]	0	0	25,200	0	28,200
1978	0	600[d]	0	0	7,700	0	10,200
1979	0	550[d]	0	0	28,300	0	29,950
1980	0	350[c]	0	0	30,000	0	33,450
1981	0	950[c]	0	0	30,700	0	36,400
1982	0	300[c]	0	0	17,400	0	21,450
1983	(600)	550[c]	0	0	26,000	0	30,200
1984	(17,600)	2,450[d]	(5,200)	(150)	72,500	0	107,150
Mean	3,500	1,250	5,800	0	32,300		45,450

[a]/ Based on applying escapement area ratios of Okanogan, Wenatchee, Snake River sockeye total commercial catch
[b]/ Colville and Okanogan Tribes only from Mullan (1984).
[c]/ Escapement ratios applied to values in Bowers (1985).
[d]/ Escapement ratios applied to values in Bowers (1985) and then added to values for Okanogan and Colville Tribes in Mullan (1984).
[e]/ Escapement area values minus Okanogan and Colville subsistence catches, all from Mullan (1984).
[f]/ Proportionment of 'Total Columbia River Sockeye Run" from ODF&W and WDF (1984); based on applying escapement area ratios in Mullan (1984) to commercial catch and counts at Priest Rapids (1970-1972) or Bonneville dam represents Snake River sockeye.
[g]/ In 1973, Rock Island and Ice Harbor dam counts exceeded Bonneville counts (the basis for total production estimate).
( ) (Preliminary).

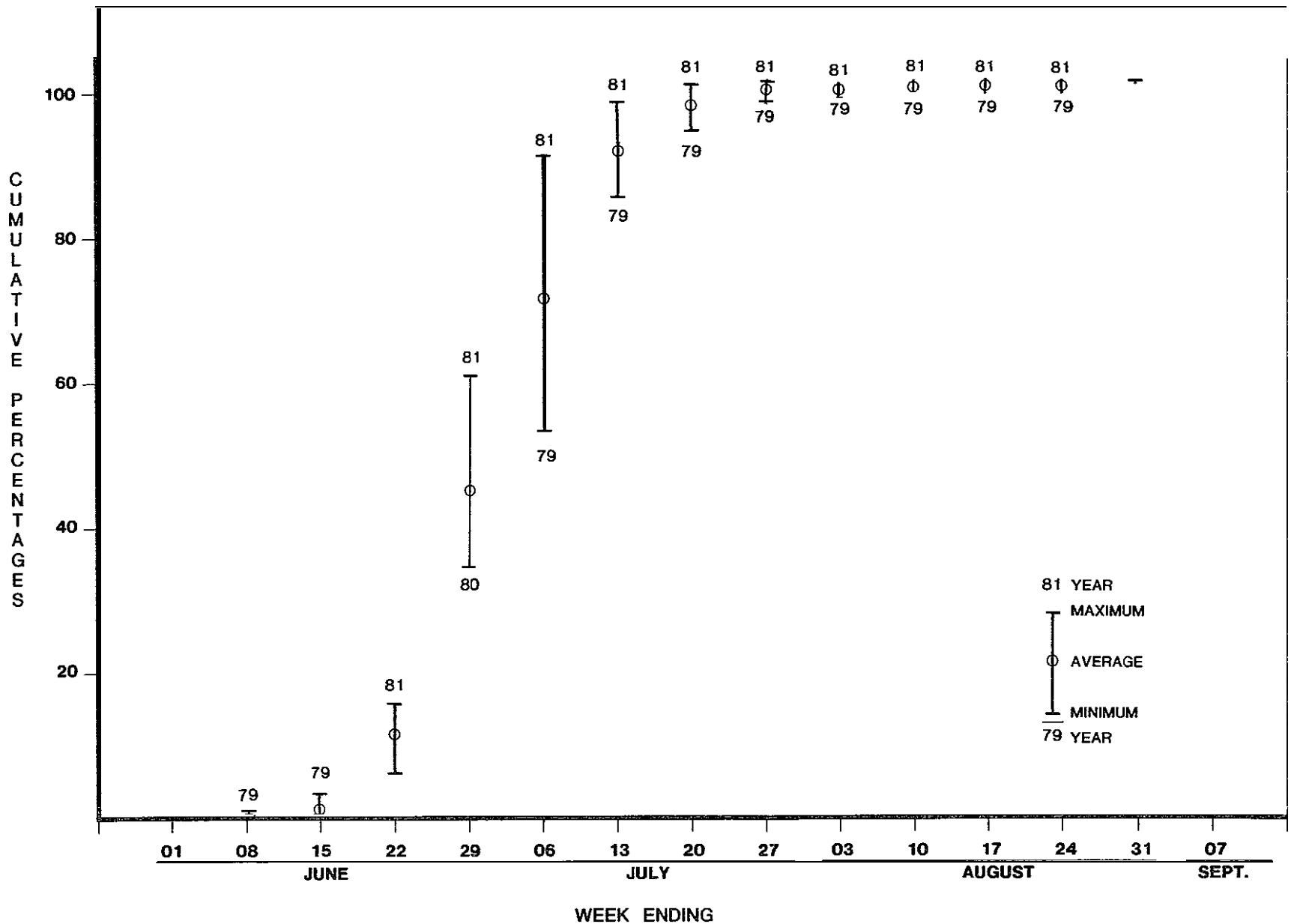

Figure 1. Cumulative percentage of upper Columbia River sockeye passing Bonneville Dam, 1979-1983.

Table 5. Sockeye spawning escapement (peak fish count) in Okanogan and Wenatchee river systems, 1970-1984[e]/.

Year	Wenatchee River[d]/ Little Wenatchee[a]/	Wenatchee River[d]/ White River[b]/	Okanogan[c]/ River
1970	1,651	7,667	13,580
1971	1,938	9,005	21,767
1972	1,264	4,825	9,441
1973	2,389	4,745	6,328
1974	1,543	2,844	3,080
1975	4,008	9,622	6,684
1976	245	1,330	8,554
1977	1,670	21,021	9,740
1978	77	656	329
1979	398	3,764	839
1980	203	2,122	NC
1981	471	4,412	NC
1982	NC	NC	NC
1983	NC	NC	NC
1984	(1,131)	(5,508)	(NC)
Mean	1,307	5,963	8,034

a/ Survey area River Mile 0.0 to River Mile 3.5
b/ Survey area River Mile 0.0 to River Mile 5.0
c/ Survey area River Mile 90.8 to River Mile 106.0
d/ Confluence of Little Wenatchee River and White River at Wenatchee River 58.6
e/ Fiscus (1980) for 1970-1971, Fiscus (1984b) for 1972-1983, and Fiscus, WDF, personal communication for 1984.
() (preliminary)
NC: not counted

Ase composition

Wenatchee River sockeye are primarily four-year-olds with minor numbers of three and five year old fish (Mullan 1984). The Okanogan sockeye run, in contrast, has a much higher and more varying number of three-year fish and no five-year-olds. From 1953-1974, the three-year-old escapement to the Okanogan system ranged between 6-93 percent and averaged 44 percent (Mullan 1984).

Size

In 1984, fork length distribution of samples from Wenatchee spawning areas ranged from 44-69 cm. and averaged 54 cm. (Fiscus 1984. Stockley and Meekin (1967) reported that female sockeye fork lengths in the Okanogan averaged 51 cm. compared to the male average of 47 cm. The distribution for males was bimodal with a nadir at about 47 cm. in the overall range of 38-58 cm.

Sex ratio

Information is very limited. The sex ratio of carcasses is highly variable and dependent on the proximity to suitable riffles and, consequently, representative samples are difficult to obtain (Fiscus 1984).

In 1972, males comprised 72 percent of the Okanogan sockeye less than 18 inches, which were considered to be three-year fish (Allen and Meekin 1973). Four-year-old sockeye were 47 percent males. Wenatchee sockeye sampled in 1972 were almost exclusively four and five-year fish and predominately females (70 percent) (Allen and Meekin 1973).

Fecundity

Based on Leavenworth, Entiat, and Winthrop hatchery records between 1944 and 1964, fecundity averaged about 2,600 eggs per female (Mullan 1984). Average fecundity of three-year-old Okanogan sockeye was estimated to be 2,000 eggs per female (Major and Craddock,1962; as reported by Allen and Meekin, 1973).

Biochemical-genetic characteristics

Information on Wenatchee and Okanogan sockeye is negligible. May and Utter (1974), as reported in Mullan (1984), found different variants of allelic frequencies for two enzyme between some individual Wenatchee and Okanogan samples, indicating possible genetic differentiation.

JUVENILE LIFE HISTORY

Time of emergence

Emergent fry were collected from the Little Wenatchee and White rivers in April (Allen and Meekin 1973). Time of emergence was expected to be slightly earlier in the Okanogan system because of warmer water temperatures.

Time, age, and size of migration

After rearing in the nursery lake for about a year, sockeye yearlings begin a rapid migration to the ocean. A small number of sockeye may remain in the nursery lake for an extra year. Between 1949-1953, yearlings comprised 93 percent of the smolts sampled at Bonneville Dam (Anas and Gauley 1956; as reported in Mullan 1984). From Leavenworth Hatchery reports, smolt migration past Tumwater Dam (river mile 32) on the Wenatchee River commenced in mid-April and continued for about a month (Mullan 1984). Based on mark recoveries of branded sockeye smolts arrival in the Columbia estuary occurs about 2 weeks after passing McNary Dam (Dawley et al. 1982).

Yearling smolts from the Okanogan system are larger than Wenatchee sockeye, averaging about 111 mm. compared to 90 mm. (Table 6).

Survival rate

No information.

DISEASE HISTORY

Hatchery production was discontinued partly because of the catastrophic losses from infectious hematopoietic necrosis (Mullan 1984). Sockeye are common carriers of this virus.

Dermocystidium was observed on the gills of adult sockeye in the Okanogan River in 1967 (Stockley and Meekin 1967).

PRIORITY INFORMATION NEEDS

Annual spawning surveys on the Wenatchee and Okanogan systems need to be reestablished in order to update the age composition data base and confirm the length intervals used to estimate the proportion of three and four-year--old sockeye.

Table 6. Average length and range of lengths of yearling (Age 1) sockeye smolts, Wenatchee and Osoyoos lakes. (Compiled by Mullan 1984 from several sources).

Lake	Average length (mm)	Range (mm)	Sample size	Year
Osoyoos	96	75-144	365	1957
	103	75-139	407	1958
	106	85-124	122	1972
	112	90-134	360	1973
	111	100-124	22	1974
	115	90-148	174	1977
	117	100-150	269	1977
	109	86-125	45	1978
	128	84-151	1385	1981
	110	76-147	3418	1982
Average	111	86-139		
Wenatchee	86	50-110	744	1955
	75	59- 97	411	1956
	96	75-138	312	1958
	93			1961
	112	70-149	562	1967
	84	65-109	81	1972
	81	65-114	132	1973
	91	70-124	23	1974
	-	75- 95		1959-63
Average	90	66-117		

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KEY TO SALMON STOCKS ON APPENDIX FIGURE 1

Chinook Salmon

1. Lower Columbia River Wild Fall Chinook
2. Lower Columbia River Hatchery Fall Chinook
3. Willamette River Fall Chinook
4. Cowlitz Stock Spring Chinook
5. Willamette River Spring Chinook (wild and hatchery)
6. Sandy River Pall Chinook (wild)
7. Bonneville Upriver Bright Fall Chinook (hatchery)
8. Carson Stock Spring Chinook
9. Bonneville Pool Fell Chinook (hatchery)
10. Klickitat River Spring Chinook
11. Deschutes River Spring Chinook (wild)
12. Deschutes River Spring Chinook (hatchery)
13. Deschutes River Fall Chinook (wild)
14. John Day River Spring Chinook (wild)
15. John Day River Fall Chinook (wild)
16. Umatilla River (upriver Bright) Fall Chinook (hatchery)
17. Snake River Fall Chinook
18. Tucannon River Spring Chinook
19. Kooskia Hatchery Spring Chinook
20. Grande Ronde River Spring Chinook (wild)
21. Grande Ronde River Spring Chinook (hatchery)
22. Grande Ronde River Fall Chinook (wild)
23. Rapid River Spring Chinook
24. Red River Rearing Pond Spring Chinook
25. South Fork Salmon River Summer Chinook
26. Middle Fork Salmon River Spring Chinook
27. Upper Salmon River Spring Chinook
28. Upper Salmon River Summer Chinook
29. Imnaha River Spring Chinook (wild)
30. Imnaha River Spring Chinook (hatchery)
31. Yakima River Spring Chinook
32. Upriver Bright Fall Chinook
33. Upper Columbia River Spring Chinook
34. Upper Columbia River Summer Chinook

Coho Salmon

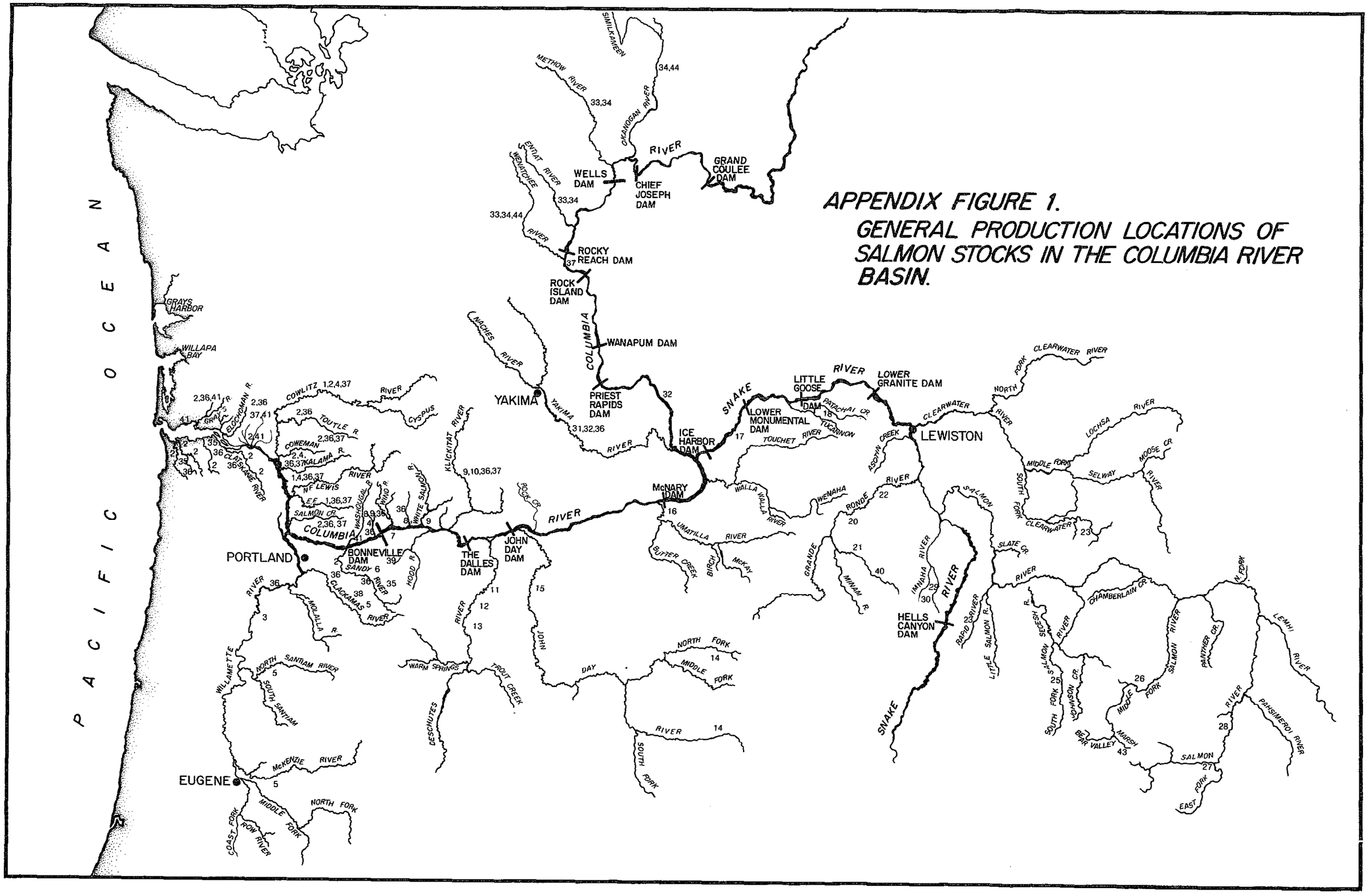
35. Lower Columbia River (Oregon) Coho (wild)
36. Early Run Coho
37. Late Run Coho
38. Clackamas River Coho (wild)
39. Hood Basin Coho (wild)
40. Grande Ronde River Coho (wild)

Chum Salmon

41. Lower Columbia River Chum (wild and hatchery)

Sockeye Salmon

42. Mackay Hatchery Sockeye
43. Redfish Lake Sockeye
44. Upper Columbia River Sockeye



APPENDIX FIGURE 1.
GENERAL PRODUCTION LOCATIONS OF SALMON STOCKS IN THE COLUMBIA RIVER BASIN.

KEY TO SALMON HATCHERY FACILITIES ON APPENDIX FIGURE 2

Washington

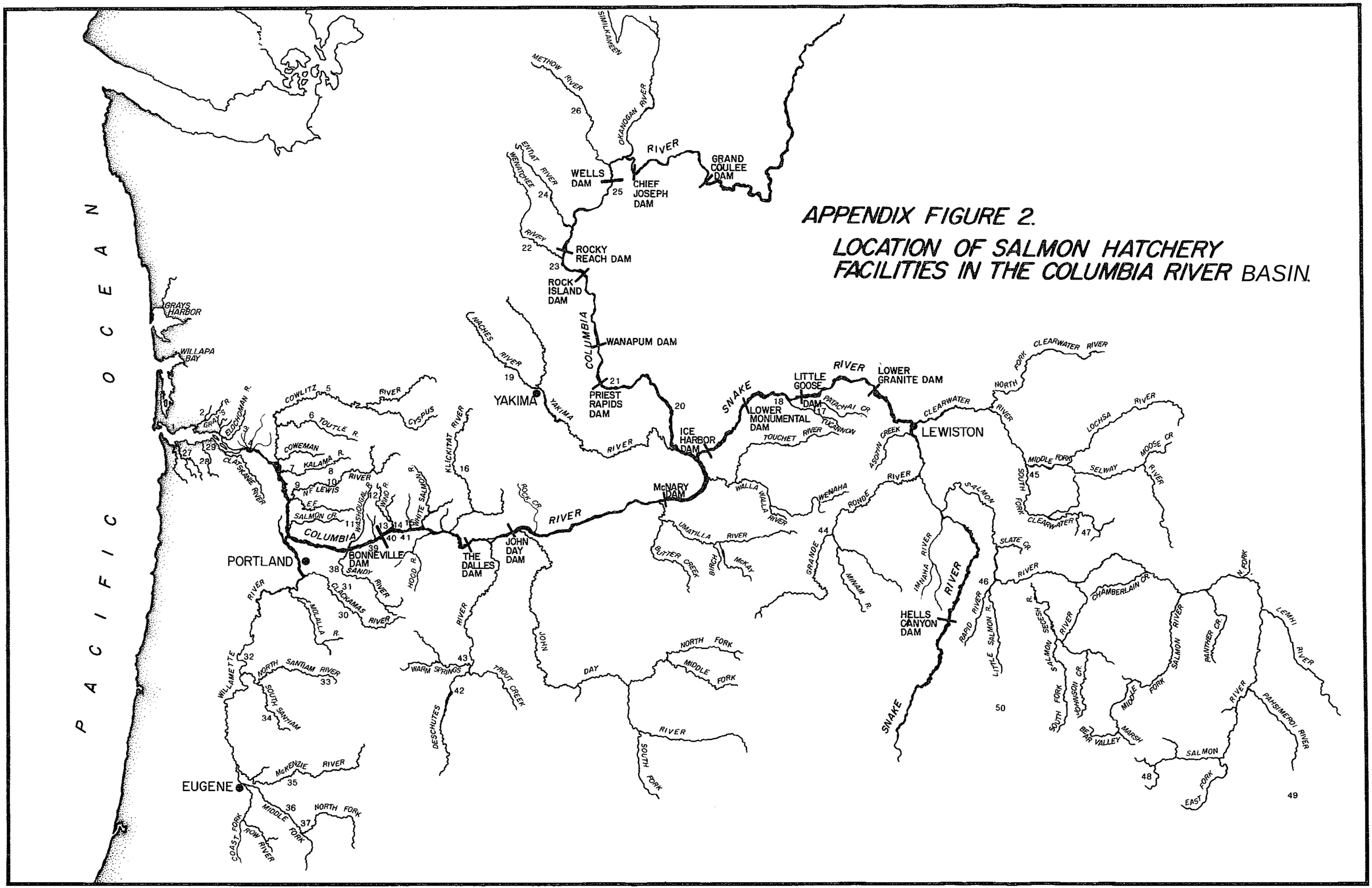
1. Sea Resources (private)
2. Grays River
3. Elokomin
4. Abernathy NFH
5. Cowlitz
6. Toutle (pre-eruption)
7. Lower Kalama
8. Kalama Falls
9. Lewis River
10. Speelyai
11. Washougal
12. Carson NFH
13. Willard NFH
14. Little White Salmon NFH
15. Spring Creek NFH
16. Klickitat
11. Tucannon
18. Lyons Ferry
19. Nile Springs Rearing Pond (cooperative)
20. Ringold Rearing Pond
21. Priest Rapids
22. Leavenworth NFH
23. Rocky Reach
24. Entiat NFH
25. Wells Dam
26. Winthrop NFH

Oregon

27. Klaskanine
28. Big Creek
29. Gnat Creek
30. Clackamas
31. Eagle Creek NFH
32. Aumsville-Stayton Pond
33. Marion Forks
34. South Santiam
35. McKenzie
36. Dexter Pond
31. Willamette
38. Sandy
39. Bonneville
40. Cascade
41. Oxbow
42. Round Butte
43. Warm Springs NFH
44. Lookinglass

Idaho

45. Kooksia NFH
46. Rapid River
47. Red River Rearing Pond
48. Sawtooth
49. Macay
50. McCall



APPENDIX FIGURE 2.

LOCATION OF SALMON HATCHERY FACILITIES IN THE COLUMBIA RIVER BASIN.