MONITORING OF DOWNSTREAM SALMON AND STEELHEAD AT FEDERAL HYDROELECTRIC FACILITIES - 1989

Annual Report

Prepared By

Richard C. Johnsen,
Lynette A. Hawkes,
W William Smith,
Gary L. Fredricks,
Rick D. Martinson,
and
William A. Hevlin

Environmental and Technical Services Division
Northwest Region
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1002 N.E. Holladay St. Room #620
Portland, Oregon 97232

Prepared For

Patrick Poe, Project Manager
Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208
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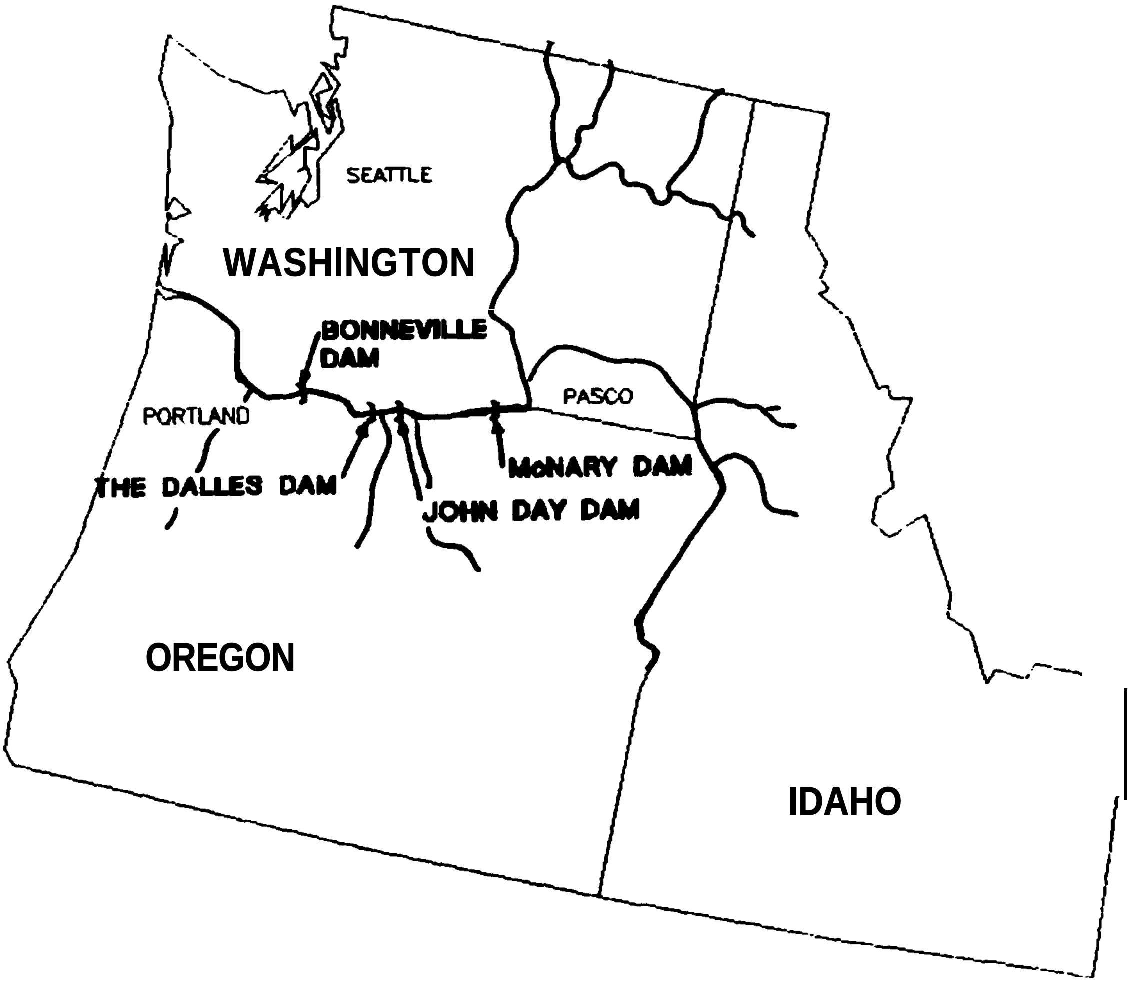

FIGURE 1. N.M.F.S. Smolt Monitoring sites on the Columbia River System.

INTRODUCTION

The seaward migration of salmonid smolts was monitored by the National Marine Fisheries Service (NMFS) at four sites on the Columbia River system in 1989. This project is a part of the continuing Smolt Monitoring Program to monitor Columbia Basin salmonid stocks coordinated by the Fish Passage Center (FPC) for the Columbia Basin Fish and Wildlife Agencies and Indian Tribes. It's purpose is to provide timely data to the Fish Passage Managers for in season flow and spill management for fish passage and post-season analysis by the FPC for travel time, relative magnitude and timing of the smolt migration. This program is carried out under the auspices of the Northwest Power Planning Council Fish and Wildlife Program and was funded by the Bonneville Power Administration (BPA).

Sampling sites were McNary, John Day and Bonneville Dams under the Smolt Monitoring program, and The Dalles Dam under the "Fish Spill Memorandum of Agreement" for 1989 (Figure 1). All pertinent fish capture, condition and brand data, as well as dam operations and river flow data were reported daily to FPC. These data were incorporated into the FPC Fish Passage Data Information System (FPDIS).

METHODS AND MATERIALS

McNARY DAM

The method of monitoring the smolt migration at McNary Dam was the same as reported in Johnsen, et al., 1984. Sampling took place at the McNary fingerling facility as described by U.S. Army CoE (1989). A portion of the total number of smolts from the entire gatewell collection system at the project was sampled by time at a rate ranging from 3% to 10% over the season to achieve a target rate of ".. .the lesser of 3% of the estimated weekly outmigration or, 10% of the weekly total of the smolts collected or bypassed....", based on the Fish Transport Oversight Team (FTOT) Annual Work Plan for 1989. Fish routed to the sample tanks were processed at the end of the 24 hr sample collection period at 0760 each day. Sample fish were then transported or bypassed according to FTOT criteria.

JOHN DAY DAM

Sampling at John Day Dam was accomplished by a funnel airlift pump system as described by Sims, et al. (1981) in unit 3 (gatewell B), as was done in 1988. The 24 hr sampling period ran frbm 1200-1200 seven days per week throughout the sampling period. Captured fish were examined hourly, and routed into the gatewell bypass channel for return to the river. Except for periods of maintenance, Unit 3 was in continuous operation, though turbine loading was variable.

THE DALLES DAM

Sampling at The Dalles Dam was by dipnetting fish from three gatewells (2-2, 12-2, and 18-2) across the powerhouse using a dip basket of the type described by Swan, et al (1979). Each gatewell was dipped hourly, 24 hours per day for five days each week during the sampling period. Sampling began at 0700 on Sundays and ended at 0600 on Friday. The first samples of each week on Sunday mornings were gatewell clean-outs of fish which had accumulated over the previous 48 hours. The lack of available qualified employees for this labor intensive sampling method prompted the decision not to pursue the original sampling schedule of seven days per week.

Two 'I-ton cranes (Grove AP308) were utilized for hoisting the dipnet baskets in and out of the sampled gatewells. After processing, sampled fish were then released into the ice-trash sluiceway for downstream passage. Vertical barrier screens were installed into the middle gatewell slots and the orifices blocked in units 2, 12, and 18, which were operated as consistently as possible through the duration of sampling.

BONNEVILLE DAM

At Bonneville Dam observations of smolt **passage** throughout the season were made from catches in the downstream migrant (DSM) trap in the bypass channel in powerhouse 1 and 2 (DSM 1&2). The DSM and sampling methods used were described by Gessel (1986), and by McConnell and Muir (1982), and Krcma et al. (1984), for PH 1 and PH 2 respectively. No gatewell dipnetting in powerhouse 1 took place this year as it was felt that the **DSM** 1 sampler could be relied upon throughout the season.

The DSM 1 sampler was manually operated eight hours per day (1600 to 2400 hrs), seven days per week. The hourly sampling rate was adjusted on a daily basis depending on smolt numbers, but was generally set at 6 to 15 minutes per hour (10-25%) at which time the trap would be raised and all fish examined. During unusually high smolt passage, the sample rate was adjusted on an hourly basis to a minimum of 30 seconds per hour when necessary.
The DSM 2 automatic sampler was normally operated 24 hours per day, seven days per week. This sampler travels at a constant rate back and forth across the width of the channel and randomly intercepts approximately 10% of the smolts passing through the DSM. These fish were routed to holding raceways where they were examined after the end of each sample period (2400-2400). After

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examination, sample fish from both DSMl and 2 were routed back to their respective bypass channels.

Specific data collected and reported to FPC at the end of the 24 hour sample period at each of the four sample sites include:

1) Total sample numbers for each salmonid species;
2) Hourly die1 passage information where possible;
3) Recording of all branded fish;
4) Descaling, general fish condition and mortality;
5) Subsample for lengths by species; and
6) Project, river, turbine and spill flow data.

Salmonid smolts at each sample site, with the exception of Bonneville, were preanesthetized using a solution of benzocaine and alcohol prior to handling to keep stress at a minimum and then transferred to an examination trough with a small amount of tricaine **(MS222)** anesthetic to keep fish calm during examination. Fish were then routed to recovery holding tanks before being released to continue their migration. All flow data for each sample site were obtained from the Corps of Engineers (CoE).

Sampling periods for each sample site are shown in Figure 2.

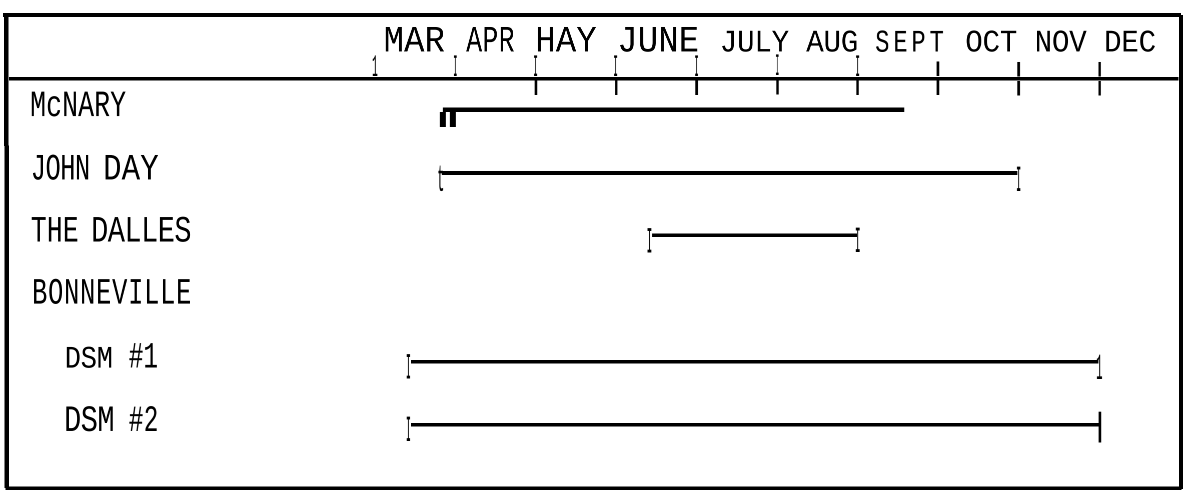

FIGURE 2. Smolt Monitoring Season, by Site, 1989

Sampling frequencies are as follows:

McNary Dam -------- Daily; 24-hour cumulative sample.
3/25 to 9/19

John Day Dam ------ Daily; 24 hourly samples, 3/28 to 10/31.

The Dalles Dam

Gatewell Dipnet 2-2, 12-2, 18-2, five days per week (Sun 0700 - Fri 0600) 24 hourly samples, 6/11 to 8/31.

Bonneville Dam

PH 1, DSMl ---- Seven days per week; 8 hourly samples plus die1 samples, 3/15 to 11/30.
PH 2, DSM2 ---- Seven days per week; 24-hour cumulative sample, 3/17 to 11/30.

RESULTS AND DISCUSSTON

Sampling results for the 1989 field season are presented in Table 1. The results of the hands-on assessments of smolt movement into or through the hydroelectric facilities at the listed sites are **summarized.** Included in the appendices is a graphic coverage of the passage index with flow for McNary Dam, die1 and seasonal passage and flow at John Day Dam, diel, capture patterns and flow at The Dalles Dam, and capture patterns and flow at Bonneville Dam. Some duplication may occur in other summaries.

McNARY DAM

For the 1989 sample season at McNary, 505,420 salmonid smolts were sampled from the collection/bypass system compared to about 767,000 in 1988. Of the total salmonids captured, about 4.4 percent were brand recaptures from upriver points.

Flows and the chronological passage pattern for McNary Dam are listed in appendix B. The inclusive dates for the 10 to 90 percent segment of passage are:

	18%	90%
Yearling Chinook - - - - -	4/30	5123
Subyearling Chinook - - - -	6/16	7118
Steelhead - - - - - - - - - -	5/2	5/28
Coho _ - - - - - - - - - - -	4/30	5/29
Sockeye - - - - - - - - - - -	4/29	5/27

The preanesthetizer (PA) and delivery system to the inside sorting troughs continue to prove very beneficial and efficient in processing sample fish at this facility. The new electric counting system (totalizer) installed in the fish handling building operated efficiently and was a definite improvement over the older counters that were in place for nearly 10 years.

Travel time estimates for yearling chinook and steelhead from McNary to John Day Dam in past seasons have been made from freeze branded smolts released below McNary Dam. Since no releases were planned by other agencies which could satisfy this need in 1989,

TABLE 1. -- SUMMARY OF 1989 SMOLT MONITORING ACTIVITIES AT McNARY, JOHN DAY, THE DALLES, AND BONNEVILLE DAMS.

SPECIES	SITE	TOTAL SAMPLE	BRANDS IN SAMPLE	ESTIMATED COLLECTION	ESTIMATED[1/] FPI
YEARLING CHINOOK	McNARY	143,817	9,912	2,332,732	2,545,629
	JOHN DAY	34,930	2,207	34,930	502,642
	THE DALLES	112	1	112	489
	BONNEVILLE PH#1 DSM[2/]	27,935	521	223,134	435,455
	BONNEVILLE PH#2 DSM	15,579	247	154,803	N/A
SUBYEARLING CHINOOK	McNARY	246,148	5,218	5,019,617	5,034,804
	JOHN DAY	129,870	1,585	129,870	1,017,342
	THE DALLES	13,072	63	13,072	49,031
	BONNEVILLE PH#1 DSM	98,521	364	1,332,736	1,756,794
	BONNEVILLE PH#2 DSM	12,197	24	121,943	N/A
STEELHEAD	McNARY	57,499	6,914	943,347	1,006,978
	JOHN DAY	19,818	2,150	19,818	281,685
	THE DALLES	59	9	59	340
	BONNEVILLE PH#1 DSM	12,240	443	106,787	206,226
	BONNEVILLE PH#2 DSM	2,049	51	20,397	N/A
COHO	McNARY	13,665	1	212,714	230,258
	JOHN DAY	6,930	1	6,930	99,811
	THE DALLES	8	0	8	41
	BONNEVILLE PH#1 DSM	29,746	0	257,244	491,618
	BONNEVILLE PH#2 DSM	9,192	0	91,437	N\A
SOCKEYE	McNARY	44,291	231	713,039	768,471
	JOHN DAY	5,496	36	5,496	78,190
	THE DALLES	59	0	59	208
	BONNEVILLE PH#1 DSM	7,723	16	72,962	138,310
	BONNEVILLE PH#2 DSM	2,247	4	22,467	N/A
TOTAL CATCH	McNARY	505,420	22,276	9,221,449	9,586,140
	JOHN DAY	197,044	5,979	197,044	1,979,670
	THE DALLES	13,310	73	13,310	50,109
	BONNEVILLE PH#1 DSM	176,165	1,344	1,922,863	3,026,403
	BONNEVILLE PH#2 DSM	41,264	326	411,047	N/A

Data Source: Fish Passage Data Service

1/. FPI is Fish Passage Index; collection counts adjusted for rate of flow.

2/. DSM is DownStream Migrant facility.

our project undertook branding of river run smolts for travel time estimates at the request of the Fish Passage Center. The target number to be branded was 30,000 each species, yearling chinook and steelhead. Between May 1 and June 3 a total of 27,036 yearling chinook and 22,716 steelhead smolts were actually freeze branded and released into the tailwater of McNary Dam. Composition of the fish branded was of hatchery and wild stocks in as nearly representative proportions as possible from the daily sample, eliminating those fish that were severely descaled, obviously moribund, or previously branded.

During the five week branding period, 83.1% of the yearling chinook and 74.0% of the steelhead were found suitable for branding. Fish examined in this period were categorized as follows:

	Total Examined	Desc.	Injury, Disease	Prev. Branded	Total Markable
Yrlg. chinook	33,124	2,207	744	2,657	27,516
		6.7%	2.2%	8.0%	83.1%
Steelhead	31,231	1,846	1,918	4,350	23,117
		5.9%	6.1%	13.9%	74.0%

Handling mortality of freeze branded fish was estimated by holding 20 yearling chinook and 20 steelhead of each mark group for 48 hours. Collective results showed a mortality of only 1.7% (8 of 480) for yearling chinook and 0.6% (3 of 500) for steelhead. Mark quality was also assessed and branding technique adjusted as necessary for successive mark groups. As a practical measure of brand quality and observer accuracy, the majority of fish held for handling mortality estimates were released into the sample holding tank, after 48 hrs., to mix with the days sample recruitment. Brand detection of these groups was 96.7% (437 of 452) for yearling chinook and 97.9% (470 of 480) for steelhead; altogether a very commendable brand application and detection effort. We hope to apply this brand detection effectiveness technique to other sites in the future.

Actual counts of chinook **fry**[1] (subyearling < 60 mm) totaled 10,900 and comprised nearly 100% of the total subyearling sample from early April through May, but diminished sharply after June 1st. The total bypass collection (FPI) of 174,000 subyearling fry was about 30% of the nearly one-half million recorded in 1986, the highest record to date.

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1 Retention of the smallest Chinook fry captured is not complete.

JOHN DAY DAM

In 1989, monitoring activities at John Day Dam were consistent with the 1988 season. From the airlift pump sampling system operated in gatewell 3B, a total of 197,044 smolts were collected. This is about a 12 percent increase over the 1988 total of 173,461, but 19% below the three year average of 244,850 since 1985 when STS screens were installed at John Day dam.

River flow, Unit 3 discharge, fish passage patterns by species and die1 passage patterns are presented in Appendix C for the 1989 season. Dates for the 10 to 90% segment of smolt passage are listed below:

	10%	90%
Yearling chinook - - - - -	5/2	5/27
Suhyearling Chinook - - - -	6/7	8116
Steelhead - - - - - - - - -	4/24	5/27
Coho - - - - - - - - - - - -	4128	5/29
Sockeye - - - - - - - - - - -	5/8	6/3

Die1 passage patterns (Appendix B, Figures 44 - 48)[2] were consistent with past years in that the majority of smolt passage (75 - 95%) usually occurs during night time hours at John Day Dam (Sims, et al., 1976 and 1981). Typically, juvenile salmonids move in the forebay during daylight hours then sound and move through the spillways and powerhouse at dusk reaching a peak during the night and dropping off sharply after sunrise. Reversals of this pattern, though infrequent, do occur. Such a reversal occurred in Hay for the beginning of the subyearling chinook migration (Appendix B, Figures 9-11) when about 72 percent of the chinook subyearling passage occurred during daytime hours. Since chinook fry (subyearling $\leq$ 60 mm) comprised about 89% (ca. 3,740) of the total subyearling chinook sampled during the month of Hay, the period when over 90% of the fry were observed, it is believed that the die1 pattern during this time is due to higher diurnal flow rather than active migration by these fry.

The incidence of descaling at John Day Dam, according to FTOT criteria, was as follows: Chinook yearling, 11.2%; Chinook subyearling, 5.1%; Steelhead, 9.6%; Coho, 6.2%; and Sockeye, 12.1%.

In the 1989 season, no major operational problems were encountered. Two new pieces of equipment contributed to this

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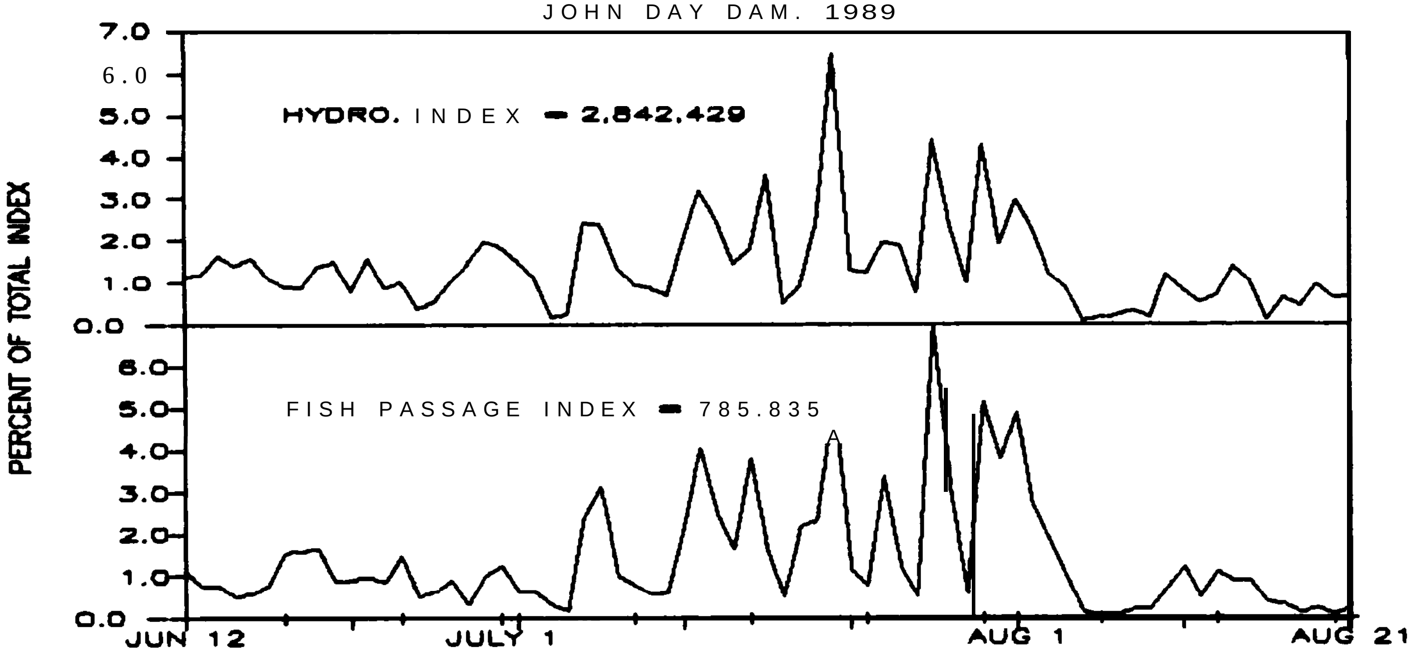
[2]. Die1 passage is shown for each species only when weekly catch exceeds 500 fish.

smooth operation. A new airlift funnel, fabricated by **NMFS,** Pasco, WA. was used this season. The transition area at the apex of the new funnel was widened and shaped to make a gradual smooth taper into the 12 inch flanged pipe fitting. This improved design facilitates passage of debris in this transition area. There was roughly a 60 percent reduction in the number of driftwood plugs this season which reduces the amount of smolt descaling and/or injury as well as the amount of down time. It also reduces the risk of injury to personnel while clearing a driftwood plug. Another major improvement was the replacement of an old pneumatic winch with an electric hydraulic winch. The quiet and easy operation of the new winch made funnel adjustment quick and safe. The fish processing building was also enlarged to accommodate a holding tank for mortality studies and a small section was added to house the recovery tank.

HYDROACOUSTICS INDEX – FPI

JOHN DAY DAM. 1989



MONITORING DATES

FIGURE 3.

The fish passage index (FPI) and hydroacoustics index (HI) (McFadden and Hedgepeth, 1989) for the concurrent sampling period, May 13 through **August 15, are presented in Figure 3.** A cursory.review of these passage indices indicate that most trends, high and low, 'are somewhat similar as to date, but the magnitude varies. For 1989, the HI was.3.6 times greater than the FPI (2,842,429 vs. 785,835) compared to a ratio of 6:l in 1988 and 1:l in 1987. The FPI and HI are not comparable in magnitude as neither index is designed to measure absolute abundance, but rather trends in abundance.

The preanesthetizer (PA) that was incorporated into the fish handling operation last year was utilized throughout the 1989 season. Delayed mortality tests (48 hr holding) were conducted in an attempt to evaluate the delayed handling mortality of the current PA method as described by Matthews, et al. (1985) compared to our previous standard method of hand dip netting smolts directly into an anesthetic solution of MS-222.

Results were inconclusive due to many variables affecting fish health and stress levels which outweighed the effects of the handling methods being tested. Groups of subyearling chinook, held 48 hours, between the end of July to the end of August displayed increased levels of descaling, incidence of disease and mortality as high as 51 percent, indicating a generally weakened groups of fish at this time. A similar increase in holding mortality was noted in 1988 between mid June to the end of July.

Incidental capture of juvenile American Shad (*Alosa sapidissima*) is shown in Appendix D, Figure 42. First capture was noted on July 9th and shad were increasingly present through the sampling season, October 31.

THE DALLES DAM

The dipnet sampling of Units 2-2, 12-2, and 18-2 at The Dalles Dam began at 0900 on June 11 and proceeded as scheduled through August 31. There were temporary interruptions of sampling due to crane and cable breakdowns, loss of one dipbasket and turbine shut-downs for maintenance purposes. A total of 13,310 smolts were collected, 98% of which were subyearling chinook. The remaining 2% represents the end of spring migrating chinook yearlings, steelhead, coho, and sockeye populations.

River flow, average sampled unit discharge and spill, weekly die1 and overall passage pattern for subyearling chinook are presented in Appendix C. Interruptions in passage pattern are due to scheduled weekend shut-downs and equipment failure. Gatewell clean-out catches of fish at the end of weekend breaks are included in the calculations of fish passage indices even though clean-out data lacks the precise time element definition assured in the hourly catch data.

Two peak migration periods are indicated in the passage pattern; one occurred immediately after the monitoring program began in June and the other occurred near the end of July. Spill for fish passage commenced the day following the early peak (June 13), continued through most of the sampling period and ended August 23rd.

Spill likely reduced subsequent gatewell catch numbers. Dates for the 10 to 90 percent segment of subyearling chinook passage in the sample period were June 13 and August 1. The shape of the initial passage pattern would indicate a portion of the early subyearling chinook had passed prior to the start of sampling.

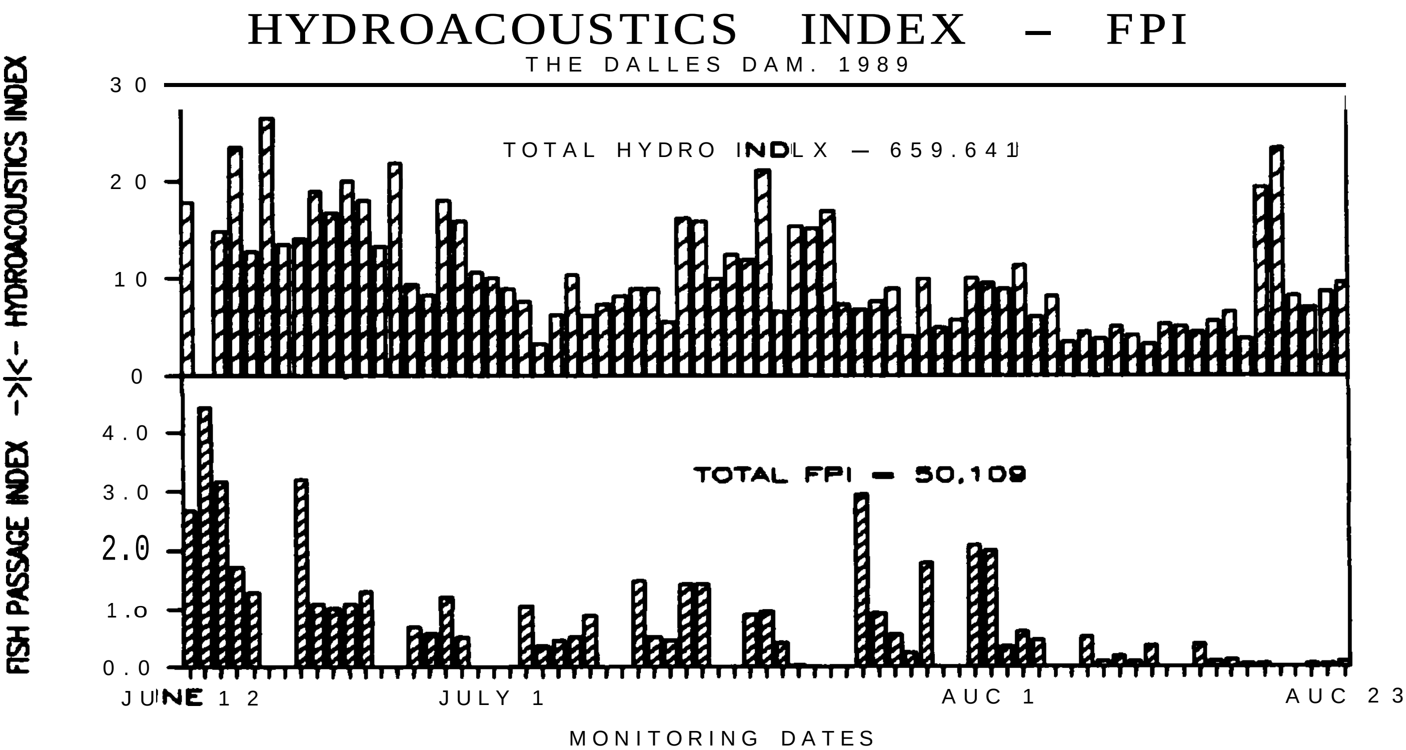


FIGURE 4.

A comparison of passage patterns (Figure 4) at the spillway as measured by hydroacoustics (HI) by McFadden, (1989) versus gatewell dipnetting (FPI) at the powerhouse is somewhat difficult to evaluate. However, discounting the gatewell accumulation of fish over the two non-fishing days, it appears that patterns are not greatly different except relative gatewell numbers are lower after early August (about August 5th) than indicated by the HI. In fact, the HI peak of August 18-19 is not evident in the FPI.

Average daily river flow, sampled units discharge and spill are shown in Appendix C, Figure 13. Total discharge declined over the sampling period from a high of 259.8 KCFS on June 12 to a low of 68.6 KCFS on August 20. Daily discharge from the three sampled units ranged from a high of 37.9 KCFS to a low of 19.2 KCFS.

To facilitate summer smolt passage, the 5% of daily average flow authorized for the spill program at The Dalles was concentrated into 8 hours per day beginning on June 13 and ending on August 23. Hours of spill were adjusted, as recommended by FPC during this time based on information from gatewell monitoring die1 patterns and CoE's hydroacoustic monitoring (Fish Passage Center, 1989). Spill averaged 6.6 KCFS (5.6% of the daily average flow) over the period.

The weekly die1 passage patterns (Appendix C, Figures 1 - 12) display smolt passage on a 24 hour basis. A consistent pattern of die1 passage did not develop until the 4th week of monitoring, July 2nd to the 6th. From the 4th through the final 12th week of the monitoring period the majority of passage (approximately 75%) occurred during the night time hours.

Of the total seasonal catch, 55.7% were captured from gatewell 2-2, 22.7% from 12-2 and 21.6% from 18-2 (see Figure 5). The majority of smolts were caught on the West end (Unit 2) of the powerhouse which may indicate the horizontal distribution of chinook subyearlings as they encounter the dam. This distribution may be a consequence of the proximity of gatewell 2-2 to the open gates of the two major routes for smolt passage through the dam, the ice-trash sluiceway and spillway (Willis, 1982). Higher catches in Unit 2 are not a result of unequal flows through the three sampled units, these were relatively equal over the sampling period.

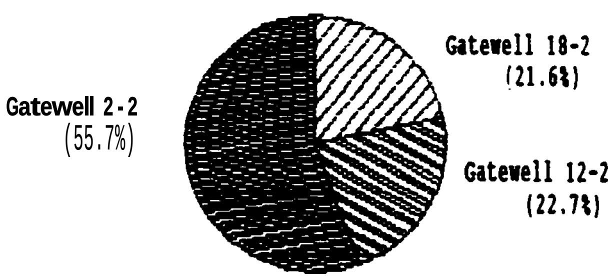


FIGURE 5.

Four 48-hour delayed handling mortality tests were conducted at the end of July and in early August to measure the impact handling techniques were having on chinook. Sample numbers in these tests were 98, 59, 50, and 60 fish. Delayed mortalities of the four tests were 3.1%, 1.7%, 2.0%, and 1.7%, with an average mortality of 2.1%; no non-handled control groups were held due to lack of space.

To assess the degree of descaling over the monitoring season subsamples of at least 50 smolts were examined on 11 sampling days between June 21 and August 2 according to FTOT criteria. Descaling in all subsamples averaged 3.7 percent; descaling levels by gatewell were 4.8% for gatewell 2-2 (6 samples), 3.2% for 12-2 (4 samples), and 3.7% for 18-2 (5 samples). No seasonal pattern of descaling was evident.

BONNEVILLE DAM

Daily river flow, powerhouse discharge, spill and fish capture patterns for DSM 1 and DSM 2 are presented in Appendix D, Figures 1 - 21. Smolt capture pattern is divided into early season, 3/9 - 6/31 (spring) and late season, 7/l - 11/30 (summer/fall) components for each DSM. The early capture pattern for the subyearling chinook migration consists mostly of Bonneville pool hatchery released smolts predominately of tule stock, and the late season segment consists mostly of upriver bright stock. This seasonal division also allows for more detailed late season examination of the passage patterns for the other species when numbers are substantially lower. The CoE removed traveling screens from all but two of the Powerhouse 1 operating units during the week of November 20 - 24, consequently reducing the percentage of smolts intercepted by the DSM system.

The DSM 1 water control and sampling equipment completed another relatively uninterrupted monitoring season. Much of this success was due to the installation of new water level sensing and automatic equipment control devices and regular monitoring by Corps personnel while the water control equipment was operated in manual mode. This sampler was out of service on March 22 to repair a faulty emergency relief gate mechanism and on September 6 and November 28 due to a sample tank hoist malfunction.

As in previous years, Powerhouse 2 was restricted to operation on an intermittent basis for N.M.F.S. and CoE research projects during most of the primary monitoring season due to historically low fish guidance efficiency. This resulted in far fewer fish captured by this facility than in the DSM 1. It should be noted that the capture patterns in Appendix D, Figures 15 - 21 more strongly reflect powerhouse discharge than actual fish abundance at this point in the river. Footnotes to these graphs denote dates when the sampler was taken out of service to avoid intercepting research fish or large numbers of Spring Creek Hatchery fish. All DSM 2 smolt by-passing and sampling equipment operated without incident until September 13 when faulty bearings were detected in the 10% sampler drive shafts. The sampler was fished from a stationary position in midstream from this date until October 23 when repair parts finally arrived and the unit was taken out of service for parts installation. The sampler was returned to normal service on November 1. Anticipated debris problems similar to those in 1988 failed to materialize partially due to modifications made to the fish conduit in July, 1988.

An early March release of Spring creek hatchery subyearling chinook triggered the first 10% of the total 1989 migration passing Bonneville Dam (CoE operated the DSM 1 trap from 3/8 to 3/15). Appendix D, Figures 22 - 24 illustrate the cumulative capture patterns for all the species monitored.

Species composition for each powerhouse was similar to that observed in 1988 (Figure 6) and in 1985 (Gessel et al. 1986).

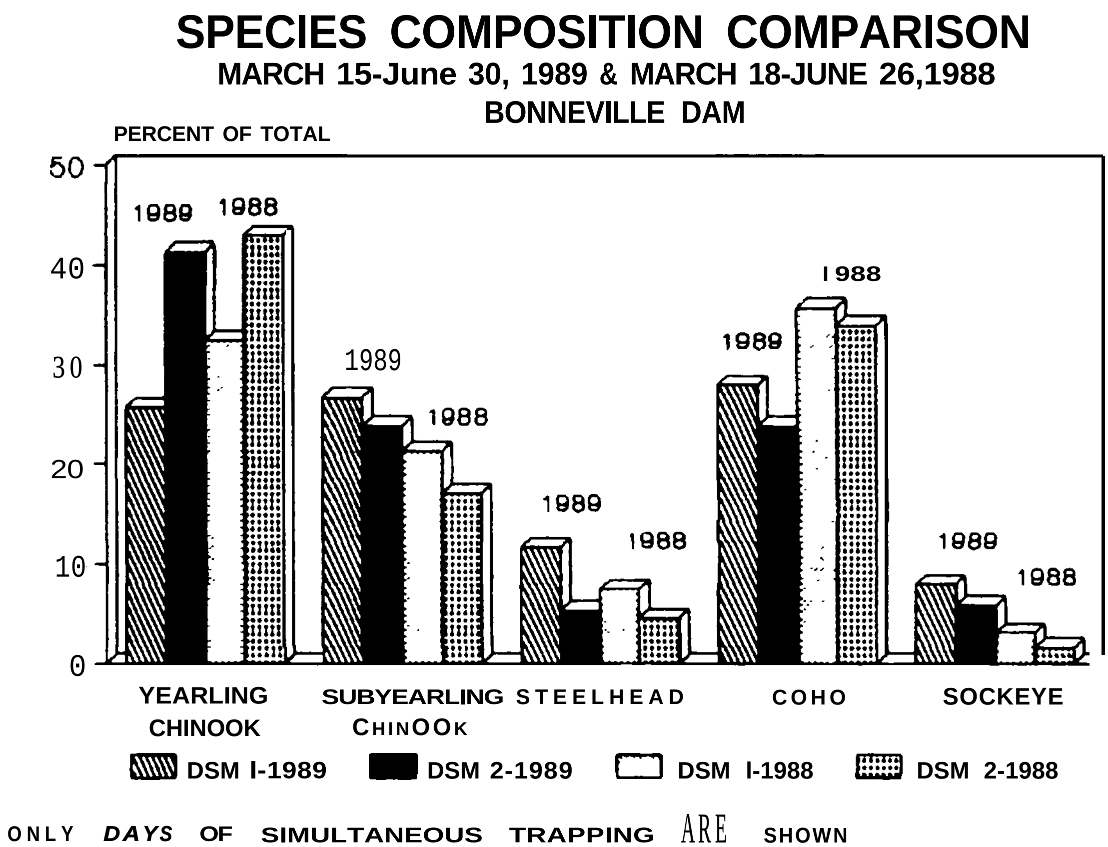


FIGURE 6.

Dates for the 10 to 90% segment of smolt passage for each species, measured at the DSM 1, are presented below:

	10%	90%
Yearling Chinook - - - - -	4/21	5/21
Steelhead - - - - - - - - -	4/22	5/29
coho - _ _ - - - _ - - - _ - -	4/21	5/29
Sockeye - - - - - - - - - - -	5/10	6/4

Early Bonneville pool hatchery releases of subyearling chinook, which comprised nearly 80 percent of the subyearlings captured, overshadow the later migrating upriver bright stock. To isolate this upriver stock the 10 and 90 percent segment dates are 6/6 and 7/29 respectively for that segment of the subyearling run that passed after June 1st.

Delayed mortality tests to evaluate handling caused stress were conducted this year on yearling chinook and steelhead in May and subyearling chinook in July. The details of these tests are presented in Appendix E. No significant difference in mortality was found to exist between the groups handled by our normal procedures and the control groups. In fact, we found an overall mortality of less than 2% for each of the three salmonid varieties tested.

The incidence of descaling for each species captured in our regular sampling was similar to that observed in 1988 and in 1987 by Gessel et al. (1988). Percentages of descaled fish and mortality occurring in each DSM trap for 1988 and 1989 are listed by species below:

	Yearling Chinook	Subyearling Chinook	Steelhead	Coho	Sockeye
		1988			
DSH 1					
Descaled	4.3	2.3	4.4	3.3	17.2
Mortality	0.1	0.4	1.1	0.02	0.14
DSM 2					
Descaled	4.7	0.6	4.8	3.2	18.7
Mortality	3.1	1.1	1.6	2.1	16.5
		1989			
DSH 1					
Descaled	4.4	1.7	6.1	3.3	23.5
Mortality	0.2	0.3	0.2	0.1	6.8
DSM 2					
Dcscaled	4.6	2.2	7.6	3.4	13.8
Mortality	2.4	4.1	1.8	1.3	15.1

The higher mortality noted for each species from DSM2 samples may be due in part to the slow passage of moribund fish through the various components of the bypass system into the sample holding tanks to be examined once per day. Severely descaled fish likely have died by the time they are examined in the sample. Since we were unable to determine whether descaled mortalities were alive when descaled, they were not included in the descaled category. Thus, the mortality category for DSM2 is inflated over samples in DSMl where capture and examination of samples is nearly instantaneous after entry into the bypass channel and short term mortality from descaling had not yet occurred.

A large percentage of mortalities examined in DSM 2 have obviously been dead for several days. These decomposing smolts are seldom noted on the water surface of gatewells in powerhouse 2. A possible explanation is the cul-de-sac, comprising at least 21 feet of the south end of the DSM 2 channel, upstream from orifice 11A. This is the only large slack water section in the DSM channel and sampling system that can not be inspected on a regular basis. Channel dewaterings after the migration season have revealed large accumulations of debris and juvenile shad in this area. Krcma, et al. (1984) noted that fish released near the upper end of the DSM 2 channel cul-de-sac took longer (up to 15 days for yearling chinook) to be recaptured in the raceways than groups released in other parts of the system.

Three die1 tests were conducted in DSM 1 in May and three in July. This sampler was operated and the resulting catch enumerated on an hourly basis for 24 hours. The results of these tests are presented in Appendix D, Figures 25 - 41. No graph is provided for sockeye on May 1 due to insufficient number collected. The collection data represented in each graph does not account for changes in powerhouse flow. It is therefore important to consider the percentage of river flow through the powerhouse (provided on each graph) when comparing hourly and daily capture data.

Peak passage for most species generally took place at or just after sunset with a lesser peak near sunrise. Increased hourly passage occurred during the night time hours. Some species show substantial variation in die1 capture pattern when the three test dates are compared. (the proportion of the 24 hour collection of yearling chinook intercepted during our normal 8 hour sampling period varied from 23 to 32 percent.) Visual observations of the die1 graphs and 24 hour river flow patterns suggest that this variability is not entirely accounted for by changes in powerhouse operation or total river flow. Similar observations were reported in 1987 by Gessel, et al. (1988). The effect of this level of variability on the daily index should be evaluated. If necessary, the precision of the daily index could be greatly improved by sampling on a continuous (24 hour/day) basis.

Fry (<60 mm) comprised 12% (Index total= 53,494) of the spring migrating subyearling chinook capture at DSM 1 .

Juvenile American shad numbers began increasing at the DSM 1 sampler in late August and peaked in early November (Appendix D, Figure 43). The overall number of juvenile shad captured in 1989 was six times higher than in 1988, a possibe result of the 63% greater 1989 adult run (from Bonneville fish ladder counts). Juvenile pacific lamprey (Entosphenus tridentatus) catch rose sharply in late March and declined in early April with a smaller peak in mid May (Appendix D, Figure 44).

SUMMARY

The 1989 smolt monitoring project of the National Marine Fisheries Service provided data on the seaward migration of juvenile salmon and steelhead at Mcnary, John Day, The Dalles and Bonneville Dams. All pertinent fish capture and condition data as well as dam operations and river flow data were provided to the FPDIS for use by FPC in developing fish passage indices and migration timing, and for water budget and spill management.

ACKNOWLEDGMENTS

Support for this smolt monitoring project comes from the region's electrical ratepayers through the Bonneville Power Administration.

The success of this program continues to involve cooperative interaction with the Northwest and Alaska Fisheries Center, Coastal Zone and Estuarine Studies Division in both personnel and facilities of the Pasco and North Bonneville Field Stations. It is appreciated.

On-site biologists, assistants and others of the Corps of Engineers provided valuable guidance and assistance at each sampling site: McNary, John Day, The Dalles and Bonneville Dams. Corps personnel at The Dalles Dam were especially helpful while we were preparing new sampling facilities and during the season.

We acknowledge the very capable efforts of our biologists, technicians, maintenance and contract persons; their work was vital. Key people were Gary Fredricks and Dave Jepsen at Bonneville, Lee Ferguson at McNary, Rick Martinson and Randy Absolon at John Day, Bill Hevlin at The Dalles, and Doug Frantum and his assistants for assembling most of the sampling components at The Dalles Dam and keeping those at John Day Dam in working order.

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APPENDIX A
McNARY DAM - 1989

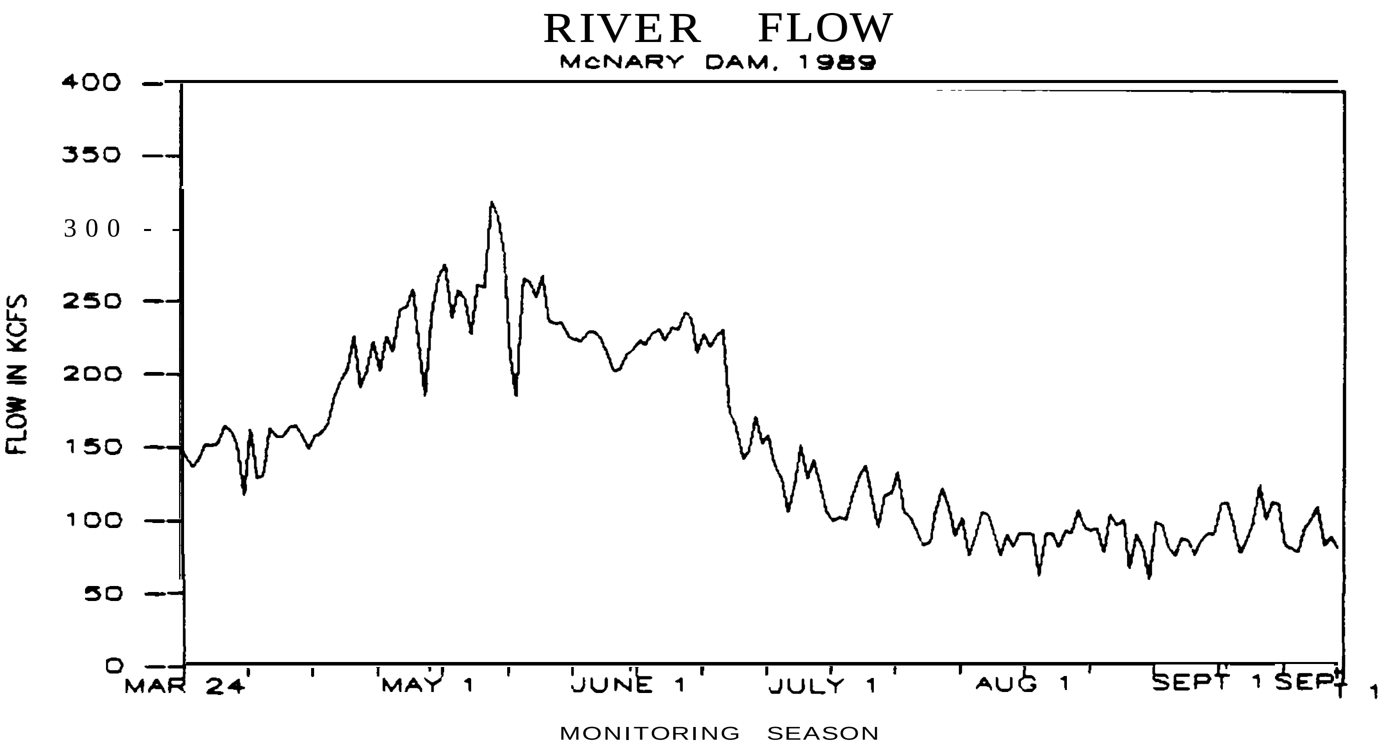


FIGURE 1

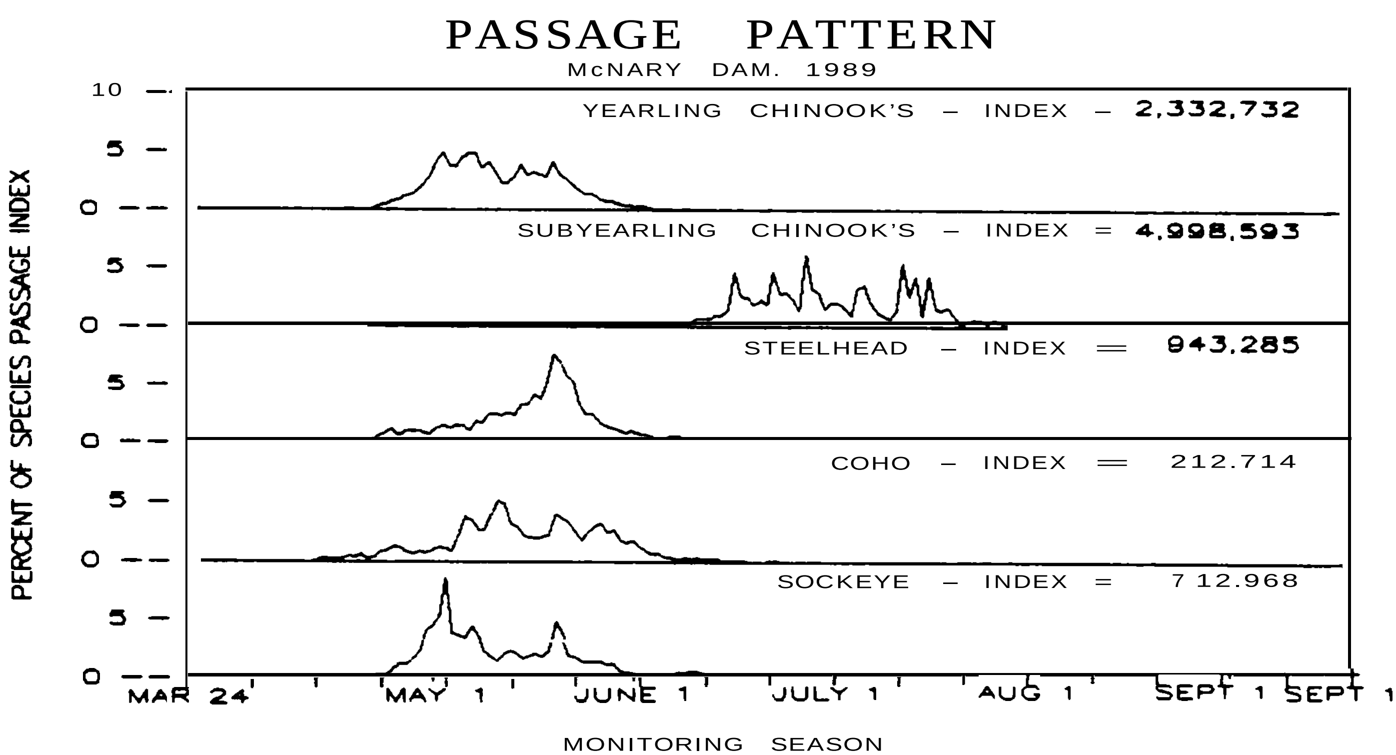


FIGURE 2

APPENDIX B
J O H N D A Y D A M – 1989

WEEKLY DIEL PATTERN

YEARLING CHINOOK – JOHN DAY DAM

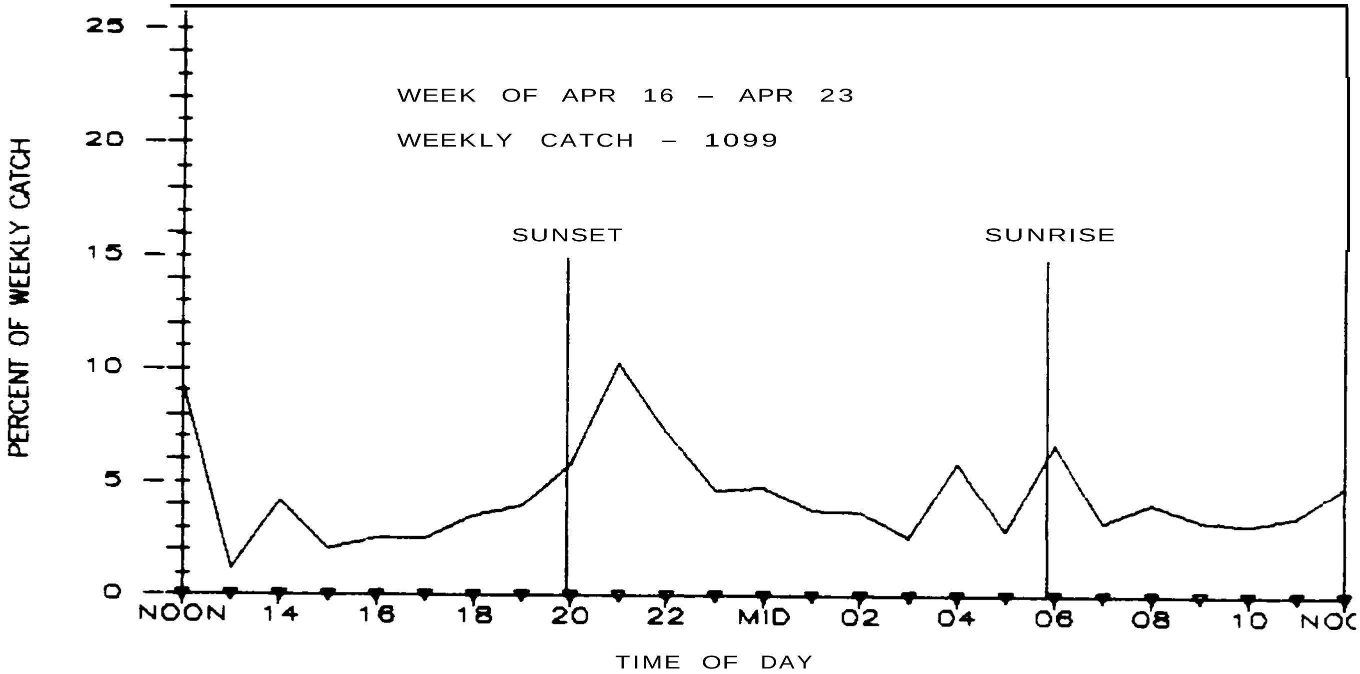


FIGURE 1

WEEKLY DIEL PATTERN

YEARLING CHINOOK – JOHN DAY DAM

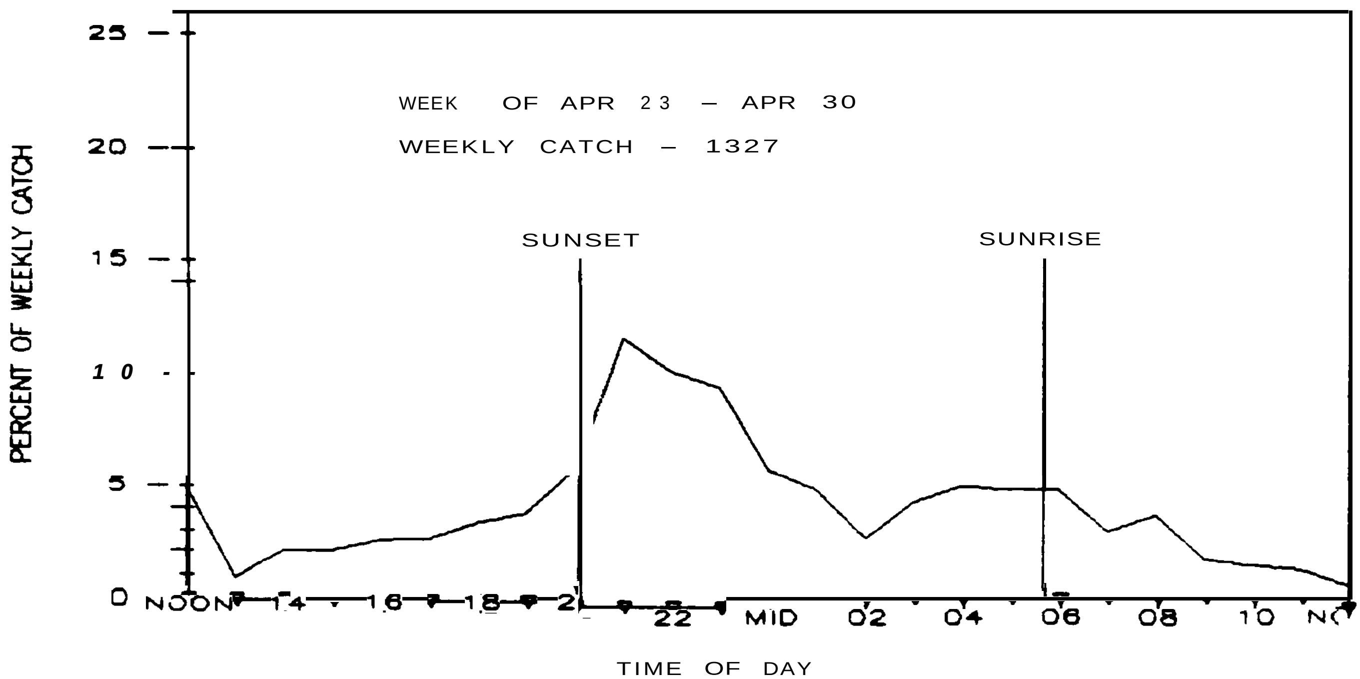


FIGURE 2

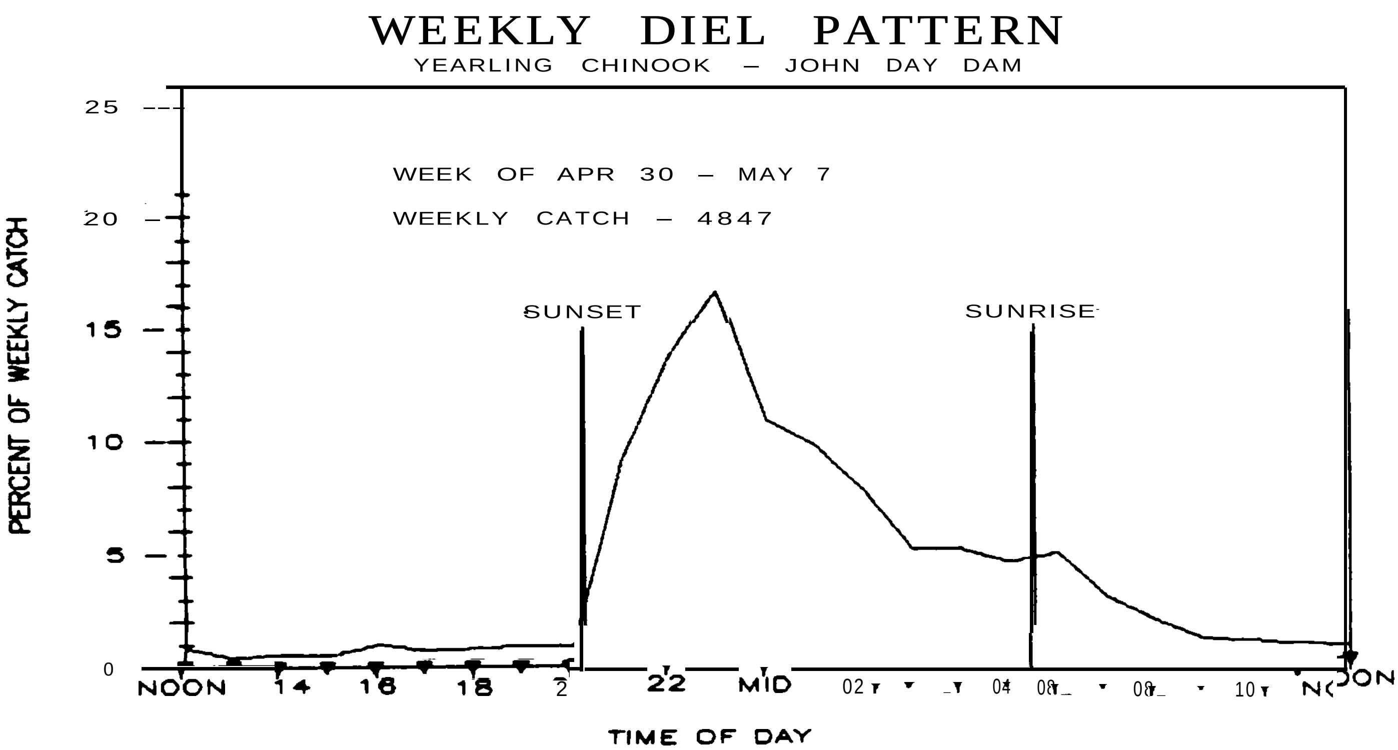
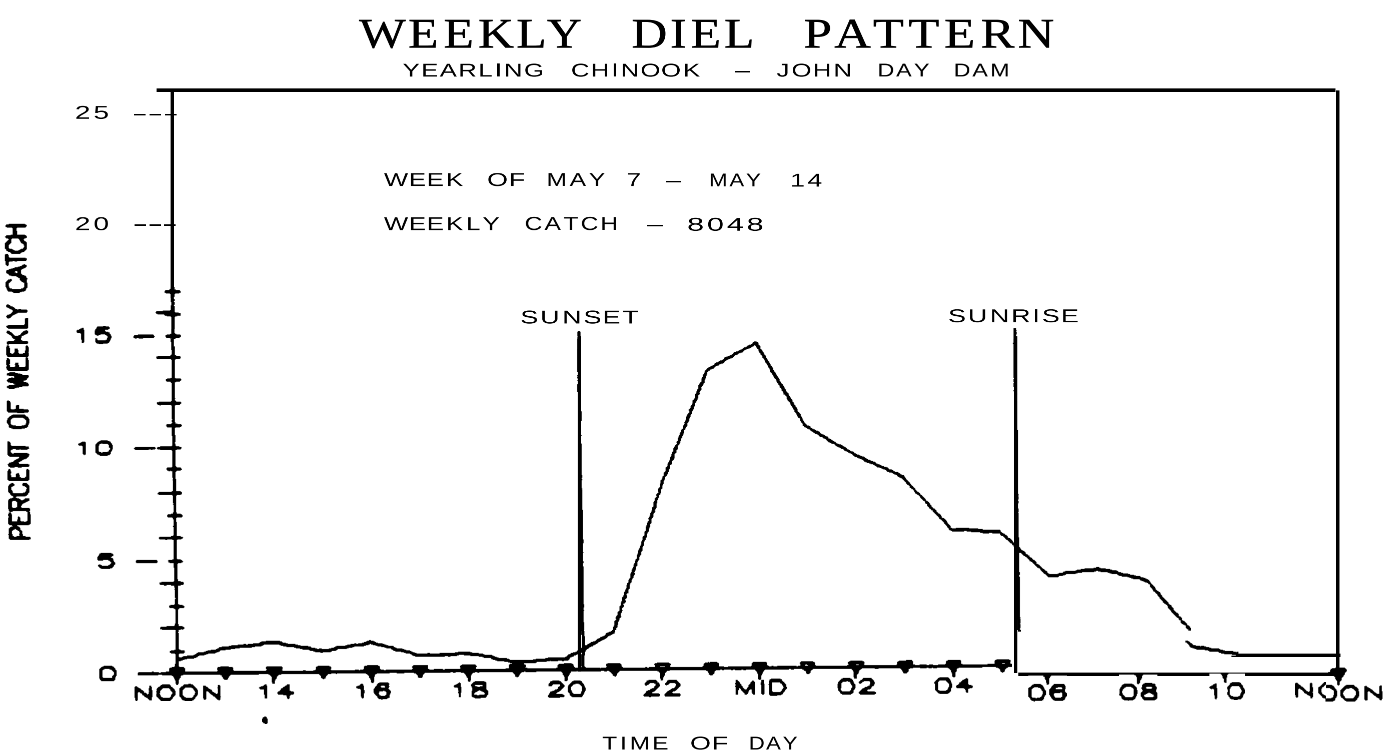


FIGURE 3



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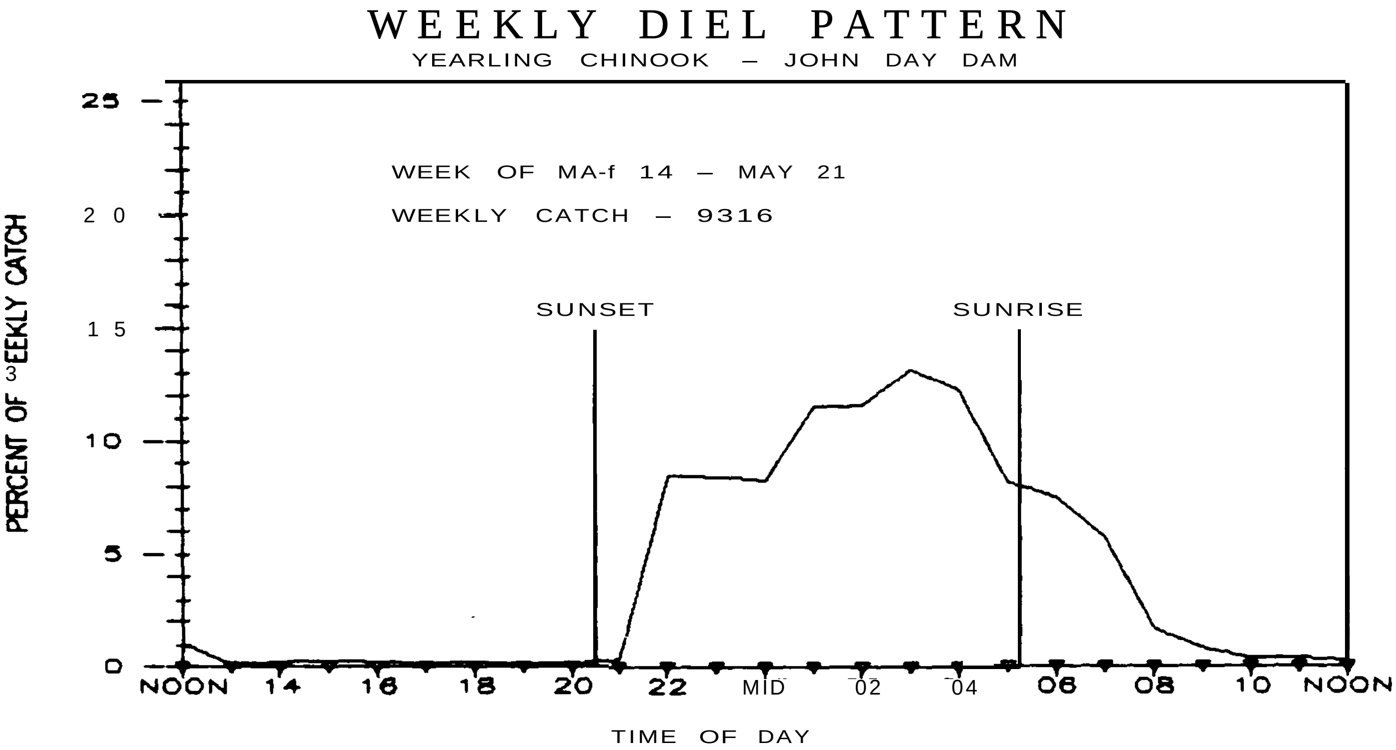
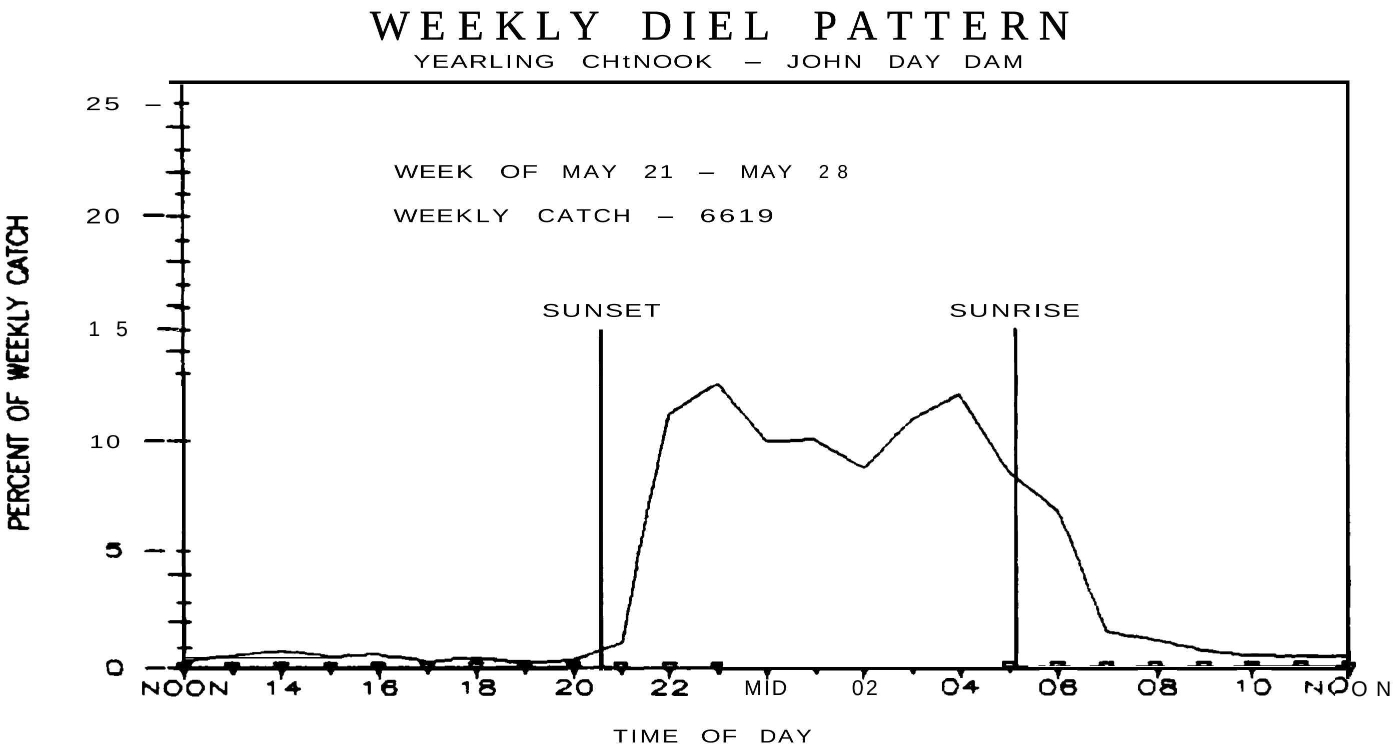


FIGURE 5



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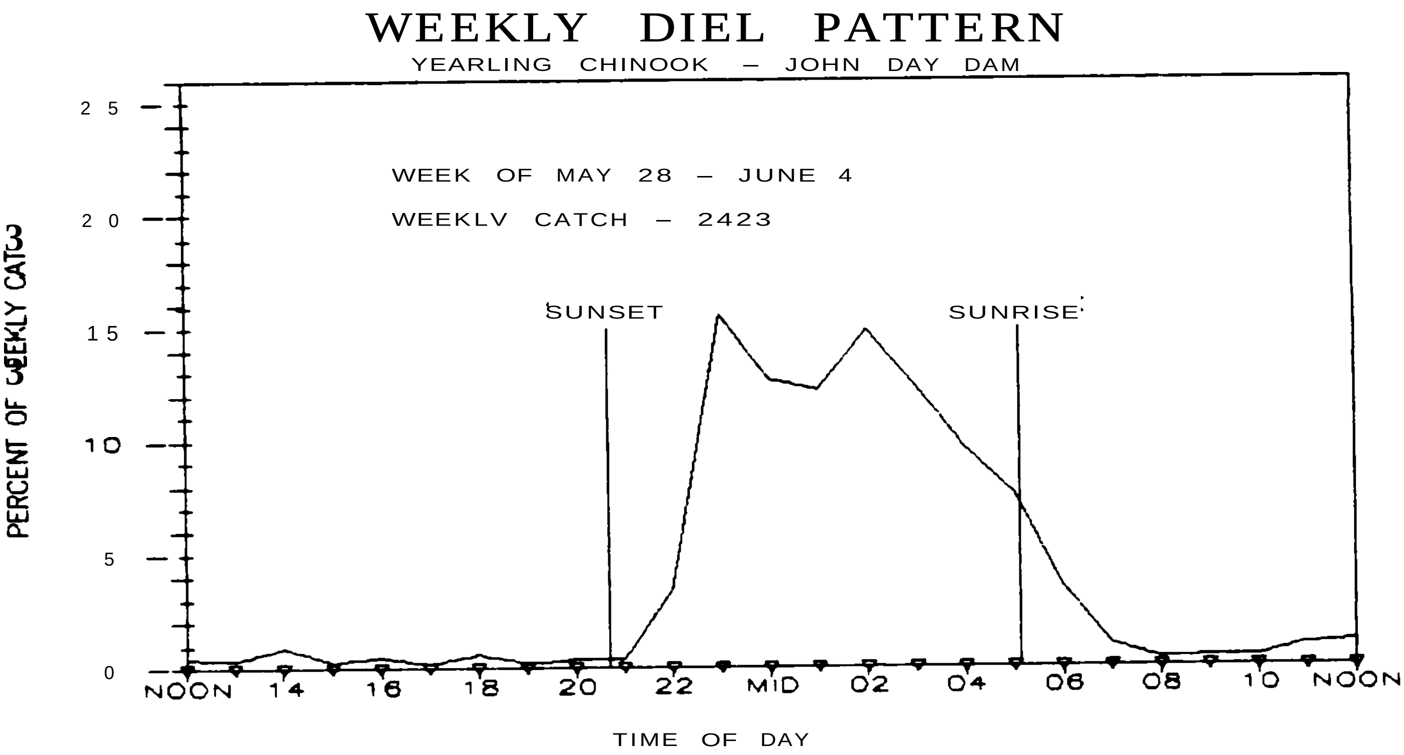


FIGURE 7

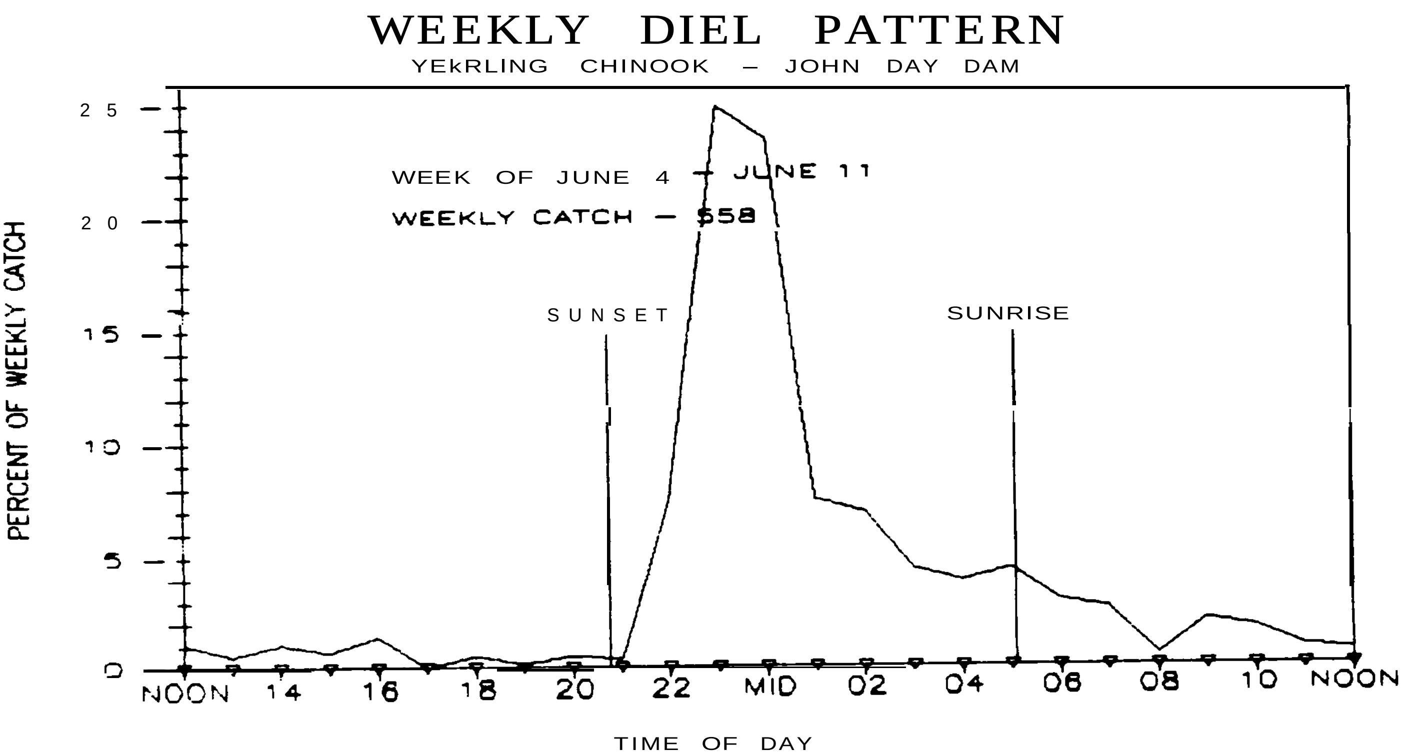
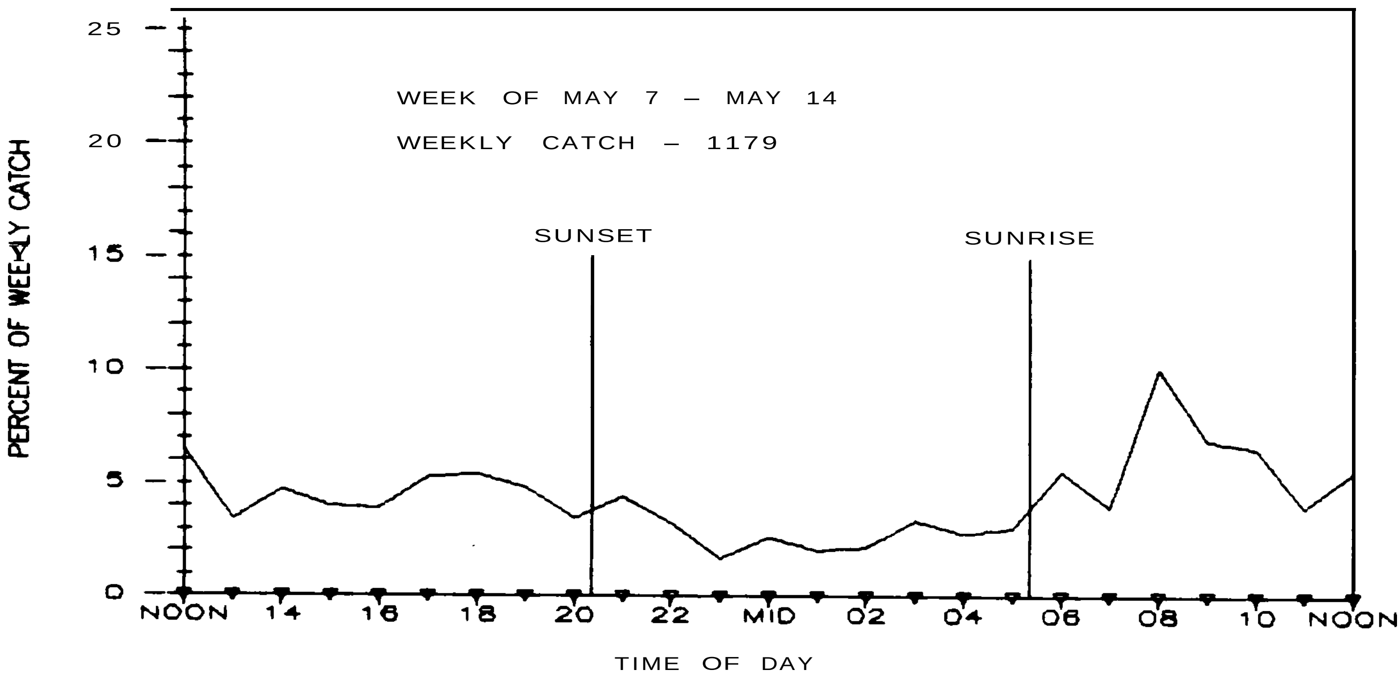


FIGURE 8

WEEKLY DIEL PATTERN

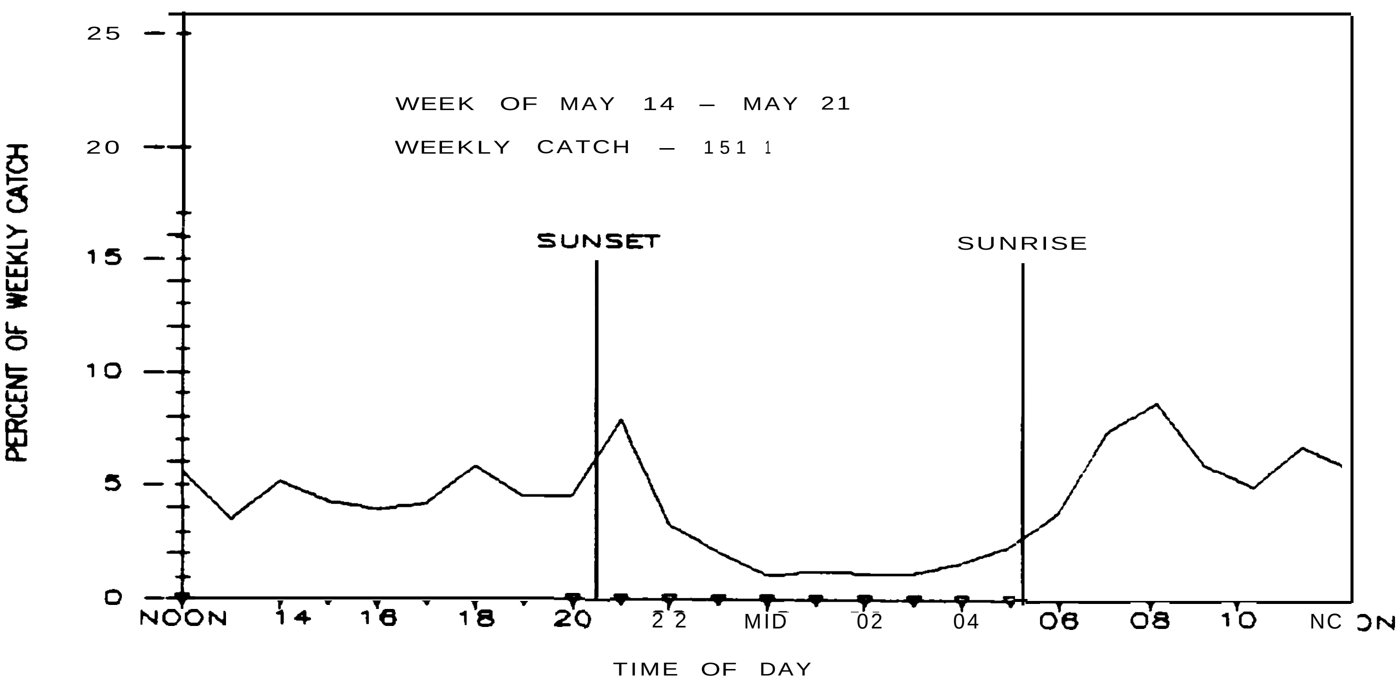
SUBYEARLING CHINOOK – JOHN DAY DAM



F I G U R E 9

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK – JOHN DAY DAM



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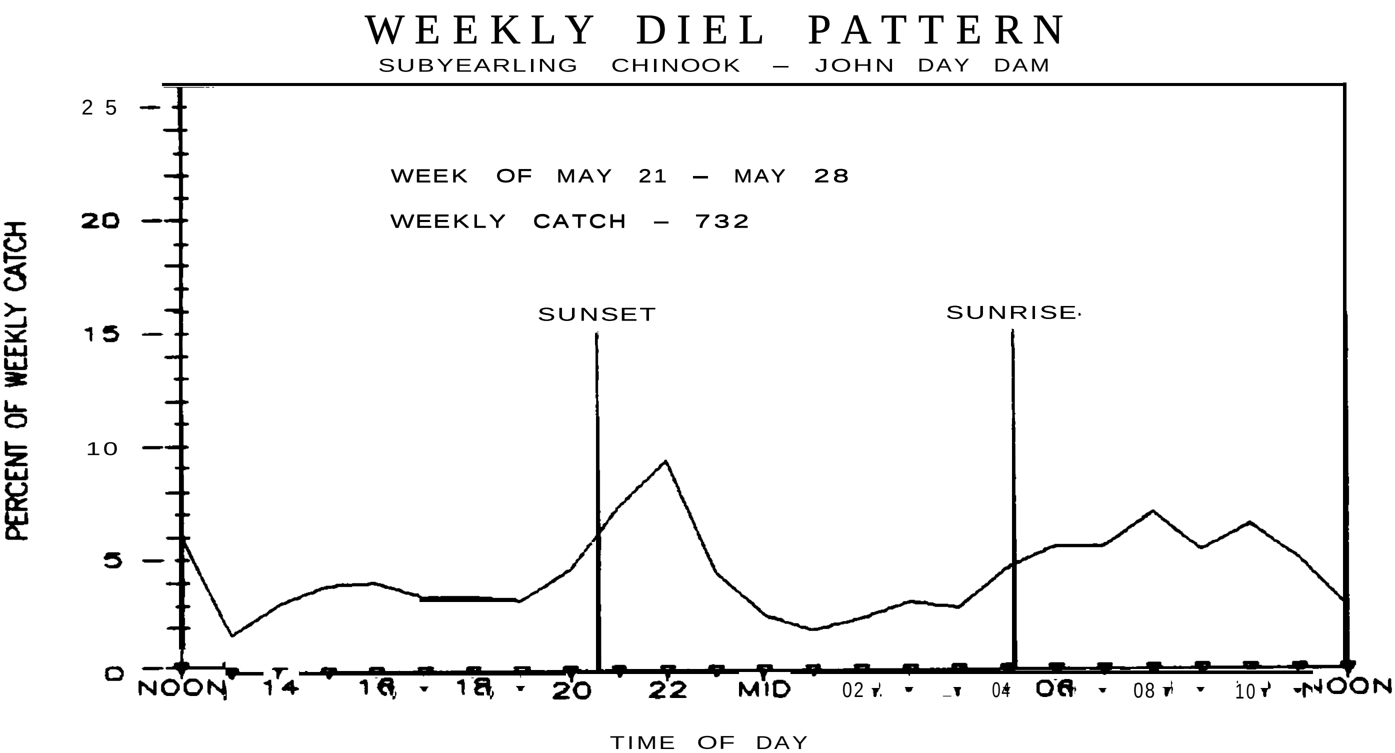


FIGURE 11

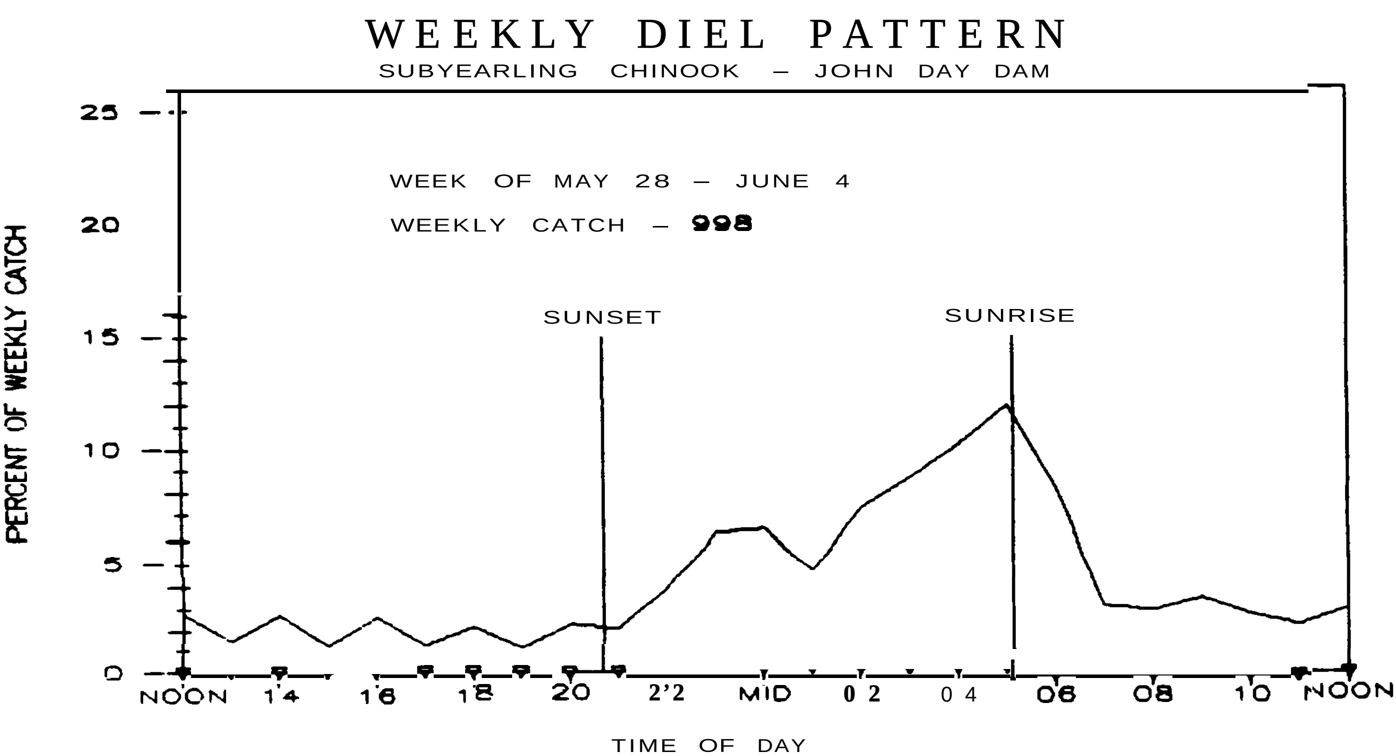


FIGURE 12

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK – JOHN DAY OAM

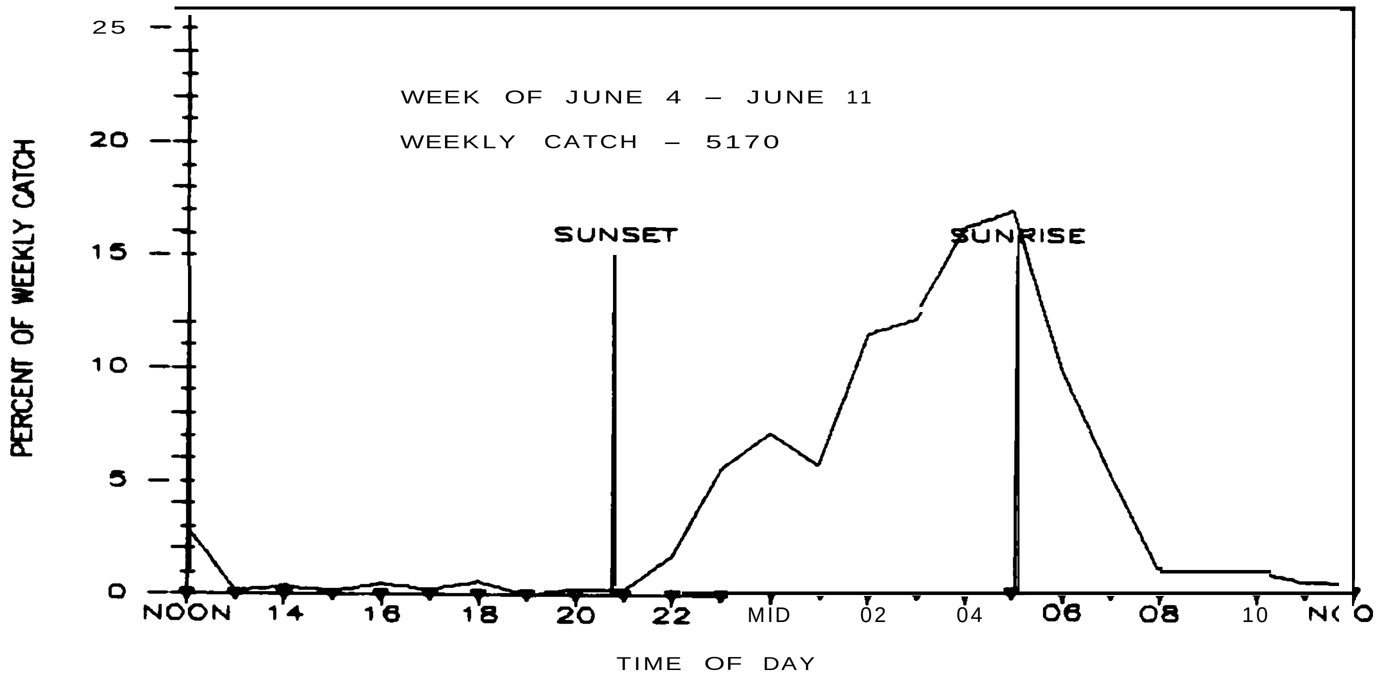
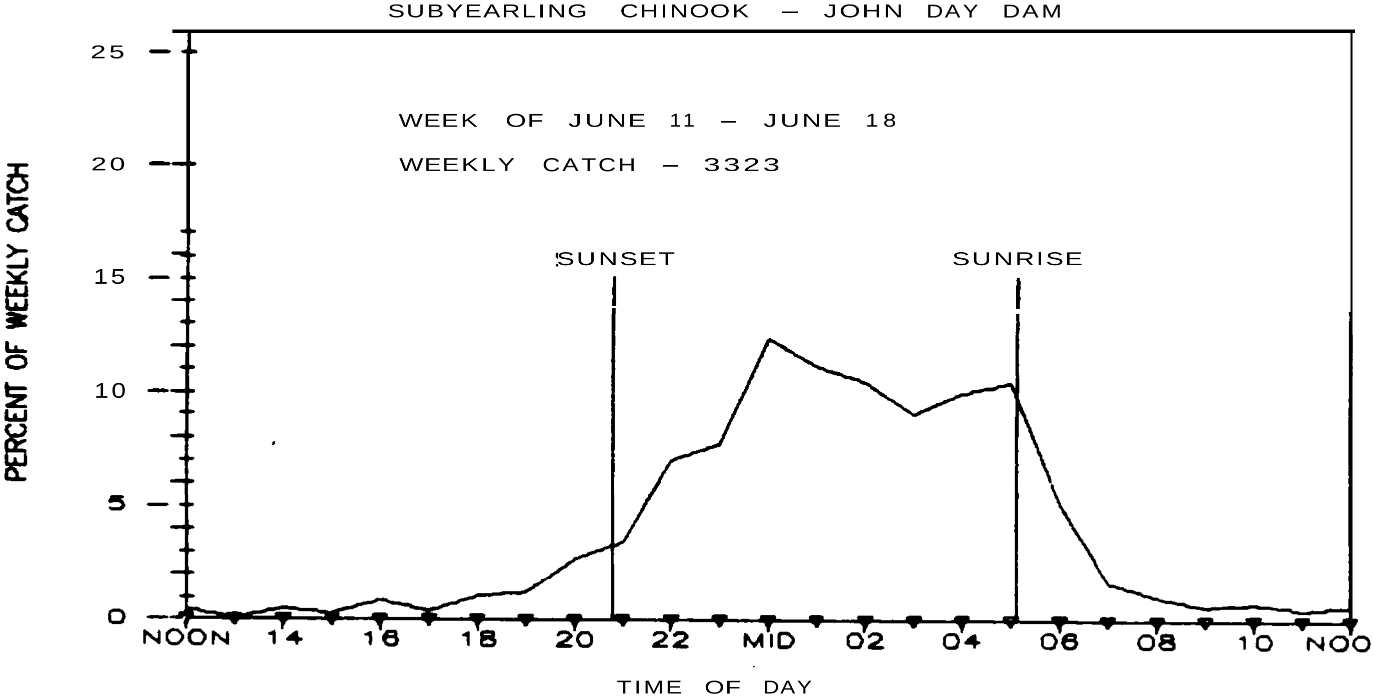


FIGURE 1 3

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK – JOHN DAY DAM



F I G U R E 1 4

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK – JOHN DAY DAM

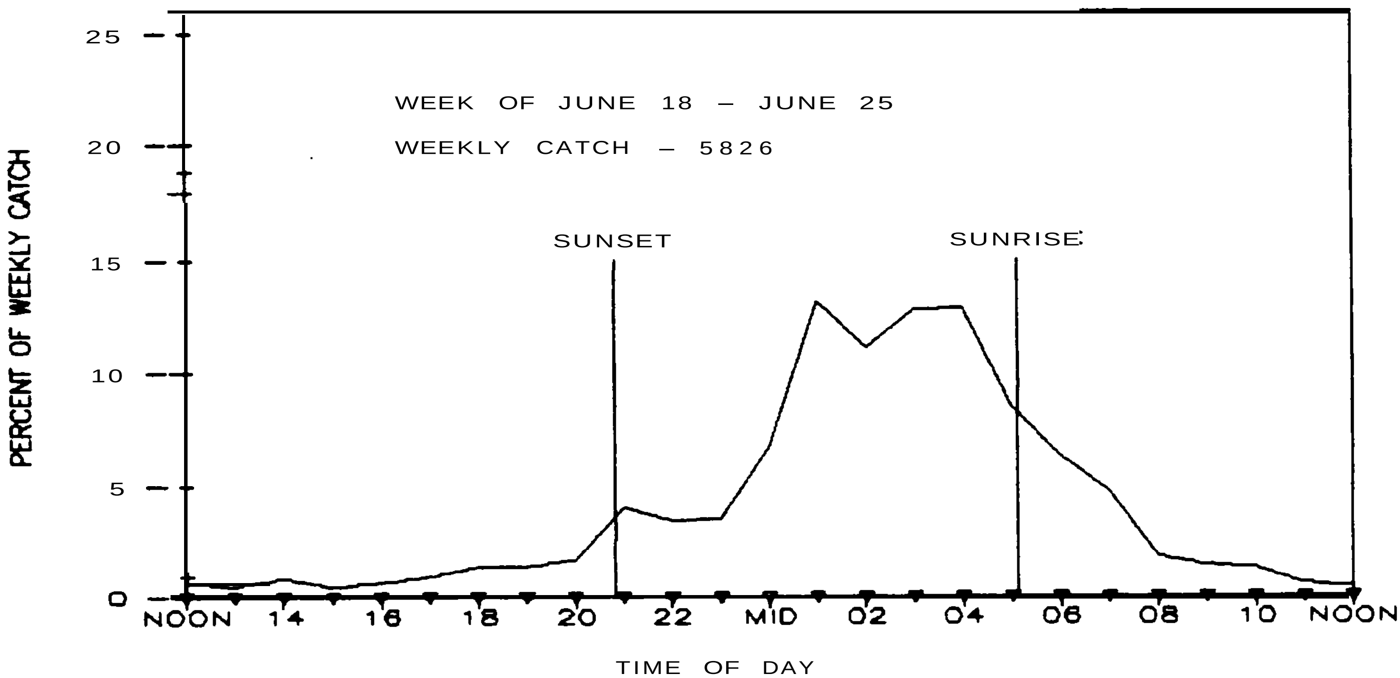


FIGURE 15

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK – JOHN DAY DAM

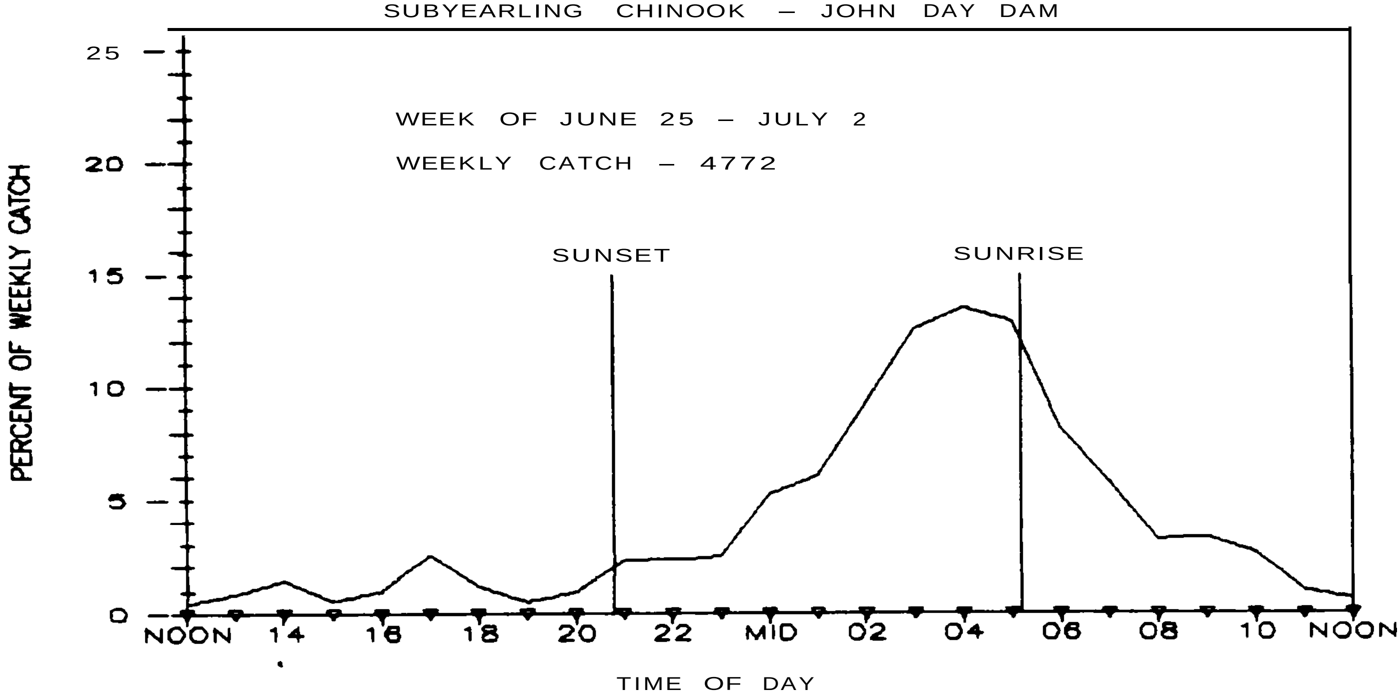


FIGURE 16

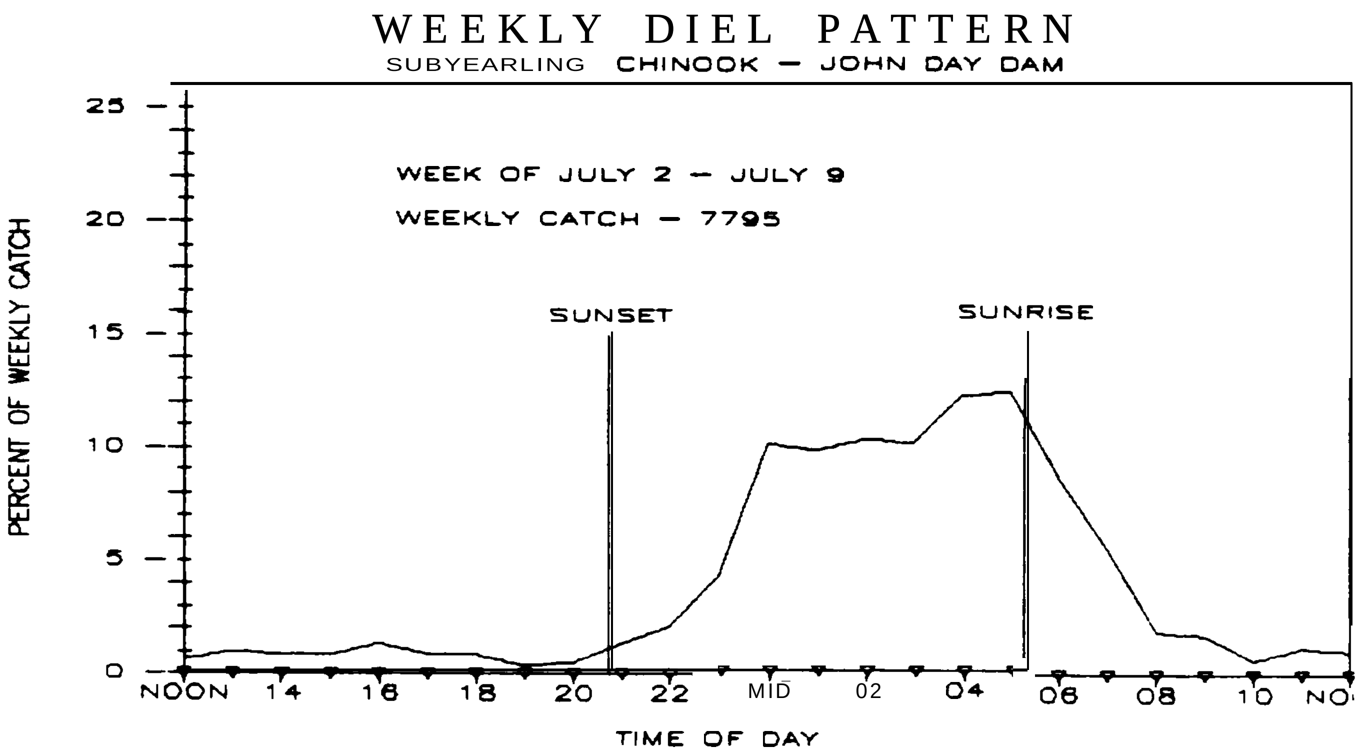


FIGURE 17

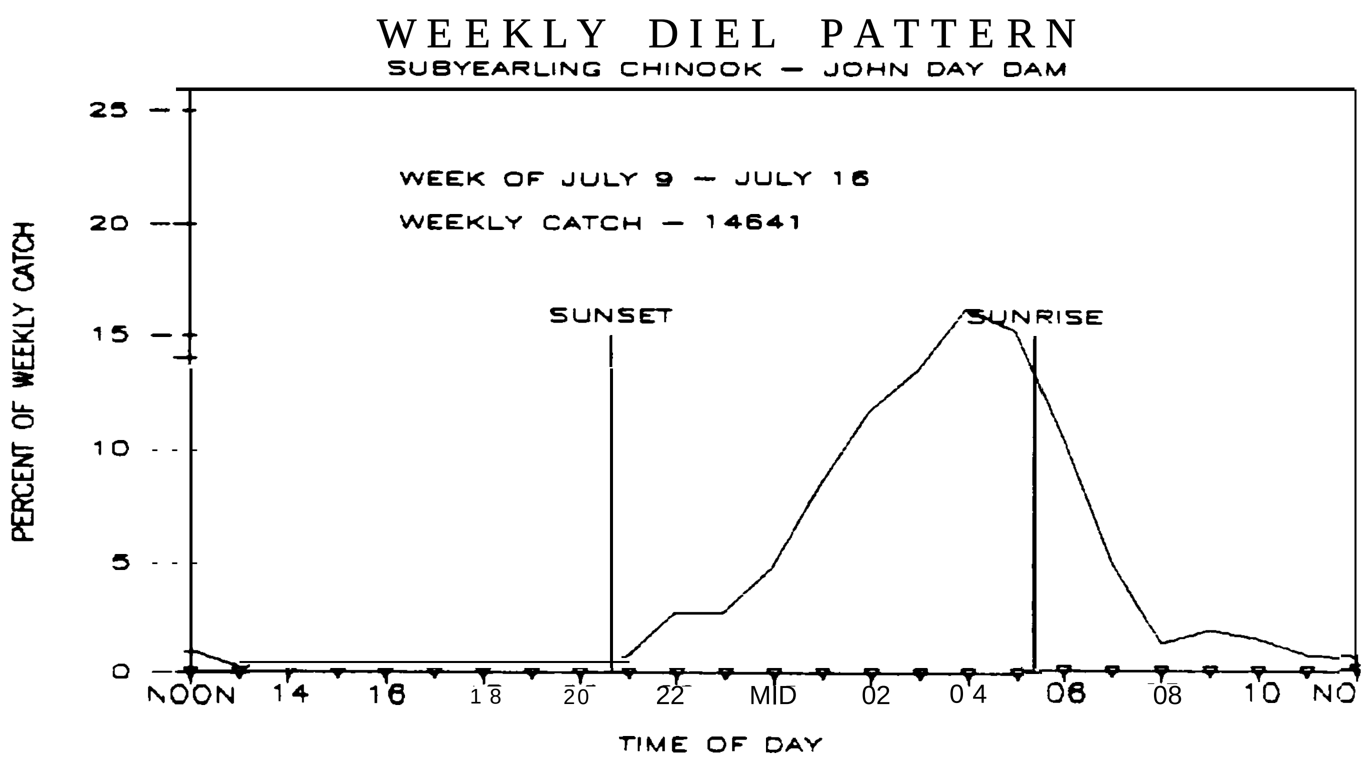


FIGURE 18

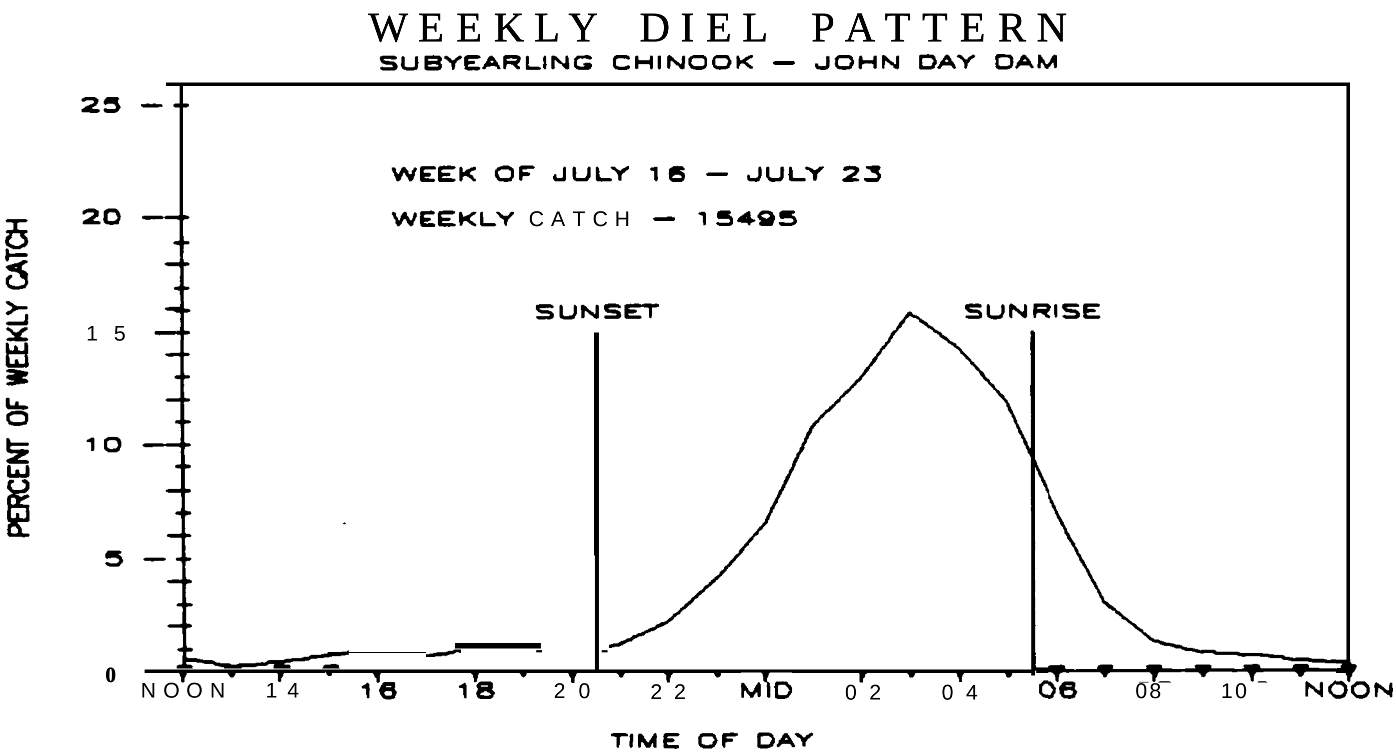


FIGURE 19

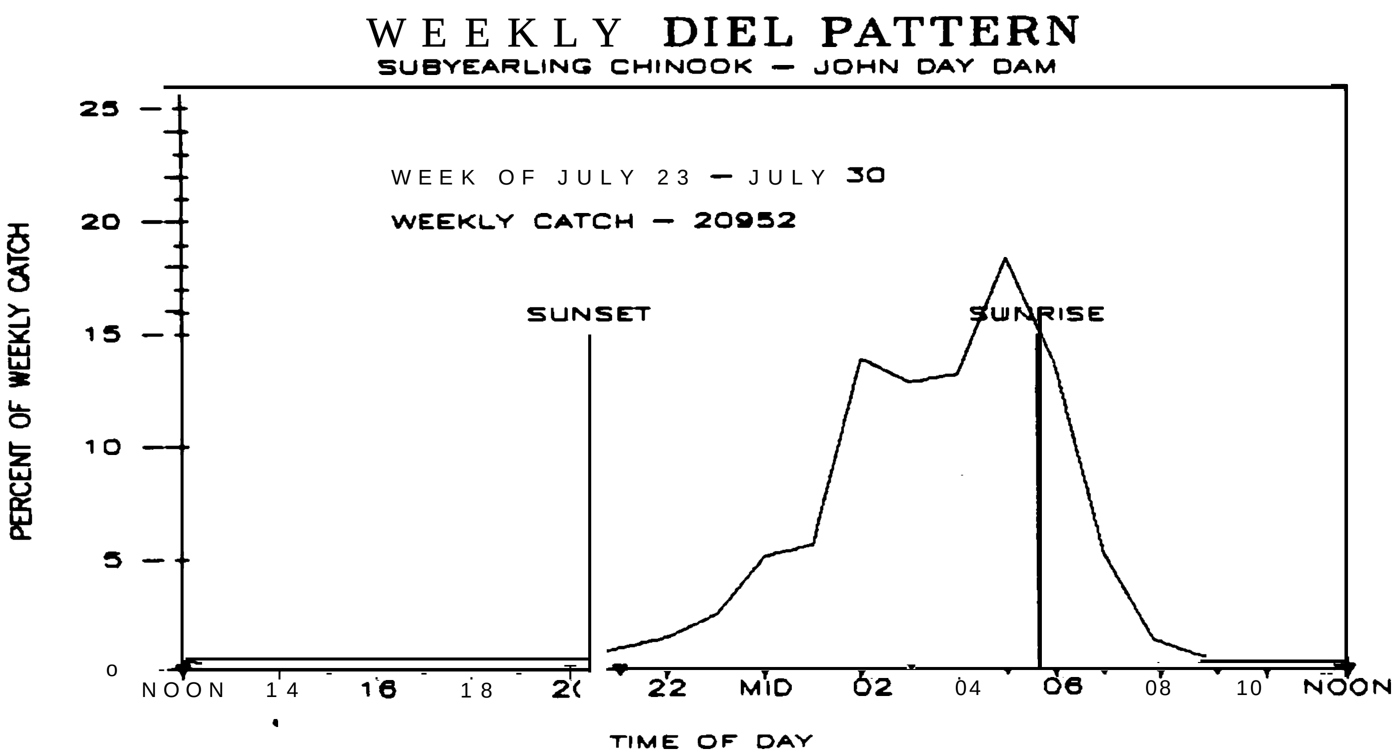


FIGURE 20

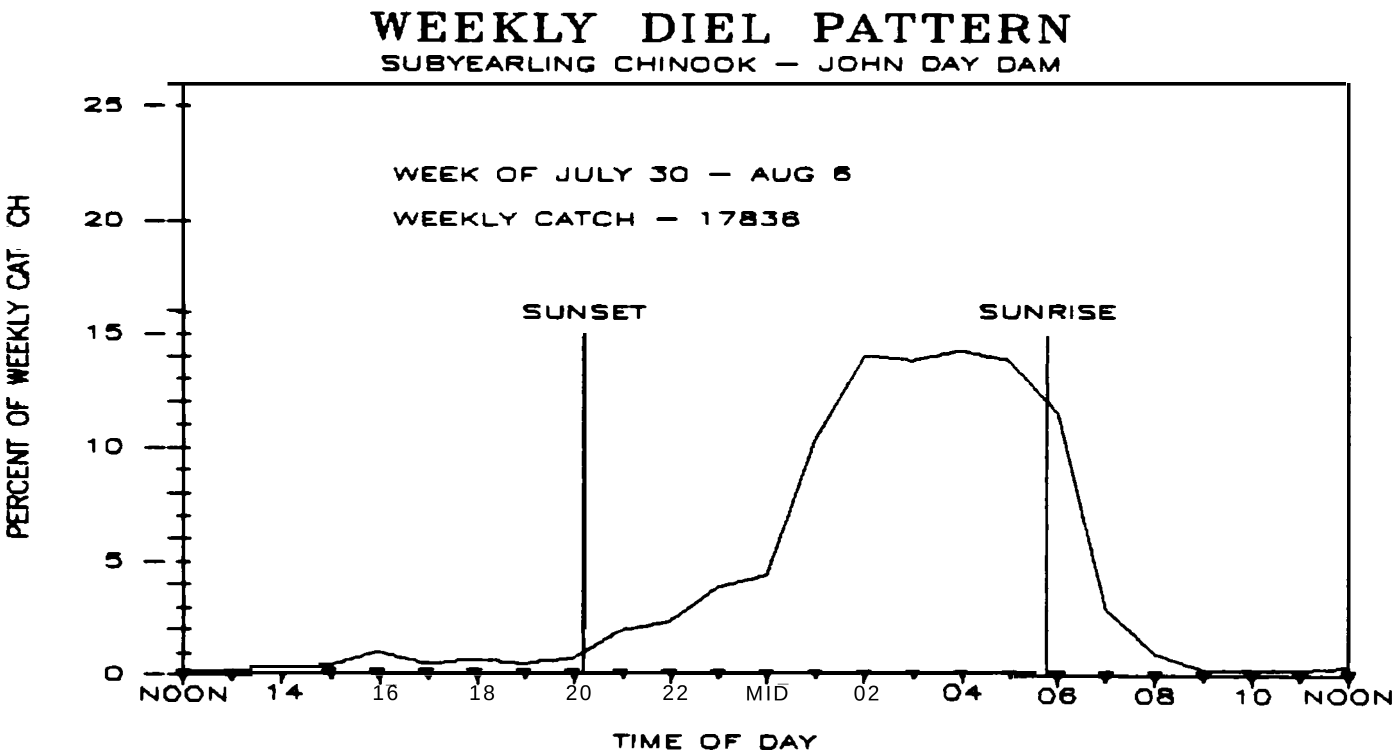


FIGURE 21

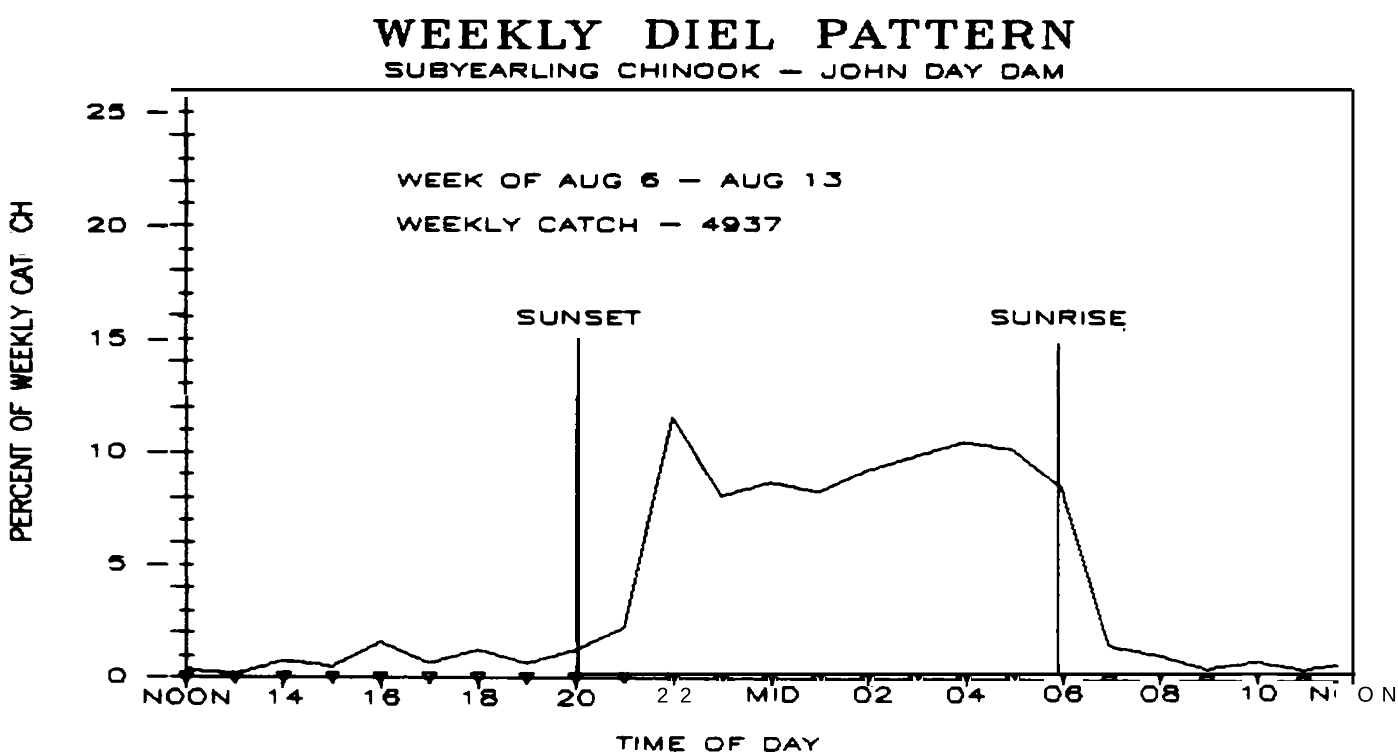


FIGURE 22

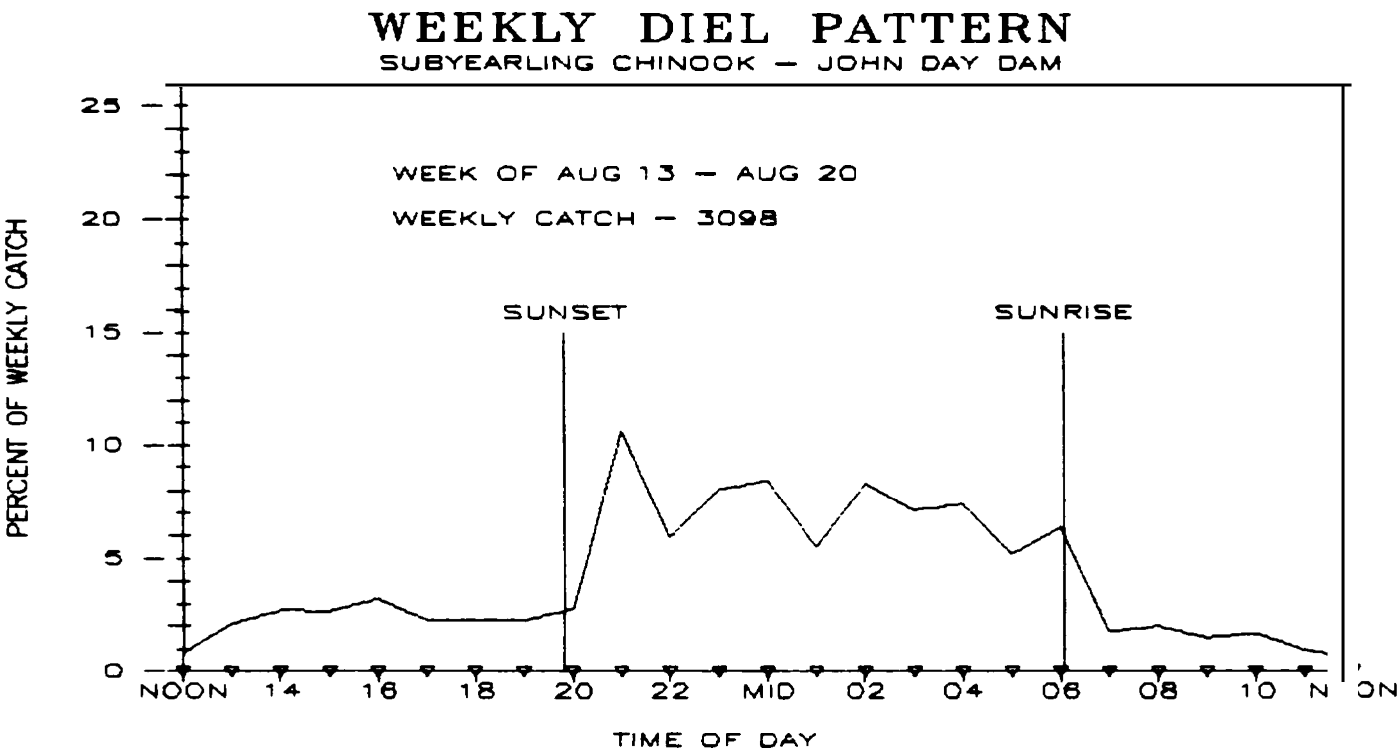


FIGURE 23

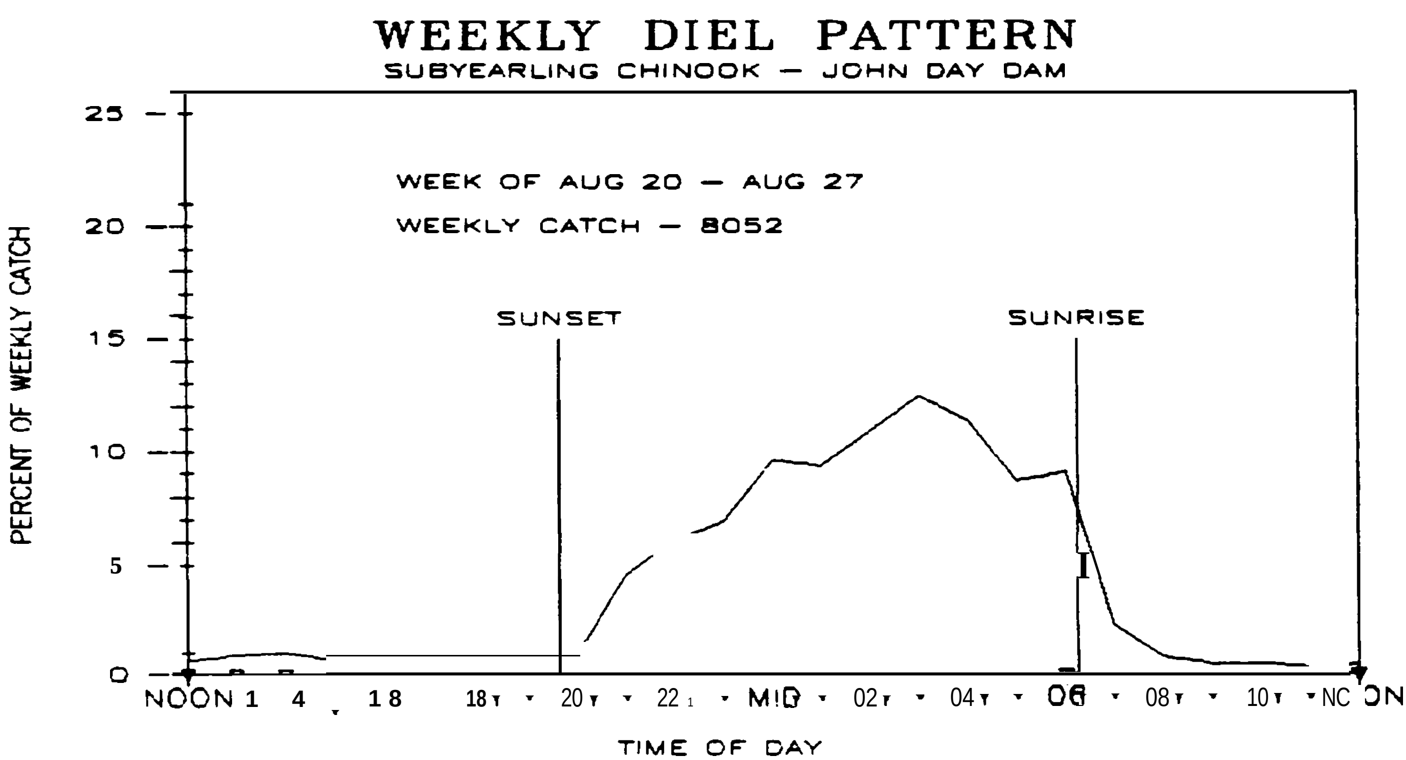


FIGURE 24

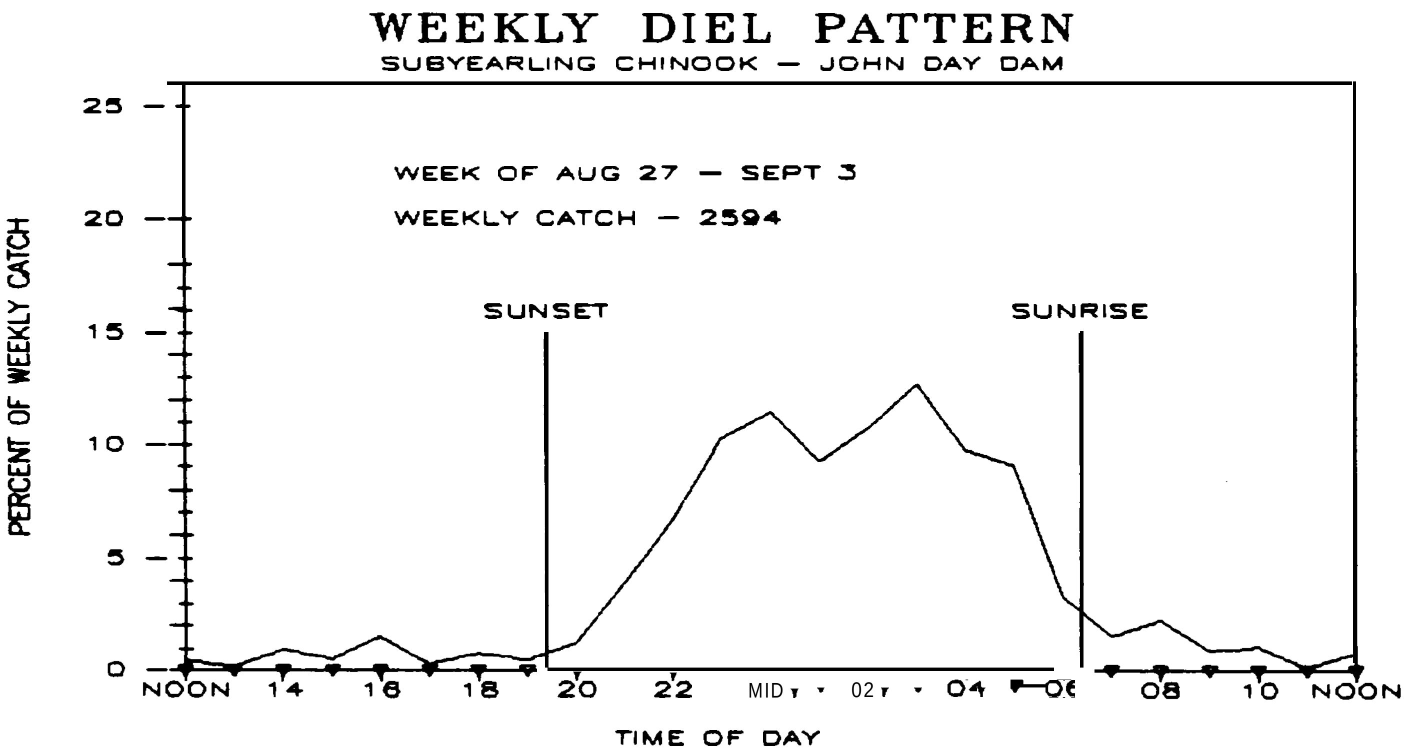


FIGURE 2 5

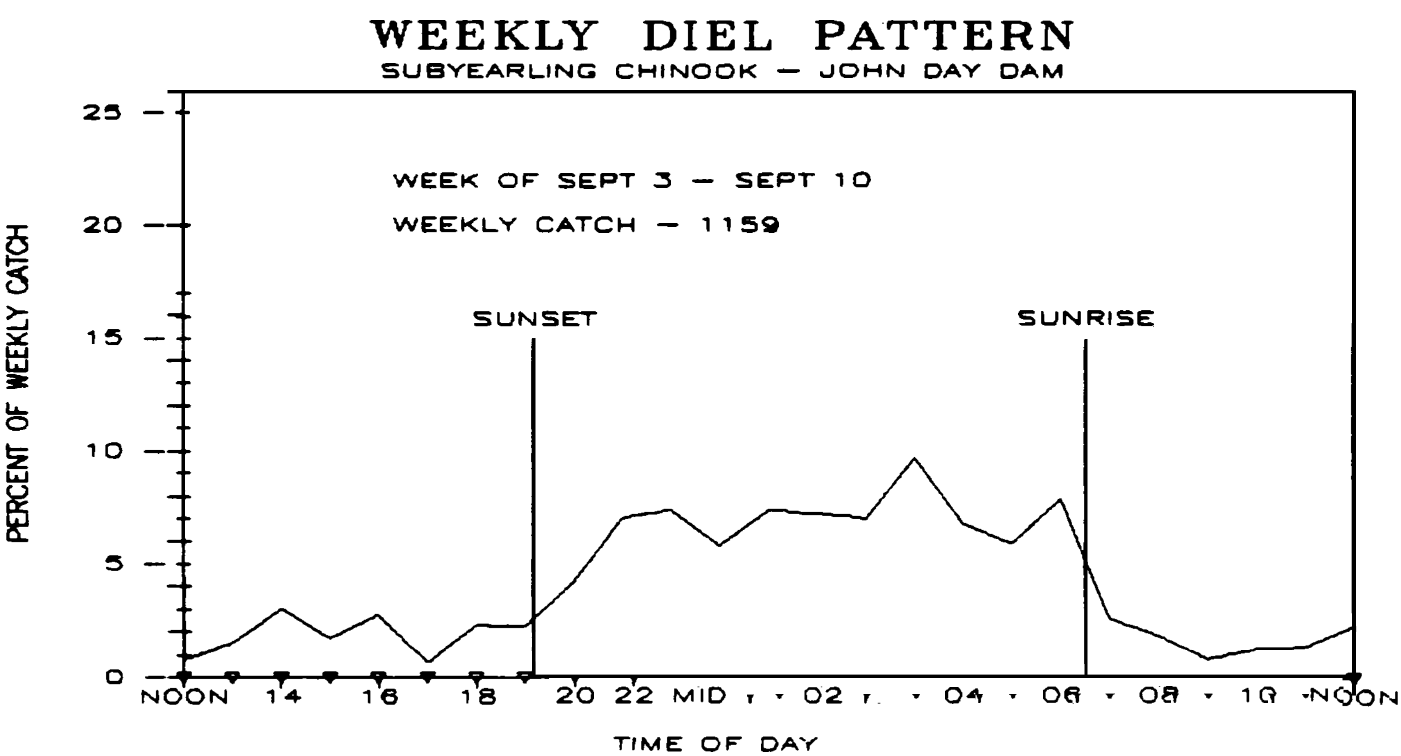


FIGURE 26

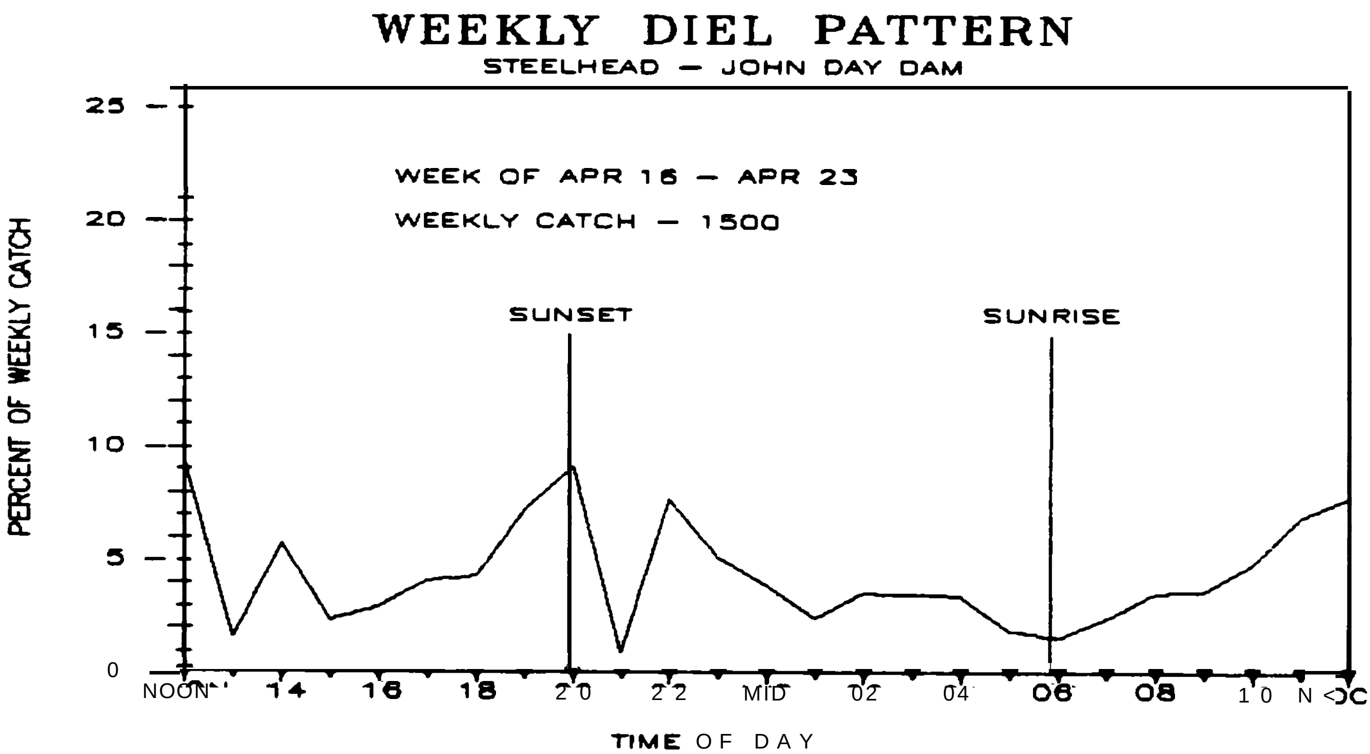


FIGURE 27

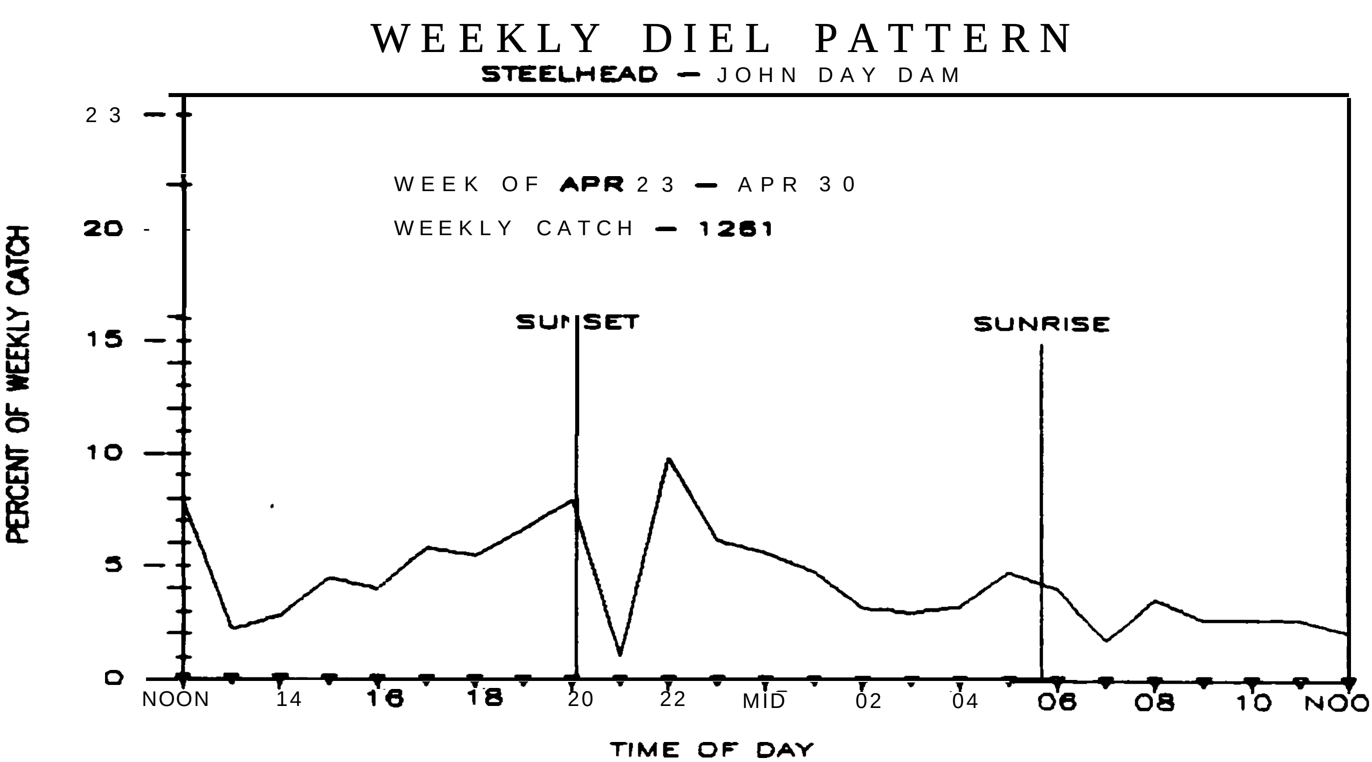
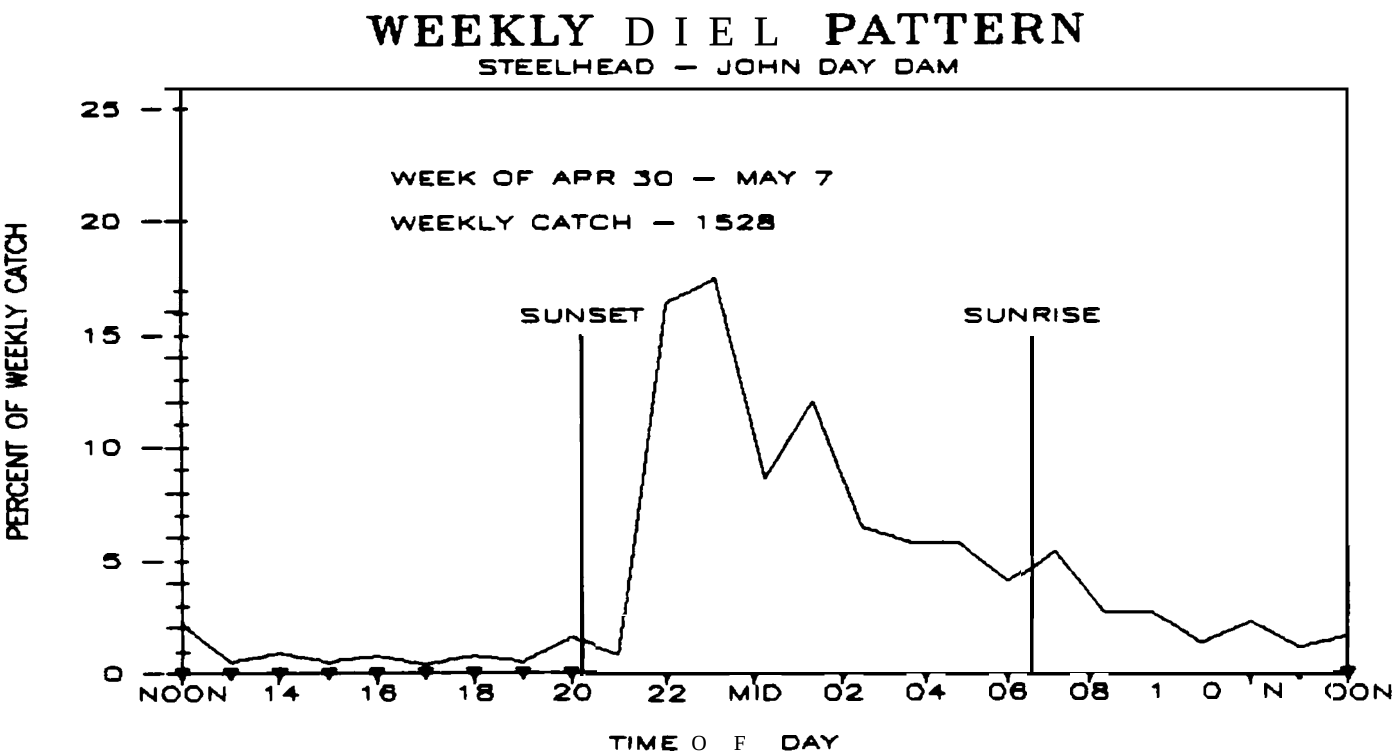


FIGURE 28



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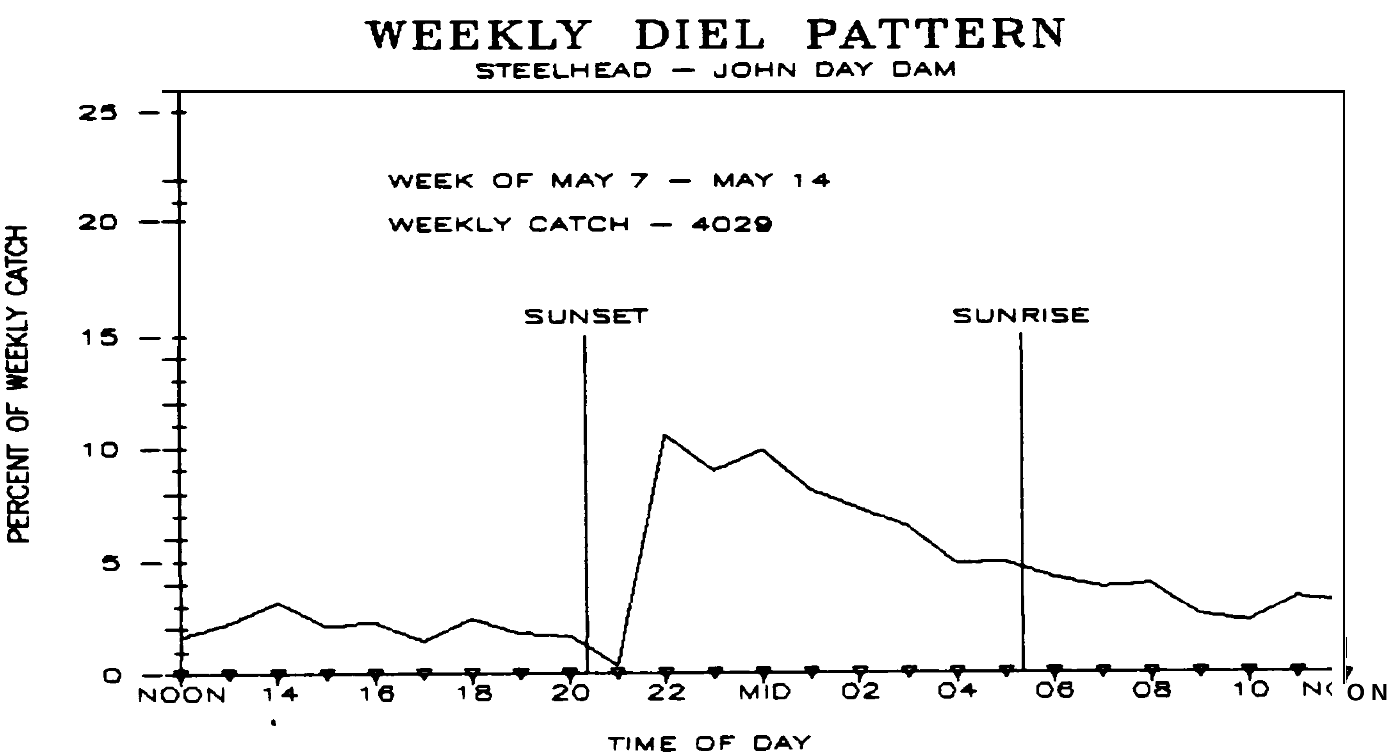


FIGURE 30

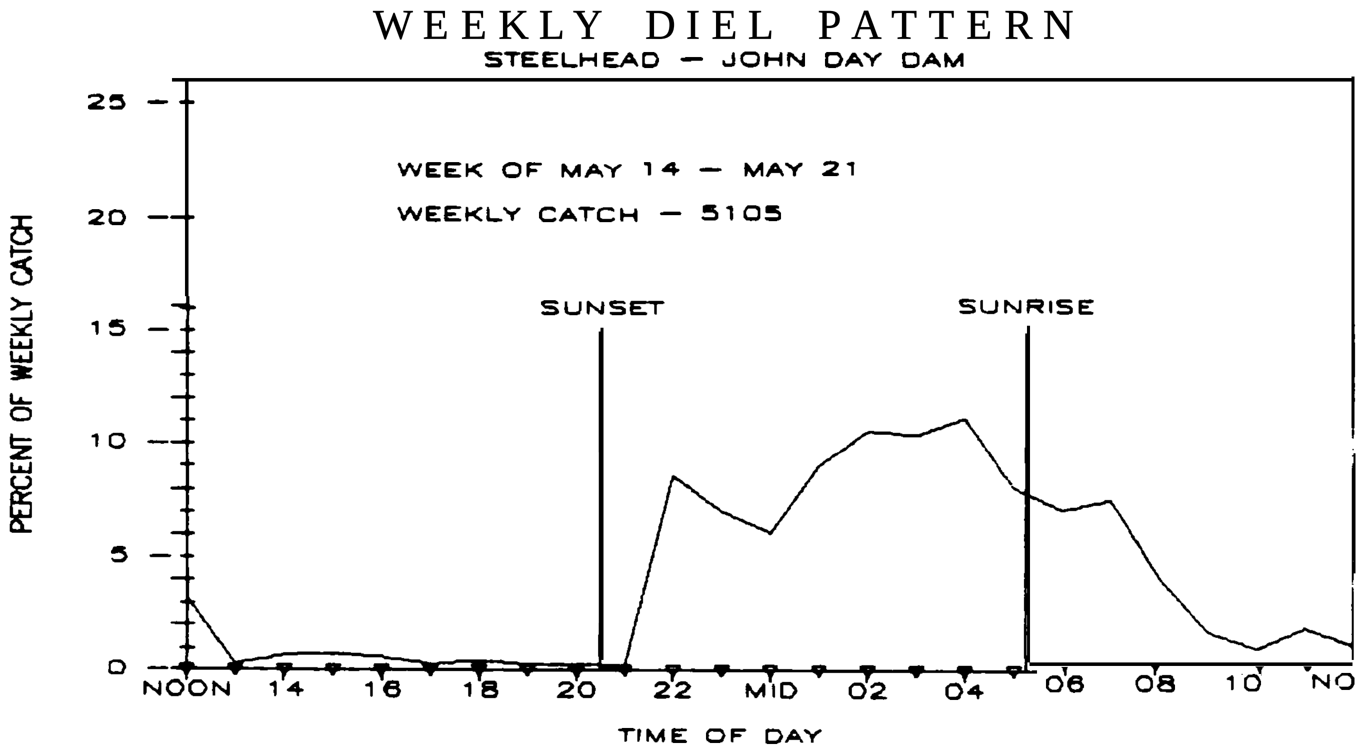


FIGURE 31

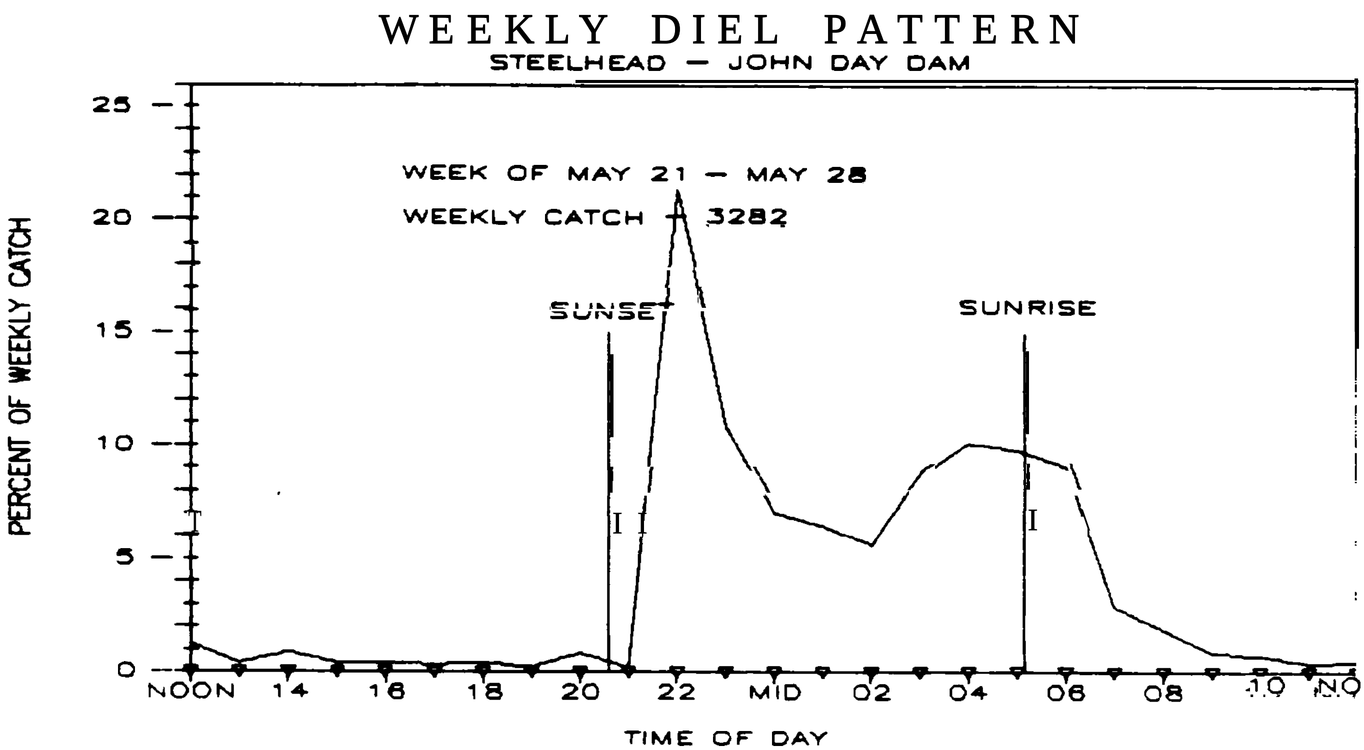


FIGURE 32

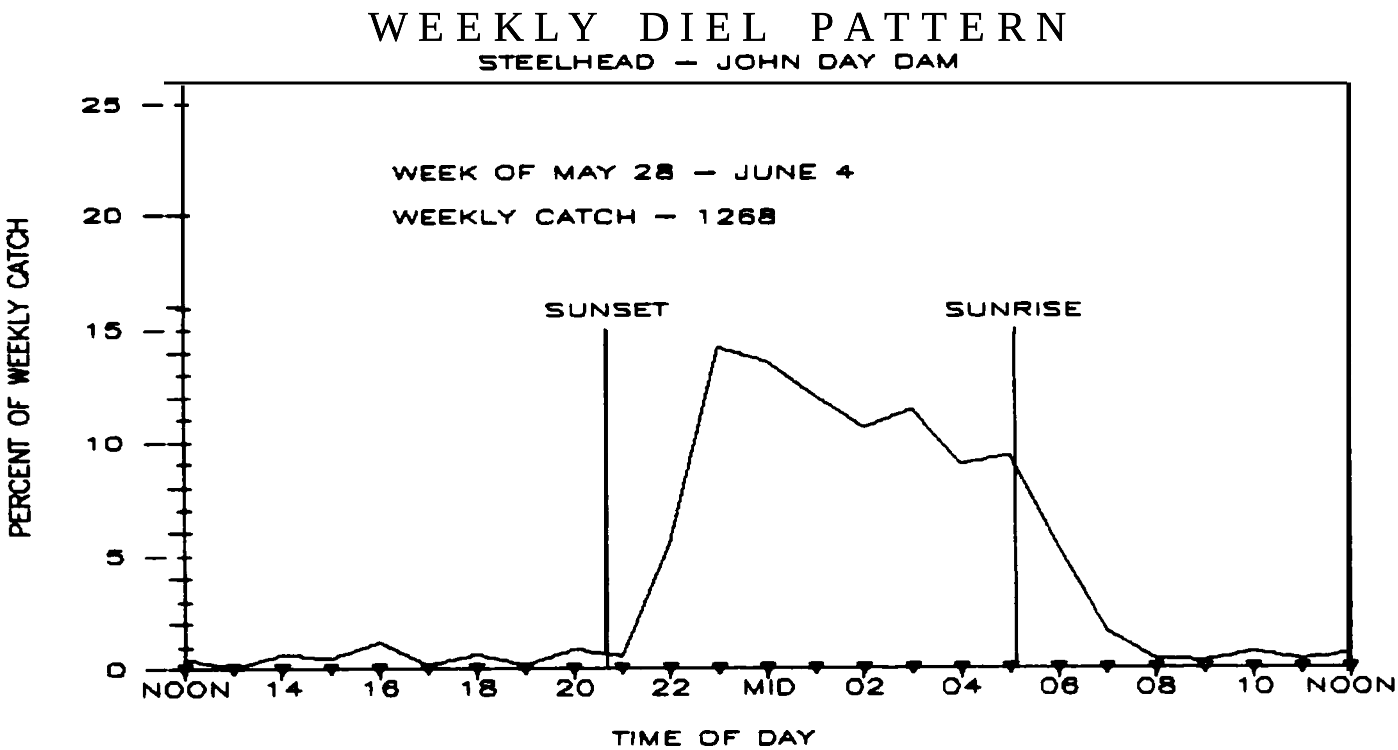

WEEKLY DIEL PATTERN
STEELHEAD — JOHN DAY DAM
WEEK OF MAY 28 — JUNE 4
WEEKLY CATCH — 1268
SUNSET
SUNRISE
PERCENT OF WEEKLY CATCH
25
20
15
10
5
0
NOON 14 16 18 20 22 MID 02 04 06 08 10 NOON
TIME OF DAY

FIGURE 3 3

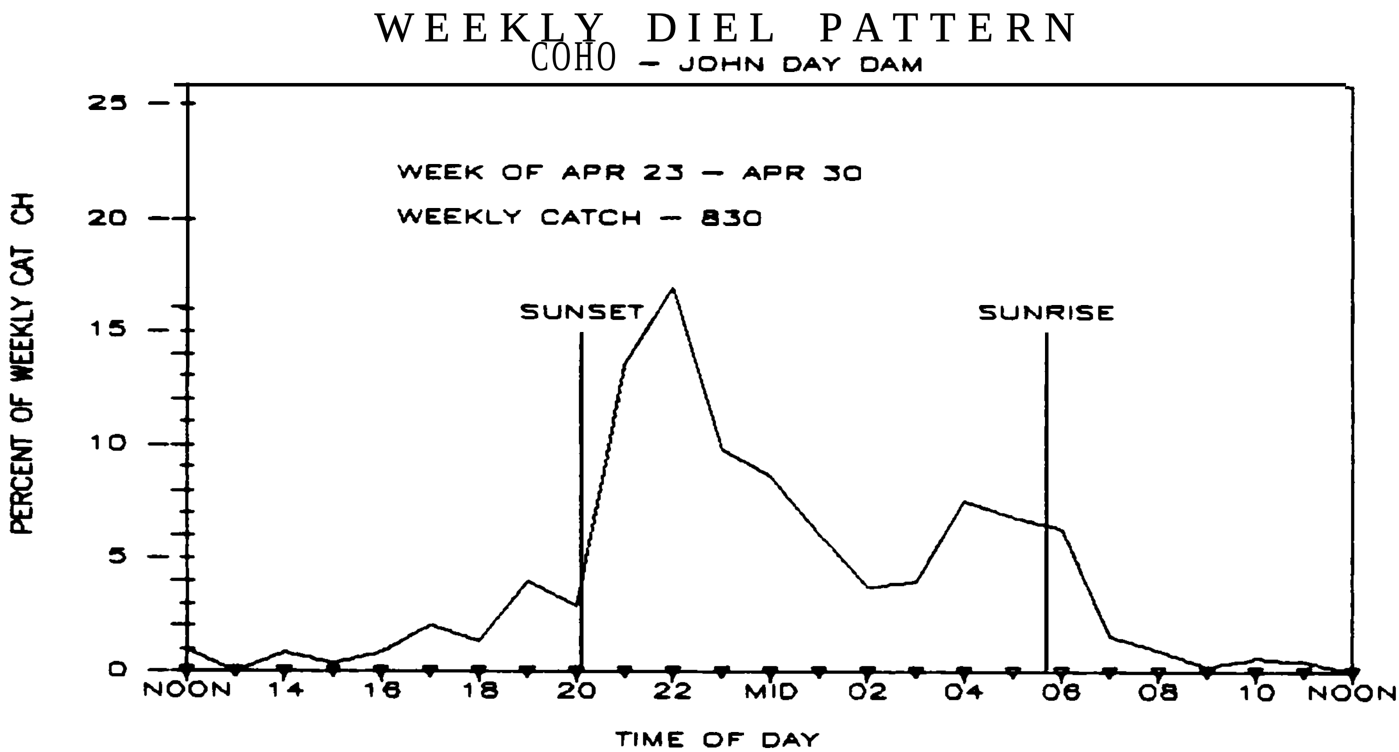


FIGURE 3 4

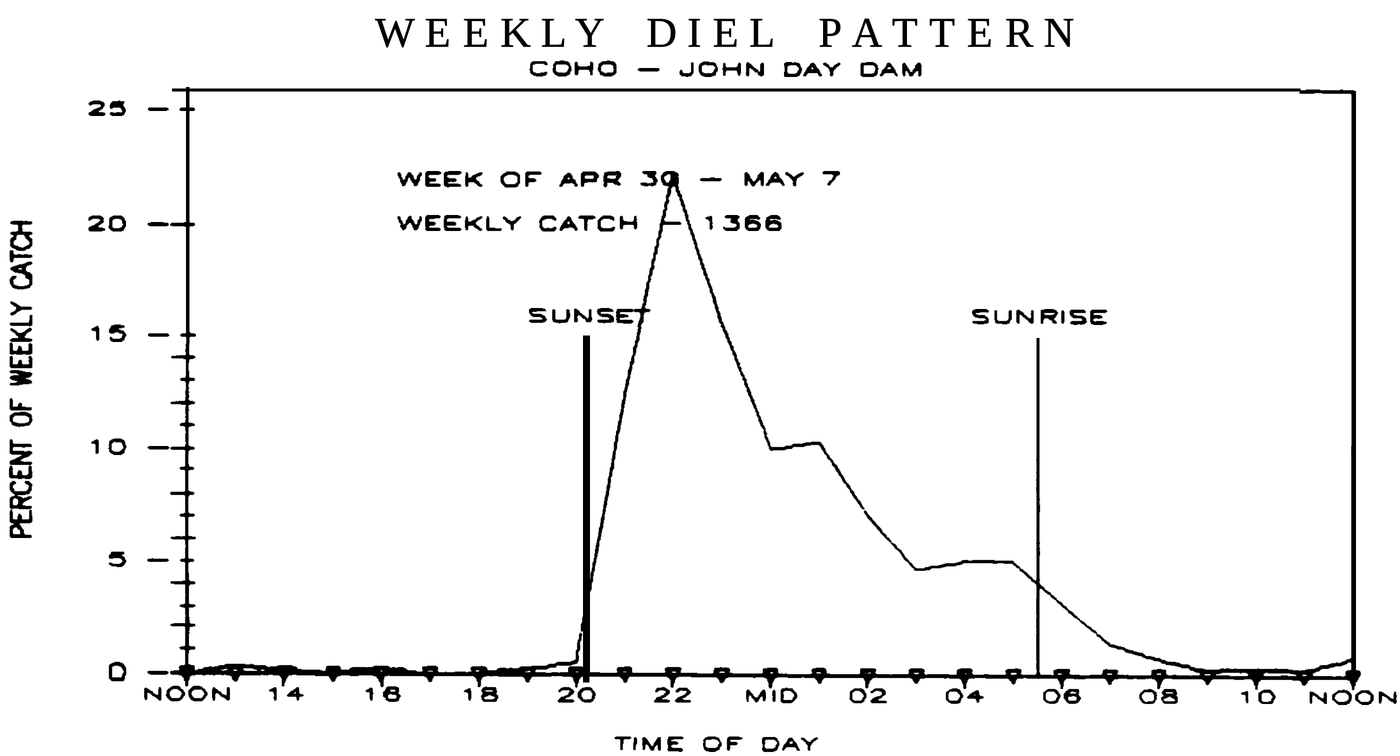


FIGURE 3 5

WEEKLY DIEL PATTERN

COHO — JOHN DAY DAM

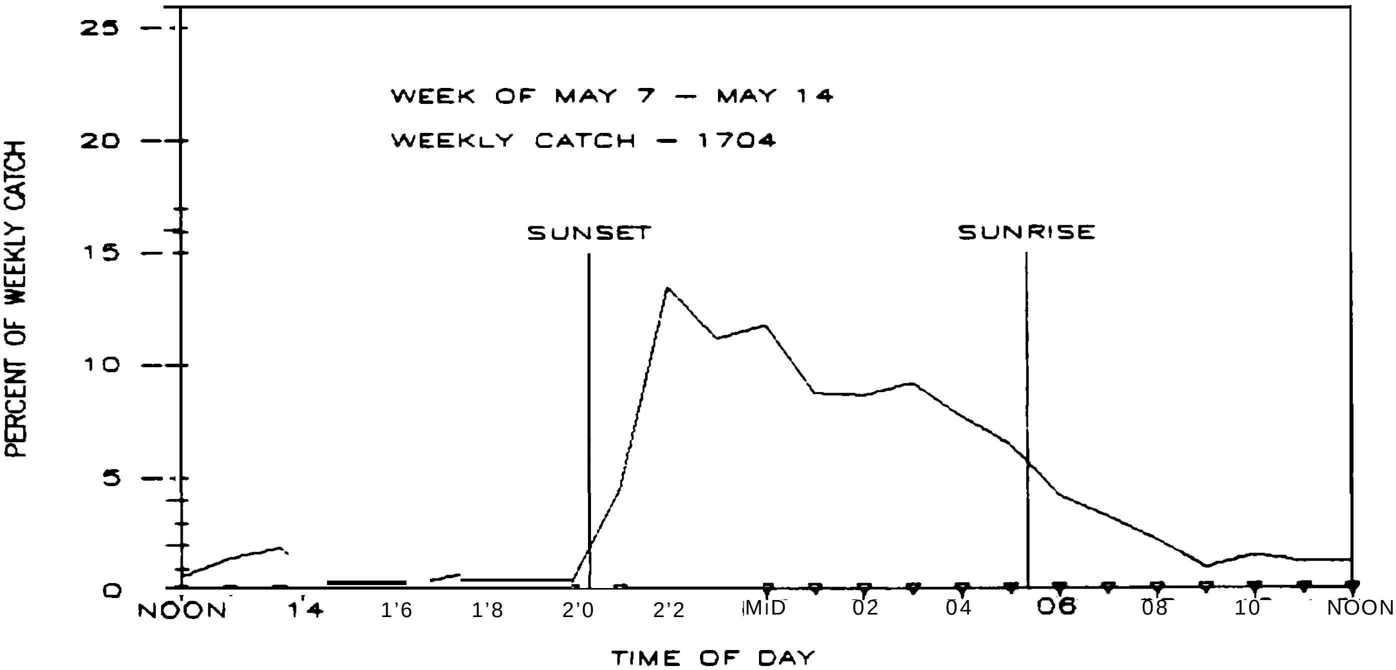


FIGURE 36

WEEKLY DIEL PATTERN

COHO — JOHN DAY DAM

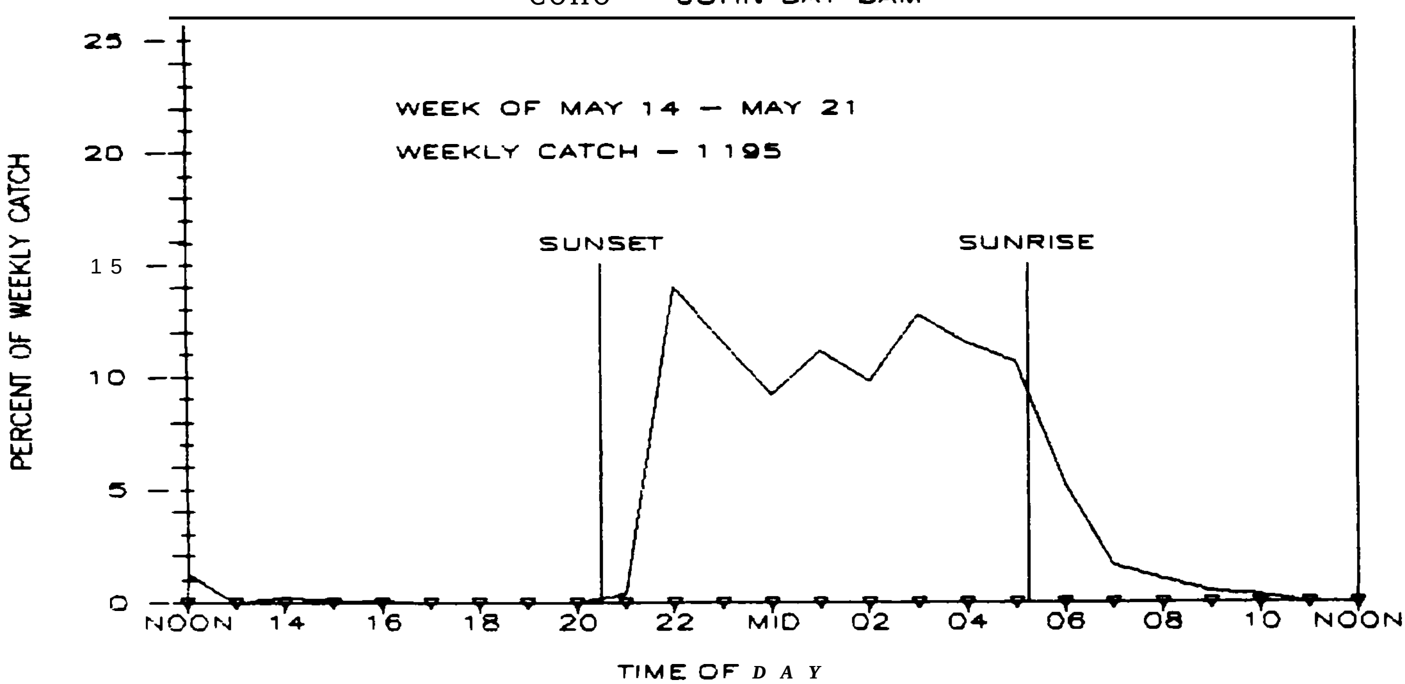


FIGURE 37

WEEKLY DIEL PATTERN
COHO — JOHN DAY DAM

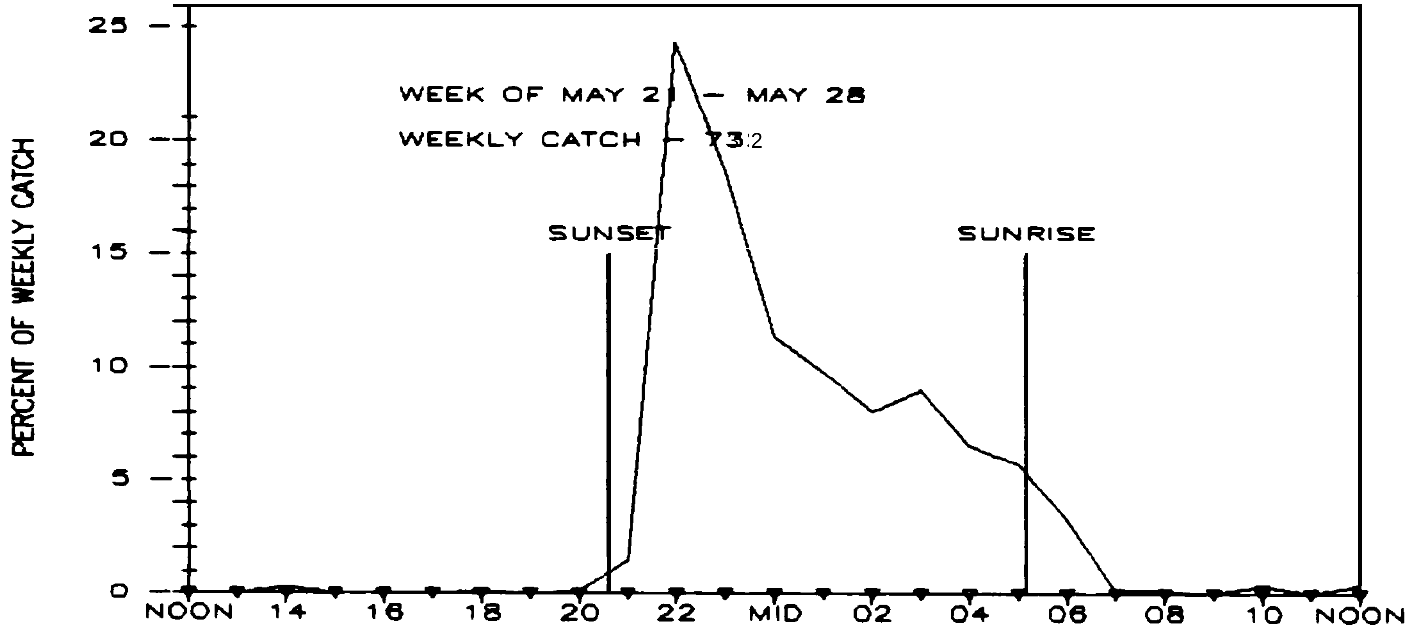


FIGURE 38

WEEKLY DIEL PATTERN
COHO — JOHN DAY DAM

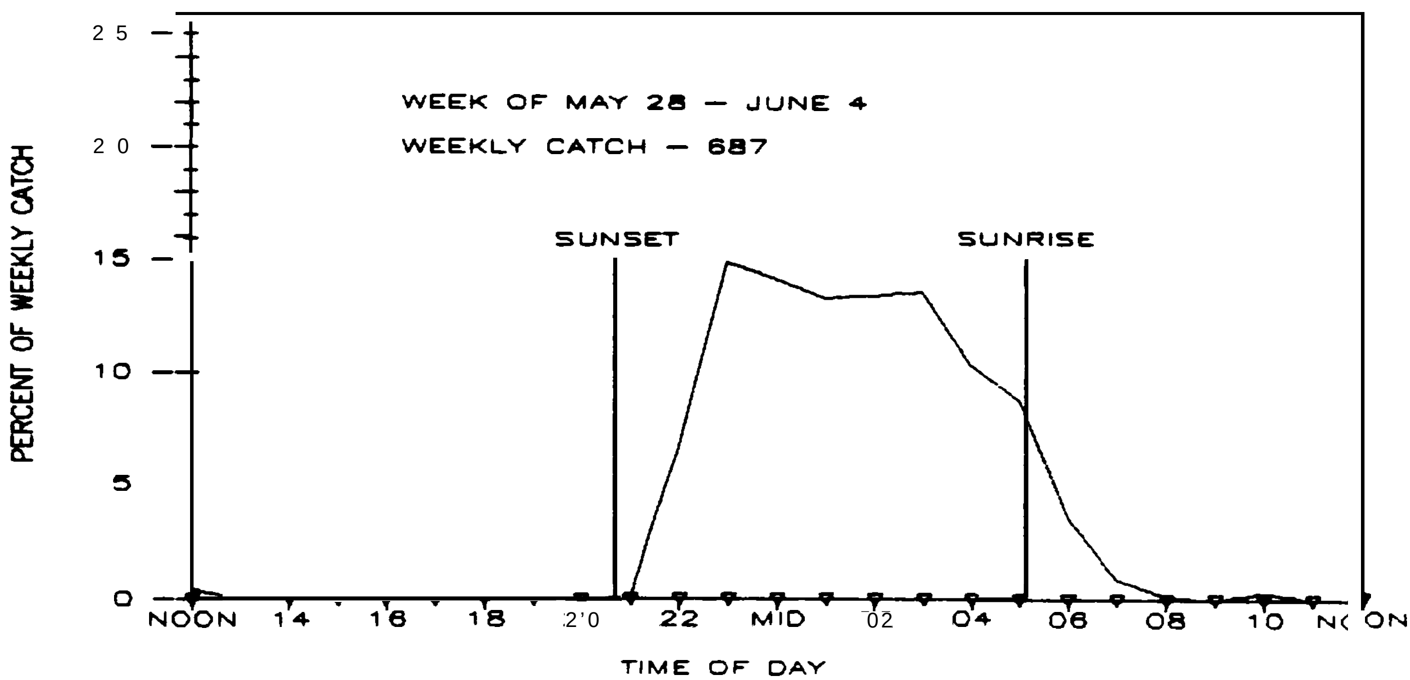


FIGURE 39

WEEKLY DIEL PATTERN

SOCKEYE — JOHN DAY DAM

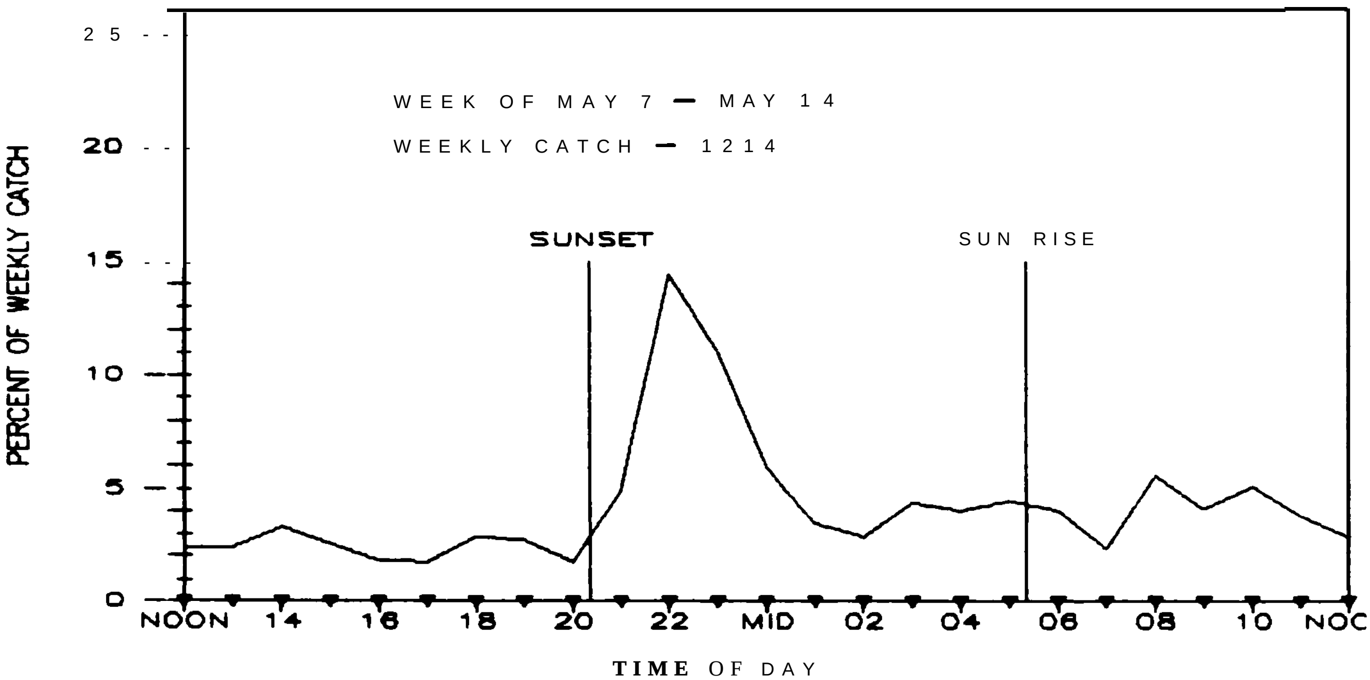


FIGURE 40

WEEKLY DIEL PATTERN

SOCKEYE — JOHN DAY DAM

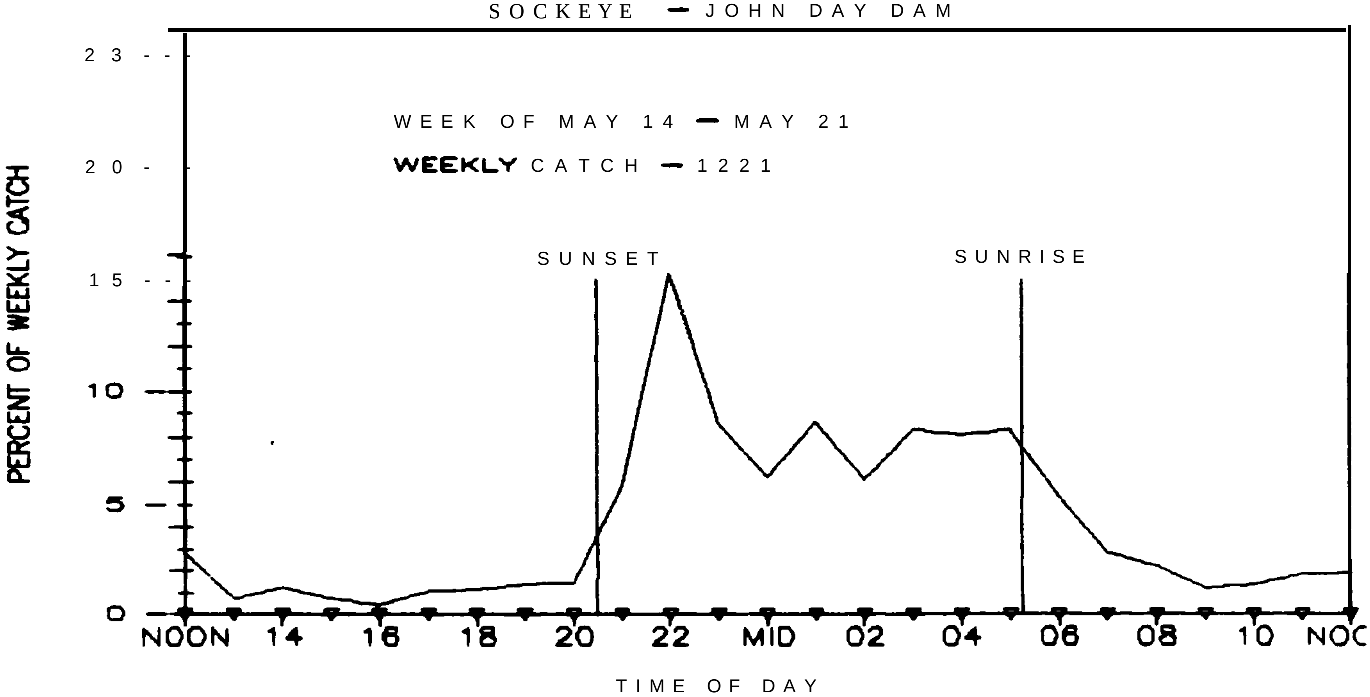


FIGURE 41

WEEKLY DIEL PATTERN

SOCKEYE — JOHN DAY DAM

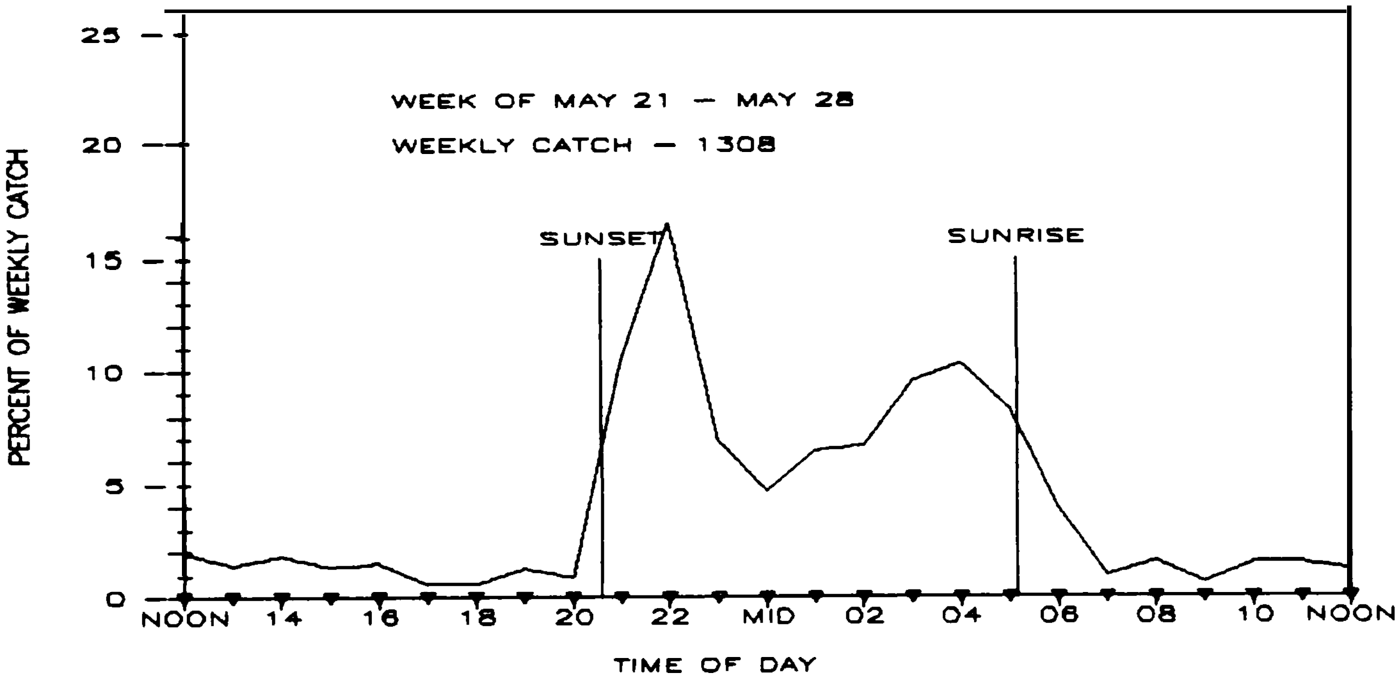


FIGURE 42

WEEKLY DIEL PATTERN

SOCKEYE — JOHN DAY DAM

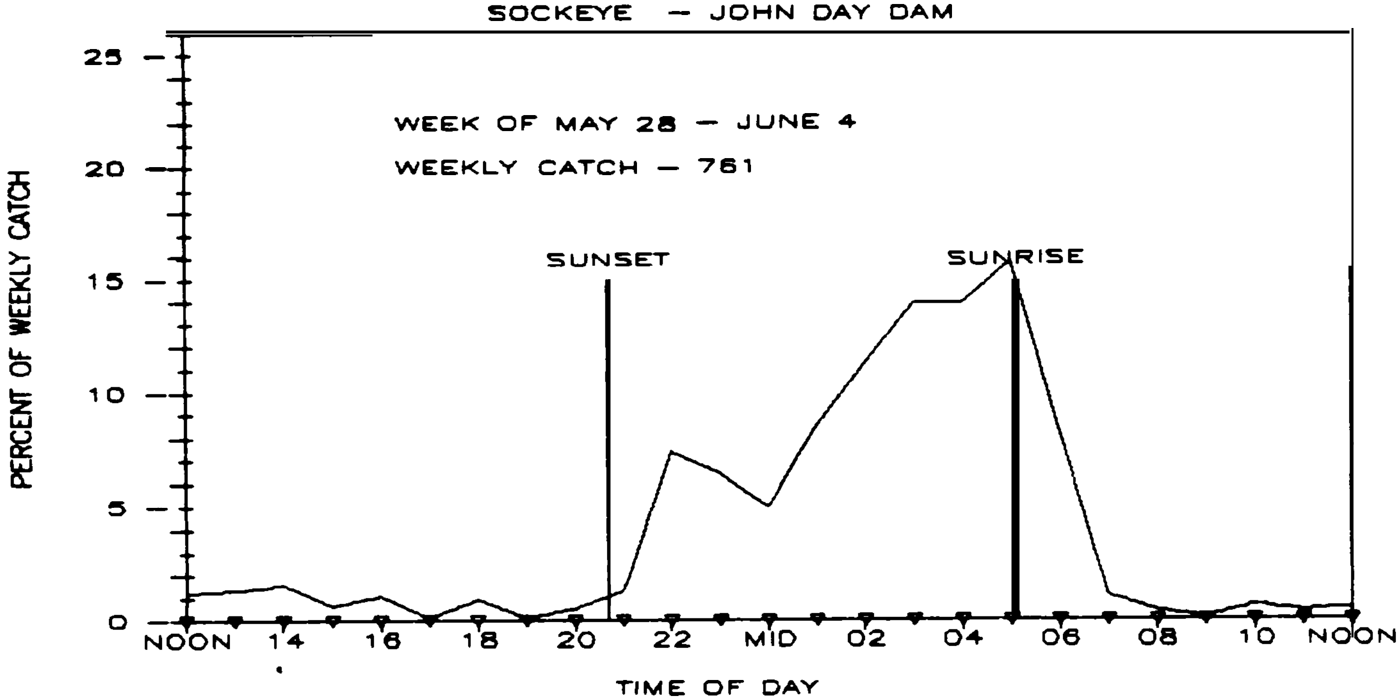


FIGURE 43

RIVER FLOW VERSUS UNIT 3 DISCHARGE

JOHN DAY DAM — 1989

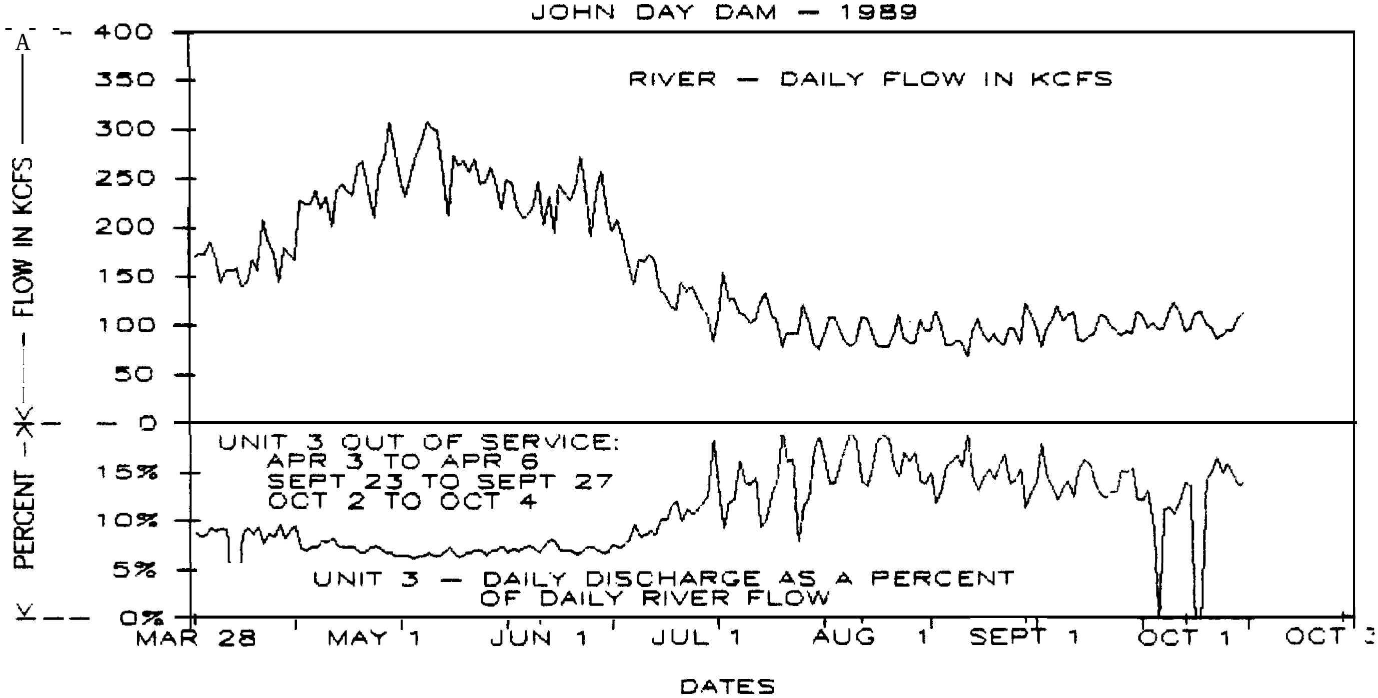


FIGURE 44

PASSAGE PATTERN — YEARLING CHINOOK

JOHN DAY DAM, 1989

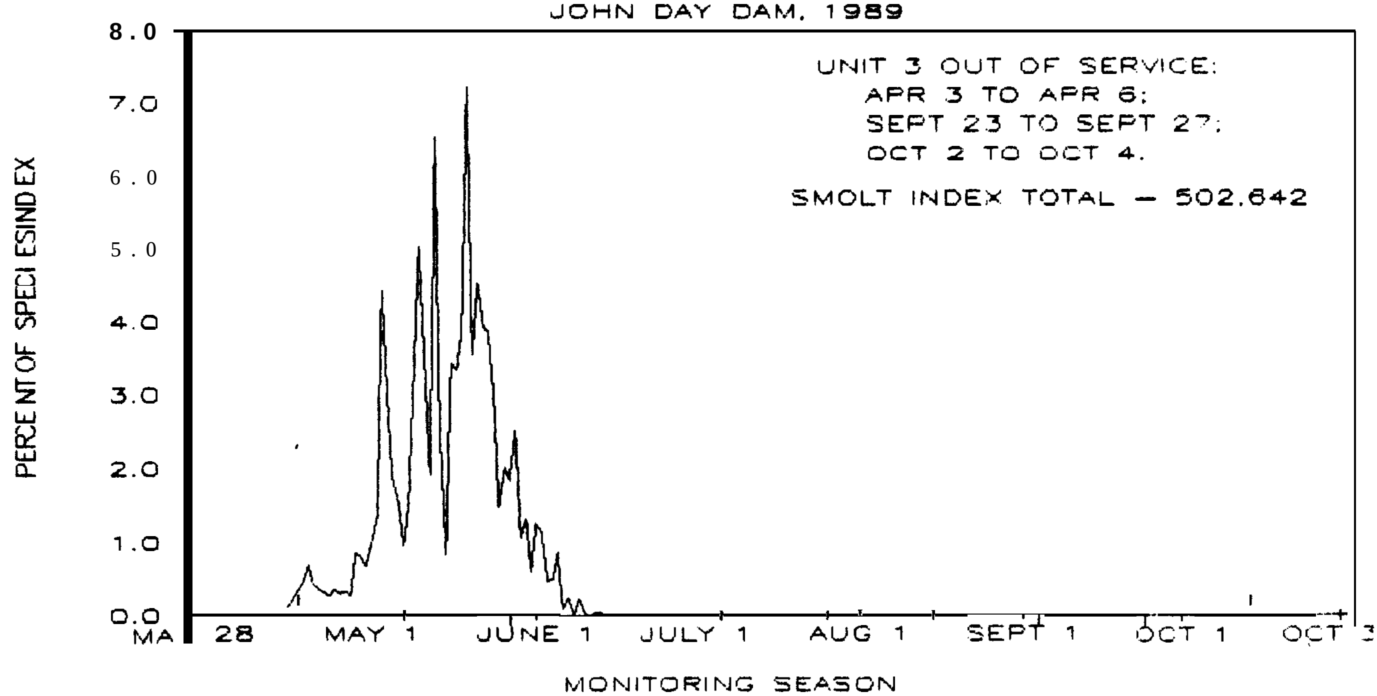


FIGURE 45

PASSAGE PATTERN – SUBYEARLING CHINOOK

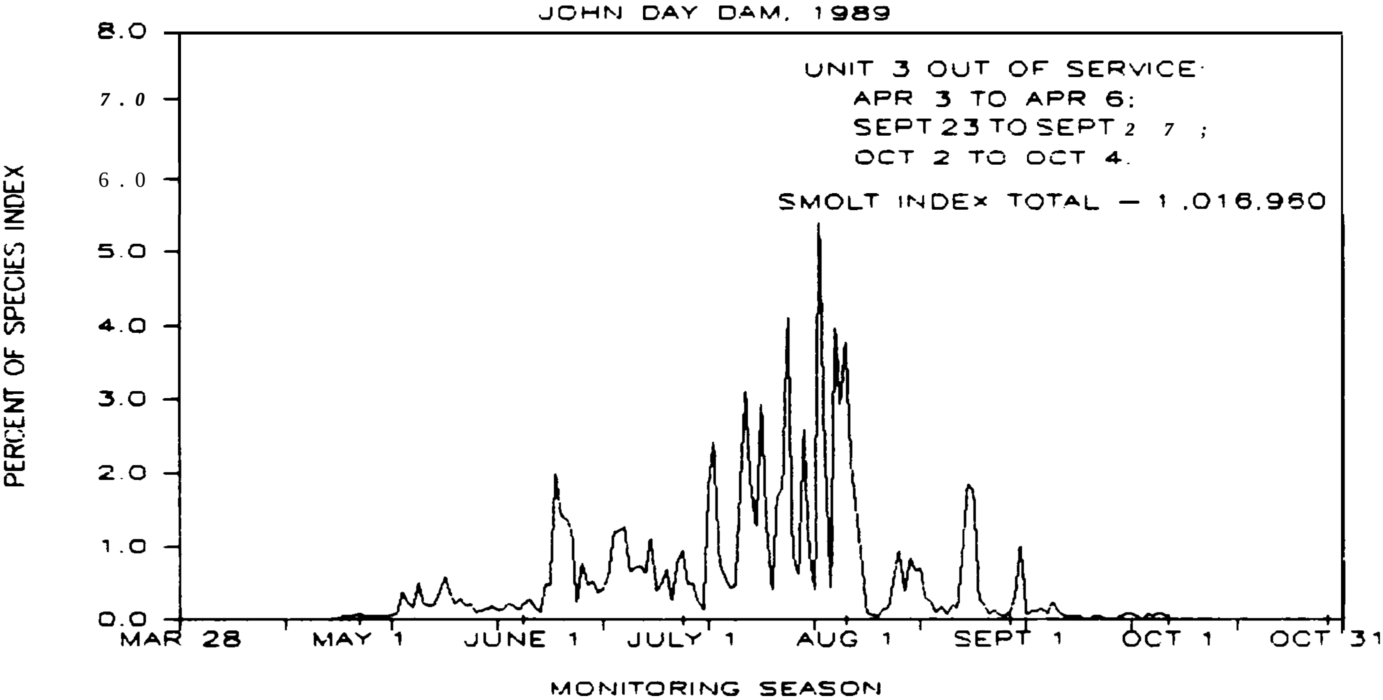


FIGURE 46

PASSAGE PATTERN – STEELHEAD

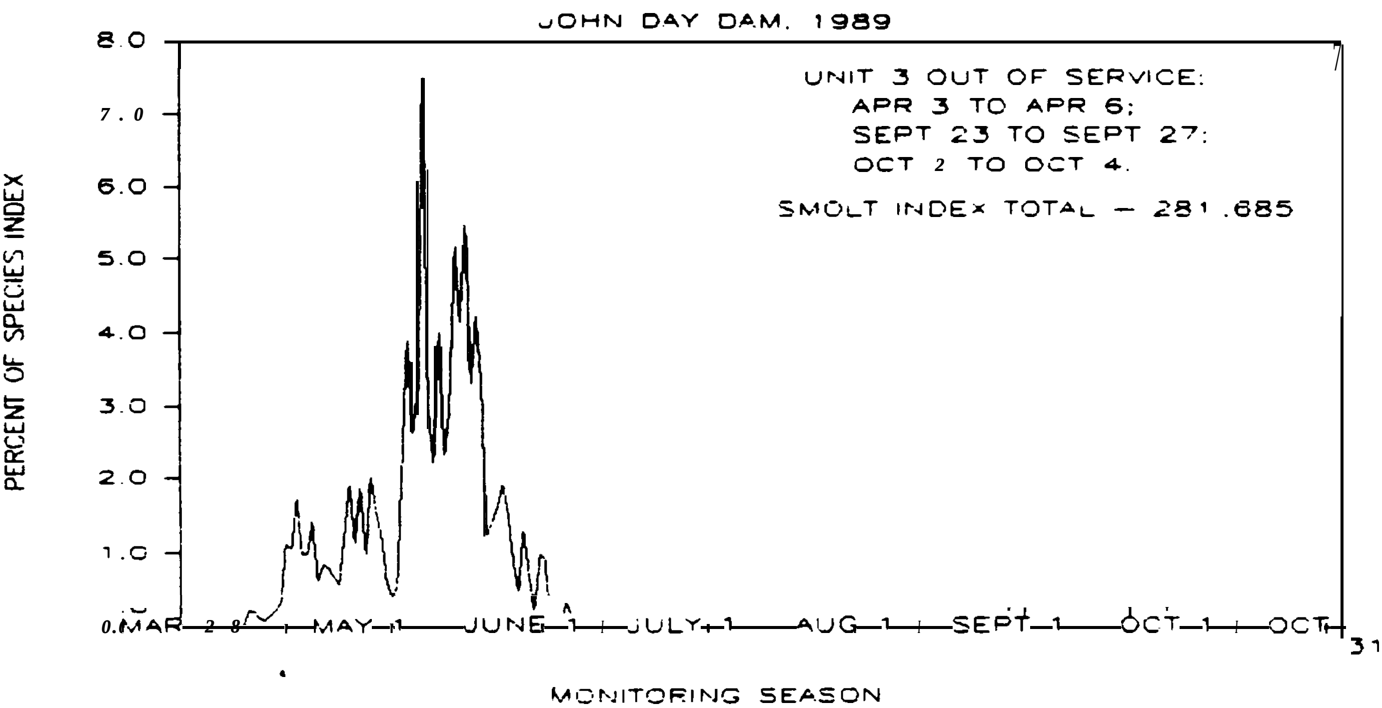


FIGURE 47

PASSAGE PATTERN – COHO

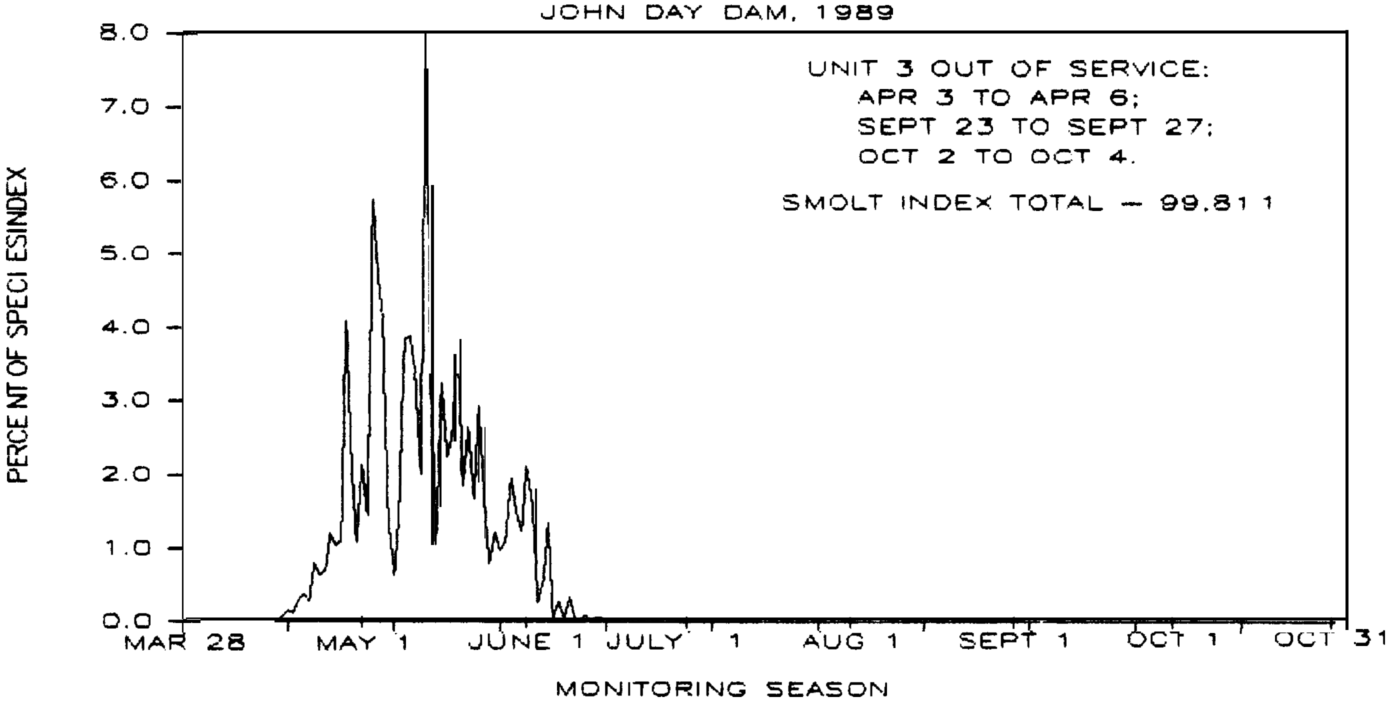


FIGURE 48

PASSAGE PATTERN – SOCKEYE

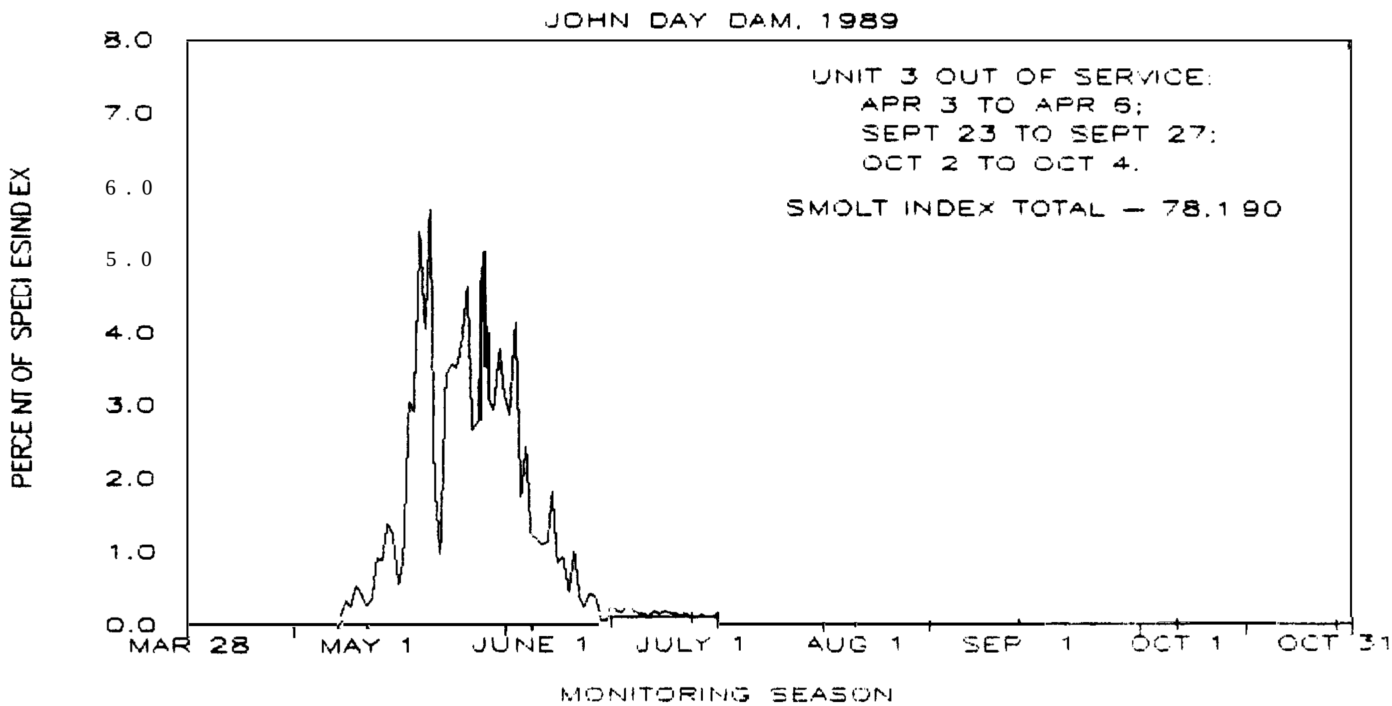


FIGURE 49

APPENDIIX C
THE DALLES DAM - 1989

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK — THE DALLES DAM

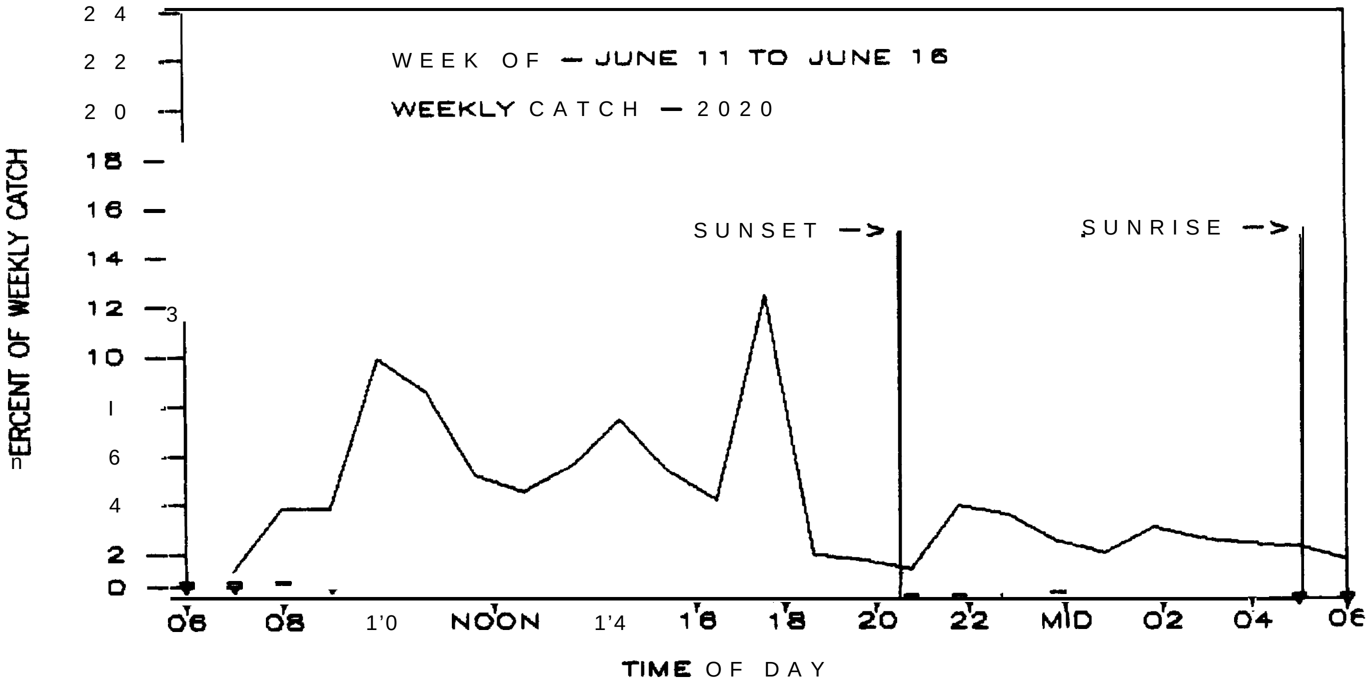


FIGURE 1

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK — THE DALLES DAM

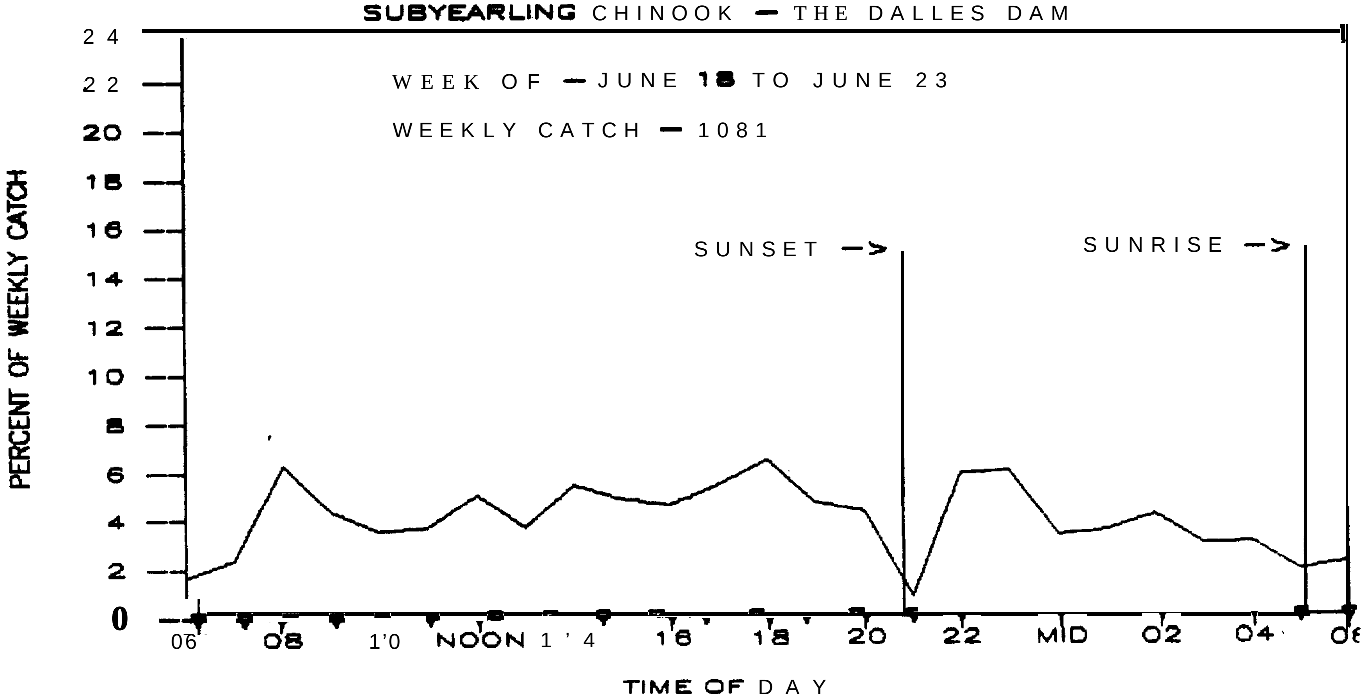


FIGURE 2

WEEKLY DIEL PATTERN

SUBYEARLING CHINOOK — THE DALLES DAM

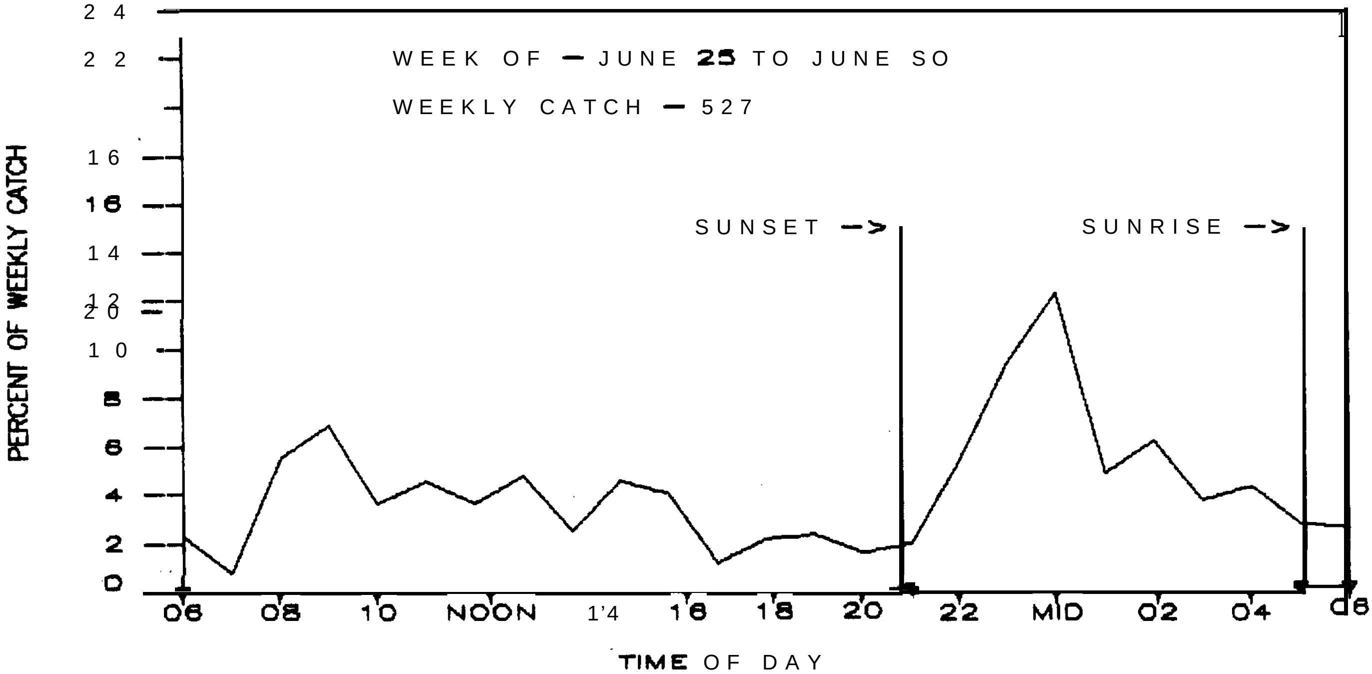


FIGURE 3

WEEKLY 'DI'EL PATTERN

SUBYEARLING CHINOOK — THE DALLES DAM

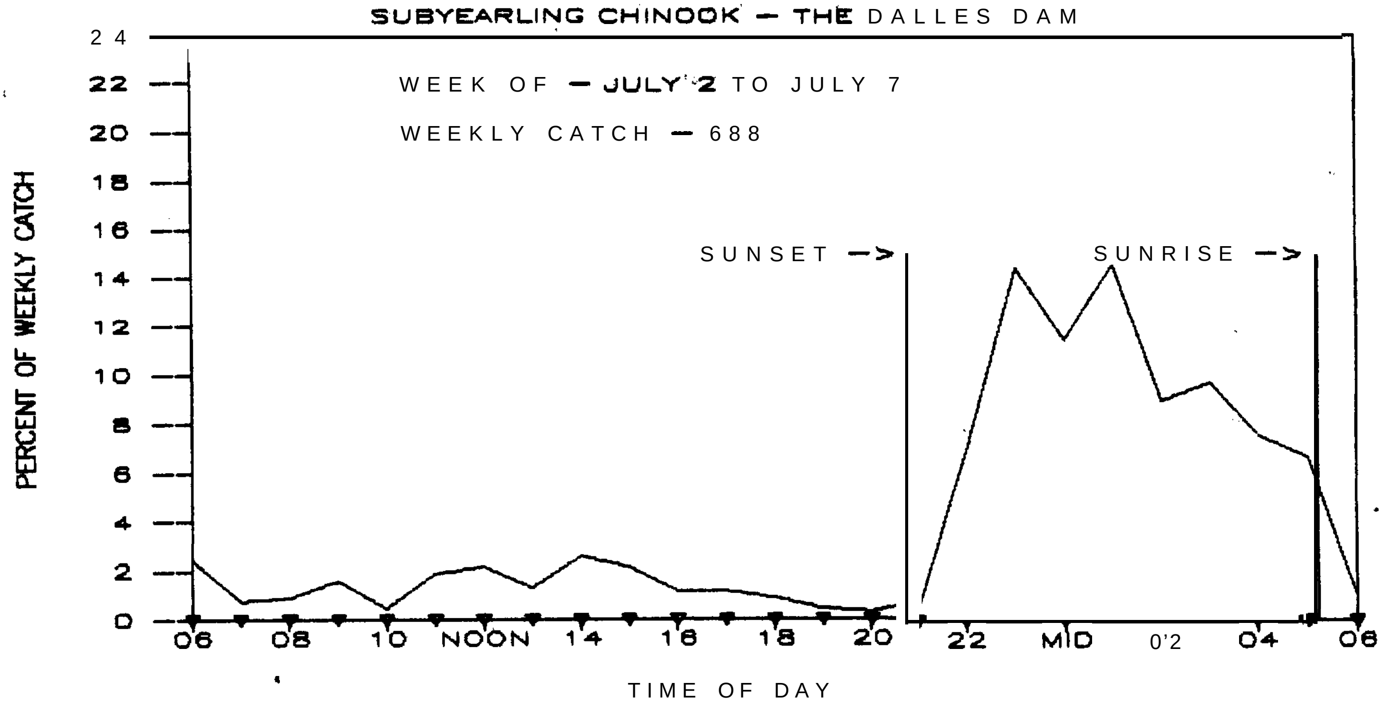


FIGURE 4

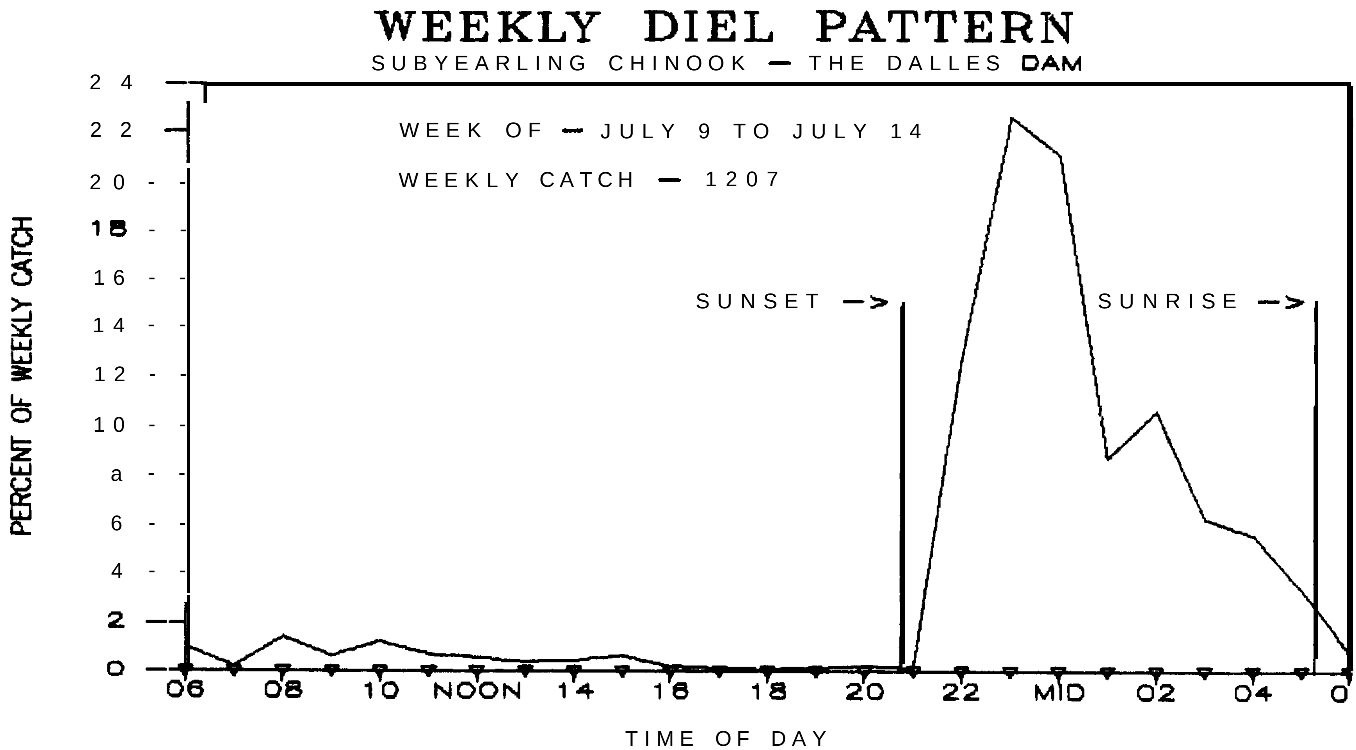


FIGURE 5

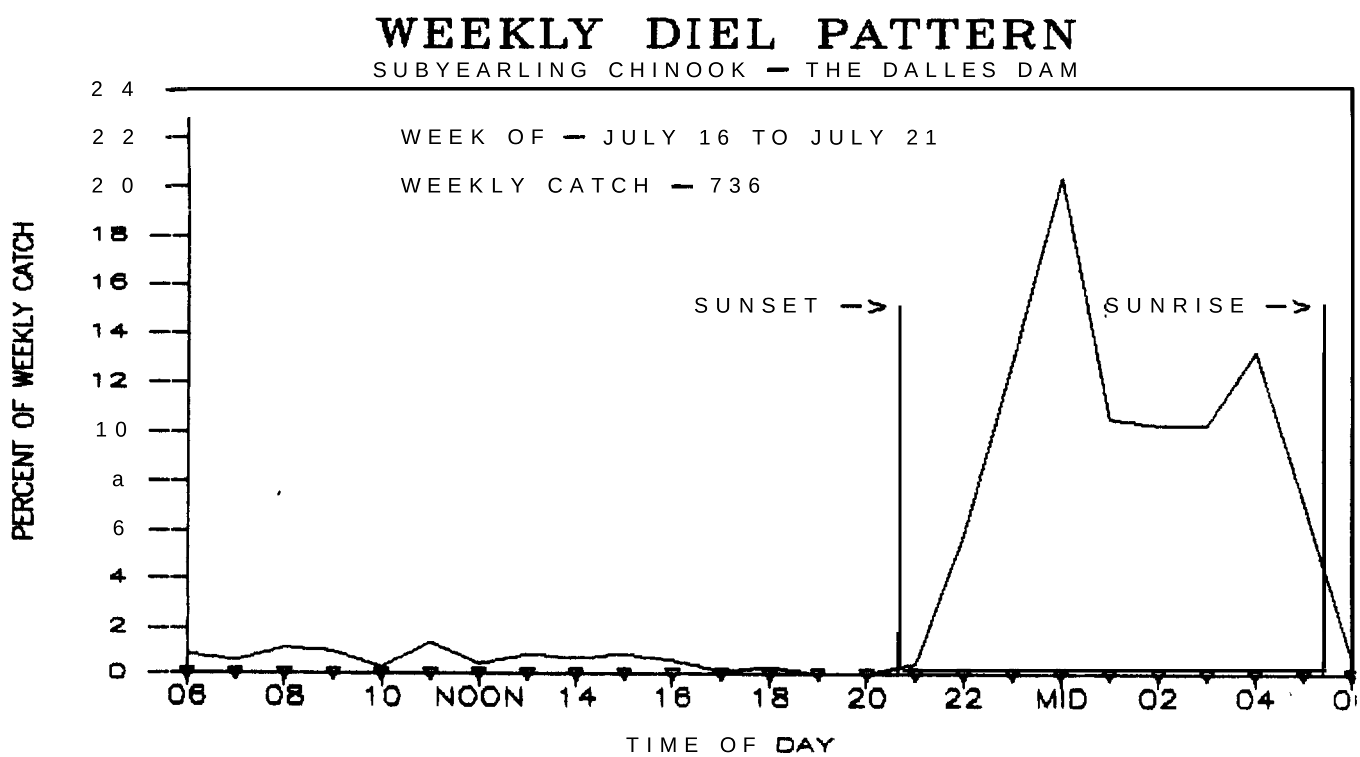


FIGURE 6

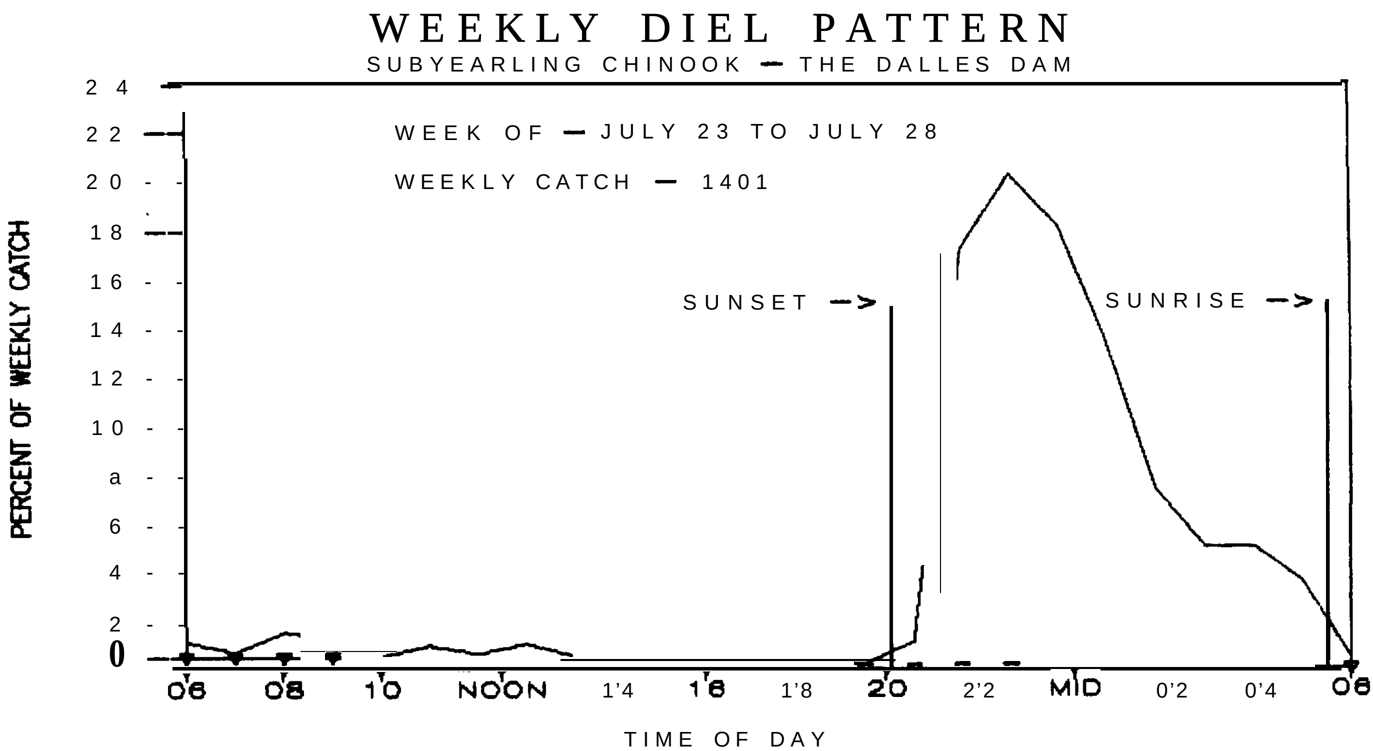


FIGURE 7

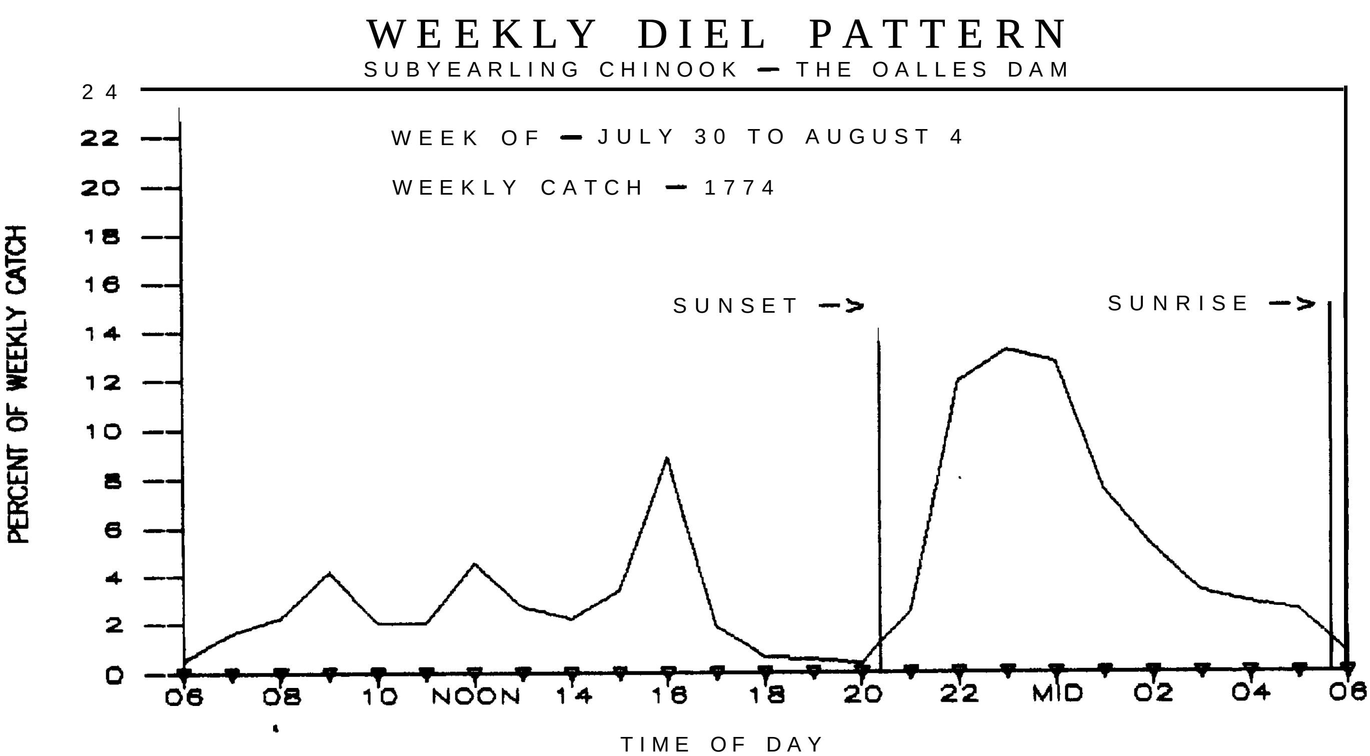


FIGURE 8

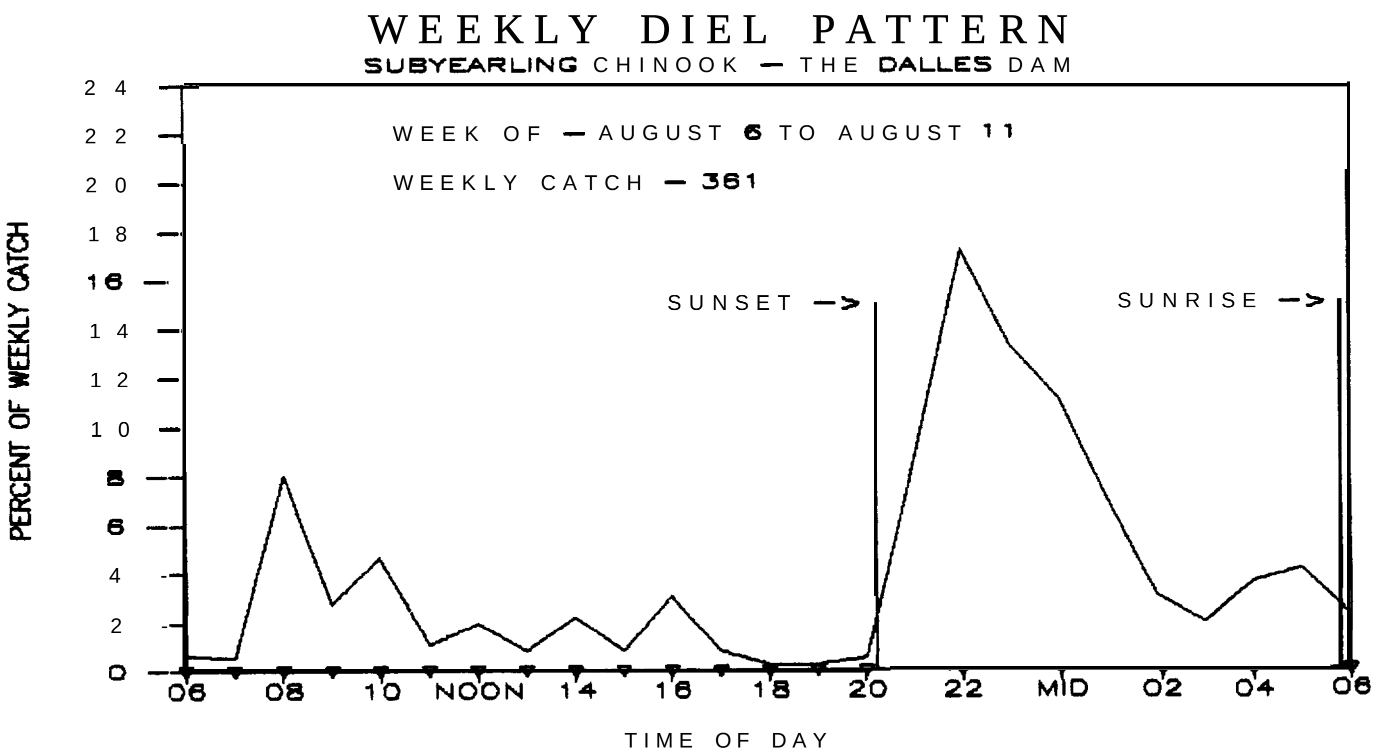


FIGURE 9

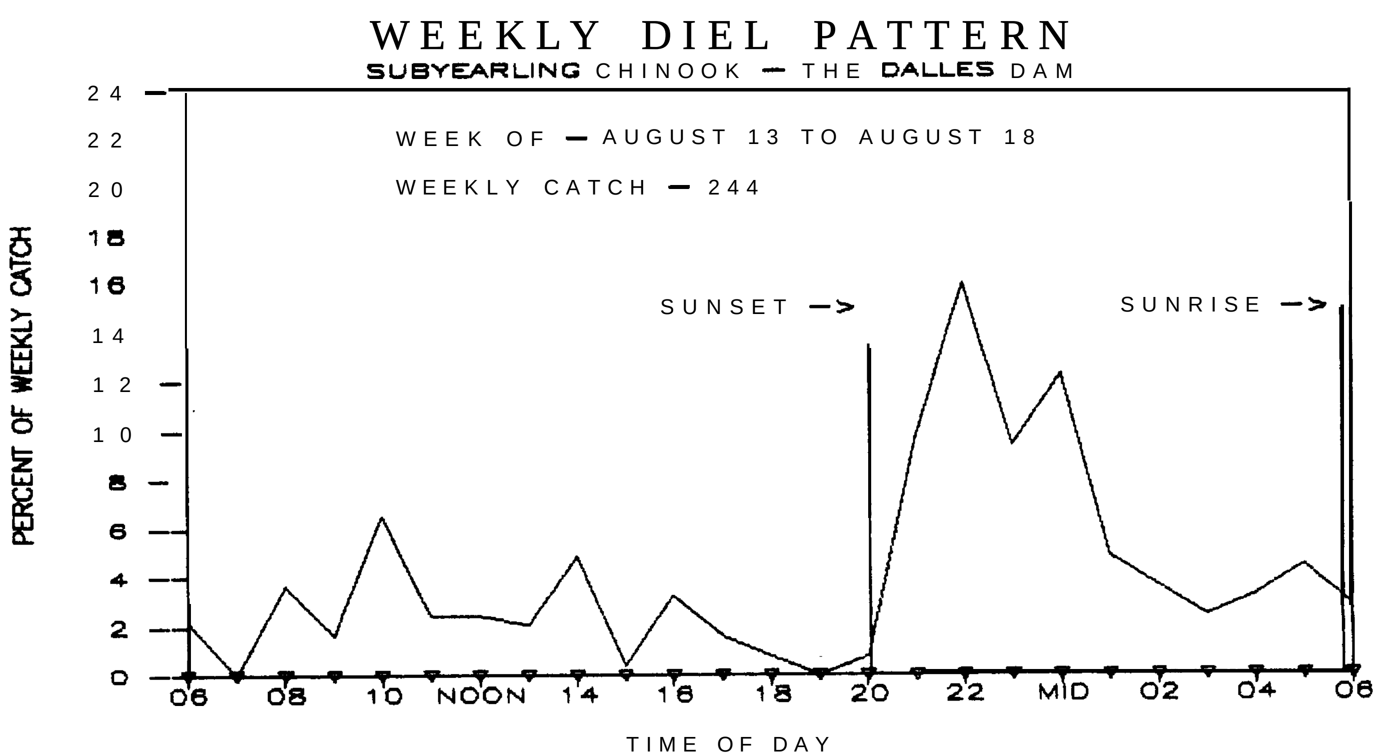
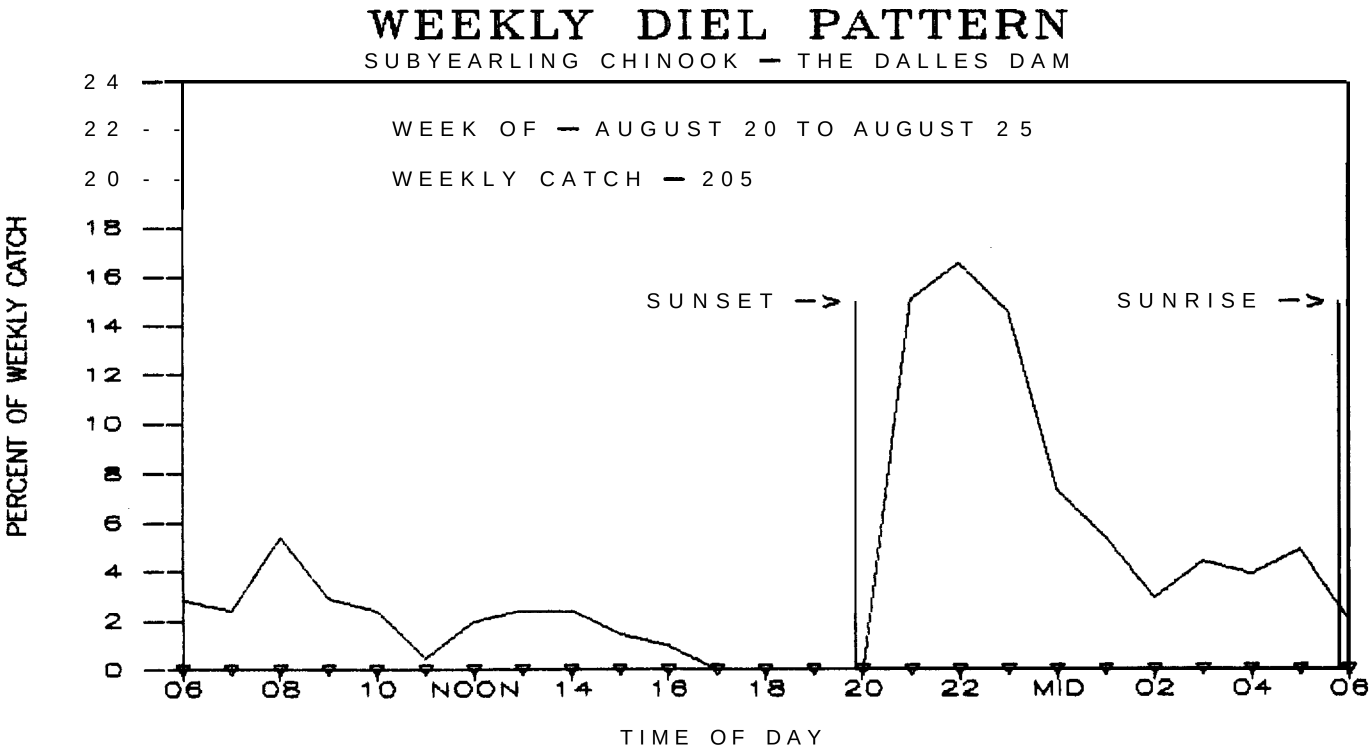
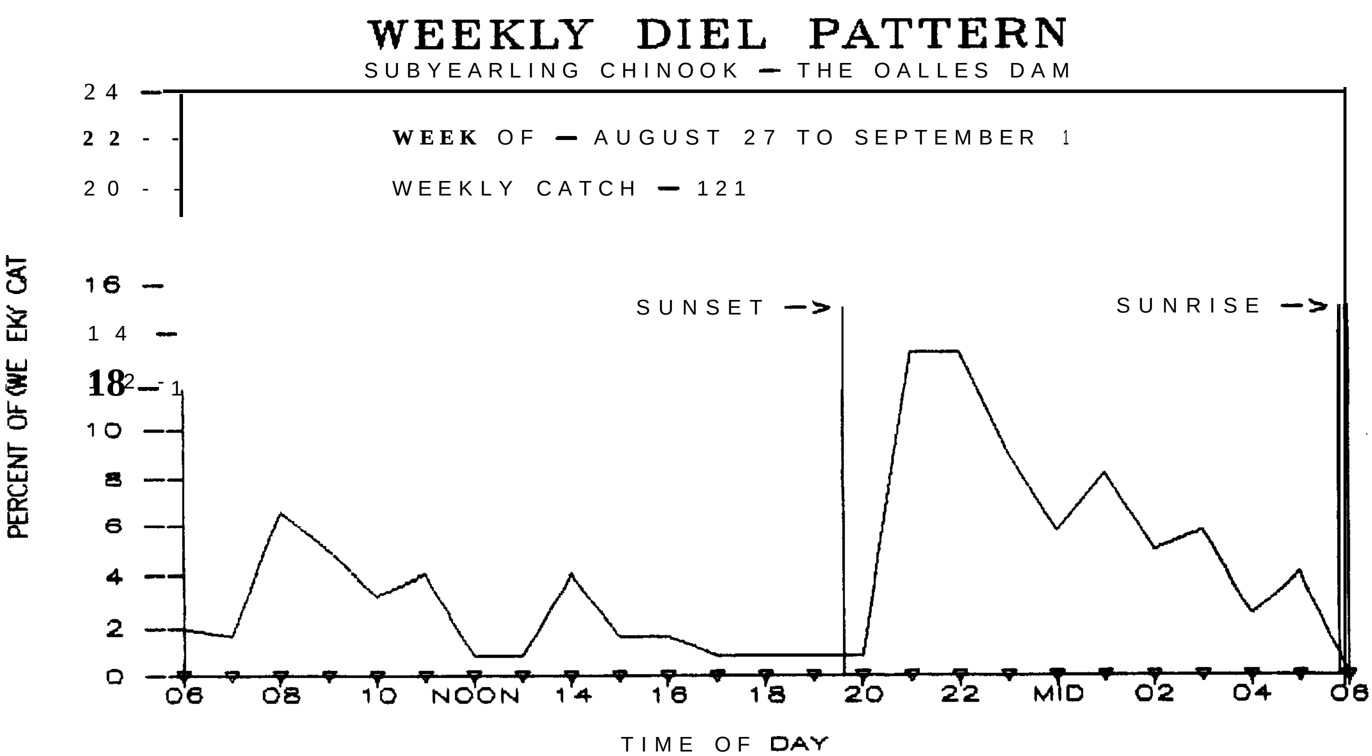


FIGURE 10



F I G U R E 11



F I G U R E 1 2

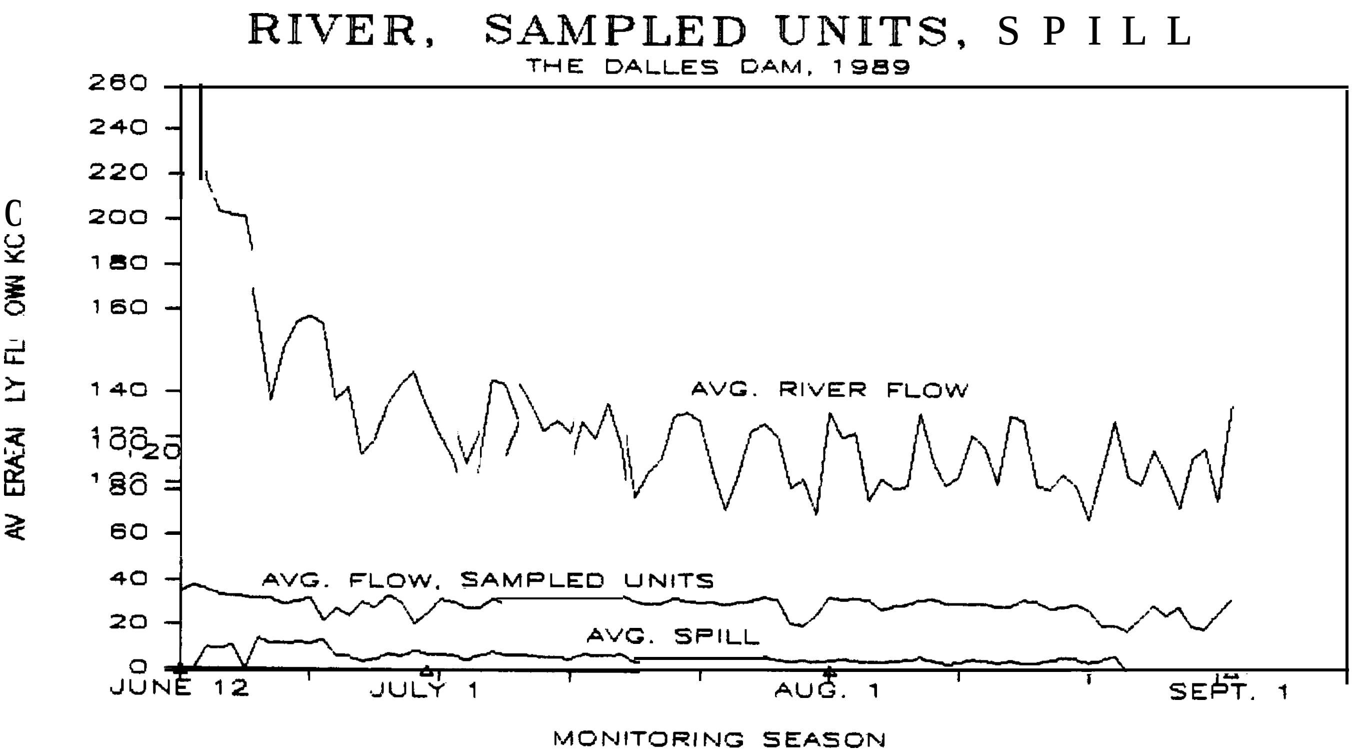


FIGURE 13

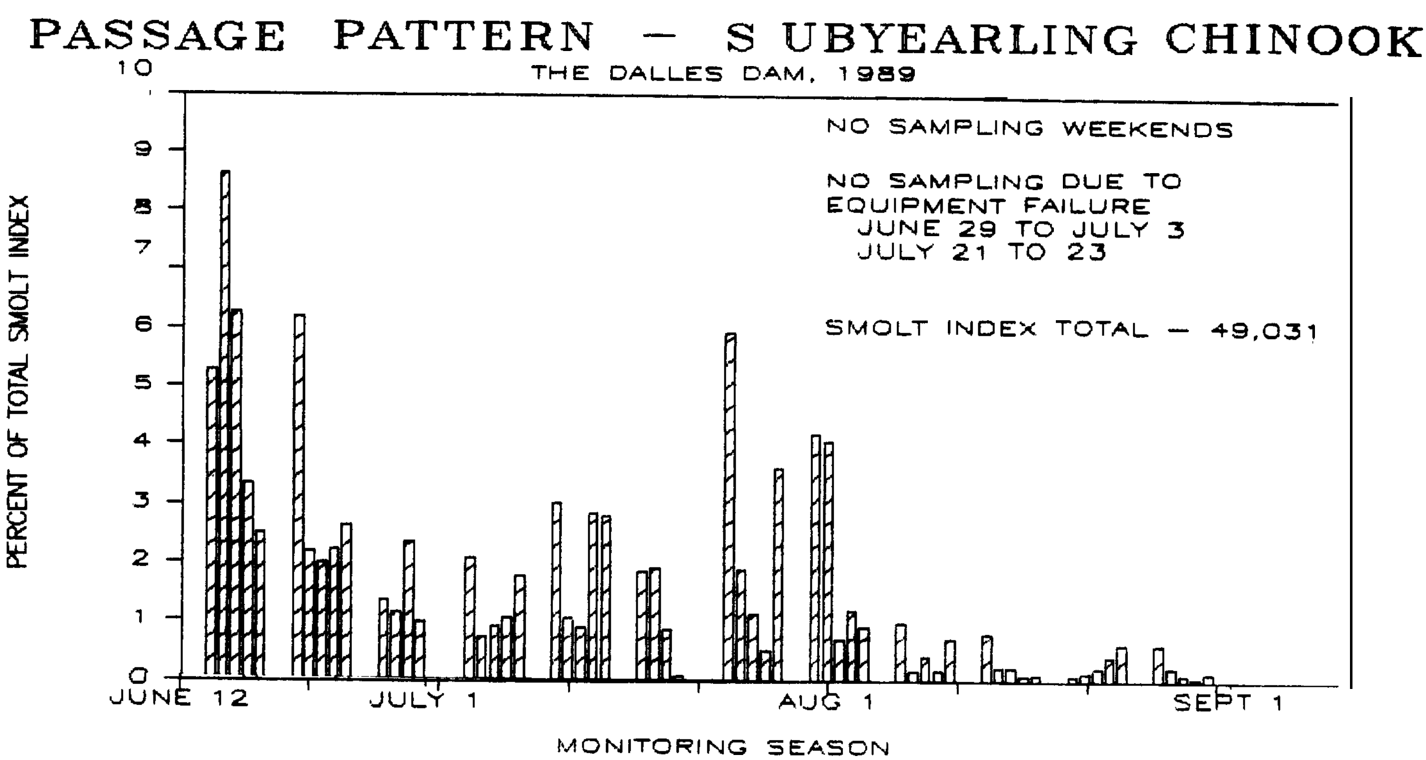


FIGURE 14

APPENDIX D
BONNEVILLE DAM 1989

TOTAL RIVER FLOW & SPILL-BONNEVILLE DAM

MARCH 9 - JUNE 30

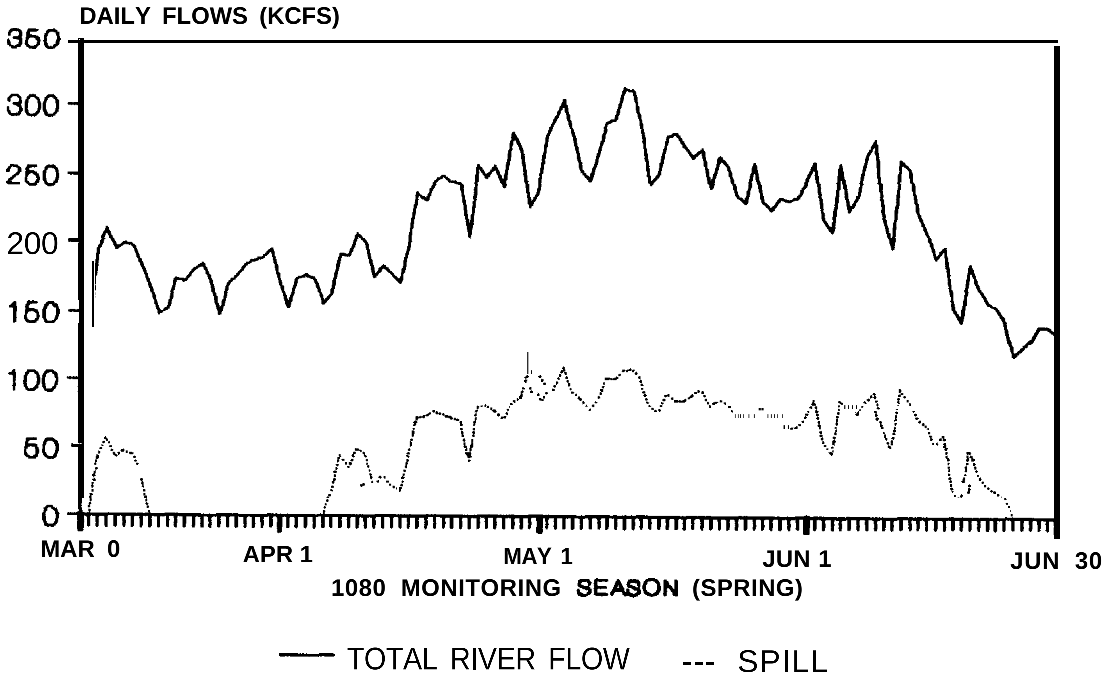


FIGURE 1

TOTAL RIVER FLOW & SPILL-BONNEVILLE DAM

JULY 1 - NOVEMBER 30

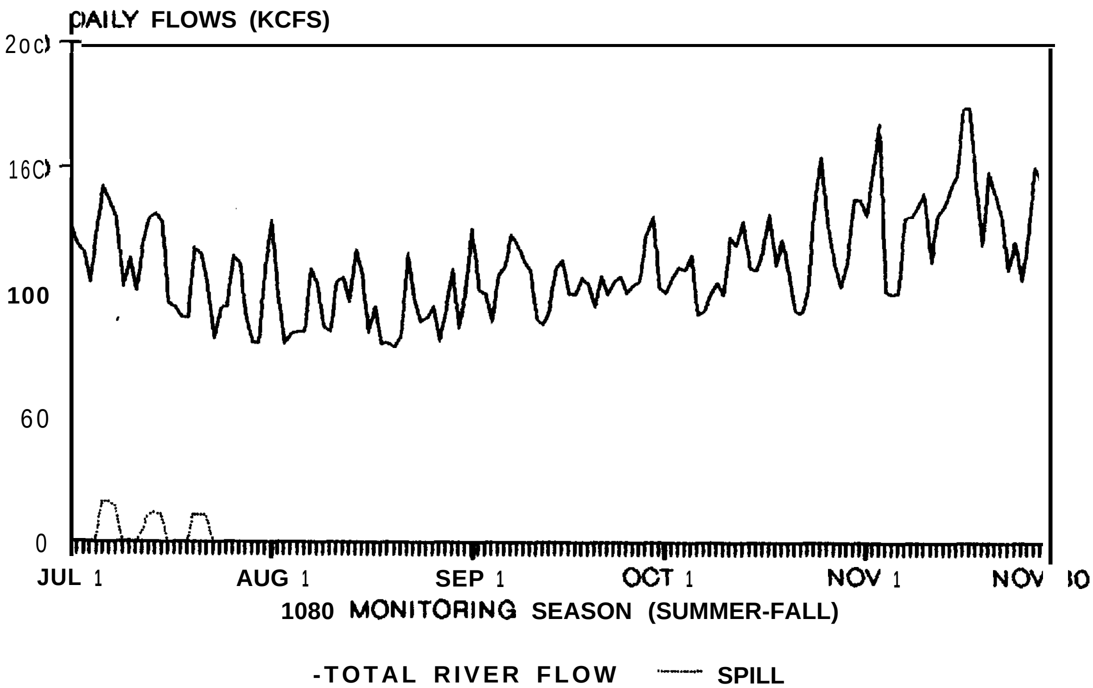
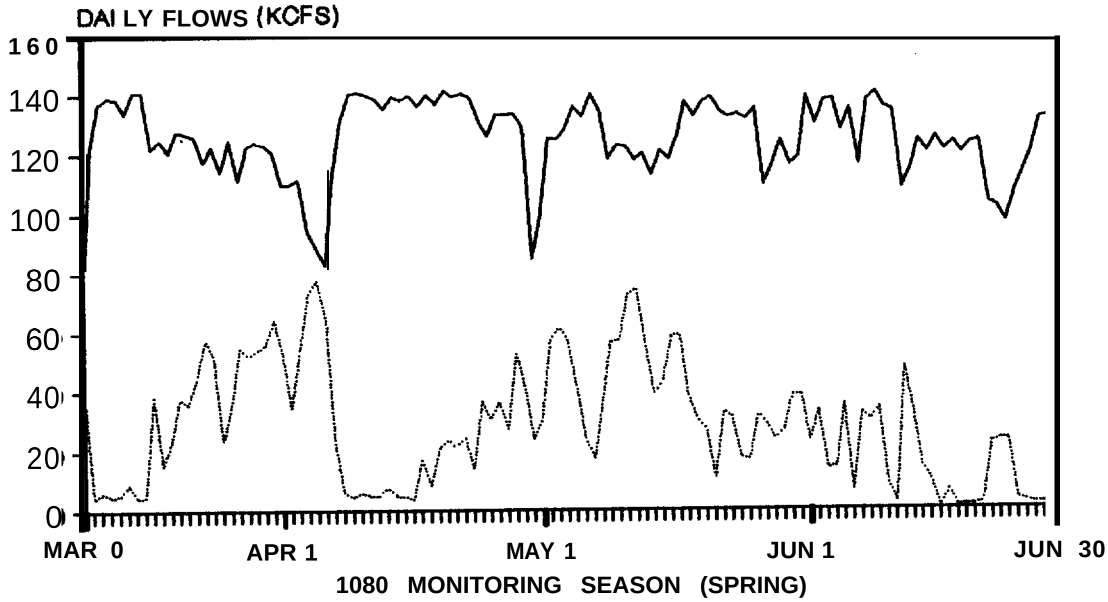


FIGURE 2

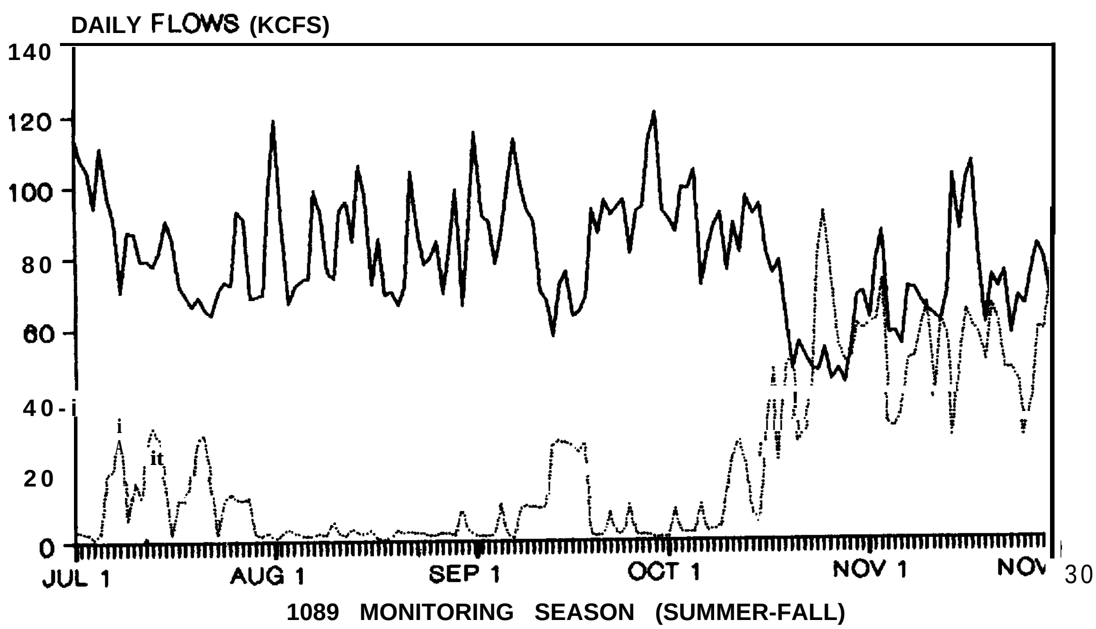
POWERHOUSE DISCHARGE-BONNEVILLE DAM
MARCH 9 - JUNE 30



—— POWERHOUSE 1 --- POWERHOUSE 2

FIGURE 3

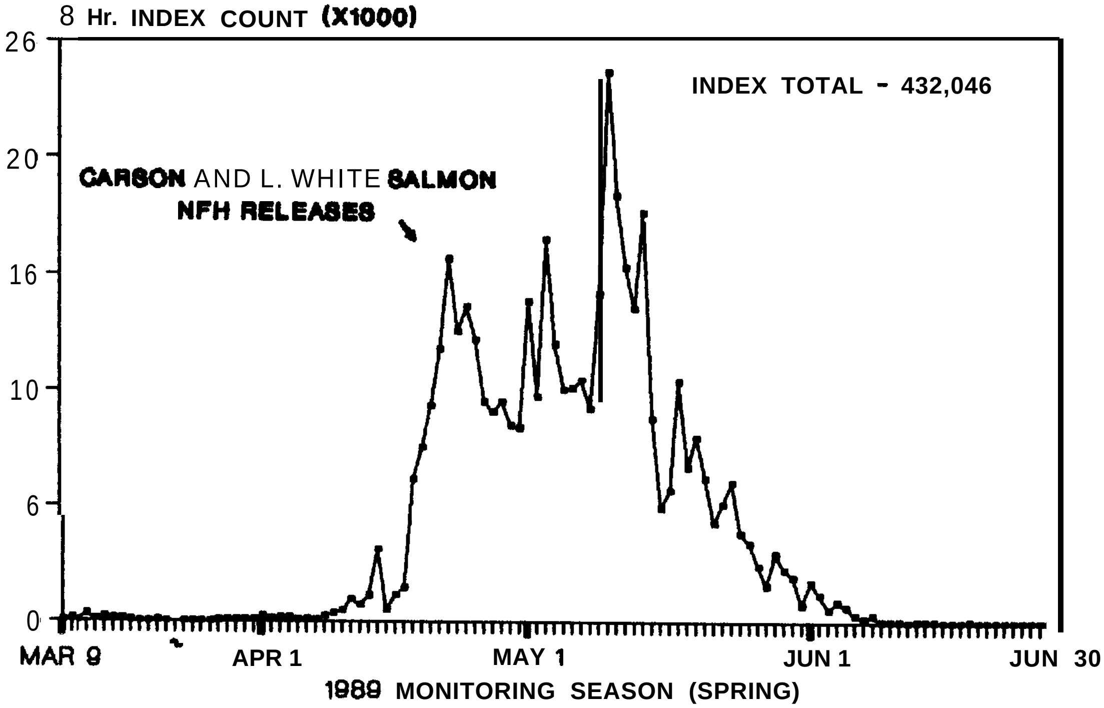
POWERHOUSE DISCHARGE-BONNEVILLE DAM
JULY 1 - NOVEMBER 30



—— POWERHOUSE 1 ----- POWERHOUSE 2

FIGURE 4

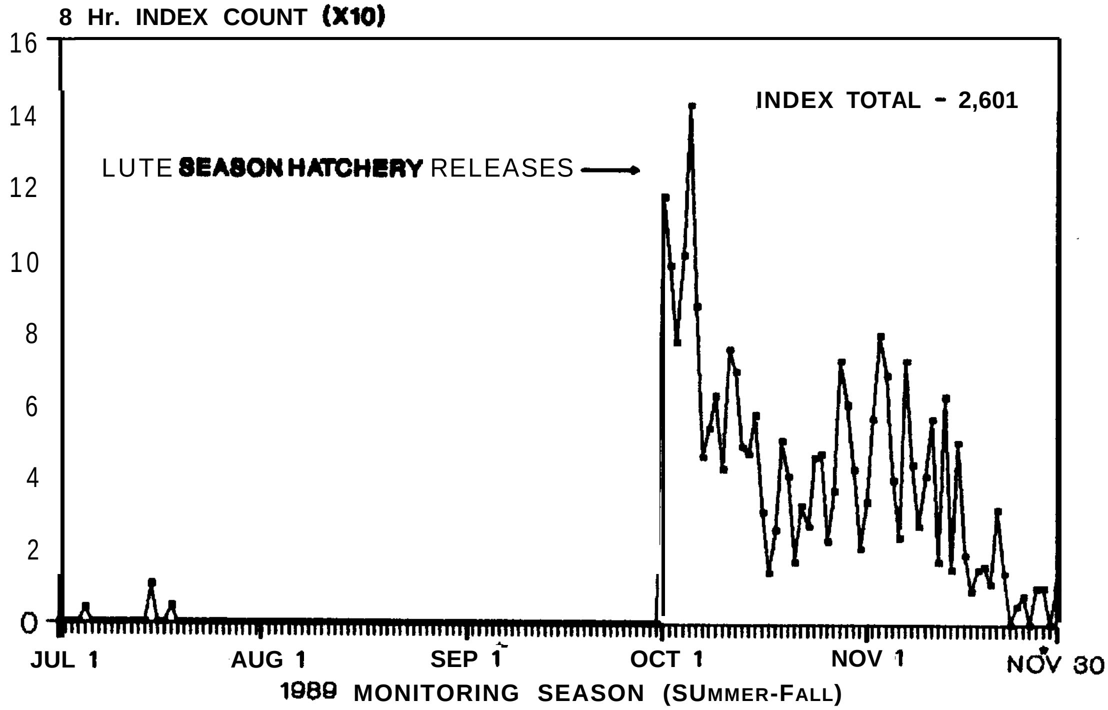
CAPTURE PATTERN, YEARLING CHINOOK
BONNEVILLE DAM, PH#1 DSM SAMPLER



• NO SAMPLE MARCH 22.

FIGURE 6

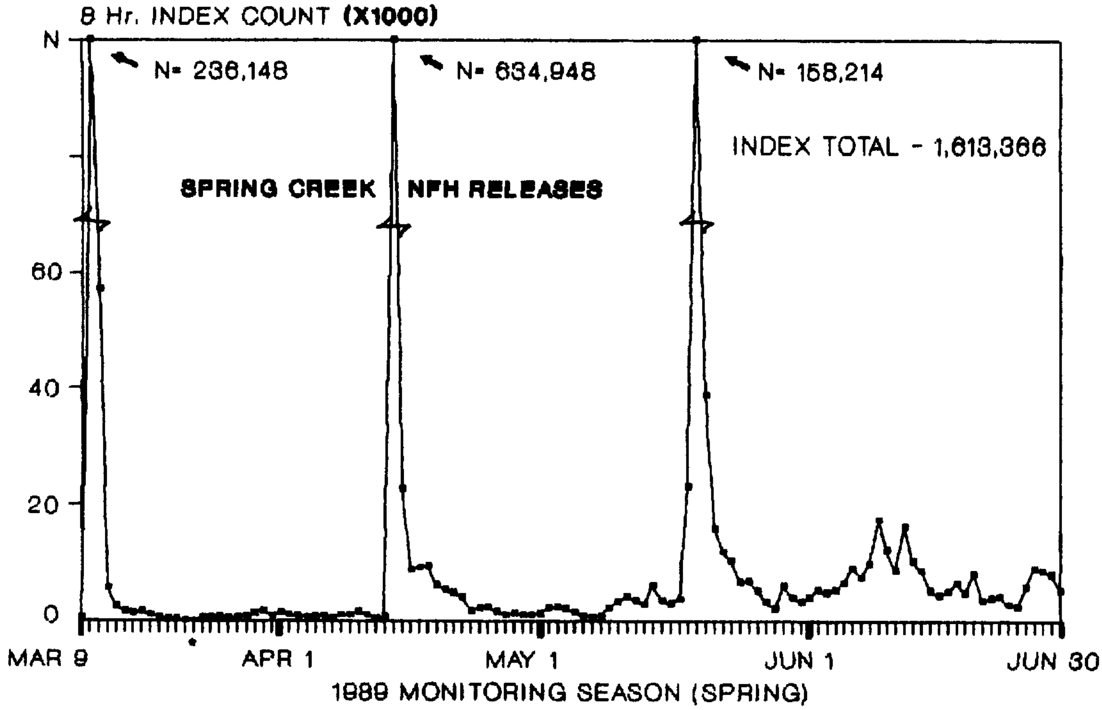
CAPTURE PATTERN, YEARLING CHINOOK
BONNEVILLE DAM, PH#1 DSM SAMPLER



. PARTIAL SAMPLE SEPT 6 a NOV 28.

FIGURE 6

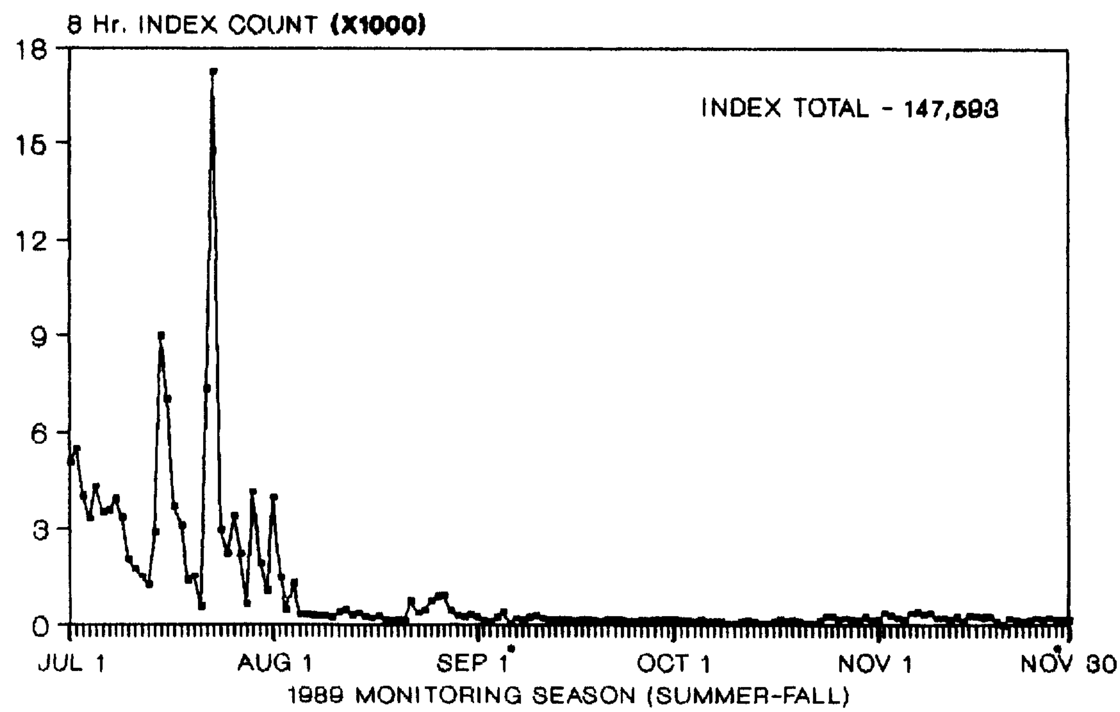
CAPTURE PATTERN, SUBYEARLING CHINOOK
BONNEVILLE DAM, PH#1 DSM SAMPLER



* NO SAMPLE MARCH 22.

FIGURE 7

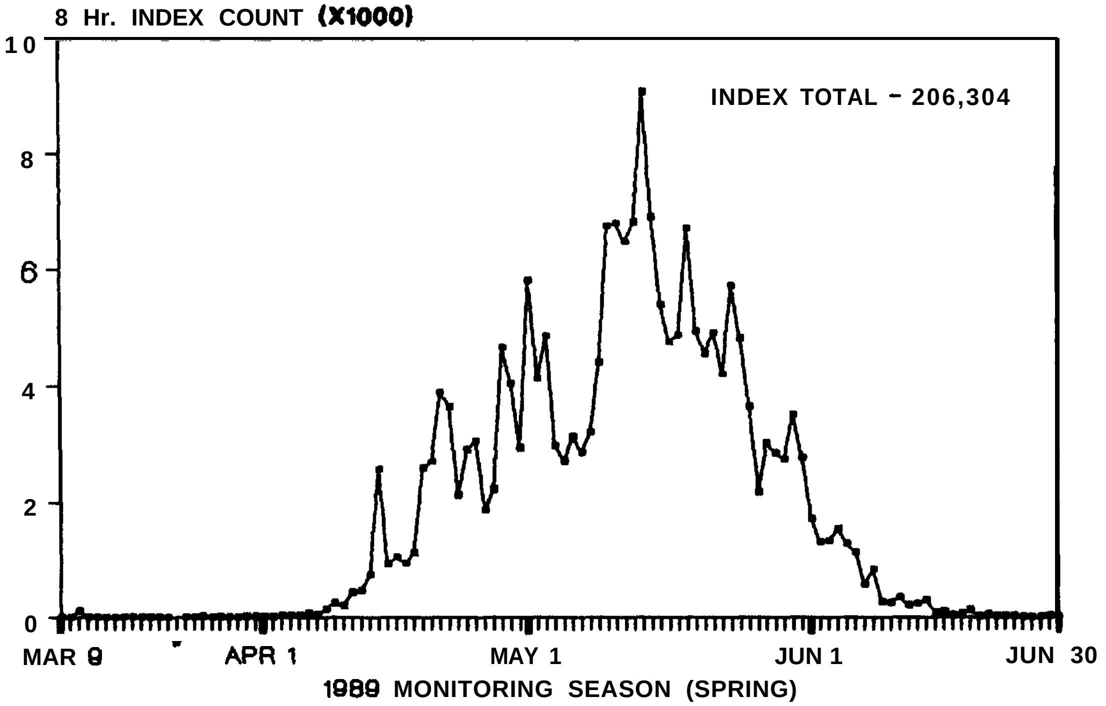
CAPTURE PATTERN, SUBYEARLING CHINOOK
BONNEVILLE DAM, PH#1 DSM SAMPLER



* PARTIAL SAMPLE SEPT 6 & NOV 28.

FIGURE 8

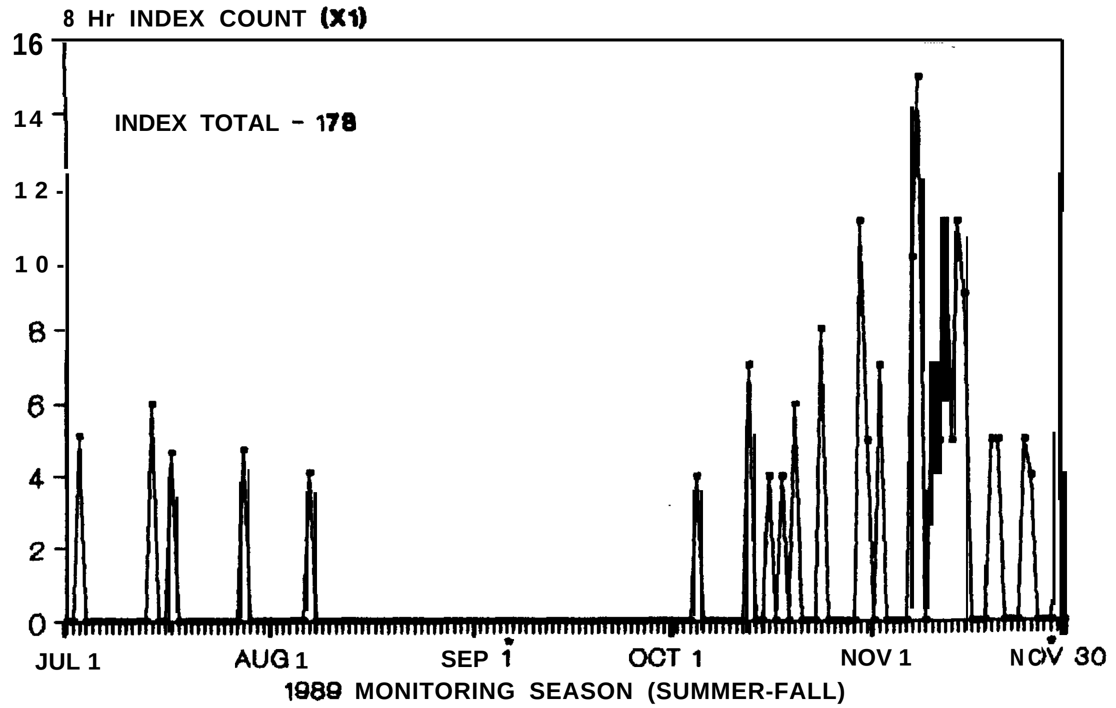
CAPTURE PATTERN, STEELHEAD
BONNEVILLE DAM, PH#1 DSM SAMPLER



• NO SAMPLE MARCH 22.

FIGURE 9

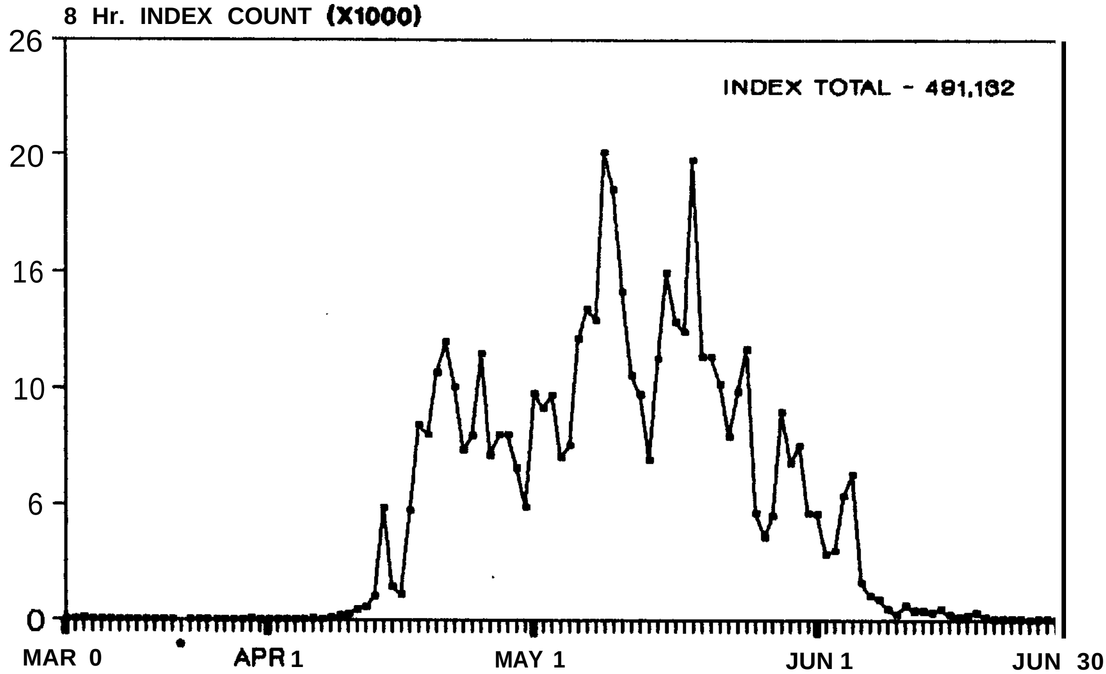
CAPTURE PATTERN, STEELHEAD
BONNEVILLE DAM, PH#1 DSM SAMPLER



• PARTIAL SAMPLE SEPT 6 & NOV 28.

FIGURE 10

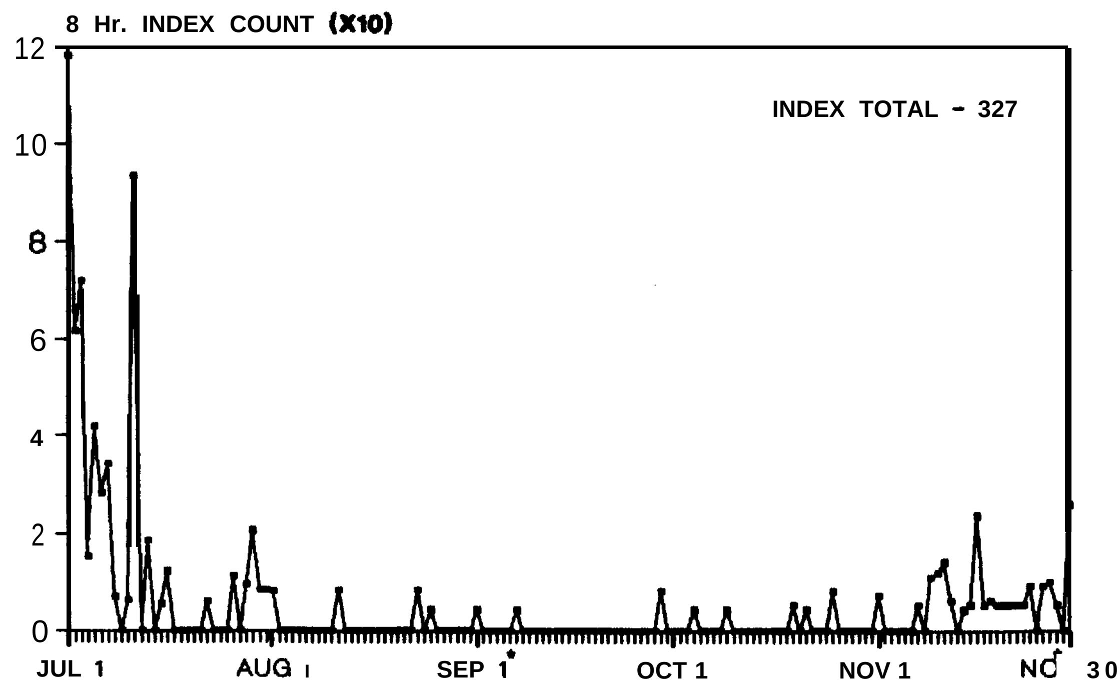
CAPTURE PATTERN. COHO
BONNEVILLE DAM, PH#1 DSM SAMPLER



• NO SAMPLE MARCH 22.

FIGURE 11

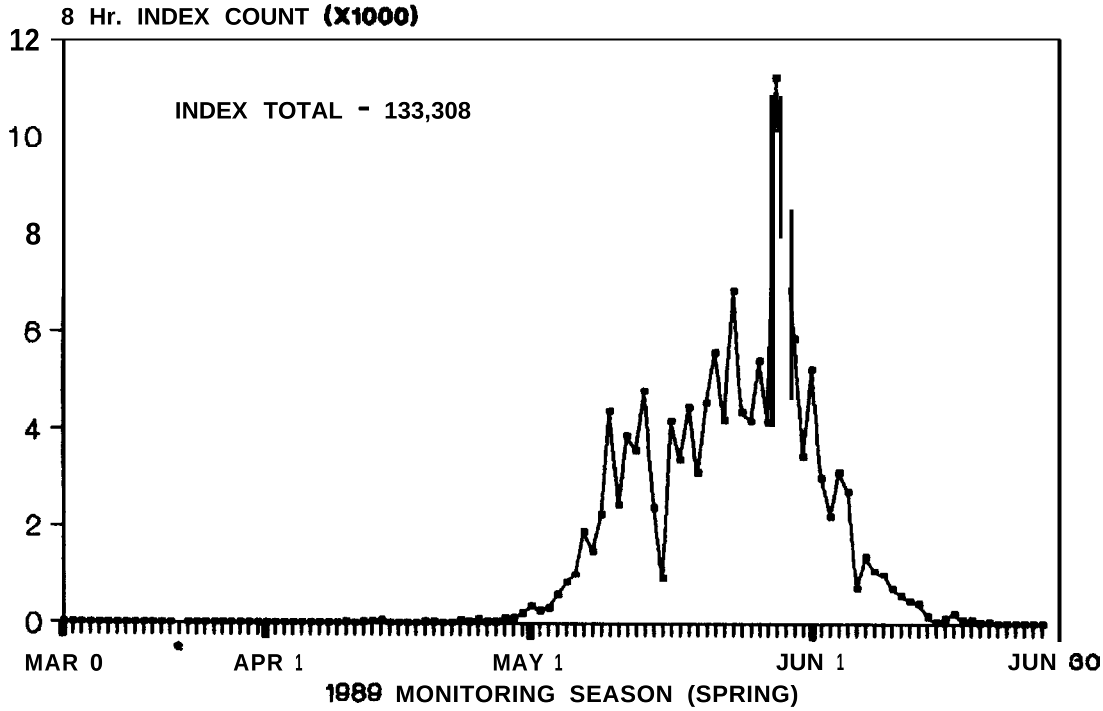
CAPTURE PATTERN, COHO
BONNEVILLE DAM, PH#1 DSM SAMPLER



• PARTIAL SAMPLE SEPT 6 8 NCV 28.

FIGURE 12

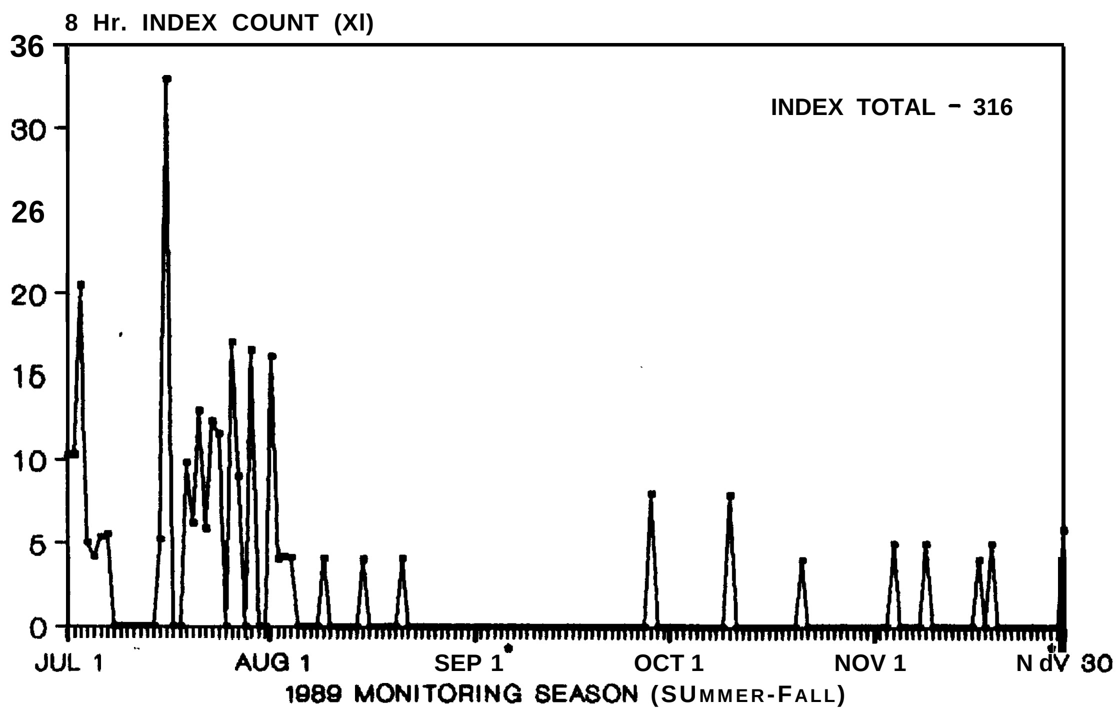
CAPTURE PATTERN, SOCKEYE
BONNEVILLE DAM, PH#1 DSM SAMPLER



• SAMPLE MARCH 22.

FIGURE 13

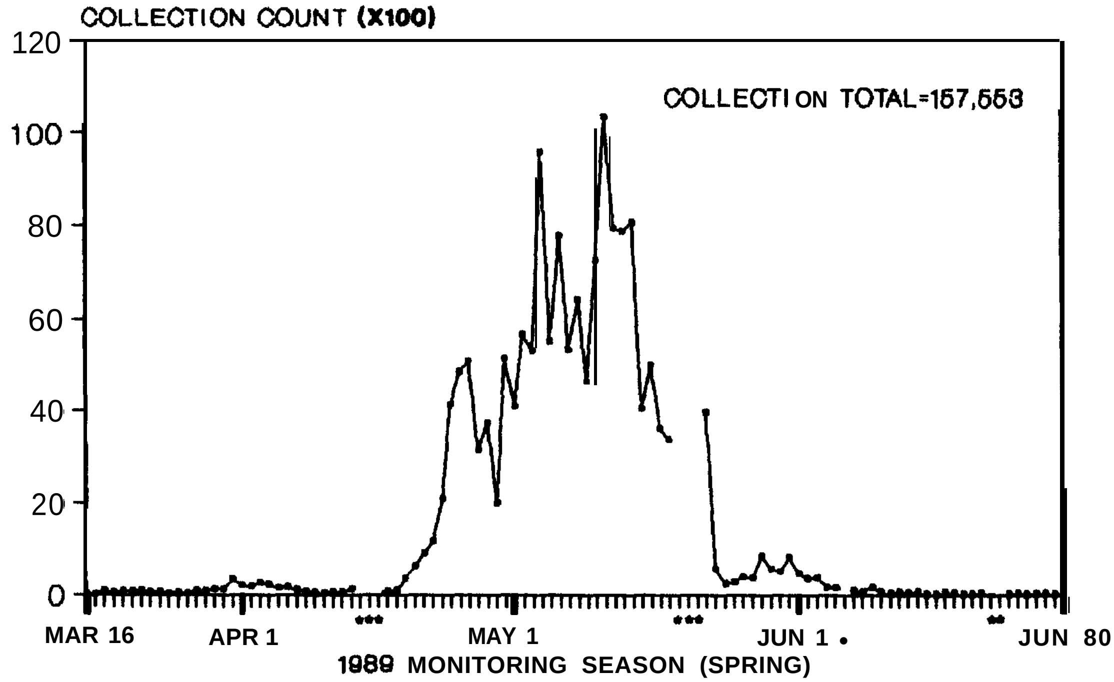
CAPTURE PATTERN, SOCKEYE
BONNEVILLE DAM. PHH DSM SAMPLER



* PARTIAL SAMPLE SEPT 6 a NOV 28.

FIGURE 14

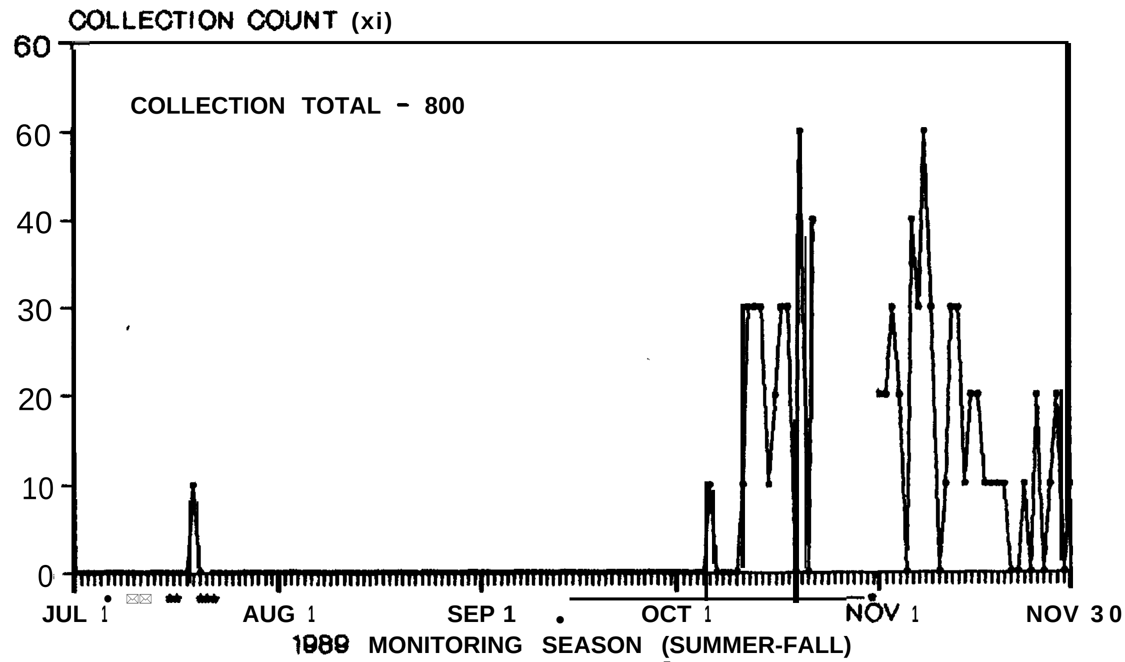
CAPTURE PATTERN, YEARLING CHINOOK
BONNEVILLE DAM, PH#2 DSM SAMPLER



● PARTIAL(<20HRS.) OR NO SAMPLES:
APR 14-16,MAY 19-21,JUN 6,22,23.

FIGURE 15

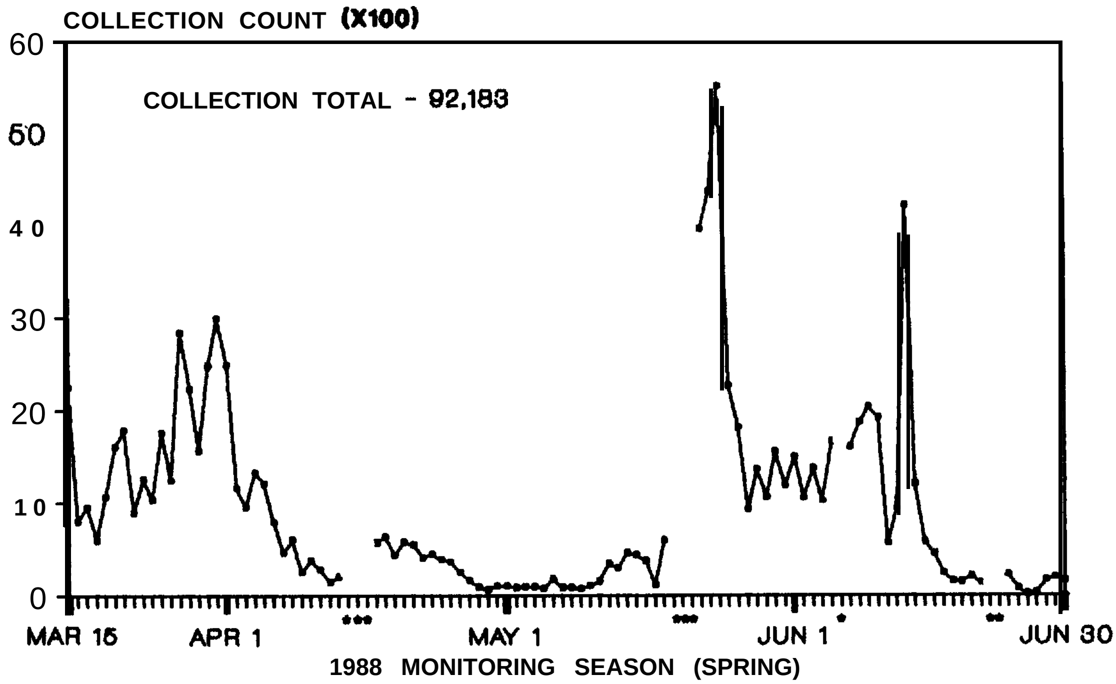
CAPTURE PATTERN, YEARLING CHINOOK
BONNEVILLE DAM, PH#2 DSM SAMPLER



*PARTIAL (<20 HRS.) OR NO SAMPLES:JUL 21,OCT 23-31.
INCOMPLETE SAMPLES(>20, <24 HRS.):JUL 6,7,8,10,14,15,20,22
BIASED SAMPLES:SEPT 13-OCT 31.

FIGURE 16

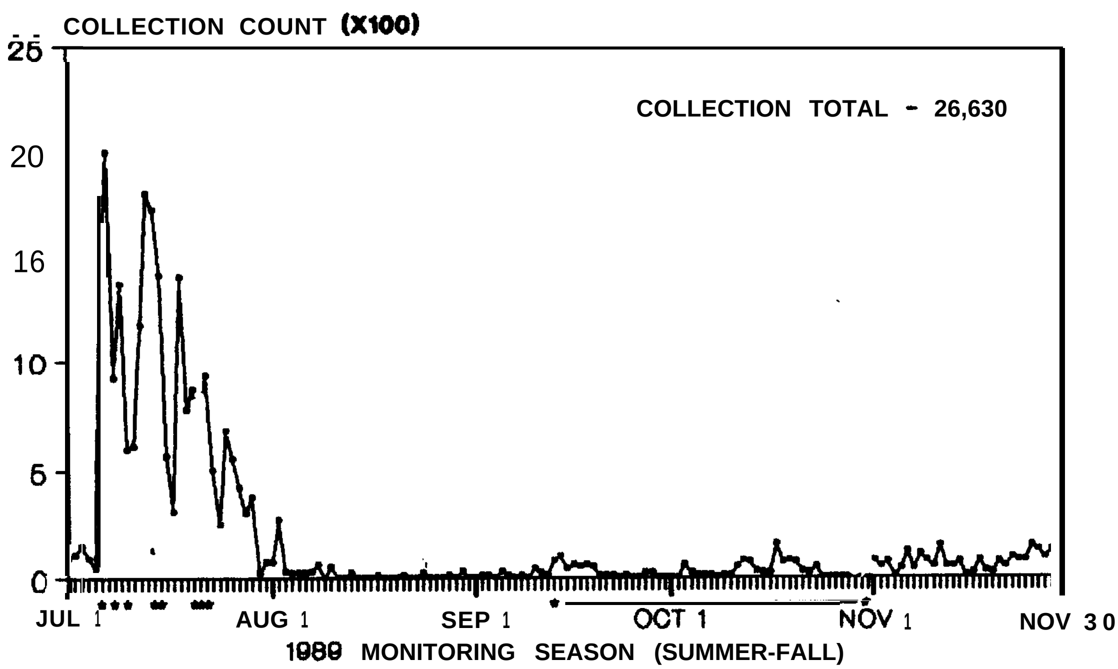
CAPTURE PATTERN, SUBYEARLING CHINOOK
BONNEVILLE DAM, PH#2 DSM SAMPLER



● PARTIAL(<20HRS.) OR NO SAMPLES:
APR 14-16,MAY 19-21,JUN 6,22,23.

FIGURE 17

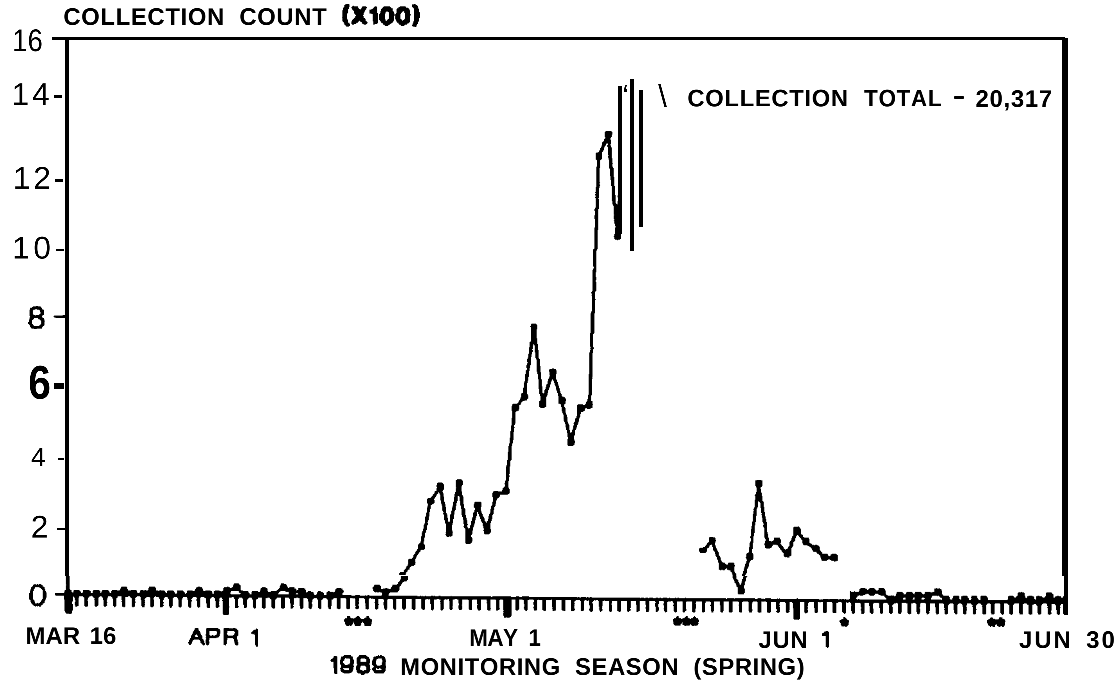
CAPTURE PATTERN, SUBYEARLING CHINOOK
BONNEVILLE DAM, PH#2 DSM SAMPLER



● PARTIAL(<20 HRS.) OR NO SAMPLE SAMPLES:JUL 21,OCT 23-31.
INCOMPLETE SAMPLES(>20, <24 HRS.):JUL 6-8,10,14-15,20,22
BIASED SAMPLES: SEPT 13-OCT 22.

FIGURE 18

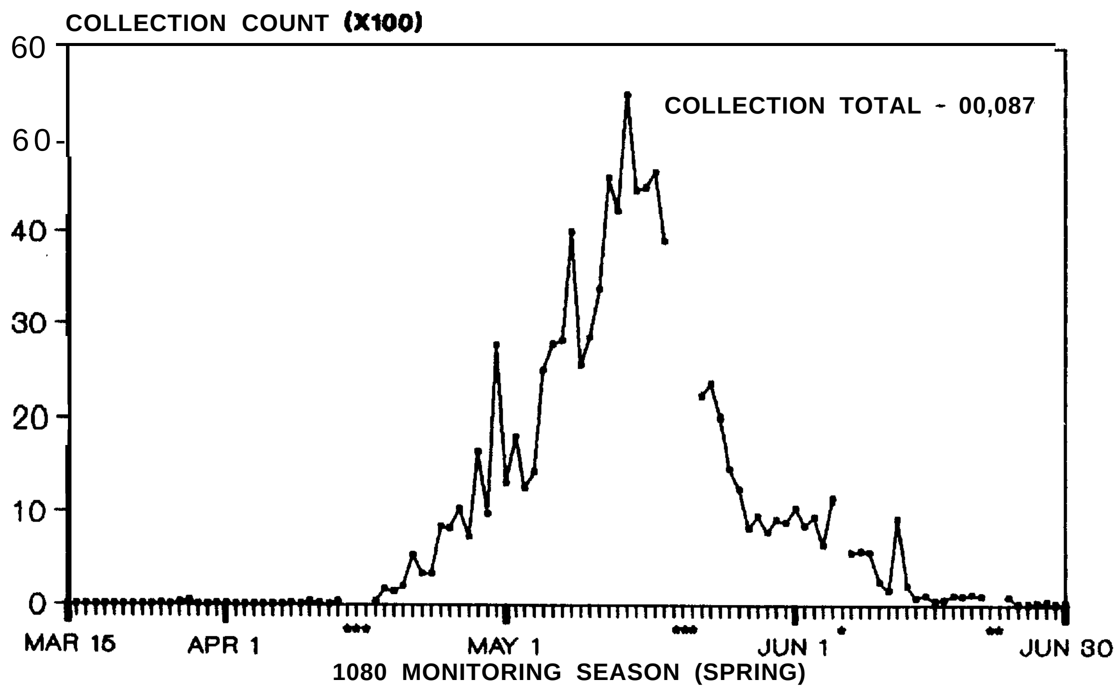
CAPTURE PATTERN, STEELHEAD
BONNEVILLE DAM. PH#2 DSM SAMPLER



● PARTIAL(QOHRS.) OR NO SAMPLES:
APR 14-16,MAY IO-21,JUN 8,22,23.

FIGURE 19

CAPTURE PATTERN, COHO
BONNEVILLE DAM, PH#2 DSM SAMPLER

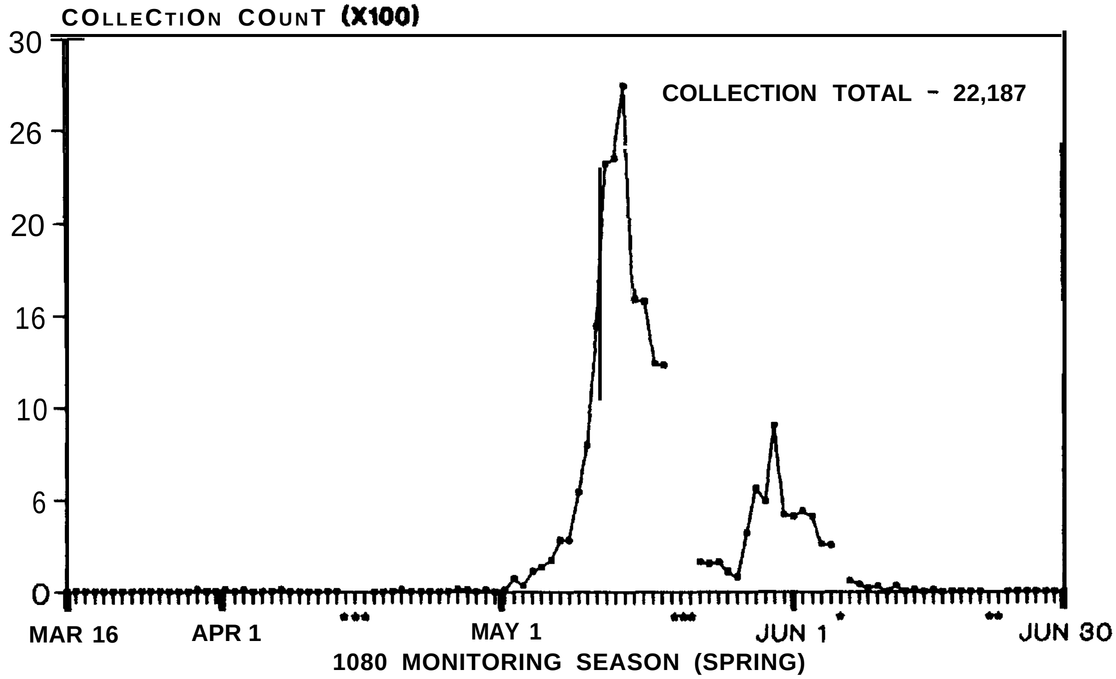


● PARTIAL(<20HRS.) OR NO SAMPLES:
APR 14-16,MAY 19-21,JUN 8,22,23.

FIGURE 20

CAPTURE PATTERN, SOCKEYE

BONNEVILLE DAM. PH#2 DSM SAMPLER



● PARTIAL(<20HRS,) OR NO SAMPLES:
APR 14-16,MAY IO-21,JUN 6,22,23.

FIGURE 21

CUMULATIVE CAPTURE - SPRING MIGRANTS
BONNEVILLE DAM, PH#1 DSM SAMPLER

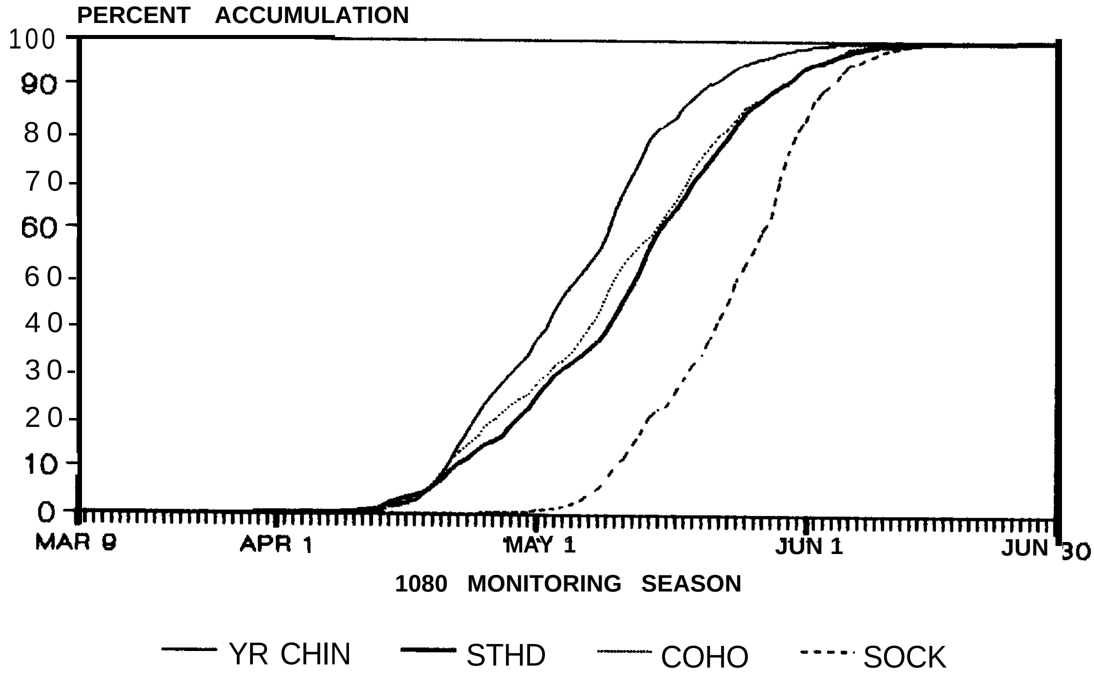


FIGURE 22

CUMULATIVE CAPTURE - SUBYEARLING CHINOOK
BONNEVILLE DAM, **PH#1** DSM SAMPLER
MARCH 9 - JUNE 30

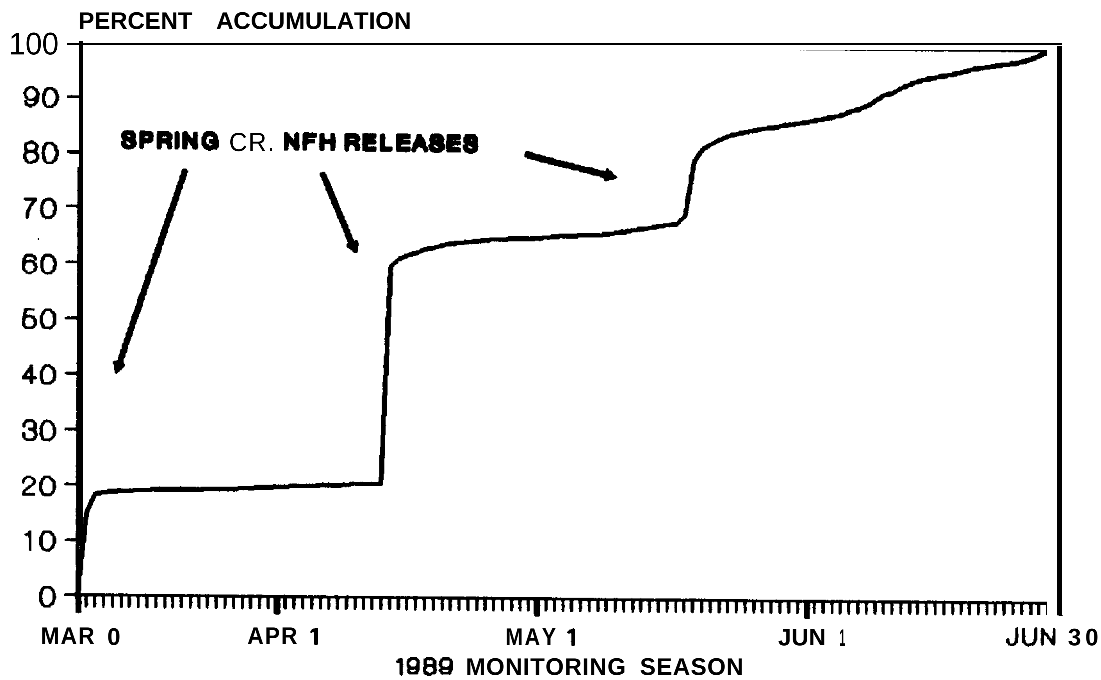


FIGURE 23

CUMULATIVE CAPTURE - SUBYEARLING CHINOOK

BONNEVILLE DAM, **PH#1 DSM SAMPLER**
JULY 1 - NOVEMBER 30

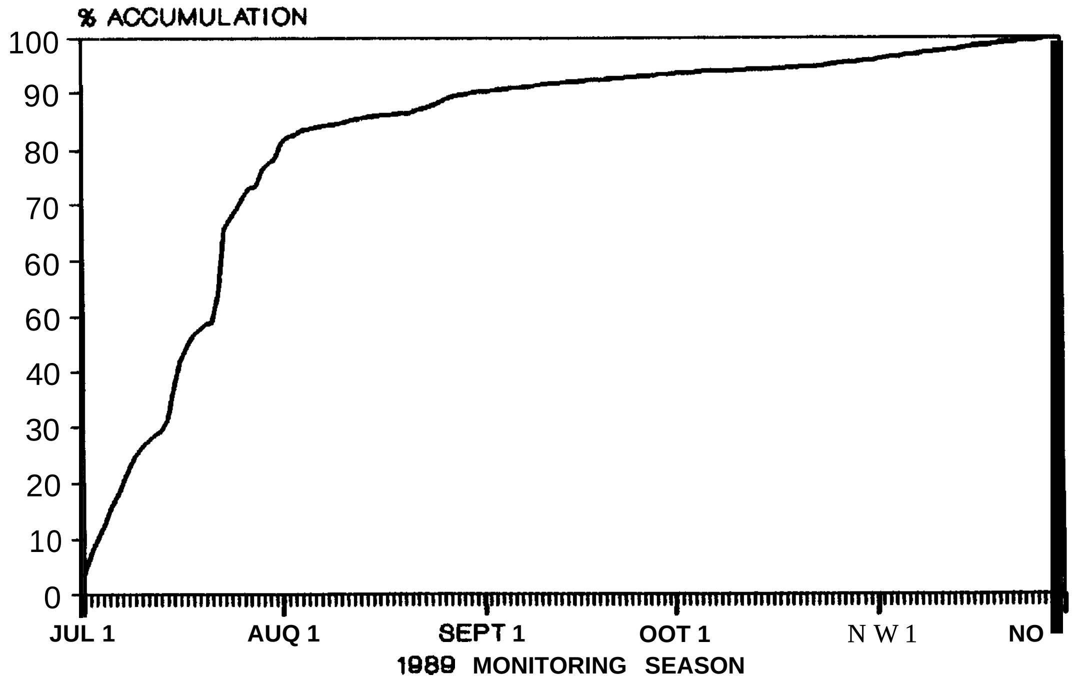
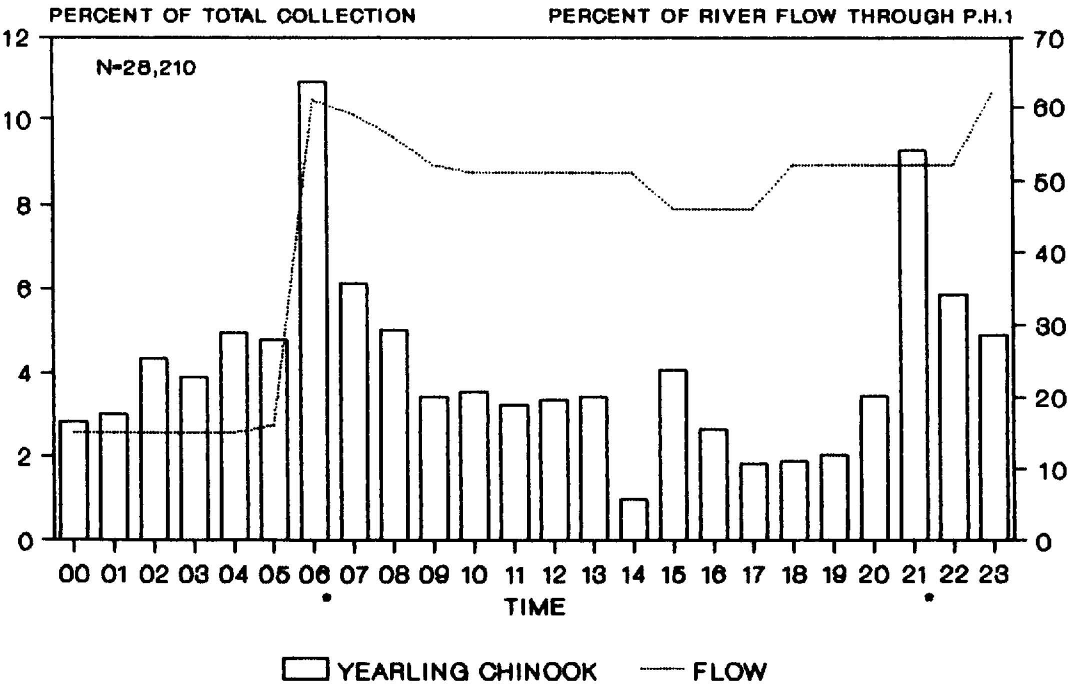


FIGURE 24

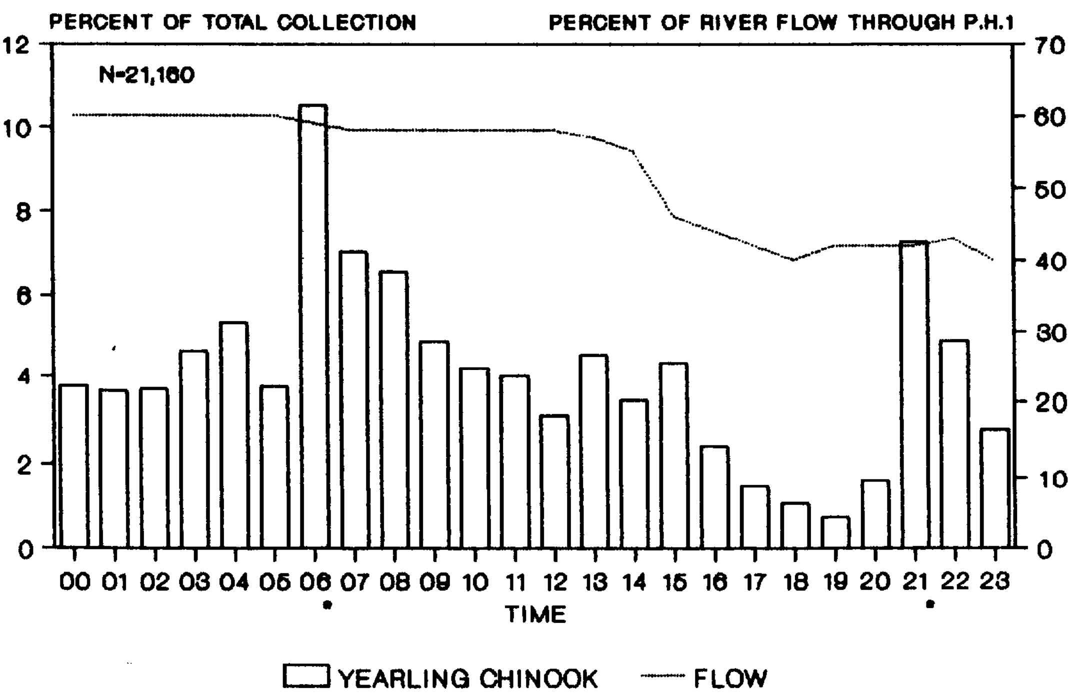
DIEL CAPTURE PATTERN - YEARLING CHINOOK
BONNEVILLE DAM, P.H.1 DSM, MAY 1, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 25

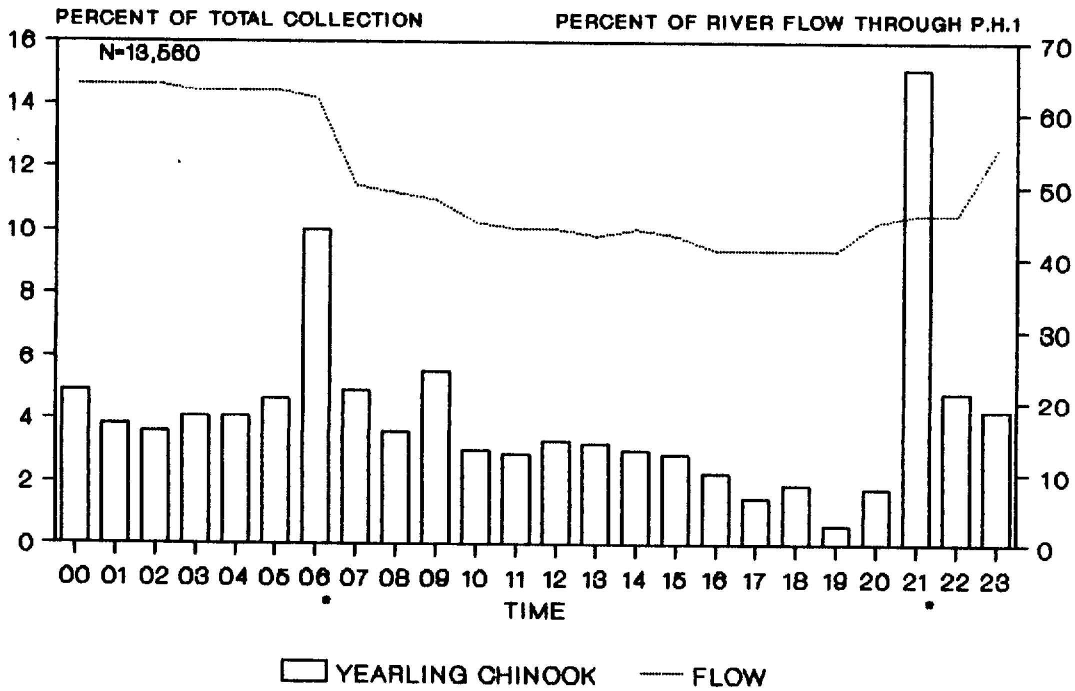
DIEL CAPTURE PATTERN - YEARLING CHINOOK
BONNEVILLE DAM, P.H.1 DSM, MAY 8, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 26

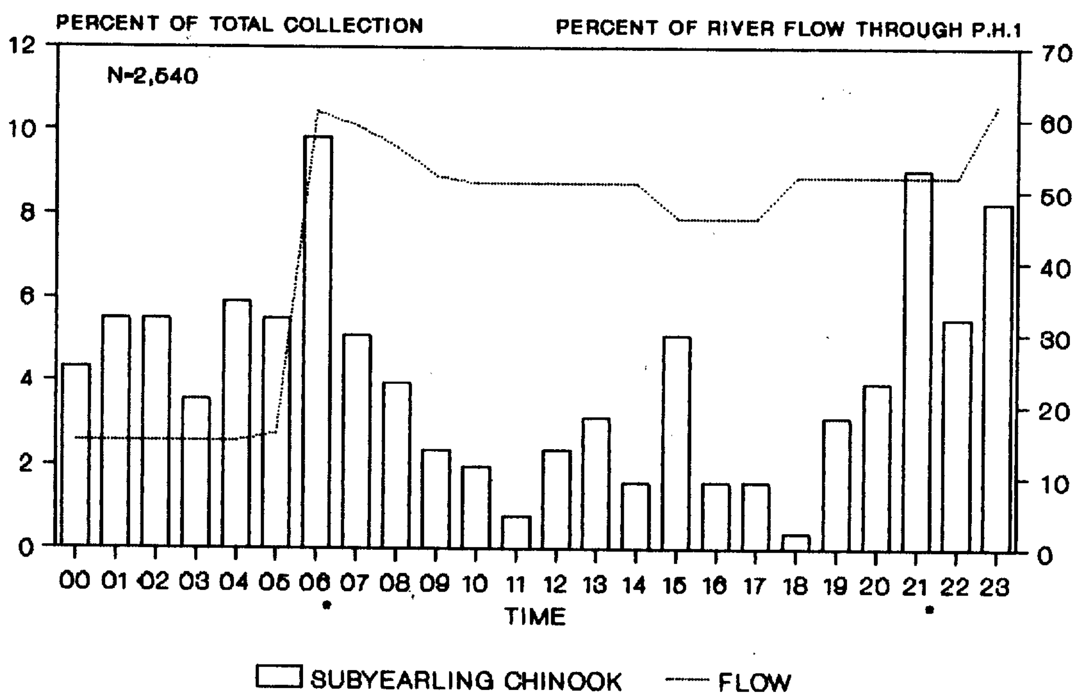
DIEL CAPTURE PATTERN - YEARLING CHINOOK
BONNEVILLE DAM, P.H.1 DSM, MAY 15, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 27

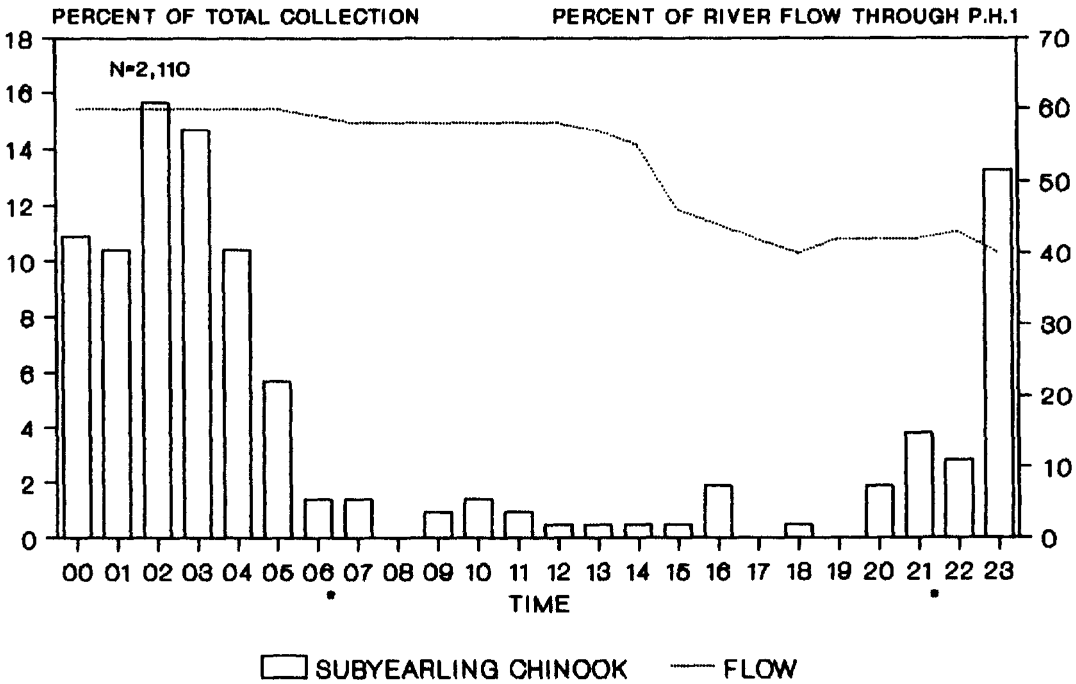
DIEL CAPTURE PATTERN -SUBYRLG CHINOOK
BONNEVILLE DAM, P.H.1 DSM, MAY 1, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 28

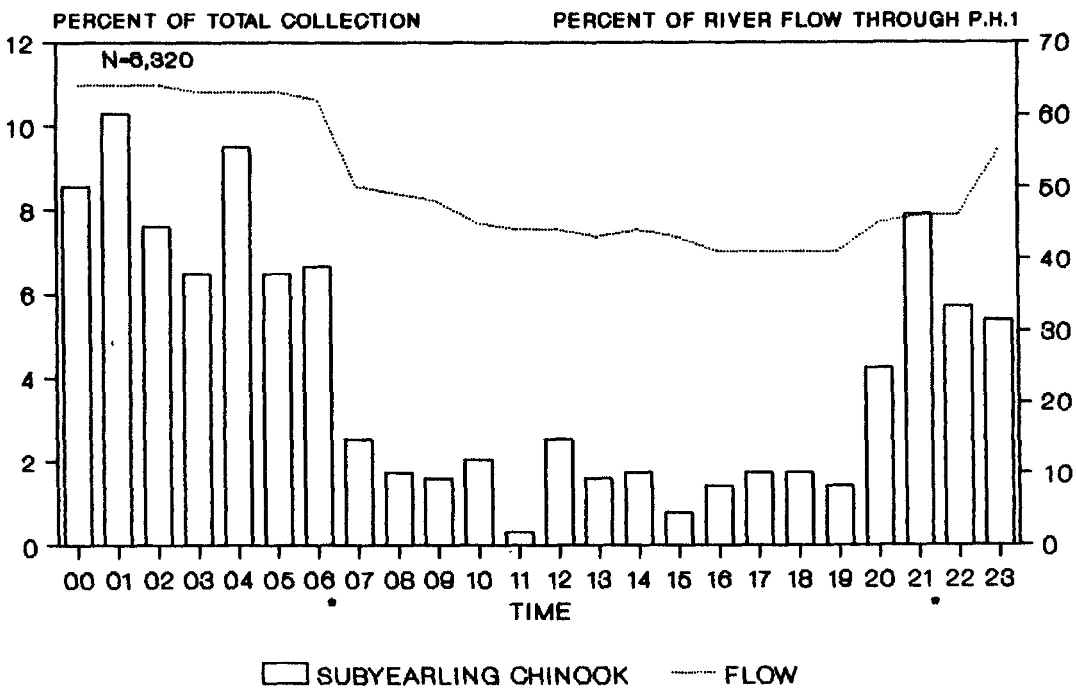
DIEL CAPTURE PATTERN - SUBYRLG CHINOOK
BONNEVILLE DAM, P.H.1 DSM, MAY 8, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 29

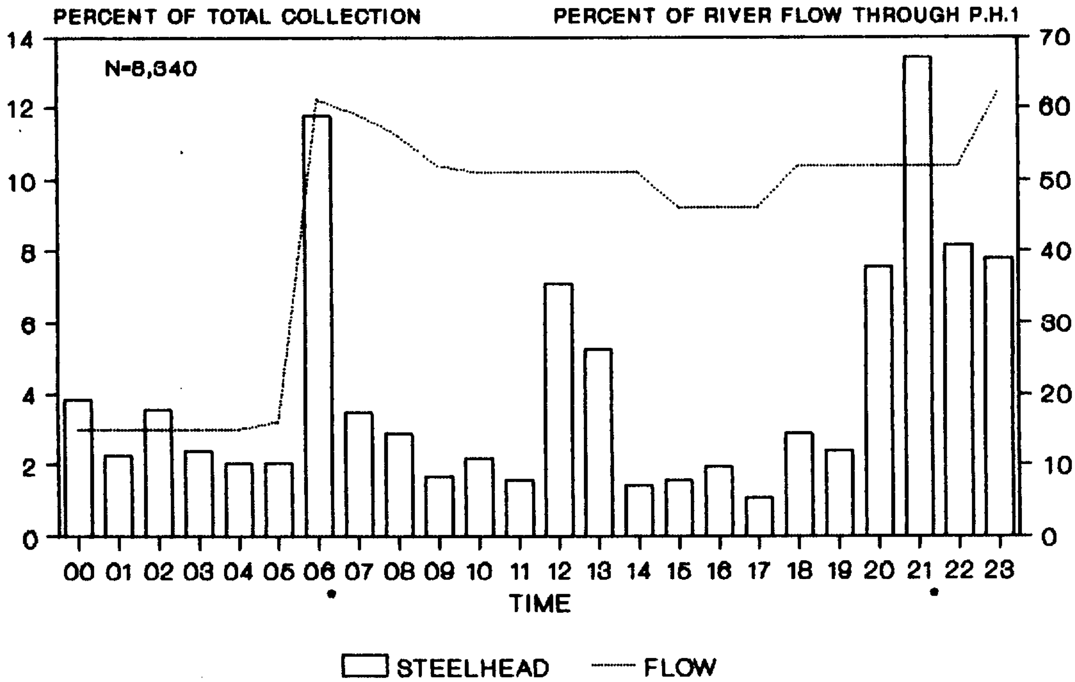
DIEL CAPTURE PATTERN - SUBYRLG CHINOOK
BONNEVILLE DAM, P.H.1 DSM, MAY 15, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 30

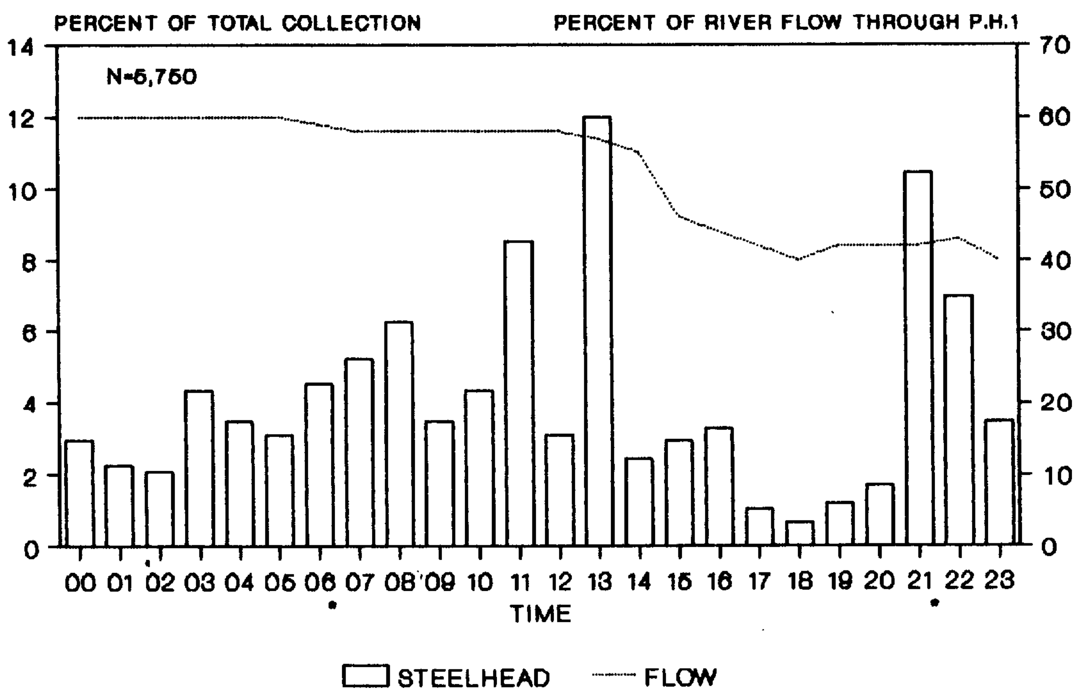
DIEL CAPTURE PATTERN - STEELHEAD
BONNEVILLE DAM, P.H.1 DSM, MAY 1, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 31

DIEL CAPTURE PATTERN - STEELHEAD
BONNEVILLE DAM, P.H.1 DSM, MAY 8, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 32

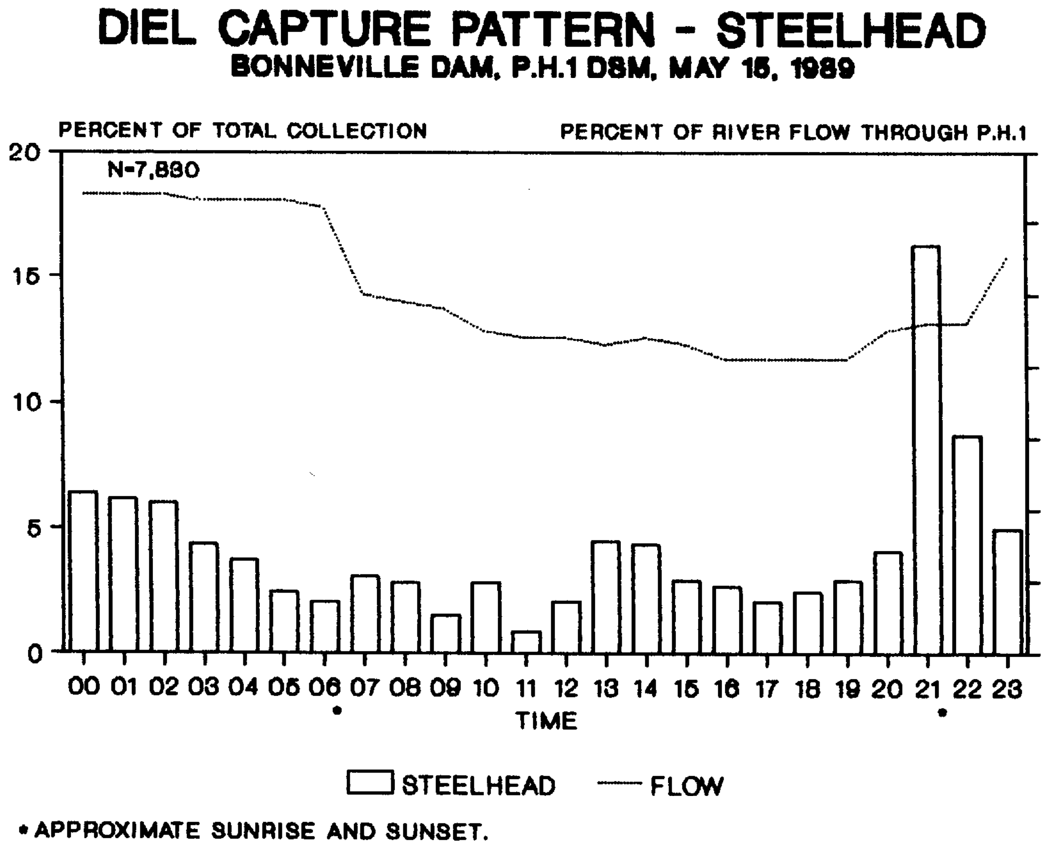


FIGURE 33

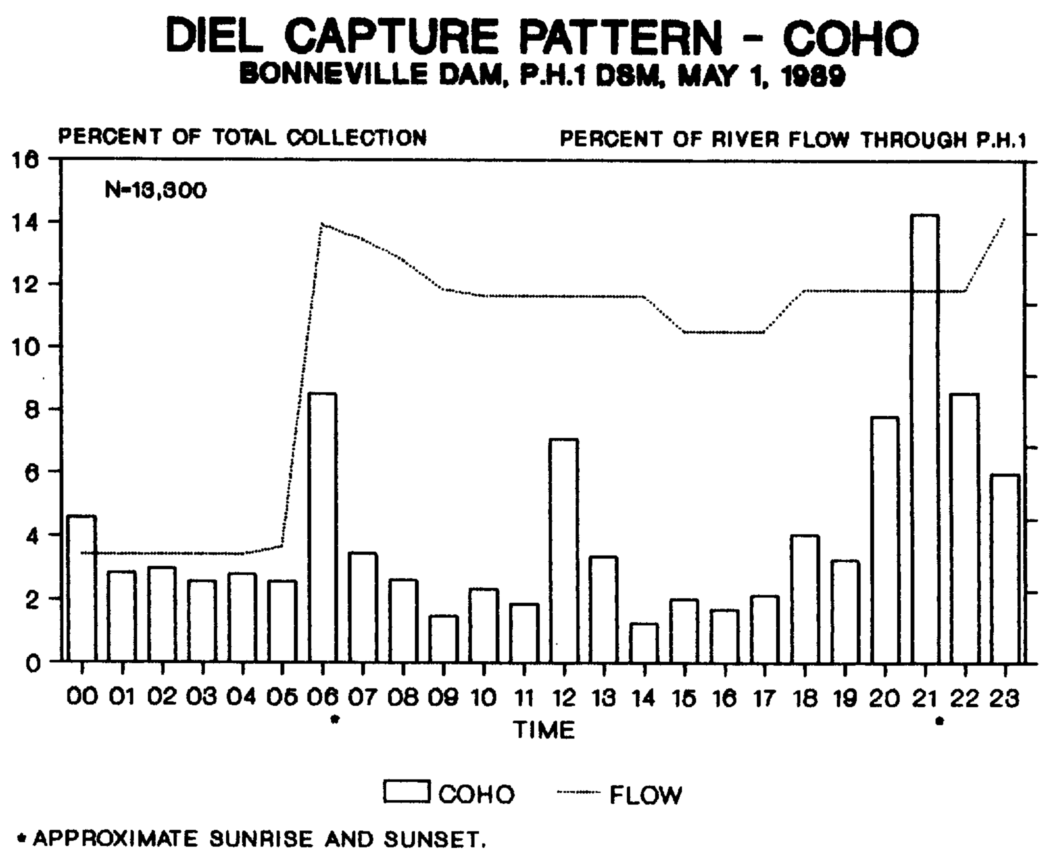
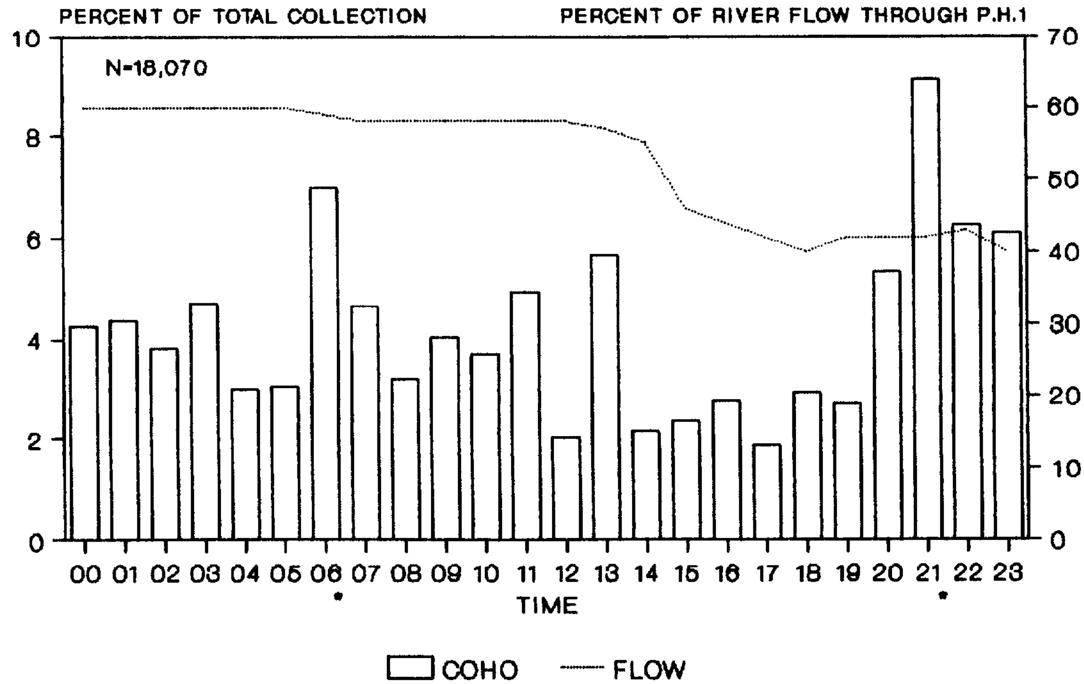


FIGURE 34

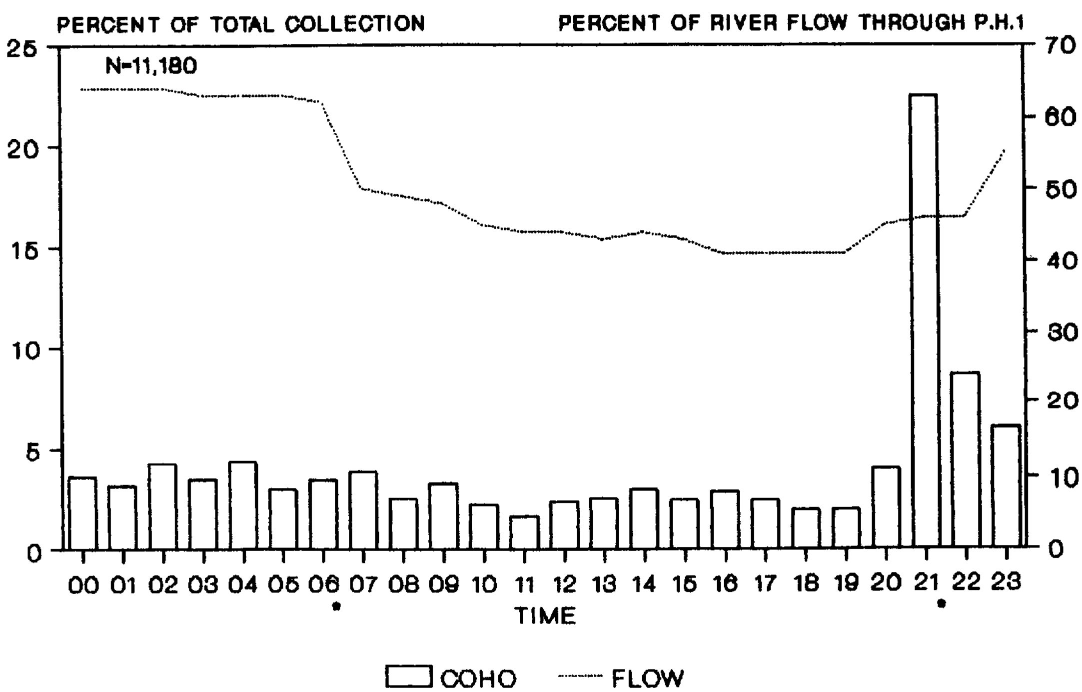
DIEL CAPTURE PATTERN - COHO
BONNEVILLE DAM, P.H.1 DSM, MAY 8, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 35

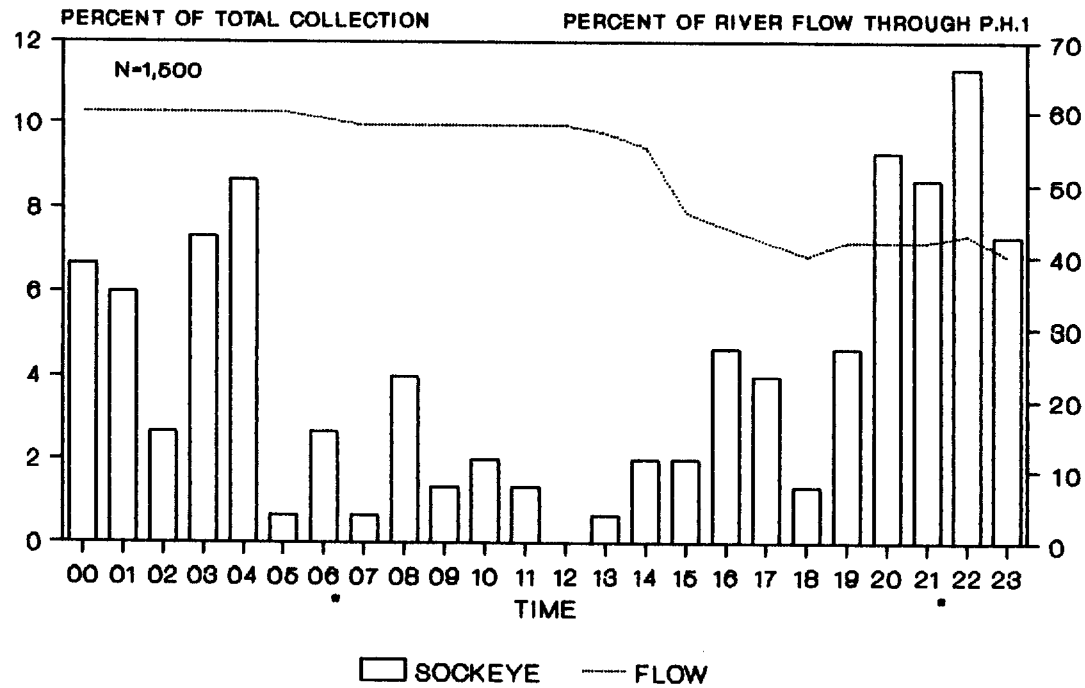
DIEL CAPTURE PATTERN - COHO
BONNEVILLE DAM, P.H.1 DSM, MAY 15, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 36

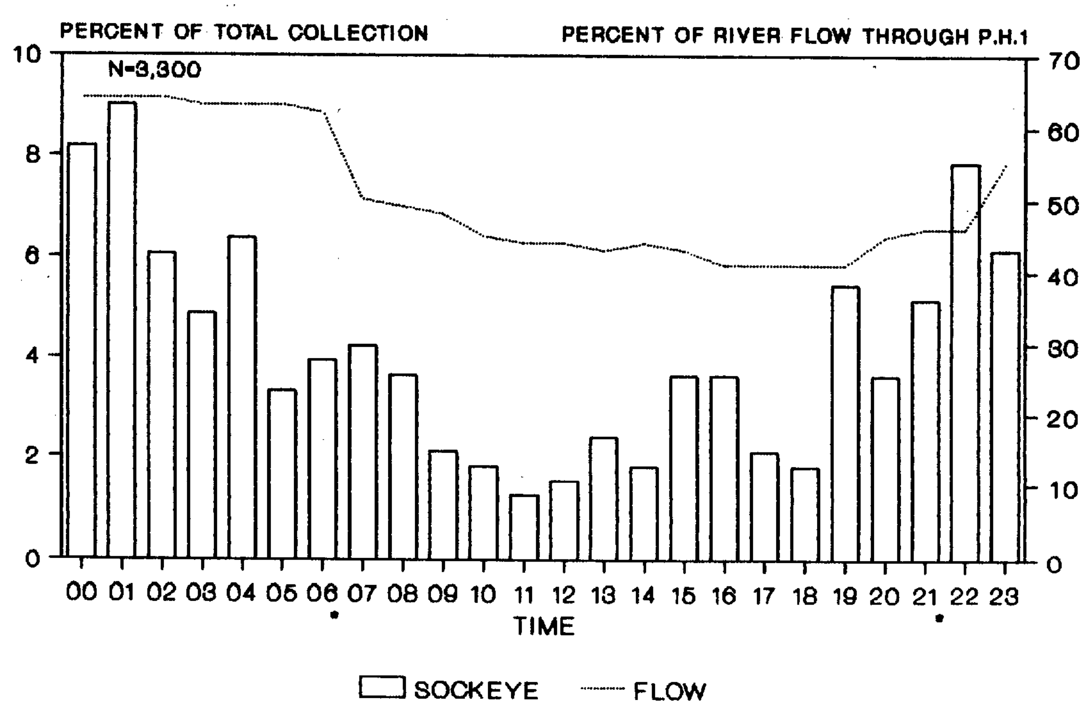
DIEL CAPTURE PATTERN - SOCKEYE
BONNEVILLE DAM, P.H.1 DSM, MAY 8, 1989



* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 37

DIEL CAPTURE PATTERN - SOCKEYE
BONNEVILLE DAM, P.H.1 DSM, MAY 15, 1989

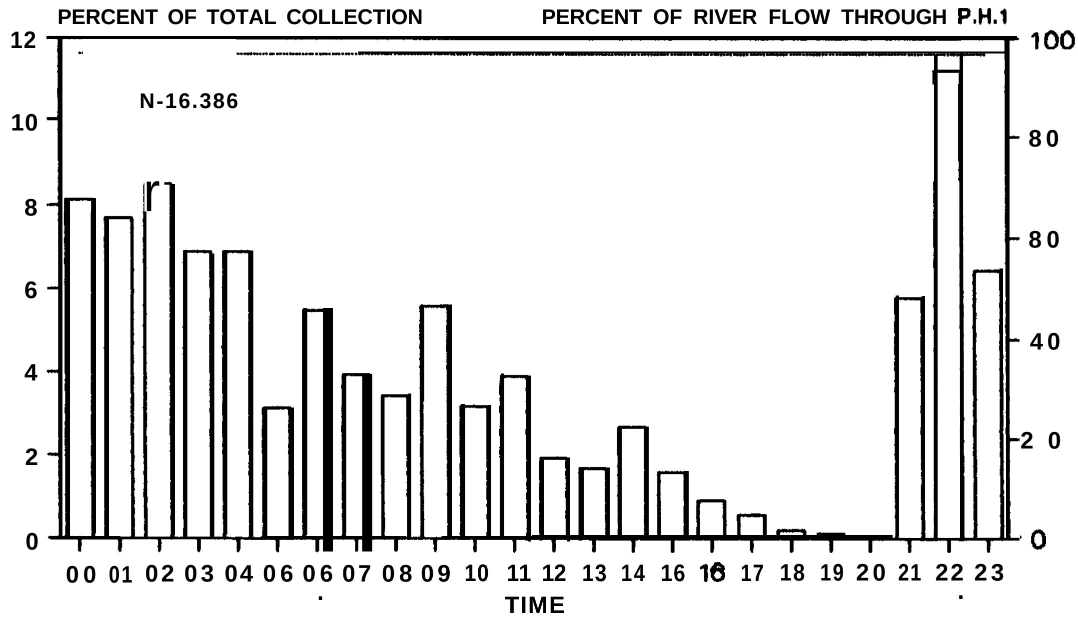


* APPROXIMATE SUNRISE AND SUNSET.

FIGURE 38

DIEL CAPTURE PATTERN - SUBYRLG CHINOOK

BONNEVILLE DAM, P.H.1 DSM, JULY 3, 1989



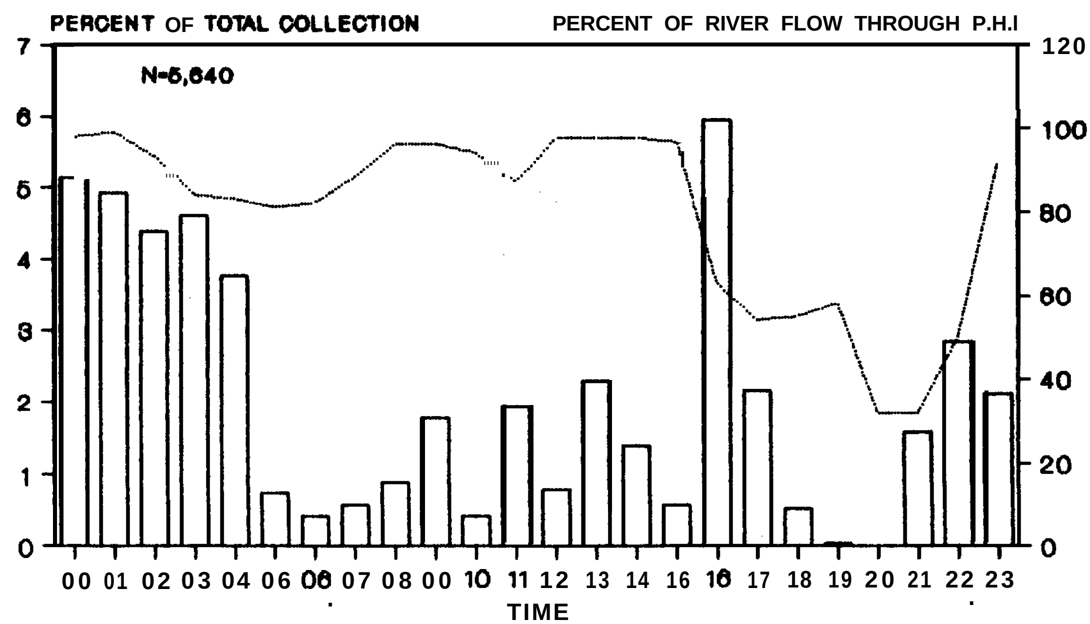
SUBYEARLING CHINOOK — FLOW

• APPROXIMATE SUNRISE AND SUNSET.

FIGURE 88

DIEL CAPTURE PATTERN - QUBYRLG CHINOOK

BONNEVILLE MM, P.H.I DSM, JULY 10, 1989

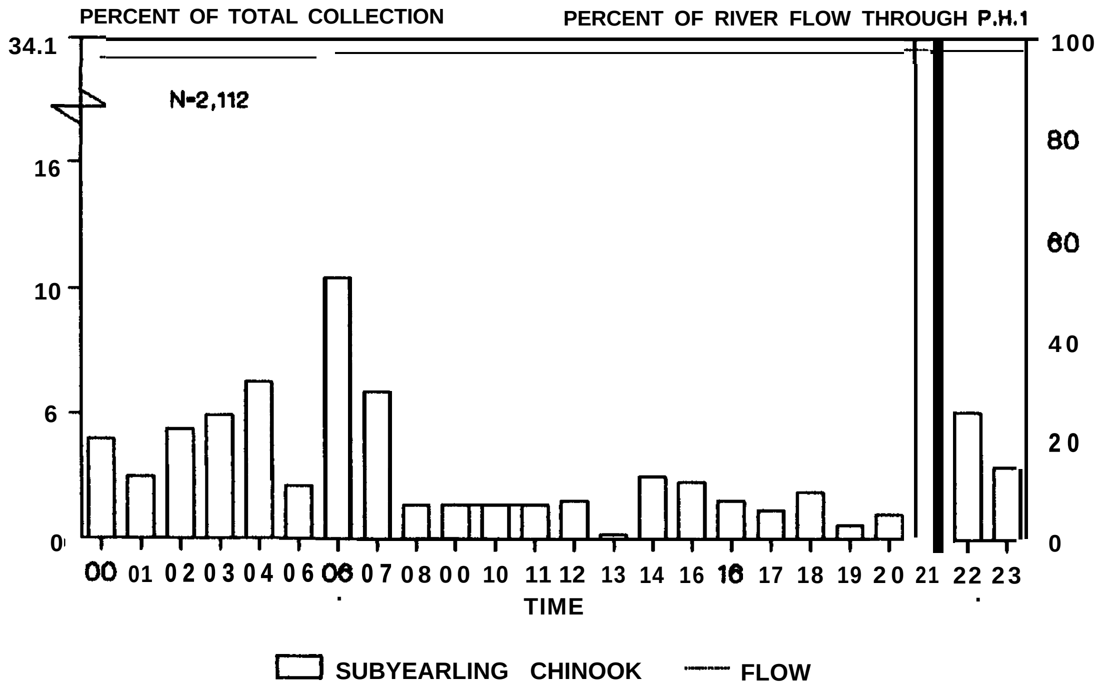


SUBYEARLING CHINOOK - - FLOW

• APPROXIMATE SUNRISE AND SUNSET.

FIGURE 40

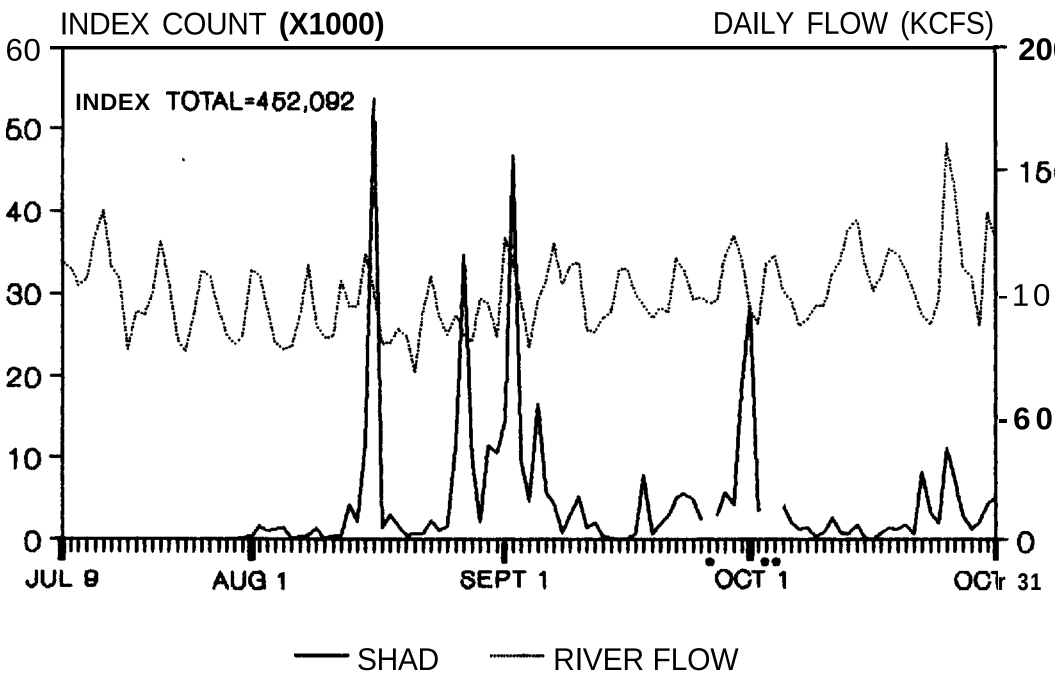
DIEL CAPTURE PATTERN - SUBYRLG CHINOOK
BONNEVILLE DAM, P.H.1 DSM, JULY 31.1989



• APPROXIMATE SUNRISE AND SUNSET.

FIGURE 41

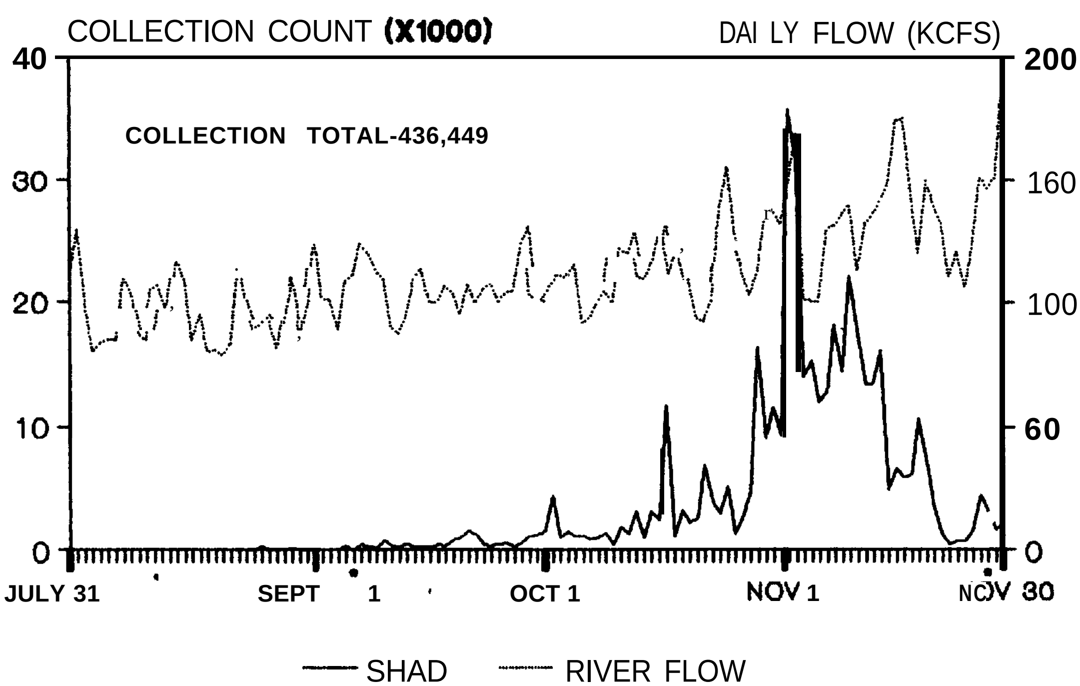
CAPTURE PATTERN, JUVENILE SHAD
JOHN DAY DAM, 1989



*NO SAMPLE: SEPT 26, OCT 3 & 4.

FIGURE 42

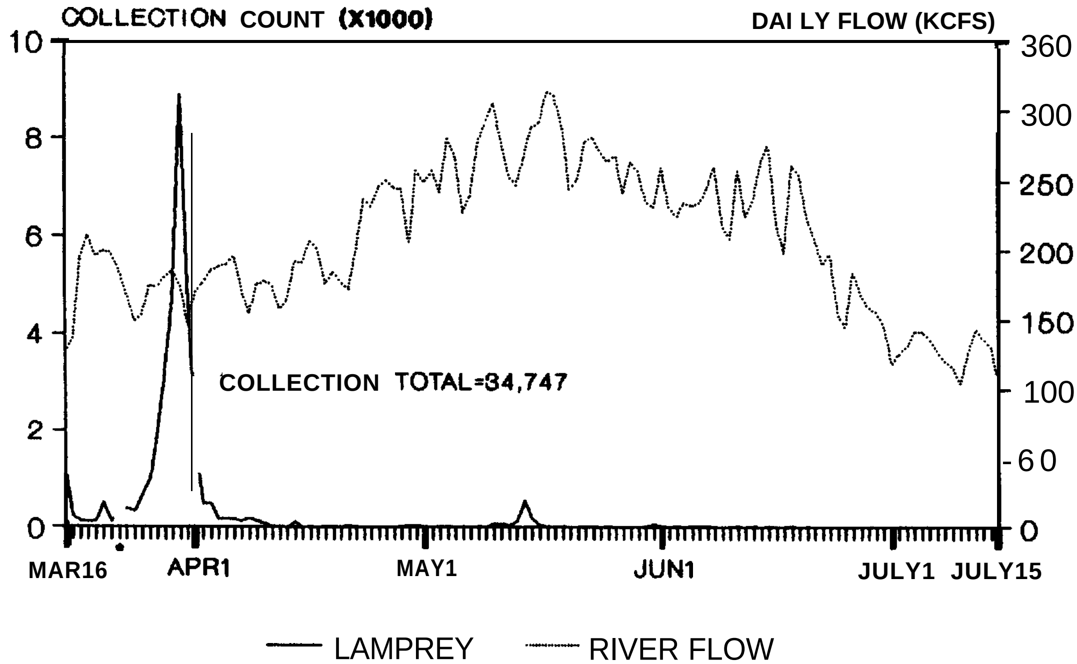
CAPTURE PATTERN, JUVENILE SHAD
BONNEVILLE DAM,PH1 DSM,1989



*NO SAMPLE ON SEPT 6 & NOV 28.

FIGURE 48

CAPTURE PATTERN, JUV. PACIFIC LAMPREY
BONNEVILLE DAM, PHI DSM SAMPLER,1989



*NO SAMPLE ON MARCH 22

FIGURE 44

APPENDIX E
BONNEVILLE DAM -1989

DELAYED MORTALITY TESTS

DELAYED MORTALITY TEST RESULTS - BONNEVILLE DAM, 1989[1/]

METHODS

Fish used in this test were from the hourly capture (1600 to 2400 hours) at the Bonneville dam First Powerhouse Downstream Migrant trap described by Gessel et. al. (1988). Since there are no holding facilities at the first powerhouse, all test fish had to be transported to a raceway in the second powerhouse. Due to the limited raceway space and the complexities of moving and holding the test fish, only subyearling and yearling chinook and steelhead were tested. Yearling chinook and steelhead were captured from 30 April to 18 May and subyearlings from 2 July to 20 July.

The treatment groups consistedof fish captured and processed during our normal nightly sampling. These fish were anesthetized in a 50 ppm solution of tricaine (MS-222), inspected for brands and condition, counted, and put into transport tanks. To provide sufficient replication and sample size for statistical comparison three replicates per species of approximately 35 fish were taken on three nights each week for three weeks. This resulted in 27 replicates and approximately 945 fish for each treatment group and spread the capture days over the peak passage period.

The control group for each species comprised 27 replicates of between 50 and 100 unsorted fish. Since this group could not be handled, it was hoped that by taking this many. fish, enough of the target species would be collected for comparison with the treatment group. These fish were captured in a separate sample concurrently with the treatment fish and transferred in water via sanctuary nets (Mathews et. al., 1986) from the holding tanks to the transport tanks.

All groups were transported by truck to net pens placed in a raceway and left undisturbed for 48 hours. A flow of river water was kept at approximately 65 gallons per minute through the raceway. Water temperature ranged from 12 to 14.5 degrees C. during the spring tests and 18 to 22 degrees C. during the summer tests. At the end of this period each group was anesthetized, counted and inspected for condition and all mortalities were counted and inspected for a possible cause of death.

1/ Test plan and completion by Gary L. Fredricks and David B. Jepsen.

RESULTS AND DISCUSSION

A total of 924 treatment and 1447 control yearling chinook were tested with a respective mortality rate of 1.95 and 1.45 percent (Attachment, Table 1), 946 treatment and 1168 control subyearling chinook were tested with mortality rates of 1.8 and 1.63 percent (Attachment, Table 2) and 940 treatment and 835 control steelhead produced mortality rates of only 0.74 and 0.48 percent respectively (Attachment, Table 3).

Although higher for the treatment groups, the differences between these average mortality rates appear quite small at 0.50, 0.17 and 0.26 of a percent for yearling, subyearling chinook and steelhead respectively.

To determine the significance of the difference between mortality rates of the treatment and control groups, an appropriate statistical test was needed. Since the comparative data were obtained over a period of three weeks and consisted of live and dead fish of each replicate of treatment and control groups, the data were arranged in 2x2 contingency tables. A test sensitive in detecting overall differences of data from grouped 2x2 tables is described by Snedecor and Cochran (1980). Results of this test are given for each species in Table 1.

Table 1. Results of Cochran's test for grouped 2x2 contingency tables.

	Yearling Chinook	Subyearling Chinook	Steelhead
Test criterion (Z)	0.87	0.48	0.62
P value (two tailed)	0.38	0.63	0.53

In this case the null hypothesis assumes that there is no difference between the treatment and control groups of each species. Because the test criteria in Table 1 are below the critical value of 1.96 at the 5% level, the null hypothesis is not rejected. Thus, using our normal handling methods, there appears to be no significant difference between mortality rates of handled verses non-handled yearling and subyearling chinook and steelhead. Not only was the difference between mortality rates statistically insignificant but also the actual mortality was only 2% or less for each group.

Physical condition played an important role in smolt survival in both the treatment and control groups with much higher incidence of descaled fish occurring in the mortalities of each group (Table 2). Sixty five percent of all mortalities were descaled as compared to an overall descaling of only 3.4%.

TABLE 2. Percentage of descaled fish occurring in the group totals and mortalities for each species. Sample size in parentheses.

	Treatment Total	Treatment Mortalities	Control Total	Control Mortalities
Chinook Yearling	5.2% (924)	83.3% (18)	4.0% (1447)	81.0% (21)
Chinook Subyearling	1.4% (946)	47.1% (17)	2.5% (1168)	31.6% (19)
Steelhead	3.5% (940)	85.7% (7)	3.6% (835)	100% (4)

Nearly 27% of all descaled fish died. This high incidence of mortality is reflected in Table 3. Steelhead demonstrated the highest tolerance for scale loss while subyearling chinook appear to be the most sensitive to handling while descaled.

TABLE 3. Mortality and % mortality for each group of descaled fish.

	Chinook Yearling			Chinook Subyearling			Steelhead		
	Test	Control	Total	Test	Control	Total	Test	Control	Total
Total Descaled	47	59	106	13	29	42	32	30	62
Mortalies Descaled	15	17	32	8	6	14	6	4	10
% Mort.	31.9	28.8	30.2	61.5	20.7	33.3	18.8	13.3	16.1

In conclusion, based on these data the present handling methods at the Bonneville dam first powerhouse sampler appear to have no significant effect on short-term survival of healthy yearling and subyearling chinook and steelhead. Descaled fish have a much lower chance for survival irrespective of how they are handled. No change is recommended in handling methods at this time but care should be taken to insure that sampling related scale loss be kept at a minimum.

It should be kept in mind that these studies in no way attempt to assess long term survival, nor do they attempt to address other issues such as stress related increases in mortality due to predation.

We wish to thank Tom Berggren of the Fish Passage Center for help with the statistical analysis.

LITERATURE CITED

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Mathews, G. M., D. L. Park, S. Achord, and T. E. Ruehle. 1986. Static Seawater Challenge Test to Measure Relative Stress Levels in Spring Chinook Salmon Smolts. Transactions of the American Fisheries Society 115:236-244.

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ATTACHMENT
DELAYED MORTALITY TEST RESULTS — BONNEVILLE DAM 1989

Attachment Table 1. Number of fish captured and statistical data for yearling chinook delayed mortality test.

CAPTURE DATE	REPLICATE	TEST TOTAL	MORT	% MORT	CONTROL TOTAL	MORT	% MORT
4-30	1	33	1	3.030	76	0	0.000
	2	37	0	0.000	56	0	0.000
	3	32	1	3.125	45	2	4.444
5-2	1	34	1	2.941	56	1	1.786
	2	34	0	0.000	62	0	0.000
	3	32	0	0.000	73	0	0.000
5-4	1	34	3	8.824	56	2	3.571
	2	35	1	2.857	80	2	2.500
	3	34	0	0.000	54	3	5.556
5-7	1	35	0	0.000	84	1	1.190
	2	35	1	2.857	77	1	1.299
	3	35	1	2.857	86	2	2.326
5-9	1	33	0	0.000	25	0	0.000
	2	35	1	2.857	37	0	0.000
	3	35	1	2.857	40	0	0.000
5-11	1	35	2	5.714	65	3	4.615
	2	35	0	0.000	45	1	2.222
	3	35	0	0.000	53	2	3.774
5-14	1	35	0	0.000	80	0	0.000
	2	34	0	0.000	96	0	0.000
	3	29	1	3.448	61	0	0.000
5-16	1	35	1	2.857	12	0	0.000
	2	34	1	2.941	17	0	0.000
	3	35	0	0.000	34	1	2.941
5-18	1	34	1	2.941	25	0	0.000
	2	35	0	0.000	31	0	0.000
	3	35	1	2.857	21	0	0.000
TOTALS		924	18		1447	21	
MEAN		34.22	0.67	1.95	53.59	0.78	1.45
STANDARD DEVIATION		1.48	0.73	2.15	23.32	1.01	1.77
MEDIAN		35	1	2.86	56	0	0
MINIMUM		29	0	0	12	0	0
MAXIMUM		37	3	8.82	96	3	5.56

Attachment Table 2. Number of fish captured and statistical data for subyearling chinook delayed mortality test.

CAPTURE DATE	REPLICTE	TEST TOTAL	TEST MORT	TEST % MORT	CONTROL TOTAL	CONTROL MORT	CONTROL % MORT
7-2	1	35	0	0.000	41	0	0.000
	2	35	1	2.857	42	1	2.381
	3	35	0	0.000	58	0	0.000
7-4	1	37	0	0.000	43	1	2.326
	2	35	1	2.857	51	0	0.000
	3	35	2	5.714	53	1	1.887
7-6	1	35	0	0.000	37	1	2.703
	2	33	1	3.030	60	4	6.667
	3	37	1	2.703	69	2	2.899
7-9	1	34	0	0.000	39	0	0.000
	2	36	0	0.000	46	3	6.522
	3	35	1	2.857	34	0	0.000
7-11	1	37	1	2.703	38	0	0.000
	2	34	0	0.000	36	0	0.000
	3	35	0	0.000	41	2	4.878
7-13	1	35	1	2.857	42	1	2.381
	2	35	0	0.000	40	0	0.000
	3	35	1	2.857	43	0	0.000
7-16	1	35	1	2.857	46	0	0.000
	2	35	1	2.857	47	0	0.000
	3	35	2	5.714	39	0	0.000
7-18	1	35	0	0.000	40	0	0.000
	2	33	0	0.000	33	2	6.061
	3	34	2	5.882	35	0	0.000
7-20	1	29	0	0.000	38	1	2.632
	2	41	0	0.000	40	0	0.000
	3	36	1	2.778	37	0	0.000
TOTAL		946	17		1168	19	
MEAN		35.04	0.63	1.8	43.26	0.7	1.63
STANDARD DEVIATION		1.93	0.69	1.97	8.48	1.07	2.21
MEDIAN		35	1	2.7	41	0	0
MINIMUM		29	0	0	33	0	0
MAXIMUM		41	2	5.88	69	4	6.67

Attachment Table 3. Number of fish captured and statistical data for steelhead delayed mortality test.

CAPTURE DATE	REPLICATE	TEST TOTAL	MORT	% MORT	CONTROL TOTAL	MORT	% MORT
4-30	1	30	0	0.000	17	0	0.000
	2	41	1	2.439	26	0	0.000
	3	31	0	0.000	26	0	0.000
5-2	1	34	0	0.000	26	0	0.000
	2	40	0	0.000	26	0	0.000
	3	31	0	0.000	22	0	0.000
5-4	1	35	1	2.857	29	0	0.000
	2	32	0	0.000	30	0	0.000
	3	34	1	2.941	16	0	0.000
5-7	1	33	0	0.000	17	0	0.000
	2	35	0	0.000	21	0	0.000
	3	36	0	0.000	26	0	0.000
5-9	1	34	0	0.000	17	0	0.000
	2	32	0	0.000	23	0	0.000
	3	35	0	0.000	24	1	4.167
5-11	1	38	1	2.632	50	0	0.000
	2	35	1	2.857	31	1	3.226
	3	35	0	0.000	24	1	4.167
5-14	1	38	0	0.000	51	0	0.000
	2	35	0	0.000	55	0	0.000
	3	35	0	0.000	66	1	1.515
5-16	1	35	0	0.000	41	0	0.000
	2	36	1	2.778	32	0	0.000
	3	35	0	0.000	53	0	0.000
5-18	1	35	1	2.857	22	0	0.000
	2	35	0	0.000	31	0	0.000
	3	35	0	0.000	33	0	0.000
TOTALS		940	7		835	4	
MEAN		34.85	0.26	0.74	30.93	0.15	0.48
STANDARD DEVIATION		2.49	0.45	1.24	13.18	0.36	1.25
MEDIAN		35	0	0	26	0	0.00
MINIMUM		30	0	0	16	0	0.00
MAXIMUM		41	1	2.94	66	1	4.17