FEEDING ACTIVITY, RATE OF CONSUMPTION, DAILY RATION AND PREY SELECTION OF MAJOR PREDATORS IN JOHN DAY RESERVOIR, 1985

ANNUAL REPORT

By

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ABSTRACT

This report summarizes activities in 1985 to determine the extent of predation on juvenile salmonids in John Day Reservoir. To estimate consumption of juvenile salmonids we used the composition of the natural diet of predators and in the laboratory determined rate of gastric evacuation by predators. Salmonids were the single most important food item (by weight) for northern squawfish (Ptychocheilus oregonensis) at McNary tailrace during all sampling periods and at John Day forebay during July. Salmonids accounted for 11.6% of the diet of walleye (Stizostedion vitreum vitreum) in 1985, which was slightly lower than in 1984, but still about twice that found in previous years. Salmonids contributed little to smallmouth bass (Micropterus dolomieui) diet but comprised about 25% of the diet of channel catfish (Ictalurus punctatus). Composition of prey taxa in beach seine catches in 1985 was similar to 1983 and 1984 with chinook salmon (Oncorhynchus tschawytscha), northern squawfish, largescale sucker (Catostomus macrocheilus), and sand roller (Percopsis transmontana) dominating the catch at main channel stations and crappies (Pomoxis spp.) and largescale sucker dominating at backwater stations. Preliminary results of beach seine efficiency studies suggest that seine efficiency varied significantly among prey species and between substrate types in 1985. Results of digestion rate experiments indicate that gastric evacuation in northern squawfish can be predicted using water temperature, prey weight, predator weight and time. Preliminary estimates of juvenile salmonid consumption by walleye using

evacuation rates from the literature indicate that walleye consumption rates are highest t&y through July and at the Irrigon station.

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INTRODUCTION

The Seattle National Fishery Research Center of the U.S. Fish and Wildlife Service (USFWS) is working in cooperation with the Oregon Department of Fish and Wildlife (ODFW) to determine the extent of predation by northern squawfish (Ptychocheilus oregonensis), walleye (Stizostedion vitreum vitreum), smallmouth bass (Micropterus dolomieui), and channel catfish (~ctalurus punctatus) on juvenile anadromous salmonids in John Day Reservoir. Three objectives, to be completed by 1987, were identified in the original USFWS proposal:

1) Determine the food habits, rate of consumption, daily ration, and feeding activity of major predators.
2) Determine the pattern of prey selection of major predators as a function of time and reservoir habitat.
3) Estimate the rate of gastric evacuation of major predators.

Following consultation with ODFW and Bonneville Power Administration (BPA) personnel two new objectives were added in 1984:

4) Determine the feasibility of regulating predation on juvenile salmonids.
5) Develop conceptual and predictive models of the predator-juvenile salmonid relationship in John Day Reservoir.

This report includes progress on activities by the USFWS to meet the first three objectives.

During 1985, the following sub-objectives were addressed:

A. Obtain field data to estimate consumption and describe food habits of northern squawfish, walleye, smallmouth bass, and channel catfish during the smolt outmigration. Stomach content data will be used to estimate the average daily consumption for a predator with the contribution of juvenile salmonids delineated.

B. Describe the composition, apparent abundance, and distribution of prey fishes in John Day Reservoir during the smolt outmigration in 1985. Apparent abundance of prey and predator food habits data (Sub-objective A) will be examined to determine if prey selection exists.

C. Determine efficiency of the beach seine in collecting various prey species over different substrate types.

D. Obtain data to describe statistical relationships between fork length of non-salmonid prey fishes and other body or bone measurements. Body length versus bone length regressions will be used to back-calculate original body length of partially digested prey fish found in stomachs of predators and length measurements will be converted to weight and used to estimate food consumption.

E. Complete digestion experiments for northern squawfish and develop the methodology and initiate single and multiple meal experiments for smallmouth bass. Regression equations of northern squawfish and smallmouth bass digestion versus time will be used to estimate time of ingestion of prey fish found in stomachs and used to calculate food consumption.

F. Estimate consumption of juvenile salmonids by walleye, 1982-1985.

G. Obtain data on whether the state of fish health could influence prey selection of northern squawfish. Histopathological examinations of smolts consumed (Sub-objective G) will be made to determine the feasibility of using this technique to reveal the state of fish health at time of ingestion.

METHODS

Food Habits

Food consumption of predators was monitored by sampling three 24 h periods at each of four stations from April through September. Sampling stations at John Day forebay, Arlington, Irrigon and McNary tailrace (Fig. 1) and techniques used to collect and process predatory fish and to analyze stomach contents were similar to those used previously (Gray et al. 1986). Percent by weight, mean number of food items per predator and percent occurrence were calculated. Percent composition by weight was considered the best indicator of a prey item's relative importance, however, mean number of food items in digestive tracts of predators was also used in comparisons.

Abundance and Distribution of Prey Fishes

Prey fishes (5 250 mm) were collected during each sampling period using a 30.5 x 2.4-m beach seine constructed of 6.4 mm knotless nylon mesh, with a 2.4 x 2.4 x 2.4-m bag. Main channel littoral habitats were sampled at McNary tailrace, Irrigon, Arlington, and John Day forebay. Backwater habitats were sampled at McNary tailrace (Plymouth slough) and Irrigon (Paterson slough). Four seine hauls were made after sunset at each station during each sampling period; Sampling and enumeration techniques followed Gray et al. (1985).

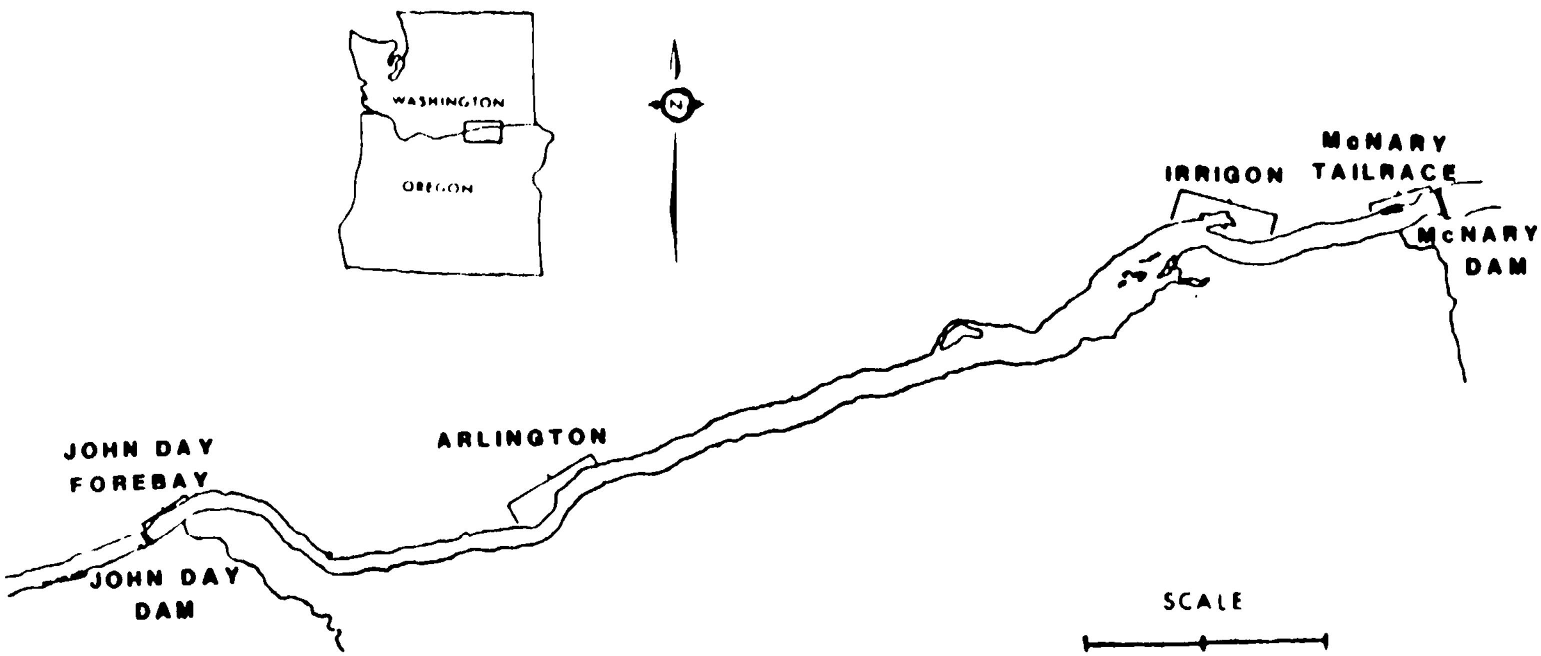


Figure 1. Location of stations sampled in John Day Reservoir, April to September, 1985.

Beach Seine Efficiency

Field experiments were conducted at John Day forebay and backwaters at McNary tailrace and Irrigon to determine the efficiency of the seine in collecting various prey species over two substrate types. Sites selected had substrates composed of either sand (particle size $\leq$ 2 mm) or a mixture of sand, gravel (particle size 2-64 mm), and cobble (particle size 64-250 mm).

Efficiency of the beach seine was determined by seining within an enclosure. A square enclosure (30.5 m sides) was constructed using a block net (91.5 x 3.1 m with 6.4 mm knotless nylon mesh) on three sides and using the shore for one side. The seine was deployed perpendicular to the shore along one side of the block net. Using an extension rope, the offshore end was then pulled to shore resulting in a haul the shape of a quarter circle. Six to ten seine hauls were made to remove the majority of fish in the enclosure. The seine was deployed along alternate sides of the block net to insure that the entire enclosure was seined. After repeated seining of the enclosure, the block net was retrieved to remove any fish remaining in the enclosure. Captured prey fishes were identified to species except for suckers (*Catostomus* spp.), crappies (*Pomoxis* spp.), and sunfishes (*Lepomis* spp.) which were identified to the genus level. Fish < 30 mm FL were not enumerated since these fish could pass through the mesh of the seine and block net.

Seine efficiency (SE) for each species or genus were calculated by the following equation:

$$SE = \frac{C}{T\ (0.64)}$$

where (C) is the catch of a given species in the first haul; (T) is the total number of that species available to the seine on the first haul; and 0.64 is the ratio of the area covered by the seine on the first haul to the area enclosed by the block net. We assumed random distribution of prey fishes in the enclosure. Seine efficiency was not calculated if 3 fish of a given species were removed from the enclosure.

Body Length Regressions

Relationships between fork length of potential prey fish and other morphological measurements (total length, standard length, nape to tail length, cleithrum, dentary, opercle, hypural plate, pharyngeal tooth, preopercle) were developed. Prey fish samples were processed in the same manner as juvenile chinook salmon in 1983 (Gray et al. 1985). Body and bone lengths were measured for steelhead trout, chinook salmon, bridgelip sucker, largescale sucker, chiselmouth, sand roller, peamouth, prickly sculpin, northern squawfish, American shad, and smallmouth bass.

Digestion Experiments

Methods used in northern squawfish digestion experiments were similar to those described in Gray et al. (1983 and 1984).

Smallmouth bass digestion experiments were similar to northern squawfish experiments with the following modifications:

(1) prey fish sizes used were 0.26-0.38 g, 1.0-1.8 g, and 3.0-5.0 g; (2) predator size groups used were < 200 mm, 200-300 mm, and > 300 mm; (3) prior to any evacuation experiments the smallmouth bass were starved for 24-48 h; and (4) the smallmouth bass which were used more than once were given a seven day period between testing.

Experiments were performed using single and multiple meals of juvenile salmonids. The prey fish were blotted on absorbent paper and weighed to the nearest 0.001 g. Fork lengths were measured to the nearest 1.0 mm. A color-coded thread was sewn between the dorsal fin and backbone to facilitate identification of consumed prey. One to three juvenile salmonid prey fish were introduced into each section of the tank, and after voluntary feeding, samples were taken at 1 to 4-h intervals until 90% evacuation occurred. Samples were obtained by pumping the stomach using the same methods as those used in the field (Gray et al. 1984).

Stepwise multiple regression (SAS 1985) was used to select variables significantly (P<0.01) affecting gastric evacuation. Variables considered included time (h), water temperature (C), meal size (prey weight/predator weight x 100), prey weight (g), predator weight (g) (weight minus weight of digestive tract contents), predator length (mm FL), and predator condition factor (105 x weight/FL3). F-tests were used to evaluate the significance of the equations and the variables. Independent variables were selected for linear, exponential, and square root models. The resulting equations were then evaluated for fit and ability to meet the linear least squares assumptions of normality, homoscedasticity, and independence of residuals.

Multiple meal experiments were analyzed differently for northern squawfish and smallmouth bass. Evacuation (g) of northern squawfish two-fish meals was compared to one-fish meals using t-tests. To validate the prediction equation, one-fish meals were compared to predicted means and confidence intervals for additional samples. Smallmouth bass multiple meals were included in the stepwise analysis. Total weight of the fish was used as the prey weight, and number of prey was tested as an additional independent variable. The relationship between fresh and preserved weights developed for northern squawfish digestive tract contents was applied to the smallmouth bass contents before the data were analyzed.

Consumption Estimates

The technique we developed to estimate daily consumption rates of salmonid smolts by walleye in the John Day Reservoir was based on the original work of Swenson (1972). This method synthesized all aspects of the predator-prey research to derive an estimate of die1 feeding chronology and number of prey eaten by the average predator (Fig. 2). The technique involves seven steps: (1) stomach contents of the predator are evaluated on a die1 schedule throughout the period of downstream smolt migration; (2) original prey weight is predicted from body length or bone measurements; (3) percent digestion is calculated from the ratio of sample weight (adjusted for preservation shrinkage) to the predicted original weight; (4) digestion experiments are conducted to formulate regression equations to predict evacuation rate

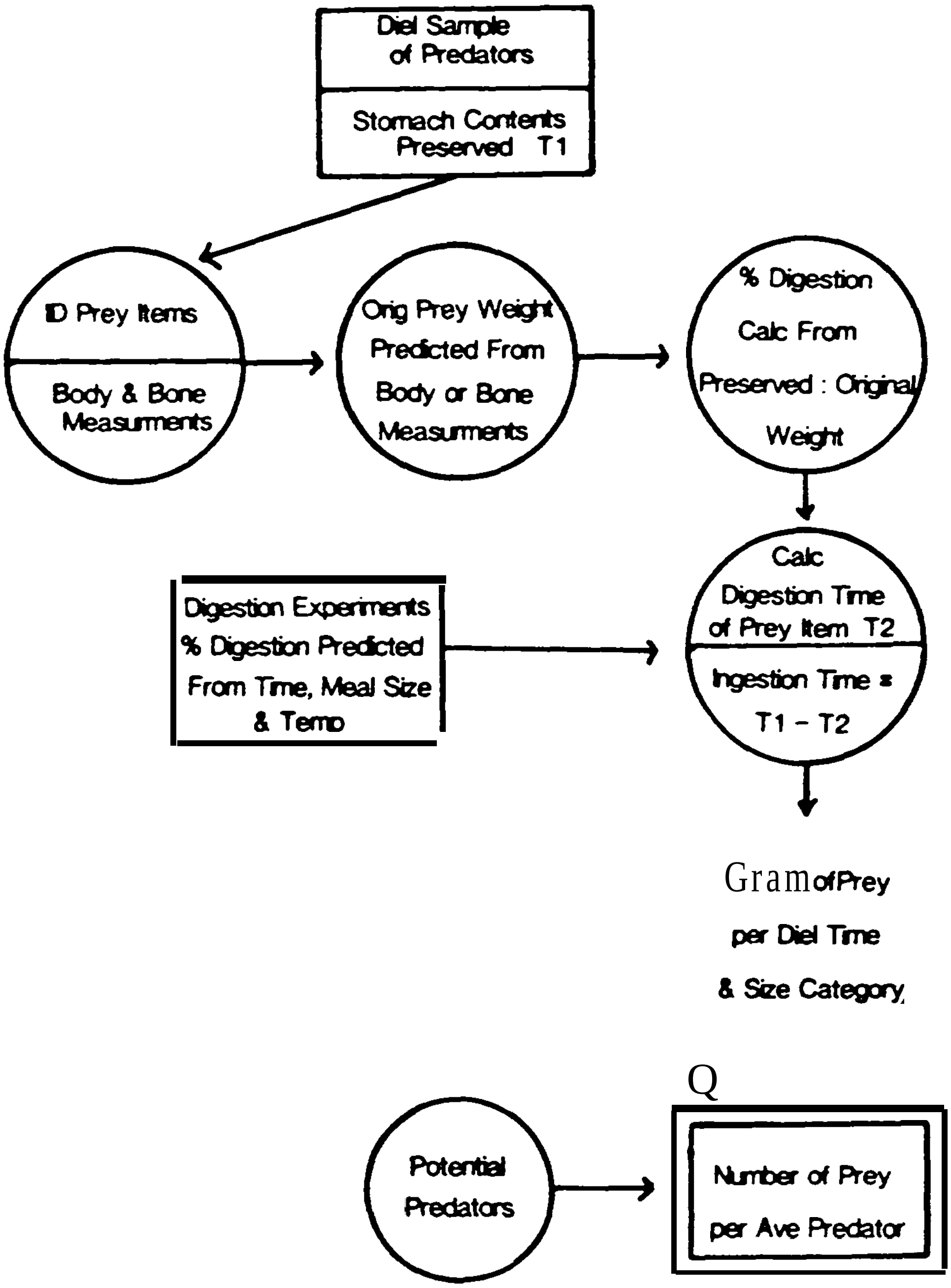


Figure 2. glow diagram showing the processes involved in calculating consumption rates.

as a function of time, meal size in terms of mg prey per gram of predator, and water temperature; (5) duration of the digestion period and time of ingestion of each prey item are calculated from data derived from (3) and (4) above; (6) grams of prey consumed per die1 time period per prey size category per day is calculated; (7) the data from (6) above are divided by the number of potential predators for each strata to estimate the daily ration ((mg) of prey/(g) of predator), from which the number of prey per average predator per day is derived. Methodology and results for the various components of research which contribute to the consumption estimation process are presented in other sections of this report.

The consumption calculation can be summarized by the following equation:

$$C = \sum_t \sum_s \frac{(\sum SC)}{F}$$

where: C is daily consumption of an average predator; SC is the total undigested weight of prey fish of a given size category (s) during a given time interval (t); and F is the predicted number of predators which could have contained prey fish of a given size (s) of a given digestion (≤ 90%) during a given time (t).

The implementation of this consumption model for walleye in John Day Reservoir via a BASIC computer program is described in detail by vigg (1985). The consumption estimate is performed in two phases by two separate computer programs: (1) "CON-WAL" converts the walleye stomach contents data file to a consumption data file, including all the digestion-related variables required for the calculation and (2) "CON-CALC" performs the daily consumption calculation from a die1 periodicity consumption estimate using the data file created by "CON-WAL and allowing for user specification of various delimiters including prey species, station, date, and predator size.

Histopathology of Juvenile Salmonids

Juvenile salmonids used in histopathological examinations were collected from the Columbia River below McNary Dam and from stomachs of northern squawfish collected in the t&Nary Dam boat restricted zone (BRZ). Tissues, including the eye, brain, digestive tract, kidney, liver, spleen, heart, skin, muscle, gill, and pseudobranch from each fish were fixed in Buoin's solution for histopathological examination.

A routine paraffin embedding technique was employed. Tissues were cut at 5μm and stained with hematoxylin and eosin and May-Grunwald Giemsa (Yasutake and Wales 1983). To confirm bacterial kidney disease (BKD) infection, suspected tissues were stained with direct fluorescent antibody technique (FAT), modified from Bullock et al. (1980).

RESULTS

Food Habits of Northern Squawfish

Digestive tracts of 1,043 northern squawfish (i.e. squawfish) ranging in fork length from 104 to 545 mm ($\bar{X}$ = 396) were analyzed and 365 (35%) had empty digestive tracts. Squawfish fed primarily on fish and crayfish which comprised 62.3% and 10.1% by weight of food items consumed, respectively (Table 1). Salnonids contributed most of the fish weight (64.1%) and were followed in importance by cottids (9.8%), percopsids (2.8%), catostomids (2.5%), and cyprinids (1.7%). The smallest northern squawfish to consume a fish was 113 mm in fork length, while the smallest to eat a salmonid was 256 mm.

The percent weight of fish in the diet of squawfish generally increased with predator length (Fig. 3). The percent weight of fish in the diet of squawfish <350 mm in length ranged from 6.1 to 23.79, with salmonids contributing up to 12.6%. For squawfish ≥ 350 mm, fish comprised 51.3 to 90.0% of the diet with salmonids contributing up to 76.6% of the total food weight.

The mean number of salmonids consumed per squawfish also increased with predator length (Fig. 4). Stomachs of squawfish >400 mm contained 0.5 to 0.8 salmonids per predator. In contrast, the mean number of non-salmonid fishes observe.? in squawfis:h >400 mm ranged from 0.1 to 3.5 per predator. Squawfish <400 mm consumed approximately 0.1 salmonids per predator.

Table 1. Percent occurrence and weight of food items in digestive tracts of northern squawfish ranging in length from 104 to 545 mm (x=396 mm) collected from John Day Reservoir, April 8 to August 30, 1985. Sample size and number of empty digestive tracts were 1,043 and 365, respectively.

Food Item	Percent Occurrence	Percent weight
MOLLUSCA	1.6	0.3
Pelecypoda	1.4	0.3
Corbicula manilensis	1.4	0.3
Gastropoda	0.2	<0.1
CRUSTACEA	26.3	12.4
Cladocerans	0.2	<0.1
Amphipoda	1.9	<0.1
Anisogammarus spp.	1.9	<0.1
Corophium spp.	14.3	2.3
unidentified Amphipoda	0.3	<0.1
Decapoda	13.4	10.1
Pacifastacus leniusculus	13.4	10.1
INSECTA	20.5	1.0
Ephemeroptera	12.1	0.4
Odonata	0.3	<0.1
orthoptera	0.6	<0.1
Dennaptera	0.0	0.0
Plecoptera	0.0	0.0
Thysanoptera	0.0	0.0
Hemiptera	0.8	<0.1
Coleoptera	2.5	0.2
Trichoptera	0.3	<0.1
Lepidoptera	0.0	0.0
Diptera	2.6	<0.1
Homoptera	0.7	<0.1
Hymenoptera	1.6	0.1
Unidentified Insecta	4.8	0.2
AGNATHA	0.5	0.2
Petromyzontidae	0.5	0.2
OSTEICHTHYES	34.8	82.3
Clupeidae	0.9	0.3
Alosa sapidissima	0.9	0.3

Table 1. (con't.)

Food Item	Percent Occurrence	Percent Weight
OSTEICHTHYES (con't.)		
Salmonidae	23.4	64.1
Oncorhynchus tshawytscha	19.1	46.5
Salmo gairdneri	2.7	11.2
Unidentified Salmonidae	1.6	4.2
Cyprinidae	0.5	1.7
Acrocheilus alutaceus	0.5	1.7
Mylocheilus caurinus	0.0	0.0
Ptychocheilus oregonensis	0.0	0.0
Cyprinus carpio	0.0	0.0
Catostomidae	1.0	2.5
Catostomus spp.	1.0	2.5
Percopsidae	2.5	2.8
Percopsis transmontana	2.5	2.8
Centrarchidae	0.1	to.1
Cottidae	6.4	9.8
Cottus spp.	6.4	9.8
Unidentified non-Salmonidae	0.6	0.4
Unidentified Osteichthyes	2.0	0.7
OTHER FOOD	9.0	3.8

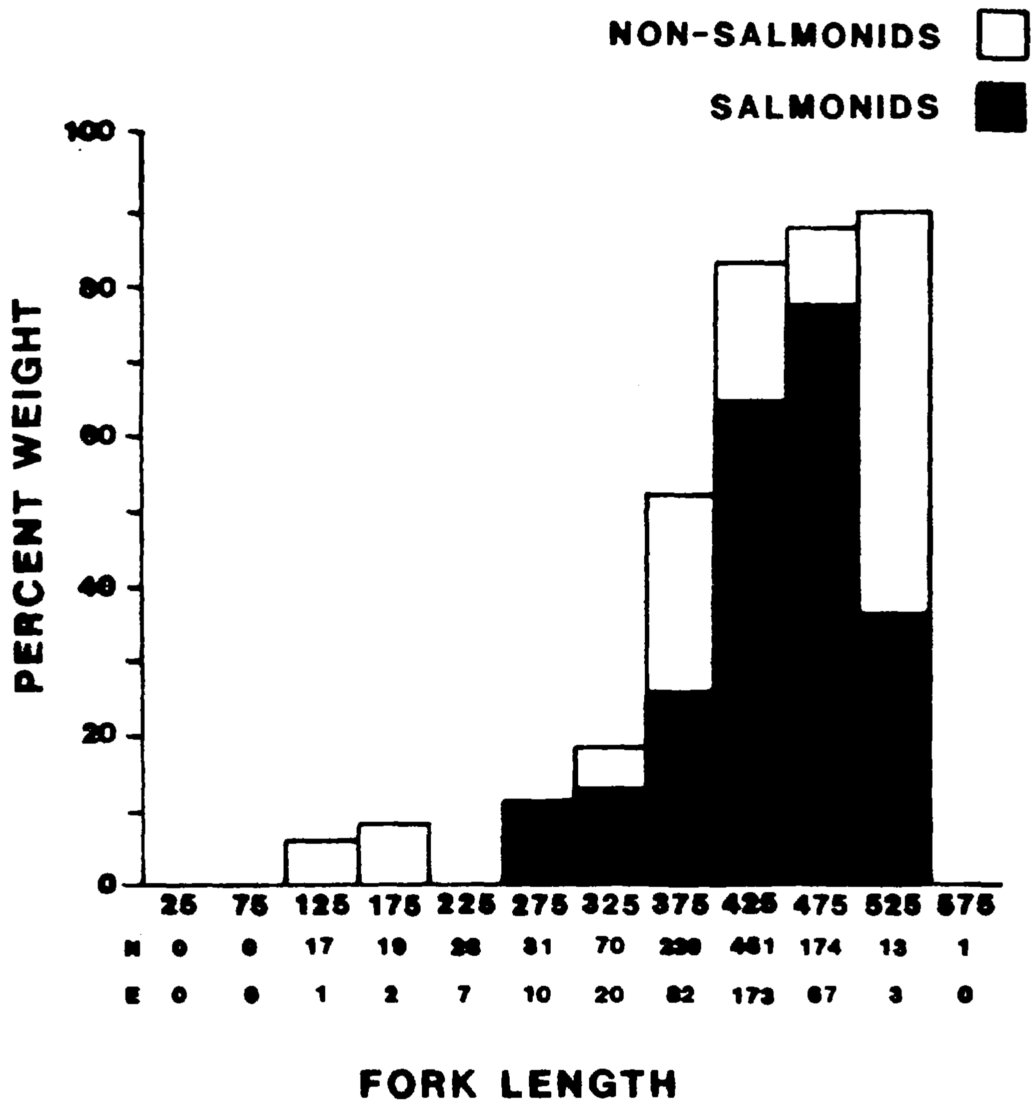


Figure 3. Percent weight of non-salmonid and salmonid fishes in the diet of northern squawfish by predator length, John Day Reservoir, 1985. Lengths are midpoints of 50 mm intervals. N = number of digestive tracts analyzed; E = number of empty digestive tracts.

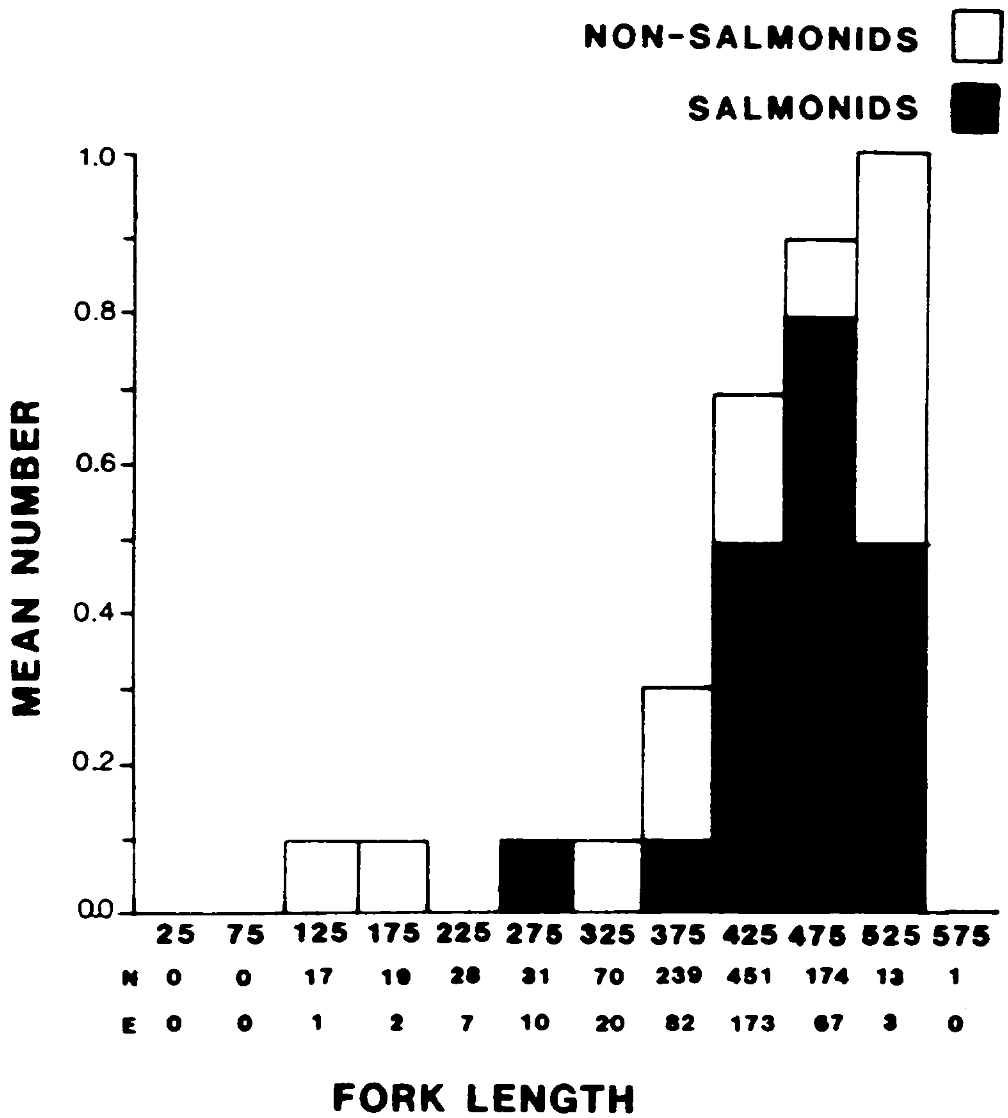


Figure 4. Mean number of non-salmonid and salmonid fishes in the diet of northern squawfish by predator length, John Day Reservoir, 1985. Lengths are midpoints of 50 mm intervals. N = number of digestive tracts analyzed; E = number of empty digestive tracts.

Crustaceans and insects were the dominant food items (by weight) at all stations for northern squawfish 100-249 mm in length (Fig. 5; Appendix Table 1); a similar pattern held for most sample periods (Appendix Tables 2-4). Crustaceans contributed most to the diet of this length category at Arlington (77.3%) , whereas insects contributed most at Irrigon (78.4%). Fishes in the diet of this length group of squawfish were uncommon, accounting for a maximum of 4.9% of the diet. No salmonids were consumed by squawfish in this length group.

Fish was the dominant food item (by weight) at all stations for larger (> 250 mm fork length) squawfish (Fig. 6; Appendix Table 5). At McNary tailrace, fish comprised 86.2 to 99.8% of the diet of large (> 250 mm) squawfish during all sample periods (Appendix Table 6). Salmonids accounted for 83.6%, 77.5%, 82.2%, 99.8% and 57.0% of the diet during April, May, June, July, and August, respectively. Similarly, the mean nunber of salmonids observed in squawfish increased from 1.0 in April and May to 1.6 in July, but decreased to 0.1 in August.

Fish was also the dominant food item (52.5 to 89.0% by weight) of large squawfish at Irrigon (Appendix Table 7). In contrast to the findings at McNary tailrace, however, salmonids were present only in May, accounting for 11.5% of the diet and comprising only 0.1 salmonids per predator.

At Arlington, fish was the most important food item of large squawfish during all sample periods except in June, when crustaceans dominated (Appendix Table 8). Salmonids contributed 7.8%, 25.6%, 20.1%, and 11.1% to the diet by weight in April, May, June and

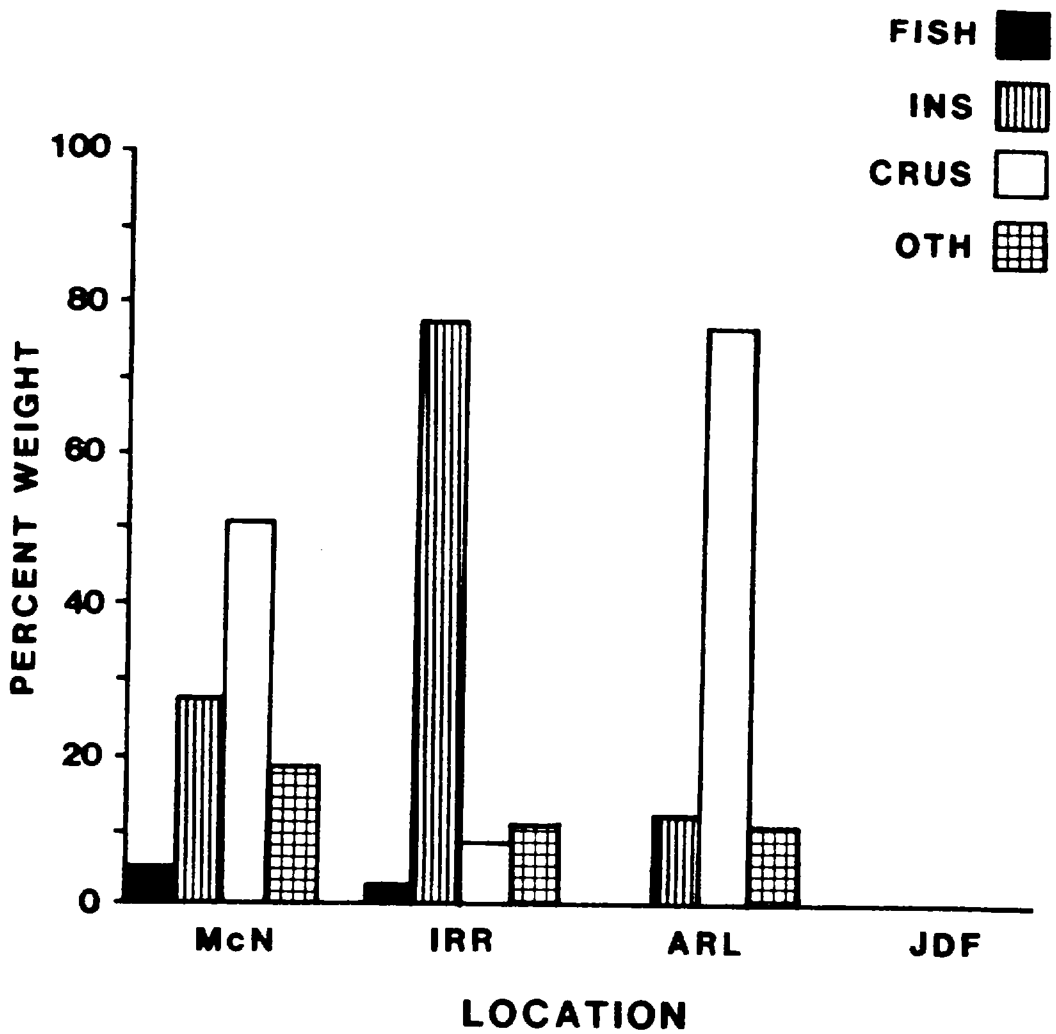


Figure 5. Percent weight of fish, insects (INS), crustaceans (CRUS), and other food items (OTH) found in the diet of northern squawfish 100-249 mm in length at McNary tailrace (McN), Irrigon (IRR), Arlington (ARL), and John Day forebay (JDF), John Day Reservoir, 1985.

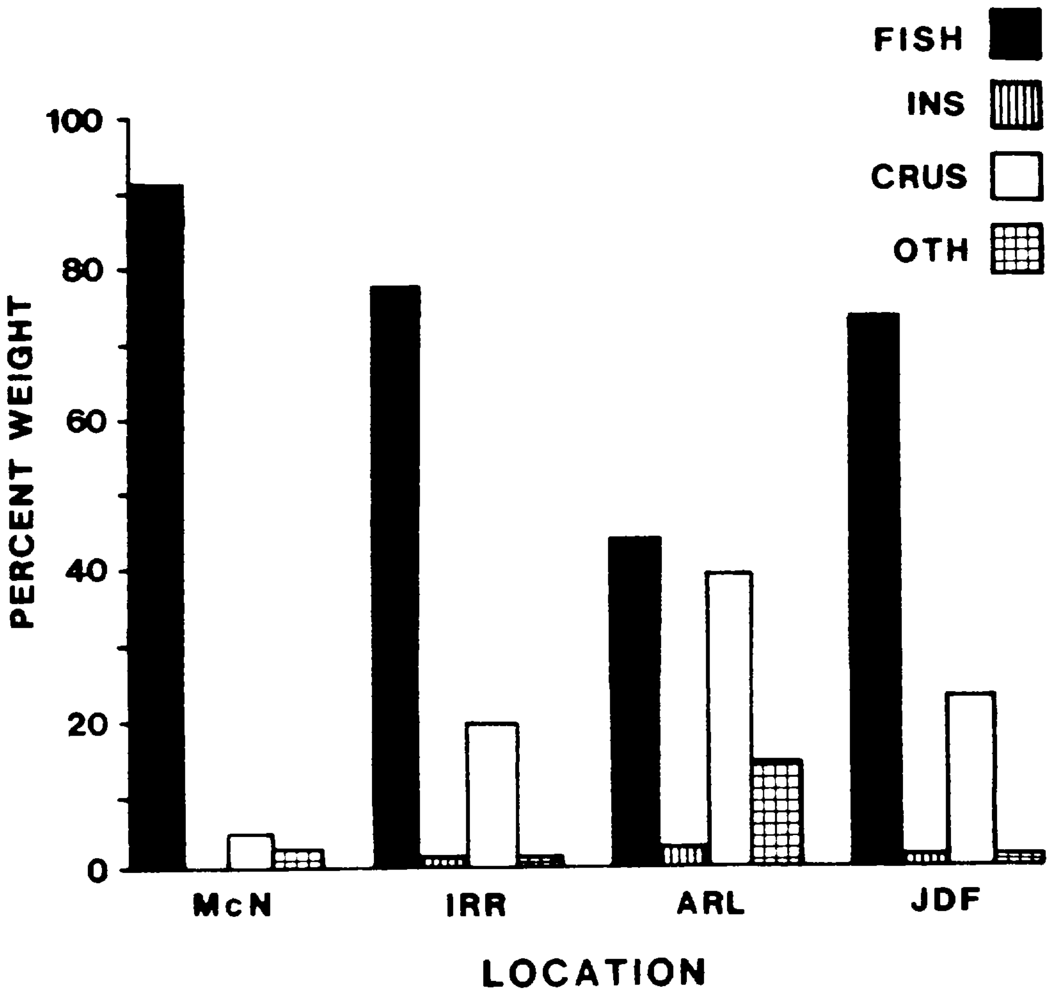


Figure 6. Percent weight of fish, insects (INS), crustaceans (CRUS), and other food items (OTH) found in the diet of northern squawfish $\geq$250 mm in length at McNary tailrace (McN), Irrigon (IRR), Arlington (ARL), and John Day forebay (JDF), John Day Reservoir, 1985.

August, respectively. A maximum of 0.1 salmonids was observed per squawfish examined.

Fish was also the most important food item of large squawfish at John Day forebay comprising 47.9 to 90.4% of the diet (by weight) during all sample periods (Appendix Table 9). Salmonids contributed to the diet during all months, but were most important in July (89.5%). The mean number of salmonids observed per squawfish increased from <O.l in April to 0.5 in July, and decreased to 0.1 in August.

Food Habits of Walleye

Stomach contents of 292 walleye were examined in 1985; 199 (65%) of those stomachs were empty. Lengths of walleye examined ranged from 329 to 764 mm ($\bar{x}$ = 602 mm). Yost walleye were collected at McNary tailrace (199) and Irrigon (81) Only 12 walleye were collected at Ariington; none were collected at John Day forebay.

Nearly 100% of the diet of walleye was composed of fish with catostomids accounting for 61.1%, salmonids 11.5%, cyprinids 9.6%, percopsids 9.3%, and cottids 6.6% of the total diet by weight (Table 2). The percent of salmonids in the diet was highest in walleye 500 to 549 mm; no salmonids were found in walleye greater than 650 mm (Figure 7). The smallest walleye to ingest a salmonid was 380 mm.

Generally, the mean number of fish observed in walleye decreased with increasing predator length (Figure 8). The mean number of non-salmonids consumed was greatest for walleye 300 to 449mm in length. Walleye 430 to 449 mm ate the nost salmonids (x = 0.3 salmonids/predator).

Table 2. Percent occurrence and weight of food items in digestive tracts of walleye ranging in length from 329 to 764 mm (x = 602 mm) collected from John Day Reservoir, April 8 to August 30, 1985. Sample size and number of empty digestive tracts were 292 and 199, respectively.

Food Item	Percent Occurrence	percent weight
MOLLUSCA	0.0	0.0
Pelecypoda	0.0	0.0
Corbicula manilensis	0.0	0.0
Gastropoda	0.0	0.0
CRUSTACEA	3.7	< 0.1
Cladocerans	0.0	0.0
Amphipoda	3.7	< 0.1
Anisoganunarus spp.	0.3	< 0.1
Corophiun spp.	3.4	< 0.1
unidentified Amphipoda	0.0	0.0
Decapoda	0.0	0.0
Pacifastacus leniusculus	0.0	0.0
INSECTA	4.5	< 0.1
Ephemeroptera	1.4	< 0.1
Odonata	0.0	0.0
Orthoptera	0.0	0.0
Dermaptera	0.0	0.0
Plecoptera	0.0	0.0
Thysanoptera	0.3	< 0.1
Hemiptera	0.3	< 0.1
Coleoptera	0.7	< 0.1
Trichoptera	0.0	0.0
Lepidoptera	0.0	0.0
Diptera	2.1	< 0.1
Homoptera	0.7	< 0.1
Hymenoptera	0.0	0.0
Unidentified Insecta	1.0	< 0.1
AGNATHA	0.0	0.0
Petromyzontidae	0.0	0.0
OSTEICHTHYES	33.2	99.9
Clupeidae	0.0	0.0
Alosa sapidissima	0.0	0.0
Salmonidae	4.1	11.5
Oncorhynchus tshawytscha	1.7	8.2
Salmo gairdneri	0.3	0.1
Unidentified Salmonidae	2.7	3.3

Table 2 (con't.)

Food Item	Percent Occurrence	Percent Weight
OSTEICHTHYES (con't.)		
Cyprinidae	2.7	9.6
Acrocheilus alutaceus	1.0	1.5
Mylocheilus caurinus	0.7	2.5
Ptychocheilus oregonensis	1.0	5.6
Cyprinus carpio	0.0	0.0
Catostomidae	13.7	61.1
Catostomus spp.	13.7	61.1
Percopsidae	7.5	9.3
Percopsis transmontana	7.5	9.3
Centrarchidae	0.0	0.0
Cottidae	4.8	6.6
Cottus spp.	4.8	6.6
Unidentified non-Salmonidae	6.8	1.9
Unidentified Osteichthyes	2.1	< 0.1
OTHER FOOD	3.1	< 0.1

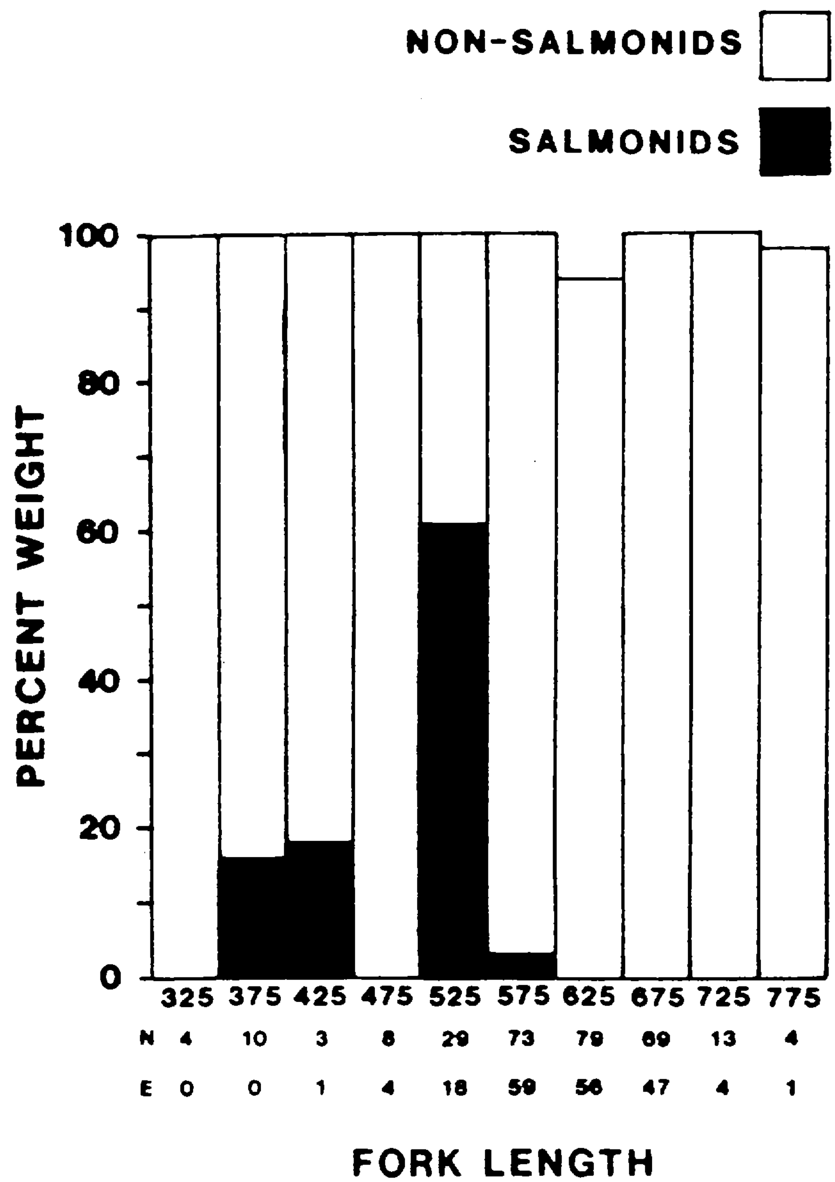


Figure 7. Percent weight of non-salmonid and salmonid fishes in the diet of walleye by predator length, John Day Reservoir, 1985. Lengths are midpoints of 50 mm intervals. N = number of stomachs analyzed; E = number of empty stomachs.

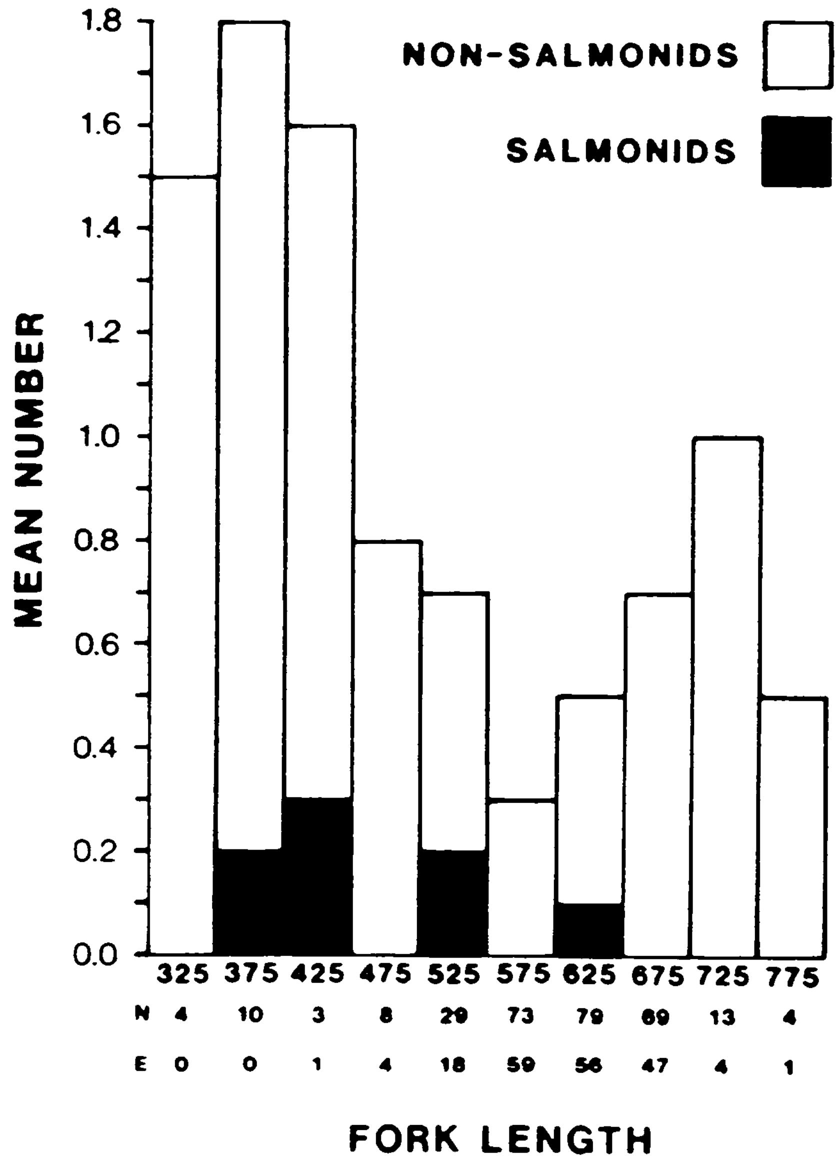


Figure 8. Mean number of non-salmonid and salmonid fishes in the diet of walleye by predator length, John Day Reservoir, 1985. Lengths are midpoints of 50 mm intervals. N = number of stomachs analyzed; E = number of empty stomachs.

At McNary tailrace and Irrigon, where most walleye were collected, salmonids contributed 27.6% and 3 .l% by weight, respectively, to the diet. The mean nunber of salmonids consumed per walleye was <0.1 at McNary tailrace and 0.1 at Irrigon, for the entire sampling Period (Appendix Table 10). The importance of salmonids in the walleye diet varied monthly, and percent weight and mean nunber of salmonids per walleye were greatest in May at McNary tailrace and Irrigon. No salmonids were found in the stomachs of walleye in August for all sample stations. At Arlington, where sample size was small, the percent by weight and mean nunber of salmonids in walleye diets were 28.2% and 0.5 %, respectively.

Food Habits of Smallmouth Bass

Stomach contents of 1,683 smallmouth bass ranging in fork length from 62 to 489 mm ($\bar{x}$ = 226 mm) were examined in 1985 with 17% (280) of the stomachs empty.

Fish and crayfish were the most common food items in the diet of smallmouth bass, representing 80.1% and 18 .0%, respectively, of the total food ingested (Table 3). Cottids were the primary fish taxa consumed (33.3%) followed by catostomids (24.2%) and cyprinids (12.3%). Salmonids contributed 3.8% to the diet of smallmouth bass.

Generally, the percent of fish in the diet of smallmouth bass (by weight) increased with predator length (Fig. 9). However, the percent weight of salmonids in the diet was greatest for smallmouth bass smaller than 300 mm in length. The smallest bass to ingest a salmonid

Table 3. Percent occurrence and percent weight of food items in stomachs of smallmouth bass ranging in length from 62 to 489 mm ($\bar{x}$ = 226 mm), John Day Reservoir, April 8 to August 30, 1985. Sample size and number of empty stomachs were 1,683 and 280, respectively.

Food Item	Percent Occurrence	Percent Weight
MOLLUSCA	0.6	< 0.1
Pelecypoda	0.5	< 0.1
Corbicula manilensis	0.5	< 0.1
Gastropoda	0.1	< 0.1
CRUSTACEA	56.9	19.0
Cladocerans	3.9	< 0.1
Amphipoda	52.8	0.9
Anisogammarus spp.	27.3	0.6
Corophium spp.	24.8	0.3
Unidentified Amphipoda	0.7	< 0.1
Decapoda	26.9	18.0
Pacifastacus leniusculus	26.9	18.0
INSECTA	32.9	0.8
Ephemeroptera	13.7	0.5
Odonata	0.3	0.1
Orthoptera	0.3	< 0.1
Dermaptera	0.0	0.0
Plecoptera	0.0	0.0
Thysanoptera	0.5	< 0.1
Hemiptera	0.6	< 0.1
Coleoptera	1.6	< 0.1
Trichoptera	2.0	< 0.1
Lepidoptera	0.3	< 0.1
Diptera	17.2	< 0.1
Homoptera	1.0	< 0.1
Hymenoptera	1.1	< 0.1
Unidentified Insecta	4.4	< 0.1
OSTEICHTHYES	51.9	80.1
Clupeidae	0.1	0.1
Alosa sapidissima	0.1	0.1

Table 3. (cant)

Food Item	Percent Occurrence	Percent Weight
OSTEICHTYES (con't.)		
Salmonidae	2.9	3.8
Oncorhynchus tshawytscha	1.8	3.2
Salmo gairdneri	0.1	0.3
Unidentified Salmonidae	1.1	0.3
Cyprinidae	4.5	12.3
Acrocheilus alutaceus	3.3	11.1
Mylocheilus caurinus	0.2	< 0.1
Ptychocheilus oregonensis	1.1	1.3
Cyprinus carpio	0.0	0.0
Catostomidae	10.5	24.2
Catostomus spp.	10.5	24.2
Percopsidae	5.3	4.6
Percopsis transmontana	5.3	4.6
Centrarchidae	1.1	0.6
Cottidae	24.3	33.3
Cottus spp.	24.3	33.3
Unidentified non-Salmonidae	8.3	0.9
Unidentified osteichthyes	3.8	< 0.1
OTHER FOOD	10	0.2

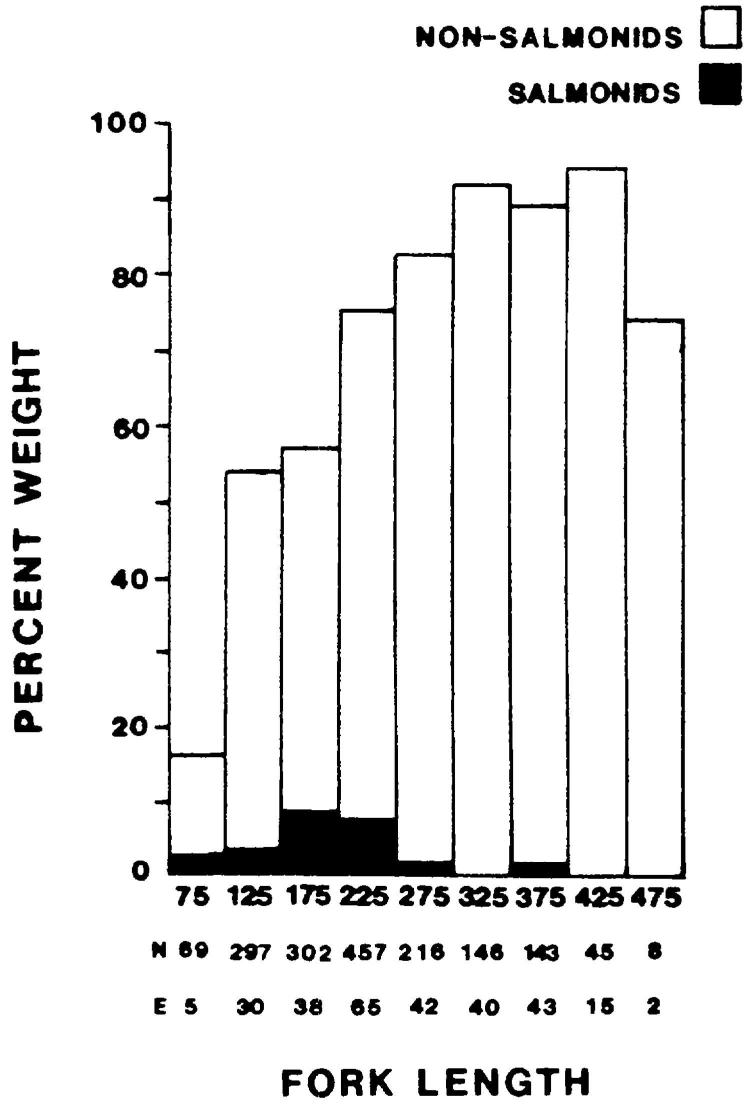


Figure 9. Percent weight of non-salmonid and salmonid fishes in the diet of smallmouth bass by predator length, John Day Reservoir, 1985. N = number of stomachs analyzed; E = number of empty stomachs.

was 94 mm; no salmonids were found in smallmouth bass larger than 400 mn in length. Mean number of fish ingested per smallmouth bass remained relatively constant for all length groups but very few of those fish were salmonids (Fig. 10).

Although fish were the dominant food item eaten by smallmouth bass throughout the reservoir, composition of the diet varied among sample stations (Fig. 11). Percent weight of fish in the diet generally decreased as consumption of crustaceans increased. Crayfish accounted for over 90% (by weight) of all crustaceans eaten by smallmouth bass at all stations. At McNary tailrace and Irrigon, fish accounted for 94.3% and 93.7% by weight, and the mean number of fish observed per smallmouth bass was 1.4 and 1.1, respectively (Appendix Table 14). Crayfish comprised 3.5% of the diet by weight at McNary tailrace, and 5.6% at Irrigon. Percent weight of fish and crayfish in the smallmouth bass diet at Arlington was 84.5% and 13.7%, respectively, while in the John Day forebay fish and crayfish accounted for 69.5% and 29.6% respectively, of the diet of smallmouth bass (Appendix Table 14).

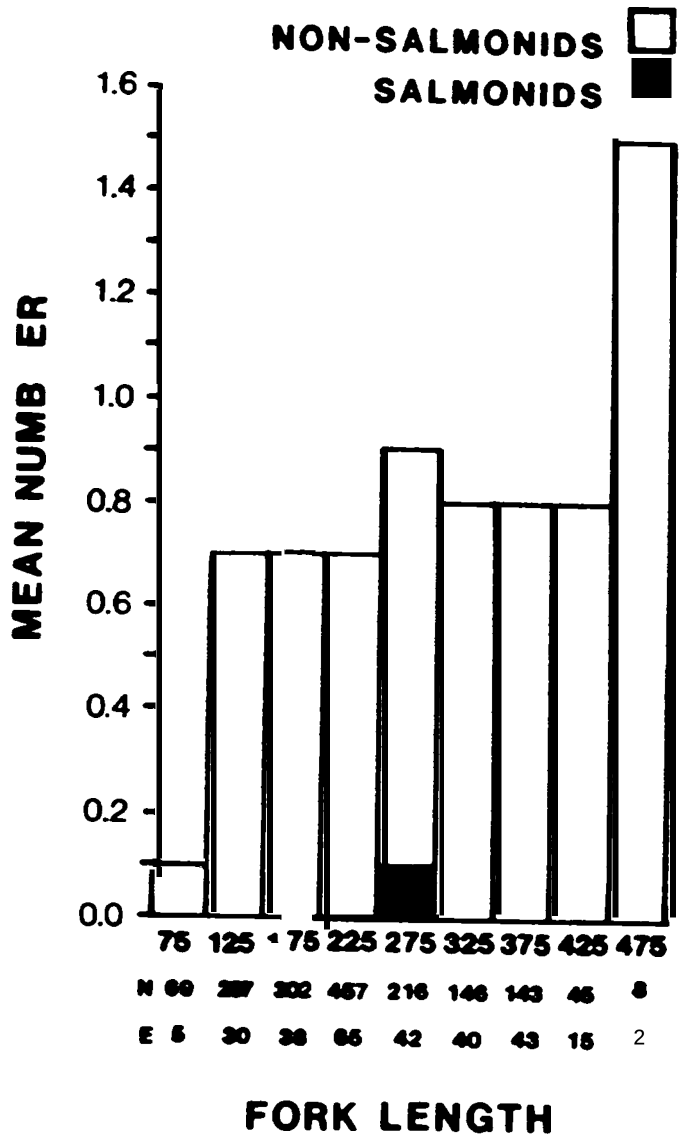


Figure 10. Mean number of non-salmonid and salmonid fishes in the diet of smallmouth bass by predator length, John Day Reservoir, 1985. N = number of stomachs analyzed; E = number of empty stomachs.

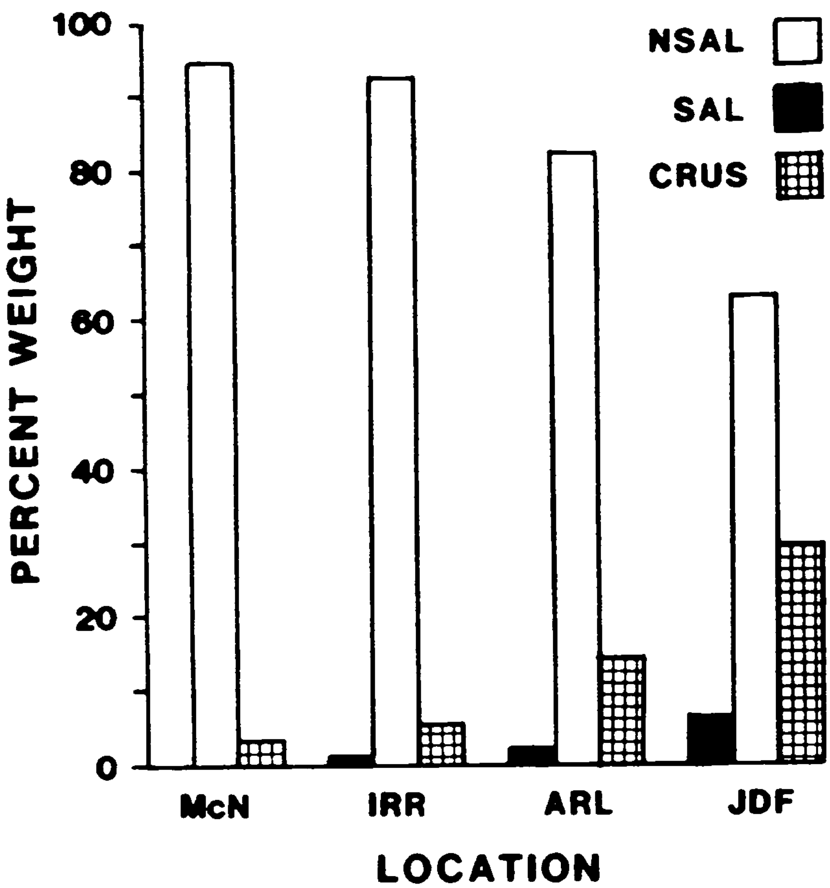


Figure 11. Percent weight of salmonids (SAL), non-salmonids (NSAL), and crustaceans (CRUS) found in the diet of smallmouth bass at McNary tailrace (McN), Irrigon (IRR), Arlington (ARL), and John Day forebay (JDF), John Day Reservoir, 1985.

Food Habits of Channel Catfish

Stomach contents of 175 channel catfish ranging from 215 to 685 mm in fork length ($\bar{X}$ = 495) were examined. The najority of these fish were collected at McNary tailrace (63.4%). The number of fish collected at Irrigon (19.4%) and Arlington (16.6%) was similar with only one channel catfish collected at John Day forebay. Monthly catches of channel catfish were sporadic except at McNary tailrace. Channel catfish were collected at Arlington only in August and the mean length (393 mm) of these fish was considerably less than of those collected at McNary tailrace (518 mm) and Irrigon (506 mm).

Food items were found in 141 (80.6%) of the stomachs examined (Table 4). Overall, fish accounted for 57.8% of the total prey weight; 24.2% were cottids and 24.9% were salmonids. Crustaceans (primarily decapods) comprised 26.7% of channel catfish diet.

The occurrence of fish in the diet of channel catfish and the mean number of prey fish consumed generally increased with predator length. The smallest channel catfish to consume a fish was 330 mm, whereas salmonids were ingested only by channel catfish greater than 420 mm in length. The percent weight of non-salmonid fishes in the diet increased with length among channel catfish 350 mm to 550 mm, then decreased for fish greater than 550 mm (Figure 12). In contrast, the percent weight of salnonids in the diet varied little with length.

Fish, crustaceans and molluscs were the primary food items of channel catfish at McNary tailrace, Irrigon and Arlington (Figure 13; Appendix Table 19). John Day forebay was not included in station

Table 4. Percent occurrence and percent weight of food items in digestive tracts of channel catfish ranging in length from 215 to 685 mm ($\bar{x}$ = 495 mm), John Day Reservoir, April 8 to August 30, 1985. Sample size and number of empty stomachs were 175 and 34, respectively.

Food item	Percent Occurrence	Percent Weight
MOLLUSCA	9.1	7.8
Pelecypoda	8.6	7.8
Corbicula manilensis	8.6	7.8
Gastropoda	0.6	< 0.1
CRUSTACEA	52.0	26.7
Cladocerans	0.0	0.0
Amphipoda	28.5	0.4
Anisogammarus spp.	3.4	< 0.1
Corophium spp.	25.1	0.4
Unidentified Amphipoda	0.0	0.0
Decapoda	28.6	26.3
Pacifastacus leniusculus	28.6	26.3
INSECTA	28.0	1.3
Ephemeroptera	20.0	1.2
Odonata	0.0	0.0
Orthoptera	0.0	0.0
Dermaptera	0.0	0.0
Plecoptera	0.0	0.0
Thysanoptera	0.0	0.0
Hemiptera	0.0	0.0
Coleoptera	1.7	< 0.1
Trichoptera	1.1	< 0.1
Lepidoptera	0.0	0.0
Diptera	6.9	0.1
Homoptera	0.0	0.0
Hymenoptera	2.9	< 0.1
Unidentified Insecta	5.1	< 0.1

Table 4. (cont)

Food Item	Percent Occurrence	Percent Weight
OSTEICHTHYES	36.0	57.8
Clupeidae	0.0	0.0
Alosa sapidissima	0.0	0.0
Salmonidae	11.4	24.9
Oncorhynchus tshawystscha	5.1	13.2
Salmo gairdneri	0.6	3.6
Unidentified Salmonidae	8.0	8.1
Cyprinidae	2.9	5.1
Acrocheilus alutaceus	0.6	0.3
Mylocheilus caurinus	0.6	0.4
Ptychocheilus oregonensis	1.1	2.9
Cyprinus carpio	0.6	1.4
Catostomidae	0.0	0.0
Catostomus spp.	0.0	0.0
Percopsidae	0.6	0.1
Percopsis transnontana	0.6	0.1
Centrarchidae	0.0	0.0
Cottidae	13.7	24.2
Cottus spp.	13.7	24.2
Unidentified non-Salmonidae	6.3	0.9
Unidentified Osteichthyes	6.9	0.9
OTHER FOOD	20.0	6.4

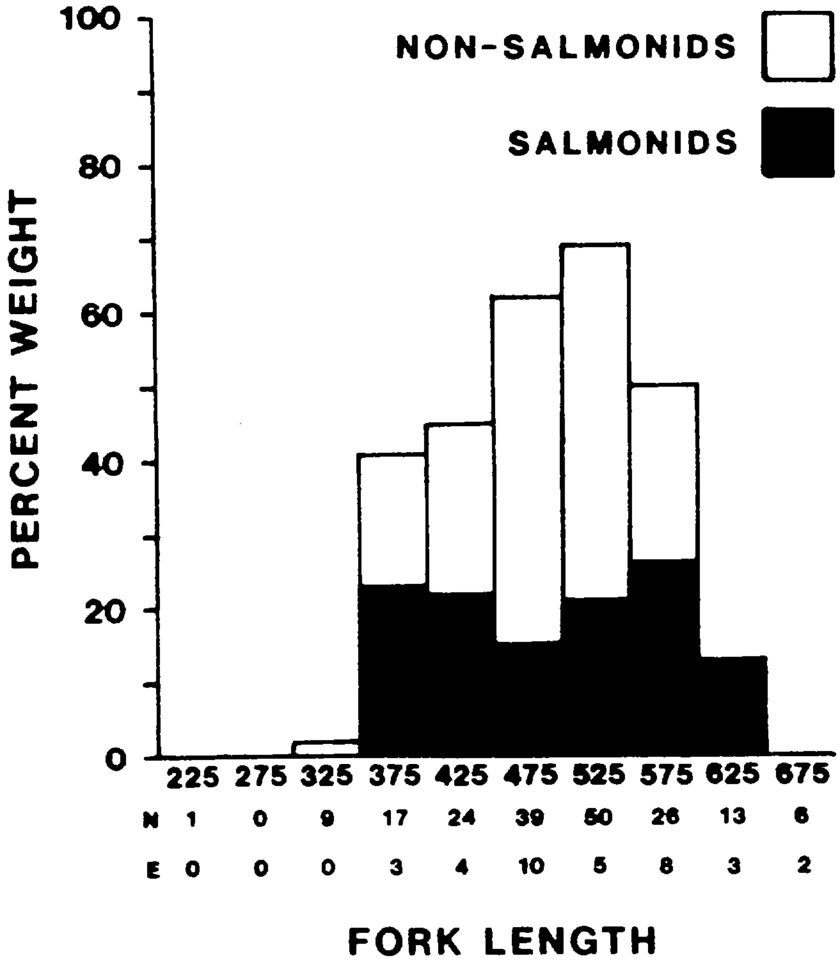


Figure 12. Percent weight of non-salmonid and salmonid fishes in the diet of channel catfish by predator length in John Day Reservoir, 1985. N = number of digestive tracts analyzed; E = number of empty digestive tracts.

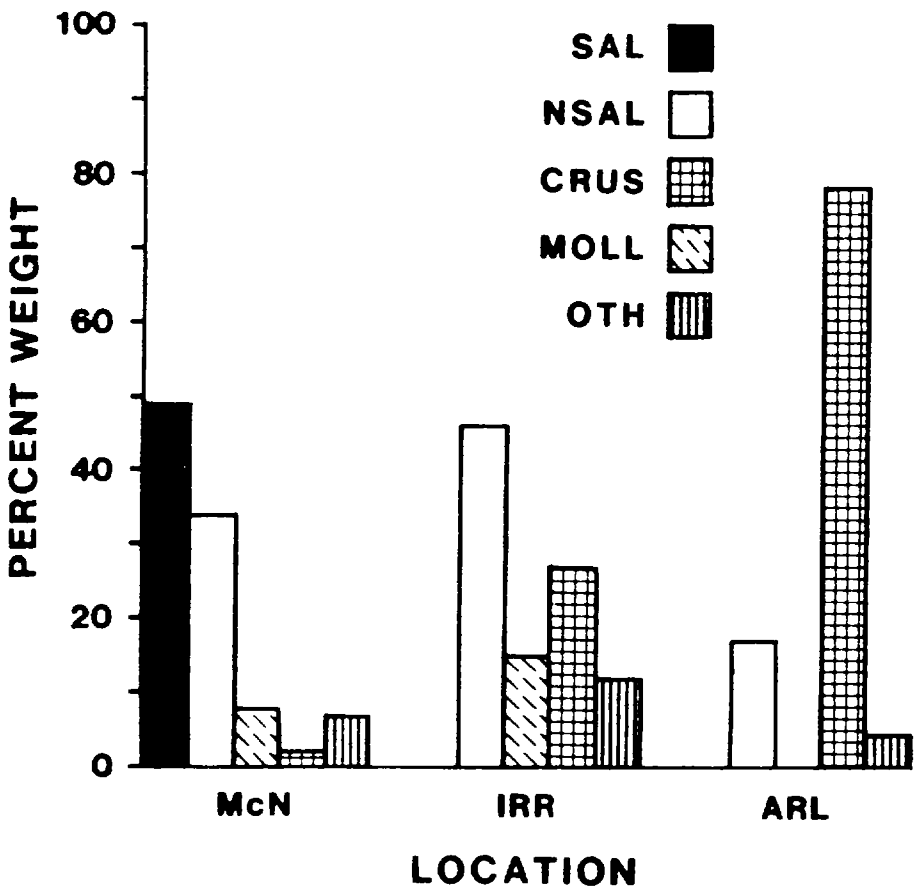


Figure 13. Percent weight of salmonids, (SAL), non-salmonids (NSAL), crustaceans (CRUS), mollusca (MOLL), and other food items (OTH) found in the diet of channel catfish at McNary tailrace (McN), Irrigon (IRR), and Arlington (ARL), John Day Reservoir, 1985.

comparisons because of a small sample size. Fish were the most common food item in the diet of channel catfish at McNary tailrace (83.2%) and decreased in importance at Irrigon (45.7%) and Arlington (16.9%) as crustaceans increased in importance. Salnonids composed 49.2% of the diet at McNary tailrace, but did not occur in stomachs of channel catfish at Irrigon or Arlington.

Abundance and Distribution of Prey Fishes

Over 16,000 prey fish (≤ 250 mm) representing 27 species were collected with a beach seine in John Day Reservoir from April to September, 1985 (Table 5). Prey fishes collected at backwater and main channel locations comprised 52.7 and 47.3% of the catch, respectively. Largescale sucker and crappies represented over half the catch at backwater stations, while chinook salmon, northern squawfish, largescale sucker, and sand roller accounted for 82.5% of the catch at main channel locations.

Fluctuations in mean catch per seine haul illustrated spatial and temporal distribution patterns for some prey taxa (Fig. 14 - 16; Appendix Tables 24 - 26). Highest catches of northern squawfish and peamouth were observed at McNary backwater during April and May and at McNary tailrace and Irrigon main channel stations in August. Mean catch per seine haul of chinook salmon and largescale sucker was generally higher at main channel and backwater stations in the upper reservoir. Catches of sand roller were highest at McNary tailrace and Irrigon main channel stations. Conversely, American shad, yellow perch

Table 5. Catch dnd percent composition of prey fishes (< 250 mm) collected with A beach seine, John Day Reservoir, April. to August, 1985.

Species[a]	McNary tailrace	McNary backwater	Irriyon	Irrigon backwater	Arlington	Forebay	Total Catch	Percent Composition
American shad	1	979		18	1		999	6.0
coho salmon			4	1			5	<0.1
sockeye salmon		3					3	<0.1
chinook salmon	123	83	326	52	57	33	674	4.0
rdinbow trout		2	1	1	11	23	38	0.2
mountain whitefish			2		1	2	5	<0.1
chiselmouth	14	134	16	3	76	241	484	2.9
carp	9	13	3	4	3		32	0.2
peamouth	155	346	79	4	6	2	592	3.5
northern squawfish	789	5YI	469	75	34	5	1963	11.7
speckled dace	4	2	3				9	<0.1
redside shiner	29	133	1		5	1	169	1.0
largescale sucker	495	2667	953	15G	410	280	4967	29.7
bridgelip sucker	17	13	19	5	71	287	412	2.5
channel catfish				1	2		3	<0.1
brown bullhead		124		5	3		132	0.8
sand roller	566	166	1763	152	198	27	2872	17.2
threespine stickleback	1	3					4	<0.1
sunfishes"	2	176	15	390	6		489	3.5
smallmouth bass	8	65	16	65	7	5	166	1.0
largemouth bass	8	149	1	76		1	235	1.4
crappies[b]		850	9	971			1830	10.9
yellow perch	6	19	13	246			2635	1.7
walleye					1	2	3	<0.1
prickly sculpin	24	22	GO	56	12	93	267	1.6
Toa l Ca tch	2251	6540	3759	2281	905	1002	16738	
Percent Composition	13.4	39.1	22.5	13.6	5.4	6.0		

a Scientific names for all common species names are given in Appendix Table 38.
b Includes pumpkinseed and bl uegi 11.
c Includes white crappie and black crappie.

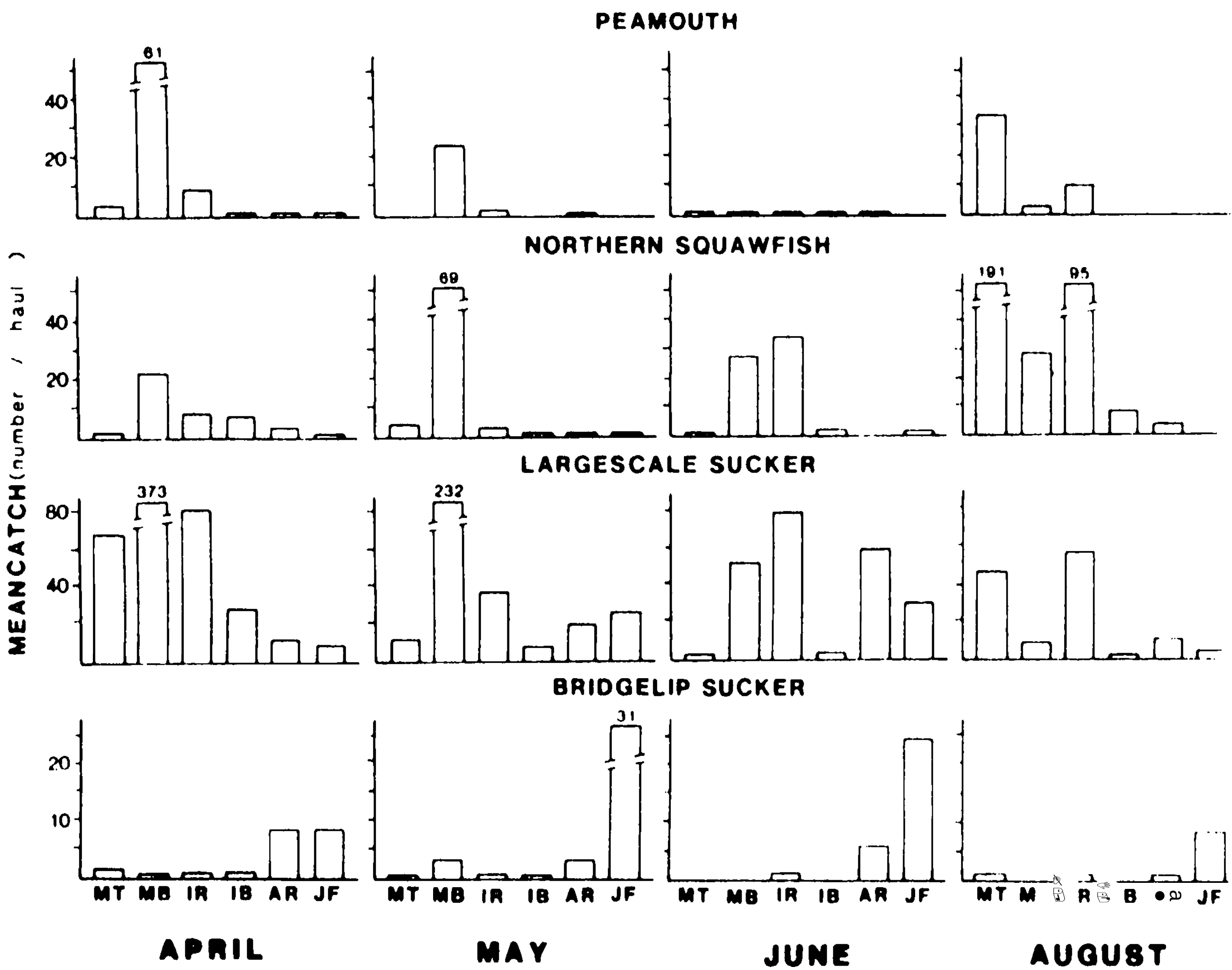


Figure 14. Mean catch per seine haul of peamouth, northern squawfish, largescale sucker, and bridgelip sucker at McNary tailrace (MT), McNary backwater (MB), Irrigon (IR), Irrigon backwater (IB), Arlington (AR), and John Day forebay (JF), April to August, 1985.

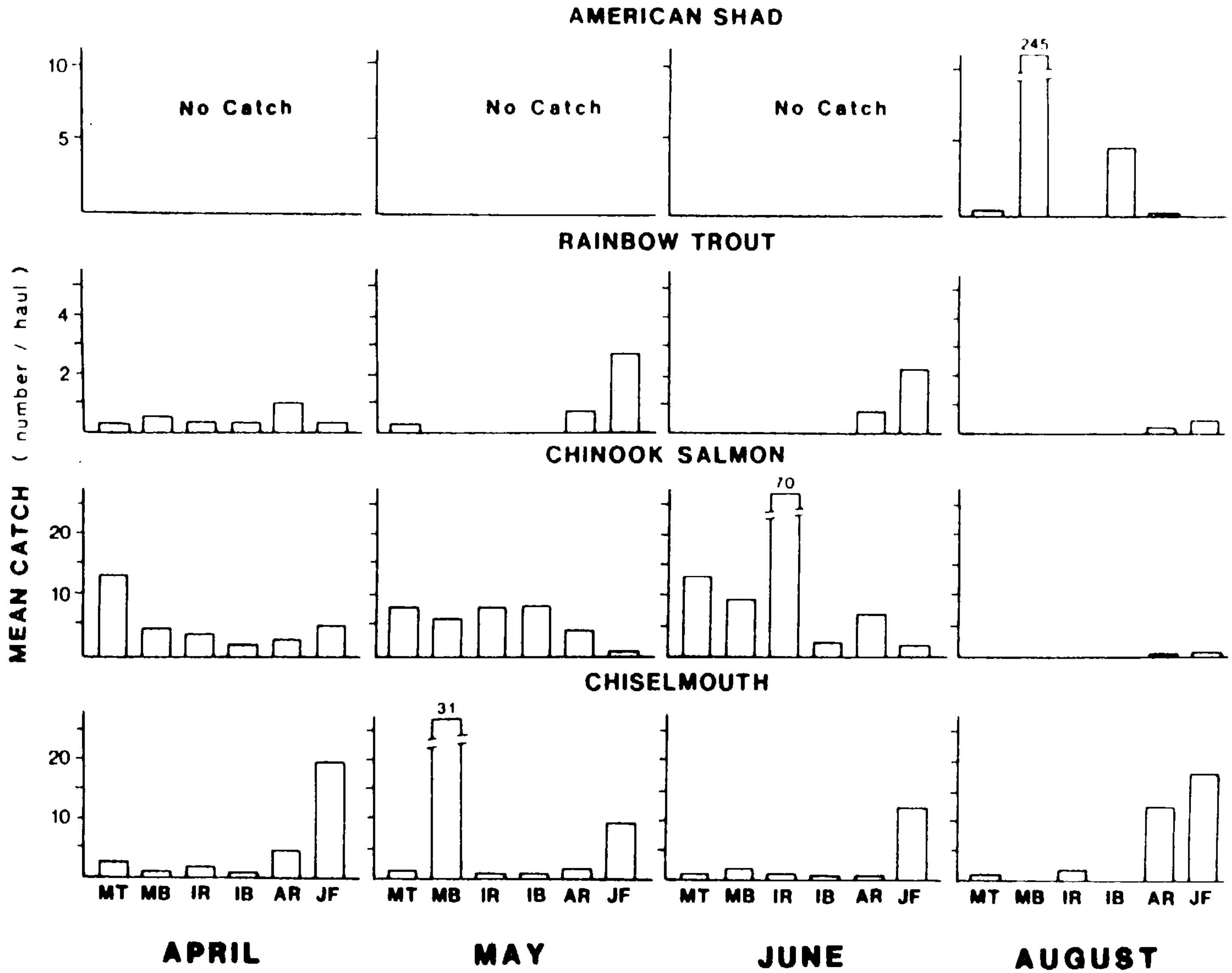


Figure 15. Mean catch per seine haul of American shad, rainbow trout, chinook salmon, and chiselmouth at McNary tailrace (MT), McNary backwater (MB), Irrigon (IR), Irrigon backwater (IB), Arlington (AR), and John Day forebay (JF), April to August, 1985.

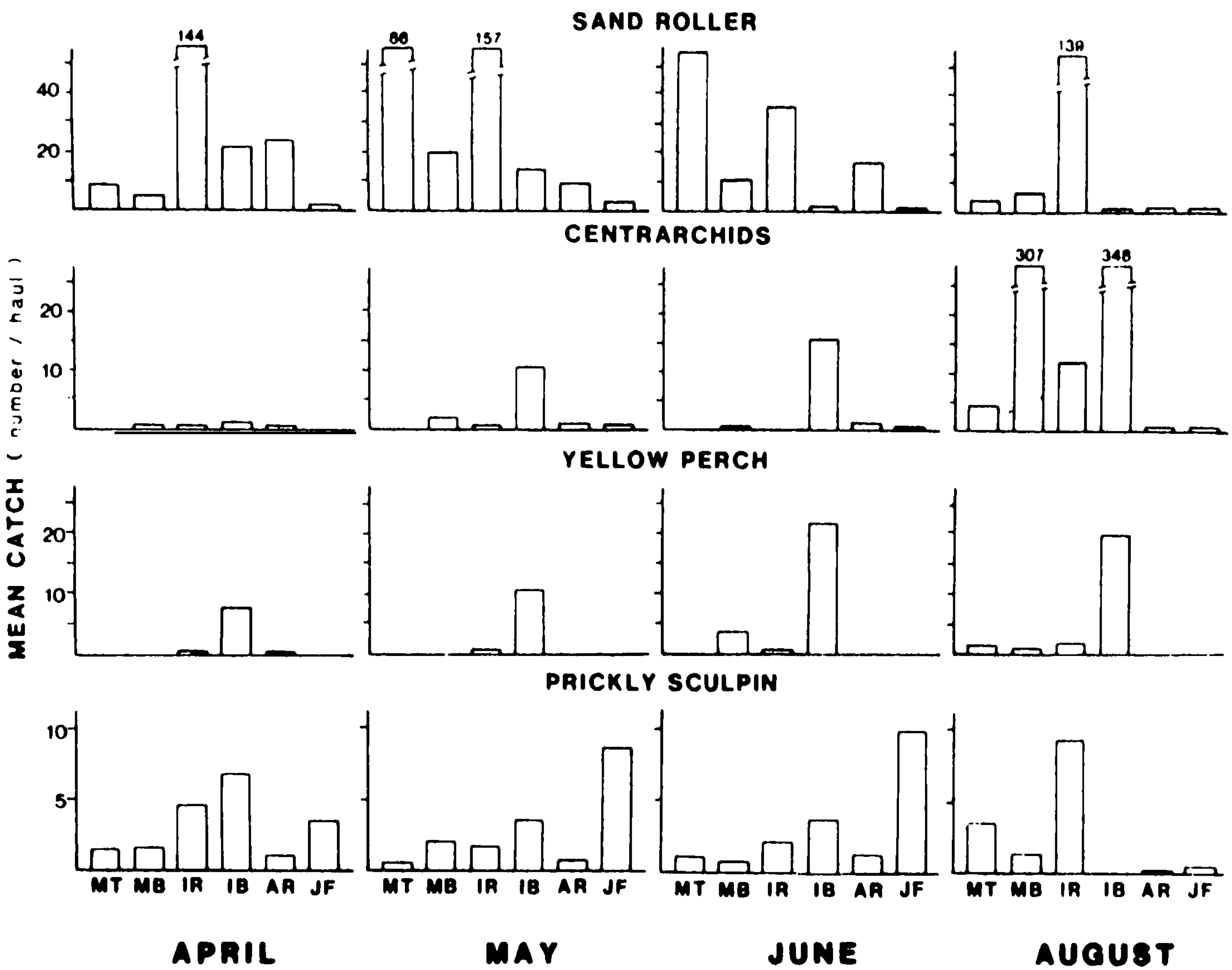


Figure 16. Mean catch per seine haul of sand roller, centrarchids, yellow perch, and prickly sculpin at McNary tailrace (MT), McNary backwater (MB), Irrigon (IR), Irrigon backwater (IB), Arlington (AR), and John Day forebay (JF), April to August, 1985.

and centrarchids (smallmouth bass, largemouth bass, crappies, and sunfishes) were caught in greater numbers at McNary tailrace and Irrigon backwater stations. Catches of bridgelip sucker and steelhead were highest at John Day forebay and Arlington. Chiselmouth and prickly sculpin were also common at these lower reservoir stations, however, higher catches were occasionally observed in the upper reservoir.

Temporal fluctuations in prey abundance were generally related to timing of anadromous outmigrations (Figure 15) or number of young-of-the-year fishes in the catch. Mean catch of anadromous salmonids (chinook salmon and steelhead) was highest during April, May, and June and lowest in August. American shad were collected only in August, the first month of the shad outmigration in John Day Reservoir. Catches of northern squawfish and centrarchids were substantially higher in August than during other months due to recruitment of young-of-year fishes to the seine. Conversely, mean catch of largescale sucker was highest in April and decreased steadily through August. No apparent pattern of temporal distribution was observed for other prey taxa.

Fourteen beach seine efficiency experiments were conducted during June, July, and August, 1985; nine over fine substrate (sand) and five over course substrate (sand, gravel, and cobble). No statistical comparisons of seine efficiency were made among taxa or between substrates because of small sample sizes, however, preliminary results suggest that some taxa are more vulnerable to capture than others (Table 6). Efficiency estimates calculated for both substrates combined indicate that chinook salmon, suckers, and cyprinids were most vulnerable to the

Table 6. Mean percent seine efficiency for prey taxa captured over fine (sand) and course (sand, gravel , and cobble) substrates in John Day Reservoir, 1985.

	Fine			Coarse			Substrates Combined	
Prey taxa	Mean % efficiency	Sd	# of estimates	Mean % efficiency	SD	# of estimates	Mean % efficiency	SD
American shad	41.0	14.6	5	67.7	0.0	1	45.3	16.8
chinook salmon	93.s	5.5	4	47.7	36.3	4	70.6	34.3
chinselmouth	95.4	9.2	4	36.5	13.8	3	70.1	33.1
peamouth	91.6	15.5	8				91.6	15.5
northern squawfish	81.0	19.3	0	82.4	16.6	4	81.5	17.8
suckers[a]	HR.3	13.0	0	49.3	19.9	4	76.3	23.7
sand roller	50.2	48.8	8	52.4	29.4	3	50.9	42.2
sunfishes[b]	37.7	27.4	7	66.1	3.5	3	47.1	26.0
smallmouth bass	58.5	37.4	7	41.2	15.4	2	54.2	33.1
largemouth bass	37.6	15.0	5	73.4	0.0	1	43.6	19.9
crappies[c]	61.0	31.1	6	87.8	8.6	3	69.9	28.4
yellow perch	35.4	39.2	8	34.4	22.8	4	35.0	33.5
prickly sculpin	33.1	29.3	8	6.6	9.1	5	22.9	26.7

a Includes largescale sucker and bridgelip sucker.

b Includes blueqil.l and pumpkinseed.

c Includes black crappie and white crappie.

seine with nean seine efficiencies greater than 70%. American shad, sand roller, and centrarchids were moderately vulnerable to the seine; mean seine efficiencies for these taxa ranged from 40 to 70% when both substrate types were combine?. Yellow perch and prickly sculpin were least vulnerable to the seine with mean efficiencies less than 36% in fine and course substrates.

Preliminary results also suggest that seine efficiency is influenced by substrate type. Chinook salmon, chiselmouth, suckers, and prickly sculpin were more vulnerable to the seine in fine substrates. Conversely, crappies and sunfishes were more vulnerable to the seine in coarse substrates. Seine efficiencies for northern squawfish, sand roller, and yellow perch were similar between substrate types.

Body Length Regressions

Additional collections of prey fish were made during 1985 to represent all lengths of prey found in stomachs of predatory fishes. Relationships between fork length (mm) and weight (g) and other selected bone or body measurements (mm) were determined for 11 common prey fishes and are found in Appendix Tables 27-37. In general, body lengths predicted fork length best, followed in order by bone lengths of the cleithrum, opercle, dentary, pharyngeal and hypural (cottid only). Coefficients of determination (r-2) ranged from 0.894 to 0.999 for body and bone measurements and from 0.890 to 0.998 for length-weight relationships.

Northern Squawfish Digestion Experiments

Evacuation over time for northern squawfish was nearly linear, with time, temperature, prey weight, and predator weight contributing to the variance in gastric evacuation ($P<0.0001$). The log-log model provided the best fit for the data. That equation in exponential form was:

(1) Evacuation (g) $= 0.0013\, t^{0.93}\, S^{0.43}\, T^{1.49}\, W^{0.25}$

$R^2 = 0.90$, $n = 284$

where t is time (h), S is prey weight (g) T is temperature (C) and W is predator weight (g) The predicted rate of gastric evacuation (g/h) increased approximately three times as the temperature was raised from 10 C to 20 C and as the prey weight was increased from 4 to 70 g, and nearly two times as predator weight was increased from 200 to 2000 g. The 90% emptying time more than doubled when the prey weight increased four times but decreased by two-thirds when the temperature doubled (Pig. 17). Predator weight had less effect on the emptying time, with an increase of 10 times the predator weight approximately doubling the 90% emptying time. Predicted 90% evacuation times ranged from 3 h (4 g prey, 20 C, 1500 g predator) to 67 h (70 g prey, 10 C, 640 g predator). The range of prey sizes could not be tested with the entire range of predator sizes (Table 7) since the small predators either refused to eat the large prey or regurgitated soon after eating.

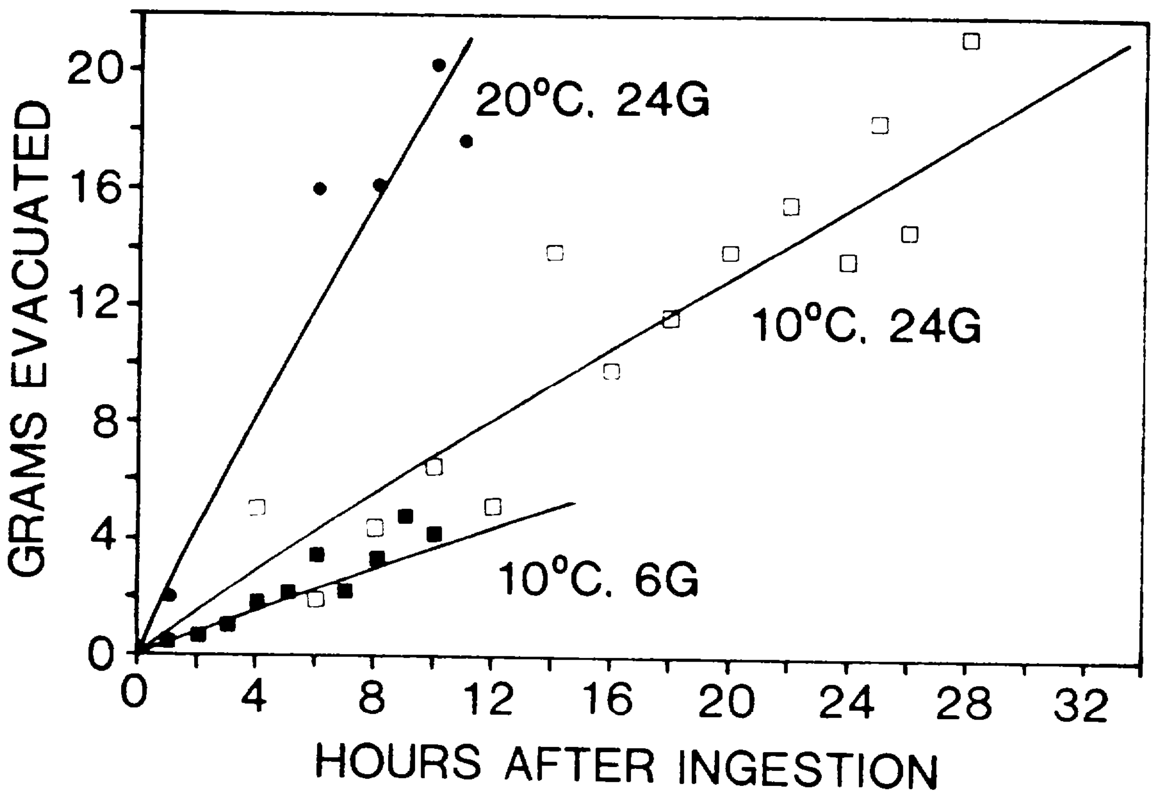


Figure 17. Comparison of the effects of increasing water temperature (C) and prey weight (g) on the gastric evacuation rates and gastric emptying times (90%) in northern squawfish (each symbol represents 1-3 samples).

Table 7. Means and (ranges) from northern squawfish single meal experiments by prey size group: small (4-14 g), medium (15-34 g), and large (35-70 g).

Prey Size (Sample Size)	Prey (g)	Meal (%BW)	Predator (g)	Predator (am FL)	Predator Condition Factor
Small (n = 130)	6 (4-14)	1 (0-5)	596 (173-1497)	375 (255-559)	1.08 (0.61-1.52)
Meduim (n = 107)	24 (15-34)	4 (1-9)	695 (305-1733)	389 (305-511)	1.12 (0.64-1.50)
Large (n = 47)	45 (35-70)	5 (2-11)	954 (420-1943)	434 (348-538)	1.13 (0.74-1.61)

Feeding two fish meals (17 to 20 g each, 35 to 39 g total) significantly (~~0.05) increased the grams evacuated at 4 h compared to feeding one-fish meals weighing 17 to 20 g, but was not significantly different ($P>0.05$) than feeding one-fish meals weighing 35 to 40 g. Evacuation of one-fish meals ($\bar{x}$=18.5 g) averaged 5.4 g (SE 0.98), while evacuation of one-fish meals ($\bar{x}$=37.7 g) and two fish neals ($\bar{X}$=36.5 g total) averaged 7.9 g (SE 4.3) and 7.8 g (SE 1.6), respectively. Predator weights were not significantly different between groups compared ($P>0.05$).

The mean number of grams evacuated in the one-fish meals were close to those predicted by the equation. For the 18.5 g prey (1047 g average predator) the equation predicted evacuation of 5.3 g (3.9 to 7.2 g CI) compared to the 5.4 g average evacuated; for the 37.7 g prey (1029 g average predator), the equation predicted evacuation of 7.2 g (5.0 to 10.4 g CI), compared to the 7.9 g average evacuated.

Preservation in 10% formalin resulted in an average 4% shrinkage. The equation:

Fresh (g) = 0.008 + 1.04 Preserved (g)

$r^2 = 0.998$, $n = 106$

should be applied to preserved stomach contents before using the prediction evacuation equations.

Preliminary results from evacuation experiments on smallmouth bass indicate findings similar to those for northern squawfish except that prey weight had less effect and water temperature slightly more effect on gastric evacuation in smallmouth bass. The log-log model, with time, water temperature, prey weight, and predator weight as independent variables also provided the best fit for the data.

That equation was:

$$\text{Evacuation (g)} = 0.0000006\ t^{1.5}\ T^{3.1}\ S^{0.56}\ W^{0.39}$$

$R^2 = 0.80$, n = 393

The gastric evacuation times again increased with increasing prey weight and decreased with increasing water temperature and predator weight, but the evacuation time did not quite double when the prey weight increased 10 times, and decreased by about three-fourths when the temperature doubled (Figure 18). Predator weight had the same effect as it did in northern squawfish, with the emptying time approximately doubling when the predator weight increased 10 times. There was no correlation (P>0.05) between predator size and size of prey consumed (Table 8) since even the smallest size smallmouth bass showed no size preference in eating salmonids. The number of prey in the meal did not significantly affect gastric evacuation, based on 68 double meals and 22 triple meals.

Consumption Estimates

Preliminary estimates of juvenile salmonid consumption by walleye populations in John Day Reservoir were calculated for 1982 through 1985 (Tables 9-12). These tabulations, stratified by sampling period and station, include estimates for the John Day tailrace during 1982-1983, and Arlington during 1984-1985. Sampling periods roughly correspond to

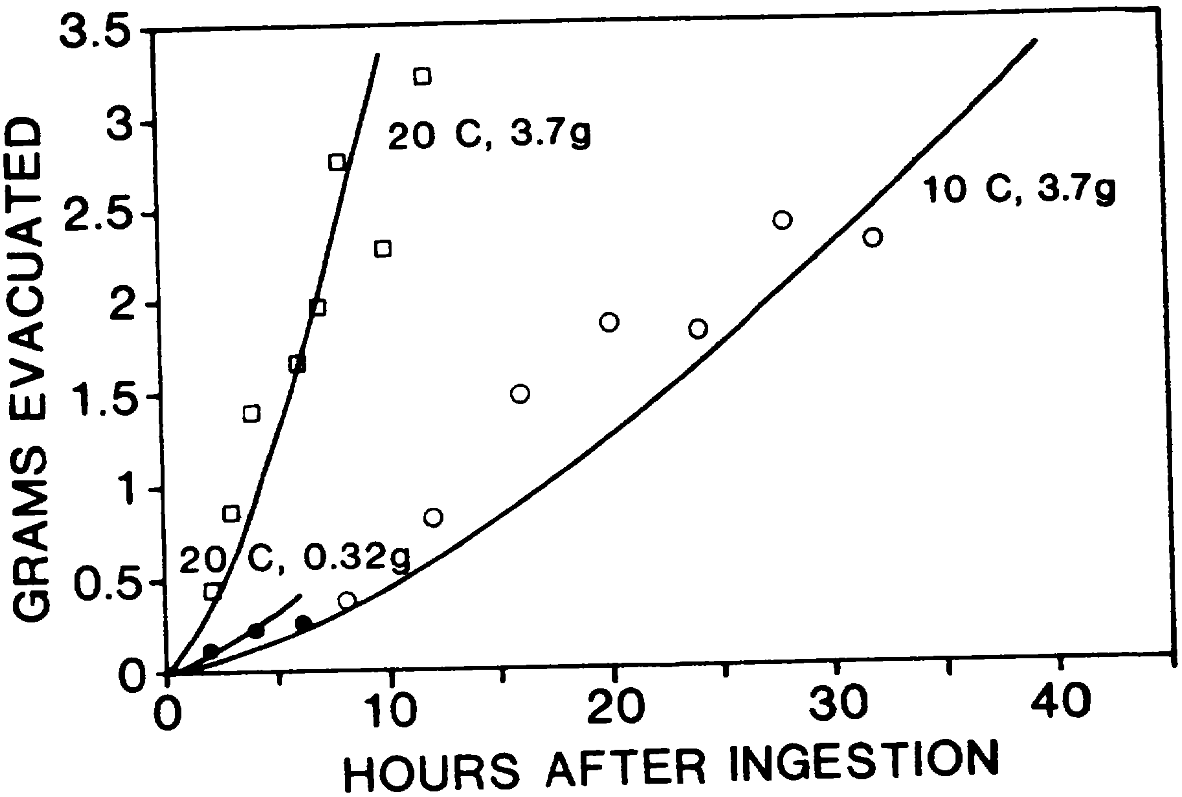


Figure 18. Comparison of the effects of increasing water temperature (C) and prey weight (g) on gastric evacuation in smallmouth bass (each symbol represents 3-11 samples).

Table 8. Means and (ranges) from smallmouth bass single meal experiments by prey size group: small (0.26 to 0.38 g), medium (1.0 to 1.8 g), and large (3.0 to 5.0 g).

Prey Size (Sample Size)	Prey (g)	Meal (%BW)	Predator (g)	Predator (mm FL)	Predator Condition Factor
Small (n=65)	0.32 (0.26-0.38)	0.3 (0.0-1.1)	180 (34-71)	212 (117-458)	1.7 (0.7-9.6)
Mediurn (n=77)	1.5 (1.0-1.8)	1.2 (0.1-5.7)	250 (29-1526)	231 (117-455)	1.8 (0.3-12.7)
Large (n=163)	3.7 (3.0-4.7)	3.5 (0.3-12.9)	183 (29-1329)	215 (129-455)	0.9 (0.6-1.2)

Table 9. Estimates of juvenile salmonid consumption by walleye populations in John Day Reservoir and tailrace stratified by station and sample period April-August, 1982; based on four diel intervals of six hours duration.

Station	Sample* period	Walleye No.	Walleye Mean wt(g)	Juvenile Salmonids No.	Juvenile Salmonids Mean wt(g)	(g) prey per avg. pred. per day	(mg) prey per g pred. per day	(No.) prey per avg. pred. per day
McNary tailrace (RZ only)	1-5	3	3388.3	0	0	0	0	0
McNary tailrace (Except RZ)	1	1	67	0	0	0	0	0
	2	56	1210.8	1	2.4	.2118	.1749	.0886
	3	17	1095.3	4	8.7	2.8332	2.5867	.3258
	4	7	577.9	0	0	0	0	0
	5	2	658.5	0	0	0	0	0
Irrigon	1	0	0	0	0	0	0	0
	2	17	1128.3	4	5.4	1.993	1.767	.3673
	3	4	1200.8	7	8.4	26.412	21.996	3.134
	4	1	251.0	0	0	0	0	0
	5	3	1389.3	0	0	0	0	0
Arlington				NO SAMPLE				
John Day forebay	1	1	966.0	0	0	0	0	0
	2	1	77.0	0	0	0	0	0
	3	1	1555.0	0	0	0	0	0
	4	0	-	-	-	-	-	-
	5	0	-	-	-	-	-	-
John Day tailrace	1	0	-	-	-	-	-	-
	2	49	519.0	21	2.2	1.405	2.708	.6538
	3	69	681.8	20	2.4	1.570	2.303	.6580
	4	0	-	-	-	-	-	-
	5	8	475.1	0	0	0	0	0
Total 4/1 thru 8/31	1-5	240	872.1	57	3.7	1.313	1.506	0.3552

*Sample period: 1 = April 2 = May 3 = June 4 = July 5 = August

Table 10. Estimates of juvenile salmonid consumption by walleye populations in John Day Reservoir and tailrace stratified by station and sample date during April-September, 1983; based on four diel intervals of six hours duration.

Station	Sample* period	Walleye No.	Walleye Mean wt(g)	Juvenile Salmonids No.	Juvenile Salmonids Mean wt(g)	(Mg) prey per avg. predator per day	(mg.) prey per g predator per day	No. prey per avg. predator per day
McNary tailrace (RZ only)	1-4	7	2261.4	0	0	0	0	0
McNary tailrace (Excluding (RZ)	1	40	2080.6	1	33.7	0.602	0.2897	0.0179
	2	70	1856.0	6	39.2	2.907	1.566	0.0742
	3	66	1795.5	1	3.7	0.116	0.065	0.0312
	4	29	1690.9	3	78.3	3.279	1.939	0.1797
Irrigon	1	3	1963.7	0	0	0	0	0
	2	68	1978.2	4	4.5	0.342	0.173	0.0757
	3	64	2264.6	10	4.9	1.130	0.499	0.2324
	4	7	699.1	0	0	0	0	0
Arlington					NO SAMPLE			
John Day forebay	1-4		0	-	-	-	-	-
John Day tailrace	1	33	1435.8	7	21.5	2.879	2.005	0.1341
	2	69	898.9	1	3.3	0.077	0.086	0.023
	3	21	971.1	0	0	0	0	0
	4	13	1391.2	1	2.3	0.250	0.180	0.1082
Total 4/4 thru 9/23	1-4	490	1703.3	34	16.2	1.396	0.819	0.0863

*Sample: 1 = April-May 2 = May-June 3 = June-July 4 = August-September

Table 11. Estimates of juvenile salmonid consumption by walleye populations in John Day Reservoir stratified by station and sample date during April-September, 1984; based on four diel intervals of six hours duration.

Station	Sample* period	Walleye		Juvenile Salmonids		(g) prey per avg. predator per day	(mg) prey per g predator per day	No. prey per avg. predator per day
		No.	Mean wt(g)	No.	Mean wt(g)			
McNary tailrace (RZ only)	1-4	11	2974.2	0	0	0	0	0
McNary tailrace (Excluding RZ)	1	86	2805.8	6	37.2	1.664	0.593	0.0448
	2	44	2215.7	9	68.5	10.798	4.873	0.1576
	3	83	1867.3	9	15.7	1.742	0.933	0.111
	4	4	903.5	2	24.4	26.668	29.516	1.0942
Irrigon	1	27	2900.2	1	82.1	1.799	0.620	0.0219
	2	46	2341.9	22	36.1	18.201	7.772	0.5044
	3	20	2808.3	0	0	0	0	0
	4	12	2403.7	2	20.0	4.476	1.862	0.2241
Arlington	1	0	-	-	-	-	-	-
	2	6	977.2	5	12.0	14.386	14.772	1.2003
	3	0	-	-	-	-	-	-
	4	0	-	-	-	-	-	-
John Day forebay	1-4	0	-	-	-	-	-	-
Total 4/4 thru 9/2	1-4	339	2380.6	56	35.8	5.414	2.274	0.1511

*Sample: 1 = April-May; 2 = May-June 3 = June-July 4 = August-September

Table 12. Estimates of juvenile salmonid consumption by walleye populations in John Day Reservoir stratified by station and sample period during April-September, 1985; based on four diel intervals of six hours duration.

Station	Sample* period	Walleye		Juvenile Salmonids		(g) prey per avg. predator per day	(mg) prey per avg. predator per day	No. prey per avg. predator per day
		No.	Mean wt(g)	No.	Mean wt(g)			
McNary tailrace (RZ only)	1-4	10	3730.0	0	0	0	0	0
McNary tailrace (Excluding RZ)	1	60	0	0	0	0	0	0
	2	112	2495.2	5	69.3	2.688	1.077	0.0388
	3	17	2457.1	0	0	0	0	0
	4	0	-	-	-	-	-	-
Irrigon	1	4	3562.5	0	0	0	0	0
	2	35	2727.3	1	142.6	11.788	4.322	0.0827
	3	37	3659.5	1	5.9	0.854	0.233	0.1449
	4	5	3445.0	0	0	0	0	0
Arlington	1	3	600.7	0	0	0	0	0
	2	2	1919.0	3	49.3	129.550	67.509	2.630
	3	1	710.0	1	5.1	76.257	107.404	15.092
	4	6	2708.3	0	0	0	0	0
John Day forebay	1-4	0	-	-	-	-	-	-
Total 4/4 thru 9/2	1-4	292	2860.3	11	58.9	2.590	0.906	0.0440

*Sample: 1 = April-May 2 = May-June 3 = June-July 4 = August-September

(1) April, (2) May, (3) June, and (4) August; slight monthly overlap occured at some stations during each year. July samples are absent with the exception of a few in 1982.

Consumption rates varied substantially among years, stations, and sample periods; the number of salmonids consumed per average walleye per day ranged from 0 to 3.13 (for stratified sample cells with more than one predator). Minimum consumption rates generally occurred in April, with subsequent increases. On an area1 basis, the highest annual consumption rates were observed at Arlington (i.e. 1.20 and 0.68 salmonids per walleye per day during 1984 and 1985, respectively). These values are based on a small sample size, however, since the walleye population was relatively low at Arlington (Nigro et al. 1986).

The overall annual consumption estimates (month and area pooled) of salmonids, non-salmonids, and total preyfish by walleyes in the John Day Reservoir, John Day tailrace excluded, are presented in Table 13. The average daily ration of salmonid prey varied substantially between years; extreme values were 0.77 and 2.27 mg salmonids /q walleye for 1983 and 1984, respectively. The salnonid daily ration, however, was balanced by the other preyfish species. The total preyfish ration was nearly constant 0.6% of walleye body weight per day with the exception of 1984 which was about 1.1%

The daily ration of predacious fishes in nature generally ranges from 0.5 to 6.0% (Swenson and Smith 1976; Doble and Eggers 1978; Keast and Walsh 1968; Thorpe 1376; Seaburg and Moyle 1964; Lane et al. 1979; Brett et al. 1969). Walleye in Lake of the Woods, Minnesota ranged from 1 to 3% depending on month (Swenson 1977; Senson and Smith 1973).

Table 13. Annual consumption estimates for three prey categories by walleye in the John Day Reservoir, 1982-1985.

Prey Category	Year	Sample Size Pred.	Sample Size Prey	Consumption Estimate: (g) Prey per avg. pred. per day	Consumption Estimate: (mg) Prey per (g) pred. per day	Consumption Estimate: No. of prey per avg. pred. per day
All salmonids:	1982	114	16	1.34	1.15	0.182
	1983	354	25	1.49	0.77	0.095
	1984	339	56	5.41	2.27	0.151
	1985	292	11	2.59	0.91	0.044
All non-salnonids:	1982	114	45	5.71	4.89	0.476
	1983	354	190	10.50	5.41	0.724
	1984	339	335	20.31	8.53	1.018
	1985	292	128	15.25	5.33	0.540
Total Species:	1982	114	61	7.05	6.04	0.654
	1983	354	215	12.00	6.18	0.819
	1984	339	391	25.75	10.81	1.578
	1985	292	139	17.84	6.24	0.582

Wahl and Nielsen (1985) determined the average annual food consumption of sauger (*Stizotedion canadense*) in the Ohio River was 1.1% body weight per day.

Histopathology

Fifteen subyearling chinook salmon and two steelhead trout were collected from the river using a beach seine and eight freshly ingested subyearling chinook were removed from stomachs of northern squawfish. Fish ranged from 120 to 180 mm and were caught on five different days.

In the non-ingested group of juvenile salmonids, very light *Renibacterium salmoninarum* (BKD) infection was observed in three chinook salmon and both steelhead trout. Most of these fish exhibited subtle inflammatory foci in the kidney and one fish had these foci in the liver. Although BKD bacteria could not be readily acertained in May-Grunwald Giemsa (M-GG) stained tissues, FAT positive bacteria were seen when they were stained with the direct FAT stain. Increase in melanin pigment was noted in the kidney of 4 of the 15 chinook salmon and the 2 steelhead trout. Two types of protozoans were seen in the digestive tract lumen. One was *Schizamoeba* sp. found in three chinook salmon (Figure 19-1) and the other, *Hexamita* sp. was found in one chinook salmon (Figure 19-2). A myxosporidan, *Myxobolus* sp., very likely *M. kisutchi*, (Yasutake and Wood 1957) (Figure 19-3 and 19-4) was found in the base of the brain (medulla oblongata) and in the anterior spinal cord of one chinook salmon.

Most of the eight ingested salmonids were in various stages of the digestive process as expected, including degeneration, necrosis and lysis (Figures 19-5 and 19-6). In spite of this, the extensive BKD infection was not difficult to detect in three of the eight fish examined. Although the bacteria did not stain well with Gram stain, they stained well with M-GG stain (Figure 19-7). The BKD infection was confirmed by FAT (Figure 19-8). FAT indicated that the infection in all three was systemic. No other organisms were seen.

Figure 19-l. Non-ingested subyearling fall chinook with several Schizamoeba sp. cysts (arrows) in the stomach lumen. May-Grunwald Giemsa M-G G stain. x310.

Figure 19-2. Non-ingested subyearling fall chinook with several Hexamita sp. (arrows) in the intestinal lumen. M-G G stain. X290.

Figure 19-3. Non-ingested subyearling fall chinook with many Myxobolus sp. cysts (arrows) in the base of the brain, including the medulla oblongata and the spinal cord. M-G G stain. x100.

Figure 19-4. Non-ingested subyearling fall chinook. Higher magnification of an area in Figure 3 showing the Myxobolus sp. spore with the two polar capsules (arrows). M-G G stain. X510.

Figure 19-5. Non-ingested subyearling fall chinook. Kidney showing relatively normal renal (a) and hematopoietic (b) elements. The black areas (c) are areas of melanin pigment containing cell, the melanophores, concentration. M-G G stain. X60.

Figure 19-6. Ingested subyearling chinook. Note the cellular breakdown of the renal tubular epithelium (a) and the melanophores and resulting diffusion of the melanin pigments in the hematopoietic tissue (b). M-G G stain x130.

Figure 19-7. Ingested subyearling fall chinook kidney tissue. Note the bacterial kidney disease BKD bacteria (a) and themelanin pigments (b). M-G G stain. x1400.

Figure 19-8. Ingested fall chinook kidney stained by the direct fluorescent antibody technique (FAT). Note the numerous FAT positive BKD bacteris (arrows). x1400.

Figure 19. Photos I-4

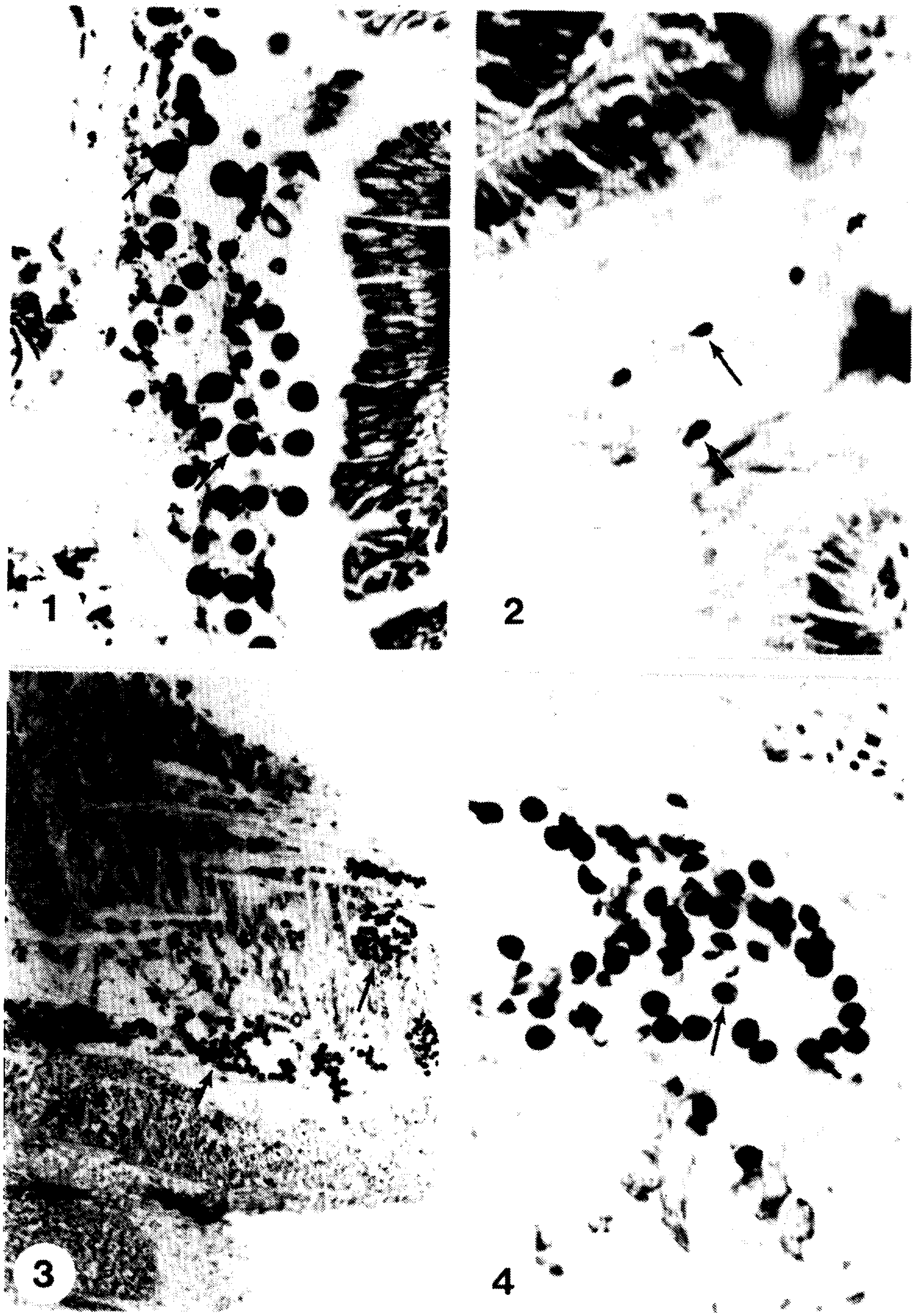
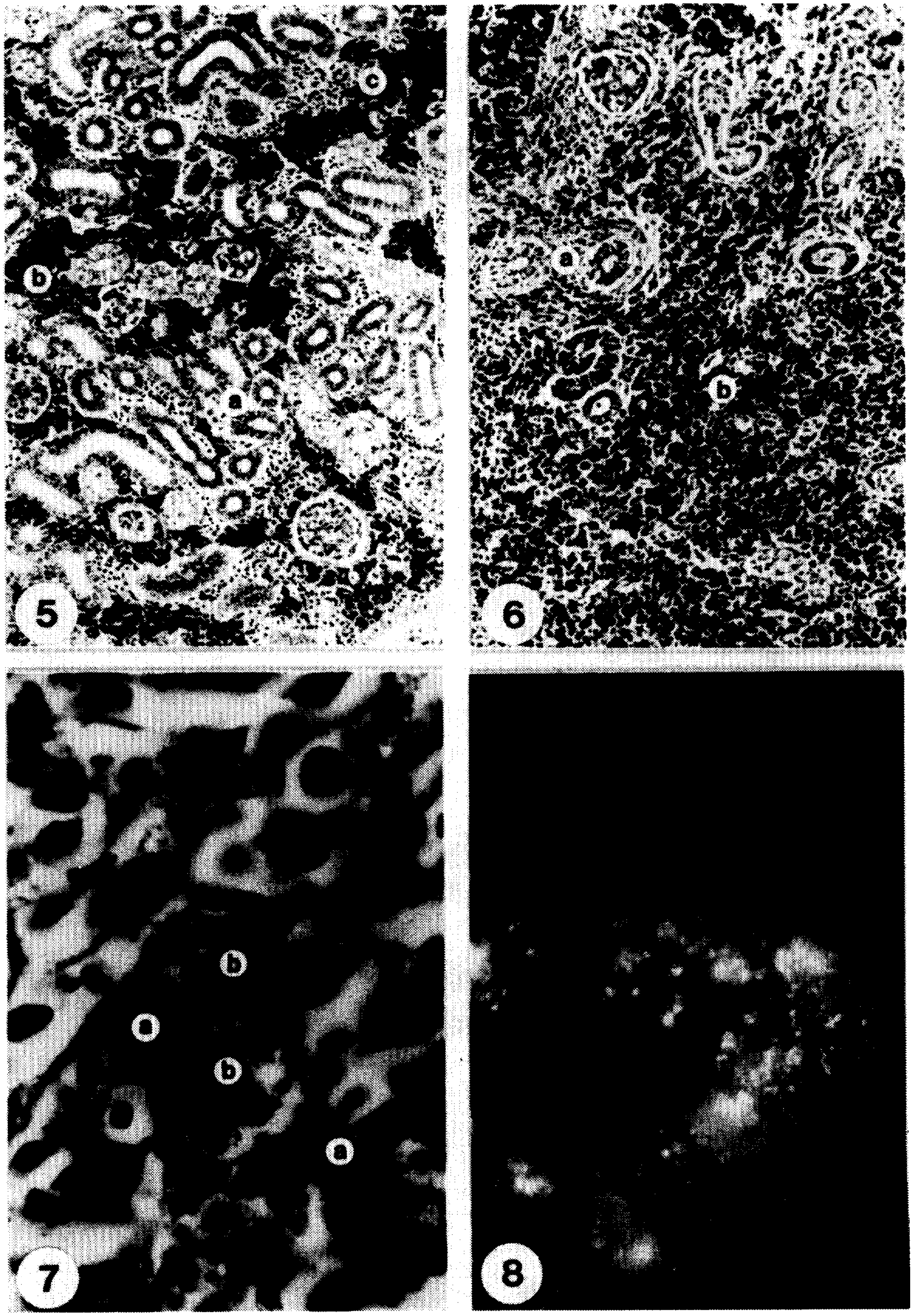


Figure 19. Photos 5 – 8.



DISCUSSION

The abundance and composition of prey items in the diets of northern squawfish, walleye, smallmouth bass, and channel catfish were generally similar to those in 1982, 1983, and 1984.

As in previous years, salmonids were the single most important food item of northern squawfish in the restricted zones at McNary tailrace and John Day forebay during April, May, June, and August. Similar to results in 1984, positive relationships between northern squawfish length and piscivory were also found as fish comprised a greater proportion of the weight of food items in the diet of larger Predators. In 1985, as in previous years, no fish were found in the stomachs of northern squawfish less than 100 mm in length.

As in 1982, 1983, and 1984, catches of walleye were highest at McNary tailrace and Irrigon, low at Arlington, and none were caught at John Day forebay. Fish have accounted for nearly all of the weight of food consumed by walleye in each year studied. In 1985 the percent weight of salmonids in the diet (11.6%) was less than in 1984 (18.1%) but about twice that found in 1983 (6.0%) and also higher than in 1982 (8.8%).

As in previous years, smallmouth bass were widely distributed throughout the reservoir, but salmonids contributed little to their diet. Percent weight of salmonids in the diet was greatest in August, at Arlington and John Day forebay, as was the case in 1983 and 1984. The contribution of fish to the diet decreased in the downstream portion of the reservoir (Arlington and John Day forebay) corresponding to increased predation on crayfish.

As in 1983 and 1984, the majority of channel catfish were collected from McNary tailrace and Irrigon during 1985. At Arlington, channel catfish were collected only in August and only one was collected at John Day forebay. Fish continued to be the major component in the diet of channel catfish, accounting for 57.8% of the weight in the diet, as compared with 73.9% and 64.1% in 1983 and 1984, respectively.

Composition of prey taxa in beach seine catches in 1985 was similar to other years with chinook salmon, northern squawfish, largescale sucker, and sand roller comprising over 82% of the catch at main channel stations and crappies and largescale sucker representing over 50% of the catch at backwater stations. As in 1984, catch of prey fishes were highest at McNary backwater (Plymouth slough) and lowest at Arlington.

Preliminary results of beach seine efficiency studies conducted in 1985 suggest that seine efficiency differs among prey species and is influenced by substrate type. During 1986 we will conduct additional seine efficiency experiments which will enable us to more accurately explain these relationships. Resulting information on beach seine efficiency will be used to adjust catch data to provide more accurate estimates of prey abundance.

The northern squawfish evacuation equation derived from this study will be applicable to the range of prey weights, predator weights, and water temperatures encountered in the field studies. The double meal experiments suggest that the total weight in the digestive tract could be used in the equations in place of initial prey weight.

Smallmouth bass evacuation experiments will be completed in 1986. Emphasis will be on obtaining one-fish meals for small prey (0.26 to 0.38 g) at 10 C and for large predators (>300 mm FL) at all combinations of prey sizes and water temperatures.

Preliminary estimates of juvenile salmonid consumption by walleye in John Day Reservoir indicate that walleye consume the highest number of juvenile salmonids from May through July at the Irrigon and John Day tailrace stations. When these results are integrated with the ODFW population estimate data it will be possible to estimate the number of juvenile salmonids consumed by walleye in John Day Reservoir.

Histopathological examination of juvenile salmonids ingested by predators was primarily intended to determine the feasibility of assessing the general health of ingested fish. The only histopathological finding of possible significance in this study appears to be the BKD infection. Five of the 17 non-ingested fish examined had the infection, but the FAT indicated that they all had very light infections. In three of the ingested fish, which had BKD, the infection was extensive and this may have increased their vulnerability to predators. Due to the presence of tissue changes caused by the digestive process in the ingested fish, we were unable to assess whether they had any physical injuries that could have impeded their escape from predators. However, by using various special staining techniques, we were able to analyze (histologically) the various tissues in spite of the effects of the digestive process.

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APPENDIX

Appendix Table 1. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish 100-249 mm in length by station, John Day Reservoir, 1985. Sample sizes and number of empty digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
McNary tailrace	Mollusca	0.0	0.0	0.0
(31, 2)	Crustacea	48.4	49.9	30.3
	Insecta	58.1	26.8	0.8
	Osteichthyes	3.2	4.9	< 0.1
	Salmonidae	0.0	0.0	0.0
	Other Food	29.0	18.5	0.3
Irrigon	Mollusca	0.0	0.0	0.0
(25, 5)	Crustacea	28.0	7.6	2.0
	Insecta	52.0	78.4	2.6
	Osteicthyes	8.0	2.6	0.1
	Salmonidae	0.0	0.0	0.0
	Other Food	28.0	11.4	0.3
Arlington	Mollusca	0.0	0.0	0.0
(7, 2)	Crustacea	42.9	77.3	2.9
	Insecta	28.6	12.1	0.4
	Osteichthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other food	14.3	10.7	0.1
John Day forebay	Mollusca			
(1, 1)	Crustacea			
	Insecta			
	Osteichthyes	Ns	Ns	Ns
	Salmonidae			
	Other Food			

Appendix Table 2. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish (100-249 mm) by sample period from McNary tailrace, John Day Reservoir, 1985. Sample sizes and number of empty digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 8 - Apr 11	Mollusca			
(2, 2)	Crustacea			
	Insecta			
	Osteicthyes	Ns	Ns	Ns
	Salmonidae			
	Other Food			
May 6 - May 9	Mollusca	0.0	0.0	0.0
(9, 0)	Crustacea	88.9	69.6	59.9
	Insecta	22.2	0.1	0.2
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	66.7	30.3	0.7
Jun 3 - Jun 5	Mollusca	0.0	0.0	0.0
(4, 0)	Crustacea	100.0	69.4	54.5
	Insecta	50.0	1.3	0.5
	Osteicthyes	25.0	23.0	0.3
	Salmonidae	0.0	0.0	0.0
	Other Food	25.0	6.4	0.3
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(16, 0)	Crustacea	18.8	14.6	11.3
	Insecta	87.5	73.9	1.3
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	12.5	11.4	0.1

Appendix Table 3. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish (100-249 mm) by sample period at Irrigon, John Day Reservoir, 1985. Sample sizes and number of empty digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 15 - Apr 17	Mollusca	0.0	0.0	0.0
(4, 0)	Crustacea	25.0	90.4	0.3
	Insecta	50.0	5.8	0.5
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	50.0	3.8	0.5
May 13 - May 17	Mollusca	0.0	0.0	0.0
(3, 1)	Crustacea	66.7	57.2	8.3
	Insecta	33.3	42.8	0.3
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	other Food	0.0	0.0	0.0
Jun 10 - Jun 13	Mollusca	0.0	0.0	0.0
(8, 2)	Crustacea	50.0	7.8	2.9
	Insecta	75.0	92.2	4.5
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other food	0.0	0.0	0.0
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(10, 2)	Crustacea	0.0	0.0	0.0
	Insecta	40.0	69.0	2.6
	Osteicthyes	20.0	5.8	0.2
	Salmonidae	0.0	0.0	0.0
	Other Food	50.0	25.2	0.6

Appendix Table 4. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish (100-249 mm) by sample period at Arlington, John Day Reservoir, 1985. Sample sizes and number of empty digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 29 May 2 (3, 2)	Mollusca	0.0	0.0	0.0
	Crustacea	33.3	100.0	4.3
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
May 21 - May 31 (3, 0)	Mollusca	0.0	0.0	0.0
	Crustacea	66.7	83.3	2.3
	Insecta	66.7	16.7	1.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Jun 17 - Jun 25 (1, 0)	Mollusca	0.0	0.0	0.0
	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	100.0	100.0	1.0
Aug 5 - Aug 31 (0, 0)	Mollusca			
	Crustacea			
	Insecta			
	Osteicthyes	Ns	Ns	Ns
	Salmonidae			
	Other Food			

Appendix Table 5. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish > 250 mm in length by station, John Day Reservoir, 1985. Sample sizes and number of digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
McNary tailrace (502, 163)	Mollusca	2.6	0.4	< 0.1
	Crustacea	20.5	4.7	11.3
	Insecta	16.1	0.2	0.5
	Osteicthyes	48.2	92.1	0.9
	Salmonidae	39.6	82.3	0.8
	Other Food	8.4	2.5	0.1
Irrigon (76, 28)	Mollusca	2.6	0.3	< 0.1
	Crustacea	27.6	19.9	0.9
	Insecta	15.8	1.1	3.1
	Osteicthyes	38.2	78.1	0.5
	Salmonidae	1.3	7.1	0.1
	Other Food	5.3	0.7	0.1
Arlington (171, 53)	Mollusca	0.6	0.1	< 0.1
	Crustacea	41.5	37.8	17.7
	Insecta	32.2	3.4	1.4
	Osteicthyes	17.5	44.1	0.2
	Salmonidae	6.4	18.1	0.1
	Other Food	11.1	14.0	0.1
John Day forebay (229, 111)	Mollusca	0.4	0.1	< 0.1
	Crustacea	23.6	23.6	30.9
	Insecta	14.4	1.0	0.2
	Osteicthyes	25.3	74.0	0.3
	Salmonidae	12.7	44.5	0.2
	Other Food	4.8	0.8	< 0.1

Appendix Table 6. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish > 250 mm in length by sample period from McNary tailrace, John Day Reservoir, 1985. Sample sizes and number of empty digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 8 - Apr 11	Mollusca	1.3	< 0.1	< 0.1
(80, 11)	Crustacea	11.3	0.9	0.2
	Insecta	28.8	0.4	1.1
	Osteicthyes	72.5	97.1	1.2
	Salmonidae	65.0	83.6	1.0
	Other Food	10.0	1.6	0.1
May 6 - May 9	Mollusca	3.4	0.6	< 0.1
(119, 23)	Crustacea	31.9	6.5	18.2
	Insecta	16.8	0.1	0.5
	Osteicthyes	58.8	88.2	1.2
	Salmonidae	47.1	77.5	1.0
	Other Food	10.9	4.4	0.1
Jun 3 - Jun 5	Mollusca	5.7	0.8	0.1
(140, 48)	Crustacea	34.3	10.7	25.0
	Insecta	15.7	0.2	0.5
	Osteicthyes	31.4	86.2	0.5
	Salmonidae	26.4	82.2	0.4
	Other Food	10.0	1.6	0.1
Jul 1 - Jul 31	Mollusca	0.0	0.0	0.0
(74, 26)	Crustacea	4.1	< 0.1	0.1
	Insecta	13.5	0.1	0.2
	Osteicthyes	60.8	99.8	1.6
	Salmonidae	59.5	99.8	1.6
	Other Food	1.4	0.1	< 0.1
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(89, 55)	Crustacea	5.6	4.4	0.1
	Insecta	6.7	1.0	0.1
	Osteicthyes	27.0	94.1	0.4
	Salmonidae	10.1	57.0	0.1
	Other Food	6.7	0.5	0.1

Appendix Table 7. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish >250 mm in length by sample period at Irrigon, John Day Reservoir, 1985. Sample sizes and number of empty disgestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 15 - Apr 17	Mollusca	8.3	0.7	0.1
(12, 3)	Crustacea	25.0	10.2	0.3
	Insecta	8.3	< 0.1	0.1
	Osteicthyes	58.3	89.0	0.7
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
May 13 - May 17	Mollusca	2.6	0.2	< 0.1
(39, 12)	Crustacea	43.6	25.2	1.5
	Insecta	15.4	0.3	0.2
	Osteicthyes	43.6	73.6	0.7
	Salmonidae	2.6	11.5	0.1
	Other Food	2.6	0.8	0.1
Jun 10 - Jun 13	Mollusca	0.0	0.0	0.0
(18, 9)	Crustacea	5.6	13.3	0.2
	Insecta	16.7	3.7	12.3
	Osteicthyes	22.2	82.0	0.2
	Salmonidae	0.0	0.0	0.0
	Other Food	16.7	0.9	0.2
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(7, 4)	Crustacea	0.0	0.0	0.0
	Insecta	28.6	47.5	0.7
	Osteicthyes	14.3	52.5	0.1
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0

Appendix Table 8. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish > 250 mm in length by sample period at Arlington, John Day Reservoir, 1985. Sample sizes and number of empty digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 29 - May 2	Mollusca	0.0	0.0	0.0
(33, 12)	Crustacea	48.5	28.1	54.2
	Insecta	24.2	0.2	0.4
	Osteicthyes	21.2	35.4	0.2
	Salmonidae	3.0	7.8	< 0.1
	Other Food	15.2	36.3	0.2
May 21 - May 31	Mollusca	2.6	0.3	0.1
(38, 5)	Crustacea	68.4	38.3	31.5
	Insecta	36.8	3.8	4.0
	Osteicthyes	18.4	46.6	0.2
	Salmonidae	10.5	25.6	0.1
	Other Food	21.1	11.1	0.2
Jun 17 - Jun 25	Mollusca	0.0	0.0	0.0
(50, 17)	Crustacea	30.0	50.0	0.5
	Insecta	34.0	3.1	0.7
	Osteicthyes	12.0	35.7	0.2
	Salmonidae	6.0	20.1	0.1
	Other Food	8.0	8.8	0.1
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(50, 19)	Crustacea	28.0	32.8	0.4
	Insecta	32.0	6.7	0.7
	Osteicthyes	20.0	59.6	0.2
	Salmonidae	12.0	11.1	0.1
	Other Food	4.0	0.9	< 0.1

Appendix Table 9. Percent occurrence, weight and mean number of food items in digestive tracts of northern squawfish > 250 mm in length at John Day forebay, John Day Reservoir, 1985. Sample sizes and number of empty digestive tracts are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 22 - May 2	Mollusca	0.0	0.0	0.0
(28, 7)	Crustacea	53.6	26.3	52.9
	Insecta	17.9	0.3	0.2
	Osteicthyes	28.6	71.8	0.4
	Salmonidae	3.6	31.9	< 0.1
	Other Food	10.7	1.6	0.1
May 21 - Jun 7	Mollusca	0.0	0.0	0.0
(55, 25)	Crustacea	32.7	20.0	91.2
	Insecta	14.5	0.4	0.2
	Osteicthyes	23.6	79.4	0.4
	Salmonidae	18.2	46.3	0.3
	Other Food	1.8	< 0.1	< 0.1
Jun 24 - Jun 29	Mollusca	0.0	0.0	0.0
(51, 36)	Crustacea	11.8	45.7	1.1
	Insecta	3.9	0.3	< 0.1
	Osteicthyes	17.6	47.9	0.2
	Salmonidae	3.9	19.7	< 0.1
	Other Food	2.0	2.7	< 0.1
Jul 15 - Jul 19	Mollusca	0.0	0.0	0.0
(32, 11)	Crustacea	9.4	6.2	0.1
	Insecta	34.4	3.4	0.5
	Osteicthyes	40.6	90.4	0.5
	Salmonidae	37.5	89.5	0.5
	Other Food	0.0	0.0	0.0
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(53, 28)	Crustacea	15.1	24.8	0.2
	Insecta	7.5	1.2	0.1
	Osteicthyes	24.5	72.8	0.2
	Salmonidae	5.7	30.0	0.1
	Other Food	11.3	1.2	0.1

Appendix Table 10. Percent occurrence, percent weight, and mean number of food items in stomachs of walleye by station from John Day Reservoir, April 8 to August 31, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
McNary tailrace	Mollusca	0.0	0.0	0.0
(199, 160)	Crustacea	2.0	< 0.1	0.1
	Insecta	1.0	< 0.1	< 0.1
	Osteicthyes	17.6	100.0	0.3
	Salmonidae	3.0	27.6	< 0.1
	Other Food	3.0	< 0.1	< 0.1
Irrigon	Mollusca	0.0	0.0	0.0
(81, 30)	Crustacea	7.4	0.1	1.1
	Insecta	8.6	< 0.1	0.4
	Osteicthyes	63.0	99.9	1.3
	Salmonidae	4.9	3.1	0.1
	Other Food	3.7	< 0.1	< 0.1
Arlington	Mollusca	0.0	0.0	0.0
(12, 0)	Crustacea	0.0	0.0	0.0
	Insecta	33.3	0.1	0.5
	Osteicthyes	91.7	99.9	1.4
	Salmonidae	16.7	28.2	0.5
	Other Food	0.0	0.0	0.0

Appendix Table 11. Percent occurrence, percent weight, and mean number of food items in stomachs of walleye by sample period from McNary tailrace, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 8 - Apr 11	Mollusca	0.0	0.0	0.0
(62, 58)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	6.5	99.9	0.1
	Salmonidae	3.2	1.9	< 0.1
	Other Food	1.6	0.1	< 0.1
May 6 - May 9	Mollusca	0.0	0.0	0.0
(116, 98)	Crustacea	2.6	0.1	0.1
	Insecta	0.9	< 0.1	< 0.1
	Osteicthyes	13.8	99.9	0.2
	Salmonidae	2.6	81.7	0.1
	Other Food	3.4	< 0.1	< 0.1
Jun 3 - Jun 5	Mollusca	0.0	0.0	0.0
(15, 1)	Crustacea	6.7	< 0.1	0.1
	Insecta	6.7	< 0.1	0.3
	Osteicthyes	86.7	100.0	2.3
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(4, 2)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	25.0	99.8	0.3
	Salmonidae	0.0	0.0	0.0
	Other Food	25.0	0.2	0.3

Appendix Table 12. Percent occurrence, percent weight, and mean number of food items in stomachs of walleye by sample period from Irrigon, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 15 - Apr 17	Mollusca	0.0	0.0	0.0
(4, 3)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	25.0	100.0	0.8
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
May 13 - May 17	Mollusca	0.0	0.0	0.0
(35, 9)	Crustacea	8.6	0.1	1.1
	Insecta	8.6	< 0.1	0.4
	Osteicthyes	74.3	99.9	1.8
	Salmonidae	8.6	7.4	0.2
	Other Food	0.0	0.0	0.0
Jun 10 - Jun 13	Mollusca	0.0	0.0	0.0
(36, 14)	Crustacea	8.3	0.1	1.4
	Insecta	11.1	< 0.1	0.4
	Osteicthyes	61.1	99.9	1.1
	Salmonidae	2.8	0.1	< 0.1
	Other Food	8.3	< 0.1	0.1
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(5, 4)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	20.0	100.0	0.2
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0

Appendix Table 13. Percent occurrence, percent weight, and mean number of food items in stomachs of walleye by sample period from Arlington, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 29 - May 2	Mollusca	0.0	0.0	0.0
(3, 0)	Crustacea	0.0	0.0	0.0
	Insecta	33.3	0.1	0.3
	Osteicthyes	100.0	99.9	1.7
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
May 21 - May 31	Mollusca	0.0	0.0	0.0
(2, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	100.0	100.0	3.0
	Salmonidae	50.0	81.7	2.5
	Other Food	0.0	0.0	0.0
Jun 17 - Jun 25	Mollusca	0.0	0.0	0.0
(1, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	100.0	100.0	1.0
	Salmonidae	100.0	100.0	1.0
	Other Food	0.0	0.0	0.0
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(6, 0)	Crustacea	0.0	0.0	0.0
	Insecta	50.0	0.2	0.8
	Osteicthyes	83.3	99.8	0.8
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0

Appendix Table 14. Percent occurrence, percent weight, and mean number of food items in stomachs of smallmouth bass by station from John Day Reservoir, April 8 to August 31, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
McNary tailrace (42, 11)	Mollusca	0.0	0.0	0.0
	Crustacea	26.2	3.5	0.8
	Insecta	33.3	1.8	0.6
	Osteicthyes	69.0	94.3	1.4
	Salmonidae	2.4	< 0.1	< 0.1
	Other Food	19.0	0.4	0.2
Irrigon (280, 67)	Mollusca	0.4	< 0.1	< 0.1
	Crustacea	25.4	5.6	0.5
	Insecta	26.1	0.4	0.4
	Osteicthyes	62.9	93.7	1.1
	Salmonidae	3.6	1.2	0.1
	Other Food	11.8	0.2	0.1
Arlington (698, 119)	Mollusca	0.4	< 0.1	< 0.1
	Crustacea	58.0	14.5	3.2
	Insecta	36.0	0.9	0.7
	Osteicthyes	52.7	84.5	0.8
	Salmonidae	2.3	2.1	< 0.1
	Other Food	10.2	0.2	0.1
John Day forebay (663, 83)	Mollusca	0.9	< 0.1	< 0.1
	Crustacea	71.0	29.6	11.3
	Insecta	32.6	0.7	0.9
	Osteicthyes	44.6	69.5	0.6
	Salmonidae	3.0	6.7	< 0.1
	Other Food	8.6	0.1	0.1

Appendix Table 15. Percent occurrence, percent weight, and mean number of food items in stomachs of smallmouth bass by sample period from McNary tailrace, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 8 - Apr 11	Mollusca	0.0	0.0	0.0
(4, 3)	Crustacea	25.0	55.8	1.0
	Insecta	25.0	0.1	0.3
	Osteicthyes	25.0	44.2	0.8
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
May 6 - May 9	Mollusca	0.0	0.0	0.0
(3, 0)	Crustacea	33.3	14.1	0.7
	Insecta	0.0	0.0	0.0
	Osteicthyes	100.0	85.9	1.3
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Jun 3 - Jun 5	Mollusca	0.0	0.0	0.0
(17, 4)	Crustacea	29.4	2.2	1.4
	Insecta	52.9	4.5	1.1
	Osteicthyes	64.7	92.2	1.2
	Salmonidae	5.9	< 0.1	0.1
	Other Food	41.2	1.1	0.4
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(18, 4)	Crustacea	22.2	2.4	0.3
	Insecta	22.2	0.3	0.3
	Osteicthyes	77.8	97.3	1.8
	Salmonidae	0.0	0.0	0.0
	Other Food	5.6	< 0.1	0.1

Appendix Table 16. Percent occurrence, percent weight, and mean number of food items in stomachs of smallmouth bass by sample period from Irrigon, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 15 - Apr 17	Mollusca	0.0	0.0	0.0
(14, 7)	Crustacea	14.3	6.1	0.3
	Insecta	7.1	< 0.1	0.1
	Osteicthyes	50.0	93.9	0.8
	Salmonidae	0.0	0.0	0.0
	Other Food	7.1	< 0.1	0.1
May 13 - May 17	Mollusca	0.9	0.1	< 0.1
(107, 28)	Crustacea	18.7	5.1	0.3
	Insecta	15.9	0.3	0.2
	Osteicthyes	60.7	94.4	0.8
	Salmonidae	0.0	0.0	0.0
	Other Food	11.2	< 0.1	0.1
Jun 10 - Jun 13	Mollusca	0.0	0.0	0.0
(97, 21)	Crustacea	39.2	10.6	1.0
	Insecta	41.2	1.5	0.6
	Osteicthyes	57.7	87.3	0.9
	Salmonidae	10.3	7.3	0.2
	Other Food	11.3	0.6	0.1
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(62, 11)	Crustacea	17.7	3.6	0.3
	Insecta	24.2	< 0.1	0.5
	Osteicthyes	77.4	96.1	1.9
	Salmonidae	0.0	0.0	0.0
	Other Food	14.5	0.2	0.1

Appendix Table 17. Percent occurrence, percent weight, and mean number of food items in stomachs of smallmouth bass by sample period from Arlington, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 29 - May 2	Mollusca	0.0	0.0	0.0
(150, 41)	Crustacea	49.3	9.2	1.8
	Insecta	26.7	0.3	0.3
	Osteicthyes	42.0	90.5	0.5
	Salmonidae	0.0	0.0	0.0
	Other Food	9.3	0.1	0.1
May 21 - May 31	Mollusca	0.5	< 0.1	< 0.1
(182, 33)	Crustacea	62.6	14.8	4.0
	Insecta	40.7	1.2	0.7
	Osteicthyes	45.6	83.9	0.6
	Salmonidae	2.2	0.8	< 0.1
	Other Food	8.8	0.1	0.1
Jun 17 - Jun 25	Mollusca	0.0	0.0	0.0
(217, 22)	Crustacea	68.2	10.1	5.2
	Insecta	42.9	1.0	0.9
	Osteicthyes	59.0	88.6	0.9
	Salmonidae	3.7	2.1	< 0.1
	Other Food	12.9	0.3	0.1
Aug 5 - Aug 31	Mollusca	1.3	< 0.1	< 0.1
(149, 22)	Crustacea	45.6	25.1	0.6
	Insecta	29.5	1.0	0.7
	Osteicthyes	63.1	73.8	1.0
	Salmonidae	2.7	5.0	< 0.1
	Other Food	8.7	0.2	0.1

Appendix Table 18. Percent occurrence, percent weight, and mean number of food items in stomachs of smallmouth bass by sample period from John Day forebay, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 22 - May 2	Mollusca	2.3	0.0	0.0
(44, 15)	Crustacea	50.0	20.3	1.6
	Insecta	13.6	0.2	0.2
	Osteicthyes	31.8	79.3	0.4
	Salmonidae	0.0	0.0	0.0
	Other Food	9.1	0.1	0.1
May 21 - Jun 7	Mollusca	0.5	< 0.1	< 0.1
(182, 14)	Crustacea	82.4	32.2	13.4
	Insecta	28.6	0.2	0.8
	Osteicthyes	44.5	67.5	0.5
	Salmonidae	0.5	0.6	< 0.1
	Other Food	3.8	< 0.1	< 0.1
Jun 24 - Jun 29	Mollusca	1.7	< 0.1	< 0.1
(174, 18)	Crustacea	70.7	27.1	8.6
	Insecta	38.5	1.3	0.8
	Osteicthyes	44.3	71.2	0.6
	Salmonidae	2.3	3.6	< 0.1
	Other Food	12.1	0.2	0.1
Jul 1 - Jul 31	Mollusca	0.7	< 0.1	< 0.1
(148, 18)	Crustacea	69.6	16.1	8.4
	Insecta	48.6	1.4	1.7
	Osteicthyes	55.4	82.2	1.0
	Salmonidae	4.1	4.0	< 0.1
	Other Food	12.2	0.3	0.2
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(115, 18)	Crustacea	63.5	43.5	19.6
	Insecta	16.5	< 0.1	0.2
	Osteicthyes	36.5	56.4	0.5
	Salmonidae	7.8	19.7	0.1
	Other Food	6.1	0.1	0.1

Appendix Table 19. Percent occurrence, percent weight, and mean number of food items in digestive tracts of channel catfish by station from John Day Reservoir, April 8 to August 31, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
McNary tailrace (111, 25)	Mollusca	10.8	7.8	0.3
	Crustacea	41.4	2.1	2.0
	Insecta	22.5	0.5	0.6
	Osteicthyes	36.9	83.2	0.7
	Salmonidae	18.0	49.2	0.3
	Other Food	24.3	6.4	0.3
Irrigon (34, 6)	Mollusca	8.8	15.1	0.4
	Crustacea	52.9	27.2	4.0
	Insecta	17.6	< 0.1	1.5
	Osteicthyes	50.0	45.7	1.0
	Salmonidae	0.0	0.0	0.0
	Other Food	17.6	11.9	0.2
Arlington (29, 3)	Mollusca	3.4	< 0.1	0.0
	Crustacea	89.7	78.4	4.3
	Insecta	58.6	4.4	5.3
	Osteicthyes	17.2	16.9	0.2
	Salmonidae	0.0	0.0	0.0
	Other Food	6.9	0.3	0.1
John Day forebay (1, 0)	Mollusca	0.0	0.0	0.0
	Crustacea	100.0	98.9	1.0
	Insecta	100.0	1.1	2.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0

Appendix Table 20. Percent occurrence, percent weight, and mean number of food items in digestive tracts of channel catfish by sample period from McNary tailrace, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 8 - Apr 11	Mollusca	23.1	18.1	0.6
(39, 6)	Crustacea	20.5	1.8	0.4
	Insecta	23.1	0.9	1.0
	Osteicthyes	30.8	66.8	0.4
	Salmonidae	23.1	65.5	0.3
	Other Food	30.8	12.3	0.3
May 6 - May 9	Mollusca	2.5	0.1	0.0
(40, 5)	Crustacea	70.0	2.9	4.7
	Insecta	37.5	0.5	0.6
	Osteicthyes	42.5	95.5	0.8
	Salmonidae	20.0	48.8	0.3
	Other Food	20.0	1.1	0.3
Jun 3 - Jun 5	Mollusca	6.7	3.6	0.1
(30, 14)	Crustacea	26.7	2.2	0.7
	Insecta	3.3	< 0.1	0.0
	Osteicthyes	33.3	87.9	0.5
	Salmonidae	10.0	42.5	0.1
	Other Food	20.0	6.2	0.2
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(2, 0)	Crustacea	100.0	0.4	1.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	100.0	99.5	6.0
	Salmonidae	0.0	0.0	0.0
	Other Food	50.0	< 0.1	0.5

Appendix Table 21. Percent occurrence, percent weight, and mean number of food items in digestive tracts of channel catfish by sample period from Irrigon, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 15 - Apr 17	Mollusca	20.0	57.3	1.4
(5, 0)	Crustacea	0.0	0.0	0.0
	Insecta	20.0	0.1	1.6
	Osteicthyes	40.0	25.4	1.0
	Salmonidae	0.0	0.0	0.0
	Other Food	60.0	17.2	0.8
May 13 - May 17	Mollusca	5.9	10.6	0.4
(17, 2)	Crustacea	58.8	33.3	6.5
	Insecta	23.5	0.1	1.5
	Osteicthyes	58.8	43.0	1.1
	Salmonidae	0.0	0.0	0.0
	Other Food	11.8	13.0	0.1
Jun 10 - Jun 13	Mollusca	0.0	0.0	0.0
(3, 1)	Crustacea	66.7	74.0	2.7
	Insecta	0.0	0.0	0.0
	Osteicthyes	33.3	26.0	0.3
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Aug 5 - Aug 31	Mollusca	11.1	< 0.1	0.1
(9, 3)	Crustacea	66.7	19.7	1.8
	Insecta	11.1	< 0.1	1.9
	Osteicthyes	44.4	69.9	1.0
	Salmonidae	0.0	0.0	0.0
	Other Food	11.1	10.5	0.2

Appendix Table 22. Percent occurrence, percent weight, and mean number of food items in digestive tracts of channel catfish by sample period from Arlington, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 29 - May 2	Mollusca	0.0	0.0	0.0
(0, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
May 21 - May 31	Mollusca	0.0	0.0	0.0
(0, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Jun 17 - Jun 25	Mollusca	0.0	0.0	0.0
(0, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Aug 5 - Aug 31	Mollusca	3.4	< 0.1	0.0
(29, 3)	Crustacea	89.7	78.4	4.3
	Insecta	58.6	4.4	5.3
	Osteicthyes	17.2	16.9	0.2
	Salmonidae	0.0	0.0	0.0
	Other Food	6.9	0.3	0.1

Appendix Table 23. Percent occurrence, percent weight, and mean number of food items in digestive tracts of channel catfish by sample period from John Day forebay, John Day Reservoir, 1985. Sample size and number of empty stomachs are in parentheses.

Date	Food Item	Percent Occurrence	Percent Weight	Mean Number
Apr 22 - May 2	Mollusca	0.0	0.0	0.0
(0, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
May 21 - Jun 7	Mollusca	0.0	0.0	0.0
(1, 0)	Crustacea	100.0	98.9	1.0
	Insecta	100.0	1.1	2.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Jun 24 - Jun 29	Mollusca	0.0	0.0	0.0
(0, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0
Aug 5 - Aug 31	Mollusca	0.0	0.0	0.0
(0, 0)	Crustacea	0.0	0.0	0.0
	Insecta	0.0	0.0	0.0
	Osteicthyes	0.0	0.0	0.0
	Salmonidae	0.0	0.0	0.0
	Other Food	0.0	0.0	0.0

Appendix Table 24 . Mean catch per seine haul of prey fishes (≤ 250 mm) collected at McNary tailrace and McNary backwater, John Day Reservoir, April to August, 1985.

Common name	McNary tailrace					McNary backwater				
	April	May	June	Aug	Mean	April	May	June	Aug	Mean
American shad				0.25	0.06				244.75	61.19
sockeye salmon							0.75			0.19
chinook salmon	13.25	7.75	13.00		8.50	4.50	6.50	9.75		5.19
rainbow trout	0.25	0.25			0.13	0.50				0.13
chiselmouth	2.00	0.50	0.67	0.50	0.92	0.25	31.50	1.75		8.38
carp				2.25	0.56	0.25	0.75		2.25	0.81
peamouth	4.00		0.67	34.25	9.73	60.75	23.00	0.25	2.50	21.63
northern squawfish	1.50	4.75	0.33	190.75	49.33	22.75	69.25	27.75	28.00	36.94
speckled dace	0.50	0.50			0.25	0.25	0.25			0.13
redside shiner	2.00	1.00		4.25	1.81	7.25	25.50		0.50	8.31
largescale sucker	66.25	11.00	1.67	45.25	31.04	372.50	231.50	53.50	9.25	166.69
bridgelip sucker	1.50	0.75		1.00	0.81	0.25	3.00			0.81
brown bullhead						0.50			30.50	7.75
sand roller	8.25	86.25	56.67	4.50	38.92	4.75	20.25	10.25	6.25	10.38
three-spine stickleback				0.25	0.06	0.25	0.50			0.19
sunfishes[a]				0.50	0.13	0.25	1.25	0.25	42.25	11.00
smallmouth bass				2.00	0.50		0.50	0.50	15.25	4.06
largemouth bass				2.00	0.50				37.25	9.31
crappies[b]						0.25	0.25		212.00	53.13
yellow perch				1.50	0.38			3.75	1.00	1.19
prickly sculpin	1.25	0.50	1.00	3.50	1.56	1.50	2.00	0.75	1.25	1.38

[a] Includes bluegill (*Lepomis macrochirus*) and pumpkinseed (*Lepomis gibbosus*).

[b] Includes black crappie (*Pomoxis nigromaculatus*) and white crappie (*Pomoxis annularis*).

Appendix Table 25 . Mean catch per seine haul of prey fishes (≤ 250 mm) collected at Irrigon and Irrigon backwater, John Day Reservoir, April to August, 1985.

	Irrigon					Irrigon backwater				
Common name	April	May	June	Aug	Mean	April	May	June	Aug	Mean
American shad									4.50	1.13
coho salmon			1.00		0.25			0.25		0.06
chinook salmon	3.50	8.00	70.00		20.38	1.75	8.75	2.50		3.25
rainbow trout	0.25				0.06	0.25				0.06
mountain whitefish	0.50				0.13					
chiselmouth	1.50	0.25	0.75	2.00	1.13	0.25	0.25	0.25		0.19
carp			0.25	0.67	0.23	0.25			0.75	0.25
peamouth	9.50	2.00	0.75	10.00	5.56	0.50		0.50		0.25
northern squawfish	8.50	3.50	34.25	94.67	35.23	7.50	0.75	1.50	9.00	4.69
speckled dace	0.75				0.19					
redside shiner	0.25				0.06					
largescale sucker	81.75	36.75	79.25	56.00	63.44	25.75	8.50	3.25	1.50	9.75
bridgelip sucker	1.25	0.75	1.25	1.00	1.06	1.00	0.25			0.31
channel catfish									0.25	0.06
brown bullhead									1.25	0.31
sand roller	143.75	156.75	35.75	139.33	118.90	21.25	14.25	2.00	0.50	9.50
sunfishes[a]	0.25			4.67	1.23	0.50	3.00	5.50	88.50	24.38
smallmouth bass	0.25	0.25		4.67	1.29	0.25	0.25	0.25	15.50	4.06
largemouth bass	0.25				0.06			0.25	18.75	4.75
crappies[b]		0.25		2.67	0.73	0.50	7.50	9.25	225.50	60.69
yellow perch	0.25	0.75	0.50	2.33	0.96	7.50	12.25	22.00	19.75	15.38
prickly sculpin	4.50	1.75	2.00	9.00	4.31	6.75	3.50	3.75		3.50

[a] Includes bluegill (*Lepomis macrochirus*) and pumpkinseed (*Lepomis gibbosus*).

[b] Includes black crappie (*Pomoxis nigromaculatus*) and white crappie (*Pomoxis annularis*).

Appendix Table 26. Mean catch per seine haul of prey fishes (≤ 250 mm) collected at Arlington and John Day forebay, John Day Reservoir, April to August, 1985.

	Arlington					John Day forebay				
Common name	April	May	June	Aug	Mean	April	May	June	Aug	Mean
American shad				0.25	0.06					
chinook salmon	2.50	4.50	7.00	0.25	3.56	5.00	0.75	1.50	1.00	2.06
rainbow trout	1.00	0.75	0.75	0.25	0.69	0.25	2.75	2.25	0.50	1.44
mountain whitefish		0.25			0.06	0.25	0.25			0.13
chiselmouth	4.25	1.25	0.75	12.75	4.75	19.50	9.25	13.25	18.25	15.06
carp	0.50			0.25	0.19					
peamouth	1.00	0.25	0.25		0.38	0.50				0.13
northern squawfish	3.00	0.75		4.75	2.13	0.50	0.50	0.25		0.31
redside shiner	0.25		0.50	0.50	0.31		0.25			0.06
largescale sucker	11.75	19.75	59.25	11.75	25.63	9.50	25.50	31.50	3.50	17.50
bridgelip sucker	8.00	3.00	5.75	1.00	4.44	7.75	31.00	24.50	8.50	17.94
channel catfish				0.50	0.13					
brown bullhead				0.75	0.19					
sand roller	23.75	9.00	16.00	0.75	12.38	0.75	4.25	0.75	1.00	1.69
sunfishes[a]	0.25	1.25			0.38					
smallmouth bass			1.25	0.50	0.44		0.50	0.50	0.25	0.31
largemouth bass							0.25			0.06
yellow perch	0.25				0.06					
walleye				0.25	0.06				0.50	0.13
prickly sculpin	1.00	0.50	1.25	0.25	0.75	3.25	8.50	9.75	1.75	5.81

[a] Includes bluegill (*Lepomis macrochirus*) and pumpkinseed (*Lepomis gibbosus*).

Appendix Table 27. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for chinook salmon, 42 to 184 mm in length.

Equation					r^2	n
weight	=	.0000169		$(\text{fork length})^{3.031}$	0.980	148
fork length	=	-2.158	+	0.941 (total length	0.999	53
fork length	=	2.225	+	1.049 (standard length)	0.999	53
fork length	=	7.398	+	1.194 (nape to tail)	0.994	50
fork length	=	-12.106	+	2.029 (dentary)	0.986	52
fork length	=	-8.558	+	1.537 (cleithrum)	0.981	52
fork length	=	2.343	+	2.110 (opercle)	0.979	50

Appendix Table 28. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for bridgelip sucker, 89 to 250 mm in length.

Equation					r^2	n
weight	=	0.0000053		$(\text{fork length})^{3.161}$	0.988	52
fork length	=	-3.937	+	0.961 (total length)	0.996	52
fork length	=	6.079	+	1.069 (standard length)	0.998	52
fork length	=	13.456	+	1,216 (nape to tail)	0.985	52
fork length	=	-25.610	+	17.725 (pharyngeal)	0.861	52
fork length	=	-20.918	+	12.563 (cleithrum)	0.929	52
fork length	=	-20.918	+	12.563 (opercle)	0.938	52

Appendix Table 29. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for steelhead trout, 93 to 210 mm in length.

Equation			r^2	n
weight	=	$0.0000084\ (\text{fork length})^{3.003}$	0.890	46
fork length	=	- 1.567 + 0.958 (total length)	0.999	46
fork length	=	5.338 + 1.042 (standard length)	0.997	46
fork length	=	7.014 + 1.233 (nape to tail)	0.991	46
fork length	=	1.706 + 18.179 (dentary)	0.898	45
fork length	=	-16.684 + 10.271 (cleithrum)	0.968	45
fork length	=	4.440 + 15.645 (opercle)	0.943	45

Appendix Table 30. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for peamouth, 57 to 194 mm in length.

Equation			r^2	n
weight	=	$.0000097\ (\text{fork length})^{3.038}$	0.992	40
fork length	=	-2.011 + 0.923 (total length)	0.995	40
fork length	=	-1.795 + 1.144 (standard length)	0.985	40
fork length	=	-1.019 + 1.337 (nape to tail)	0.989	34
fork length	=	-1.838 + 14.768 (pharyngeal)	0.982	40
fork length	=	-9.554 + 8.711 (cleithrum)	0.986	40
fork length	=	-2.768 + 13.196 (opercle)	0.987	40

Appendix Table 31. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for northern squawfish, 40 to 238 mm in length.

Equation	r^2	n
weight = $.000013\ (\text{fork length})^{2.970}$	0.998	50
fork length = -0.185 + 0.899 (total length)	0.999	48
fork length = 1.805 + 1.083 (standard length)	0.999	48
fork length = 5.601 + 1.299 (nape to tail)	0.995	50
fork length = -1.059 + 13.243 (pharyngeal)	0.993	49
fork length = -5.924 + 8.592 (cleithrum)	0.995	50
fork length = -1.342 + 13.697 (opercle)	0.993	50

Appendix Table 32. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for largescale sucker, 61 to 229 mm in length.

Equation	r^2	n
weight = $.0000065\ (\text{fork length})^{3.130}$	0.997	58
fork length = -1.644 + 0.936 (total length)	0.999	58
fork length = 3.400 + 1.091 (standard length)	0.999	58
fork length = 5.432 + 1.268 (nape to tail)	0.996	58
fork length = -7.951 + 14.979 (pharyngeal	0.989	58
fork length = 1.103 + 8.056 (cleithrum)	0.988	58
fork length = 0.149 + 10.651 (opercle)	0.987	58

Appendix Table 33. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for sand roller, 30 to 110 mm in length.

Equation	r^2	n
weight = .000017 $(\text{fork length})^{2.983}$	0.959	46
fork length = 1.890 + 0.899 (total length)	0.957	46
fork length = 2.156 + 1.094 (standard length)	0.962	46
fork length = 2.448 + 1.373 (nape to tail)	0.943	46
fork length = -5.064 + 35.075 (dentary)	0.894	46
fork length = 1.591 + 5.518 (cleithrum)	0.941	46
fork length = 2.620 + 10.086 (opercle)	0.934	44
fork length = 1.161 + 7.811 (pre-opercle)	0.957	46

Appendix Table 34. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for chiselmouth, 98 to 242 mm in length.

Equation	r^2	n
weight = .000022 $(\text{fork length})^{2.907}$	0.989	52
fork length = -2.518 + 0.906 (total length)	0.996	52
fork length = 4.014 + 1.077 (standard length)	0.999	52
fork length = 8.397 + 1.217 (nape to tail)	0.996	52
fork length = -10.495 + 16.954 (pharyngeal)	0.973	52
fork length = -14.501 + 8.728 (cleithrum)	0.983	52
fork length = -3.844 + 13.024 (opercle)	0.985	50

Appendix Table 35. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for American shad, 39 to 98 mm in length.

Equation	r2	n
weight = .0000068 (fork length)$^{3.113}$	0.995	46
fork length = -0.147 + 0.890 (total length)	0.998	44
fork length = 1.453 + 1.060 (standard length)	0.997	44
fork length = 4.197 + 1.269 (nape to tail)	0.994	44
fork length = 5.600 + 6.939 (dentary)	0.982	42
fork length = 3.938 + 5.668 (cleithrum)	0.982	42
fork length = 7.217 + 7.996 (opercle)	0.984	42

Appendix Table 36. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for smallmouth bass, 34 to 95 mm in length.

Equation	r2	n
weight = .00001 (fork length)$^{3.117}$	0.991	36
fork length = 0.009 + 0.956 (total length)	0.956	36
fork length = 1.850 + 1.101 (standard length)	0.997	36
fork length = 7.609 + 1.171 (nape to tail)	0.986	36
fork length = 7.421 + 12.591 (dentary)	0.969	36
fork length = -3.589 + 5.969 (cleithrum)	0.981	36
fork length = 4.864 + 11.204 (opercle)	0.981	33

Appendix Table 37. Regression equations describing relations between fork length (mm) and weight (g) and other bone or body measurements (mm) for prickly sculpin, 40 to 137 mm in length.

Equation	r^2	n
weight = .0000053 (total length)$^{3.187}$	0.991	49
total length = 3.444 + 1.151 (standard length)	0.998	49
total length = 2.181 t 1.458 (nape to tail)	0.993	49
total length = 8.427 + 19.528 (dentary)	0.983	59
total length = 5.077 + 5.479 (cleithrum)	0.989	49
total length = -6.093 + 26.603 (hypural)	0.972	49

Appendix Table 38. Common and scientific names of all prey fishes collected in 1985.

Common name	Scientific name
American shad	Alosa sapidissma
coho salmon	Oncorhynchus kisutch
sockeye salmon	Oncorhynchus nerka
chinook salmon	Oncorhynchus tshawytscha
rainbow trout	Salmo gairdneri
mountain whitefish	Prosopium williamsoni
chiselmouth	Acrocheilus alutaceus
carp	Cyprinus carpio
peamuth	Mylocheilus caurinus
northern squawfish	Ptychocheilus oregonensis
speckled dace	Rhinichthys osculus
redside shiner	Richardsonius balteatus
largescale sucker	Catostomus macrocheilus
bridgelip sucker	Catostomus columbianus
channel catfish	Ictalurus punctatus
brown bullhead	Ictalurus nebulosus
sand roller	Percopsis transmontana
threespine stickleback	Gasterosteus aculeatus
sunfishes	Lepomis spp.
smallmouth bass	Micropterus dolomieui
largemouth bass	Micrc- salmoides
crappies	Pomoxis spp.
yellow perch	Perca flavescens
walleye	Stizostedion vitreum vitreum
prickly sculpin	Cottus asper