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PISCINE PREDATION ON BULL TROUT IN THE FLATHEAD RIVER, MONTANA

Emily Catharine Zollweg, 1998

Populations of bull trout, *Salvelinus confluentus*, in the Flathead drainage of Montana declined from the population abundance index of 600 redds in 1982 to 243 redds in 1991. Bull trout were listed as a species of special concern by Montana Department of Fish, Wildlife and Parks (MDFWP) in 1989, and the Columbia River population is currently proposed for listing as a threatened species under the Endangered Species Act. My study was initiated after MDFWP personnel became concerned that nonnative lake trout, *Salvelinus namaycush*, may prey upon juvenile bull trout in the Flathead River during their migration from natal tributaries to Flathead Lake. The objectives were to determine the spatial and temporal distributions of lake trout, the piscivorous native cyprinid *Ptychocheilus oregonensis*, and other piscine predators, to determine if these predators were eating juvenile bull trout, and if so, to determine if piscine predation was limiting recovery of the bull trout population. To accomplish these objectives, I collected fish from the Flathead River by a variety of methods throughout the year, examined stomach contents of predators, and calculated consumption estimates and population estimates. Lake trout and *P. oregonensis* were present in the Flathead River and its sloughs downstream of Columbia Falls during all seasons sampled. No lake trout captured in this study contained bull trout in their stomach contents. *P. oregonensis* were abundant in the Flathead River and its sloughs downstream of the confluence with the Stillwater River during all seasons sampled. Two *P. oregonensis* contained bull trout in their stomach contents. Consumption estimates of bull trout by *P. oregonensis* during spring (April through June) were 1.8 and 5.8 bull trout per individual predator per season. These consumption estimates combined with conservative population estimates of 621 or 1176 *P. oregonensis* result in estimates of about 900 and 6800 bull trout eaten by *P. oregonensis* each spring. Research recommendations include determination of abundance and timing of migrating juvenile bull trout. Piscine predation is probably limiting the population; therefore, management actions need to be taken to restore habitat in the tributaries and Flathead River, and to limit predation by reducing predator populations.

PISCINE PREDATION ON BULL TROUT IN THE FLATHEAD RIVER, MONTANA

by

Emily Catharine Zollweg

A thesis submitted in partial fulfillment
of the requirements for the degree

of

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in

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APPROVAL

of a thesis submitted by

Emily Catharine Zollweg

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date April 17, 1998

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ABSTRACT

Populations of bull trout, *Salvelinus confluentus*, in the Flathead drainage of Montana declined from the population abundance index of 600 redds in 1982 to 243 redds in 1991. Bull trout were listed as a species of special concern by Montana Department of Fish, Wildlife and Parks (MDFWP) in 1989, and the Columbia River population is currently proposed for listing as a threatened species under the Endangered Species Act. My study was initiated after MDFWP personnel became concerned that nonnative lake trout, *Salvelinus namaycush*, may prey upon juvenile bull trout in the Flathead River during their migration from natal tributaries to Flathead Lake. The objectives were to determine the spatial and temporal distributions of lake trout, the piscivorous native cyprinid *Ptychocheilus oregonensis*, and other piscine predators, to determine if these predators were eating juvenile bull trout, and if so, to determine if piscine predation was limiting recovery of the bull trout population. To accomplish these objectives, I collected fish from the Flathead River by a variety of methods throughout the year, examined stomach contents of predators, and calculated consumption estimates and population estimates. Lake trout and *P. oregonensis* were present in the Flathead River and its sloughs downstream of Columbia Falls during all seasons sampled. No lake trout captured in this study contained bull trout in their stomach contents. *P. oregonensis* were abundant in the Flathead River and its sloughs downstream of the confluence with the Stillwater River during all seasons sampled. Two *P. oregonensis* contained bull trout in their stomach contents. Consumption estimates of bull trout by *P. oregonensis* during spring (April through June) were 1.8 and 5.8 bull trout per individual predator per season. These consumption estimates combined with conservative population estimates of 621 or 1176 *P. oregonensis* result in estimates of about 900 and 6800 bull trout eaten by *P. oregonensis* each spring. Research recommendations include determination of abundance and timing of migrating juvenile bull trout. Piscine predation is probably limiting the population; therefore, management actions need to be taken to restore habitat in the tributaries and Flathead River, and to limit predation by reducing predator populations.

INTRODUCTION

Bull trout, *Salvelinus confluentus,* are piscivorous native fish that were held in low esteem early in the 20th century. They were harvested in a commercial fishery on Flathead Lake starting in 1913 and targeted for eradication (Fraley 1994). Bull trout populations are declining and efforts are being made to recover the species as concern about biodiversity and species extinction has increased. The bull trout is a species of special concern according to the Montana Department of Fish, Wildlife and Parks (MDFWP) (Phippen 1997) and the Columbia River population is proposed for listing as a threatened population under the Endangered Species Act (U. S. Fish and Wildlife Service 1997). Many gaps exist in our knowledge of the habits of the bull trout, although considerable effort has been put into habitat protection and angling regulations (Rieman and McIntyre 1993).

Genetically distinct populations of bull trout with different life history characteristics exist in Montana (Rieman and McIntyre 1993). Dams and natural falls separate some populations. Unfavorable habitats such as warm, silty waters divide others. Bull trout in the Flathead River drainage include fluvial populations which spawn in streams and migrate to rivers to grow to maturity, and adfluvial populations which spawn in streams and migrate to lakes to grow to maturity. Resident populations, which live only in tributary streams, are unknown in the upper Flathead drainage (Thomas 1992).

Adfluvial juvenile bull trout in the Flathead drainage migrate from natal tributaries during summer and arrive at Flathead Lake in early autumn (Fraley and Shepard 1989). Migration occurs at ages I through IV which correspond to mean lengths at age I of 73 mm, age II of 117 mm, age III of 155 mm, and age IV of 228 mm (Fraley and Shepard 1989). Fish of these sizes are vulnerable to predation by lake trout, *Salvelinus namaycush,* (Yule and Luecke 1993) and *Ptychocheilus oregonensis* (Poe et al. 1991). Bull trout redd counts declined from 600 redds in 1982 to 243 redds in 1991 following reports of lake trout upriver from Flathead Lake (Thomas 1992). Possible reasons for this decline include predation by lake trout, competition with lake trout and brook trout, *Salvelinus fontinalis*, overfishing or illegal harvest, increased sedimentation from timber harvest, and rural residential development (Fraley et al. 1989; Thomas 1995). Observations of the presence of lake trout in the Flathead River, which is the migration route for juvenile adfluvial bull trout, led to speculation that lake trout may be feeding on them; however, results of a pilot study were inconclusive (B. Marotz, MDFWP, personal communication).

Lake trout were introduced into the Flathead system in 1905 and became an important part of the fish assemblage (Spencer et al. 1991). Until 1985, the primary forage for lake trout was kokanee (landlocked sockeye salmon), *Oncorhynchus nerka.* Kokanee also supported an annual sport fishery harvest in excess of 200,000 fish (Beattie and Clancey 1991). Kokanee reproductive success was reduced by annual winter drawdown of Flathead Lake for power generation at Kerr Dam, as well as by fluctuating flows in the mainstem and South Fork of the Flathead River below Hungry Horse Dam, which exposed eggs in shallow spawning redds (Fraley and Decker-Hess 1987). However, most importantly, the kokanee population crashed because fry-to-adult survival of kokanee was affected by the increasing population of invading *Mysis relicta* and the resulting decreases in abundances of crustacean zooplankton which are forage for kokanee (Beattie and Clancey 1991). Thus, it has been hypothesized that lake trout may be moving up the Flathead River in search of food because of the resultant low abundance of forage fish in Flathead Lake. Lake trout were caught in the river at the same time as lake whitefish, *Coregonus clupeaformis,* and were suspected of following pygmy whitefish, *Prosopium coulteri,* on their spawning migrations upriver in autumn (B. Marotz, personal communication).

Lake trout were found upriver from Flathead Lake beginning in the late 1980's (Thomas 1992), but little information existed on when and where lake trout were in the river and in what abundance. Anglers reported lake trout caught as far as 191.8 km upriver at Polebridge on the North Fork of the Flathead River (B. Marotz, personal communication). As their common name implies, rivers are an unusual habitat for lake trout (Scott and Crossman 1973); however certain areas of the Flathead River and its sloughs may be suitable habitat for lake trout. Water temperatures of the Flathead River may have been made suitable for lake trout throughout much of the year by 4°C releases from Hungry Horse Dam. Lake trout in lakes tend to inhabit water cooler than 13°C (Eschmeyer 1957; McCauley and Tait 1970; Scott and Crossman 1973), but may spend short periods of time in warmer water to feed (Snucins and Gunn 1995). A selective withdrawal system was made operational on Hungry Horse Dam in August, 1995, to mediate the unnaturally cooler river temperatures and perhaps make the river less suitable for lake trout (Marotz et al. 1994). If the Flathead River were less suitable for lake trout, then the bull trout would have more time to grow and would be less vulnerable to predation when they first encounter lake trout in Flathead Lake.

Predation and competition by nonnative species has been implicated in the decline of native fishes. Predation by brown trout, *Salmo trutta,* has been implicated in the declines of native golden trout, *Oncorhynchus aguabonita,* and cutthroat trout, *O. clarki,* in California (Taylor et al. 1984). Introduction of Nile perch, *Lates niloticus*, contributed to destruction of a fishery for hundreds of native species in Lake Victoria when the Nile perch population exploded and consumed the native haplochromines (Kaufman 1992). In fact, lake trout have been shown to compete with and displace bull trout when lake trout were introduced into lakes with native bull trout (Donald and Alger 1993). Lake trout also competed with and displaced bull trout when both species were native (Donald and Alger 1993).

In addition to lake trout, species in the Flathead River which may prey upon or compete with bull trout include the native piscivorous cyprinid, *P. oregonensis*, northern pike, *Esox lucius,* yellow perch, *Perca flavescens,* and largemouth bass, *Micropterus salmoides*. Brook trout, which hybridize and compete with bull trout, are present in the Flathead drainage according to Holton (1990), but absent according to Thomas (1992). *P. oregonensis* (also known as northern squawfish, northern bigmouth minnow, and northern pike minnow), are native to northwestern Montana (Holton 1990). In deference to Native Americans, the common name "northern squawfish" is being phased out. Proposed new common names include northern bigmouth minnow and northern pike minnow. I used *P. oregonensis* in this document because the matter is currently under debate.

P. oregonensis are omnivorous feeders, eating plankton, terrestrial insects, aquatic insect larvae, crustaceans and small fish (Scott and Crossman 1973). *P. oregonensis* do not compete strongly with salmonids; however, they can be significant sources of salmonid predation, especially under "highly localized, seasonal or unusual circumstances" (Brown and Moyle 1981:104). For instance, *P. oregonensis* are major predators on migrating juvenile salmonids in the John Day Reservoir on the Columbia River where each *P. oregonensis* eats up to 0.7 salmonids per day (Vigg et al. 1991). *P. oregonensis* accounted for 78% of the annual loss of 2.7 million juvenile salmonids to predation in the John Day Reservoir (Rieman et al. 1991). *P. oregonensis* smaller than 350 mm had high consumption rates of juvenile salmonids during a period of high abundance of the juvenile salmonids in the Columbia River near Richland, Washington, which is not impounded like the John Day Reservoir (Tabor et al. 1993). As a result, fishery managers have implemented sport-reward and directed fisheries to control *P. oregonensis* in order to increase production and survival of salmon and steelhead smolts in the Columbia and Snake rivers (Beamesderfer et al. 1996).

Northern pike were illegally introduced into the Flathead River drainage (Holton 1990), but its abundance and distribution is largely unknown. Since northern pike are highly piscivorous, and occur in warm, slow velocity waters, and vegetated sloughs (Scott and Crossman 1973), I considered northern pike a potential source of predation on juvenile bull trout.

The purpose of this study was to determine the spatial and temporal distributions of lake trout and other piscivores in the mainstem of the Flathead River, to determine if these piscivores were preying on bull trout, and if so, to quantify that effect to determine if fish predation is limiting recovery of bull trout populations in the Flathead system.

STUDY AREA

To assess relative abundance of bull trout and potential predators, the mainstem of the Flathead River from the confluence of the North and Middle Forks to Flathead Lake, Montana, was stratified into three sections differing in gradient, width, depth, and degree of sinuosity (Figure 1). The lower Impounded River Section was 36.1 km long, began at river kilometer 165.7 and ended at river kilometer 201.8 where the Stillwater River enters the Flathead River. It was designated as the Impounded River Section because depths were regulated by Kerr Dam at the downstream end of Flathead Lake. Sand, silt and gravel substrates were prevalent in this section and water velocities were slow. The deepest point measured in the Impounded River Section was 26.8 m. Several large sloughs connected in the Impounded River Section (Church, Fennon, Mill Creek and Halfmoon) were combined for analysis as the Slough Section. These sloughs were connected to the river throughout the year. Substrates were primarily sand, silt and gravel, with rooted and floating aquatic vegetation in summer. The deepest point measured in the Slough Section was 15 m.

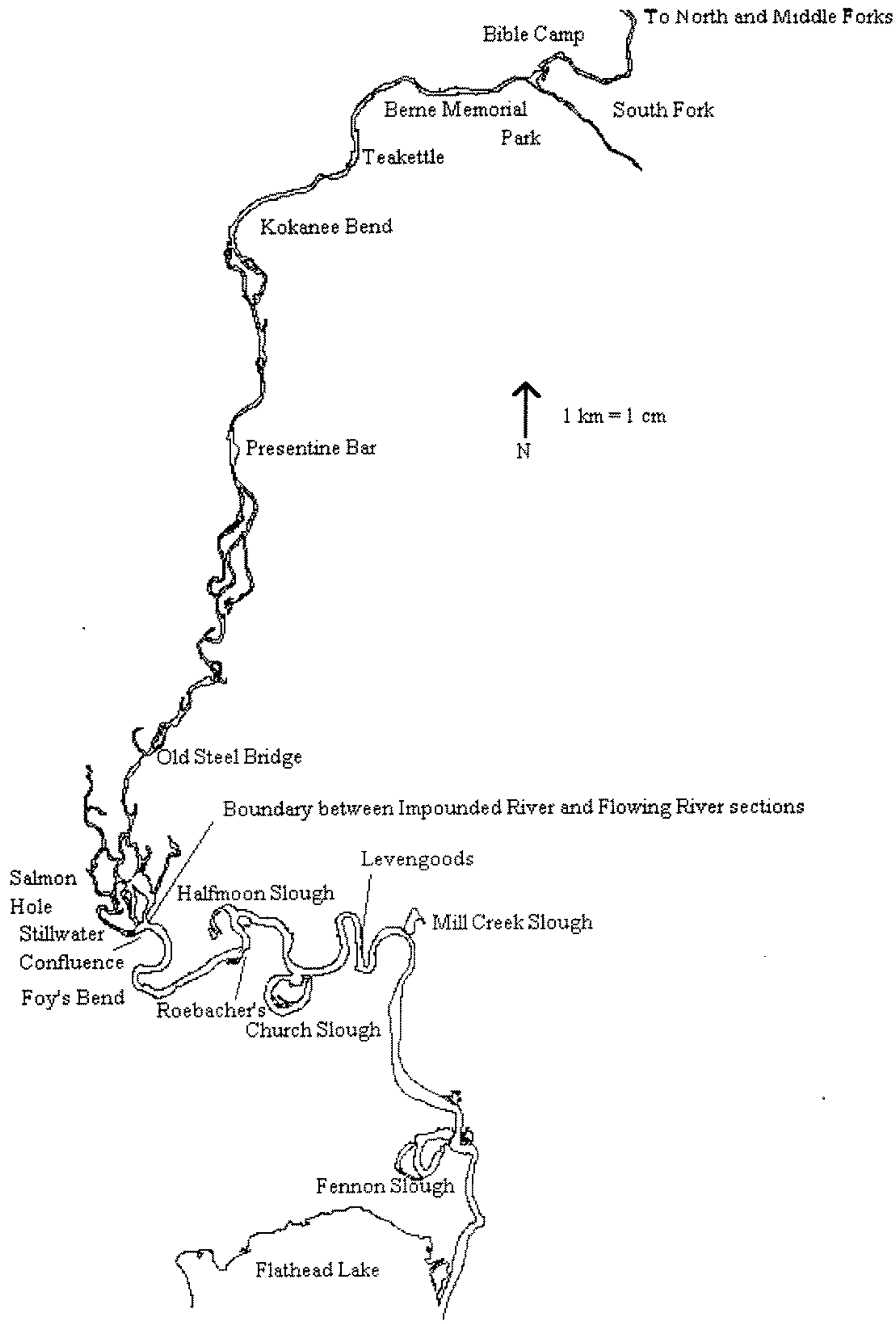

Figure 1. Map of study area in northwestern Montana.

The river reach between the confluence of the Stillwater River with the Flathead River and Great Northern Flats on the North Fork of the Flathead River, including the South Fork to Hungry Horse Dam, was designated the Flowing River Section. Depths in the Flowing River Section were not affected by changes in Flathead Lake levels and water velocities were higher than in the Impounded River Section. The Flowing River Section was 8 m deep at the deepest point sampled, 33.8 km in length with mostly cobble, sand and boulder substrates. The Flathead River is braided between the confluence of the Stillwater River and Flathead River (river km 201.8) and Presentine Bar Fishing Access (river km 138.2).

Water temperatures and discharges of the South Fork and the mainstem of the Flathead River downstream of Hungry Horse Reservoir were regulated in part by Hungry Horse Dam. Average discharge of the Flathead River at Columbia Falls was 273 cubic meters per second (m^3/s) or 9626 cubic feet per second (ft^3/s) for 1951-1996. Maximum water temperature recorded at Columbia Falls was 21°C on August 23, 1963. The river and sloughs freeze over in some areas during the winter (USGS 1996, 1997).

METHODS

Spatial and Temporal Distributions of Flathead River Fishes

Fish were collected from the Flathead River during all seasons and from as many different sections as possible to determine seasonality and distribution of lake trout, *P. oregonensis,* and other Flathead River species. Data recorded for each fish collected included species, length, date, time, location, water temperature, and capture method. When more than 30 peamouth, *Mylocheilus caurinus,* redside shiners, *Richardsonius balteatus,* or pygmy whitefish were collected, they were counted and not measured or weighed.

Seasons were determined subjectively by examining changes in river temperature and discharge at Columbia Falls (USGS 1996, 1997; Figure 2). Winter included December through March when water temperatures and discharges were low. Water temperatures and discharges increased through the spring months of April, May and June. During July, August and September, discharges dropped to low levels and temperatures remained high. The autumn months of October and November were characterized by decreasing water temperatures and increasing discharges.

A combination of gears and methods (Merwin traps, fyke traps, gill nets, boat electrofishing, collection from anglers, and snorkeling) were used to collect and observe

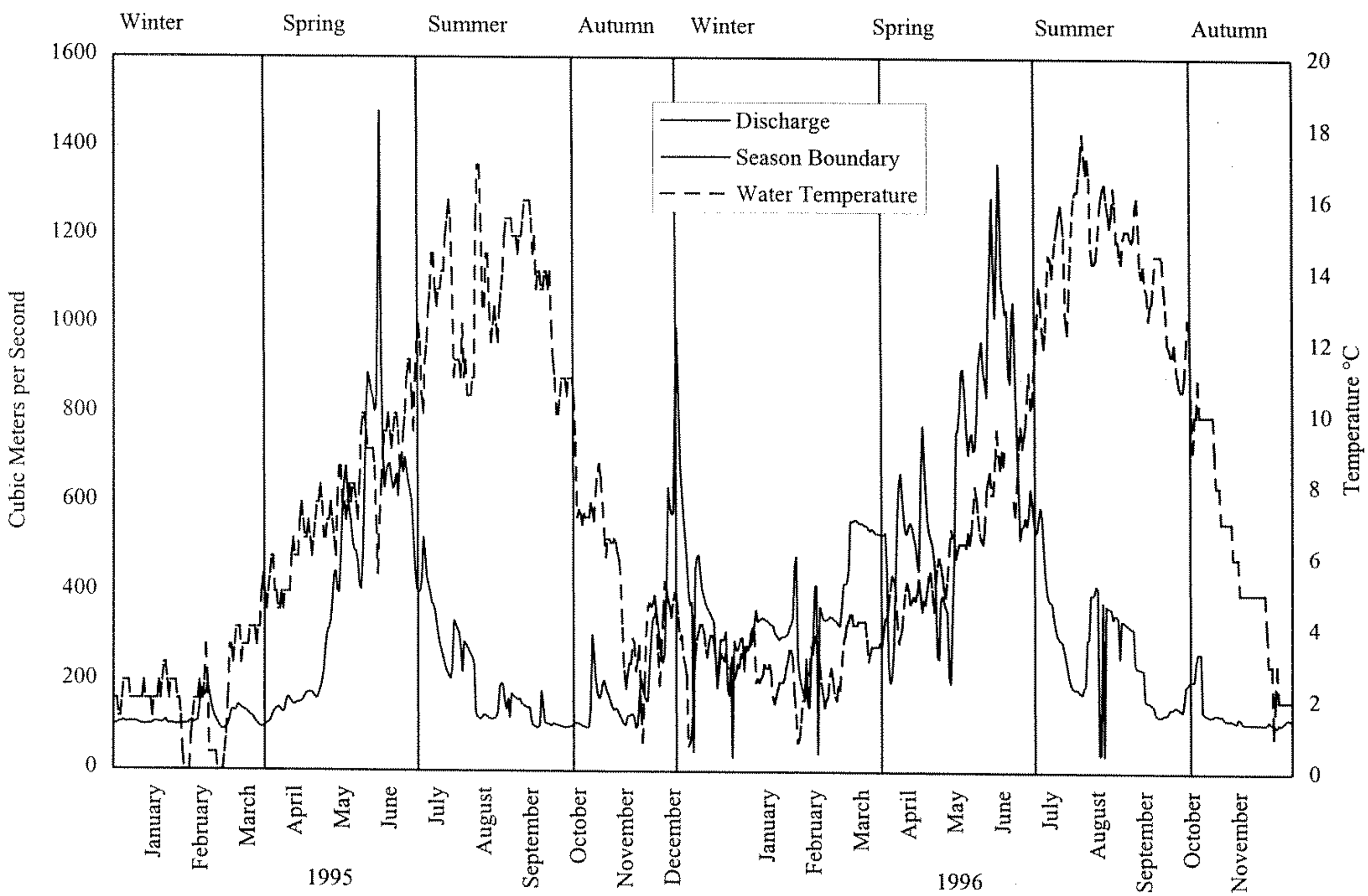

Figure 2. Discharge and water temperature, Flathead River, Columbia Falls, Montana (1995-1996). Data courtesy of the United States Geological Survey, Bureau of Reclamation, and Montana Department of Fish, Wildlife & Parks.

fish. This variety of gears was needed because the Flathead River is variable seasonally and longitudinally in depth, velocity, discharge and turbidity.

Floating Merwin traps were used in the slowest water velocity areas of all sections. Merwin traps are large trap-type nets with a 38 or 46 meter lead to shore, and wings, holding area and pot hung from anchored pontoon structures. The first two Merwin traps were fitted with 3.2-cm knotless mesh. The third Merwin trap was fitted with a 1-cm delta mesh net prior to deployment in Church Slough in May 1996. Traps were deployed perpendicular to the flow with the lead anchored on shore and the trap 38 or 46 meters toward the center of the river or slough. Fish were removed from traps daily and either sacrificed for food habits or released at the side of the trap. One to three traps were operated 3 or 4 days per week whenever possible. The Merwin traps were fished in the river (Figure 3) when discharges were lower than 283 m^3/s (10,000 ft^3/s) because river discharges higher than about 283 m^3/s resulted in water velocities which pushed the nets to the surface, closing their entrances. When river discharges were higher than 283 m^3/s, the Merwin traps were fished only in the sloughs (Figure 3).

The first Merwin trap (of three) was set at Foys Bend (Impounded River Section) on January 31, 1995. On March 14, 1995, a second Merwin trap was set at the confluence of the Stillwater and Flathead rivers (Flowing River Section). On April 26, 1995, the Foys Bend trap was moved to Roebachers where it did not fish effectively. The two traps were moved into Church and Halfmoon sloughs early in May 1995 because discharge in the Flathead River rose above 283 m^3/s with spring runoff. The two Merwin traps were moved to Levengoods and Foys Bend in the Impounded River Section when

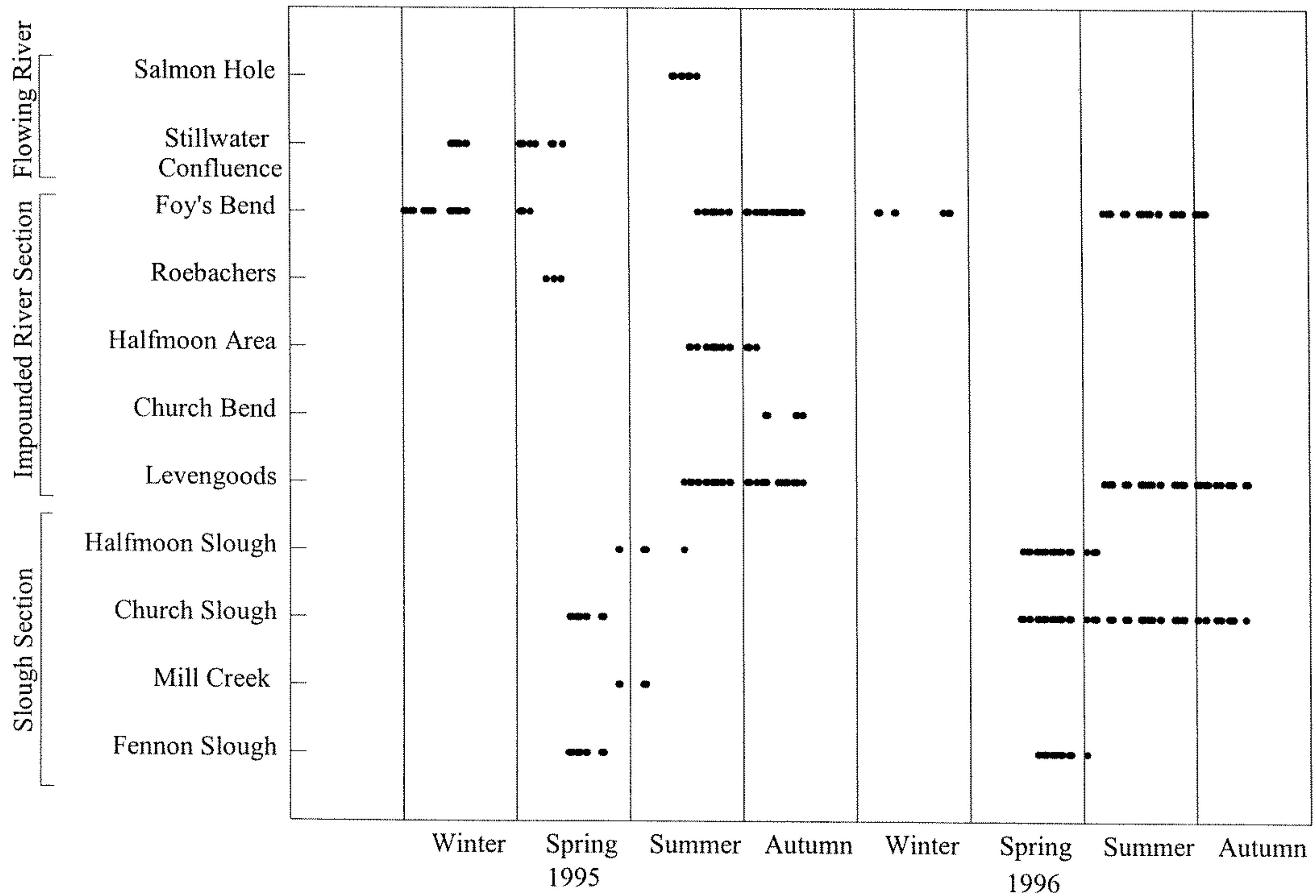

Figure 3. Periods of Merwin trapping the Flathead River and its sloughs. Each dot represents a day of sampling.

discharge dropped below 283 m^3/s at the beginning of August 1995; a third Merwin trap was deployed at this time at the Salmon Hole in the Flowing Section. A flood damaged all of the traps in late November 1995. One Merwin trap remained in the river at Foys Bend and was fished for three days late in December 1995, two days early in January 1996, and three days in February 1996, when discharge decreased enough for the trap to fish effectively. Discharge remained above 283 m^3/s for most of the winter and spring. The other two Merwin traps were stored, repaired and redeployed in May 1996 in Halfmoon and Fennon sloughs. They were moved to Foys Bend and Levengoods in late July 1996, where they remained until November 30, 1996.

Sampling with gill nets and fyke traps was attempted in 1995 in slow water velocity areas of all sections. An adult bull trout was killed during exploratory sampling with gill nets; therefore, use of gill nets was deemed inappropriate for this project. The fyke traps did not catch piscivorous fish; use of them was discontinued in November 1995.

Boat electrofishing was used at night in waters less than 4 m deep and in current slow enough for one or two collectors to dip the fish before they got out of reach. A Coffelt MARK XXII-M variable voltage pulsator (VVP) was employed using continuous DC and CPS (Coffelt copyright) at less than 5 amps. The VVP and generator were installed on a 5.5-m flat-bottomed jet boat with two electrode booms mounted from the bow. The two electrode arrays each had four lengths of 5-mm diameter stainless steel cable in a modified Wisconsin ring array. Availability of a jet boat with functional electrofishing wiring limited use of this method (Table 1). I used two electrofishing boats for this project. One boat, supplied by MDFWP, was shared with two other projects which had priority over my project and was not readily available. The other boat, supplied by Montana Cooperative Fishery Research Unit (MTCFRU), was not properly wired for electrofishing, but did work a few times.

Table 1. Electrofishing effort in the Flathead River and sloughs. Transects were fifteen minutes in duration unless otherwise indicated.

Date Sampled	Impounded River	Slough Section	Flowing River
		Summer 1995	
July 12, 1995			1 transect (2 hours)
August 23, 1995			1 transect (2 hours)
		Autumn 1995	
November 17, 1995	1 transect		1 transect
		Winter 1996	
December 15, 1995			6 transects
December 16, 1995			4 transects
January 11, 1996			4 transects
March 9, 1996			4 transects
March 10, 1996	4 transects		
March 22, 1996	1 transect	1 transect	1 transect
March 23, 1996	1 transect	1 transect	2 transects
		Summer 1996	
July 10, 1996			5 transects
July 24, 1996			2 transects
July 25, 1996			3 transects
July 26, 1996			2 transects

Catch per unit effort of *P. oregonensis* and other species was defined as number caught per Merwin trap day. Two way analysis of variance was performed to discern differences in catch rates of *P. oregonensis* among seasons and locations of capture using the general linear model procedure in SAS for catch by section, season and an interaction term of section*season. Data were transformed by the ln(x+1) transformation due to nonnormality of the data and heteroscedasticity of the variances. Multiple comparisons using the Tukey's Studentized Range (HSD) tests were considered significantly different at the alpha = 0.05 level.

Food Habits and Relative Weights of Predators

Stomachs were collected from piscivorous fish captured by all methods. In addition, stomachs from angler caught lake trout were obtained from July 1995 to November 1996. A card was completed for each stomach and entered into a lottery for a US$200 gift certificate which was drawn in November 1996. Stomachs were collected from anglers at the Old Steel Bridge Fishing Access site in Kalispell or turned in by anglers at the Regional office of MDFWP in Kalispell. A single stomach of a lake trout caught in the North Fork of the Flathead River above the confluence with the Middle Fork was also obtained.

Fish sacrificed for stomach content analysis were placed on ice or held in a cool place until dissection. Fish were weighed before stomach contents were removed.

Stomachs (esophagus to anus of *P. oregonensis;* esophagus to beginning of pyloric caeca of other predators) were removed and contents were preserved in 95% ethanol (February 1995 to July 1995) or 10% buffered formalin (July 1995 to November 1996). Buffered 10% formalin fixed the tissues without dissolving otoliths and stopped digestive enzymes and bacterial growth in the samples. Stomachs were placed in containers marked with date and location of collection and species code, gender, length, and weight. Stomach contents of five lake trout that were tagged and released were removed by stomach flushing (Seaburg 1957). Stomach flushing is ineffective for *P. oregonensis* because of the shape of their digestive tract (Tabor et al. 1993); therefore, *P. oregonensis* were sacrificed to sample stomach contents.

Stomachs and contents were rinsed to remove preservative in a 425-µm sieve, then contents were removed from the stomach lining and sorted in an enamel pan. If necessary, food items were transferred to clear plastic dishes for identification under a dissecting microscope. Invertebrate food items were identified to order (Merritt and Cummins 1984; Pennak 1989) whenever possible. Invertebrate food items not identifiable to order were designated as unidentifiable invertebrates. Individual invertebrates less than 0.1 gram were pooled by order and a total weight was obtained. The mean weight was calculated for all specimens weighing less than 0.1 grams from each invertebrate order.

A reference collection and keys to diagnostic fish bones (Frost et al. 1996; Appendix A) were developed to identify fish food items to species. Five to 10 fish of each species, ranging in size from 25 mm to 230 mm, collected with Merwin traps in July and August of 1996, were set aside and frozen for the reference collection. These specimens were digested by the pancreatin enzyme method (Tabor et al. 1993). Westslope cutthroat trout, *Oncorhynchus clarki lewisi,* were obtained from the MDFWP Washoe Park Trout Hatchery in Anaconda, Montana, and bull trout were obtained from the U.S. Fish and Wildlife Service Hatchery at Creston, Montana. Because the bull trout were preserved in formalin, their flesh was removed from their bones with hot water instead of enzymes. The trout and char in stomachs were identified by comparing diagnostic bones of prey items to diagnostic bones in the reference collection (Appendix A) and by pyloric caeca counts (McPhail and Lindsey 1970; Scott and Crossman 1973; Nelson and Paetz 1992). Wet weights and lengths of fish in stomach contents were measured and recorded.

Diets were summarized by frequency of occurrence, mean percent composition by number, and aggregate percent composition by weight for each food type (Bowen 1996). Raw percent composition by number for each food type in each stomach was transformed by the arcsin$\sqrt{p}$ transformation (Sokal and Rohlf 1981). Means, standard errors, and confidence intervals were then calculated for percent composition by number for each food type. These means and confidence intervals were transformed back to proportions by the $(\sin(\theta))^2$ transformation (Sokal and Rohlf 1981).

Standard relative weight equations were used to determine mean relative weights for lake trout (Anderson and Neumann 1996) and *P. oregonensis* (Parker et al. 1995) during each season and for each 50 mm size class. Relative weight is an index of body condition, and mean relative weight is an index of body condition for a population. A value of relative weight below 100 indicates low prey availability, stressful conditions, or recent spawning. A value above 100 indicates abundant prey availability or ripening gonads (Anderson and Neumann 1996).

Consumption Estimates and Abundance Estimates

Consumption estimates were calculated by integrating food habits data obtained in this study with digestion rates determined from previous laboratory studies (Figure 4, Vigg et al. 1991). Mass evacuation was the difference between sample and original prey weights. Original prey weights were obtained using regressions of weight against body total length, standard length, and nape-to-tail length (Vigg et al. 1991) and observations of length recorded when stomach contents were analyzed. Original prey weights of the trout and char food items were calculated by assuming they were similar to steelhead, *O. mykiss,* in length and weight. The length-weight relationship of redside shiners was assumed to be similar to that of peamouth which have a similar body shape (Vigg et al. 1991). Original prey weights of yellow perch, mountain whitefish, *Prosopium williamsoni*, and pumpkinseed, *Lepomis gibbosus,* were calculated using the weight-length equations developed by Willis et al. (1991), Rogers et al. (1996), and Liao et al. (1995), respectively. When the original calculated weight was less than the sample weight, the mass evacuated was assumed to be zero. I used an algorithm modified by

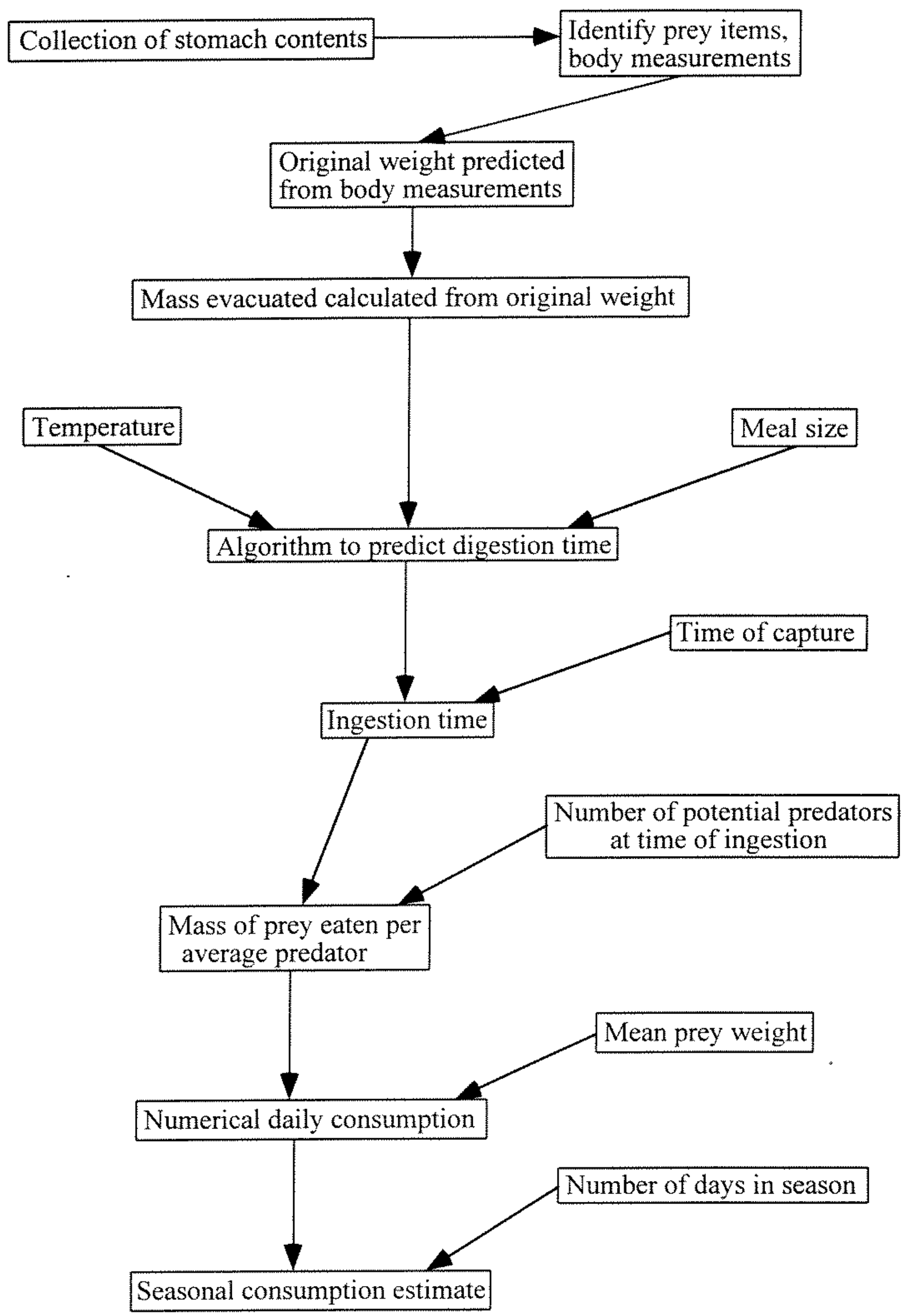

Figure 4. Consumption estimate calculation procedure. Adapted from Vigg et al. (1991).

Vigg et al. (1991) from Beyer et al. (1988) to solve for digestion time from prey mass evacuated, prey meal weight, temperature (°C) at time of collection and predator weight. The mean temperature on the date of collection recorded by USGS at the Columbia Falls gauging station was used for two dates (August 22 and 24, 1995) when the temperature at time and place of collection was not available. The number of potential predators at the time of ingestion for each prey item was the number of predators captured on the same day or later as the predator of that food item, which had eaten prey on the same day or earlier than that prey item was consumed. The mass of each prey type consumed each day was divided by the number of potential predators to obtain the mass of prey eaten per average predator per day for each prey type which was the daily consumption estimate. Daily consumption estimates were extrapolated to seasonal consumption estimates by multiplying the mean daily consumption estimate for that season by the number of days in the season. Seasonal estimates of consumption by weight were converted to numbers of prey eaten by an individual predator by dividing the estimates by the mean estimated original weight of that prey type. No error estimate was calculated because this process uses pooled data; however, there is error associated with each step in the process including measurement error of length and weight of the prey items, temperature measurements, length-weight relationships, algorithms to predict digestion time, and sampling error associated with location of the Merwin traps and environmental variability. Variability of this model can be assessed using the method of Rieman et al. (1991).

To determine the effect of predation on the prey population, I multiplied the seasonal consumption estimates by estimates of the most abundant predator, in this case, *P. oregonensis*. I estimated abundances of *P. oregonensis* in the mainstem and sloughs of the Flathead River during a 44-day period in summer 1996. *P. oregonensis* greater than 250 mm long that were not sacrificed for food habits analysis were released with individually coded blue floy tags. POPAN-4, an open population estimation computer program, was used to estimate abundance of *P. oregonensis* on the final day of the sampling period (Arnason et al. 1996). An open population model was used because this population uses both the Flathead River and Flathead Lake and the sampling period for the population estimate was during spawning season (Pollock et al. 1990). POPAN-4 calculates population abundances using the Jolly-Seber open population family of models. Dilutions are additions to the population at each time step by birth, recruitment and/or immigration. Dilutions are coded as either present or absent. Losses are deaths and emigrations at each time step that are coded as either present, absent, fixed, or heterogeneous. An abundance estimate was calculated using the modified Schnabel method (Ricker 1975) for *P. oregonensis* captured in Church Slough, under the assumption that this population was closed to immigration and emigration.

In order to assess the impact of consumption by *P. oregonensis* on the bull trout population, I estimated the number of juvenile bull trout migrating through the mainstem every year (Figure 5). The average number of redds in the North and Middle Forks of the Flathead from 1991 through 1995 was about 250 (Thomas 1995), because the redd count index counts about 50% of the redds (Thomas 1992). The average number of eggs per

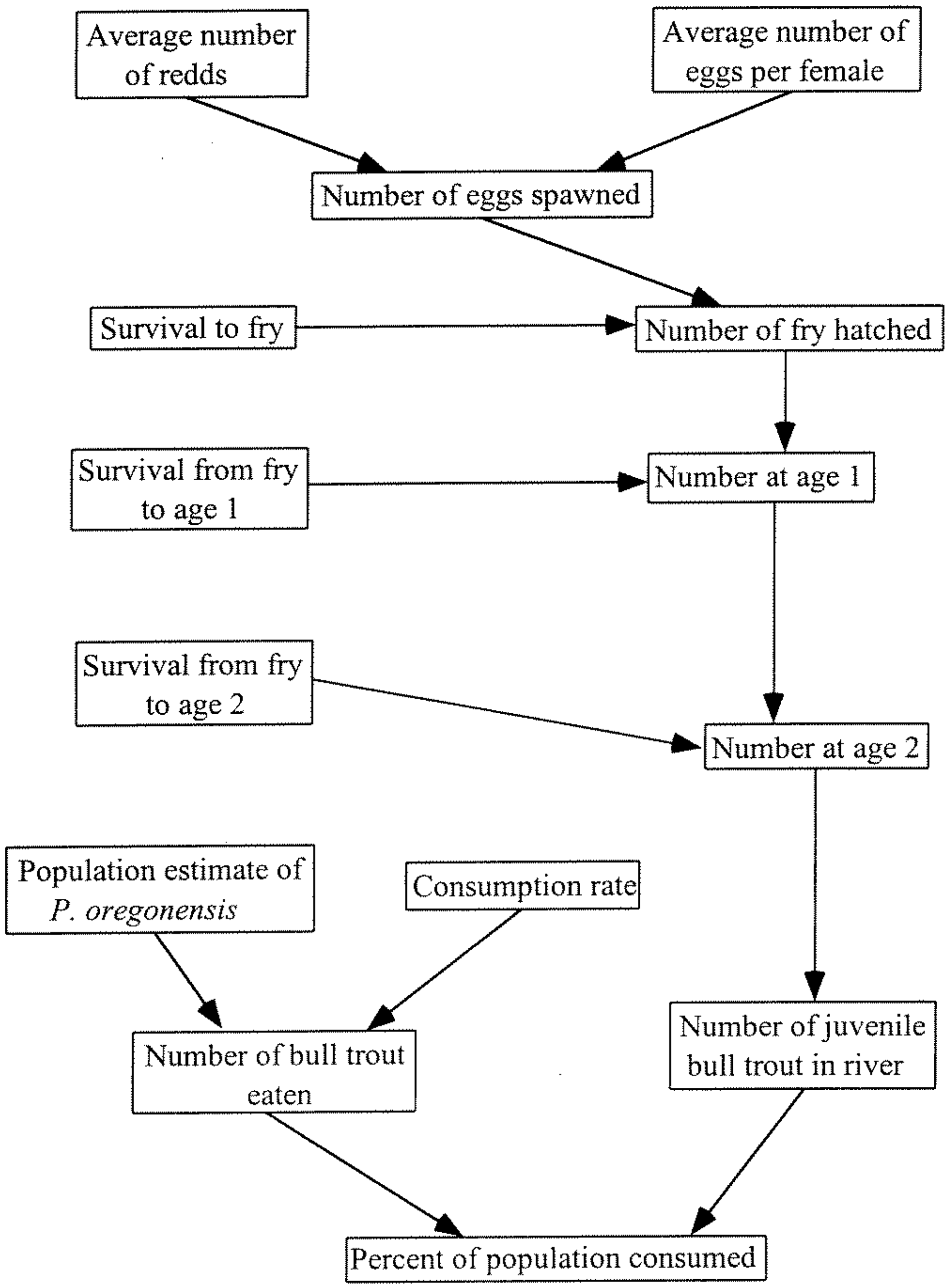

Figure 5. Process for calculation of impact of predation by *P. oregonensis* on juvenile bull trout in the Flathead River, Montana.

female is 5,482 (Fraley and Shepard 1989); which, assuming females spawn completely, equates to about 1,370,500 eggs spawned each year in the tributaries of the Flathead River. Survival from egg to fry in the Coal Creek tributary of the North Fork of the Flathead River was 53% (Weaver and White 1985), which applied to the entire system, would result in about 727,000 fry hatched every year from 1992 through 1996. Survival from fry to age 1 was assumed to be 10% and annual survival from age 1 to age 4 was assumed to be 50% (Griffith 1993). Assuming all juvenile bull trout migrate and that 18% of those migrating were age 1, 49% were age 2, 32% were age 3 and 1% were age 4 (Fraley and Shepard 1989), the estimated number of juvenile bull trout migrating each year from 1994 through 1997 was 28,850.

RESULTS

Spatial and Temporal Distributions of Flathead River Fishes

Lake Trout

Overall, 202 lake trout were captured during the study. Fifty were captured in Merwin traps (Slough Section 23, Impounded River Section 26, Flowing River Section 1) (Figure 6). From the Flowing River Section, an additional 148 lake trout were collected from anglers and four were electrofished. Of the lake trout collected from anglers in the Impounded River Section, 7 and 8 were captured in the summer and autumn 1996 respectively. Two lake trout were collected from anglers from the Slough Section in autumn 1996. From the Flowing River Section, 52 lake trout were collected from anglers in the summer of 1996, and 79 were collected from anglers in the autumn of 1996. Lake trout were captured most often by Merwin traps in the Slough Section during summer 1995 and spring 1996 when runoff was occurring (Figure 6). After the high water subsided, lake trout moved into the Impounded River Section during summer and autumn of 1995 and 1996. Lake trout were not captured in the Slough Section in summer or autumn of 1996, despite extensive sampling. Lake trout were captured in Merwin traps in the Flowing River Section only in spring 1995, but are known to have occurred there in

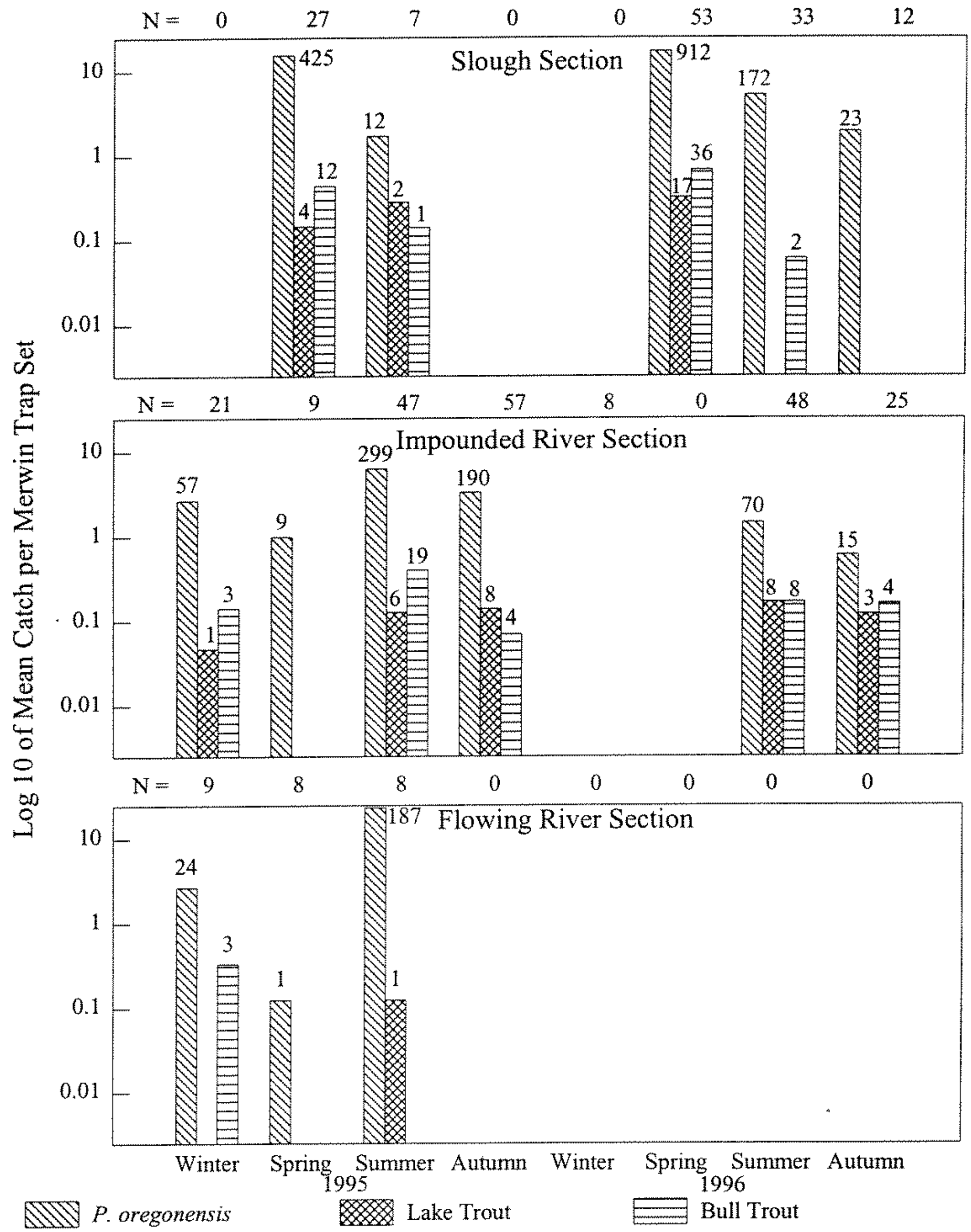

Figure 6. Log10 of relative abundances of *P. oregonensis*, lake trout and bull trout caught in Merwin traps in the Flathead River, Montana. Numbers at tops of bars are the number of Merwin trap sets in that season and section. Numbers in figure are the actual number of fish caught in that season and section.

summer of 1995 and 1996 and autumn of 1996 from angler collections during the pygmy whitefish spawning migration. The Flowing River Section was not sampled with Merwin traps after the summer of 1995 because of problems keeping the traps anchored in the current and high amounts of debris. Occurrence of lake trout during winter 1995-1996 is not known because of sampling difficulties resulting from flooding and ice cover in the sloughs. Lake trout were never captured in the South Fork of the Flathead River or between the confluences of the North, Middle and South forks; however , little sampling effort was expended in these areas (Figure 3 and Table 1).

P. oregonensis

Overall, 2,462 *P. oregonensis* were captured for this study. Most were captured in Merwin traps, but 19 were captured in gill nets, 12 in fyke nets, 29 while electrofishing, and 6 were collected from anglers. *P. oregonensis* were present in all sections and all seasons in which sampling occurred (Figure 6), but differences existed among seasonal catch rates ($P = 0.0001$, analysis of variance). Catch rates were significantly higher in spring of 1995 and spring of 1996 ($P < 0.05$, Tukey's test) than in any other season sampled; however, it is not known whether *P. oregonensis* were present or not during December 1995 through February 1996 (winter 1995-1996). Differences in catch rates also existed among all three sections ($P = 0.0006$, analysis of variance). *P. oregonensis* were most abundant in the sloughs during runoff and spawning season (late May to July), then moved into the Impounded River Section in the summer. The relationship between season and section was significant as an interaction term (P = 0.0001, analysis of variance). *P. oregonensis* were not captured north of Kokanee Bend Fishing Access site in the Flowing River Section; however, little sampling effort was expended in the northern part of the Flowing River Section.

Bull Trout

Overall, 121 bull trout were captured in all seasons and sections in which sampling occurred (Figure 6); however, they were much less abundant than *P. oregonensis*. Twice as many bull trout were caught in Merwin traps as were lake trout. More than 10 bull trout were caught in spring 1995 and 1996 in the Slough Section and in summer 1995 and 1996 in the Impounded River Section. Less than six bull trout were caught in each of the other seasons sampled. Bull trout were most abundant in the Slough Section in the spring during highwater and were also present in the Impounded River Section during winter of 1995 and during summer and autumn of 1995 and 1996.

Bull trout captured ranged from 160 mm to 620 mm in length (Figure 7). The migration of juvenile bull trout in autumn from the natal tributaries to Flathead Lake includes bull trout from about 50 to 360 mm total length (Fraley and Shepard 1989) and 59 of the 117 bull trout measured were less than 360 mm in length. Bull trout 50 to 300 mm long would be edible by lake trout 225 to 800 mm long or larger; however, bull trout 300 to 360 mm long would not be vulnerable to predation by an average lake trout 750 mm or larger but are within the size range of prey eaten by lake trout 750 mm or larger

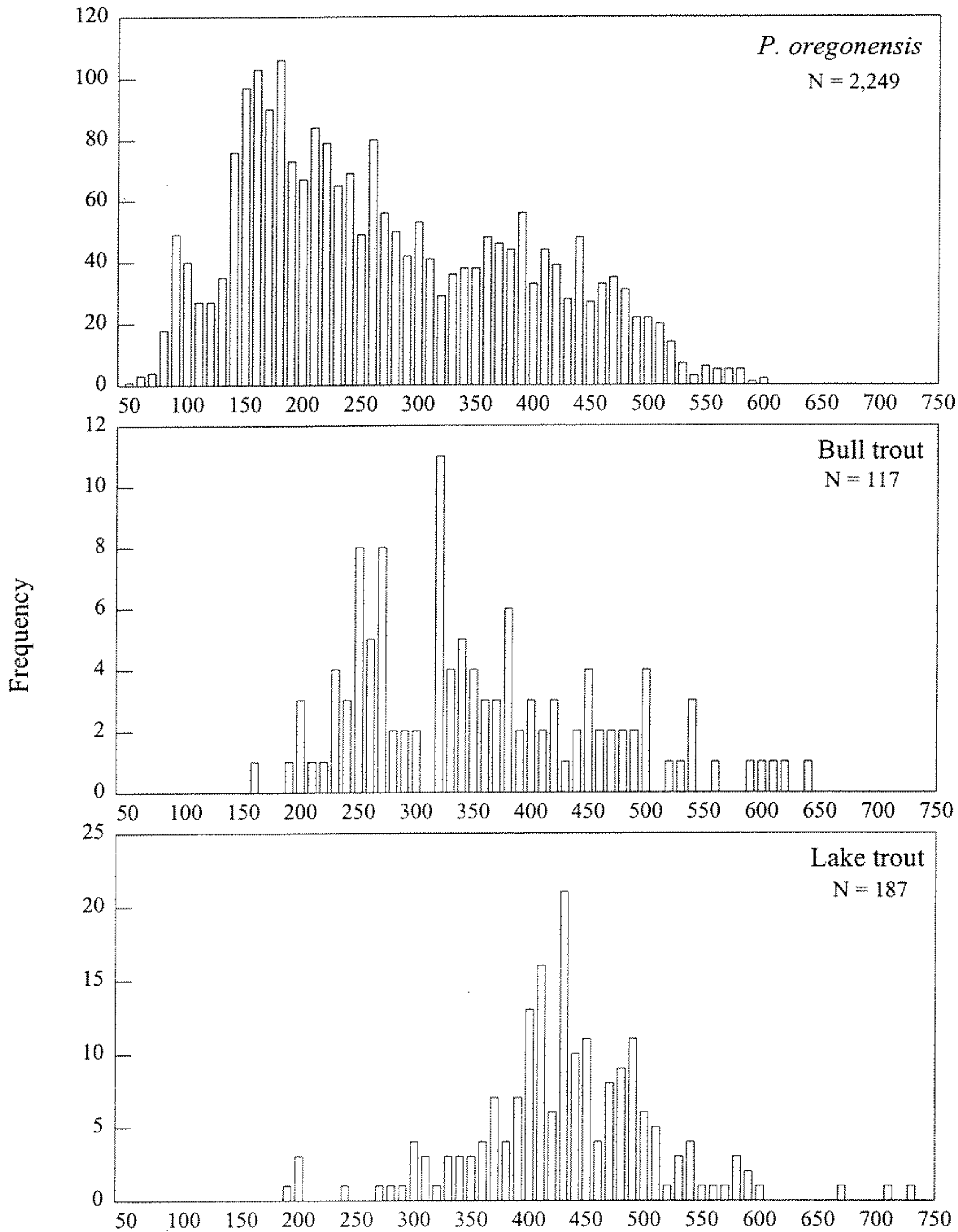

Figure 7. Length-frequency of lake trout, bull trout and *P. oregonensis* caught in the Flathead River, Montana.

(Yule and Luecke 1993). Bull trout 50 to 360 mm long would be vulnerable to predation by *P. oregonensis* 220 to 500 mm long or larger (Poe et al. 1991). Therefore, about 56% of the bull trout captured were vulnerable to predation by the largest predators captured.

Other Species

Other potential predators, such as northern pike and largemouth bass, were captured infrequently. Only 16 northern pike (305 to 1100 mm), and six largemouth bass (99 to 230 mm), were captured in the Slough and Impounded River sections during this study. Salmonids other than bull trout and lake trout included three kokanee (188 to 330 mm), 37 rainbow trout (146 to 457 mm), and 329 westslope cutthroat trout (77 to 484 mm). Catch rates of westslope cutthroat trout were highest in winter 1995 and autumn 1995. Coarsescale and longnose suckers were caught most frequently in the spring (Figure 8). Coregonids were present in low abundance in all seasons, but pygmy whitefish were abundant in autumn 1995 during the spawning migration (Figure 8). Cyprinids were present in all seasons except winter 1995-1996, and peamouth were the most abundant in all seasons, especially spring 1996. Pumpkinseed and yellow perch were also present in the sloughs.

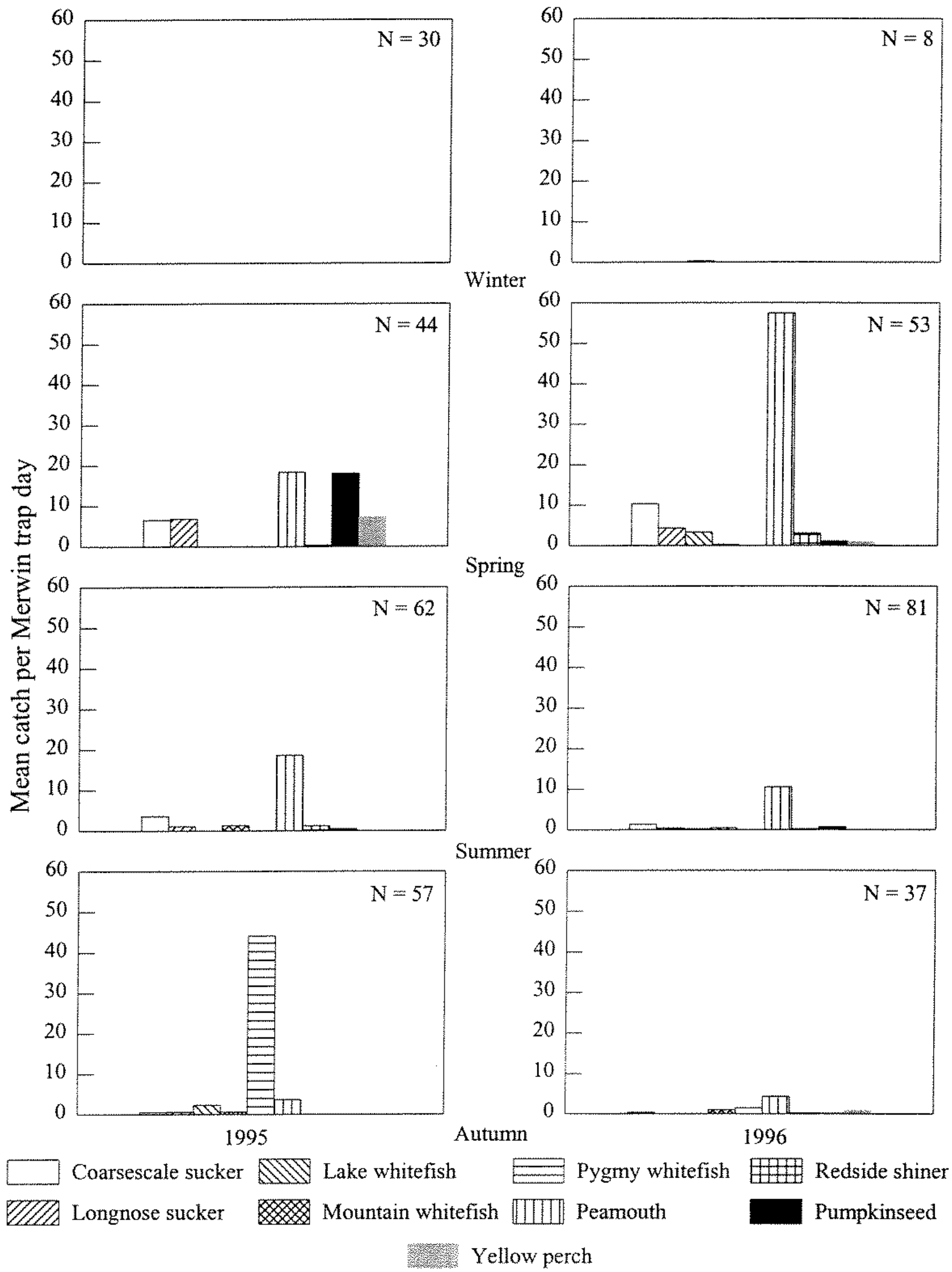

Figure 8. Relative abundance of other Flathead River species. N is the number of Merwin trap sets in that season.

Food Habits and Relative Weights of Predators

Lake Trout

None of the 140 lake trout stomachs collected contained fish identifiable as bull trout. Thirty-three percent of lake trout stomachs examined were empty. One westslope cutthroat trout and two rainbow trout were found and 15 stomachs contained fish or pieces of fish that were identifiable only as salmonid (*Oncorhynchus* spp. or *Salvelinus* spp.) (Figure 9). The westslope cutthroat trout (200 mm, 82.4 g) was from the stomach of a 589 mm lake trout collected on October 4, 1996, at the Old Steel Bridge Fishing Access. One of the rainbow trout (54 mm, 0.9 g) was eaten on July 12, 1995, by a 408 mm long female lake trout that weighed 451 grams collected just north of the State Route 206 bridge (river kilometer 210). The other rainbow trout (no length or weight because of digestion of the food item) was from a 457 mm lake trout which was caught by an angler at Old Steel Bridge Fishing Access on August 25, 1996.

The two rainbow trout, one westslope cutthroat trout and 12 of the items that were either *Oncorhynchus* spp. (trout) or *Salvelinus* spp. (char) were from stomachs of lake trout captured in the Flowing River Section. The other three food items identifiable only as either *Oncorhynchus* spp. or *Salvelinus* spp. were from stomachs of lake trout captured in the Slough Section during spring 1996 (2) or the Impounded River Section in the

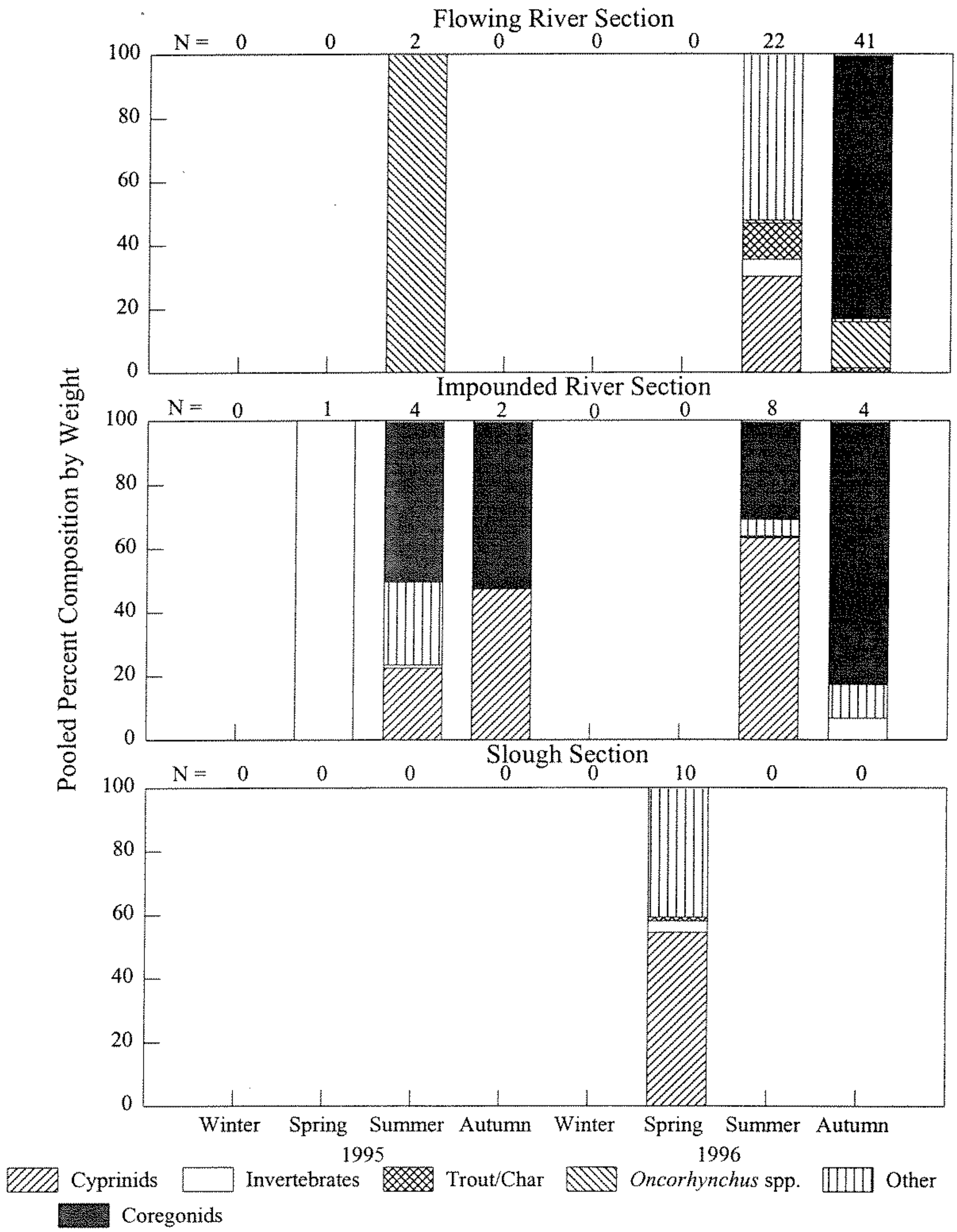

Figure 9. Food habits of Flathead River lake trout. Numbers at the top of bars are the number of non-empty stomachs examined.

summer of 1996 (1). It is possible that some of these unidentifiable food items were bull trout.

Lake trout diets varied by season and section. Cyprinids were important in the diets of lake trout captured in all three sections and all seasons except autumn 1996 in the Impounded River Section, and coregonids were important in the diets of lake trout captured in the Impounded River and Flowing River sections during summer and autumn of both 1995 and 1996. Cyprinids were 54% of the diet by weight of lake trout captured in the sloughs during spring 1996; and 63% and 30% of the diet by weight of lake trout captured in the Impounded River and Flowing River sections, respectively, during summer 1996. Pygmy whitefish were especially important in the diet of lake trout captured in the Flowing River Section in autumn (83% by weight) during the spawning migration of pygmy whitefish. Eggs similar to those found in the pygmy whitefish prey were also found in lake trout stomachs from autumn 1996, even when fish were not present in the stomachs. Invertebrates were numerous in some lake trout stomachs but contributed little to the weight of the lake trout diet. Yellow perch were not present in lake trout stomachs.

Catostomids, centrarchids, sculpins and ictalurids occurred in less than 10% of stomachs examined. More specific information on which species were eaten, in what amounts and how often, is given in Appendix B.

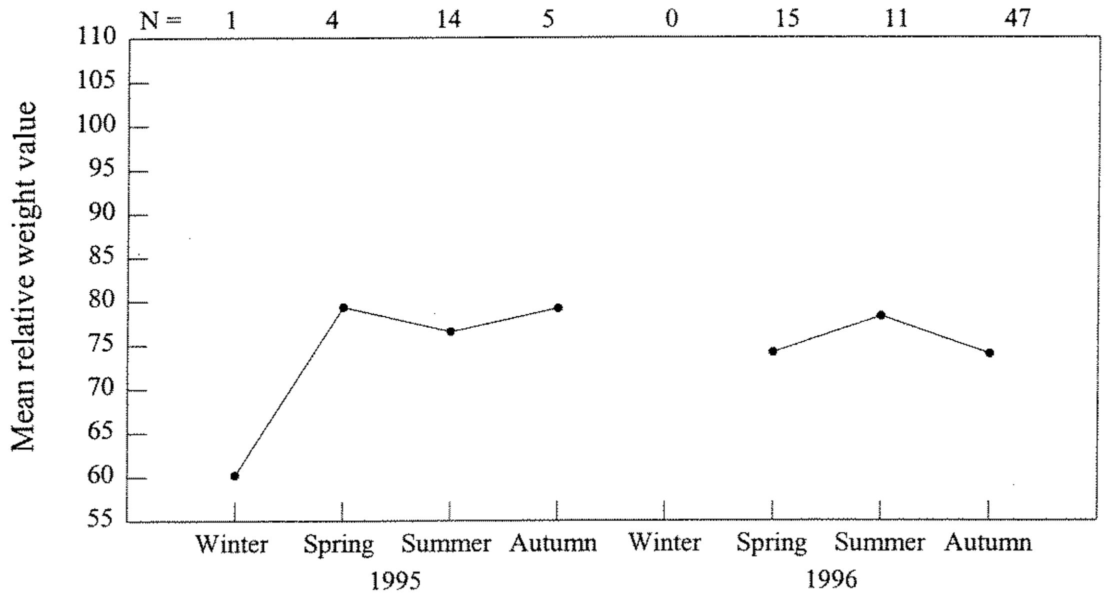

Figure 10. Seasonal mean relative weight values for lake trout caught in the Flathead River compared to the standard established by Piccolo et al. (1993). Sample sizes are indicated by N at the top of the figure.

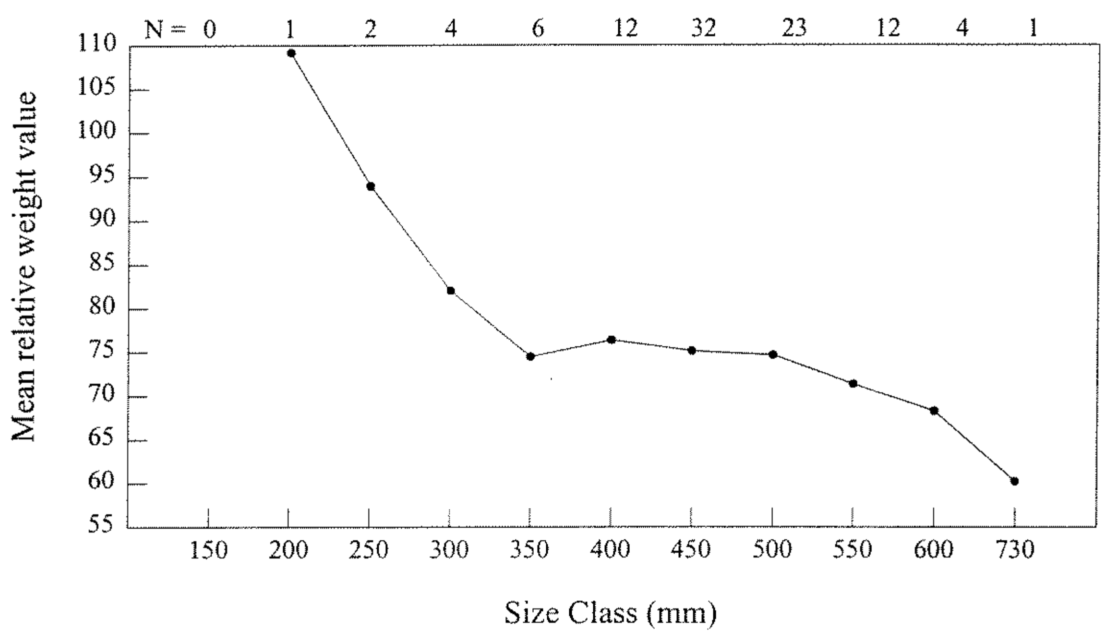

Figure 11. Mean relative weight values for size classes of lake trout caught in the Flathead River compared to the standard established by Piccolo et al. (1993). Sample sizes are indicated by N at the top of the figure.

Relative weights of lake trout in all seasons (Figure 10) and most size classes (Figure 11) were well below the accepted standard of 100 for a lake trout in good condition (Anderson and Neumann 1996). Large (> 400 mm) lake trout were in particularly poor condition, with average relative weight values of 76 to 60.

P. oregonensis

Overall, 53% of *P. oregonensis* stomachs examined were empty. Fullness varied little by season and location, but did vary by predator size. The smallest (less than 150 mm) *P. oregonensis* were more likely to be empty (53%) than the largest (greater than 550 mm) *P. oregonensis* (9%). Two of the 728 *P. oregonensis* stomachs examined contained food items that were probably bull trout (Figure 12). One *P. oregonensis* that may have eaten a bull trout was captured May 31, 1995, in Church Slough. The 511 mm long female *P. oregonensis* weighed 1303 grams. The prey item weighed 8.1 grams, was 100 mm long, and was identified as either a bull trout or a brook trout. Further identification was not possible because of digestion of the skin, indeterminate meristic counts and indistinguishable diagnostic bones. Another *P. oregonensis* that may have eaten a bull trout was captured May 29, 1996, in Half moon Slough. This 530 mm long female *P. oregonensis* weighed 1588 grams. The prey item weighed 13 grams, was 180 mm long, and was identified as either a bull trout or a brook trout. One westslope cutthroat trout was identified in a stomach collected in summer 1995 from the Impounded River Section and no rainbow trout were identified in stomachs of *P. oregonensis*.

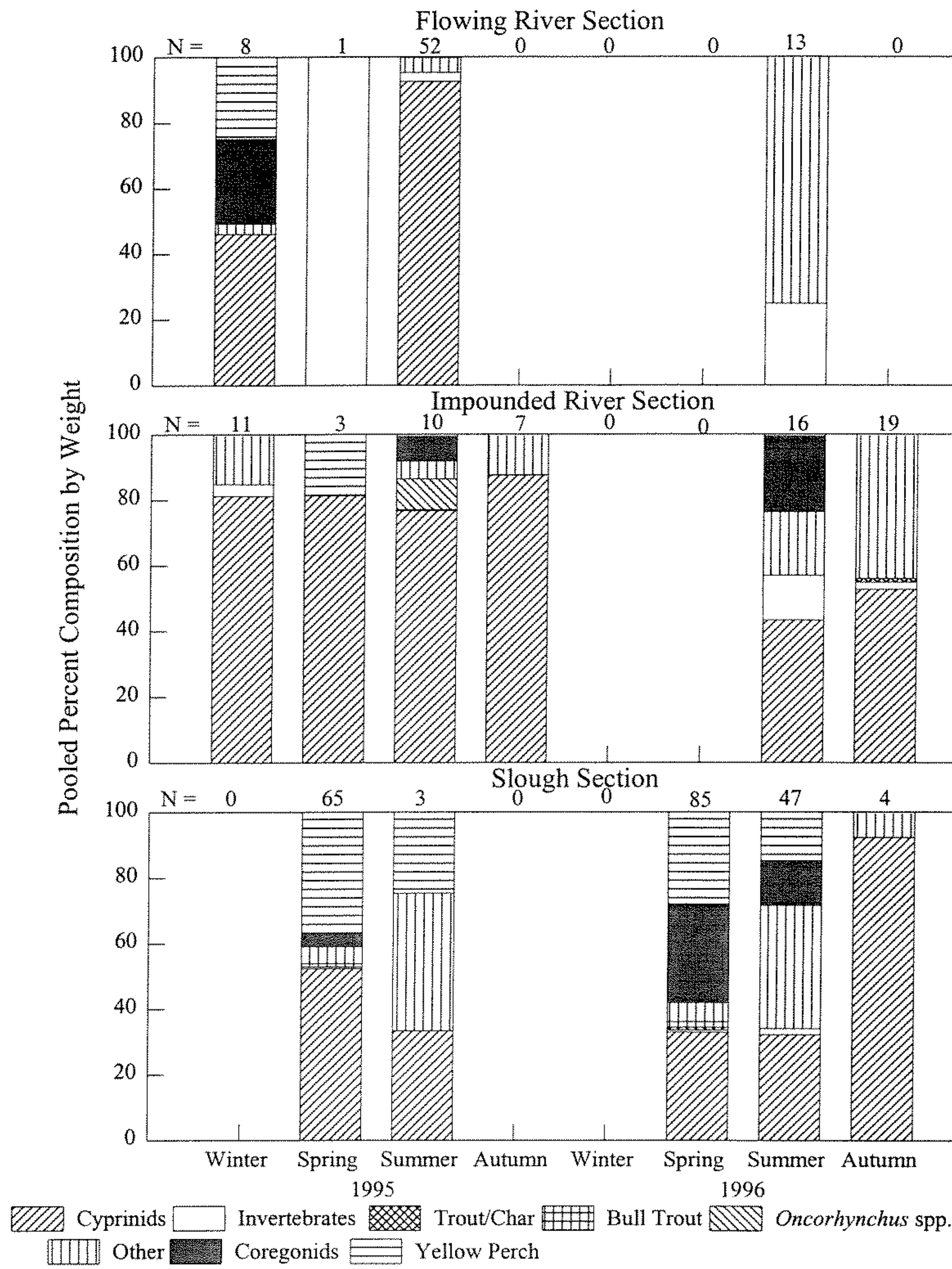

Figure 12. Food habits of Flathead River *P. oregonensis*. Numbers at the top of bars are the number of non-empty stomachs examined.

Five food items were identified as either *Oncorhynchus* spp. (trout) or *Salvelinus* spp. (char) from *P. oregonensis* stomachs collected in the Slough Section in spring of 1995 and 1996 and the Impounded River Section in autumn 1996. Some of these food items may have been bull trout.

Cyprinids were the most important food items by weight in the diets of *P. oregonensis* contributing 33% to 95% of the diet by weight from all areas of the Flathead River and sloughs in every season sampled (Figure 12) except spring 1995 and summer 1996 in the Flowing River Section when invertebrates and other food items were most important. Coregonids contributed less than 30% of the diet by weight in all sections and seasons sampled (Figure 12). *P. oregonensis* captured in the Flowing River Section ate more invertebrates (Figure 12) than lake trout caught in the same section. Unlike lake trout, *P. oregonensis* captured in all sections consumed yellow perch; however, consumption was most frequent in the spring and summer in the Slough Section (Figure 12).

Cyprinids were 50% or more of the diet by weight of *P. oregonensis* longer than 300 mm and very few were eaten by smaller predators (Figure 13). Although coregonids were more important to *P. oregonensis* greater than 350 mm long, they never contributed more than 40% of the diet by weight for any size class (Figure 13). Invertebrates were most important by weight to *P. oregonensis* less than 200 mm long and were less important for larger predators (Figure 13). Although they never contributed more than 40% of the diet by weight, yellow perch were important to *P. oregonensis* greater than 200 mm long and were more frequently eaten by predators greater than 300 mm long

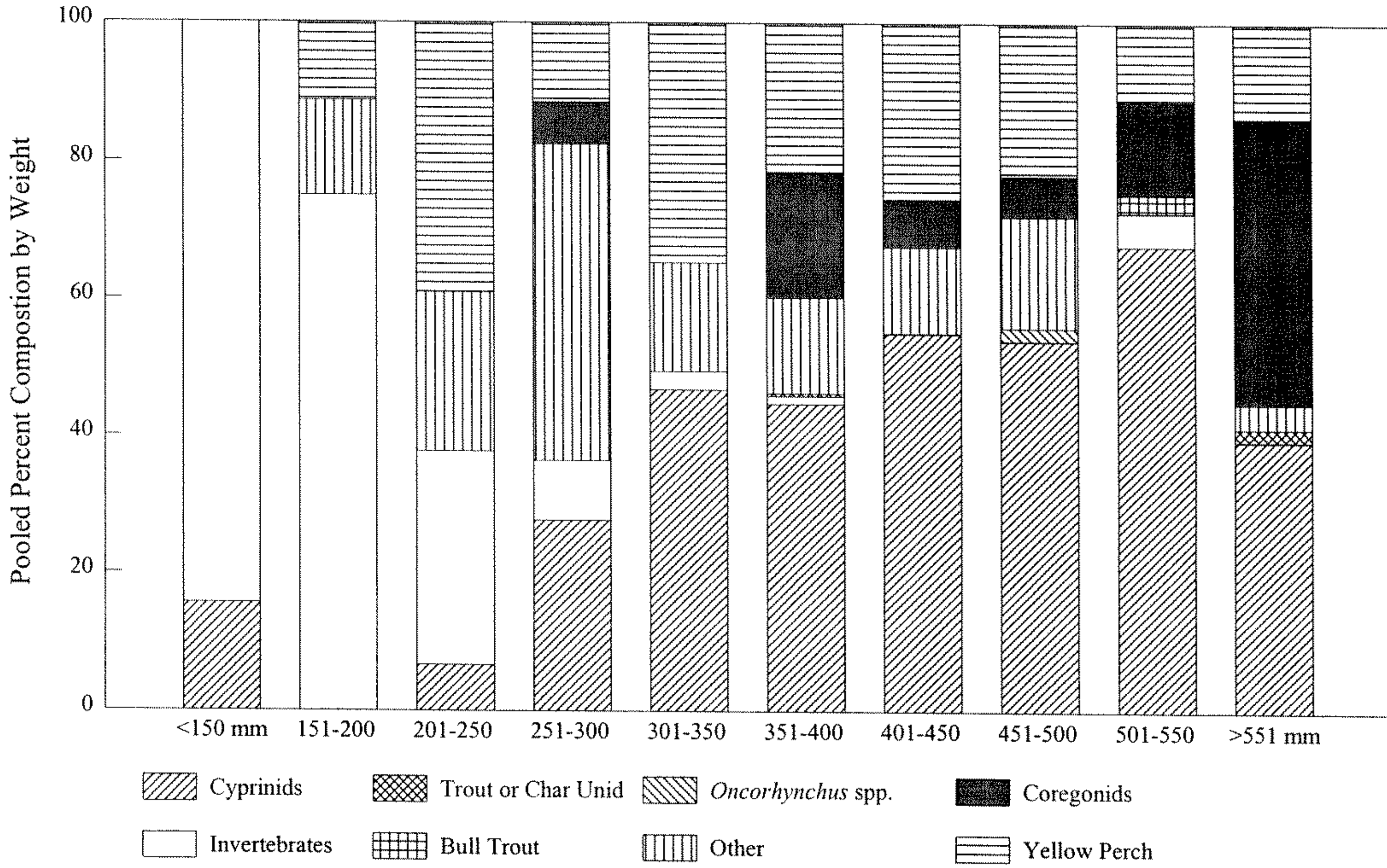

Figure 13. Food habits of Flathead River *Ptychocheilus oregonensis* by 50 mm size class.

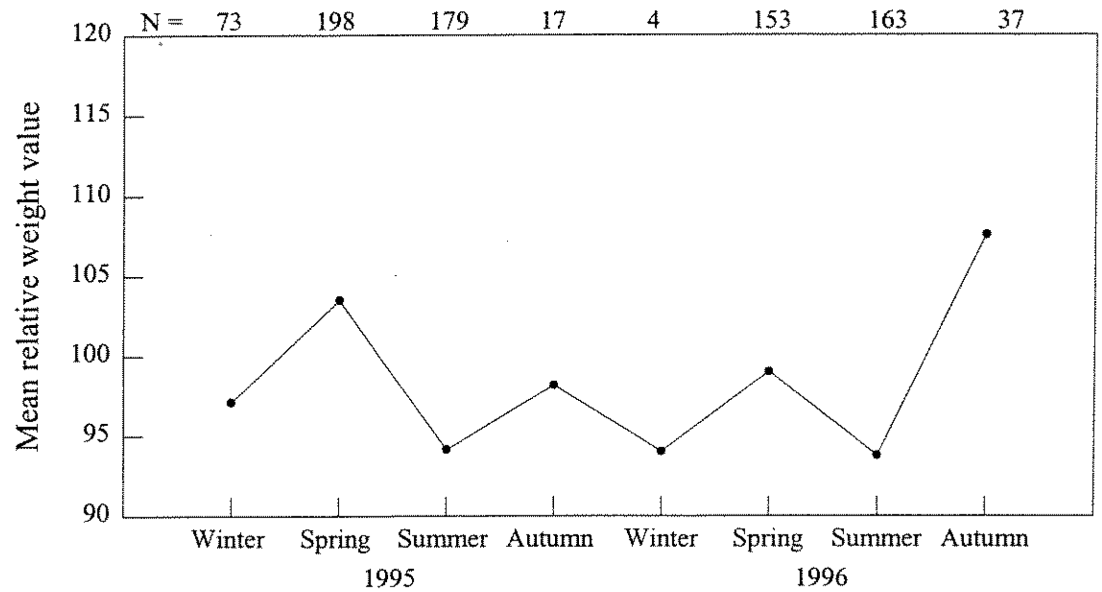

Figure 14. Seasonal mean relative weight values for *P. oregonensis* caught in the Flathead River compared to the standard developed by Parker et al. for the lower Columbia and Snake rivers (1995). Sample sizes are indicated by N at the top of the figure.

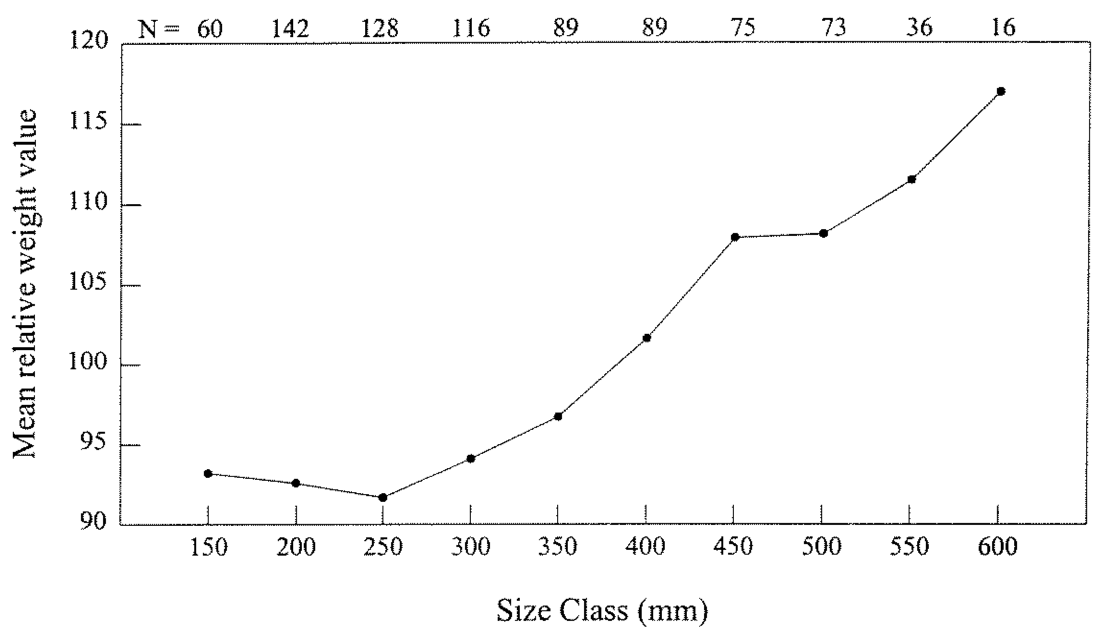

Figure 15. Mean relative weight values for size classes of *P. oregonensis* caught in the Flathead River compared to the standard developed by Parker et al. (1995) for the lower Columbia and Snake rivers. Sample sizes are indicated by N at the top of the figure.

(Figure 13). Two large (486 mm and 563 mm) *P. oregonensis* ate small birds in the Slough Section in spring and summer of 1995.

Relative weight values for *P. oregonensis* from the Flathead River were comparable to those of *P. oregonensis* from the lower Columbia and Snake rivers (Parker et al. 1995), and were close to the standard of 100 for *P. oregonensis* in good condition. All seasonal means (Figure 14) and most size-class means (Figure 15) were between 90 and 110. *P. oregonensis* larger than 500 mm were in good condition according to this index.

Other Predators

Largemouth bass, northern pike, and rainbow trout were the other potential predators of bull trout. Few specimens of each of the above mentioned species were captured and none contained bull trout (Table 2).

Table 2. Food habits of largemouth bass, northern pike and rainbow trout collected in the Flathead River, Montana.

Predator Species	N	Section	length (mm)	Food Habits	Season
Largemouth bass	1	Slough Section	230	two peamouth	Summer 1996
Northern pike	5	Slough Section	388 to 892	one to three peamouth, unidentified non-salmonid	Spring 1995 Summer 1995 Autumn 1995 Spring 1996
Rainbow trout	7	Flowing River Section	179 to 337	one catostomid, Ephemeroptera, Gastropoda,	Winter 1995, Summer 1996

Predator Species	N	Section	length (mm)	Food Habits	Season
				Hemiptera, Hymenoptera, Diptera, Coleoptera, Plecoptera, Megaloptera, Trichoptera	

Consumption Estimates and Abundance Estimates

Comparison of consumption estimates of number of prey eaten by an individual *P. oregonensis* (Table 3) indicates that relatively few bull trout, westslope cutthroat trout, unidentifiable trout or char, mountain whitefish, or pumpkinseed were consumed (less than 20 prey per predator in a season). Yellow perch and catostomids were eaten more frequently (20 to 30 prey per predator in a season), whereas peamouth, redside shiner and *P. oregonensis* were the prey most frequently eaten (30 to 60 prey per predator in a season).

Table 3. Estimates of numbers of prey eaten per individual *Ptychocheilus oregonensis* in each season in the Flathead River. Proportion of total weight consumed that season is in parentheses.

Prey Species	Winter 1995	Spring 1995	Summer 1995	Autumn 1995	Spring 1996	Summer 1996	Autumn 1996
Bull trout	0	1.8	0	0	5.8	0	0
	(0)	(0.02)	(0)	(0)	(0.04)	(0)	(0)
Mountain whitefish	7.8	1.9	5.5	0	17.4	9.9	0.5
	(0.15)	(0.02)	(0.08)	(0)	(0.13)	(0.09)	(0.00)
P. oregonensis	7.9	7.5	19.8	0	4.5	0	38.3

Prey Species	Winter 1995	Spring 1995	Summer 1995	Autumn 1995	Spring 1996	Summer 1996	Autumn 1996
	(0.15)	(0.07)	(0.30)	(0)	(0.03)	(0)	(0.35)
Peamouth	5.9	37.5	13.8	21.0	33.5	58.1	46.8
	(0.11)	(0.35)	(0.21)	(0.69)	(0.25)	(0.51)	(0.42)
Redside shiner	4.5	4.4	8.6	0	42.2	0	15.0
	(0.09)	(0.04)	(0.13)	(0)	(0.32)	(0)	(0.14)
Catostomid	5.3	2.6	0	9.6	2.7	27.0	0
	(0.10)	(0.02)	(0)	(0.31)	(0.02)	(0.24)	(0)
Trout or char	0	18.2	0	0	0	0	0
	(0)	(0.17)	(0)	(0)	(0)	(0)	(0)
Westslope	0	0	13.1	0	0	0	0
cutthroat trout	(0)	(0)	(0.20)	(0)	(0)	(0)	(0)
Yellow perch	21.4	22.3	5.1	0	26.3	2.4	0
	(0.41)	(0.21)	(0.08)	(0)	(0.20)	(0.02)	(0)
Pumpkinseed	0	9.8	0	0	0	15.7	9.9
	(0)	(0.09)	(0)	(0)	(0)	(0.14)	(0.09)
Total	52.8	106	65.9	30.6	132.4	113.1	110.5

The estimate of population abundance of *P. oregonensis* in the Impounded River Section and Slough Section during the summer of 1996 was 621 fish from the Jolly-Seber Birth-Only Model (Table 4). This estimate was similar to a modified Schnabel estimate of 624 fish (standard deviation = 25.0; 76 marked, 16 recaptured) in those two sections. The largest estimate was 1176 fish in the Impounded River and Slough Sections from the Jolly-Seber Birth Only Model with constant capture probability (Table 4), which is low compared to 2462 *P. oregonensis* that were captured during all sampling in 1995 to 1996. A modified Schnabel estimate was calculated for Church Slough alone assuming little movement between sloughs and the river during the marking period. The resulting estimate of population abundance for Church Slough during the summer of 1996 was 496 *P. oregonensis* (standard deviation = 22.3; 64 marked, 15 recaptured). A modified

Schnabel estimate of the larger (> 400 mm) *P. oregonensis* was 178 (standard deviation = 13.3; 23 marked, 6 recaptured).

Table 4. Population abundance estimates for *P. oregonensis* in the Impounded River and Slough sections of the Flathead River during the summer of 1996 computed by program POPAN-4 (Arnason et al. 1996).

Model	Effort	Losses	Dilutions	N	SE
Jolly-Seber Birth-Only Model	Non Constant	Absent	Present	621	577.4149
Jolly-Seber Birth-Only Model (with Constant Capture Prob.)	Constant	Absent	Present	1176	402.3390

P. oregonensis predation on bull trout was estimated by multiplying the *P. oregonensis* population abundance estimates by the individual consumption estimates. These estimates range from about 900 bull trout eaten each spring in Church Slough (n = 496 *P. oregonenesis*) to a total of about 6800 bull trout eaten each spring in the Impounded River and Slough sections combined (n = 1,176 *P. oregonenesis*). These values probably grossly underestimate the total amount of predation on bull trout because the *P. oregonensis* population abundance estimates were unreliable (failed to meet assumptions of population closure and constant sampling effort), because some of the stomach contents identified only as either trout or char may have been bull trout, and because the consumption estimates are based on only two probably bull trout prey items.

In order to assess the impact of consumption by *P. oregonensis* on the bull trout population, I estimated that the number of juvenile bull trout migrating through the mainstem every year was 28,850. The amount of impact on the bull trout population abundance would be 3% to 24% depending on the population abundance estimate of *P. oregonensis* and consumption rate estimate.

DISCUSSION

Spatial and Temporal Distributions of Flathead River Fishes

Lake trout were present but not highly abundant in all sampled sections of the Flathead River from May to November in both 1995 and 1996. However, despite their preference for lentic habitats, it was not unusual to catch lake trout in the Flathead River. About one of every 10 Merwin trap sets in the Impounded River Section and one of every four Merwin trap sets in the Slough Section in spring and summer caught a lake trout. Anglers at Old Steel Bridge Fishing Access in the Flowing River Section caught lake trout daily. Many of the impounded areas of the Flathead River are slow moving, with abundant minnow prey and the flowing areas of the Flathead River are sources of abundant aquatic insect prey and whitefish.

Selective withdrawal, which began in August 1995, appears to have decreased abundance of lake trout in the river by increasing river temperature. Water temperatures were slightly warmer in the summer of 1996 (70 days above 13°C) than summer of 1995 (56 days above 13°C) and relative abundance of lake trout was less in the Impounded River Section in summer of 1996 (10% of Merwin trap sets had lake trout) than summer 1995 (13% of Merwin trap sets had lake trout). Lake trout prefer water temperatures less than 13°C (Eschmeyer 1957; McCauley and Tait 1970; Scott and Crossman 1973) and mean river temperatures in the summer of 1995 were about 13°C, whereas mean river temperatures in the summer of 1996 were about 15°C. This temperature difference is small and may be due to the longer runoff of 1996 compared to 1995. A small difference in temperature above the preferred temperature may be enough to deter lake trout; however, they can tolerate warmer waters for short periods of time when cooler refugia are available (Snucins and Gunn 1995). Cool water refugia may be available in the Flathead River, or the lake trout may only be spending a few days in the warmer river water before moving back into Flathead Lake. The incipient upper lethal temperature for lake trout is 23.5°C (Gibson and Fry 1954); water temperatures in the sloughs can exceed 23.5°C at the surface during the summer. Water temperatures in the main river did not exceed 18°C during this study, but temperatures in the sloughs were occasionally as much as 9.4°C higher than the main river.

P. oregonensis were captured in all sections of the Flathead River and during all seasons except winter 1996 when sampling was limited because of weather. *P. oregonensis* were more abundant than lake trout in the Impounded River and Slough sections, but were not found as far upriver in the Flowing River Section as lake trout. The timing of the peak abundance of *P. oregonensis* for spawning coincided with the peak abundance of juvenile bull trout migrating to Flathead Lake. Relative abundances of both *P. oregonensis* and bull trout in the Merwin traps were highest in the same sections in spring and summer.

Juvenile bull trout migrate out of the natal tributary streams and through the Flathead River to Flathead Lake between May and September and adult bull trout migrate to the tributaries to spawn from April to July (Fraley and Shepard 1989). However, juvenile and adult bull trout were captured in the Flathead River and sloughs in every season sampled; therefore, there is either a fluvial population of bull trout in the Flathead River or it takes juveniles longer to migrate between the tributaries and lake than previously believed. Juvenile bull trout may also be using the Impounded River Section and sloughs as rearing areas instead of or in addition to Flathead Lake.

Food Habits and Relative Weights of Predators

The presence of lake trout in the Flathead River to feed on the available prey is not unexpected because of recent changes in Flathead Lake such as the recent decline in abundance of kokanee for forage. In fact, lake trout sampled in the Flathead River were in very poor condition, indicating that they were not getting enough prey to meet their nutritional requirements. Lake trout are a mobile species (Scott and Crossman 1973) moving long distances over short periods of time; therefore, poor condition cannot be attributed solely to conditions in the river or in the lake. Lake trout from Flathead Lake have been caught by anglers as far north in the Flathead River as Polebridge, which is about 89 km from Flathead Lake. Lake trout condition in Flathead Lake varies by season and size of fish (M. Deleray, MDFWP, personal communication). In the spring, Flathead Lake lake trout are in poor condition and condition improves through the summer and in autumn (M. Deleray, personal communication). Spring condition factor for Flathead Lake lake trout 300 to 400 mm long ranged from 0.63 to 0.72 from 1990 to 1995 (M. Deleray, personal communication). Condition factor for Flathead Lake lake trout 500 to 600 mm was 0.71 to 0.78 from 1990 to 1995 (M. Deleray, personal communication). As the lake trout population continues to respond to the changed trophic structure of Flathead Lake, their condition may improve as they continue to use the Flathead River and sloughs as feeding areas because of high concentrations of potential prey, such as cyprinids and coregonids, in those areas.

In contrast to lake trout, *P. oregonensis* captured during this study were in good to excellent condition. *P. oregonensis* were more abundant in the Slough and Impounded River sections than in the Flowing River Section and fed upon the most abundant prey, cyprinids and yellow perch. Lake trout may have avoided eating yellow perch because of the spines in yellow perch fins; however, they do eat yellow perch in other systems (Eschmeyer 1957). Coregonids were most abundant in autumn and were very important in the diets of lake trout; however, most *P. oregonensis* moved back into Flathead Lake in autumn and winter and few coregonids were eaten by the remaining *P. oregonensis*.

The increase in reports of lake trout caught in the river by anglers occurred during the spawning migration of pygmy whitefish, and it was hypothesized that the lake trout had followed the whitefish from the lake and were taking advantage of the concentration of these prey in the river. There is no evidence from this study that the lake trout followed the pygmy whitefish from the lake into the river, but it is clear that the lake trout were eating them while they were abundant in the river for spawning.

The fact that predation by lake trout on bull trout was not detected was not surprising because detection of predation on a scarce prey by a scarce predator requires large sample sizes. Although lake trout were probably more abundant in the Flathead River before 1989 (B. Marotz, personal communication), they were less abundant than bull trout in the Merwin trap catch for most months I sampled. They were found in the same sections at the same times of year and occasionally in the same traps. Therefore, if selective predation on bull trout by lake trout did occur, I should have been able to identify bull trout in at least one of the 141 lake trout stomachs examined.

P. oregonensis are the most likely predatory threat to juvenile bull trout in the Flathead River; however, only two possible bull trout were found in 728 *P. oregonensis* stomachs. It was likely that both prey items were bull trout because brook trout were not encountered during sampling.

Consumption Estimates and Abundance Estimates

Compared to other prey species, *P. oregonensis* consumption of bull trout is low. However, for a declining species such as bull trout, losing 3% or 24% of migrating juveniles every year may be a significant source of mortality. The true impact of *P. oregonensis* predation on juvenile bull trout depends on the temporal and spatial synchrony of the two species. My results suggest that *P. oregonensis* could be a significant source of mortality for juvenile bull trout given observed predation rates, temporal and spatial overlap of the two species, and relatively high population abundances of *P. oregonensis*. However, the consumption estimates should be interpreted with caution because they are based on only two probable bull trout prey items. If, by chance, there had been no bull trout prey items, the consumption estimate would have been zero. If, by chance, there had been twice as many bull trout eaten under exactly the same circumstances, the consumption estimate would have been twice as high and the impact would have been twice as high (6% to 48%). The consumption estimate would have been much higher if the temperature the prey were consumed at were higher because temperature is the most influential factor for consumption rates of fish (Vigg et al. 1991).

The relatively low bull trout redd index, 123 to 115 per year in 1992 to 1994 compared to 243 to 436 per year in 1980 to 1991 (Thomas 1995), which indicates low population abundance, combined with a large population abundance of *P. oregonensis* and the estimate of consumption of bull trout by *P. oregonensis,* lead me to believe that bull trout have declined in abundance to the point where predation in the Flathead River and sloughs by *P. oregonensis* may be a significant source of mortality. Although I found no evidence that lake trout or *P. oregonensis* are consuming large numbers of bull trout prey, the level of predation (3% to 24%) may be enough to prevent the bull trout population from recovering to previous levels. In the Columbia River system, predation loss of salmonids ranged from 9% to 19% which resulted in the loss of 2.7 million salmonids per year and contributed to the inability of the salmon stocks to recover (Rieman et al. 1988). Other potential causes of the decline or mortality factors in bull trout abundance may be a decline in availability of spawning habitat and changes in water quality, such as changes in temperatures in the tributaries or chemical changes such as pH, conductivity, concentrations of heavy metals and other pollutants (Rieman and McIntyre 1993; Thomas 1995). Lack of prey, or competition with lake trout and other fish for prey in Flathead Lake may also play a role in the current status of the bull trout population in the Flathead drainage (Donald and Alger 1993). Predation by lake trout on bull trout in Flathead Lake is another possible limiting factor; however, only one bull trout was found in 449 lake trout stomachs collected for monitoring in Flathead Lake (L. Knotek, MDFWP, personal communication). In Yellowstone Lake, introduced lake trout threaten the native Yellowstone cutthroat trout, eating an estimated 59 cutthroat trout per lake trout per year (Ruzycki and Beauchamp 1997).

The amounts of predation by *P. oregonensis* and lake trout on westslope cutthroat trout and rainbow trout were similar to the amount of predation on bull trout by *P. oregonensis*. Westslope cutthroat trout and rainbow trout were more common in the Flathead River than bull trout, but they were still scarce relative to the number of predators and may or may not be limited by predation depending on other factors such as prey availability and habitat.

Mountain whitefish and pygmy whitefish were both abundant in the Flathead River. Although predation by *P. oregonensis* and lake trout was higher on these species than on other salmonids, it appeared not to be limiting population abundances of whitefishes.

MANAGEMENT RECOMMENDATIONS

Juvenile bull trout abundance and the timing of migration from the tributaries to Flathead Lake need to be better understood before further action is taken. The sloughs connected to the Flathead River are distinctive habitats when compared to the Flathead River and Flathead Lake. The sloughs are warmer, shallower, contain rooted aquatic vegetation for cover, and have abundant prey fish. Use of the sloughs by juvenile bull trout needs to be investigated and quantified in order to determine the effect of predation on juvenile bull trout in these habitats and to determine the proper management actions to be taken to reduce that predation if necessary (Clancy et al. 1995). Population abundance of bull trout is small enough that predation by *P. oregonensis* is probably limiting recovery of the population to historical abundances, therefore actions need to be taken which enhance survival and reproduction of bull trout, or which limit predation by *P. oregonensis*. Such actions could include limiting timber harvest, road building and development near important bull trout spawning and rearing tributaries, habitat restoration and enhancement in the tributaries and Flathead River, removal of barriers to migration to historical bull trout spawning grounds, and limiting predation on juvenile bull trout by reducing abundance of lake trout in Flathead Lake and reducing abundance of *P. oregonensis* in the Flathead River and especially in its sloughs. Methods for reducing populations of piscine predators include removal trapping by MDFWP, increased angler harvest through regulations on the lake trout fishery, and creation of a sport or commercial fishery for *P. oregonensis.* Lake trout and *P. oregonensis* captured in conjunction with research or removal efforts could be donated to food banks or sold for fish meal. In the Columbia River system, a sport-reward fishery has been developed for *P. oregonensis* which has the goal of reducing the predator population by 10-20% (Beamesderfer et al. 1996). By removing the large piscivorous *P. oregonensis,* they hope that freshwater survival will increase enough to help restore and protect endangered stocks of native salmonids. In the Flathead drainage, the problem is similar, in that the *P. oregonensis* eating bull trout are the large, older fish. A similar anger removal program could be employed on the Flathead River and its sloughs to help restore and protect our threatened native bull trout.

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APPENDICES

APPENDIX A

KEY TO DIAGNOSTIC BONES OF FLATHEAD DRAINAGE SALMONIDS

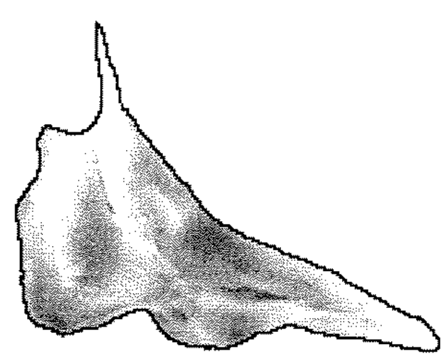
KEY TO DIAGNOSTIC BONES OF FLATHEAD DRAINAGE SALMONIDS

1a. "Cleithrum with greatly expanded, contiguous, ventral and horizontal limbs with distinct concavity along posterior margin where two limbs meet" (Frost et al. 1996) *Prosopium* spp. 2

1b. "Expansion [of cleithrum] not as pronounced and without concavity along posterior margin where two limbs meet" (Frost et al. 1996)...3

2a. Horizontal limb of cleithrum longer than vertical limb; large, round vertical lobe on side of vertical limb of cleithrum; 13-33 pyloric caeca; no teeth on shaft of vomer

P. williamsoni



cleithrum

2b. Horizontal and vertical limbs of cleithrum equal in length; large, less rounded vertical lobe on side of vertical limb of cleithrum; 50-146 or 60-140 pyloric caeca; no teeth on shaft of vomer

P. coulteri

cleithrum

2c. 150-200 or 140-222 pyloric caeca; no teeth on shaft of vomer *P. clupeaformis*

3a. Angle formed by vertical and horizontal limbs of cleithrum greater than 90°

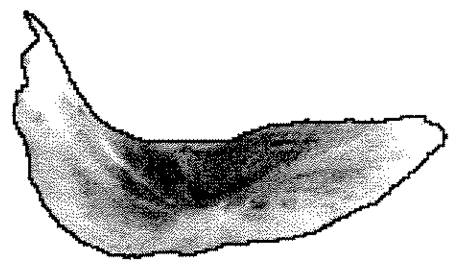
Oncorhynchus spp. 4

3b. Angle formed by vertical and horizontal limbs of cleithrum = 90°

Salvelinus spp. 5

4a. Large vertical lobe on side of cleithrum; slender spine at top of vertical limb of cleithrum; 25-57 pyloric caeca; teeth on shaft of vomer

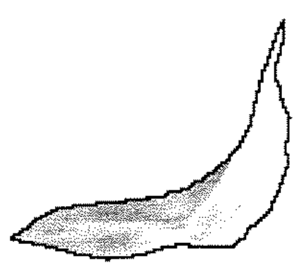
O. clarki lewisi



cleithrum

4b. Small lobe on side of vertical limb of cleithrum blends to slender spine; 25-80 pyloric caeca; teeth on shaft of vomer

O. mykiss

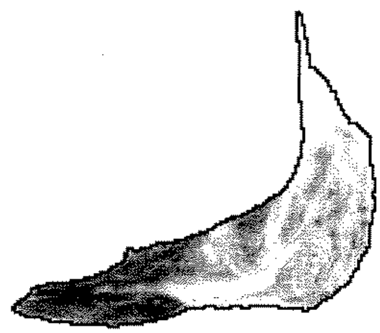


cleithrum

4c. 45-115 pyloric caeca; teeth on shaft of vomer *O. nerka*

5a. Large lobe on side of vertical limb of cleithrum, lobe square on outer lower corner; no teeth on shaft of vomer; 13-47 or 20-40 pyloric caeca, *S. confluentus*

or 23-49 pyloric caeca *S. fontinalis*



cleithrum

5b. Smaller lobe on side of vertical limb, rounded on outer lower corner; 93-208 or 81-190 pyloric caeca; single row of teeth on anterior shaft of vomer

S. namaycush

Photos of *S. namaycush*, *O. nerka*, and *P. clupeaformis* cleithra were not included because the samples were too large to photograph or not available. I recommend collecting samples of these species and keeping them on hand for reference purposes.

APPENDIX B

FOOD HABITS TABLES

Table 5. Percent frequency of occurrence of food items in diets of Flathead River lake trout. N = the number of non-empty stomachs examined.

Food Items	All Sections N = 94	Impounded River N = 18	Sloughs N = 12	Flowing River N = 64
Bird	0	0	0	0
Vegetation	13.8	16.7	9.1	14.1
Coleoptera	6.4	0	18.2	6.3
Decapoda	2.1	5.6	0	1.6
Diptera	6.4	16.7	9.1	3.1
Ephemeroptera	5.3	5.6	0	6.3
Hemiptera	3.2	0	0	4.7
Hirudinea	1.1	0	0	1.6
Hymenoptera	1.1	0	0	1.6
Nemotoda	1.1	5.6	0	0
Odonata	1.1	0	0	1.6
Plecoptera	9.6	5.6	0	12.5
Trichoptera	11.7	11.1	9.1	14.1
Invertebrates Unid	9.6	5.6	27.3	7.8
Invertebrates	35.1	44.4	45.5	29.7
Black Bullhead	0	0	0	0
Sculpin	2.1	5.6	0	1.6
Yellow Perch	0	0	0	0
Pumpkinseed	1.1	0	9.1	0
Largemouth Bass	1.1	0	9.1	0
Centrarchids	2.1	0	18.2	0
Coarsescale Sucker	3.2	0	0	4.7
Longnose Sucker	4.3	5.6	9.1	3.1
Sucker Unid	2.1	5.6	0	1.6
Catostomids	9.6	11.1	9.1	9.4
P. oregonensis	8.5	11.1	27.3	9.4
Peamouth	10.6	22.2	9.1	7.8
Redside Shiner	3.2	0	18.2	1.5
Cyprinids	17.0	22.2	45.5	12.5
Lake Whitefish	2.1	0	0	3.1
Mountain Whitefish	5.3	11.1	9.1	3.1
Pygmy Whitefish	25.5	16.7	0	32.8
Whitefish Unid	5.3	5.6	0	6.3
Eggs	6.4	0	0	9.4
Coregonids	36.2	27.8	9.1	43.8
Not Trout or Char Unid	9.6	5.6	18.2	9.4
Rainbow Trout	2.1	0	0	3.1
Westslope Cutthroat	1.1	0	0	1.6
Oncorhynchus spp.	3.2	0	0	4.7
Bull Trout	0	0	0	0
Trout or Char Unid	12.8	5.6	18.2	14.1
Salmonids	43.6	38.9	27.3	53.1
Fish Unid	9.6	11.1	9.1	9.4
Fish	69.2	61.1	72.7	71.9

Table 6. Percent frequency of occurrence of food items in diets of Flathead River lake trout. Spring was April through June, summer was July through September, and autumn was October through November. No lake trout stomachs were sampled in winter of 1995 (January through March 1995) or winter of 1996 (December 1995 through March 1996).

Food Items	1995 N = 10	Spring 1996 N = 11	Summer 1996 N = 28	Autumn 1996 N = 45
Bird	0	0	0	0
Vegetation	30.0	9.1	3.6	15.6
Coleoptera	10.0	9.1	7.1	4.4
Decapoda	0	0	3.6	2.2
Diptera	0	9.1	7.1	6.7
Ephemeroptera	0	0	14.3	2.2
Hemiptera	0	0	3.6	4.4
Hirudinea	0	0	0	2.2
Hymenoptera	0	0	3.6	0
Nemotoda	0	9.1	0	0
Odonata	10.0	0	0	0
Plecoptera	0	0	17.9	8.9
Trichoptera	10.0	9.1	21.4	6.7
Invertebrates Unid	0	27.3	14.3	4.4
Invertebrates	30.0	45.5	42.9	28.9
Black Bullhead	0	0	0	0
Sculpin	0	0	3.6	2.2
Yellow Perch	0	0	0	0
Pumpkinseed	0	9.1	0	0
Largemouth Bass	0	9.1	0	0
Centrarchids	0	18.2	0	0
Coarsescale Sucker	0	0	10.7	0
Longnose Sucker	10.0	9.1	7.1	0
Sucker Unid	0	0	7.1	0
Catostomids	10.0	9.1	25.0	0
P. oregonensis	20.0	27.3	10.7	0
Peamouth	30.0	9.1	21.4	0
Redside Shiner	0	18.2	3.6	0
Cyprinids	30.0	45.5	39.3	0
Lake Whitefish	0	0	0	4.4
Mountain Whitefish	20.0	9.1	0	4.4
Pygmy Whitefish	0	0	7.1	48.9
Whitefish Unid	10.0	0	3.6	6.7
Eggs	0	0	0	13.3
Coregonids	30.0	9.1	10.7	60.0
Not Trout or Char Unid	10.0	18.2	14.3	4.4
Rainbow Trout	10.0	0	3.6	0
Westslope Cutthroat	0	0	0	2.2
Oncorhynchus spp.	10.0	0	3.6	2.2
Bull Trout	0	0	0	0
Trout or Char Unid	0	18.2	14.3	13.3
Salmonids	40.0	27.3	21.4	64.4
Fish Unid	10.0	9.1	14.3	6.7
Fish	60.0	72.7	67.9	71.1

Table 7. Mean percent composition by number of food items in diets of Flathead River lake trout with 95% confidence intervals in parentheses.

Food Items	All t(0.05, 93 df)	Impounded River t(0.05, 17 df)	Sloughs t(0.05, 11 df)	Flowing River t(0.05, 63 df)
Bird	0	0	0	0
Vegetation	2.2 (0.4-5.3)	4.0 (0.3-19.1)	1.7 (2.4-16.4)	1.8 (0.2-5.3)
Coleoptera	0.2 (0.0-0.8)	0	3.3 (1.3-21.2)	0.1 (0.0-0.5)
Decapoda	0.1 (0.0-0.4)	0.8 (0.9-7.2)	0	0.0 (0.0-0.1)
Diptera	0.4 (0.0-1.3)	2.4 (0.2-12.2)	0.5 (0.8-5.4)	0.1 (0.0-0.7)
Ephemeroptera	0.2 (0.0-0.7)	0.8 (0.9-7.2)	0	0.1 (0.0-0.5)
Hemiptera	0.1 (0.0-0.3)	0	0	0.1 (0.0-0.6)
Hirudinea	0.0 (0.0-0.3)	0	0	0.1 (0.1-0.5)
Hymenoptera	0.0 (0.0-0.0)	0	0	0.0 (0.0-0.0)
Nemotoda	0.0 (0.0-0.3)	0.8 (0.9-7.2)	0	0
Odonata	0.0 (0.0-0.1)	0	0	0.0 (0.0-0.1)
Plecoptera	0.5 (0.0-1.5)	0.1 (0.1-1.1)	0	0.9 (0.0-2.8)
Trichoptera	1.2 (0.2-3.1)	1.7 (0.5-10.6)	0.3 (0.4-2.6)	1.3 (0.1-3.8)
Invertebrate Unid	0.6 (0.0-2.0)	0.8 (0.9-7.2)	5.4 (1.3-21.2)	0.2 (0.0-1.1)
Invertebrates	19.7 (10.1-31.4)	28.9 (4.7-62.9)	34.7 (3.6-77.0)	14.9 (5.5-28.0)
Black Bullhead	0	0	0	0
Sculpin	0.0 (0.0-0.1)	0.3 (0.3-2.7)	0	0.0 (0.0-0.0)
Yellow Perch	0	0	0	0
Pumpkinseed	0.0 (0.0-0.0)	0	0.2 (0.2-1.5)	0
Largemouth Bass	0.0 (0.0-0.0)	0	0.2 (0.2-1.5)	0
Centrarchids	0.0 (0.0-0.1)	0	0.6 (0.1-3.6)	0
Coarsescale Sucker	0.2 (0.0-0.8)	0	0	0.3 (0.0-1.6)
Longnose Sucker	0.1 (0.0-0.4)	0.0 (0.1-0.4)	1.7 (2.4-16.4)	0.0 (0.0-0.1)

Food Items	All t(0.05, 93 df)	Impounded River t(0.05, 17 df)	Sloughs t(0.05, 11 df)	Flowing River t(0.05, 63 df)
Sucker Unid	0.1 (0.0-0.4)	0.1 (0.1-1.1)	0	0.1 (0.1-0.5)
Catostomids	0.9 (0.1-2.6)	0.3 (0.1-1.8)	1.7 (2.4-16.4)	0.9 (0.0-3.3)
P. oregonensis	0.2 (0.0-0.6)	0.3 (0.1-1.8)	2.0 (0.1-9.5)	0.1 (0.0-0.2)
Peamouth	0.5 (0.1-1.2)	2.1 (0.0-8.2)	0.4 (0.6-4.3)	0.2 (0.0-0.8)
Redside Shiner	0.1 (0.0-0.4)	0	0.8 (0.2-4.9)	0.1 (0.1-0.5)
Cyprinids	2.1 (0.6-4.5)	3.0 (0.0-11.5)	15.8 (0.9-44.0)	0.8 (0.0-2.4)
Lake Whitefish	0.0 (0.0-0.1)	0	0	0.1 (0.0-0.3)
Mountain Whitefish	0.3 (0.0-1.0)	1.7 (0.5-10.6)	1.7 (2.4-16.4)	0.0 (0.0-0.1)
Pygmy Whitefish	10.0 (4.0-18.3)	6.7 (0.1-28.3)	0	15.1 (5.9-27.7)
Whitefish Unid	0.1 (0.0-0.3)	0.0 (0.1-0.4)	0	0.1 (0.0-0.5)
Eggs	0.3 (0.0-1.1)	0	0	0.7 (0.0-2.3)
Coregonids	14.7 (7.1-24.3)	16.1 (0.7-45.8)	1.7 (2.4-16.4)	19.8 (9.2-33.2)
Not Trout or Char Unid	0.8 (0.1-2.2)	0.0 (0.1-0.4)	1.1 (0.3-6.8)	1.0 (0.0-3.6)
Rainbow Trout	0.0 (0.0-0.3)	0	0	0.1 (0.0-0.6)
Westslope Cutthroat	0.0 (0.0-0.3)	0	0	0.1 (0.1-0.5)
Oncorhynchus spp.	0.1 (0.0-0.7)	0	0	0.3 (0.0-1.5)
Bull Trout	0	0	0	0
Trout or Char Unid	0.8 (0.1-2.0)	0.1 (0.2-1.1)	1.3 (0.3-7.7)	1.0 (0.1-2.8)
Salmonids	25.0 (14.5-37.2)	18.7 (1.4-48.9)	5.9 (0.4-27.9)	31.6 (17.4-47.7)
Fish Unid	0.7 (0.0-2.1)	1.2 (0.6-8.3)	0.2 (0.2-1.5)	0.7 (0.0-2.6)
Fish	62.0 (48.0-75.1)	51.8 (18.8-83.9)	52.5 (12.3-90.7)	66.6 (49.9-81.4)

Table 8. Mean percent composition by number of food items in Flathead River lake trout diets with 95% confidence intervals in parentheses. Spring was April through June, summer was July through September, and autumn was October through November. No lake trout stomachs were sampled in winter 1995 (January through March 1995) or winter 1996 (December 1995 through March 1996).

Food Items	1995 t(0.05, 9 df)	Spring 1996 t(0.05, 10 df)	Summer 1996 t(0.05, 27 df)	Autumn 1996 t(0.05, 44 df)
Bird	0	0	0	0
Vegetation	24.5 (0.9-81.9)	2.0 (3.1-19.8)	0.1 (0.1-0.5)	2.1 (0.1-6.7)
Coleoptera	2.4 (6.4-29.0)	0.3 (0.5-3.2)	0.2 (0.1-1.3)	0.0 (0.0-0.2)
Decapoda	0	0	0.1 (0.1-0.7)	0.1 (0.1-1.1)
Diptera	0	0.7 (1.0-6.6)	0.6 (0.2-4.0)	0.4 (0.0-1.8)
Ephemeroptera	0	0	1.5 (0.0-6.9)	0.0 (0.0-0.0)
Hemiptera	0	0	0.1 (0.1-0.9)	0.1 (0.0-0.6)
Hirudinea	0	0	0	0.1 (0.1-1.1)
Hymenoptera	0	0	0.0 (0.0-0.1)	0
Nemotoda	0	2.0 (3.1-19.8)	0	0
Odonata	0.6 (1.6-7.9)	0	0	0
Plecoptera	0	0	0.5 (0.0-2.0)	1.0 (0.0-4.1)
Trichoptera	0.6 (1.6-7.9)	0.3 (0.5-3.2)	5.1 0.2-16.2)	0.3 (0.1-1.6)
Invertebrate Unid	0	6.4 (0.7-31.6)	0.3 (0.0-1.3)	0.5 (0.1-2.8)
Invertebrates	9.5 (2.0-48.5)	26.8 (0.9-70.1)	32.6 (10.1-60.7)	13.6 (3.5-28.9)
Black Bullhead	0	0	0	0
Sculpin	0	0	0.0 (0.0-0.2)	0.0 (0.1-0.4)
Yellow Perch	0	0	0	0
Pumpkinseed	0	0.2 (0.3-1.8)	0	0
Largemouth Bass	0	0.2 (0.3-1.8)	0	0
Centrarchids	0	0.7 (0.2-4.4)	0	0

Food Items	1995 t(0.05, 9 df)	Spring 1996 t(0.05, 10 df)	Summer 1996 t(0.05, 27 df)	Autumn 1996 t(0.05, 44 df)
Coarsescale Sucker	0	0	1.7 (0.1-8.4)	0
Longnose Sucker	0.1 (0.3-1.7)	2.0 (3.1-19.8)	0.1 (0.0-0.7)	0
Sucker Unid	0	0	0.6 (0.2-4.0)	0
Catostomids	0.1 (0.3-1.7)	2.0 (3.1-19.8)	5.7 (0.2-17.9)	0
P. oregonensis	1.0 (0.6-7.2)	2.4 (0.1-11.3)	0.3 (0.0-1.2)	0
Peamouth	4.8 (0.7-24.8)	0.5 (0.8-5.2)	1.5 (0.1-4.7)	0
Redside Shiner	0	1.0 (0.3-6.0)	0.3 (0.4-2.9)	0
Cyprinids	7.0 (0.9-34.9)	8.9 (0.4-26.8)	5.3 (0.1-17.8)	0
Lake Whitefish	0	0	0	0.1 (0.0-0.6)
Mountain Whitefish	5.5 (4.1-39.2)	2.0 (3.1-19.8)	0	0.0 (0.0-0.2)
Pygmy Whitefish	0	0	1.3 (0.2-7.2)	32.2 (15.1-52.1)
Whitefish Unid	0.1 (0.3-1.7)	0	0.0 (0.0-0.1)	1.4 (0.0-4.6)
Eggs	0	0	0	0.2 (0.0-0.8)
Coregonids	7.2 (2.6-42.2)	2.0 (3.1-19.8)	1.5 (0.1-7.8)	40.0 (22.1-59.4)
Not Trout or Char Unid	0.1 (0.3-1.7)	1.3 (0.4-8.2)	2.7 (0.0-10.8)	0.2 (0.1-1.3)
Rainbow Trout	2.4 (6.4-29.0)	0	0.0 (0.0-0.1)	0
Westslope Cutthroat	0	0	0	0.1 (0.1-1.1)
Oncorhynchus spp.	2.4 (6.4-29.0)	0	0.0 (0.0-0.1)	0.1 (0.1-1.1)
Bull Trout	0	0	0	0
Trout or Char Unid	0	1.5 (0.4-9.3)	0.8 (0.0-3.2)	1.0 (0.0-3.5)
Salmonids	17.3 (1.3-68.2)	7.0 (0.6-32.8)	4.3 (0.1-14.1)	51.7 (31.7-71.3)
Fish Unid	0.1 (0.3-1.7)	0.2 (0.3-1.8)	2.2 (0.0-9.7)	0.4 (0.0-2.0)
Fish	45.4 (2.5-93.8)	59.8 (16.0-95.5)	65.3 (37.4-88.5)	64.2 (44.1-82.0)

Table 9. Pooled percent composition by weight of food items in Flathead River lake trout diets. N = the number of non-empty stomachs examined.

Food Items	All Sections N = 94	Impounded River N = 18	Sloughs N = 12	Flowing River N = 64
Bird	0	0	0	0
Vegetation	1.1	6.2	0.2	0.2
Coleoptera	0.1	0	0.4	0.1
Decapoda	0.1	0.7	0	0
Diptera	0.0	0.0	0.1	0.0
Ephemeroptera	0.0	0.0	0	0.0
Hemiptera	0.0	0	0	0.0
Hirudinea	0.0	0	0	0.1
Hymenoptera	0.0	0	0	0.0
Nemotoda	0	0	0	0
Odonata	0.1	0	0	0.2
Plecoptera	0.1	0.0	0	0.1
Trichoptera	0.2	0.3	1.0	0.1
Invertebrate Unid	0.3	0	2.3	0.2
Invertebrates	1.0	1.0	3.7	0.8
Black Bullhead	0	0	0	0
Sculpin	0.8	1.1	0	0.8
Yellow Perch	0	0	0	0
Pumpkinseed	0.8	0	13.8	0
Largemouth Bass	0.0	0	0	0
Centrarchids	0.9	0	13.8	0
Coarsescale Sucker	2.0	0	0	2.5
Longnose Sucker	1.6	0.0	25.9	0.0
Sucker Unid	0.9	1.9	0	0.8
Catostomids	4.4	1.9	25.9	3.3
P. oregonensis	3.5	8.6	35.4	0.1
Peamouth	7.2	33.4	0	2.7
Redside Shiner	1.3	0	19.0	0.2
Cyprinids	12.1	42.0	54.4	3.1
Lake Whitefish	0	0	0	0
Mountain Whitefish	7.8	26.4	0	4.8
Pygmy Whitefish	58.0	20.7	0	69.6
Whitefish Unid	0.0	0.0	0	0.0
Eggs	0.5	0	0	0.6
Coregonids	65.8	47.1	0	74.4
Not Trout or Char Unid	0.8	0.2	0.2	1.0
Rainbow Trout	0.2	0	0	0.2
Westslope Cutthroat	10.3	0	0	13.0
Oncorhynchus spp.	10.4	0	0	13.3
Bull Trout	0	0	0	0
Trout or Char Unid	2.0	0.2	1.0	2.4
Salmonids	78.2	47.3	1.0	90.1
Fish Unid	0.3	0.2	0.8	0.3
Fish	97.5	92.8	96.1	98.5

Table 10. Pooled percent composition by weight of food items in Flathead River lake trout. Spring was April through June, summer was July through September, and autumn was October through November. No lake trout stomachs were sampled winter 1995 (January through March 1995) or winter 1996 (December 1995 through March 1996).

Food Items	1995 N = 10	Spring 1996 N = 11	Summer 1996 N = 28	Autumn 1996 N = 45
Bird	0	0	0	0
Vegetation	11.9	0.2	0.1	0.2
Coleoptera	0.1	0.2	0.2	0.0
Decapoda	0	0	0	0.2
Diptera	0	0.1	0.0	0.0
Ephemeroptera	0	0	0.1	0.0
Hemiptera	0	0	0.0	0.0
Hirudinea	0	0	0	0.1
Hymenoptera	0	0	0.1	0
Nemotoda	0	0	0	0
Odonata	0	0	1.0	0
Plecoptera	0	0	0.3	0.1
Trichoptera	0.5	1.0	0.5	0.0
Invertebrate Unid	0	2.3	1.0	0
Invertebrates	0.6	3.6	3.2	0.4
Black Bullhead	0	0	0	0
Sculpin	0	0	4.5	0.2
Yellow Perch	0	0	0	0
Pumpkinseed	0	13.8	0	0
Largemouth Bass	0	0.4	0	0
Centrarchids	0	14.2	0	0
Coarsescale Sucker	0.1	0	14.2	0
Longnose Sucker	0	25.9	0.0	0
Sucker Unid	0	0	6.6	0
Catostomids	0.1	25.9	20.8	0
P. oregonensis	16.5	35.5	0.6	0
Peamouth	18.0	0	42.1	0
Redside Shiner	0	19.0	1.4	0
Cyprinids	34.4	54.5	44.1	0
Lake Whitefish	0	0	0	0
Mountain Whitefish	50.7	0	0	5.3
Pygmy Whitefish	0	0	13.0	77.7
Whitefish Unid	0.1	0	0	0
Eggs	0	0	0	0.7
Coregonids	50.8	0	13.0	83.0
Not Trout or Char Unid	0.5	0.4	5.3	0.0
Rainbow Trout	1.4	0	0.5	0
Westslope Cutthroat	0	0	0	14.2
Oncorhynchus spp.	1.4	0	0.5	14.2
Bull Trout	0	0	0	0
Trout or Char Unid	0	1.3	7.3	1.3
Salmonids	52.2	1.2	20.8	98.4
Fish Unid	0.3	0	1.2	0.1
Fish	87.5	96.2	96.8	98.8

Table 11. Percent frequency of occurrence of food items in Flathead River *Ptychocheilus oregonensis* stomachs. N = number of non-empty stomachs examined.

Food Items	All Sections N = 345	Impounded River N = 66	Sloughs N = 205	Flowing River N = 74
Bird	0.6	0	1.0	0
Vegetation	12.5	16.7	10.7	13.5
Coleoptera	4.4	1.5	3.9	8.1
Decapoda	0.6	1.5	0.5	0
Diptera	4.4	1.5	5.4	4.1
Ephemeroptera	4.1	4.6	3.4	5.4
Gastropoda	0.9	0	1.0	1.4
Hemiptera	1.5	1.5	2.0	1.4
Hirudinea	0.3	0	0	1.4
Hymenoptera	0.9	0	0.5	2.7
Isopoda	0.3	0	0.4	0
Odonata	0.3	0	0	1.4
Plecoptera	11.3	4.6	4.9	36.5
Trichoptera	8.7	1.5	7.3	18.9
Invertebrate Unid	20.3	27.3	16.6	25.7
Invertebrates	45.2	39.4	37.6	78.4
Black Bullhead	0.3	0	0	1.4
Sculpin	4.1	3.0	1.0	14.9
Yellow Perch	25.2	4.6	38.5	5.4
Pumpkinseed	2.3	3.0	2.9	0
Largemouth Bass	0.3	0	0	1.4
Centrarchids	2.6	3.0	2.9	1.4
Coarsescale Sucker	1.5	4.6	0.5	1.4
Longnose Sucker	0.9	1.5	1.0	0
Sucker Unid	2.9	4.6	2.4	2.7
Catostomids	4.9	9.1	3.9	4.1
P. oregonensis	5.5	12.1	2.4	8.1
Peamouth	16.5	21.2	19.0	6.8
Redside Shiner	3.5	7.6	2.4	2.7
Cyprinids	20.9	30.3	21.6	12.2
Lake Whitefish	1.2	1.5	1.5	0
Mountain Whitefish	3.2	9.1	2.0	1.4
Pygmy Whitefish	0.3	1.5	0	0
Whitefish Unid	0.6	1.5	0.5	0
Coregonids	5.2	13.6	3.9	1.4
Not Trout or Char Unid	2.6	4.6	2.0	2.7
Rainbow Trout	0	0	0	0
Westslope Cutthroat	0.3	1.5	0	0
Oncorhynchus spp.	0.3	1.5	0	0
Bull Trout	0.6	0	1.0	0
Trout or Char Unid	0.9	1.5	1.0	0
Salmonids	5.8	15.2	4.4	1.4
Fish Unid	2.3	3.0	2.9	0
Fish	58.3	65.2	65.4	36.5

Table 12. Percent frequency of occurrence of food items in Flathead River *Ptychocheilus oregonensis* stomachs collected in 1995. Winter was January through March, spring was April through June, summer was July through September, and autumn was October through November. N = number of non-empty stomachs examined.

Food Items	Winter 1995 N = 19	Spring 1995 N = 69	Summer 1995 N = 65	Autumn 1995 N = 7
Bird	0	1.5	1.5	0
Vegetation	10.5	4.4	13.9	0
Coleoptera	0	2.9	9.2	14.3
Decapoda	0	1.5	0	0
Diptera	0	0	3.1	0
Ephemeroptera	5.3	1.5	4.6	0
Gastropoda	0	1.5	1.5	0
Hemiptera	0	1.5	3.1	0
Hirudinea	0	0	1.5	0
Hymenoptera	0	0	3.1	0
Isopoda	0	0	0	0
Odonata	0	1.5	0	0
Plecoptera	10.5	8.7	32.3	0
Trichoptera	0	2.9	16.9	0
Invertebrate Unid	15.8	0	30.8	28.6
Invertebrates	21.1	17.4	76.9	42.9
Black Bullhead	0	0	0	0
Sculpin	0	1.5	12.3	0
Yellow Perch	15.8	62.3	6.2	0
Pumpkinseed	0	2.9	0	0
Largemouth Bass	5.3	0	0	0
Centrarchids	5.3	2.9	0	0
Coarsescale Sucker	10.5	0	0	14.3
Longnose Sucker	5.3	0	0	0
Sucker Unid	21.1	2.9	1.5	0
Catostomids	31.6	2.9	1.5	14.3
P. oregonensis	31.6	1.5	7.7	14.3
Peamouth	21.1	31.9	13.9	28.6
Redside Shiner	15.8	2.9	4.6	0
Cyprinids	57.9	33.3	15.4	42.9
Lake Whitefish	0	0	0	0
Mountain Whitefish	5.3	1.5	1.5	0
Pygmy Whitefish	0	0	0	0
Whitefish Unid	0	0	0	0
Coregonids	5.3	1.5	1.5	0
Not Trout or Char Unid	5.3	1.5	3.1	0
Rainbow Trout	0	0	0	0
Westslope Cutthroat	0	0	1.5	0
Oncorhynchus spp.	0	0	1.5	0
Bull Trout	0	1.5	0	0
Trout or Char Unid	0	1.5	0	0
Salmonids	5.3	2.9	3.1	0
Fish Unid	0	0	1.5	0
Fish	89.5	94.2	33.9	57.1

Table 13. Percent frequency of occurrence of food items in Flathead River *Ptychocheilus oregonensis* collected in 1996. Spring was April through June, summer was July through September, and autumn was October through November. Two *P. oregonensis* stomachs were examined winter 1996 (December 1995 through March 1996), both were empty.

Food Items	Spring 1996 N = 86	Summer 1996 N = 76	Autumn 1996 N = 23
Bird	0	0	0
Vegetation	16.3	9.2	34.8
Coleoptera	18.6	4.0	0
Decapoda	3.5	1.3	0
Diptera	0	4.0	0
Ephemeroptera	11.6	4.0	0
Gastropoda	7.0	0	0
Hemiptera	1.2	2.6	0
Hirudinea	1.2	0	0
Hymenoptera	0	1.3	0
Isopoda	1.2	0	0
Odonata	0	0	0
Plecoptera	3.5	7.9	8.7
Trichoptera	12.8	6.6	0
Invertebrate Unid	18.6	34.2	17.4
Invertebrates	48.8	59.2	26.1
Black Bullhead	0	1.3	0
Sculpin	0	5.3	8.7
Yellow Perch	30.2	10.5	0
Pumpkinseed	1.2	4.0	8.7
Largemouth Bass	0	0	0
Centrarchids	1.2	4.0	8.7
Coarsescale Sucker	0	2.6	0
Longnose Sucker	1.2	1.3	0
Sucker Unid	2.3	1.3	0
Catostomids	3.5	5.3	0
P. oregonensis	3.5	2.6	4.4
Peamouth	11.6	7.9	21.7
Redside Shiner	2.3	1.3	4.4
Cyprinids	15.1	11.8	21.7
Lake Whitefish	2.3	1.3	4.4
Mountain Whitefish	1.2	6.6	8.7
Pygmy Whitefish	0	0	4.4
Whitefish Unid	1.2	0	4.4
Coregonids	4.7	7.9	21.7
Not Trout or Char Unid	2.3	2.6	4.4
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	1.2	0	0
Trout or Char Unid	1.2	0	4.4
Salmonids	4.7	7.9	21.7
Fish Unid	0	4.0	17.4
Fish	51.2	44.7	60.9

Table 14. Mean percent composition by number of each food type from Flathead River *Ptychocheilus oregonensis* stomachs, with 95% confidence intervals in parentheses.

Food Items	All Sections z(0.05)	Impounded River t(0.05, 65 df)	Sloughs z(0.05)	Flowing River t(0.05, 73 df)
Bird	0.0 (0.0-0.0)	0	0.0 (0.0-0.0)	0
Vegetation	1.8 (0.8-3.0)	4.4 (0.7-10.8)	1.4 (0.5-2.9)	1.0 (0.1-3.0)
Coleoptera	0.2 (0.1-0.6)	0.1 (0.1-0.5)	0.2 (0.0-0.6)	0.7 (0.0-2.5)
Decapoda	0.0 (0.0-0.0)	0.0 (0.0-0.1)	0.0 (0.0-0.0)	0
Diptera	0.3 (0.1-0.6)	0.1 (0.1-0.5)	0.4 (0.1-1.1)	0.2 (0.0-0.8)
Ephemeroptera	0.1 (0.0-0.2)	0.2 (0.0-0.8)	0.1 (0.0-0.3)	0.1 (0.0-0.4)
Gastropoda	0.0 (0.0-0.0)	0	0	0.0 (0.0-0.2)
Hemiptera	0.0 (0.0-0.1)	0.1 (0.1-0.5)	0.0 (0.0-0.1)	0.0 (0.0-0.0)
Hirudinea	0.0 (0.0-0.0)	0	0	0.0 (0.0-0.0)
Hymenoptera	0.0 (0.0-0.0)	0	0.0 (0.0-0.0)	0.0 (0.0-0.2)
Isopoda	0.0 (0.0-0.0)	0	0.0 (0.0-0.0)	0
Odonata	0.0 (0.0-0.0)	0	0	0.0 (0.0-0.4)
Plecoptera	1.3 (0.6-2.2)	0.1 (0.0-0.4)	0.2 (0.0-0.6)	13.6 (5.9-23.7)
Trichoptera	1.0 (0.4-1.8)	0.0 (0.0-0.2)	0.8 (0.2-1.8)	3.7 (0.9-8.5)
Invertebrate Unid	6.5 (4.0-9.6)	10.5 (3.3-20.9)	4.6 (2.1-8.0)	9.3 (3.0-18.6)
Invertebrates	34.6 (27.6-41.8)	22.1 (10.2-37.0)	24.8 (17.1-33.4)	75.2 (61.5-86.8)
Black Bullhead	0.0 (0.0-0.0)	0	0	0.0 (0.0-0.1)
Sculpin	0.2 (0.0-0.3)	0.1 (0.0-0.4)	0.0 (0.0-0.0)	1.8 (0.3-4.6)
Yellow Perch	9.5 (6.2-13.5)	0.3 (0.0-12.5)	22.7 (15.5-31.0)	0.1 (0.0-0.5)
Pumpkinseed	0.1 (0.0-0.2)	0.2 (0.0-1.3)	0.1 (0.0-0.2)	0
Largemouth Bass	0.0 (0.0-0.0)	0	0	0.0 (0.0-0.1)

Food Items	All Sections z(0.05)	Impounded River t(0.05, 65 df)	Sloughs z(0.05)	Flowing River t(0.05, 73 df)
Centrarchids	0:1 (0.0-0.2)	0.2 (0.0-1.3)	0.1 (0.0-0.2)	0.0 (0.0-0.1)
Coarsescale Sucker	0.0 (0.0-0.1)	0.4 (0.0-1.7)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Longnose Sucker	0.0 (0.0-0.1)	0.0 (0.0-0.1)	0.0 (0.0-0.1)	0
Sucker Unid	0.1 (0.0-0.3)	0.2 (0.0-0.9)	0.1 (0.0-0.3)	0.1 (0.0-0.6)
Catostomids	0.4 (0.1-0.8)	1.2 (0.0-4.3)	0.3 (0.0-0.7)	0.1 (0.0-0.7)
P. oregonensis	0.3 (0.1-0.7)	1.0 (0.1-3.1)	0.1 (0.0-0.3)	1.0 (0.0-3.1)
Peamouth	3.5 (2.0-5.5)	5.6 (1.3-12.7)	4.5 (2.2-7.6)	0.5 (0.0-1.9)
Redside Shiner	0.1 (0.0-0.3)	0.5 (0.0-2.0)	0.0 (0.0-0.2)	0.1 (0.0-0.6)
Cyprinids	7.0 (4.3-10.2)	15.1 (5.6-28.1)	6.6 (3.4-10.6)	2.9 (0.4-7.8)
Lake Whitefish	0.0 (0.0-0.1)	0.1 (0.1-0.5)	0.0 (0.0-0.2)	0
Mountain Whitefish	0.2 (0.0-0.4)	1.1 (0.0-3.8)	0.1 (0.0-0.3)	0.0 (0.0-0.0)
Pygmy Whitefish	0.0 (0.0-0.0)	0.0 (0.0-0.1)	0	0
Whitefish Unid	0.0 (0.0-0.0)	0.0 (0.0-0.1)	0.0 (0.0-0.1)	0
Coregonids	0.4 (0.1-0.8)	2.3 (0.2-6.3)	0.3 (0.0-0.8)	0.0 (0.0-0.0)
Not Trout or Char Unid	0.1 (0.0-0.2)	0.1 (0.0-0.4)	0.0 (0.0-0.1)	0.1 (0.0-0.6)
Rainbow Trout	0	0	0	0
Westslope Cutthroat	0.0 (0.0-0.0)	0.1 (0.1-0.5)	0	0
Oncorhynchus spp.	0.0 (0.0-0.0)	0.1 (0.1-0.5)	0	0
Bull Trout	0.0 (0.0-0.0)	0	0.0 (0.0-0.0)	0
Trout or Char Unid	0.0 (0.0-0.0)	0.0 (0.0-0.1)	0.0 (0.0-0.03)	0
Salmonids	0.5 (0.2-1.1)	3.2 (0.5-8.3)	0.4 (0.1-1.1)	0.0 (0.0-0.0)
Fish Unid	0.1 (0.0-0.2)	0.1 (0.0-0.8)	0.1 (0.0-0.3)	0
Fish	52.5 (44.7-60.2)	59.0 (41.1-75.8)	63.9 (54.0-73.2)	17.4 (7.9-29.6)

Table 15. Mean percent composition by number with 95% confidence interval in parentheses for each food type found in Flathead River *Ptychocheilus oregonensis* stomachs. Winter was December through March, spring was April through June, summer was July through September, and autumn was October through November.

Food Items	Winter 1995 t(0.05, 18 df)	Spring 1995 t(0.05, 67 df)	Summer 1995 t(0.05, 62 df)	Autumn 1995 t(0.05, 6 df)
Bird	0	0.0 (0.0-0.1)	0.0 (0.0-0.0)	0
Vegetation	1.3 (0.5-8.6)	0.2 (0.0-0.8)	1.2 (0.1-3.8)	0
Coleoptera	0	0.0 (0.0-0.3)	1.0 (0.0-3.4)	4.9 (10.1-48.7)
Decapoda	0	0.0 (0.0-0.1)	0	0
Diptera	0	0	0.0 (0.0-0.1)	0
Ephemeroptera	0.1 (0.1-0.5)	0.0 (0.0-0.1)	0.1 (0.0-0.3)	0
Gastropoda	0	0.0 (0.0-0.1)	0.0 (0.0-0.2)	0
Hemiptera	0	0.0 (0.0-0.1)	0.1 (0.0-0.7)	0
Hirudinea	0	0	0.0 (0.0-0.0)	0
Hymenoptera	0	0	0.1 (0.0-0.3)	0
Isopoda	0	0	0	0
Odonata	0	0.1 (0.1-0.5)	0	0
Plecoptera	0.5 (0.1-3.2)	0.5 (0.0-1.9)	10.7 (3.6-21.1)	0
Trichoptera	0	0.1 (0.0-0.7)	3.3 (0.7-7.7)	0
Invertebrate Unid	0.9 (0.0-4.3)	0	15.3 (5.6-28.8)	18.8 (6.6-84.0)
Invertebrates	3.5 (0.0-14.5)	3.1 (0.6-7.5)	76.4 (61.0-88.9)	38.9 (1.1-98.5)
Black Bullhead	0	0	0	0
Sculpin	0	0.0 (0.0-0.1)	0.9 (0.1-2.9)	0
Yellow Perch	1.0 (0.0-4.5)	57.5 (40.6-73.5)	0.3 (0.0-1.3)	0
Pumpkinseed	0	0.1 (0.0-0.7)	0	0
Largemouth Bass	0.1 (0.2-1.2)	0	0	0

Food Items	Winter 1995 t(0.05, 18 df)	Spring 1995 t(0.05, 67 df)	Summer 1995 t(0.05, 62 df)	Autumn 1995 t(0.05, 6 df)
Centrarchids	0.1 (0.2-1.2)	0.1 (0.0-0.7)	0	0
Coarsescale Sucker	0.4 (0.1-2.7)	0	0	4.9 (10.1-48.7)
Longnose Sucker	0.2 (0.2-1.6)	0	0	0
Sucker Unid	5.6 (0.0-22.1)	0.1 (0.0-0.7)	0.0 (0.0-0.0)	0
Catostomids	11.5 (0.4-34.9)	0.1 (0.0-0.7)	0.0 (0.0-0.0)	4.9 (10.1-48.7)
P. oregonensis	12.0 (0.4-35.8)	0.0 (0.0-0.2)	0.2 (0.0-0.6)	4.9 (10.1-48.7)
Peamouth	3.9 (0.0-15.7)	11.4 (4.2-21.4)	1.7 (0.2-4.7)	18.8 (6.6-84.0)
Redside Shiner	6.0 (0.1-25.7)	0.0 (0.0-0.2)	0.1 (0.0-0.3)	0
Cyprinids	50.0 (17.2-82.7)	13.5 (5.2-24.8)	3.1 (0.3-8.5)	38.9 (1.1-98.5)
Lake Whitefish	0	0	0	0
Mountain Whitefish	0.1 (0.1-0.6)	0.1 (0.1-0.5)	0.1 (0.1-0.6)	0
Pygmy Whitefish	0	0	0	0
Whitefish Unid	0	0	0	0
Coregonids	0.1 (0.1-0.6)	0.1 (0.1-0.5)	0.1 (0.1-0.6)	0
Not Trout or Char Unid	0.1 (0.1-1.0)	0.0 (0.0-0.1)	0.0 (0.0-0.2)	0
Rainbow Trout	0	0	0	0
Westslope Cutthroat	0	0	0.1 (0.1-0.6)	0
Oncorhynchus spp.	0	0	0.1 (0.1-0.6)	0
Bull Trout	0	0.0 (0.0-0.0)	0	0
Trout or Char Unid	0	0.0 (0.0-0.2)	0	0
Salmonids	0.1 (0.1-0.6)	0.2 (0.0-0.9)	0.3 (0.0-1.4)	0
Fish Unid	0	0	0.0 (0.0-0.1)	0
Fish	91.8 (72.7-99.9)	95.0 (89.2-98.7)	15.2 (5.8-28.1)	61.2 (1.5-99.0)

Table 16. Mean percent composition by number with 95% confidence intervals for each food type in Flathead River *Ptychocheilus oregonensis* stomachs. Spring was April to June, summer was July through September, and autumn was October through November. Two empty stomachs were examined winter 1996 (December 1995 to March 1996).

Food Items	Spring 1996 t(0.05, 86 df)	Summer 1996 t(0.05, 77 df)	Autumn 1996 t(0.05, 22 df)
Bird	0	0	0
Vegetation	3.4 (0.7-8.0)	0.7 (0.0-2.3)	21.7 (3.2-50.5)
Coleoptera	0.2 (0.0-0.9)	0.3 (0.0-1.3)	0
Decapoda	0	0.0 (0.0-0.1)	0
Diptera	1.9 (0.3-4.9)	0.5 (0.0-2.0)	0
Ephemeroptera	0.4 (0.0-1.2)	0.2 (0.0-0.7)	0
Gastropoda	0.0 (0.0-0.3)	0	0
Hemiptera	0.0 (0.0-0.0)	0.1 (0.0-0.6)	0
Hirudinea	0	0	0
Hymenoptera	0	0.0 (0.0-0.0)	0
Isopoda	0.0 (0.0-0.0)	0	0
Odonata	0	0	0
Plecoptera	0.1 (0.0-0.3)	1.0 (0.1-3.0)	0.3 (0.1-1.8)
Trichoptera	1.9 (0.3-4.8)	0.7 (0.0-2.4)	0.5 (0.5-4.3)
Invertebrate Unid	4.7 (1.2-10.2)	19.0 (8.6-32.4)	3.9 (0.0-15.5)
Invertebrates	37.6 (23.5-52.9)	56.4 (40.0-72.1)	6.2 (0.2-20.0)
Black Bullhead	0	0.0 (0.0-0.1)	0
Sculpin	0	0.4 (0.0-1.3)	0.6 (0.1-3.4)
Yellow Perch	13.5 (5.7-23.8)	2.3 (0.2-6.3)	0
Pumpkinseed	0.0 (0.0-0.0)	0.1 (0.0-0.4)	1.9 (0.4-10.7)
Largemouth Bass	0	0	0
Centrarchids	0.0 (0.0-0.0)	0.1 (0.0-0.4)	1.9 (0.4-10.7)
Coarsescale Sucker	0	0.1 (0.0-0.7)	0
Longnose Sucker	0.0 (0.0-0.3)	0.0 (0.0-0.4)	0
Sucker Unid	0.1 (0.0-0.5)	0.0 (0.0-0.4)	0
Catostomids	0.2 (0.0-1.0)	0.5 (0.0-2.1)	0
P. oregonensis	0.9 (0.0-0.9)	0.2 (0.0-1.1)	0.1 (0.1-0.6)
Peamouth	2.5 (0.4-6.3)	1.1 (0.0-3.5)	4.0 (0.0-14.1)
Redside Shiner	0.0 (0.0-0.2)	0.0 (0.0-0.4)	0.0 (0.0-0.3)
Cyprinids	4.7 (1.2-10.4)	2.3 (0.3-6.2)	4.9 (0.1-16.7)
Lake Whitefish	0.1 (0.0-0.4)	0.0 (0.0-0.4)	0.5 (0.5-4.3)
Mountain Whitefish	0.0 (0.0-0.1)	0.7 (0.0-2.4)	0.9 (0.3-5.9)
Pygmy Whitefish	0	0	0.1 (0.1-0.7)
Whitefish Unid	0.0 (0.0-0.3)	0	0.1 (0.1-1.1)
Coregonids	0.3 (0.0-1.2)	1.0 (0.0-3.4)	4.9 (0.0-17.6)
Not Trout or Char Unid	0.1 (0.0-0.5)	0.1 (0.0-0.6)	0.1 (0.1-0.7)
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0.0 (0.0-0.0)	0	0
Trout or Char Unid	0.0 (0.0-0.0)	0	0.1 (0.1-0.7)
Salmonids	0.4 (0.0-1.6)	1.0 (0.0-3.4)	5.6 (0.1-19.5)
Fish Unid	0	0.3 (0.0-1.2)	2.1 (0.0-9.3)
Fish	43.9 (28.5-60.0)	35.3 (20.7-51.4)	56.0 (24.9-84.8)

Table 17. Mean percent composition by number with 95% confidence interval in parentheses for each food type from Flathead River *Ptychocheilus oregonensis* stomachs.

Food Items	1995 t(0.5, 156 df)	1996 t(0.05, 187 df)
Bird	0.0 (0.0-0.0)	0
Vegetation	0.6 (0.1-1.5)	3.2 (1.3-6.0)
Coleoptera	0.3 (0.0-1.0)	0.2 (0.0-0.6)
Decapoda	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Diptera	0.0 (0.0-0.0)	0.9 (0.2-2.0)
Ephemeroptera	0.0 (0.0-0.1)	0.2 (0.0-0.5)
Gastropoda	0.0 (0.0-0.1)	0.0 (0.0-0.1)
Hemiptera	0.0 (0.0-0.1)	0.0 (0.0-0.1)
Hirudinea	0.0 (0.0-0.0)	0
Hymenoptera	0.0 (0.0-0.1)	0.0 (0.0-0.0)
Isopoda	0	0.0 (0.0-0.0)
Odonata	0.0 (0.0-0.1)	0
Plecoptera	3.0 (1.2-5.7)	0.4 (0.1-1.0)
Trichoptera	0.8 (0.2-1.8)	1.1 (0.3-2.4)
Invertebrate Unid	3.7 (1.4-7.1)	9.4 (5.1-14.9)
Invertebrates	27.9 (18.7-38.0)	40.4 (30.5-50.7)
Black Bullhead	0	0.0 (0.0-0.0)
Sculpin	0.2 (0.0-0.5)	0.1 (0.0-0.4)
Yellow Perch	15.7 (9.2-23.4)	5.5 (2.5-9.5)
Pumpkinseed	0.0 (0.0-00.1)	0.1 (0.0-0.3)
Largemouth Bass	0.0 (0.0-0.0)	0
Centrarchids	0.0 (0.0-0.2)	0.1 (0.0-0.3)
Coarsescale Sucker	0.0 (0.0-0.2)	0.0 (0.0-0.1)
Longnose Sucker	0.0 (0.0-0.0)	0.0 (0.0-0.2)
Sucker Unid	0.2 (0.0-0.7)	0.0 (0.0-0.2)
Catostomids	0.5 (0.1-1.3)	0.3 (0.0-0.8)
P. oregonensis	0.6 (0.1-1.4)	0.2 (0.0-0.6)
Peamouth	5.9 (2.8-10.0)	2.0 (0.7-3.9)
Redside Shiner	0.2 (0.0-0.7)	0.0 (0.0-0.2)
Cyprinids	12.3 (6.8-19.3)	3.6 (1.5-6.6)
Lake Whitefish	0	0.1 (0.0-0.3)
Mountain Whitefish	0.1 (0.0-0.3)	0.3 (0.0-0.8)
Pygmy Whitefish	0	0.0 (0.0-0.0)
Whitefish Unid	0	0.0 (0.0-0.1)
Coregonids	0.1 (0.0-0.3)	0.9 (0.2-2.1)
Not Trout or Char Unid	0.0 (0.0-0.1)	0.1 (0.0-0.3)
Rainbow Trout	0	0
Westslope Cutthroat	0.0 (0.0-0.1)	0
Oncorhynchus spp.	0.0 (0.0-0.1)	0
Bull Trout	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Trout or Char Unid	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Salmonids	0.2 (0.0-0.6)	1.0 (0.3-2.4)
Fish Unid	0.0 (0.0-0.0)	0.2 (0.0-0.5)
Fish	65.10 (54.2-75.3)	41.8 (31.6-52.3)

Table 18. Pooled percent composition by weight of food items from Flathead River *Ptychocheilus oregonensis* stomachs. N = the number of non-empty stomachs examined.

Food Items	All Sections N = 345	Impounded River N = 205	Sloughs N = 66	Flowing River N = 74
Bird	0.7	0	1.1	0
Vegetation	1.2	1.5	1.1	1.0
Coleoptera	0.0	0.0	0.0	0.1
Decapoda	1.2	4.6	0.1	0
Diptera	0.0	0.0	0.0	0.0
Ephemeroptera	0.0	0.0	0.0	0.1
Gastropoda	0.1	0	0.1	0.1
Hemiptera	0.0	0.0	0.0	0.0
Hirudinea	0.0	0	0	0.0
Hymenoptera	0	0	0	0
Isopoda	0.0	0	0.0	0
Odonata	0.0	0	0	0.3
Plecoptera	0.2	0.1	0.1	1.0
Trichoptera	0.1	0.0	0.1	0.3
Invertebrate Unid	0.3	0.4	0.2	0.5
Invertebrates	2.0	5.1	0.6	2.5
Black Bullhead	0.1	0	0	0.6
Sculpin	0.4	0.3	0.0	2.7
Yellow Perch	19.1	1.7	28.8	8.0
Pumpkinseed	3.4	3.1	4.2	0
Largemouth Bass	0.0	0	0	0.1
Centrarchids	3.4	3.1	4.2	0.1
Coarsescale Sucker	2.3	8.5	0.0	0.2
Longnose Sucker	0.7	0.1	1.0	0
Sucker Unid	0.6	0.4	0.7	0.5
Catostomids	3.5	9.1	1.8	0.7
P. oregonensis	4.3	3.8	3.0	12.4
Peamouth	47.2	58.7	39.9	59.0
Redside Shiner	2.6	2.2	2.3	5.0
Cyprinids	54.1	64.7	45.1	76.4
Lake Whitefish	3.4	0	5.5	0
Mountain Whitefish	9.1	10.2	8.8	8.1
Pygmy Whitefish	0	0	0	0
Whitefish Unid	0.3	0.2	0.5	0
Coregonids	12.8	10.4	14.8	8.1
Not Trout or Char Unid	0.4	1.0	0.3	0.1
Rainbow Trout	0	0	0	0
Westslope Cutthroat	0.6	2.1	0	0
Oncorhynchus spp.	0.6	2.1	0	0
Bull Trout	0.7	0	1.1	0
Trout or Char Unid	0.3	0.2	0.4	0
Salmonids	14.3	12.7	16.2	8.1
Fish Unid	0.7	0.9	0.8	0
Fish	96.1	93.4	97.2	96.5

Table 19. Pooled percent composition by weight of food items from Flathead River *Ptychocheilus oregonensis* stomachs collected in 1995. Winter was January through March, spring was April through June, summer was July through September, and autumn was October through November.

Food Items	Winter 1995	Spring 1995	Summer 1995	Autumn 1995
Bird	0	0.7	3.1	0
Vegetation	0.9	0.1	0.7	0
Coleoptera	0	0.0	0.1	0.1
Decapoda	0	0.1	0	0
Diptera	0	0	0.0	0
Ephemeroptera	0.0	0.0	0.1	0
Gastropoda	0	0.0	0.0	0
Hemiptera	0	0.0	0.0	0
Hirudinea	0	0	0.0	0
Hymenoptera	0	0	0	0
Isopoda	0	0	0	0
Odonata	0	0.1	0	0
Plecoptera	0.5	0.1	0.6	0
Trichoptera	0	0.1	0.2	0
Invertebrate Unid	0.1	0	0.5	0
Invertebrates	0.6	0.5	1.6	0.1
Black Bullhead	0	0	0	0
Sculpin	0	0.0	1.8	0
Yellow Perch	20.6	35.4	2.5	0
Pumpkinseed	0	3.0	0	0
Largemouth Bass	0.3	0	0	0
Centrarchids	0.2	3.0	0	0
Coarsescale Sucker	1.6	0	0	12.3
Longnose Sucker	0.6	0	0	0
Sucker Unid	2.0	0.6	0.5	0
Catostomids	4.2	0.6	0.5	12.3
P. oregonensis	31.8	0.5	5.4	0.9
Peamouth	11.2	53.1	71.0	86.7
Redside Shiner	9.2	1.1	4.6	0
Cyprinids	52.1	54.7	81.0	87.6
Lake Whitefish	0	0	0	0
Mountain Whitefish	21.4	3.7	3.0	0
Pygmy Whitefish	0	0	0	0
Whitefish Unid	0	0	0	0
Coregonids	21.4	3.7	3.0	0
Not Trout or Char Unid	0	0.4	1.8	0
Rainbow Trout	0	0	0	0
Westslope Cutthroat	0	0	3.5	0
Oncorhynchus spp.	0	0	3.5	0
Bull Trout	0	0.9	0	0
Trout or Char Unid	0	0.1	0	0
Salmonids	21.4	4.7	6.6	0
Fish Unid	0	0	0.5	0
Fish	98.5	98.7	94.6	99.9

Table 20. Pooled percent composition by weight of food items from Flathead River *Ptychocheilus oregonensis* stomachs collected in 1996. Spring was April through June, summer was July through September, and autumn was October through November. Two *P. oregonensis* stomachs were examined in winter 1996 (December 1995 through March 1996), both were empty.

Food Items	Spring 1996	Summer 1996	Autumn 1996
Bird	0	0	0
Vegetation	2.4	1.0	3.8
Coleoptera	0.0	0.1	0
Decapoda	0	8.5	0
Diptera	0.1	0.0	0
Ephemeroptera	0.0	0.0	0
Gastropoda	0.2	0	0
Hemiptera	0.0	0.0	0
Hirudinea	0	0	0
Hymenoptera	0	0	0
Isopoda	0.0	0	0
Odonata	0	0	0
Plecoptera	0.0	0.2	0.0
Trichoptera	0.2	0.1	0
Invertebrate Unid	0.2	0.7	1.0
Invertebrates	0.7	9.5	1.0
Black Bullhead	0	0.5	0
Sculpin	0	0.4	1.1
Yellow Perch	28.0	5.3	0
Pumpkinseed	0.0	11.9	1.1
Largemouth Bass	0	0	0
Centrarchids	0.0	11.9	10.8
Coarsescale Sucker	0	11.3	0
Longnose Sucker	2.6	0	0
Sucker Unid	0.7	0.6	0
Catostomids	3.3	12.0	0
P. oregonensis	4.9	0	8.5
Peamouth	24.3	38.8	62.9
Redside Shiner	3.8	0.0	2.6
Cyprinids	33.0	38.9	74.0
Lake Whitefish	14.0	0	0
Mountain Whitefish	14.9	19.8	1.1
Pygmy Whitefish	0	0	0
Whitefish Unid	1.2	0	0.6
Coregonids	30.0	19.8	1.7
Not Trout or Char Unid	0.1	0.1	0.1
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	1.7	0	0
Trout or Char Unid	0.8	0	0.5
Salmonids	32.5	19.8	2.3
Fish Unid	0	0.9	7.0
Fish	96.9	89.6	95.2

Table 21. Food habits of Flathead River *Ptychocheilus oregonensis* less than 150 mm long. Of 48 stomachs collected, 62.50% were empty.

Food Items	Percent Frequency of Occurrence N = 18	Mean Percent Composition by Number t(0.05, 17 df)	Pooled Percent Composition By Weight
Bird	0	0	0
Vegetation	5.6	0.8 (0.9-7.2)	0
Coleoptera	5.6	0.8 (0.9-7.2)	13.3
Decapoda	0	0	0
Diptera	11.1	0.6 (0.1-3.6)	3.6
Ephemeroptera	0	0	0
Gastropoda	0	0	0
Hemiptera	5.6	0.8 (0.9-7.2)	0.2
Hirudinea	0	0	0
Hymenoptera	0	0	0
Isopoda	0	0	0
Odonata	0	0	0
Plecoptera	11.1	1.2 (0.6-8.6)	3.1
Trichoptera	11.1	0.8 (0.2-4.5)	1.6
Invertebrate Unid	55.6	58.7 (20.9-91.3)	62.6
Invertebrates	83.3	97.0 (82.8-99.4)	84.4
Black Bullhead	0	0	0
Sculpin	0	0	0
Yellow Perch	0	0	0
Pumpkinseed	0	0	0
Largemouth Bass	0	0	0
Centrarchids	0	0	0
Coarsescale Sucker	0	0	0
Longnose Sucker	0	0	0
Sucker Unid	0	0	0
Catostomids	0	0	0
P. oregonensis	0	0	0
Peamouth	0	0	0
Redside Shiner	5.6	0.8 (0.9-7.2)	15.6
Cyprinids	5.6	0.8 (0.9-7.2)	15.6
Lake Whitefish	0	0	0
Mountain Whitefish	0	0	0
Pygmy Whitefish	0	0	0
Whitefish Unid	0	0	0
Coregonids	0	0	0
Not Trout or Char Unid	0	0	0
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0	0	0
Trout or Char Unid	0	0	0
Salmonids	0	0	0
Fish Unid	0	0	0
Fish	5.6	0.8 (0.9-7.2)	15.6

Table 22. Food habits of Flathead River *Ptychocheilus oregonensis* 151-200 mm long. Of 111 stomachs collected, 55.86% were empty.

Food Items	Percent Frequency of Occurrence N = 49	Mean Percent Composition by Number t(0.05, 48 df)	Pooled Percent Composition By Weight
Bird	0	0	0
Vegetation	8.2	0.5 (0.0-2.1)	13.7
Coleoptera	18.4	4.3 (0.4-11.8)	10.4
Decapoda	0	0	0
Diptera	12.2	2.3 (0.1-7.5)	1.2
Ephemeroptera	8.2	0.5 (0.0-1.9)	7.8
Gastropoda	0	0	0
Hemiptera	0	0	0
Hirudinea	0	0	0
Hymenoptera	2.0	0.0 (0.0-0.1)	0
Isopoda	0	0	0
Odonata	0	0	0
Plecoptera	14.3	1.9 (0.1-6.3)	8.9
Trichoptera	22.5	7.3 (1.4-17.3)	9.3
Invertebrate Unid	40.8	26.4 (10.8-46.0)	37.5
Invertebrates	87.8	96.2 (89.0-99.7)	75.0
Black Bullhead	0	0	0
Sculpin	0	0	0
Yellow Perch	6.1	0.9 (0.0-4.2)	11.2
Pumpkinseed	0	0	0
Largemouth Bass	0	0	0
Centrarchids	0	0	0
Coarsescale Sucker	0	0	0
Longnose Sucker	0	0	0
Sucker Unid	0	0	0
Catostomids	0	0	0
P. oregonensis	2.0	0.4 (0.1-2.4)	0
Peamouth	0	0	0
Redside Shiner	0	0	0
Cyprinids	2.0	0.1 (0.1-0.9)	0
Lake Whitefish	0	0	0
Mountain Whitefish	0	0	0
Pygmy Whitefish	0	0	0
Whitefish Unid	0	0	0
Coregonids	0	0	0
Not Trout or Char Unid	0	0	0
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0	0	0
Trout or Char Unid	0	0	0
Salmonids	0	0	0
Fish Unid	0	0	0
Fish	8.2	1.6 (0.0-6.3)	11.2

Table 23. Food habits of Flathead River *Ptychocheilus oregonensis* 201-250 mm long. Of 108 stomachs collected, 60.19% were empty.

Food Items	Percent Frequency of Occurrence N = 43	Mean Percent Composition by Number t(0.05, 42 df)	Pooled Percent Composition By Weight
Bird	0	0	0
Vegetation	18.6	2.6 (0.1-10.4)	9.8
Coleoptera	0	0	0
Decapoda	0	0	0
Diptera	2.3	0.1 (0.1-1.2)	0.0
Ephemeroptera	9.3	0.6 (0.0-2.5)	0.3
Gastropoda	2.3	0.1 (0.1-0.5)	1.1
Hemiptera	2.3	0.0 (0.0-0.1)	0.0
Hirudinea	2.3	0.0 (0.0-0.1)	0.6
Hymenoptera	4.7	0.1 (0.0-0.6)	0
Isopoda	0	0	0
Odonata	0	0	0
Plecoptera	23.3	9.0 (1.6-21.5)	9.8
Trichoptera	16.3	3.0 (0.2-9.0)	5.7
Invertebrate Unid	34.9	12.8 (3.4-27.1)	13.7
Invertebrates	72.1	67.0 (46.6-84.6)	31.1
Black Bullhead	0	0	0
Sculpin	9.3	0.7 (0.0-3.1)	7.3
Yellow Perch	14.0	3.3 (0.1-10.5)	39.1
Pumpkinseed	2.3	0.0 (0.0-0.3)	0.6
Largemouth Bass	0	0	0
Centrarchids	2.3	0.0 (0.0-0.3)	0.6
Coarsescale Sucker	2.3	0.1 (0.1-0.5)	3.4
Longnose Sucker	0	0	0
Sucker Unid	0	0	0
Catostomids	2.3	0.1 (0.1-0.5)	3.4
P. oregonensis	0	0	0
Peamouth	4.7	0.3 (0.1-1.9)	6.1
Redside Shiner	2.3	0.1 (0.1-1.2)	0.6
Cyprinids	7.0	0.8 (0.0-3.9)	6.7
Lake Whitefish	0	0	0
Mountain Whitefish	0	0	0
Pygmy Whitefish	0	0	0
Whitefish Unid	0	0	0
Coregonids	0	0	0
Not Trout or Char Unid	4.7	0.3 (0.1-1.9)	2.2
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0	0	0
Trout or Char Unid	0	0	0
Salmonids	0	0	0
Fish Unid	0	0	0
Fish	34.9	19.5 (6.2-37.9)	59.1

Table 24. Food habits of Flathead River *Ptychocheilus oregonensis* 251-300 mm long. Of 111 stomachs collected, 53.15% were empty.

Food Items	Percent Frequency of Occurrence N = 52	Mean Percent Composition by Number t(0.05, 51 df)	Pooled Percent Composition By Weight
Bird	0	0	0
Vegetation	25.0	7.6 (1.6-17.5)	30.2
Coleoptera	3.9	0.2 (0.1-1.1)	0.2
Decapoda	0	0	0
Diptera	9.6	1.4 (0.0-4.9)	0.7
Ephemeroptera	3.9	0.1 (0.0-0.4)	0.1
Gastropoda	0	0	0
Hemiptera	1.9	0.0 (0.0-0.0)	0.0
Hirudinea	0	0	0
Hymenoptera	0	0	0
Isopoda	0	0	0
Odonata	0	0	0
Plecoptera	11.5	0.7 (0.0-2.3)	1.3
Trichoptera	3.9	0.1 (0.0-0.7)	1.2
Invertebrate Unid	36.5	19.2 (7.1-35.4)	5.4
Invertebrates	63.5	46.7 (28.9-65.0)	8.8
Black Bullhead	0	0	0
Sculpin	13.5	1.7 (0.1-5.1)	11.3
Yellow Perch	11.5	1.9 (0.1-6.3)	11.5
Pumpkinseed	3.9	0.0 (0.0-0.3)	0.3
Largemouth Bass	0	0	0
Centrarchids	3.9	0.0 (0.0-0.3)	0.3
Coarsescale Sucker	1.9	0.0 (0.0-0.2)	2.6
Longnose Sucker	1.9	0.0 (0.0-0.2)	1.3
Sucker Unid	0	0	0
Catostomids	1.9	0.1 (0.1-0.8)	3.9
P. oregonensis	7.7	0.5 (0.0-2.2)	13.3
Peamouth	5.8	0.2 (0.0-0.8)	3.2
Redside Shiner	3.9	0.2 (0.1-1.2)	11.2
Cyprinids	13.5	2.4 (0.1-7.5)	27.7
Lake Whitefish	0	0	0
Mountain Whitefish	3.9	0.1 (0.0-0.3)	3.9
Pygmy Whitefish	0	0	0
Whitefish Unid	1.9	0.0 (0.0-0.2)	2.2
Coregonids	5.8	0.2 (0.0-0.7)	6.1
Not Trout or Char Unid	1.9	0.0 (0.0-0.1)	0
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0	0	0
Trout or Char Unid	0	0	0
Salmonids	5.8	0.2 (0.0-1.0)	6.1
Fish Unid	1.9	0.1 (0.1-0.8)	0.3
Fish	46.2	26.9 (12.5-44.4)	61.1

Table 25. Food habits of Flathead River *Ptychocheilus oregonensis* 301-350 mm long. Of 80 stomachs collected, 60.00% were empty.

Food Items	Percent Frequency of Occurrence N = 32	Mean Percent Composition by Number t(0.05, 31 df)	Pooled Percent Composition By Weight
Bird	0	0	0
Vegetation	12.5	1.7 (0.0-7.4)	5.2
Coleoptera	0	0	0
Decapoda	0	0	0
Diptera	0	0	0
Ephemeroptera	3.1	0.0 (0.0-0.1)	0.0
Gastropoda	0	0	0
Hemiptera	3.1	0.2 (0.3-2.2)	0.0
Hirudinea	0	0	0
Hymenoptera	0	0	0
Isopoda	0	0	0
Odonata	3.1	0.2 (0.3-2.2)	1.2
Plecoptera	12.5	1.9 (0.0-8.0)	0.6
Trichoptera	12.5	1.4 (0.0-5.9)	0.6
Invertebrate Unid	12.5	2.9 (0.0-11.4)	0.1
Invertebrates	40.6	25.0 (7.4-48.4)	2.7
Black Bullhead	3.1	0.1 (0.1-0.6)	2.7
Sculpin	3.1	0.0 (0.0-0.3)	4.1
Yellow Perch	3.1	15.8 (2.9-36.4)	64.7
Pumpkinseed	0	0	0
Largemouth Bass	0	0	0
Centrarchids	0	0	0
Coarsescale Sucker	0	0	0
Longnose Sucker	3.1	0.2 (0.3-2.2)	0
Sucker Unid	9.4	0.9 (0.1-4.3)	3.8
Catostomids	12.5	2.0 (0.0-8.2)	3.8
P. oregonensis	6.3	0.1 (0.0-0.7)	14.3
Peamouth	9.4	1.4 (0.1-6.6)	23.6
Redside Shiner	3.1	0.2 (0.3-2.2)	8.9
Cyprinids	15.6	3.7 (0.0-13.0)	46.9
Lake Whitefish	3.1	0.2 (0.3-2.2)	0
Mountain Whitefish	3.1	0.2 (0.3-2.2)	0
Pygmy Whitefish	0	0	0
Whitefish Unid	0	0	0
Coregonids	6.3	1.0 (0.2-5.5)	0
Not Trout or Char Unid	0	0	0
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0	0	0
Trout or Char Unid	0	0	0
Salmonids	6.3	1.0 (0.2-5.5)	0
Fish Unid	3.1	0.2 (0.3-2.2)	0
Fish	68.8	63.7 (38.5-85.4)	92.1

Table 26. Food habits of Flathead River *Ptychocheilus oregonensis* 351-400 mm long. Of 82 stomachs collected, 43.90% were empty.

Food Items	Percent Frequency of Occurrence N = 46	Mean Percent Composition by Number t(0.05, 45 df)	Pooled Percent Composition By Weight
Bird	0	0	0
Vegetation	8.7	1.1 (0.0-4.4)	0.4
Coleoptera	4.4	0.3 (0.1-1.6)	0.1
Decapoda	2.2	0.0 (0.0-0.1)	0.3
Diptera	2.2	0.1 (0.1-1.1)	0.0
Ephemeroptera	2.2	0.1 (0.1-1.1)	0.0
Gastropoda	4.4	0.3 (0.1-1.6)	0.5
Hemiptera	4.4	0.1 (0.0-0.5)	0.0
Hirudinea	0	0	0
Hymenoptera	0	0	0
Isopoda	0	0	0
Odonata	0	0	0
Plecoptera	4.4	0.1 (0.0-0.4)	0.0
Trichoptera	6.5	0.4 (0.0-1.8)	0.2
Invertebrate Unid	2.2	0.0 (0.0-0.3)	0
Invertebrates	26.1	11.1 (2.7-24.2)	1.1
Black Bullhead	0	0	0
Sculpin	4.4	0.1 (0.0-0.7)	0.3
Yellow Perch	39.1	23.9 (8.8-43.5)	21.5
Pumpkinseed	2.2	0.1 (0.1-1.1)	3.3
Largemouth Bass	2.2	0.0 (0.0-0.2)	0.1
Centrarchids	4.4	0.2 (0.1-1.5)	3.4
Coarsescale Sucker	4.4	0.2 (0.1-1.3)	6.1
Longnose Sucker	0	0	0
Sucker Unid	0	0	0
Catostomids	4.4	0.2 (0.1-1.3)	6.1
P. oregonensis	6.5	1.0 (0.0-4.7)	12.0
Peamouth	15.2	2.8 (0.2-8.6)	30.0
Redside Shiner	2.2	0.0 (0.0-0.2)	2.8
Cyprinids	19.6	7.9 (1.3-19.4)	44.8
Lake Whitefish	2.2	0.1 (0.1-1.1)	0
Mountain Whitefish	6.5	0.6 (0.0-3.1)	15.4
Pygmy Whitefish	2.2	0.0 (0.0-0.2)	0
Whitefish Unid	2.2	0.1 (0.1-1.1)	2.9
Coregonids	13.0	2.5 (0.1-8.5)	18.3
Not Trout or Char Unid	2.2	0.0 (0.0-0.2)	0.1
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0	0	0
Trout or Char Unid	2.2	0.0 (0.0-0.2)	0.4
Salmonids	13.0	2.8 (0.1-9.0)	18.7
Fish Unid	6.5	0.5 (0.0-2.3)	3.7
Fish	82.6	81.6 (64.6-93.9)	98.5

Table 27. Food habits of Flathead River *Ptychocheilus oregonensis* 401-450 mm long. Of 72 stomachs collected, 35.00% were empty.

Food Items	Percent Frequency of Occurrence N = 36	Mean Percent Composition by Number t(0.05, 35 df)	Pooled Percent Composition By Weight
Bird	0	0	0
Vegetation	13.9	2.6 (0.0-9.6)	1.3
Coleoptera	0	0	0
Decapoda	0	0	0
Diptera	0	0	0
Ephemeroptera	2.8	0.0 (0.0-0.1)	0.0
Gastropoda	0	0	0
Hemiptera	0	0	0
Hirudinea	0	0	0
Hymenoptera	0	0	0
Isopoda	0	0	0
Odonata	0	0	0
Plecoptera	8.3	0.4 (0.0-1.7)	0.2
Trichoptera	0	0	0
Invertebrate Unid	2.8	0.0 (0.0-0.1)	0
Invertebrates	8.3	0.7 (0.0-3.4)	0.2
Black Bullhead	0	0	0
Sculpin	0	0	0
Yellow Perch	44.4	30.4 (11.3-54.0)	25.4
Pumpkinseed	8.3	1.1 (0.1-5.3)	7.1
Largemouth Bass	0	0	0
Centrarchids	8.3	1.1 (0.1-5.3)	7.1
Coarsescale Sucker	0	0	0
Longnose Sucker	2.8	0.2 (0.2-1.7)	3.3
Sucker Unid	2.8	0.0 (0.0-0.3)	0.7
Catostomids	5.6	0.4 (0.1-2.4)	4.0
P. oregonensis	0	0	0
Peamouth	41.7	28.5 (10.0-51.9)	55.0
Redside Shiner	0	0	0
Cyprinids	41.7	28.5 (10.0-51.9)	55.0
Lake Whitefish	0	0	0
Mountain Whitefish	2.8	0.1 (0.1-0.8)	7.0
Pygmy Whitefish	0	0	0
Whitefish Unid	0	0	0
Coregonids	2.8	0.1 (0.1-0.8)	7.0
Not Trout or Char Unid	0	0	0
Rainbow Trout	0	0	0
Westslope Cutthroat	0	0	0
Oncorhynchus spp.	0	0	0
Bull Trout	0	0	0
Trout or Char Unid	0	0	0
Salmonids	2.8	0.1 (0.1-0.8)	7.0
Fish Unid	0	0	0
Fish	88.9	94.5 (83.7-99.6)	98.5

Table 28. Food habits of Flathead River *Ptychocheilus oregonensis* 451-500 mm long. Of 68 stomachs collected, 41.18% were empty.

Food Items	Percent Frequency of Occurrence N = 40	Mean Percent Composition by Number t(0.05, 39 df)	Pooled Percent Composition By Weight
Bird	2.5	0.0 (0.0-0.07)	1.6
Vegetation	7.5	0.7 (0.0-3.3)	0.1
Coleoptera	2.5	0.0 (0.0-0.2)	0.0
Decapoda	0	0	0
Diptera	0	0	0
Ephemeroptera	0	0	0
Gastropoda	0	0	0
Hemiptera	0	0	0
Hirudinea	0	0	0
Hymenoptera	0	0	0
Isopoda	0	0	0
Odonata	0	0	0
Plecoptera	5.0	0.2 (0.0-0.9)	0.1
Trichoptera	2.5	0.5 (0.1-2.8)	0.0
Invertebrate Unid	2.5	0.0 (0.0-0.4)	0
Invertebrates	10.0	0.9 (0.0-3.7)	0.1
Black Bullhead	0	0	0
Sculpin	0	0	0
Yellow Perch	42.5	24.1 (8.7-44.2)	22.0
Pumpkinseed	2.5	0.0 (0.0-0.4)	5.7
Largemouth Bass	0	0	0
Centrarchids	2.5	0.0 (0.0-0.4)	5.7
Coarsescale Sucker	2.5	0.2 (0.2-1.4)	5.4
Longnose Sucker	0	0	0
Sucker Unid	12.5	2.2 (0.0-7.9)	0.7
Catostomids	15.0	3.4 (0.1-11.3)	6.1
P. oregonensis	12.5	1.3 (0.0-5.2)	5.8
Peamouth	40.0	9.8 (3.0-20.0)	43.3
Redside Shiner	12.5	0.5 (0.0-1.8)	4.9
Cyprinids	50.0	20.8 (7.9-37.7)	54.0
Lake Whitefish	0	0	0
Mountain Whitefish	5.0	0.6 (0.1-3.5)	5.9
Pygmy Whitefish	0	0	0
Whitefish Unid	0	0	0
Coregonids	5.0	0.6 (0.1-3.5)	5.9
Not Trout or Char Unid	10.0	0.4 (0.0-1.7)	1.3
Rainbow Trout	0	0	0
Westslope Cutthroat	2.5	0.2 (0.2-1.4)	1.9
Oncorhynchus spp.	2.5	0.2 (0.2-1.4)	1.9
Bull Trout	0	0	0
Trout or Char Unid	0	0	0
Salmonids	7.5	1.4 (0.0-6.2)	7.8
Fish Unid	7.5	0.2 (0.0-0.7)	1.2
Fish	100.0	96.7 (90.3-99.8)	98.2