This is to certify that the

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FEEDING HABITS OF CHINOOK SALMON
IN EASTERN LAKE MICHIGAN

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Robert Fee Elliott

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Niles R. Kevern
Major professor

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FEEDING HABITS OF CHINOOK SALMON IN EASTERN LAKE MICHIGAN

By

Robert Fee Elliott

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ABSTRACT

FEEDING HABITS OF CHINOOK SALMON IN EASTERN LAKE MICHIGAN

By

Robert Fee Elliott

Diet of angler-caught chinook salmon (Oncorhynchus tshawytscha) from eastern Lake Michigan waters was examined in 1985-1986 to characterize feeding habits following a change in the dominant forage from alewife (Alosa pseudoharengus) to bloater (Coregonus hoyi). Diet differed both in content and amount depending on season, region, and predator size. Forage use appeared strongly influenced by prey distribution and availability, indicating opportunistic predation. Juvenile bloater (<160 mm) were an important portion of the chinook diet, particularly in the southern basin, but adult bloater were conspicuously absent despite their great abundance. Adult alewife were still a major component of the diet, particularly in the spring, in the northern basin, and for larger chinook. Smelt (Osmerus mordax) contributed primarily in the north and perch (Perca flavescens) contributed primarily in the south. In the fall, young-of-the-year forage dominated the diet. Chinook from the northern basin consumed 2-3 times more alewife and subsequently twice as much prey as chinook from the southern basin. Differences in regional and seasonal apparent rations seemed to correlate with catch rates indicating chinook may congregate seasonally in different regions of the lake in response to prey abundance.

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INTRODUCTION

Aquatic fauna of the Laurentian Great Lakes have changed dramatically since European settlement of the region. Within the last 100 years, Lake Michigan's fish populations have been most strongly influenced by the introduction and invasion of exotic species, by the degradation of habitat, and by the harvesting of fish for food -- all associated with rapid growth of human development in the region.

Historical descriptions of the evolution of the Lake Michigan fishery have been offered by many authors (Van Oosten 1936, Miller 1957, Powers and Robertson 1966, Smith 1968, Wells and McLain 1972, Christie 1974, Bailey and Smith 1981, Emery 1985, Brown et al. 1987, Keller and Smith 1990, Mills et al. 1993). Of great influence in the evolution of the present fishery were the invasion of sea lamprey (Petromyzon marinus) and alewife (Alosa pseudoharengus), and the introduction of rainbow smelt (Osmerus mordax). Through competition and predation, the presence of these exotics had substantial and deleterious effects on the native fishes of Lake Michigan, many of which were of commercial importance.

It is generally believed that perturbations by these exotics in combination with the adaptability of an efficient selective commercial fishery, caused the succession of species-specific stock collapses in Lake Michigan (Smith 1968, Wells and McLain 1972). By the mid-1950s, and only 20 years after the sea lamprey became noticeably established in the lake, the important large piscivores, lake trout (Salvelinus namaycush) and burbot (Lota lota) had been severely depleted. Also depleted was the once dominant pelagic planktivore lake herring (Coregonus artedi), the lake whitefish (C. clupeaformis), and six of the original seven species of deep water chubs. Though bloater (C. hoyi) were later depleted for a short period in the 1970s, they were the only member of the native chub species complex to persist through this initial period of despeciation. Their smaller size apparently made them both less vulnerable to lamprey predation and last targeted as a commercial chub species.

Alewife were first noticed in Lake Michigan in 1949 (Miller 1957). Without a pelagic piscivore in Lake Michigan, and lacking competition from other pelagic planktivores, alewife were able to expanded rapidly throughout the lake. By the 1960s, this exotic species that was perceived to be of little value, accounted for an estimated 80% of the fish biomass in Lake Michigan (Sommers et al. 1981). In 1967, such imbalance in the predator prey system was made graphically evident when alewife experienced a massive die-off that drew national attention. As in several previous years, dead alewife washed ashore, fouling beaches and harbors, clogging municipal water intakes, and resulting in a loss to the tourism industry of millions of dollars (Brown 1972). By this time, control of sea lamprey had been initiated in Lake Michigan, allowing for the potential recovery of top level piscivores. In response, resource agencies involved with management of Lake Michigan fisheries stepped up active management of the lake's fishery. In addition to stocking lake trout for the purposes of rehabilitation beginning in 1965, coho salmon (Oncorhynchus kisutch) and chinook salmon (O. tshawytscha) were stocked beginning in 1966 and 1967 respectively, along with steelhead (O. mykiss), and brown trout (Salmo trutta), to convert the low value alewife forage into a valuable sport fishery (Tody and Tanner 1966). What resulted was a world class recreational fishery. Two of the larger native species, lake whitefish and burbot also recovered and, along with bloater and yellow perch, help to support a viable commercial fishery.

Of the several species of salmonines stocked, chinook salmon quickly assumed dominance both anthropomorphically as a preferred sport fish and ecologically as a major piscivore. Through continued stocking and some natural reproduction, they reached peak population abundance in 1985-1987 (Smith 1993) and accounted for the majority of the salmonine sport harvest in Lake Michigan (Rakoczy and Nelson 1990, Hansen et al. 1991).

In apparent response to growing predation, alewife declined gradually through the 1970s and then abruptly in the early 1980s, reaching lowest levels in 1983. Although this decline has been attributed mostly to predation by the large salmonine population (Stewart et al. 1981), a series of colder than average winters in the late 1970s was also likely involved (Eck and Brown 1985) as may have been an increasing commercial harvest of alewife.

With temporary closure of the commercial chub fishery and reduced interactions with alewife, bloater increased quickly. By 1982, bloater surpassed alewife in measured abundance (Eck and Wells 1987) and have since reached levels eclipsing both their historic abundance and the high abundance of alewife in the mid 1960s. Today, rainbow smelt, yellow perch (Perca flavescens), and bloater represent species that persisted through the major periods of despeciation and continue as both forage for today's salmonine fishery, and as sport and commercial species.

Prior to the bloater recovery, alewife had been the dominant and at times nearly exclusive forage of salmon and trout in Lake Michigan (Jude et al. 1987, McComish 1989). With the persistent reduction in alewife abundance and the continued abundance of bloater, the propensity for Lake Michigan salmonines to feed on bloater has been a major interest, and seen by many to be a key to the continued support of healthy and abundant stocks of salmon and trout in Lake Michigan. Bioenergetics analyses of predator demands on the reduced alewife forage of the early 1980s led several authors (Stewart et al. 1981, Brandt et al. 1991, Kitchell and Hewett 1987) to conclude that alewife alone were not capable of supporting the production demands of stocked salmon and trout populations in the Lake. However, it was also apparent that if the large bloater biomass were effectively used as forage, a large population of predators could be supported (Eck and Brown 1985). Particle size applications have even indicated that piscivore biomass is lower than would be predicted based on lower trophic production, indicating the potential for increased piscivore production if all forage were available and used by predators (Sprules et al. 1991).

The need to understand how predator populations were interacting with the forage species complex following the alewife decline stimulated the scientific community to conduct a Great Lakes wide assessment of salmonine diets. These studies were initiated primarily through major universities surrounding the Great Lakes with funding from the Sea Grant College Program. The work presented here was an extension of that effort for eastern Lake Michigan. Other results of this "Salmonid Diet

Study" have been reported for each of the Great Lakes (Hagar 1984, Kogge 1985, McComish 1989, Diana 1990, Brandt 1986). Early reports from several of the Lake Michigan studies indicating that sport salmonines were feeding selectively on the lesser abundant alewife reinforced the concern about the ability of forage stocks to support the number of salmonines being stocked.

Trends observed in the chinook fishery, such as declining average weight and declining trophy weight in the catch (Hansen 1986), increasing diet diversity (Hagar 1984, Kogge 1985), and some limited measures of declining stomach fullness (Hagar 1984, Jude 1987) were possible indications of forage limitation. Definitive interpretation, however, was seriously confounded by the continuous increase in stocking levels, an increase in fishing effort, and a likely decrease in the average age of the catch. The continued dominance of alewife in the diets and lack of conclusive evidence showing declining growth suggested to some that despite their decline, alewife were still available enough to meet predatory demands and thus continued to dominate the diets (Eck and Wells 1987).

In the spring of 1988, a substantial mortality of chinook salmon occurred that was most evident in the southern regions of Lake Michigan and bacterial kidney disease (BKD) was identified as being involved. That year, and in years since, returns of chinook salmon were and have been greatly reduced and BKD has persisted. As an outbreak of BKD has traditionally indicated the presence of stress, the possibility of forage limitation was reinforced, although it was just one of many possible contributing factors.

In general, the study design and data summary associated with most diet studies have limited their ability to directly answer important questions relating to lake wide differences in forage availability and forage consumption over time. Contributing to this has been the pervasive use of present composition as a means of describing diets and the logistic difficulty of collecting an adequate sample to describe diet on a lake wide and season long basis.

The objective of this study was to adequately quantify and describe the diet of angler caught salmonines collected from eastern Lake Michigan following a shift in the lakes forage composition from one dominated by alewife to one dominated by bloater. The period of this study, 1986, represents a time of greatest disparity between alewife abundance (near record lows) and chinook abundance (near record highs). As such, this work establishes a benchmark for comparison both with prior and latter measures of forage consumption that can be of particular importance in ascertaining if reductions in alewife abundance have severely limited available forage for Lake Michigan salmonines.

METHODS

Field Collections

Angler-caught salmonines were sampled at 15 ports along eastern Lake Michigan in October of 1985 and from April through October of 1986 (Figure 1). Permanent cleaning stations located near boat launches and marinas provided locations for sampling sport-caught fish. At each port, fish were sampled from as many boats as possible over all hours of the day. As soon as anglers returned to shore and before they began cleaning their fish, permission was obtained to examine and sample their catch. Most anglers were interested in the research work and were cooperative in allowing the examination of their fish. To ensure that fish sampled were representative of the overall catch from the lake, all fish creeled by anglers aboard an individual boat were sampled. Fish captured inside pier heads and from rivers were not sampled as most of these fish were returning to spawn and were no longer feeding.

Sampled fish were identified to species, measured (total length) to the nearest millimeter (mm), weighed to the nearest 0.1 kilograms (Kg), and examined for external marks, fin clips, and lamprey scars prior to cleaning. Because of the interest anglers had in the size of many of their fish, weight was usually measured in pounds (Lbs), and then later converted to kilograms. Scale samples were taken from approximately 25% of the fish to provide age validation of length frequencies. During

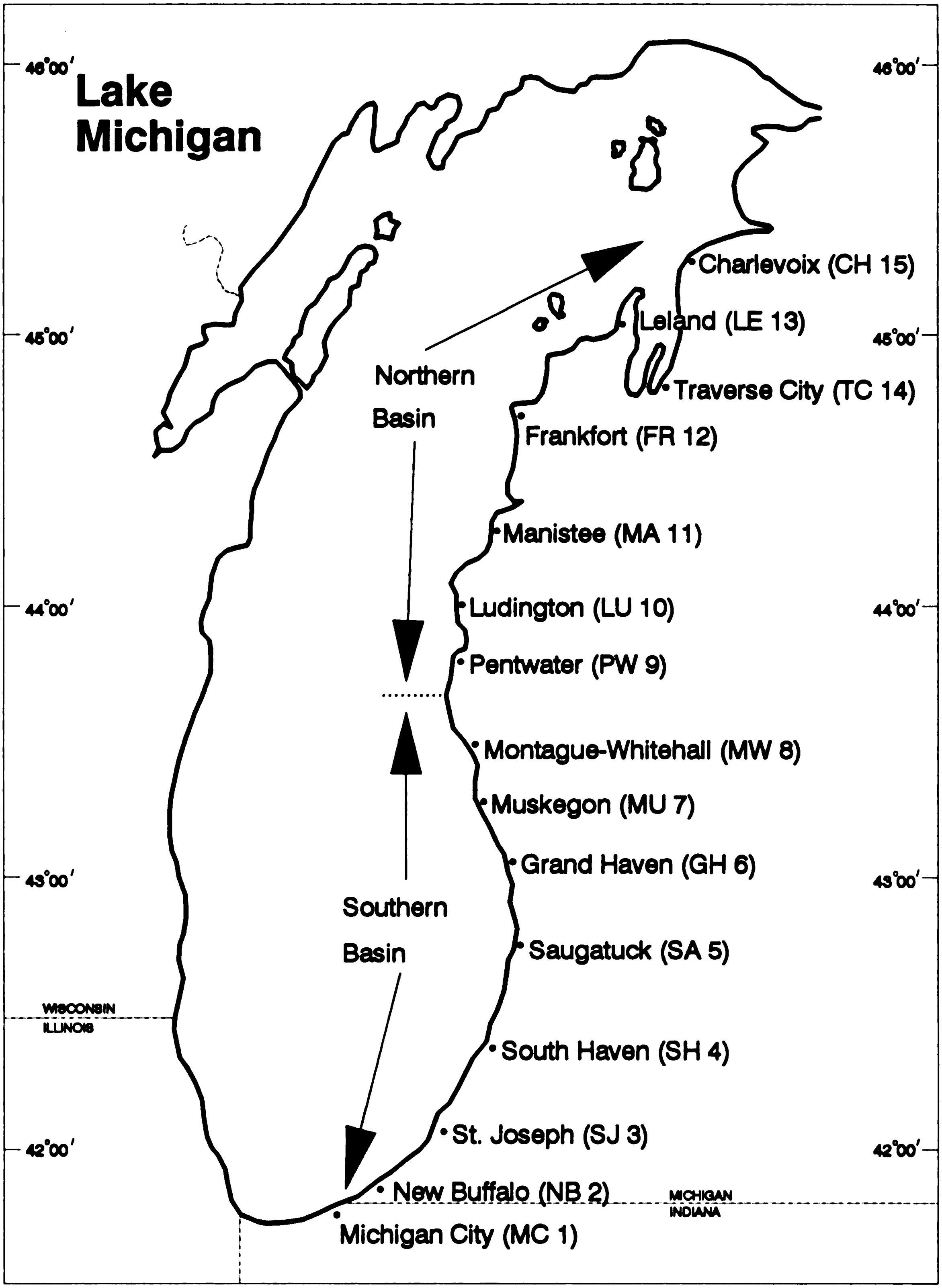

Figure 1. Locations and basin divisions where salmonines were collected from eastern Lake Michigan in 1986 (abbreviations for port names are in parentheses).

cleaning of the fish, sex was determined visually, unusual internal characteristics were noted, and all stomach contents removed, placed in individually numbered whirl-pac bags, and preserved in 10-15% formalin. The orientation of prey fish in the stomach (head up or head down) was also recorded when possible. Occasionally, it was uncertain whether the complete contents of a stomach were present, either because some or all of its contents had been regurgitated (indicated by a stretched or distended stomach), or because the stomach wall had been slit prior to our examination. These stomach samples were not included in further analysis of diet.

Anglers were interviewed to determine depths and water temperatures where fish were caught, the hours fished, and the total number of fish caught. General weather, lake, and fishing conditions were also recorded.

Laboratory Analysis

In the lab, prey items from each stomach were identified, assigned a digested state value, measured (total length when possible) to the nearest mm, and weighed to the nearest 0.1 grams (gr). Identification was to species for fish and common invertebrates, and to order for less common invertebrates.

As many prey fish were well digested, characteristics of scaling pattern, lateral line musculature, pyloric caeca, carapace bones, and vertebra were used to verify species. If identification was uncertain, contents were classified as unidentified. This accounted for less than 6.5% of the fish. As an index of when the predator had consumed the prey, each prey item was assigned subjectively to one of five groups:

intact and undigested (1), less than 25% of body mass digested but some flesh digested (2), between 25% and 75% of body mass digested (3), more than 75% of body mass digested but some flesh remaining (4), and only bones remaining (5). These groupings were consistent with those used by Kogge (1985) and Nurse (1986). Because determining total length of each prey item was sometimes difficult because of the digested state of the prey, standard length was often measured or estimated based on the vertebral column length, and converted to total length using equations developed from whole fish (Appendix A). When large numbers of invertebrates were present, their total weight was used to estimate their number based on weight of a known number of individuals from that stomach. Volume (by water displacement) was also measured (nearest milliliter) for representatives of each prey type and digested state.

These methods were generally consistent with those used by Kogge (1985) and by Nurse (1986) for diet studies of eastern Lake Michigan salmonines conducted in the three years preceding this study. However, no measure of prey mass (weight or volume) was measured in 1983 or 1984, and volume (but not weight) of prey was measured in 1985. So that complete comparisons of diet parameters could be made among all four years and to facilitate comparisons with other studies, relations among length, digested state, and wet weight of prey were used to estimate weight of prey for the 1983 and 1984 data. Relations between volume and wet weight for each prey species (Appendix A) were used to estimate weight of prey for the 1985 data, and to estimate volume for all prey items collected in 1986.

<u>Data Analysis</u>

Other studies of Lake Michigan salmonines have shown diet to differ with predator size and among regions (Jude et al 1987, Kogge 1985, Stewart and Ibarra 1991, Miller and Holey 1992, Toneys 1991). Preliminary analysis of these data confirmed these observations. Because of the large sample size of this collection, an effort was made to base all stratification of the data on both observed differences in diet and natural biological or physical characteristics that distinguished samples from one another rather than on arbitrary divisions.

Predator size stratification. It was initially apparent that the size distribution of chinook sampled differed between season and region, and from other studies. It was therefore not only desirable, but necessary to separate chinook into size classes so that valid comparisons could be made. Dividing salmon into size classes is somewhat complicated by their typically fast growth, particularly if fish are sampled throughout the growing season. If fixed season-long size divisions (such as <50 cm, 50-85 cm, and > 85 cm) are used, many fish that would be classified into one size group in the spring, would grow into the next size group by fall. This can change the age structure of the size class over time, and confound seasonal effects with age or size effects.

To avoid this problem, apparent growth rates and length frequencies of sport-caught fish were used to divide chinook into size classes that were representative of the seasonally increasing average size of age-1, age-2, and age-3 and older chinook. Scales from 1986 were aged as described by Seelbach and Beyerle (1984) and following methods developed for chinook by D. Anson and S. Lazar (Michigan Department of Natural Resources, Fisheries Division). Back-calculation of size at annulus formation was used to verify the determined age. Straight line regression was then used to calculate apparent or population growth rates (Ricker 1975) for each age class sampled in 1986 and for chinook sampled from the same waters by the Michigan Department of Natural Resources (MDNR) biological sampling program for 1986-1989. Age data from prior years were not included because of inaccuracies in aging mature fish (K. Smith, MDNR, personal communication). Calculated apparent growth rates for the 1986 MDNR-aged fish and the fish collected during this study produced similar results, confirming that both samples were from the same population. Using the apparent growth rates calculated for MDNR-aged chinook collected in 1986, length for all chinook sampled for diet in 1986 was then normalized to July 15 (the median date) as described in Table 1. This procedure simply calculated an apparent growth rate for each fish depending on its size and time of capture. The rate, proportionally based on the apparent growth rates of known-aged fish, was used to calculate the size the fish would have been on any given date.

A frequency plot of chinook lengths normalized to July 15 revealed three distinct modes (Figure 2). The low points between each mode established the division of chinook into three size classes. These divisions, although not entirely representative of all age-1, age-2, and age-3 and older chinook, were representative of the average size of each age class, and precluded the growing of fish from one size division into the next during the season. These divisions were consistent for both sexes, and for fish collected from all sampling locations.

Table 1. Procedure used to calculate normalize lengths (L_n) of chinook salmon for a median sample date of July 15, 1986.

$$L_n = L_x + (G * (D_x - D_n)$$

when:

$$G = [(L_x - L_s) / (L_b - L_s) * G_b] + [(L_b - L_x) / (L_b - L_s) * G_s]$$

where:

L_n = calculated length in cm of fish on normalized date
G = individual daily growth increment
L = observed length in cm on day of capture
D = capture day of year (1-365) for the given fish
D_n = median day of year (1-365) used for normalizing length
L_b = average length of the nearest larger age class on capture day
L_s = average length of the nearest smaller age class on capture day
G_b = aparent growth rate of nearest larger age class
G_s = aparent growth rate of nearest smaller age class

average length ($L_{s\&b}$) and apparent growth rate ($L_{s\&b}$) for each age class in 1986 are described by the following functions:

	average length		day of year (1-365)	growth rate		constant
Age 0.1 chinook:	S	=	D	* (0.1087)	+	23.0
Age 0.2 chinook:	S	=	D	* (0.0674)	+	53.5
Age 0.3 chinook:	S	=	D	* (0.0404)	+	74.7

All fish larger than the average length of age-3 fish were assigned the apparent growth rate of age-3 fish since the apparent growth rate of age-4 fish did not differ significantly from age-3 fish in all four years.

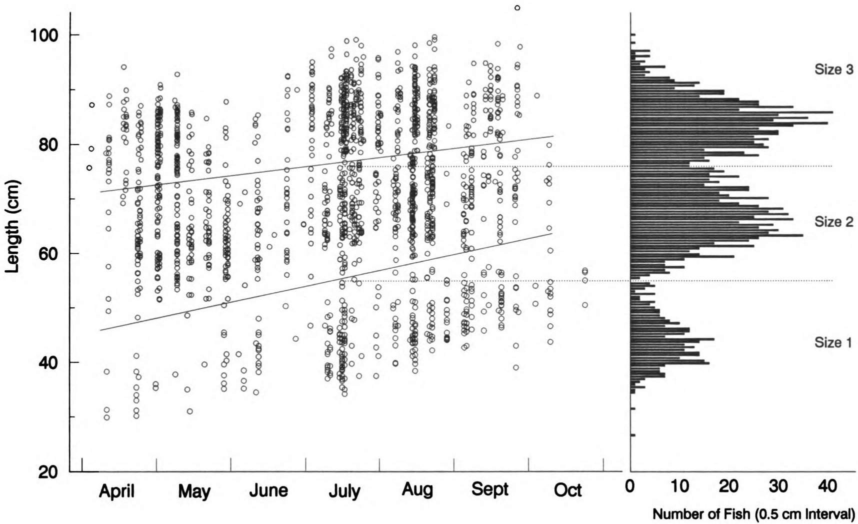

Figure 2. Sizes of chinook salmon sampled in 1986, and division of the sample into three size groups, that represent age, based on the frequency distribution of lengths normalized to July 15.

Statistical Tests. Because of the high degree of variance among samples, statistical tests made use of paired samples whenever possible. Wilcoxon's Signed Rank tests were used to test differences in diet between predator size and sex. Wilcoxon-Mann-Whitney two sample tests were used to test differences in diet between locations. T-tests were used to measure differences in prey size consumed by predator groups. Chi-square tests of independence were used to test differences in the digested state of prey and in the percent of predators feeding.

Regional and Seasonal Stratification. Tests among locations, and examination of the data, indicated that a significant and consistent difference in diet existed between fish from the northern and southern regions of eastern Lake Michigan ($p < 0.05$). The best division of the study area was into two regions north and south of Little Sable Point at approximately 43°40' of latitude. Since this division coincided with the batheometric division of the lake into the southern and northern basins (Mortimer 1975), it had both statistical and physical merit. Though further divisions could have been made based on diet, differences could not be solely attributed to location effects as opposed to season effects.

Samples were then grouped by week and chi square tests of independence ($p < 0.05$) performed to determine differences in percent feeding, and in the number and type of prey consumed for samples collected on the same week. On only 2 of 61 occasions did diet differ for samples from the same week (within a basin). For these samples, descriptive statistics of diet were averaged to provide weekly values.

Samples that did not differ, were combined by week and then descriptive statistics recalculated.

Descriptive statistics of percent feeding, frequency of occurrence, average number, average weight, percent by number (fish only), and percent by weight for each prey type, and for all prey combined, were used to describe the weekly diet for each size class of chinook from the two regions. Since sample size was usually adequate for weekly samples, and since preliminary analysis showed variation between weeks was often great, no further summary of diet into monthly or seasonal periods was justified. Generalizations about seasonal diet were based on observed trends from several concurrent weeks.

Average diet over the entire season was calculated by averaging all weekly values for each size class by basin over the period that data were collected. Values for weeks where no data were collected for a particular size class were estimated by averaging the data of the two closest weeks (one before and one after the missing week). If several weeks were missing, proportionally greater weight was given to the week closer in time to the missing week. In this manner, average seasonal values were not affected by differences in weekly sample sizes.

RESULTS

Characteristics of Sampled Predators

In 1986, a total of 3,472 salmonines were sampled. Chinook salmon accounted for 56%, lake trout 22%, coho 14%, steelhead 6%, and brown trout 2% of the collection. Samples were collected on 74 of the 204 days between April 5 and October 25 at up to 4 of the 15 ports each day. Collections are listed by species, sample date, location, and sex in Appendix B and also by size group for chinook in Appendix C. This sample represented 0.38% of the total estimated harvest of these species from Michigan waters of Lake Michigan in 1986.

Sex ratios for lake trout, coho, steelhead, and brown trout did not differ significantly from a 1:1 ratio ($p < 0.05$), with lake trout showing the largest percentage of males (53.6%). For chinook, males were a significantly larger proportion of the size-1 sample (60%) than the size 2 (49%) or size 3 (46%) samples ($p < 0.05$), a condition that is likely related to the early maturing and return of many age-1 (jack) males to their rivers of origin.

The number and distribution of sizes (and presumably ages) of chinook sampled differed both between basin (region) and season (Figure 3). Most of the chinook sampled in April and May were caught in the south, most sampled in June and July were caught in the north, and in August through October, fairly equal numbers came from both basins. The sample from the south was dominated by size-2 chinook and from the north by

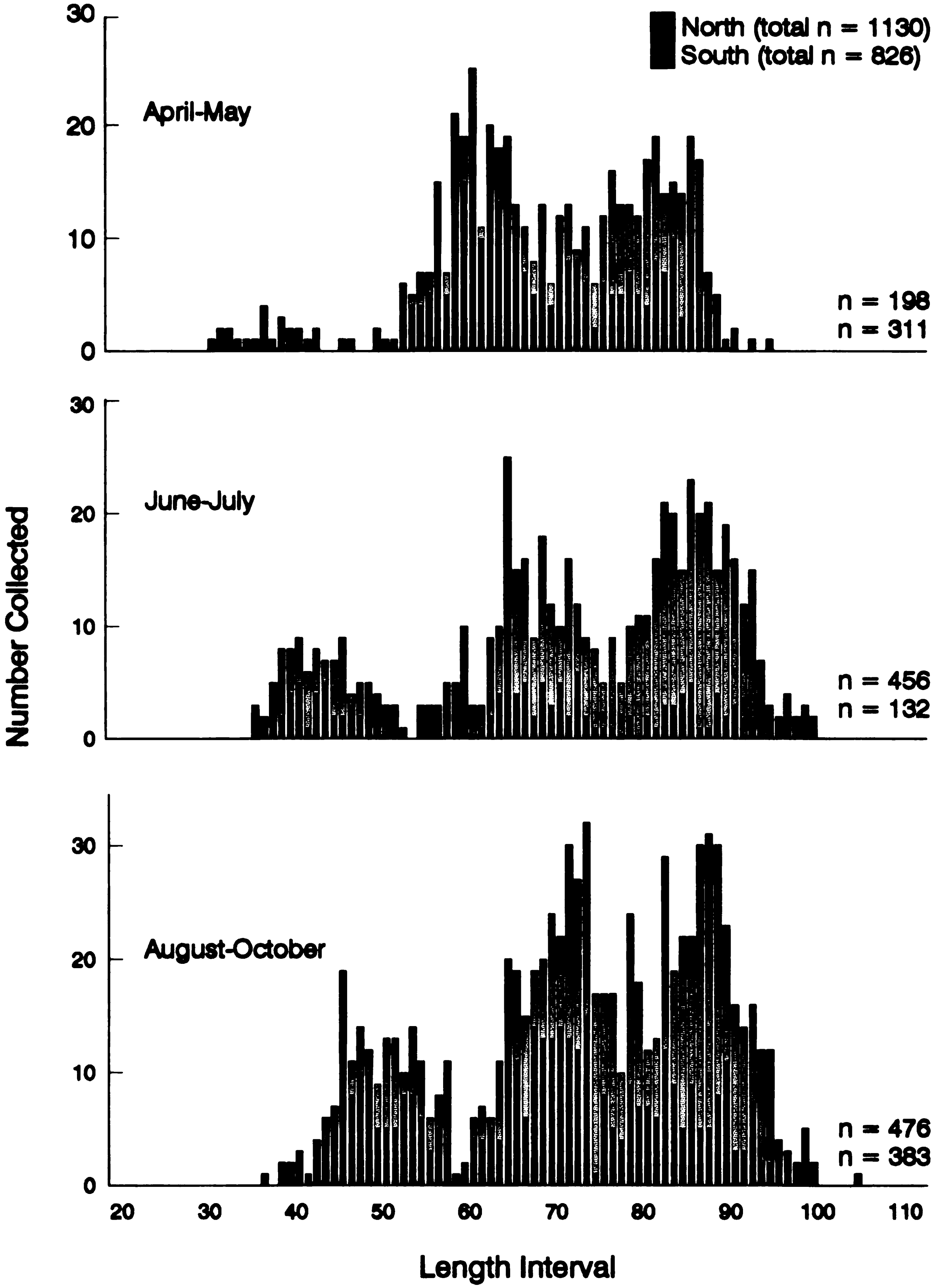

Figure 3. Number and lengths of chinook salmon sampled during different seasons from the southern and northern basins of eastern Lake Michigan, 1986.

size-3 chinook through all months. More size-1 chinook were collected in the south, where they were equal in proportion to size-3 chinook from June through October. Very few size-1 chinook were caught in April and May in either basin. These trends were fairly consistent from 1983-1986, although size-1 and size-2 chinook were a greater proportion of the catch in 1986 than in 1983-1985. Fewer very large chinook were collected in 1986 than in the earlier years.

Apparent growth rates calculated from aged fish from the creel showed only minor, if any, differences between 1986-1989. Despite apparent changes in fishing effort, harvest, mortality, forage availability, and possibly growth, modes in the normalized length distributions of chinook for 1983-1986 (including the points of division between the modes) showed no obvious shifts between years, although the size-3 mode encompassed larger fish in earlier years.

For 1986, water temperatures at depths where chinook were captured (reported by anglers) were consistent between basins, increasing from 5-7 °C in April to 9-13 °C by the end of May. Water temperatures where chinook were captured remained between 9 and 13 °C from June through October. These similarities indicated direct comparisons of diet between regions and across seasons should not be confounded by potential temperature effects.

Characteristics of the Diet

A total of 1,956 chinook stomachs were examined in 1986. Of these, 1,070 contained food, 860 were empty, and 26 were of a questionable state (described previously) and were not included in further analysis. Overall, the distributions of prey weight and prey number per stomach followed a poisson-like distribution (Figure 4). Most stomachs containing food had small amounts while fewer had full stomachs. A similar distribution was reported by Diana (1990), indicating this was typical at least for Great Lakes chinook. The 860 empty stomachs also fit the same poisson distribution, indicating that the state of being empty was just a continuation of the distribution of feeding levels observed.

Random variation within samples (among fish) was high, so that for small samples, differences were not easily interpreted. Comparison between large samples indicated that variation in the frequency of occurrence, in the amount consumed, and in the size of prey consumed was generally greatest between dates, less between sample locations on a given date, and least between size groups within samples. Because of the variation between dates, generalizations about seasonal diet characteristics were made based on observable trends from several sequential samples.

Within size classes of chinook, there was a direct, although weak, relationship between the percent of fish feeding and the amount of prey consumed (Figure 5). This, relation, along with the earlier described fit of empty stomachs to the poisson-like distribution of consumed prey, indicated that it was appropriate to combine fish with empty stomachs with feeding fish when calculating diet parameters. Trends observed in the amount and composition of diet for all chinook, and for feeding chinook only, were generally the same, differing only in magnitude. Calculated values of percent feeding, frequency of occurrence, average number, average weight, percent by number (for prey fish only), and percent by weight for each prey type are presented for all fish, and for

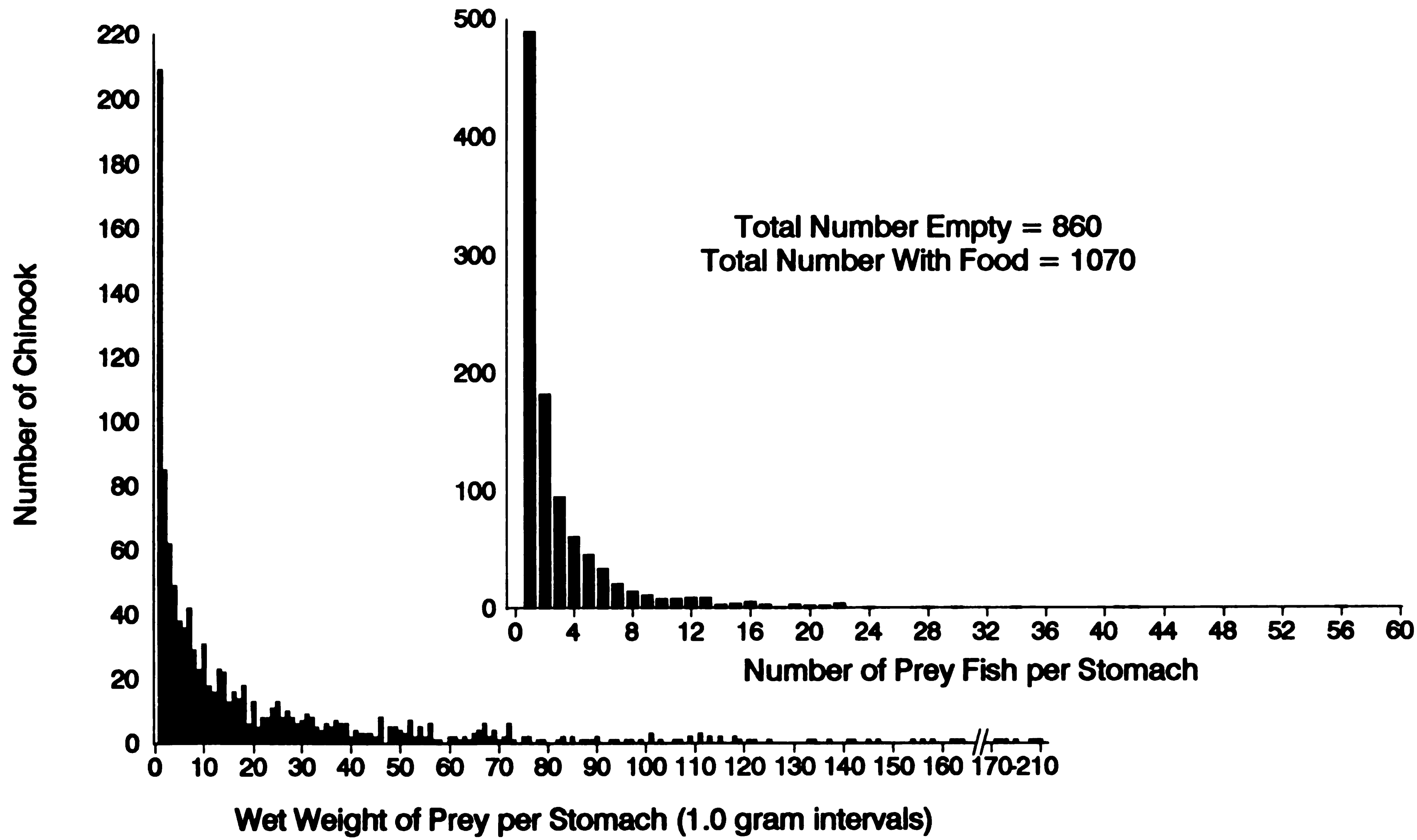

Figure 4. Frequency distributions of the number and weight of prey consumed by chinook salmon from eastern Lake Michigan, 1986.

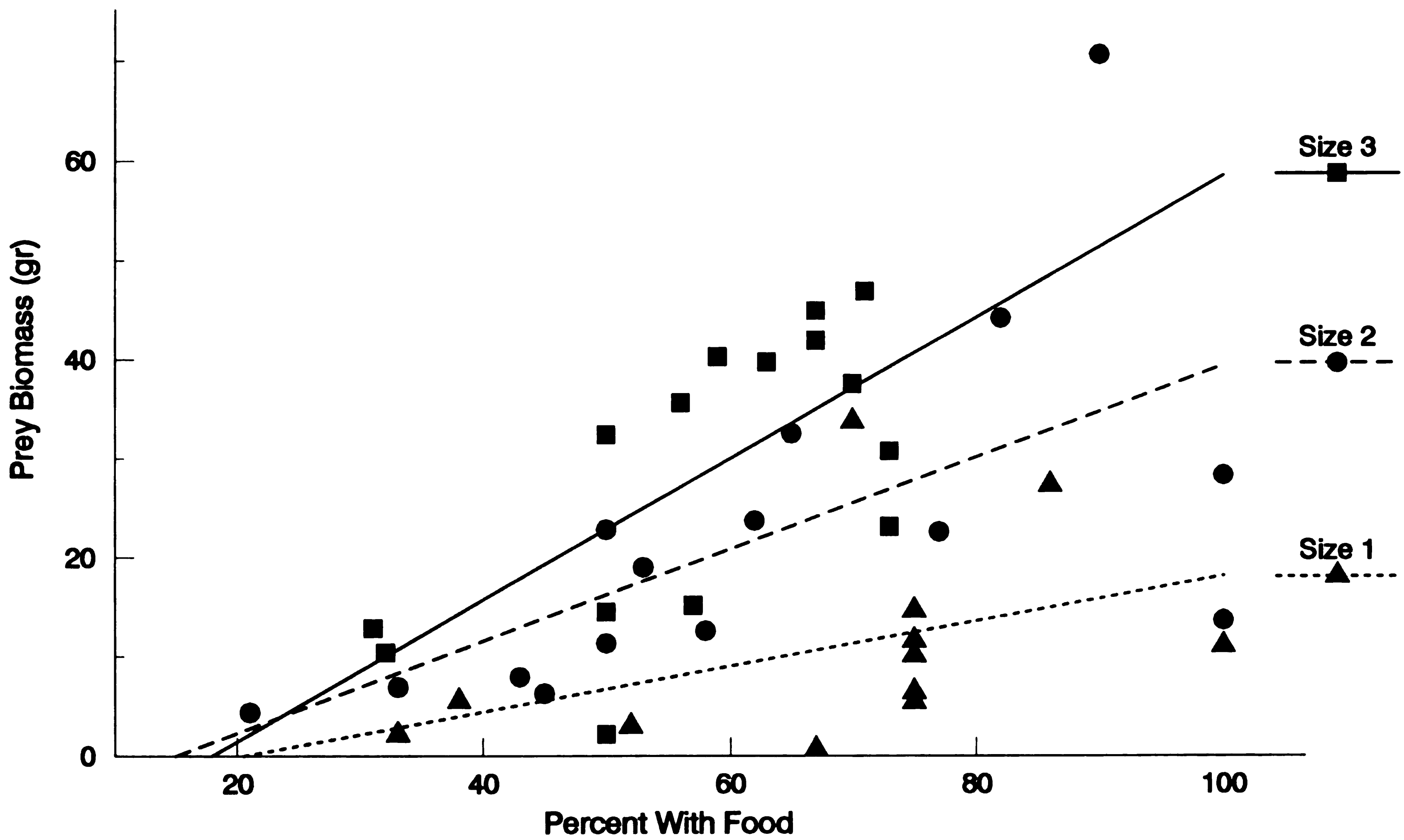

Figure 5. Relation between the percent feeding and the average amount of prey consumed by the three size classes of chinook salmon from eastern Lake Michigan, 1986.

feeding fish only, in Appendix D.

Diet of chinook salmon varied seasonally, differing among predators of different size and between predators from the north and south basins. Trends in the diet were similar for frequency of occurrence of prey types (Figures 6a, 6b, and 7), number of prey fish per chinook stomach (Figures 8a, 8b, and 9), biomass of prey per stomach (Figure 10a, 10b, and 11), percent number (Figure 9), and percent biomass (Figure 11). Seasonal and regional differences were related to prey distribution, availability, and size (Tables 2-5, Figures 12-17). There were no observed differences in diet between sexes other than in the fall for size-3 chinook, when males had a small but significantly higher incidence of empty stomachs ($p < 0.05$).

Alewife occurred in the diet in the spring and summer as adults and yearlings, and in the fall primarily as young-of-the-year (YOY). They were the dominant prey found in age-3 and larger chinook from the southern basin and in age-2 and age-3 and larger chinook from the northern basin. Sizes of alewife consumed ranged from 20-240 mm, representing all sizes of alewife typically found in the lake. The frequency, absolute amount, and proportion of alewife in the diet increased with predator size in both basins, but was much greater in the north than in the south. The amount of alewife in the diet was responsible for a much larger amount of prey per stomach (referred to hereafter as apparent ration) observed for all size chinook from the northern basin.

Bloater occurred in the diet primarily from July on as juveniles and young adults less than 160 mm in length. They were the dominant prey found in age-1 and age-2 chinook from the southern basin. The

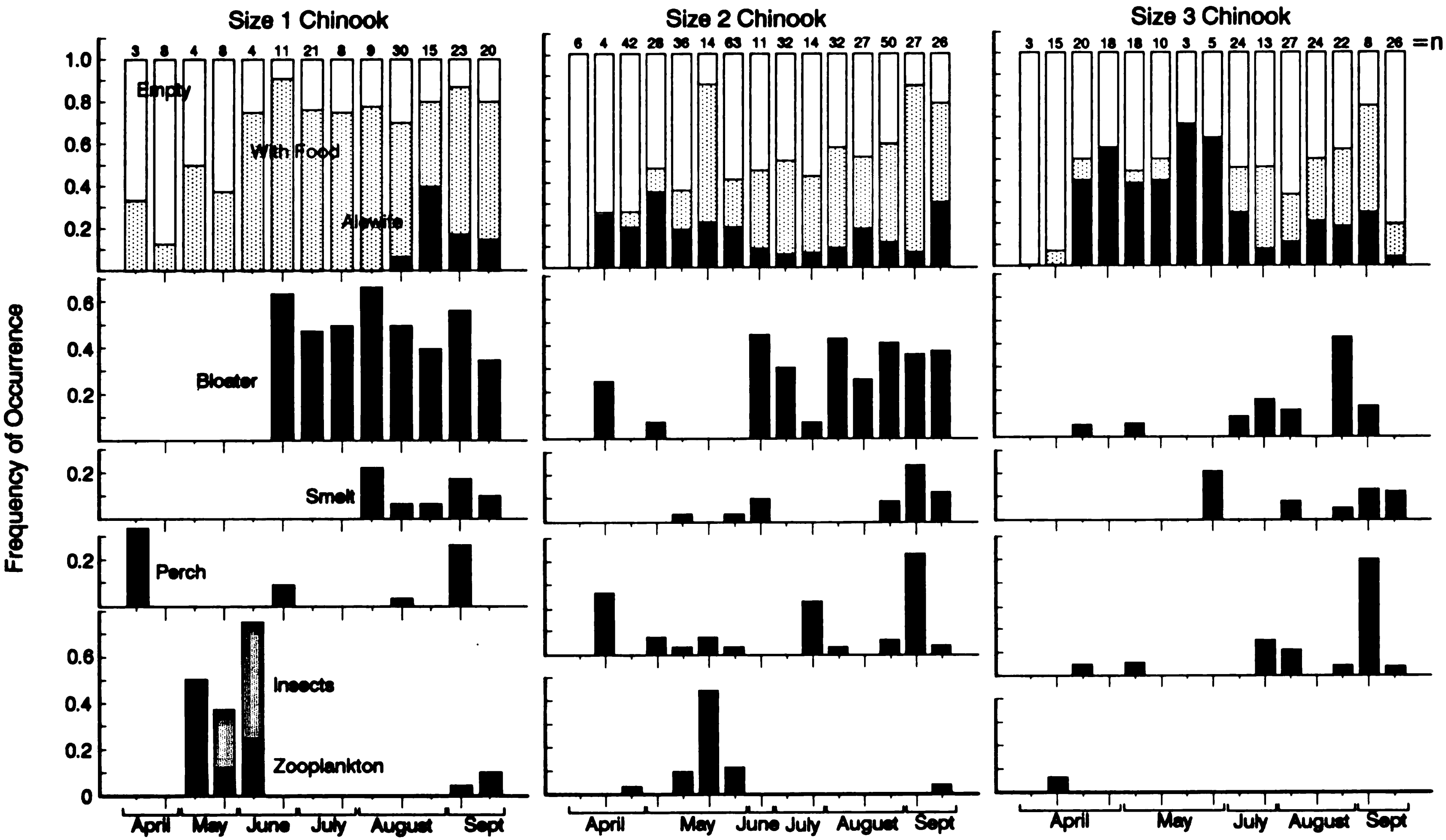

Figure 6a. Frequency of occurrence of prey types consumed by size class of chinook salmon from the southern basin of eastern Lake Michigan, 1986. The number above each bar indicates the sample size.

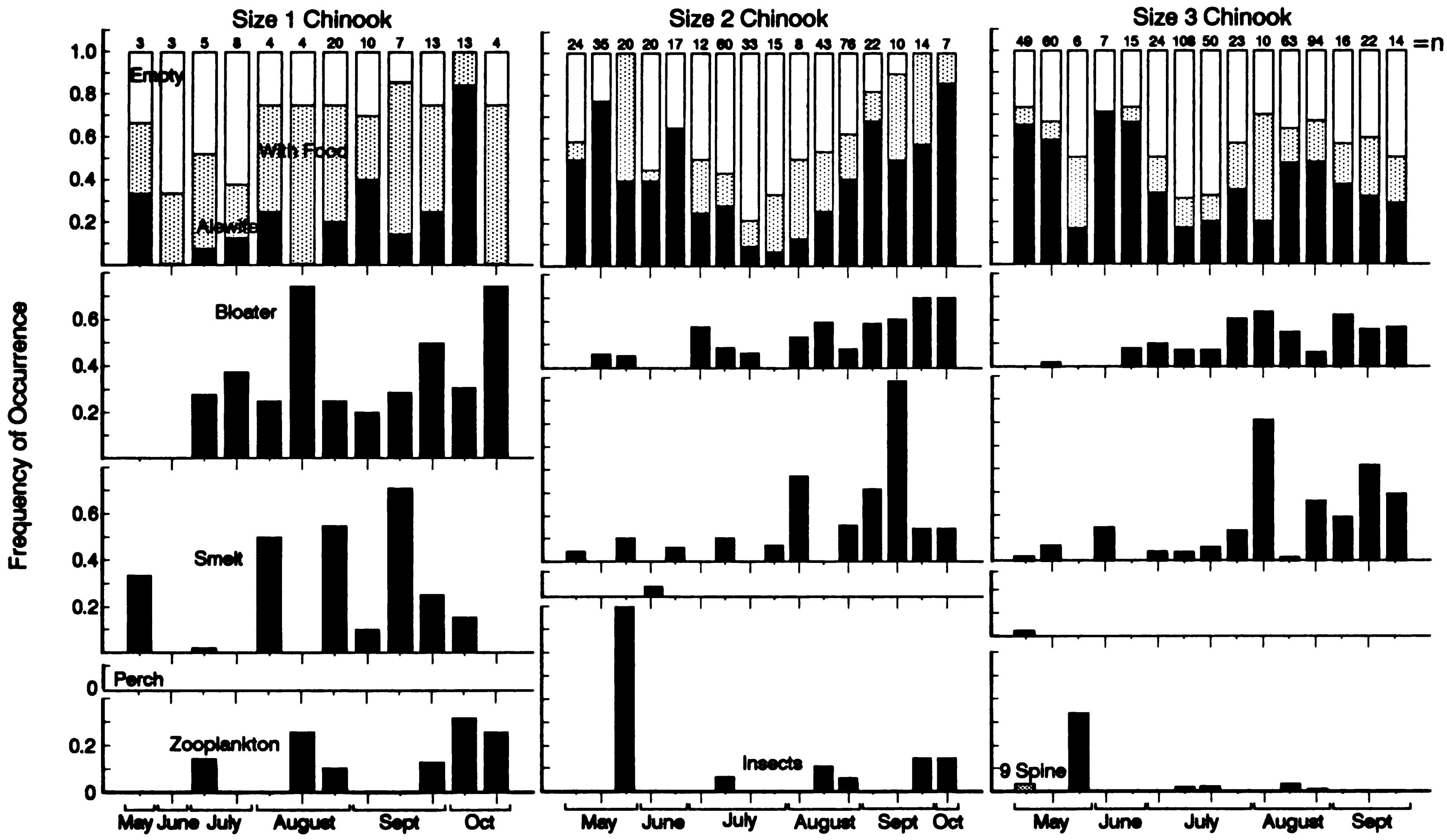

Figure 6b. Frequency of occurrence of prey types consumed by size class of chinook salmon from the northern basin of eastern Lake Michigan, 1986. The number above each bar indicates the sample size.

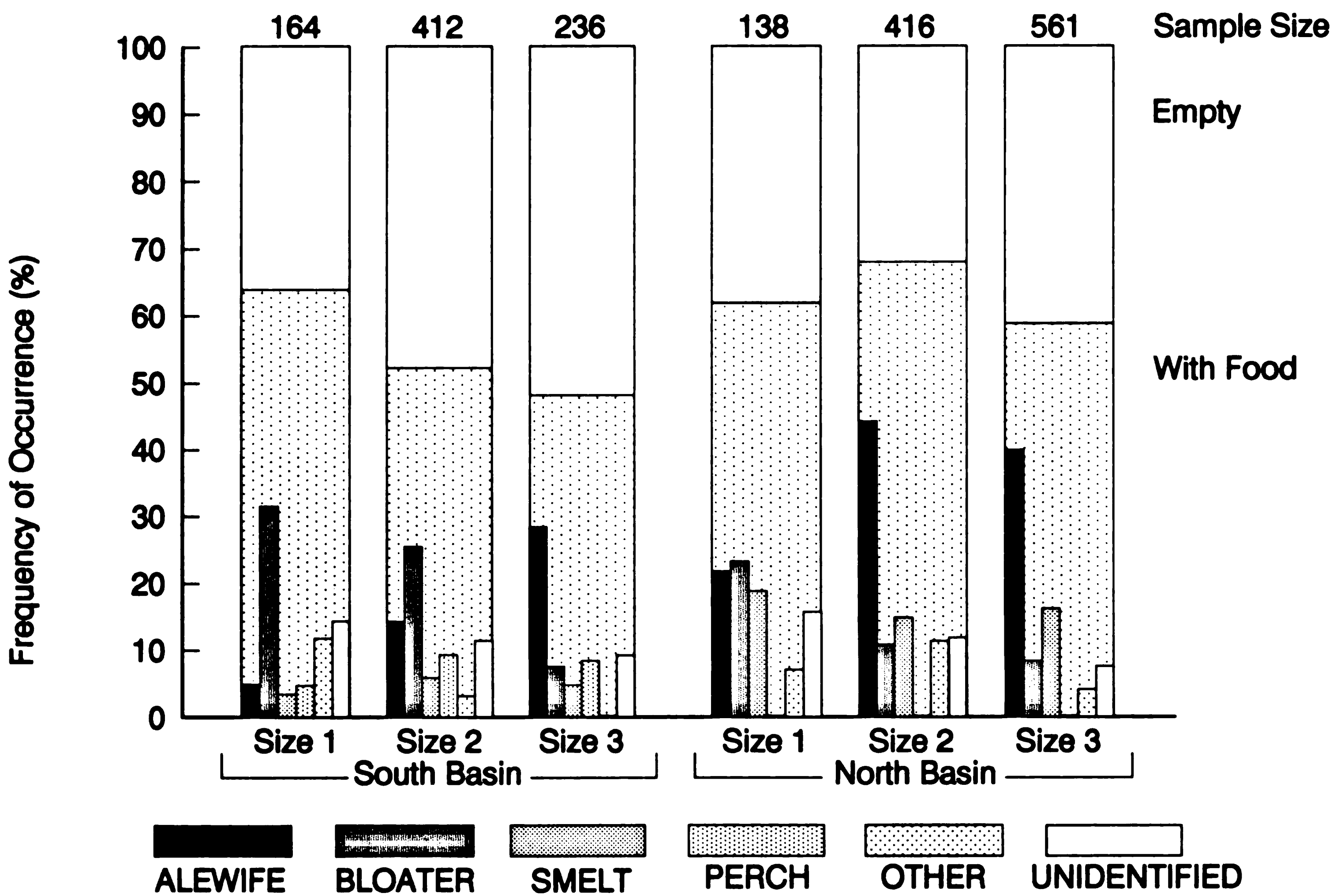

Figure 7. Average frequency of occurrence of prey types consumed by each size class of chinook salmon from the southern and northern basins of eastern Lake Michigan for April-October, 1986.

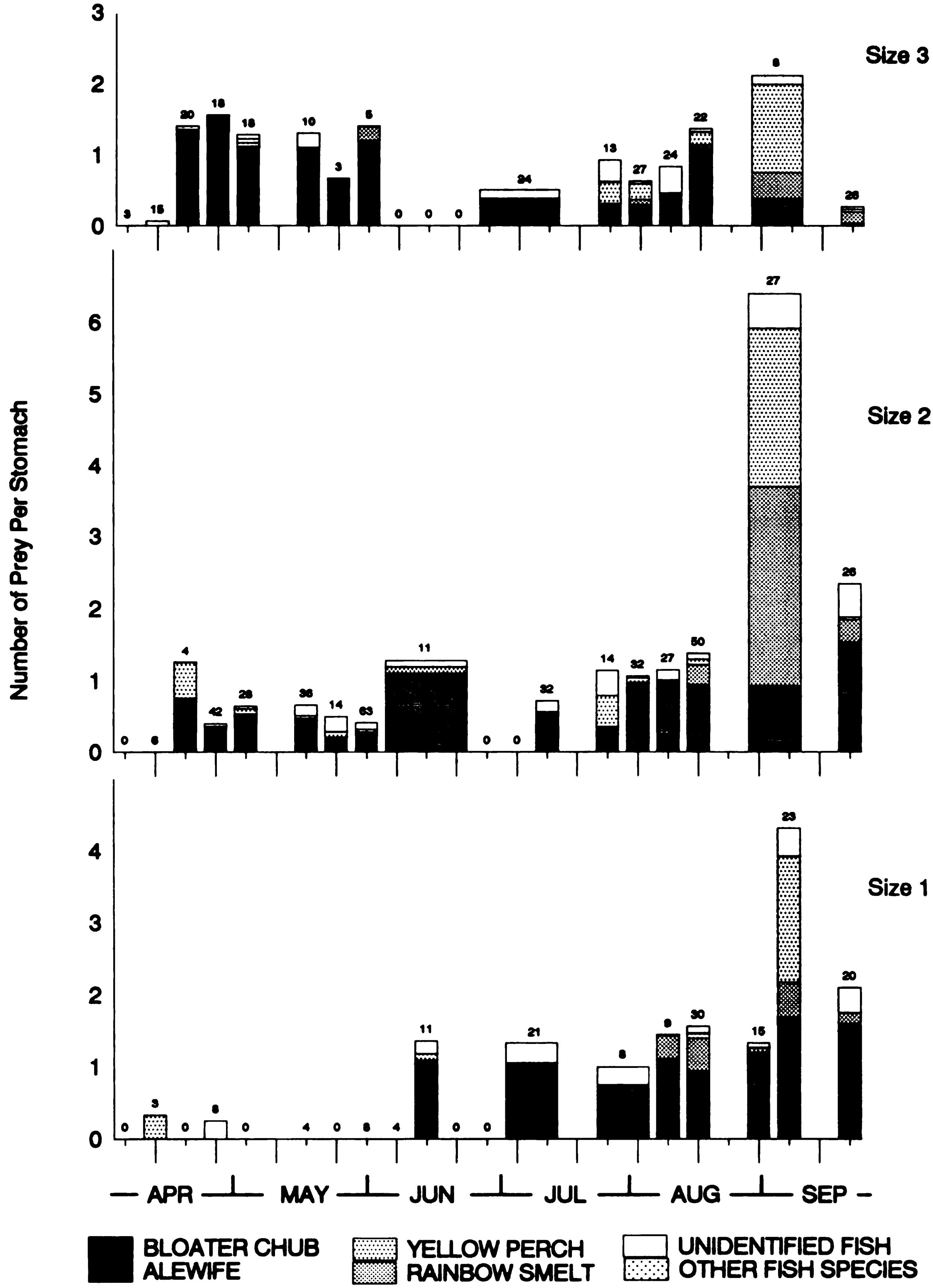

Figure 8a. Number of prey fish consumed by size class of chinook salmon from the southern basin of eastern Lake Michigan, 1986. The number above each bar indicates the sample size.

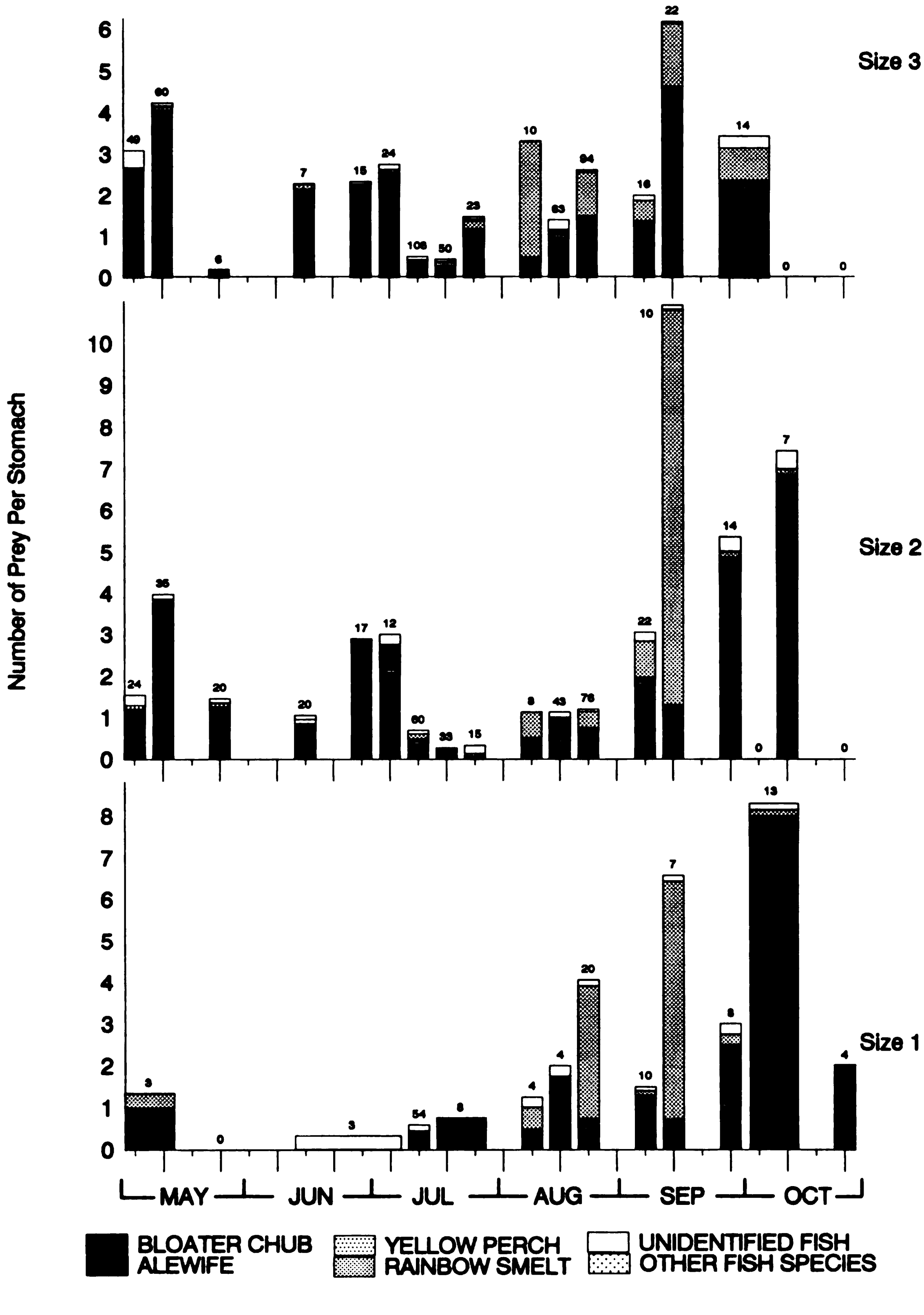

Figure 8b. Number of prey fish consumed by size class of chinook salmon from the northern basin of eastern Lake Michigan, 1986. The number above each bar indicates the sample size

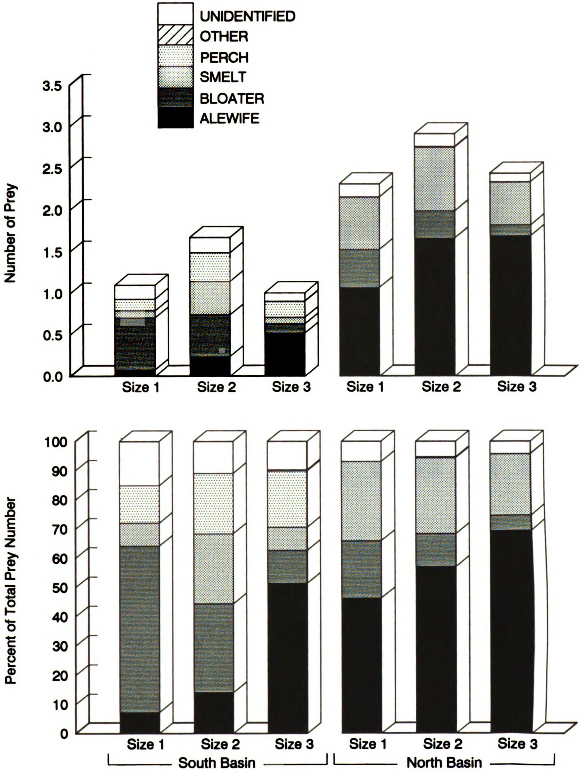

Figure 9. Average number and percent of the number of prey fish consumed by each size class of chinook salmon from both basins of eastern Lake Michigan for April-October, 1986.

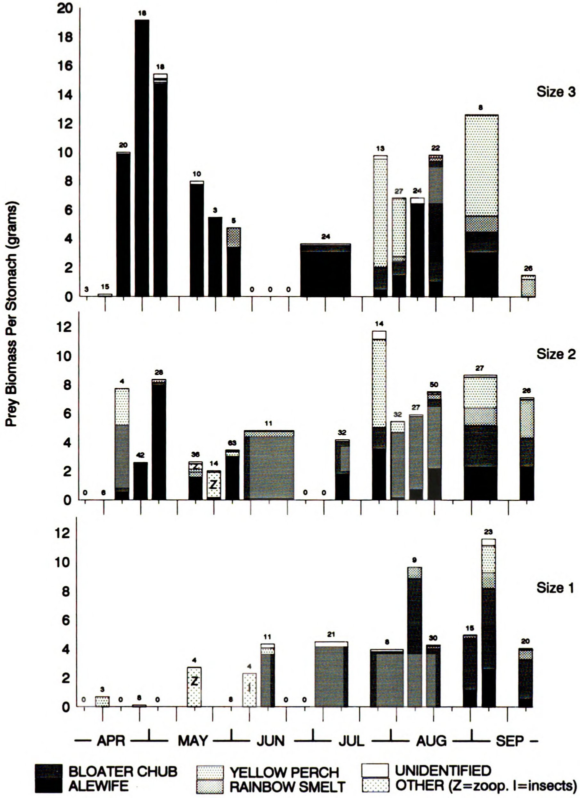

Figure 10a. Biomass of prey consumed by size class of chinook salmon from the southern basin of eastern Lake Michigan, 1986. The number above each bar indicates the sample size.

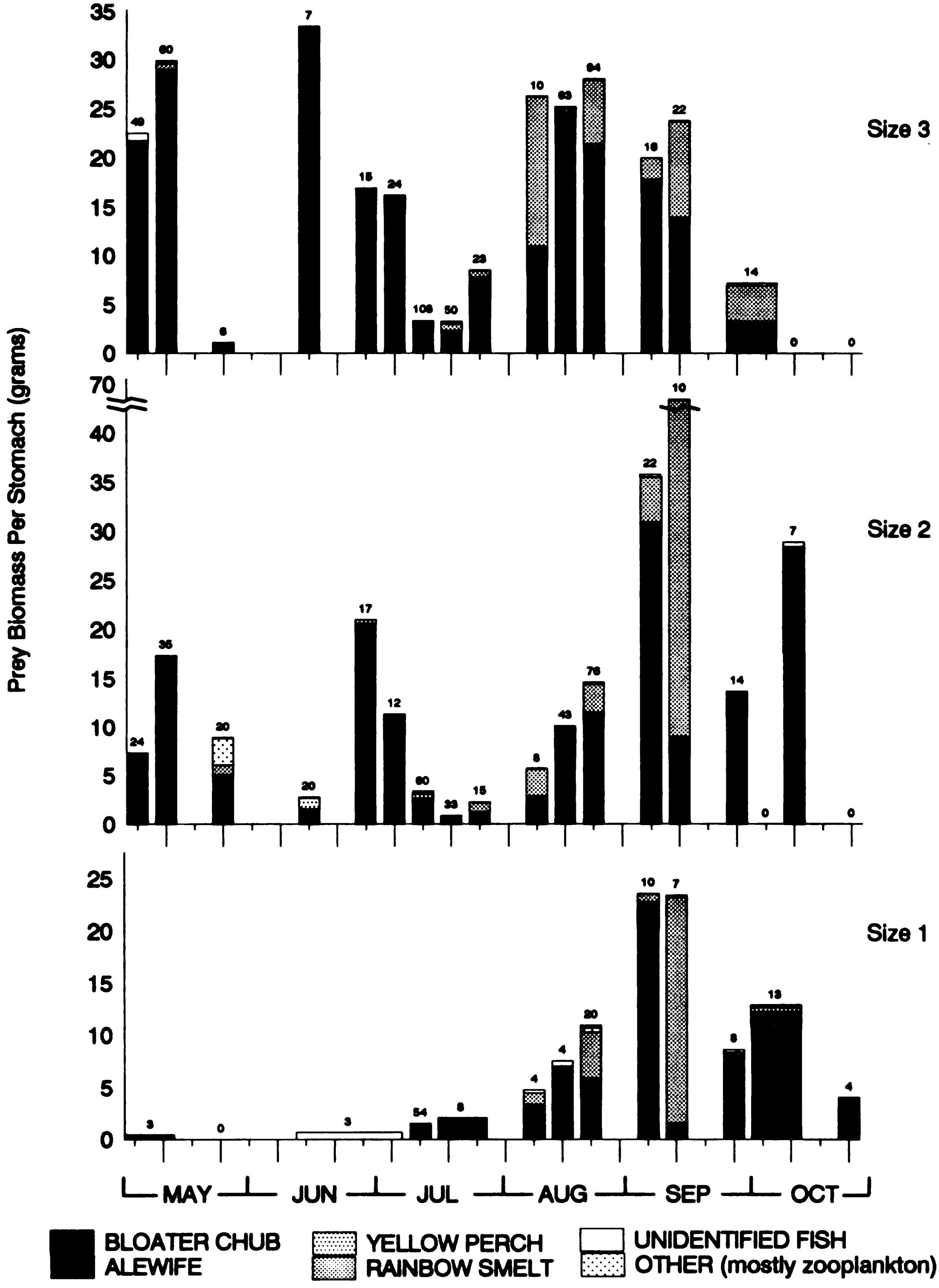

Figure 10b. Biomass of prey consumed by size class of chinook salmon from the northern basin of eastern Lake Michigan, 1986. The number above each bar indicates the sample size.

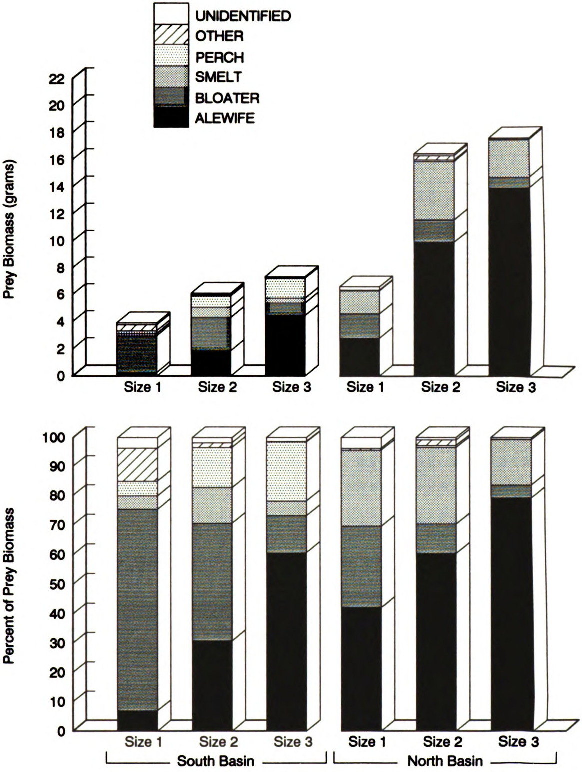

Figure 11. Average biomass and percent of the biomass of prey consumed by each size class of chinook salmon from both basins of eastern Lake Michigan for April - October, 1986.

Table 2. Length statistics of alewife consumed by chinook salmon from eastern Lake Michigan, 1986. Only sample dates where at least three prey were measured from at least one predator size class are listed. Bold text indicates those samples where bloater size differs between chinook size class.

		SIZE 1						SIZE 2						SIZE 3					
PO	DATE	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.
6	04/19	0	-	-	-	-	-	0	-	-	-	-	-	11	103 - 171	141.9	31	4.6	131 - 153
5	04/20	0	-	-	-	-	-	0	-	-	-	-	-	8	81 - 164	129.7	59	10.4	106 - 154
2	04/26	0	-	-	-	-	-	5	121 - 174	149.4	43	9.7	120 - 179	17	117 - 180	154.4	32	3.9	146 - 162
10	05/03	0	-	-	-	-	-	25	53 - 182	98.0	67	6.7	85 - 111	87	47 - 197	113.0	72	3.9	105 - 121
6	05/04	0	-	-	-	-	-	10	74 - 195	142.4	81	12.7	113 - 172	13	81 - 202	141.4	66	9.2	120 - 163
12	05/10	0	-	-	-	-	-	0	-	-	-	-	-	22	69 - 200	99.2	57	6.1	86 - 112
10	05/11	0	-	-	-	-	-	25	70 - 170	106.1	70	7.0	92 - 120	67	54 - 197	105.6	69	4.2	97 - 114
11	05/11	0	-	-	-	-	-	**34**	**70 - 191**	**95.5**	**53**	**4.5**	**86 - 105**	**29**	**70 - 190**	**118.7**	**76**	**7.0**	**105 - 133**
9	05/24	0	-	-	-	-	-	5	72 - 165	106.4	74	16.5	57 - 156	0	-	-	-	-	-
12	05/24	0	-	-	-	-	-	7	60 - 175	85.3	75	14.1	53 - 118	1	-	133.0	-	-	-
6	05/31	0	-	-	-	-	-	7	84 - 183	145.6	65	12.2	118 - 174	4	108 - 158	134.4	35	8.8	108 - 161
6	06/01	0	-	-	-	-	-	6	51 - 183	118.8	114	23.2	61 - 177	0	-	-	-	-	-
10	06/12	0	-	-	-	-	-	0	-	-	-	-	-	9	51 - 189	148.2	75	12.5	119 - 177
10	06/13	0	-	-	-	-	-	3	98 - 173	135.0	61	17.7	82 - 188	0	-	-	-	-	-
13	06/25	0	-	-	-	-	-	42	67 - 185	101.5	58	4.5	93 - 110	22	65 - 205	102.7	79	8.4	85 - 120
11	07/05	0	-	-	-	-	-	18	64 - 144	95.5	37	4.4	86 - 105	41	72 - 186	103.6	50	3.9	96 - 111
3	07/11	0	-	-	-	-	-	2	92 - 98	95.2	-	-	-	4	125 - 177	143.9	39	9.9	114 - 173
11	07/18	0	-	-	-	-	-	1	-	125.0	-	-	-	4	26 - 215	150.3	147	36.8	40 - 261
10	07/19	1	-	84.0	-	-	-	3	85 - 199	126.0	103	29.9	36 - 216	7	82 - 159	120.8	59	11.2	95 - 147
13	07/22	0	-	-	-	-	-	3	85 - 149	114.0	60	10.8	87 - 141	6	90 - 181	131.0	76	15.5	92 - 170
12	07/25	2	62 - 81	71.5	-	-	-	1	-	155.0	-	-	-	5	117 - 191	145.6	52	11.7	110 - 181
3	08/09	0	-	-	-	-	-	1	-	132.9	-	-	-	8	104 - 169	148.3	41	7.2	132 - 165
4	08/09	0	-	-	-	-	-	3	61 - 84	71.9	19	5.4	56 - 88	0	-	-	-	-	-
10	08/16	0	-	-	-	-	-	8	118 - 183	161.3	40	7.1	145 - 178	32	95 - 208	177.1	48	4.2	169 - 186
6	08/17	4	28 - 140	58.6	95	23.6	0 - 130	2	125 - 180	152.7	-	-	-	2	148 - 174	161.1	-	-	-
11	08/22	2	166 - 169	167.5	-	-	-	13	132 - 201	172.0	43	6.0	158 - 186	18	151 - 200	170.9	30	3.5	163 - 178
13	08/23	0	-	-	-	-	-	4	128 - 163	146.7	29	7.1	125 - 168	10	128 - 178	147.3	33	5.3	135 - 159
12	08/24	**4**	**27 - 35**	**31.3**	**6**	**1.6**	**26 - 36**	**4**	**133 - 163**	**153.0**	**24**	**5.9**	**135 - 171**	**29**	**93 - 216**	**150.0**	**46**	**4.3**	**141 - 159**
13	08/24	0	-	-	-	-	-	6	95 - 182	152.3	61	12.4	124 - 181	4	150 - 193	175.1	36	9.1	148 - 202
2	08/30	8	41 - 78	62.4	0	4.5	52 - 73	0	-	-	-	-	-	0	-	-	-	-	-
13	09/09	8	112 - 205	157.4	60	10.6	133 - 182	23	32 - 195	143.9	115	12.0	119 - 169	8	43 - 193	147.6	93	16.4	110 - 185
10	09/14	0	-	-	-	-	-	6	35 - 169	70.1	94	19.1	26 - 114	1	35 - 43	39.0	-	-	-
10	09/16	1	-	39.0	-	-	-	1	-	40.2	-	-	-	91	20 - 203	61.0	56	2.9	55 - 67
8	09/20	0	-	-	-	-	-	3	40 - 87	63.0	38	11.1	30 - 96	0	-	-	-	-	-
6	09/21	4	50 - 86	69.0	27	6.6	49 - 89	8	64 - 75	68.9	8	1.4	66 - 72	0	-	-	-	-	-
11	09/27	5	27 - 55	35.3	20	4.5	22 - 49	23	39 - 73	51.8	17	1.8	48 - 56	13	36 - 70	50.3	17	2.3	45 - 56
12	09/27	0	-	-	-	-	-	25	35 - 182	47.4	62	6.2	34 - 60	0	-	-	-	-	-
10	10/10	11	45 - 68	55.1	11	1.7	51 - 59	1	-	64.0	-	-	-	0	-	-	-	-	-
10	10/11	65	35 - 92	52.7	29	1.8	49 - 56	28	35 - 175	58.3	74	7.0	44 - 72	0	-	-	-	-	-
TOTAL		117	27 - 205	63.5	74	3.4	57 - 70	367	32 - 201	102.2	96	2.5	97 - 107	594	20 - 235	115.7	93	1.9	112 - 120

Table 3. Length statistics of bloater consumed by chinook salmon from eastern Lake Michigan, 1986. Only sample dates where at least two prey were measured from at least one predator size class are listed.

		SIZE 1						SIZE 2						SIZE 3					
PO	DATE	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.
6	05/04	0	-	-	-	-	-	2	74 - 79	76.5	5	1.8	-	1	-	78.8	-	-	-
5	06/14	6	76 - 106	91.5	21	4.3	82 - 101	3	80 - 127	108.7	41	11.9	58 - 160	0	-	-	-	-	-
6	06/18	0	-	-	-	-	-	5	69 - 90	80.6	14	3.2	71 - 90	0	-	-	-	-	-
11	07/05	0	-	-	-	-	-	7	74 - 95	83.9	13	2.4	78 - 89	6	78 - 101	87.0	15	3.0	80 - 94
3	07/11	2	81 - 102	91.7	21	7.5	-	5	84 - 122	101.3	26	5.9	84 - 119	0	-	-	-	-	-
4	07/12	3	88 - 97	91.1	8	2.4	81 - 101	1	-	86.0	-	-	-	0	-	-	-	-	-
5	07/12	7	75 - 107	90.2	19	3.7	82 - 99	1	-	121.1	-	-	-	1	-	122.0	-	-	-
6	07/13	4	89 - 136	109.3	35	8.8	83 - 136	0	-	-	-	-	-	0	-	-	-	-	-
9	07/17	2	72 - 115	93.5	43	15.2	-	2	79 - 89	84.2	10	3.7	-	1	-	119.0	-	-	-
11	07/18	4	82 - 106	94.1	19	4.7	80 - 108	0	-	-	-	-	-	0	-	-	-	-	-
10	07/19	3	95 - 110	101.7	12	3.6	86 - 117	1	-	86.0	-	-	-	5	77 - 100	87.2	16	3.5	77 - 98
13	07/22	1	-	135.2	-	-	-	2	87 - 94	90.5	7	2.5	-	2	109 - 148	128.5	39	13.8	-
15	07/24	0	-	-	-	-	-	0	-	-	-	-	-	3	106 - 142	125.9	30	8.7	89 - 163
12	07/25	1	-	82.3	-	-	-	0	-	-	-	-	-	3	83 - 157	109.4	67	19.5	26 - 193
8	08/01	1	-	102.0	-	-	-	20	88 - 107	97.0	11	1.2	94 - 100	5	90 - 102	94.7	8	1.8	89 - 100
8	08/02	3	90 - 106	97.1	13	3.8	81 - 114	1	-	97.0	-	-	-	0	-	-	-	-	-
3	08/09	8	35 - 150	106.3	88	15.6	70 - 142	13	71 - 148	108.5	41	5.7	96 - 122	0	-	-	-	-	-
15	08/09	0	-	-	-	-	-	2	115 - 123	119.0	8	2.8	-	1	-	130.0	-	-	-
4	08/10	2	112 - 138	125.0	26	9.2	-	3	95 - 110	104.0	13	3.7	88 - 120	0	-	-	-	-	-
9	08/15	4	89 - 105	96.3	13	3.2	87 - 106	1	-	101.0	-	-	-	0	-	-	-	-	-
5	08/16	10	90 - 130	111.4	25	4.0	102 - 120	22	73 - 134	107.4	31	3.3	101 - 114	1	-	70.6	-	-	-
10	08/16	1	-	103.0	-	-	-	13	92 - 105	98.0	9	1.2	95 - 101	5	94 - 100	96.2	4	0.9	93 - 99
6	08/17	7	82 - 118	102.5	24	4.6	92 - 113	11	47 - 213	103.1	81	12.1	75 - 131	18	68 - 148	111.1	43	5.0	101 - 122
11	08/22	2	91 - 105	98.0	14	4.9	-	0	-	-	-	-	-	1	-	76.0	-	-	-
12	08/24	1	-	95.0	-	-	-	4	92 - 102	97.7	7	1.8	92 - 103	4	92 - 106	97.3	11	2.8	89 - 106
2	08/30	6	95 - 136	113.7	26	5.3	102 - 126	1	-	143.5	-	-	-	0	-	-	-	-	-
3	09/06	11	51 - 133	79.6	49	7.4	63 - 97	8	46 - 114	72.2	46	8.1	54 - 91	1	-	128.0	-	-	-
4	09/07	9	77 - 115	97.8	27	4.5	87 - 108	1	-	111.0	-	-	-	0	-	-	-	-	-
13	09/09	2	141 - 156	148.6	15	5.3	-	2	77 - 123	100.0	46	16.3	-	1	-	124.0	-	-	-
10	09/14	1	-	76.0	-	-	-	2	82 - 115	98.7	33	11.6	-	0	-	-	-	-	-
10	09/16	2	66 - 75	70.5	9	3.2	-	0	-	-	-	-	-	2	71 - 74	72.3	3	1.2	-
8	09/20	1	-	76.0	-	-	-	2	64 - 65	64.5	1	0.4	-	0	-	-	-	-	-
6	09/21	5	66 - 118	89.0	40	8.9	62 - 116	9	61 - 110	83.0	31	5.2	71 - 95	0	-	-	-	-	-
11	09/27	2	119 - 135	127.0	16	5.7	-	2	65 - 93	78.8	28	10.0	-	1	-	139.9	-	-	-
12	09/27	1	-	102.0	-	-	-	2	91 - 100	95.5	9	3.2	-	0	-	-	-	-	-
10	10/10	0	-	-	-	-	-	9	72 - 112	93.2	24	4.0	84 - 103	0	-	-	-	-	-
10	10/11	5	71 - 88	78.6	12	2.6	71 - 86	4	45 - 88	66.2	32	8.1	42 - 90	0	-	-	-	-	-
10	10/25	7	60 - 70	68.4	7	1.3	65 - 71	0	-	-	-	-	-	0	-	-	-	-	-
Total		129	35 - 156	96.9	46	2.0	93 - 101	167	45 - 213	96.2	42	1.6	93 - 99	69	59 - 157	101.9	44	2.7	97 - 107

Table 4. Length statistics of rainbow smelt consumed by the three size classes of chinook salmon from eastern Lake Michigan, 1986. Bold text indicates those samples where smelt size differs between chinook size class.

		SIZE 1						SIZE 2						SIZE 3					
PO	DATE	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.
10	05/03	1	-	57.3	-	-	-	2	61 - 63	61.9	2	0.8	-	1	-	102.1	-	-	-
10	05/11	0	-	-	-	-	-	0	-	-	-	-	-	2	120 - 134	127.0	14	4.9	-
3	05/17	0	-	-	-	-	-	1	-	128.4	-	-	-	0	-	-	-	-	-
12	05/24	0	-	-	-	-	-	2	117 - 132	124.4	15	5.3	-	0	-	-	-	-	-
6	05/31	0	-	-	-	-	-	0	-	-	-	-	-	1	-	136.5	-	-	-
6	06/01	0	-	-	-	-	-	2	60 - 96	77.8	36	12.9	-	0	-	-	-	-	-
5	06/14	0	-	-	-	-	-	1	-	110.1	-	-	-	0	-	-	-	-	-
11	07/05	0	-	-	-	-	-	0	-	-	-	-	-	1	-	67.7	-	-	-
9	07/17	0	-	-	-	-	-	1	-	101.0	-	-	-	0	-	-	-	-	-
10	07/19	1	-	105.0	-	-	-	1	-	127.0	-	-	-	3	96 - 111	103.9	12	3.5	89 - 119
13	07/22	0	-	-	-	-	-	0	-	-	-	-	-	2	85 - 195	140.0	110	38.9	-
13	07/23	0	-	-	-	-	-	0	-	-	-	-	-	2	63 - 195	129.0	132	46.6	-
14	07/24	0	-	-	-	-	-	0	-	-	-	-	-	3	80 - 100	88.7	16	4.7	68 - 109
12	07/25	0	-	-	-	-	-	1	-	152.5	-	-	-	1	-	223.6	-	-	-
8	08/01	0	-	-	-	-	-	0	-	-	-	-	-	1	-	103.2	-	-	-
15	08/08	2	74 - 92	82.9	18	6.3	-	2	80 - 132	106.1	52	18.2	-	14	63 - 180	104.2	54	7.3	89 - 119
3	08/09	2	73 - 105	89.2	32	11.5	-	0	-	-	-	-	-	0	-	-	-	-	-
15	08/09	0	-	-	-	-	-	2	80 - 120	100.3	40	14.2	-	8	67 - 142	96.6	46	8.0	78 - 115
14	08/10	0	-	-	-	-	-	0	-	-	-	-	-	4	64 - 96	81.6	23	5.8	64 - 99
5	08/16	0	-	-	-	-	-	13	40 - 110	45.5	37	5.2	34 - 57	0	-	-	-	-	-
6	08/17	8	20 - 30	25.0	7	1.2	22 - 28	1	-	100.9	-	-	-	0	-	-	-	-	-
11	08/22	3	83 - 119	105.5	33	9.4	65 - 146	17	84 - 169	118.7	47	5.8	107 - 131	71	45 - 160	103.1	42	2.5	98 - 108
13	08/23	5	29 - 150	54.1	96	21.5	0 - 118	0	-	-	-	-	-	0	-	-	-	-	-
12	08/24	42	29 - 65	**34.8**	12	0.9	33 - 37	3	45 - 120	90.0	65	18.7	10 - 170	9	76 - 141	**102.6**	46	7.7	**85 - 120**
13	08/24	6	46 - 122	97.5	52	10.7	73 - 122	1	-	168.6	-	-	-	1	-	134.0	-	-	-
3	09/06	5	31 - 47	40.8	13	2.9	32 - 49	70	32 - 45	37.0	5	0.3	36 - 38	0	-	-	-	-	-
4	09/07	1	-	144.0	-	-	-	0	-	-	-	-	-	2	44 - 120	82.0	77	27.2	-
13	09/09	1	-	114.7	-	-	-	7	94 - 195	131.5	69	13.1	101 - 162	2	109 - 134	121.5	25	8.9	-
14	09/09	0	-	-	-	-	-	8	29 - 103	44.9	45	8.0	26 - 63	1	-	41.3	-	-	-
9	09/14	1	-	152.0	-	-	-	0	-	-	-	-	-	2	120 - 144	132.2	24	8.7	-
10	09/14	15	74 - 147	117.4	38	4.9	107 - 128	44	48 - 167	121.0	45	3.4	114 - 128	7	50 - 135	104.8	50	9.4	83 - 126
10	09/16	23	37 - 52	**38.6**	10	1.0	36 - 41	40	40 - 112	63.5	31	2.5	**59 - 68**	21	42 - 165	**89.4**	73	7.9	**73 - 106**
5	09/19	0	-	-	-	-	-	0	-	-	-	-	-	1	-	57.3	-	-	-
8	09/20	0	-	-	-	-	-	2	46 - 149	97.5	103	36.5	-	2	132 - 156	143.9	24	8.5	-
6	09/21	3	46 - 138	77.0	86	24.9	0 - 184	2	45 - 139	91.7	94	33.2	-	0	-	-	-	-	-
11	09/27	2	53 - 60	56.5	7	2.5	-	0	-	-	-	-	-	4	83 - 116	104.3	26	6.4	85 - 124
	Total	123	20 - 152	57.5	74	3.3	51 - 64	223	29 - 195	75.4	83	2.8	70 - 81	170	41 - 224	102.9	59	2.3	98 - 107

Table 5. Length statistics of prey fish (all species combined) consumed by the three size classes of chinook salmon from eastern Lake Michigan, 1986. Bold text indicates those samples where prey size differs between chinook size class.

		SIZE 1						SIZE 2						SIZE 3					
PO	DATE	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.
3	04/13	1	-	61.4	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
6	04/19	0	-	-	-	-	-	3	82 - 127	111.0	41	11.9	60 - 162	12	67 - 171	135.7	51	7.3	119 - 153
5	04/20	0	-	-	-	-	-	0	-	-	-	-	-	9	59 - 164	121.8	71	11.8	95 - 149
2	04/25	1	-	86.0	-	-	-	0	-	-	-	-	-	1	-	202.0	-	-	-
3	04/25	0	-	-	-	-	-	0	-	-	-	-	-	1	-	132.9	-	-	-
2	04/26	0	-	-	-	-	-	5	121 - 174	149.4	43	9.7	120 - 179	17	117 - 180	154.4	32	3.9	146 - 162
10	05/03	1	-	57.3	-	-	-	31	47 - 182	**90.4**	68	6.1	**78 - 103**	99	47 - 197	**109.2**	71	3.6	**102 - 116**
6	05/04	0	-	-	-	-	-	14	63 - 195	122.9	92	12.3	97 - 149	16	79 - 202	138.0	71	8.8	120 - 157
12	05/10	0	-	-	-	-	-	0	-	-	-	-	-	22	69 - 200	99.2	57	6.1	86 - 112
10	05/11	0	-	-	-	-	-	25	70 - 170	106.1	70	7.0	92 - 120	70	54 - 197	105.9	68	4.0	98 - 114
11	05/11	0	-	-	-	-	-	35	70 - 191	**95.1**	52	4.4	**86 - 104**	30	70 - 190	**119.7**	75	6.9	**106 - 133**
7	05/16	0	-	-	-	-	-	0	-	-	-	-	-	1	-	109.0	-	-	-
3	05/17	0	-	-	-	-	-	2	82 - 128	105.4	46	16.3	-	2	112 - 133	122.5	21	7.4	-
7	05/23	0	-	-	-	-	-	1	-	134.0	-	-	-	2	120 - 171	145.3	51	17.9	-
9	05/24	0	-	-	-	-	-	6	72 - 165	109.6	69	14.0	77 - 142	0	-	-	-	-	-
12	05/24	0	-	-	-	-	-	9	60 - 175	94.0	74	12.3	66 - 122	1	-	132.9	-	-	-
6	05/31	0	-	-	-	-	-	10	63 - 183	127.8	84	13.4	97 - 159	5	108 - 158	134.8	32	7.1	114 - 156
5	06/01	0	-	-	-	-	-	1	-	176.0	-	-	-	0	-	-	-	-	-
6	06/01	0	-	-	-	-	-	8	51 - 183	95.9	94	16.7	58 - 134	0	-	-	-	-	-
10	06/12	0	-	-	-	-	-	0	-	-	-	-	-	10	51 - 189	143.8	76	12.0	116 - 171
8	06/13	1	-	76.4	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-
10	06/13	0	-	-	-	-	-	6	76 - 173	125.9	62	12.7	97 - 155	0	-	-	-	-	-
5	06/14	8	76 - 114	93.9	24	4.2	84 - 104	4	80 - 127	109.0	36	8.9	82 - 136	0	-	-	-	-	-
6	06/18	0	-	-	-	-	-	5	69 - 90	80.6	14	3.2	71 - 90	0	-	-	-	-	-
13	06/25	0	-	-	-	-	-	42	67 - 185	101.5	58	4.5	93 - 110	22	65 - 205	102.7	79	8.4	85 - 120
1	06/29	0	-	-	-	-	-	0	-	-	-	-	-	1	-	164.2	-	-	-
11	07/05	0	-	-	-	-	-	25	64 - 144	92.2	34	3.4	85 - 99	48	68 - 186	100.8	49	3.5	94 - 108
3	07/11	2	81 - 102	91.7	21	7.5	-	7	84 - 122	**99.5**	23	4.4	**90 - 110**	4	125 - 177	**143.9**	39	9.9	**114 - 173**
4	07/12	3	88 - 97	91.1	8	2.4	81 - 101	1	-	86.0	-	-	-	0	-	-	-	-	-
5	07/12	8	75 - 117	**93.6**	25	4.5	**83 - 104**	3	121 - 173	**150.4**	43	12.5	**97 - 204**	3	82 - 122	95.9	37	10.7	50 - 142
6	07/13	5	71 - 136	101.6	44	9.8	72 - 131	0	-	-	-	-	-	0	-	-	-	-	-
9	07/17	2	72 - 115	93.5	43	15.2	-	4	79 - 170	109.8	71	17.8	56 - 163	1	-	119.0	-	-	-
10	07/17	0	-	-	-	-	-	0	-	-	-	-	-	2	154 - 160	157.0	6	2.1	-
10	07/18	0	-	-	-	-	-	0	-	-	-	-	-	1	-	101.0	-	-	-
11	07/18	4	82 - 106	94.1	19	4.7	80 - 108	1	-	125.0	-	-	-	4	26 - 215	150.3	147	36.8	40 - 261
10	07/19	5	84 - 110	98.8	18	4.0	87 - 111	5	85 - 199	118.2	86	19.3	60 - 176	15	77 - 159	106.2	51	6.6	92 - 120
13	07/21	0	-	-	-	-	-	0	-	-	-	-	-	4	60 - 163	126.9	81	20.3	66 - 188
13	07/22	1	-	135.2	-	-	-	3	87 - 149	110.1	56	16.0	41 - 179	10	65 - 195	123.3	87	13.7	92 - 155
13	07/23	0	-	-	-	-	-	2	85 - 108	96.6	23	8.2	-	2	63 - 195	129.0	132	46.6	-

Table 5. (cont'd).

		SIZE 1						SIZE 2						SIZE 3					
PO	DATE	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.	N	Range	AVG	2SD	S.E.	95% C.I.
2	07/24	0	-	-	-	-	-	0	-	-	-	-	-	2	83 - 109	96.2	26	9.3	-
14	07/24	0	-	-	-	-	-	0	-	-	-	-	-	3	80 - 100	88.7	16	4.7	68 - 109
15	07/24	0	-	-	-	-	-	0	-	-	-	-	-	4	77 - 142	113.7	50	12.5	76 - 151
1	07/25	0	-	-	-	-	-	6	81 - 190	132.8	65	13.3	102 - 163	2	119 - 132	125.5	13	4.6	-
12	07/25	3	62 - 82	75.1	19	5.4	52 - 98	2	153 - 155	153.8	2	0.9	-	9	83 - 224	142.2	86	14.4	109 - 175
8	08/01	1	-	102.0	-	-	-	23	88 - 160	101.6	33	3.4	94 - 109	14	65 - 235	118.4	77	10.3	97 - 140
8	08/02	3	90 - 106	97.1	13	3.8	81 - 114	1	-	97.0	-	-	-	1	-	160.0	-	-	-
15	08/08	3	74 - 135	100.3	51	14.9	36 - 164	2	80 - 132	106.1	52	18.2	-	14	63 - 180	104.2	54	7.3	89 - 119
3	08/09	10	35 - 150	102.9	81	12.9	73 - 133	15	71 - 148	110.0	40	5.2	99 - 121	8	104 - 169	148.3	41	7.2	132 - 165
4	08/09	0	-	-	-	-	-	3	61 - 84	71.9	19	5.4	49 - 95	0	-	-	-	-	-
15	08/09	0	-	-	-	-	-	4	80 - 123	109.7	34	8.6	84 - 135	10	67 - 158	106.1	57	9.0	85 - 127
4	08/10	2	112 - 138	125.0	26	9.2	-	3	95 - 110	104.0	13	3.7	88 - 120	3	85 - 153	112.0	59	17.0	- -
14	08/10	0	-	-	-	-	-	0	-	-	-	-	-	6	64 - 164	107.1	75	15.3	72 - 142
9	08/15	4	89 - 105	96.3	13	3.2	87 - 106	2	101 - 173	137.0	72	25.5	-	0	-	-	-	-	-
5	08/16	11	56 - 130	106.3	40	6.0	93 - 120	41	40 - 150	83.0	70	5.5	72 - 94	3	51 - 71	59.4	16	4.7	39 - 80
9	08/16	0	-	-	-	-	-	0	-	-	-	-	-	1	-	202.3	-	-	-
10	08/16	1	-	103.0	-	-	-	22	20 - 183	117.5	78	8.3	100 - 135	42	13 - 208	151.5	109	8.4	135 - 168
6	08/17	19	20 - 140	60.6	83	9.5	41 - 81	14	47 - 213	110.1	82	11.0	87 - 133	21	68 - 174	116.2	50	5.4	105 - 128
11	08/22	8	40 - 169	110.9	80	14.1	78 - 143	30	84 - 201	141.8	70	6.4	129 - 155	90	45 - 200	116.4	68	3.6	109 - 124
13	08/23	6	29 - 150	66.9	105	21.4	18 - 116	4	128 - 163	146.7	29	7.1	125 - 168	10	128 - 178	147.3	33	5.3	135 - 159
12	08/24	48	27 - 95	36.7	24	1.7	33 - 40	11	45 - 163	115.7	68	10.2	92 - 139	42	76 - 216	134.8	63	4.9	125 - 145
13	08/24	6	46 - 122	97.5	52	10.7	73 - 122	8	95 - 182	152.3	55	9.7	130 - 175	6	52 - 193	147.7	96	19.5	103 - 193
2	08/30	15	41 - 136	83.7	55	7.1	69 - 99	1	-	143.5	-	-	-	0	-	-	-	-	-
3	09/06	30	31 - 196	66.9	64	5.9	55 - 79	103	32 - 180	43.1	36	1.8	40 - 47	1	-	128.0	-	-	-
4	09/07	20	34 - 144	75.9	60	6.7	62 - 90	23	46 - 111	57.6	26	2.7	52 - 63	11	42 - 161	69.6	71	10.7	45 - 94
13	09/09	12	30 - 205	141.8	87	12.5	113 - 171	32	32 - 195	138.4	106	9.3	120 - 157	11	43 - 193	140.7	83	12.5	112 - 170
14	09/09	0	-	-	-	-	-	12	29 - 103	39.9	40	5.7	27 - 53	3	35 - 70	48.9	30	8.7	11 - 86
9	09/14	1	-	152.0	-	-	-	0	-	-	-	-	-	4	35 - 144	92.7	85	21.2	29 - 156
10	09/14	16	74 - 147	114.9	42	5.3	104 - 126	52	35 - 169	114.3	62	4.3	106 - 123	8	43 - 135	97.0	62	11.0	72 - 122
10	09/16	26	37 - 75	41.1	20	1.9	37 - 45	41	40 - 112	62.9	32	2.5	58 - 68	114	20 - 203	66.5	63	3.0	61 - 72
5	09/19	0	-	-	-	-	-	0	-	-	-	-	-	1	-	57.3	-	-	-
8	09/20	1	-	76.0	-	-	-	7	40 - 149	73.3	68	12.8	44 - 103	2	132 - 156	143.9	24	8.5	-
6	09/21	12	46 - 138	79.3	55	8.0	61 - 98	22	40 - 139	73.8	44	4.7	64 - 84	0	-	-	-	-	-
11	09/27	9	27 - 135	60.4	75	12.5	32 - 89	25	39 - 93	54.0	23	2.3	49 - 59	20	36 - 140	66.1	58	6.5	52 - 80
12	09/27	1	-	102.0	-	-	-	10	41 - 182	77.3	83	13.1	47 - 107	0	-	-	-	-	-
12	09/28	0	-	-	-	-	-	17	35 - 35	35.5	0	0.0	35 - 35	0	-	-	-	-	-
13	09/28	2	91 - 100	95.5	9	3.2	-	0	-	-	-	-	-	0	-	-	-	-	-
10	10/10	13	25 - 68	52.7	19	2.6	47 - 59	10	64 - 112	90.3	29	4.6	80 - 101	0	-	-	-	-	-
10	10/11	70	35 - 92	54.5	31	1.8	51 - 58	32	35 - 175	59.3	70	6.2	47 - 72	0	-	-	-	-	-
10	10/25	7	60 - 70	68.4	7	1.3	65 - 71	0	-	-	-	-	-	0	-	-	-	-	-
	Total	402	20 - 205	72.1	72	1.8	68 - 76	836	20 - 213	90.0	86	1.5	87 - 93	881	13 - 235	110.4	85	1.4	108 - 113

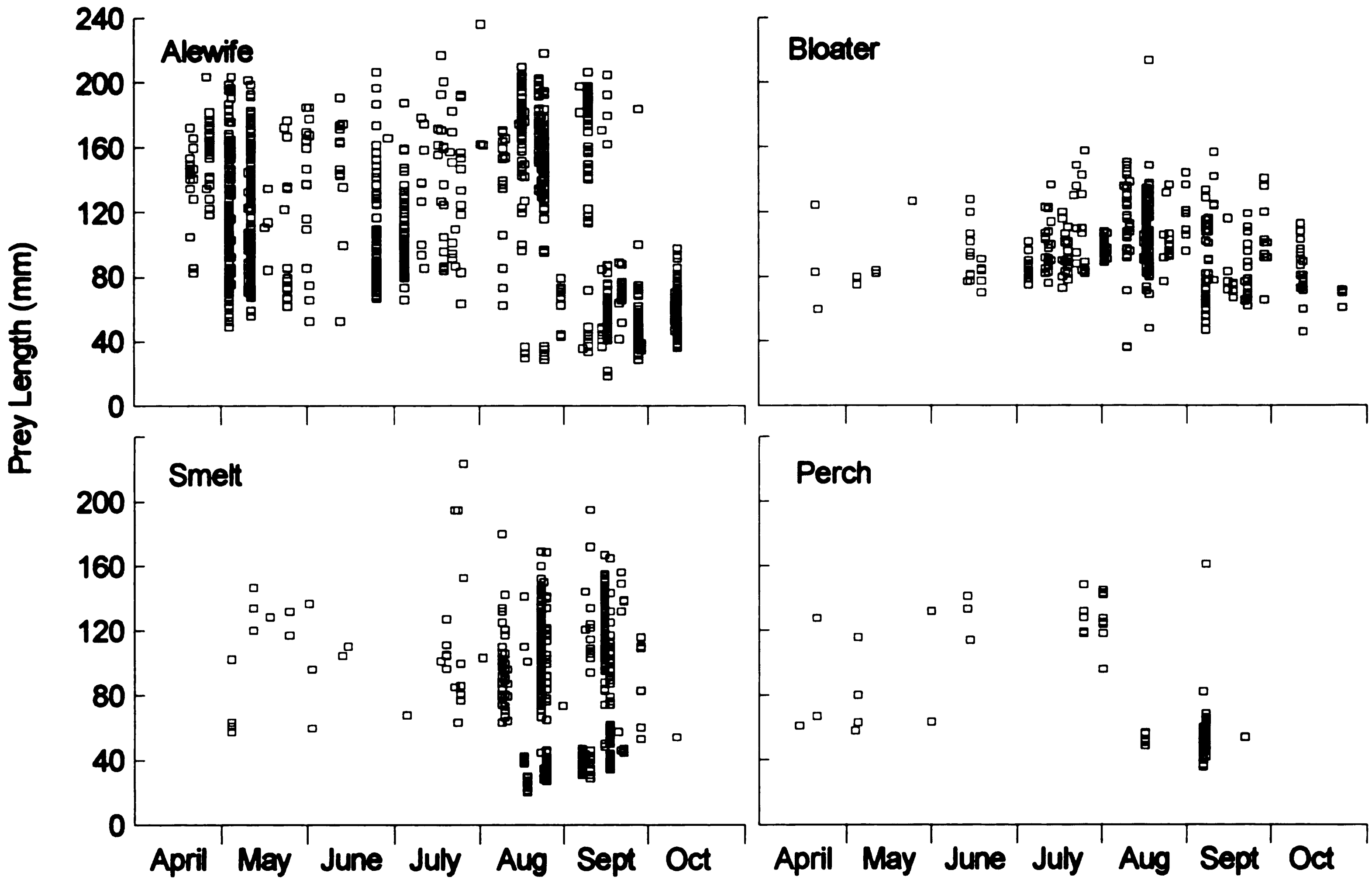

Figure 12. Length of alewife, bloater, smelt, and perch consumed by all sizes of chinook salmon from the eastern Lake Michigan, 1986.

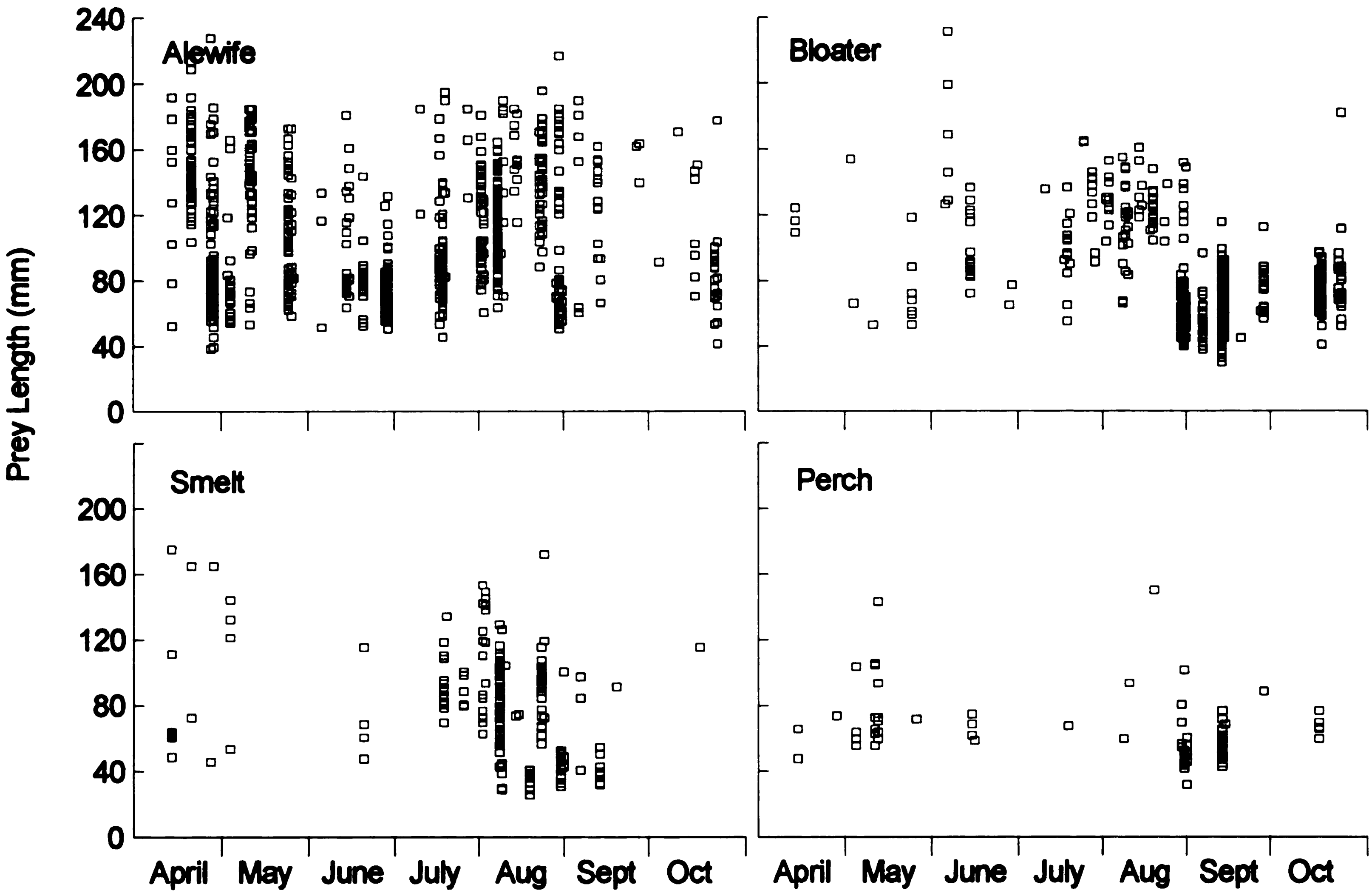

Figure 13. Length of alewife, bloater, smelt, and perch consumed by all sizes of chinook salmon from the eastern Lake Michigan, 1985.

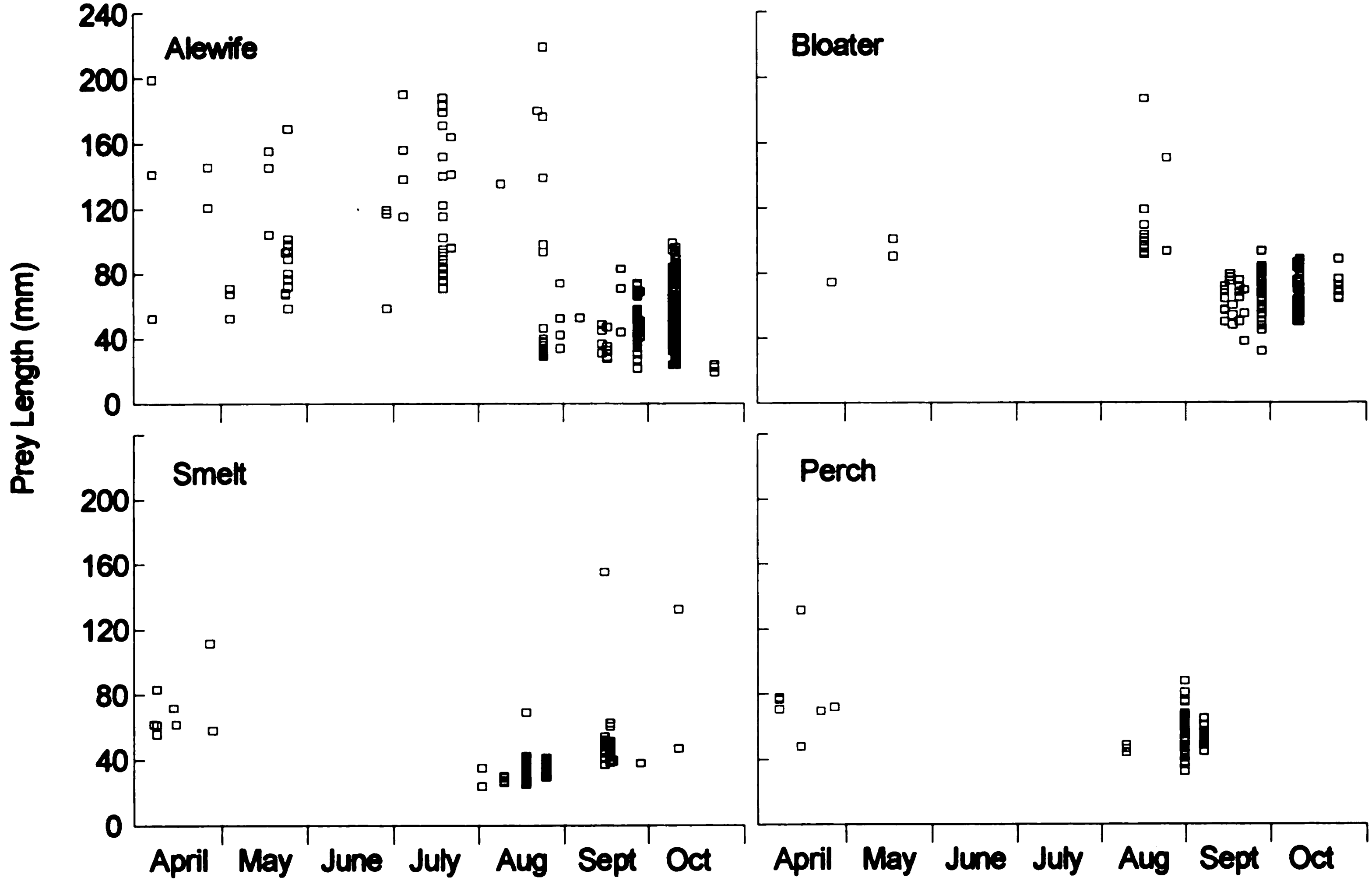

Figure 14. Length of alewife, bloater, smelt, and perch consumed by all sizes of coho salmon from the eastern Lake Michigan, 1986.

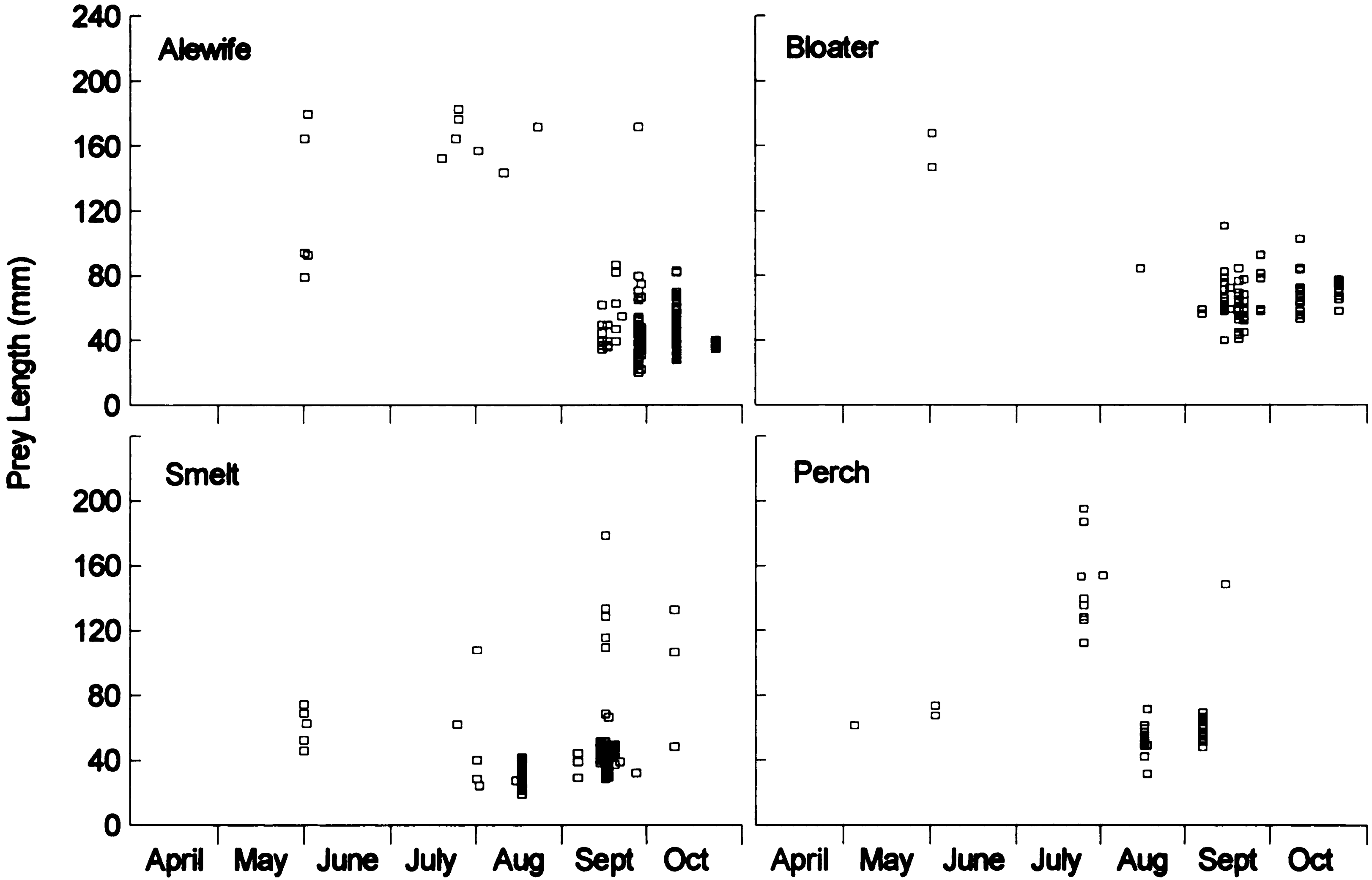

Figure 15. Length of alewife, bloater, smelt, and perch consumed by all sizes of steelhead from the eastern Lake Michigan, 1986.

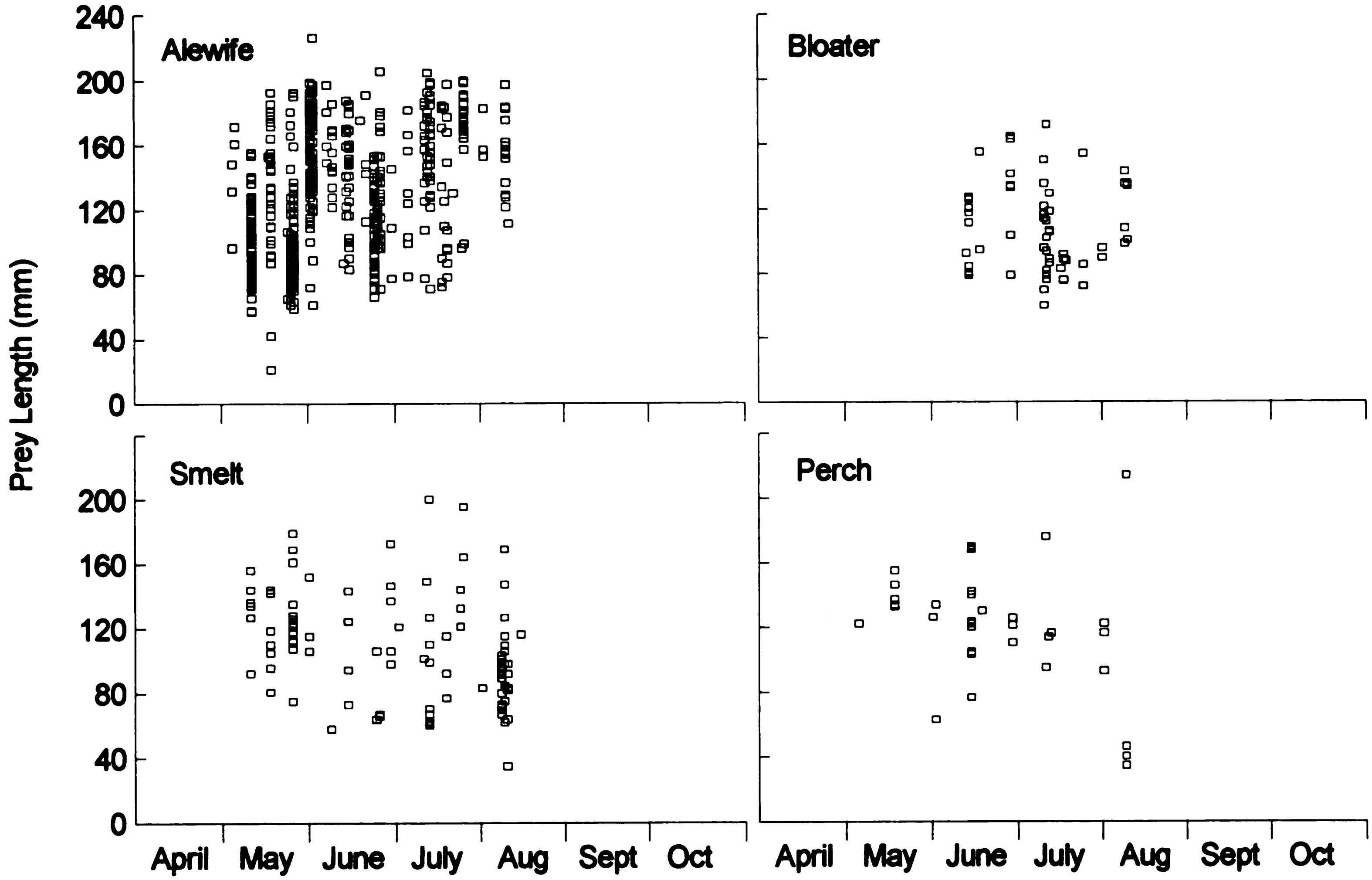

Figure 16. Length of alewife, bloater, smelt, and perch consumed by all sizes of lake trout from the eastern Lake Michigan, 1986.

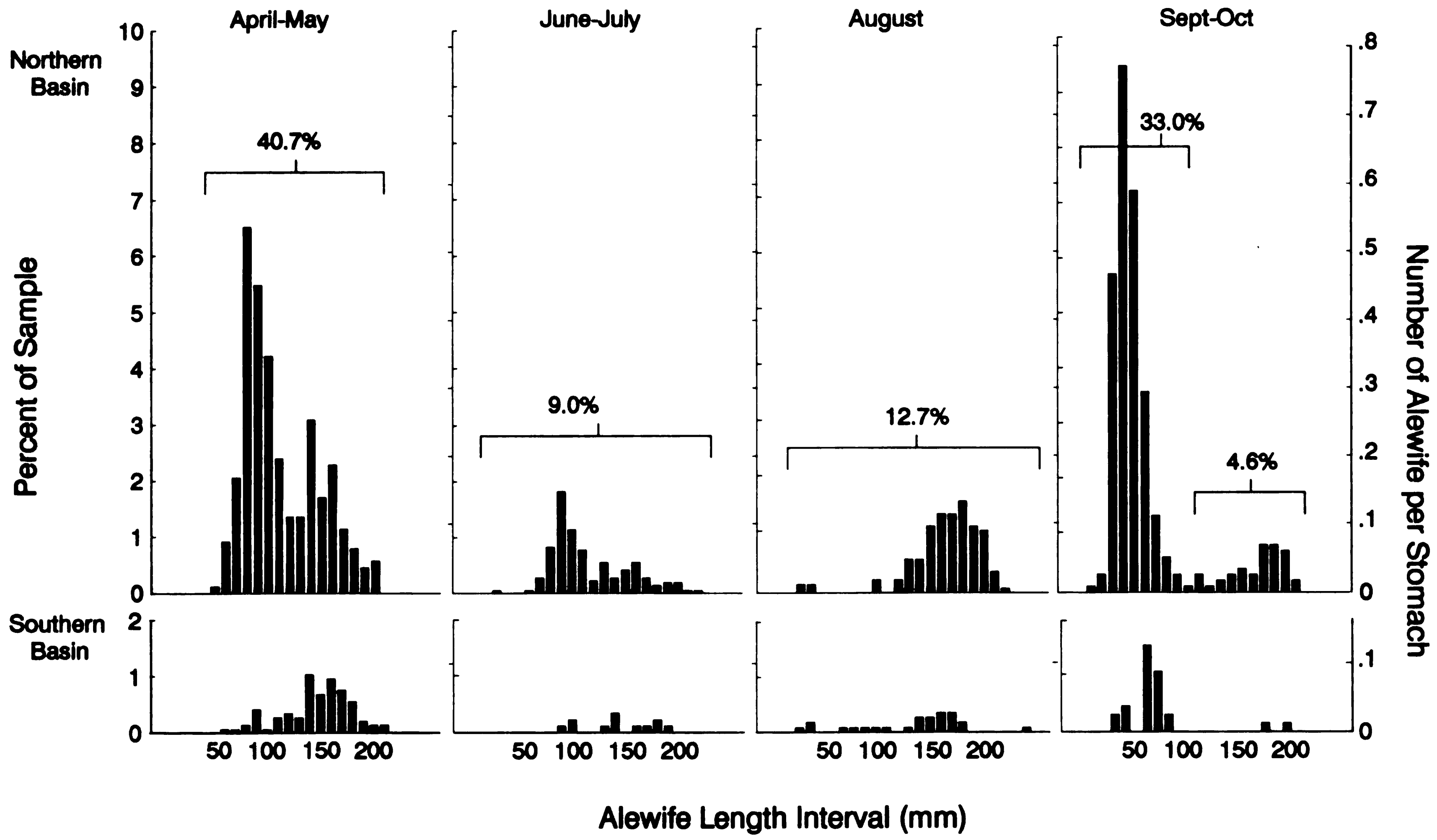

Figure 17. Seasonal differences in the length distribution and number of alewife consumed by chinook salmon from the southern and northern basins of eastern Lake Michigan, 1986.

frequency, absolute amount, and proportion of bloater in the diet decreased with increasing predator size in both basins. While the proportion of bloater in the diet was significantly greater in the south than in the north, this was due primarily to the lesser amount of alewife in the diet in the south and not to a greater amount of bloater. Frequency of occurrence of bloater in the diet was slightly greater in the south from July on, but the number and biomass consumed did not differ significantly between the two regions.

Rainbow smelt occurred in the diet periodically from April through July as adults and then consistently from August on as both adults and YOY. Sizes consumed ranged from 20-240 mm and like alewife, were representative of sizes typically found in the lake. The frequency, absolute amount, and proportion of rainbow smelt in the diet were consistent among predator size class, and were much greater in the north than the south.

Yellow perch rarely occurred in the diet in the north, but occurred periodically in the south in all months as small adults less than 170 mm, and in the fall primarily as juveniles 40-80 mm in length. In the south, the frequency, absolute amount, and proportion of yellow perch in the diet appeared consistent between predator size class, and were equal to or greater than the contribution of smelt.

Other species of fish occurred only occasionally in the diets and, overall, contributed very little. Of these, nine-spine stickleback (Pungitius pungitius)occurred most often, and primarily in chinook caught near the Manitou Islands. Of some interest was the occurrence in the diet of several species of fish that are not typical inhabitants of Lake Michigan waters such as northern pike (Esox lucius) and bluegill

(Lepomis macrochirus). Heavy rains in September of 1986 led to a 100-year flood event that washed out local dams and caused extreme discharge from area rivers. Coincident occurrence in the chinook diets of these typically riverine fish indicated that many of the fish species associated with these rivers were flushed into Lake Michigan and that the chinook were opportunistic in their predation on them.

Invertebrates occurred periodically through the year with some apparent seasonal trends. The amphipod Diporeia spp. appeared to be the most important aquatic invertebrate for these chinook, although Daphnia sp. and Mysis relicta were also found. Although less frequently, terrestrial insects were also consumed, occasionally in large numbers. These aquatic and terrestrial invertebrates occurred primarily earlier in the season and contributed more to the diet of smaller chinook, where they were occasionally the predominant prey item (Figure 10a). The large exotic cladoceran, Bythotrephes cederstroemi, which appeared in Lake Michigan in the summer of 1986 (Lehman 1991), was first observed in the chinook diets on July 18, 1986. From then on it was the only zooplankton that occurred in the diet and remained common through the fall. Although Bythotrephes were found in chinook of all sizes, it occurred more frequently and in greater numbers in the diet of smaller chinook, and more frequently in chinook from the northern basin. Overall, invertebrates contributed only a small portion to the diet, primarily occurring in smaller chinook, particularly in the spring.

Of some concern may be the occurrence in the stomachs of chinook of other items associated with human litter such as plastic food wrappers and cigarettes. Such items were more common in the stomachs of steelhead (data not presented here), which typically feed near the surface and in association with scum or trash lines where this material may collect.

Digested State of Prey

There was little diversity in the observed contents of individual chinook stomachs. Although several prey types typically characterized the diet of all chinook on a given day at one location, most fish had just one prey type in their stomachs. When more than one were present, the digested state of the prey often indicated the two types had been consumed at different times. The occurrence of multiple prey types appeared similar for all size classes of chinook, though was more common in summer and fall than in spring.

The digestion state of the four major forage fish showed similar distribution patterns, although each differed significantly from one another ($p < 0.05$)(Figure 18). For all species, most were 50% to 75% digested, with only a small percent appearing to have been ingested shortly before the chinook was caught. Yellow perch and rainbow smelt tended to be less digested than alewife or bloater.

On four dates, enough chinook were collected from catches in both the morning and the afternoon of the same day at one location so that comparisons of diet between morning and afternoon caught chinook could be made. In each case, the diet was different between morning and afternoon, but in no consistent manner that indicated anything other than the usual random variation typically observed between fish. However, alewife and bloater in the stomachs of chinook caught in the afternoon were somewhat less digested than in chinook caught in the morning (Figure 19). Days when samples were collected in both morning

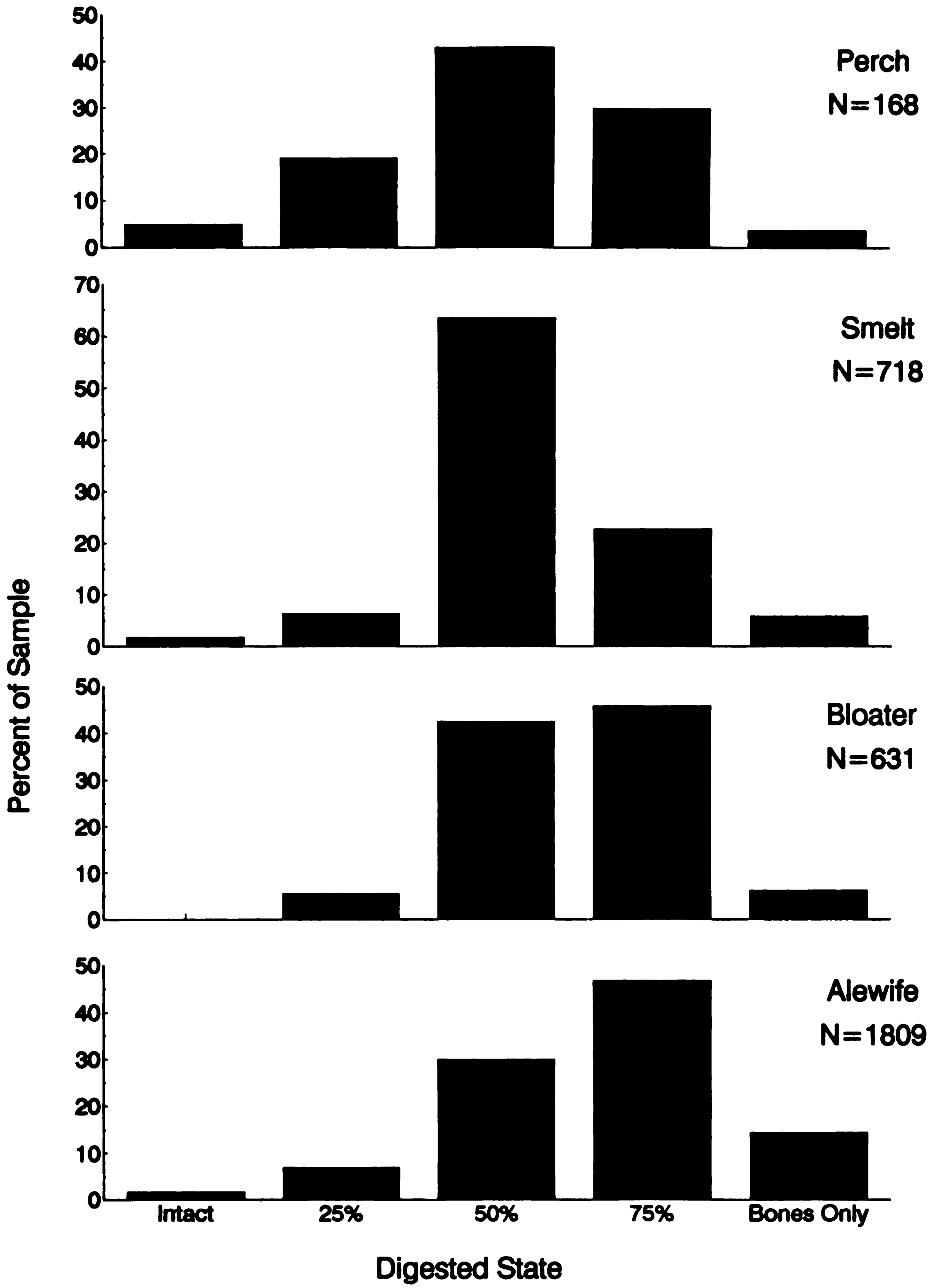

Figure 18. States of digestion observed for alewife, bloater, smelt, and perch consumed by chinook salmon from eastern Lake Michigan, 1986.

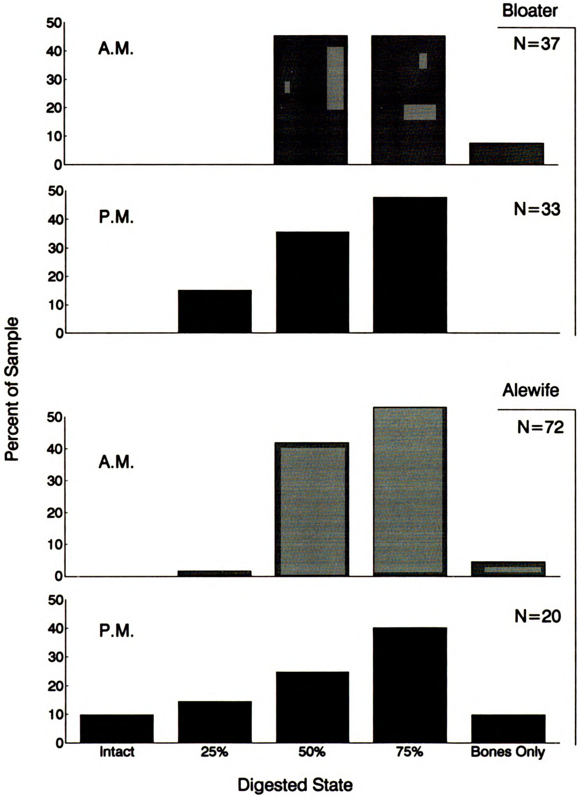

Figure 19. States of digestion observed for alewife and bloater consumed by chinook collected in the morning and in the afternoon from eastern Lake Michigan, 1986.

and afternoon from one location were limited and did not include enough perch or smelt for similar comparisons. When all morning and all afternoon samples were combined (regardless of date or location), no differences were apparent, indicating that the variation from day to day and from location to location was greater that any diel differences that may exist. There was no observed difference in the digested state of prey between basins or among seasons.

Sizes of Prey Consumed

Seasonal trends in size of prey consumed by chinook showed marked similarities between 1986 (Figure 12) and 1985 (Figure 13), indicating patterns observed are likely typical of annual forage use. Chinook consumed alewife and smelt of all sizes available in Lake Michigan, but rarely consumed adult bloater or perch over 160 mm in length, despite their recent increased abundance in the lake. In both years, large adult alewife were commonly consumed in April through May and August through early September, but were less frequently consumed in June and early July. Sizes of bloater, smelt, and perch in the diet were consistent from April through mid-August, a period when only adult prey (including yearling alewife) were consumed. But from mid-August through October, YOY alewife, bloater, and smelt, as well as juvenile perch were the primary diet.

Similarity in the sizes of bloater, smelt, and perch consumed by predators from both the northern and southern basin of eastern Lake Michigan indicate their size composition was similar regardless of region. Sizes of alewife consumed from April through July, however, indicated that yearling alewife (50-120 mm) were a much smaller proportion of the diet in the south than the north (Figures 18 and 19).

Of all alewife consumed by chinook in 1986, 33% were young-of-the-year consumed in from September through October (Figure 17). In 1985, bloater, rather than alewife were the dominant YOY fish consumed by chinook (Figure 13). Heavy consumption of primarily YOY fish in the fall was also observed for coho and steelhead (Figures 15 and 16) and for both accounted for the majority of fish found in their diet. From May 1 through August 15, lake trout ate primarily alewife, followed by smelt, bloater, and perch. Like chinook, they ate all sizes of alewife and smelt available, and consumed few bloaters and perch larger than 160 mm (Figure 16). Closure of the lake trout season on August 15 precluded determination of their fall diet using sport caught fish.

There was little evidence that larger chinook regularly ate larger individuals of a particular prey type (Tables 2-4). There was no difference in the sizes of alewife, bloater or smelt consumed for 44 of 50 paired comparisons ($p < 0.05$). Only three of the paired comparisons indicated larger chinook had consumed larger alewife, and three comparisons indicated larger chinook had consumed larger smelt. Larger individuals of both these prey types provided more opportunity for selection differences to exist than for bloaters. In each case, the magnitude of these differences was small compared to differences in size of each prey type consumed between dates and over time.

Because of the increase in predation on alewife by the larger size classes of chinook, particularly in the spring, and the larger average size of alewife consumed relative to bloater, differences in prey size consumed by different size chinook were more common when size of all prey types were combined (Table 5). Larger chinook consumed larger prey fish in 17 of 65 paired comparisons, while smaller chinook consumed significantly larger fish for 3 of the 65 comparisons ($p < 0.05$). Still, for the majority of samples, there was no difference in the sizes of prey fish consumed by different size chinook. Overall, predator size (over the range of sizes examined) seemed of lesser importance in determining sizes of prey consumed than availability of certain size prey at a given location and time.

Comparisons of Apparent Rations

Based on the observed quantities of stomach contents, Chinook from the northern basin of eastern Lake Michigan apparently consumed roughly twice the number and twice the biomass of prey (apparent ration) compared to chinook from the southern basin. This difference was consistent throughout the season and across all predator size classes (Figures 8a, 8b, 9, 10a, 10b, and 11). Within each basin, differences in the amount of prey consumed by the different size classes of chinook were evident, but only in the spring. Through May in the south and through June in the north, size-3 chinook had apparently consumed roughly twice the number and biomass of prey compared to size-2 chinook. Size-1 chinook apparently consumed very little during this period. From June on in the south, and July on in the north, there was very little difference in the amount and type of prey found in the stomachs of different size chinook from the same basin.

The greater apparent rations of larger chinook were not in proportion to their greater size. When adjusted for predator weight (grams of prey per kg of predator), size-1 chinook from both basins and size-2 chinook from the north had the largest adjusted rations (0.50-0.62% body weight), and size-2 chinook in the south and size-3 chinook in both basins had smaller adjusted rations (0.13-0.30% body weight)(Figure 20). Similarly, size-2 chinook from the south and size-3 chinook from both basins had a significantly greater proportion with empty stomachs than did size-1 chinook from both basins and size-2 chinook from the north (Figures 6a, 6b, and 7)($p < 0.05$).

Seasonally, both apparent ration and frequency of stomachs containing food were highest in the fall for all sizes of chinook from both basins and coincided with the predominance of YOY fish in the diet. Ration and frequency of feeding were also high for size-2 and size-3 chinook in the spring, when they feed primarily on alewife. Apparent ration and frequency of stomachs with food were the lowest for size-2 and size-3 chinook in July when the occurrence and amount of alewife in the diet was low. For size-1 chinook, apparent ration and frequency of stomachs with food were lowest in the spring when few were feeding on fish. Once bloater began to occur in their diet in June (in the south) and July (in the north), apparent ration and frequency of stomachs with food increased to and remained at high levels through the rest of the season.

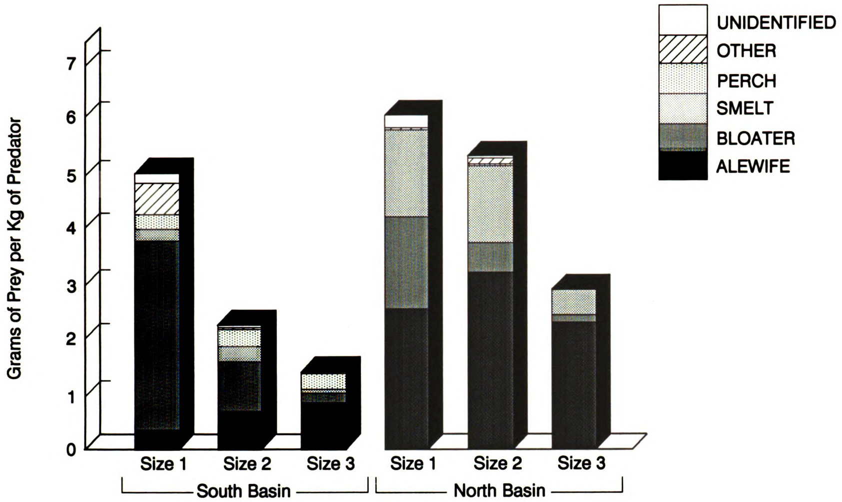

Figure 20. Average biomass of prey consumed by size class of chinook salmon from the southern and northern basins of eastern Lake Michigan in 1986, expressed as a proportion of predator biomass.

DISCUSSION

The sampling of 9,427 salmonines over four successive years: 1,513 in 1983 and 2,705 in 1984 by Kogge (1985); 1,578 in 1985 by Nurse (1986); and 3,631 from the fall of 1985 through 1986 reported here, represent one of the largest collections of data describing the diet of Lake Michigan salmonines.

Diet Composition

Bloater appear to have been a consistently important portion of the diet of eastern Lake Michigan chinook salmon from at least 1984 through 1992. Results from Kogge (1985), Nurse (1986), and Rybicki (1993) indicate bloater to be a major if not dominant component of the diet, ranging from 21-30% in the south to 5-26% in the north and from 39-83% for small (age 1) to 11-29% for large chinook. However, throughout this same period alewife, despite their reduced abundance, have remained a predominate forage, particularly for larger fish.

Effects of Prey Vulnerability

Substantial changes in prey type consumed both from day to day and over the season indicate Lake Michigan salmonines are apparently capable of quickly switching among alternate prey types (Ware 1971, Murdoch et. al 1975), and are capable of feeding on whatever prey happens to be most available and most easily caught.

Following the decline in consumption of large adult alewife from relatively high levels in the spring to low levels in June (south) and July (north), consumption of other prey species increased (Figures 6a and 6b). A similar summer decline in overall apparent ration and a shift to other species was noted by Jude et al. (1987) for fish collected from 1973-1982 in southeastern Lake Michigan, a period when alewife were generally more abundant. The movement of mature alewife into shallow nearshore waters to spawn may limit their availability as prey during this summer period. By August, after most alewife have finished spawning, large alewife were again more common in the diet (Figure 15). Along with the continued consumption of other species, alewife accounted for an increase in apparent ration over that of the mid-summer lows.

The abrupt switch from predation on adult prey fish in August to YOY fish in September was likely prompted by the breakdown in thermal stratification that through summer had provided both the preferred warmer epilimnetic habitat for YOY fish (Brandt et al. 1980) and isolation from predation by the typically cold water salmonines. At this same time, YOY fish likely were reaching sizes at which they begin to move into deeper, cooler waters, making them more available as prey. In experimental feeding studies (Savitz and Bardygula 1989), prey fish that remained near the surface were rarely attacked, but were readily attacked when suspended in the water column. Savits and Bardygula (1989) also noted that adult alewife were more difficult to capture than small alewife because of faster escape swimming speeds and their ability to turn very sharply when attacked. Slower swimming speeds of YOY alewife and their inexperience with predator attacks likely contribute to their easy capture and thus dominance in the fall diet.

The near cessation of adult alewife consumption by chinook in the fall in lieu of YOY fish indicates Lake Michigan salmonines may exhibit the theoretical tendency to feed disproportionately on the most available prey (Ware 1972). It may also indicate that the abundance and ease of capture of YOY fish is sufficient to meet predator consumption demands in the fall.

The establishment of search images (Ware 1971) has also been associated with such disproportionate predation. YOY fish, primarily alewife, are typically the first fish heavily preyed upon by juvenile chinook (Elliott 1993). Formation during this time of a restricted search image may increase the tendency for adult chinook to pursue YOY fish when they become available in late summer and fall.

Vulnerability of adult alewife to capture may also vary seasonally with changes in their energy content and condition. In Lake Michigan, the energy content of adult alewives is highest in the fall and lowest in the spring (Flath and Diana 1985, Strange and Pelton 1986). Adult alewife often experience die-offs during the spring period when their energy reserves are low and condition is poor. These factors may also act to impair the ability of alewife to evade predators, increasing their vulnerability in the spring -- a period when many are consumed. Higher energy reserves in the fall may help adult alewife better evade predators and contribute to a greater disparity in vulnerability between adult and YOY alewife.

Predator-Prey Size Relations

Variation in the size of prey consumed by different size predators appears largely dependent on periodic and seasonal differences in prey availability. Although some evidence for size selective predation was observed (Table 4), differences were minor in comparison to seasonal effects.

Predator size is often positively correlated with prey size in systems where relative density of large prey is high (so that gape size rather than prey availability limits maximum size of prey consumption - see Daan (1987) for example of ocean cod population). In Lake Michigan, the dominance of smaller prey and the scarcity of prey items large enough to avoid predation precludes the occurrence of strongly positive predator prey length relations. The capability of these large predators to eat much larger prey is evidenced by the rare observation of a 300 mm chinook salmon found in the stomach of a 70 cm (3.6 kg) lake trout (Denny Grinold 1989, photographed data). In Lake Superior where lake herring provide an abundant large prey item, lake trout commonly consume individuals in excess of 300 mm in length (Conner et al. 1993).

Earlier surveys of southern Lake Michigan salmonines (Jude et al. 1987) and of Lake Ontario salmonines (Brandt 1986) did document much stronger positive correlations between predator and alewife size. At the time of both studies, abundance of large adult alewife was high and may have provided a greater likelihood of size dependent predation. Jude et al. (1987) also reported seasonal differences in size of alewife consumed for the years of 1973-1982 that were very similar to those observed in this study (Figures 13 and 14). It appears that seasonal differences in abundance and availability of different size prey may have always been more important determinants in forage use than size selective tendencies, even during periods of high adult alewife abundance.

The greatest indication of size dependent predation observed in this study was the tendency of smaller chinook to have consumed more juvenile bloaters and less large alewife than larger chinook. Further support was the greater occurrence of differences in average prey size between the different size chinook when all prey types were combined. This follows the generally excepted premises of optimal foraging theory (Werner and Hall 1974). During this study, chinook 50 cm or greater in length consumed maximum sizes of all prey types while during the previous decade chinook had to reach lengths of 60 to 70 cm to do the same. The difference is again related to a greater abundance of larger alewife during the 1970s.

It should be noted that much stronger positive correlations between predator and prey length can also be shown for these data if the dependence of prey size on season is ignored. However, because smaller chinook only fed heavily on alewife in the fall when mostly YOY fish were consumed (by all size chinook), these correlations are artifacts of the seasonal differences in prey use by different size chinook.

Relation of Diet to Forage Abundance and Distribution

An apparently disproportionate reliance on alewife by chinook despite the lakewide decrease in alewife abundance has been interpreted by many to indicate a preference for adult alewife by chinook (Stewart and Ibarra 1991). This interpretation may not be appropriate. Because only bloater less than 160 mm in length were consumed by chinook salmon, most of the adult portion of the bloater forage biomass was not utilized.

In recent years, Stewart and Ibarra (1991), Brandt et al. (1991), Crowder and Crawford (1984), and Eck and Brown (1991), have all concluded that much of the bloater biomass is of large adults that are too deeply distributed, and occupy water too cold, for effective predation by the exotic salmonines. In contrast, adult alewife prefer the same temperatures and thus occupy the same habitat as salmon (Brandt et. al. 1980), making them more available for predation. Juvenile bloaters, which remain spatially segregated from the adult bloaters by inhabiting pelagic waters (Crowder and Magnuson 1982, Brandt et al 1991, Crowder and Crawford 1984) are also available as prey for pelagic predators.

For 1990, Eck and Brown (1991) estimated that of the 300,000 metric tones of bloater in Lake Michigan (estimated from fall forage surveys using bottom trawls), only 30,000 mt, or 10%, were of sizes typically consumed by salmon. This compares an estimated 42,000 mt of alewife present that same year, and an estimated 17,000-51,000 mt of alewife present since 1981 (Brown et al 1993). Thus, alewife may still be more available as forage than bloater, despite the predominance of bloater in the lake.

The pelagic nature of alewife and benthic nature of adult chub indicate abundance estimates using bottom trawls may not be representative of total prey availability, although trawls do provide a meaningful index of year to year forage abundance (Eck and Brown 1985). Hydroacoustic methods of forage assessment have indicated alewife, particularly those less than 120 mm, may account for a much larger proportion of the forage biomass than has been indicated by bottom trawls. Large adult alewife are known to be more deeply distributed during the day than smaller alewife (Brandt 1980). While all alewife, juvenile bloater, and smelt exhibit vertical migration at night (Janssen and Brandt 1980), moving into the pelagic environment, adult bloaters apparently remain near the bottom (Brandt et al. 1980). Although hydroacoustic techniques may lead to an underestimate of the more benthic oriented forage, the estimated higher proportion of smaller fish more closely matches prey composition of salmonine diets, and thus may more closely reflect forage used by pelagic predators.

The reduced alewife abundance observed for 1983-1985 (US Fish and Wildlife Service (USFWS) forage assessment surveys) spurred a great deal of concern about the adequateness of an apparently depleted supply of forage. It is quite possible that because of increases in juvenile bloater abundance and a greater than estimated abundance of YOY fish, forage available to salmon did not decline nearly as precipitously as was perceived from bottom trawl surveys.

Across-lake Differences in Diet

The major presence of bloater in the diet of eastern Lake Michigan chinook is in marked contrast to the apparent lack of bloater in the diets reported for angled chinook from western Lake Michigan. In 1982 and 1983 (Hagar 1984) and in 1990-1993 (Toneys 1992, Peeters 1993), bloater accounted for less than 0.6-2.5% of the diet of chinook from western waters. Of species other than alewife, rainbow smelt was the most common. Although the occurrence of smelt in diets of predators from western Lake Michigan can at times be considerable (Stewart and

Ibarra 1991) and comparable to proportions of prey species other than alewife from eastern Lake Michigan chinook, alewife appear to have generally accounted for a greater proportion of the diet of chinook from western waters than from eastern waters of Lake Michigan over the past decade.

Regional differences in diet are compatible with the apparent spatial distribution of alewife, bloater, smelt, and perch in Lake Michigan. Hydroacoustic measures of planktivore abundance in 1987 (Brandt et al. 1991) indicated that forage abundance and distribution varied seasonally. In 1987, and generally in most years since the decline of alewife and recovery of bloater, alewife and smelt have been more abundant and made up greater proportions of forage in the northern and western regions of the lake. Bloater have been fairly abundant throughout the lake but are more dominate in eastern waters. Perch have been more abundant in the southern regions of the lake (Gary Eck and Ed Brown, USFWS, personal communication).

Thus, seasonal and regional differences in the characteristics of the diet of chinook seem to follow trends in the complementary use of habitat by predators and prey. Diet, therefore, may best be explained as a reflection of prey vulnerability and availability. This would indicate that Lake Michigan salmonines might be better characterized as being highly opportunistic feeders within their habitat. Description of their behavior as being selective is only an indication of our incomplete understanding of their seasonally changing interactions with a dynamic prey base.

Lakewide Similarities in Diet Trends

Several trends in diet observed in this study support observations reported for other years and regions. The increase in the proportion of alewife in the diet with increasing predator size, and the increase in proportion of species other than alewife through the season has been reported for nearly all diet studies in Lake Michigan since the late 1970s. In general these trends have been most pronounced in areas where and during times when alewife abundance was the lowest. For example, the seasonal increase in the proportion of other species in the chinook diet began in June in the southeastern basin, in July in the northeastern basin, and finally in August and September along the western side of Lake Michigan. Similarly, species other than alewife contributed the most to the diets of chinook from the southern basin of eastern Lake Michigan, less to chinook from the northern basin, and least to chinook from western Lake Michigan. The increase in the amount of forage consumed in September and October for eastern Lake Michigan chinook may also occur elsewhere, but few data have been reported for late fall for western Lake Michigan.

Prior to the alewife decline, and again in recent years for areas where alewife are most abundant, other species contribute less to the diet of chinook salmon (Jude et.al. 1987, Hagar 1984, Toneys 1992, Peeters 1993) than they did during periods of lowest alewife abundance (Stewart and Ibarra 1991, Kogge 1985, McComish 1989, data presented here). Again, increases in the proportion of species other than alewife does not necessarily indicate their increased consumption.

Comparisons of Ration size

The potential for forage limitation in a system where predator abundance is not directly governed by food availability but is largely controlled by stocking, has been a major concern. Evidence for reduced forage availability, and thus consumption, has hinged on observed differences in growth of predators, changes in the abundance and composition of forage stocks, and subsequent changes (or lack of change) in diet composition -- all integrated through the bioenergetics analysis of predator demands. A more direct measure of changes in forage availability would be possible if some measure of stomach fullness (apparent ration, amount of prey per stomach) were compared for homogeneous groups of predators from different times and different regions of the lake.

The reduced amount of alewife in the diet of chinook in the southern basin observed here, and particularly, the relative lack of yearling alewife compared to the northern basin, appears to indicate that rations may have been limited for chinook in southeastern Lake Michigan in 1986. How long this may have been the case is difficult to judge. Few of the earlier diet studies have reported actual amounts of consumption. Those that have (Jude et al. 1987) are difficult to compare because of differing methods of collection and small sample size.

The most revealing comparison of apparent rations may be between this data and data collected in 1991 and 1992 for angler-caught chinook from Wisconsin waters of western Lake Michigan (Toneys 1992). Despite the poor survival of chinook since 1988, many of those now caught are much larger than those caught in 1986 and average size at age of chinook since 1988 appears to have increased (Smith 1993, M. Toneys, Wisconsin

DNR, personal communication). It might therefor be expected that chinook in more recent years may be consuming more prey than in earlier years. However, the diet data from Wisconsin waters indicate the average amount of prey consumed by chinook from both northern and southern waters of western Lake Michigan may be similar now to what it was for chinook from the northern waters of eastern Lake Michigan in 1986 (Figure 21). This evidence may support a hypothesis that lakewide forage abundance was not, and is not now, strongly limiting chinook growth, at least in the northern and western regions of Lake Michigan.

Forage availability, however, may have been limiting in the southeastern region of the Lake in 1986 compared to elsewhere, and could have contributed to reduced growth for chinook that spent extended time there. Whether this is still the case is not known. Possible forage limitation in the southeastern region of the Lake may have occurred for some time prior to 1986. Jude and Tesar (1985) reported a 84% decline in adult alewife abundance in the near-shore region of southeastern Lake Michigan from 1974-1977 after which alewife remained at low levels. This localized reduction in alewife was four years earlier than the largest lakewide decline of adult alewife observed for 1981-83. If greater production of alewife occurs in the northern basin of Lake Michigan, and particularly in Green Bay, the southeastern portion of Lake Michigan might be expected to show earlier declines in alewife abundance.

Growth and Condition

A reduction in ration of approximately 50%, as might be indicated here for fish residing in the southeastern waters of Lake Michigan,

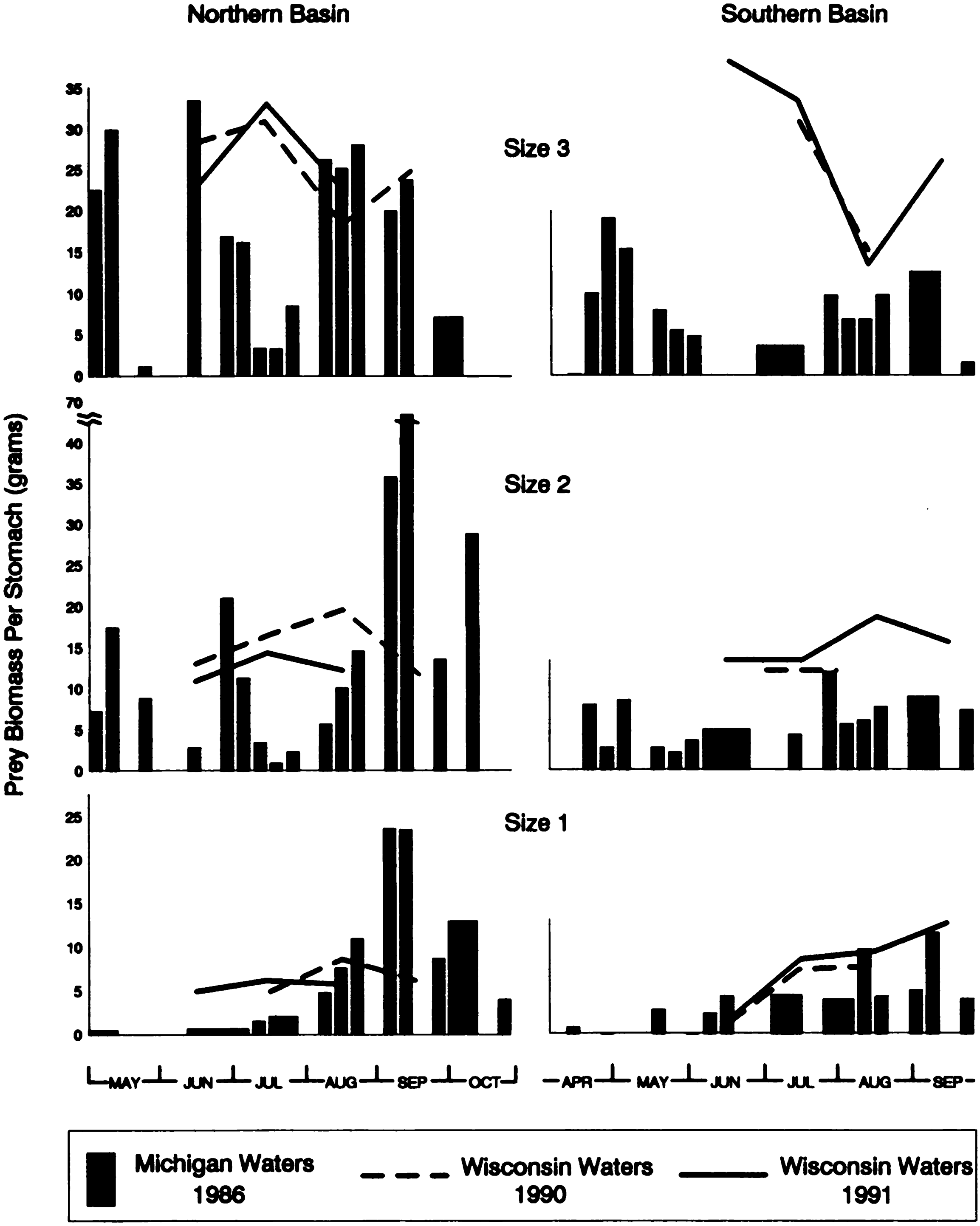

Figure 21. A comparison of the amount of prey consumed by chinook salmon from the eastern and western waters of Lake Michigan. Wisconsin waters values are based on reconstructed biomass data from Toneys (1992) but have been adjusted to reflect actual biomass per stomach. This adjustment is based on the average proportion of the reconstructed biomass that was observed in the stomach as actual biomass in 1986.

might theoretically result in poorer condition or slower growth for fish that spend an extended period of time in the southeastern part of the lake. Typical measures of condition that rely on various forms of the length-weight relation (Anderson and Gutreuter 1983) may not work well for chinook salmon. Chinook have the ability to replace depleted fat reserves with water, thus maintaining the same length-weight relationship despite differences in physiological condition. A more detailed analysis of health and condition that includes measures of lipid and water content might be more appropriate indicators of true condition or well-being.

In recent years, the discovery that annular growth rings do not appear to form on chinook scales until mid-summer (D. Anson and S. Lazar, MDNR, personal communication) has caused a modification in the methods used by MDNR to determine age of chinook since 1985, particularly for mature fish. Back calculations of size at annular formation and apparent growth since formation observed on chinook scales collected during this study confirm these findings, and also indicate that the time of annulus formation may be quite variable. For some fish, recently formed annular rings were apparent in early spring, while others were not apparent until late-summer.

These findings might be consistent with differences in lipid and water content of chinook in the spring. If chinook come out of winter with expended energy reserves, much of their spring consumption may go into rebuilding these reserves. The initiation of post-winter somatic growth, during which annulus formation becomes apparent, may not be realized until later in the spring or summer after fat reserves have been rebuilt. Differences in regional forage availability could therefore contribute to variation in the time of annulus formation.

The ability to determine growth of Lake Michigan chinook has been a constant topic of debate. It has been inferred from changes in average size of chinook in the sport catch, that growth of chinook has changed. Although Hansen (1986) did observe declines in average size of sport caught chinook from western Lake Michigan waters as well as a general decline in trophy weight and condition, he could not, using a more complete data set, support the assertions by Hagar (1984) and Stewart and Ibarra (1991) that growth had declined.

Confounding variables have to date likely precluded an accurate and acceptable measure of chinook growth. These include increasing population size driven by stocking and increasing fishing pressure and harvest characteristic of the pre-1987 fishery; decreasing population size and decreasing fishing pressure and harvest characteristic of the post-1987 fishery; potential inaccuracies in aging of fish with scales; and variation in recruitment of natural fish (Elliott 1993, Zafft 1992). Further investigation of the effect that changing fishing pressure and harvest can have on the size structure of the chinook population is needed. For example, declines in fishing effort, and particularly declines in the targeting of chinook since 1987, could be a factor in the apparent increase in size observed in recent years. Accurate determination of growth trends and of growth increments for Lake Michigan chinook will necessitate the comparison of size at age (both actual and back calculated) of known age and known source (hatchery and natural) fish from the sport fishery, from assessment netting, and from fish returning to rivers.

<u>Catch Rates and Movement</u>

Catch rates and harvest of chinook from Lake Michigan seem to mirror both the regional and seasonal differences in apparent ration (Figure 22). In eastern Lake Michigan, lowest catch per unit effort (CPE) for chinook typically occurs in March and then later in June (Rakoczy 1986, 1992) coincident with lowest observed apparent rations. Highest CPE typically occurs in late spring and in the fall coincident with higher apparent rations. In western Lake Michigan, chinook are rarely caught before June (Brad Eggold, WDNR creel data). Beginning in June, CPE for chinook quickly reaches high levels where it remains through August, after which CPE declines into the fall. This difference in the seasonal trends of CPE between the eastern and western waters of Lake Michigan may indicate a movement of chinook from eastern waters into western waters in June, and then back again in the fall.

As they are in the marine environment, Great Lakes chinook, coho, and steelhead appear to be highly mobile through all life stages (Keller 1993, Elliott 1993, Terry Lychwick, WDNR, Rakoczy, MDNR, Hess, IDOC, personal communication). Preliminary results from returns of coded wire tagged salmon (Keller 1993) seem to confirm a general migration pattern of chinook in Lake Michigan that takes much of the population away from southeastern Lake Michigan through mid summer. It seems probable that although chinook are present in the southern basin, residence there for any one individual may be short term. Because they may be able to move from areas of low prey availability to areas of the lake where forage, particularly alewife, are more abundant, they may not exhibit reduced growth or condition to the degree that would be expected if reduced rations were persistent. Such movement would also indicate that seasonal

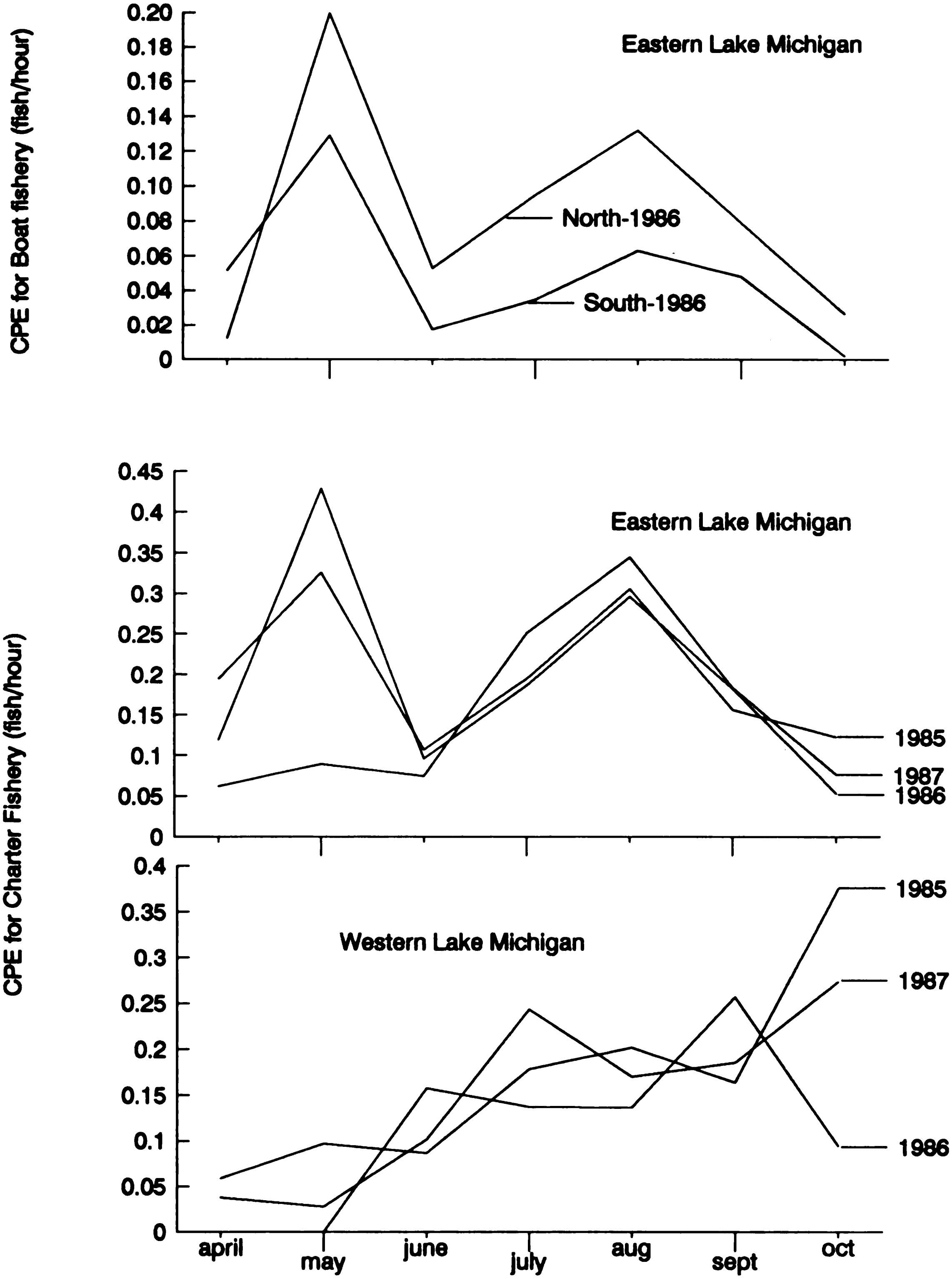

Figure 22. Monthly catch rates estimated for chinook salmon from eastern and western waters of Lake Michigan, 1986 (data from Michigan and Wisconsin DNR creel census programs).

averages of diet may not be representative of the lake population. Actual seasonal average data will need to include the combination of all regions diet, known CPE, and perceived movement data.

Lake trout have been characterized as having slower growth in the southern basin compared to the northern basin of Lake Michigan (Rybicki et al. 1990, Eck and Wells 1983). Although lake trout can be fairly migratory, as a population they typically have a relatively small home range compared to pacific salmon, and commonly remained in the vicinity of their stocking site (Holey and Miller 1992, Rybicki 1990). Lake trout may, therefore, be more affected by localized forage abundance than salmon. Since habitat typically occupied by more near-shore populations of lake trout overlaps strongly with adult alewife and alewife have been the dominant forage of near-shore lake trout (Miller and Holey 1992, Kogge 1985), reduced growth of these near-shore fish appears to support the notion that alewife as forage is more limiting in the southern basin than in the northern basin.

Use of Bioenergetics Models

Continued heavy predation on alewife following their decline in the early 1980s, has led several authors to the conclusion that the alewife population is not capable of supporting the predatory demands of Lake Michigan's stocked salmonines (Stewart and Ibarra 1991, Brandt et al. 1991). Much of this has been supported by bioenergetics assessments of the predator-prey dynamics of Lake Michigan (Stewart et al. 1991, Kitchell and Hewett 1987).

Empirical data presented here, however, differ somewhat from data used in these bioenergetics assessments. First, most recent bioenergetics models for Lake Michigan have assumed a lakewide diet of adult fish reflective of angled fish sampled from May through August from western Lake Michigan (Stewart and Ibarra 1981). Previously described differences between the diets of chinook from eastern and western Lake Michigan, and the substantial differences in diet composition in the fall, particularly in the sizes of prey fish consumed, indicate that use of more detailed diet data would be beneficial in these model applications. Winter diet data collected in 1991-92 by Indiana DNR (D. Brazo, personal communication) and limited data collected by Jude et al. (1987) indicate that chinook may feed very little over winter -- unlike lake trout, which have been found to feed on alewife throughout winter. During this study, the few chinook that were collected in early April had consumed very little prey compared to those sampled in late April and early May. Exposure of chinook to the winter temperature regime of the Great Lakes may have a substantial effect on their feeding and behavior.

Second, the models have also predicted consumption by salmonines to be highest in late summer when water temperature is high and chinook are large (Stewart 1991, Kitchell and Hewett 1987). Amount of prey consumed by chinook collected in this study consistently indicated that rations were the highest in September and October for all size chinook, and also higher in the spring for the largest chinook. Warmer late summer water temperatures should have had little effect on consumption since temperatures occupied by feeding chinook were consistent from July through October. Thermal stratification of the lake during summer may isolate prey from predators. Typically water along the shore of eastern Lake Michigan is more strongly stratified than along the western shore

(Mortimer 1975). Thermal habitat may, therefore, be more limiting for chinook in the eastern waters than in western waters during summer.

Large alewife apparently have been the forage that has best provided the large ration needed for large chinook to meet energetic demands. With declines in the abundance of larger alewife, it has been expected that chinook will have to rely more on smaller alewife. Stewart and Ibarra (1991) indicated that a shift in chinook diet from large alewife to smaller alewife, combined with slower growth of chinook, would result in a 20% decline in conversion efficiency. This would necessitate an increase in daily rations to maintain net energy gain. The consumption of small alewife by eastern Lake Michigan chinook appears to be seasonally dependent. Further, in the fall when chinook diets were dominated by YOY fish, apparent rations were greatest. Since forage value of alewife is as much as 1.6 times greater in the fall than during other times of the year (Flath and Diana 1985), this is likely the period of greatest energy intake. While this energy intake could be even greater if large alewife rather than small alewife were consumed, the available data indicate that chinook have always consumed smaller alewife in the fall than during other times of the year, even when large alewife were very abundant.

If future bioenergetics assessments of predator-prey dynamics in Lake Michigan are to be reasonably accurate, they will need to: determine lake-wide estimates of consumption by integrating movement and CPE data with regional diet data that encompasses the entire season; account for seasonal differences in energy content of prey; account for seasonal and size specific differences in the lipid and water content of chinook; and most importantly, use unbiased measures of true growth.

Partitioning Total Consumption

Because of the differences observed in the diet of different size (and presumably different age) chinook, overall consumption of different forage species by chinook in eastern Lake Michigan waters is dependent on the size specific abundance of the chinook population. To present a comparative index of total seasonal consumption (April-October) by all cohorts of chinook, a simple model was developed (Figure 23). Annual mortality rates from 20% to 80% were applied to age-1 recruits and then diet, expressed as biomass of prey per age-1 recruits, was summed for all surviving fish ages 0.1 through age 0.5.

To keep this process simple, mortality adjustments were made for each age class prior to the season rather than during the season. Also, the contents of chinook stomachs were assumed to reflect the type and amount of food consumed so no adjustment for differences in digestion or evacuation rates due to seasonal temperature changes, or due to different prey types or predator sizes, was made. The first assumption likely overemphasizes the fall diet when fishing mortality would reduce the number of chinook. The second assumption likely overemphasizes the spring diet when colder water temperatures would reduce consumption. Because the nature of these biases counter each other, this method may be a realistic approximation. Using mortality rates typically assumed for chinook salmon in Lake Michigan (Stewart and Ibarra 1991, Eck and Brown 1985, Kitchell 1987), the model indicates that only 25% of the total seasonal consumption of forage by chinook in eastern Lake Michigan would be attributed to age-3 and older chinook. Alewife would account for roughly 30% (in the south) to 60% (in the north) of total prey consumed (Figure 23).

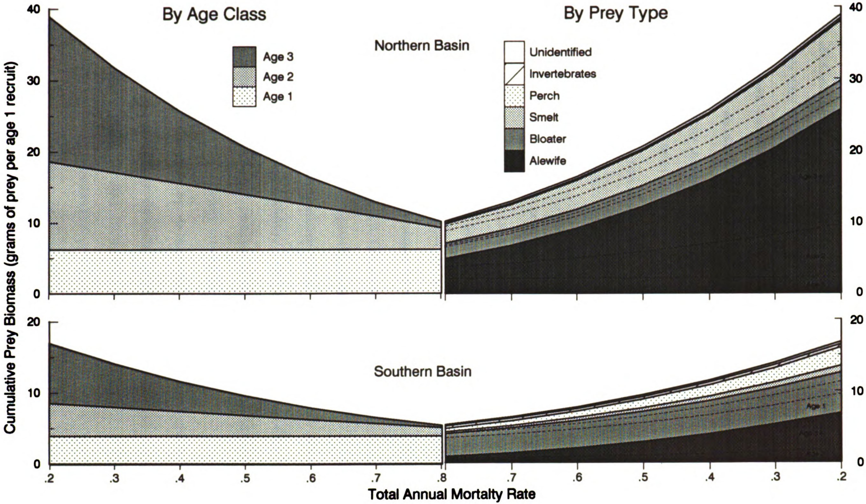

Figure 23. Estimated cumulative biomass consumed during the months of April through October, 1986, by chinook of all ages, given different mortality rates. Estimates are for chinook inhabiting the southern and northern waters of eastern Lake Michigan and are expressed per age-1 recruit.

Despite the dominance of adult alewife in the diet of larger and older chinook, total consumption of forage appears driven to a larger extent by the more abundant age-1 and age-2 chinook, which in eastern Lake Michigan rely very little on adult alewife. Since the reduced abundance and shift in age structure of chinook salmon since the 1988 episodic mortality associated with bacterial kidney disease (Smith 1993, Nelson and Hnath 1990), large alewife should have experienced a greater decrease in consumption relative to smaller alewife and bloater.

Prey Dynamics

Alewife recruitment is controlled by a number of biotic and abiotic factors. The difficulty this marine species has with functioning optimally in the cold Great Lakes environment has been well documented, and is generally considered one of the major factors affecting alewife abundance (Bergstedt and O'Gorman 1989, O'Gorman et al 1987, Eck and Wells 1987). Several authors theorize that alewife lost their often observed resiliency when spawner numbers reached their lowest levels in 1983-84 (O'Gorman and Schneider 1986, Wells 1985, Kircheis and Stanley 1981, Stewart and Ibarra 1981). Both predation pressure and competition with recovering stocks of native fishes have likely played a roll in suppressing a quick recovery of alewife stocks.

Predation on alewife by salmonines has been estimated to remove 52.9% of the annual alewife production (Brandt et al. 1991). Although over half of this predation has been attributed to chinook (Stewart and Ibarra 1991), heavy predation on adult alewife by lake trout and the other exotic salmonines, as well as predation in the fall on YOY alewife by steelhead, coho (Figures 17, 18, and 19), and younger chinook (data not presented here) can be substantial. An increase in the numbers of stocked lake trout and increased survival of stocked steelhead since the mid 1980s has likely increased their proportion of the total predation in Lake Michigan in recent years, particularly with the poorer survival of chinook observed since 1988. Three native species, yellow perch, walleye (Stizostedion vitreum), and burbot, are known to consume alewife, often to the exclusion of other forage during certain times of the year (Peterson 1993, Wagner 1972). All three have increased in abundance since the early 1980s. There also have been major changes in the plankton community in Lake Michigan since 1986 and continued reductions in nutrient inputs (Scavia et al. 1986, Scavia et al. 1988) that are likely to reduce total community production.

Alewife and Bloater Abundance

Alewife have been strongly implicated in the past suppression of several native forage stocks of Great Lakes fish, notably bloater and yellow perch (Crowder and Binkowski 1983, Miller and Crowder 1990, Brown et al. 1987, Eck and Wells 1987, Luecke et al. 1989). The increased abundance of these two species commensurate with the decline in alewife through the early 1980s might persist if alewife abundance were to remain at reduced levels. Although bloater and perch can be important forage species for Lake Michigan salmonines, most perch and large adult chub typically occupy thermal habitats outside the range preferred by salmon (warmer water for perch, colder water for bloater). Thus, they do not present salmon with the abundance of larger prey items that alewife can. However, prior to the dominance of alewife in Lake Michigan's forage base, bloaters remained pelagic for longer, and reached larger sizes before moving into their more benthic habitat. As the alewife population expanded, bloaters began to abandon their pelagic existence at earlier ages presumably as a compensatory mechanism to reduce competition (Crowder and Crawford 1984). If reduced interactions with alewife permits the re-extension of the bloater's pelagic life history, presence of larger bloaters in the pelagic zone could provide predators with a large prey item that might functionally replace adult alewife.

Bloater have traditionally had a higher energy content than alewife, although in recent years this trend may be reversed (Noguchi 1993) as bloater continue to show characteristics of density dependent growth suppression. Bloater are also more efficient in their use of energy (Stewart and Binkowski 1986), indicating that the system could theoretically support more bloater production than it has alewife. Predators might gain more energy from consuming equal rations of bloater rather than alewife.

There is some concern that higher contaminant levels in bloater relative to alewife may lead to higher contaminant concentrations in salmon (Hesselberg 1990, Noguchi et al. 1993, Bowker et al. 1993). If the more benthic nature of chubs contributes to their higher contaminant load, then this loading may be more reflective of adult bloaters rather than the more pelagically distributed juveniles. Consumption of primarily juvenile bloater by chinook salmon may isolate them somewhat from this contaminant exposure.

The stability of juvenile bloater as a source of forage may be questionable. Very low catches (in the USFWS fall forage assessment surveys) of YOY bloater since 1991, and of YOY and yearling bloaters in

1992 seem to indicate a trend of poor bloater recruitment in recent years (Brown et al. 1993). Potential causes under investigation include: density dependent, compensatory changes in bloater reproduction; negative interactions (competition and/or predation) between Bythotrephes and larval bloaters; and renewed competition and predation by other forage species (Stedman and Argyle 1985, Lehman 1991, Brown et al. 1993). If successive poor year classes of bloaters are not offset by increases in alewife or smelt abundance, available forage for salmon could be reduced, despite the continued abundance of adult bloater.

Consideration of Sampling Methods

Interpretation of these results is predicated on the acceptance of some basic assumptions. First, it has been assumed that what is observed in the stomachs is representative of what was consumed, both in content and amount. The slight differences in the digested state of different prey reported here and the likely differences in evacuation rates of different prey types such as small zooplankton, hard bodied insects, and large bodied fish, are challenges to this assumption. Although differences in the digested state between species were small, smelt and perch may be slightly over-represented in the observed diet because of their less digested state. The heavier scaling and thicker skin of these two species may have contributed to this difference although patterns of diel consumption that differ between prey types could also explain the observed differences. Larval fish and zooplankton (other than Bythotrephes) may be under-represented in the diet because of higher digestion and evacuation rates.

The effect of temperature on metabolism and foraging efficiency also challenge this assumption. However, in this study, the similarity of water temperature where fish were sampled from (across regions and seasons) provides no evidence that these effects were substantially involved in the differing trends observed in diet through seasons and between basins.

Similarities in the seasonal use of different size prey by the different salmonine predators likely indicate the opportunistic nature of these fish. However, the diet of these salmonines may also reflect the tendency of the sport fishery to select fish inhabiting similar waters. The sport fishery typically targets certain species at certain times of the year, taking advantage of when and where the most fish can be caught. For example, in the early to mid 1980s, chinook salmon were the salmonine species most often sought by anglers throughout most of the fishing season (Rakoczy and Nelson 1990). Coho salmon were targeted primarily in the spring along the nearshore waters of southern Lake Michigan. Steelhead were targeted by many anglers in the fall either from the further offshore surface waters or from piers. Harvesting of lake trout was confined to the regulated May 1 - August 15 season, but targeting was usually limited to periods when chinook were either difficult to find, or so plentiful that a limit catch of salmon had been reached.

Because the catch of non-targeted species is common (for example, catching lake trout while fishing for chinook), the sport fishery does not always sample each species from its primary habitat or in proportion to its abundance. This may partially explain the dominance of alewife in the diets of sport caught lake trout. Angler-caught trout are typically taken from bottom waters within easy boating distance of shore, a habitat where adult alewife are abundant. Lake trout from deeper more offshore habitats are known to feed on bloater (Miller and Holey 1992) but are rarely sought by anglers. Historically, bloaters were the most common coregonine fed upon by lake trout (Van Oosten and Deason 1938) and should provide an adequate forage supply for lake trout and other traditionally deep-water predators. An understanding of the lakewide distribution of lake trout, and the migration patterns and habitat preference of the different strains currently being stocked, is important to interpreting their overall predation on alewife and bloaters.

The seasonal targeting of species can change from year to year in response to species abundance. For example, since 1988, the fishery has changed from one dominated by chinook to a fishery increasingly dominated by steelhead. Changes in the observed diet over these years could simply be the result of changed fishing practices, such as the shift from fishing nearshore waters where chinook used to be plentiful, to fishing offshore surface waters where steelhead are now plentiful.

The modern Lake Michigan sport fishery evolved during years of an alewife dominated forage base. Methods of fishing developed during those years, including depths of water fished and types of lures used, were likely influenced by the characteristics of alewife. During the initial years of alewife decline, continued use of these earlier developed fishing methods may have selected salmonines that were feeding on alewife over those that had changed their feeding behavior in response to the changing forage base.

Adjusted rations indicated that the smaller size classes of chinook were apparently consuming more per unit of body weight than the larger chinook. While this might indicate that forage was more limiting for the larger fish. It cannot be certain that the lower than expected apparent ration for large (size-3) chinook was indicative of forage limitation.

The potential effects that fishing could have on growth have already been discussed. These same selective tendencies could also influence how we interpret differences in apparent ration observed between different size predators. Fishing effort in the mid 1980s culminated 15 years of rapidly increasing catch and effort for chinook salmon in Lake Michigan (Hansen 1991). In intensively fished salmonid stocks, fishing has been shown to remove the faster growing (and probably more aggressively feeding) individuals (Ricker 1981). If this were to occur in Lake Michigan, then the fish contributing to the sample of larger fish (mostly age-3 and older), having been exploited for more years, may not represent the same range of growth and feeding characteristics that are represented by samples of smaller fish.

The occurrence of empty stomachs is another parameter that can be influenced by collection methods and procedures. For example, some of the increased frequency of empty stomachs that was apparent later in the summer for the sample of the larger chinook was likely related to the inclusion in the samples of some mature fish that had stopped feeding. Although collections intentionally did not include mature fish that were caught in rivers, it likely included some that, although were caught in Lake Michigan, were in the process of returning to spawn and were no longer actively feeding. The small difference in the frequency of empty stomachs between male and female size-3 chinook may have been related to differences in timing of the return of males and females for the spawning run. These same trends might not have been observed if samples were collected only from non-maturing fish.

Several studies conducted in Lake Michigan have reported that fish collected with gill nets have a greater percent of empty stomachs than fish collected by anglers (Miller and Holey 1992, Hagar 1984). As an extension of this study, a sample of chinook collected with gill nets and by anglers from the same waters on the same days were compared. Although the difference was not statistically significant because of the small sample size, a slightly higher occurrence of empty stomachs in the gill netted sample (71% compared to 64% for angler-caught chinook) was observed.

A lower incidence of empty stomachs in samples of angler-caught fish versus netted fish has often been attributed to the selection of actively feeding fish by anglers. While this may be true, digestion and regurgitation of stomach contents that can occur for fish that are caught in gill nets or trap nets can also contribute to the same observed trend. The potential variation in digestion between fish caught soon after the net is set, and those caught just before it is pulled, is a complication with diet assessments of netted fish. Because angler-caught fish are typically put on ice immediately after being caught, variation in the digestion of prey may be less dependent on when the fish was caught, and more reflective of actual variation in feeding times. While regurgitation is often a concern for angler-caught fish, the same should be true for gill netted fish. Traditionally, gill nets have been most effectively used at night, while angler-caught fish are most often caught during the day. Diel feeding patterns of salmonines would, therefore, also contribute to differences in diet for netted and angled fish. Regardless of the reason, the higher incidence of feeding fish in angler-caught samples precludes the direct comparison of stomach fullness or apparent ration between angler caught and netted fish. However, proportional diet seems to be consistent between netted and angler-caught fish.

Differences in the decomposition state of prey among different periods of the day may not be reflective of diel feeding habits if chinook become satiated on a regular basis and stop feeding. Becoming regularly satiated, however, would affect the interpretation of several parameters. Differences in the observed biomass consumed, in numbers of prey consumed, and in proportion of empty stomachs would be unrelated to prey abundance, and would be expected to vary without persistent regional or seasonal trends. If fish regularly became satiated, catch per effort might vary depending on forage availability, being high when prey was scarce. This does not seem a likely scenario given its inconsistency with the data presented and discussed here.

Diet of angler-caught fish admittedly may not be typical of the entire population of that species. However, it is reasonable to assume that it is generally representative of those inhabiting the near-shore environment fished by anglers. Use of the sport fishery as a means of collecting data for scientific purposes, despite its possible biases, has many advantages. The lack of a commercial net fishery for these sport fish has limited sampling alternatives in the Great Lakes to assessment netting. In comparison, netting can provide only limited numbers of fish, is comparatively costly and labor intensive, and has substantial bias of its own. Angler-caught fish, in many cases, provide the only feasible means of collecting adequate numbers of fish from a geographically wide area.

SUMMARY AND CONCLUSIONS

Sampling angler-caught salmonines provided a cost effective means of collecting the necessary data capable of adequately describing the diet of salmonine predators inhabiting the coastal waters of Eastern Lake Michigan. While alewife, bloater, rainbow smelt, and yellow perch were the dominant species found in the diet of chinook salmon, the contribution of each differed across seasons, among predators of different size, and between predators from the north and south basins. Predators appeared strongly opportunistic in their foraging. Differences in the size distribution and in the amount of each prey type consumed reflected the spatial and temporal distributions of prey and the thermal habitat overlap between predators and their prey.

Alewife were the dominant prey of larger chinook, particularly in the northern basin, and bloater were the dominant prey of smaller chinook, particularly in the southern basin. Smelt were also an important part of the diet in the northern basin while perch contributed primarily to the diet of chinook from the southern basin. Chinook salmon consumed alewife and smelt of all sizes available, but rarely consumed adult bloater or perch over 160 mm in length, despite their abundance. Seasonally, both the amount and frequency of prey consumed were highest in the fall for all sizes of chinook, and in the spring for larger chinook. These periods coincided with a dominance of young-of-the-year fish in the fall diet and a dominance of large adult alewife in the spring diet.

Chinook from the northern basin typically consumed twice the amount of alewife and subsequently a greater overall apparent ration than chinook from the southern basin. Bloater were consumed in nearly equal amounts by chinook in both basins, but represented a larger percentage of the diet in the southern basin because of the reduced amount of overall forage consumed by chinook in the south.

Although alewife may be the species that contributed most to the diet of an individual chinook that lives to maturity, predation pressure is heavily influenced by the more abundant younger chinook. For this reason, bloater account for a substantial and in some locations, the majority of prey consumed by all chinook inhabiting eastern Lake Michigan. However, correlations between CPE and amount of prey consumed indicate chinook may congregate seasonally in different regions of the lake in response to available prey abundance.

A bloater dominated forage base may not provide as many large prey individuals for salmon consumption as would an alewife dominated forage base. But, the present forage assemblage does provide the potential for sustaining both a reasonable salmon and trout fishery in waters accessible to anglers (supported by alewife, smelt, and young bloaters) and a deep water population of lake trout and burbot (supported by adult bloaters). Such a species mix might have greater potential for stability than a fishery dependent on one dominant but characteristically unstable prey species such as alewife. Unfortunately, with apparent poor recruitment of bloaters in recent years, and the continued inadvertent introductions and subsequent spread of non-indigenous species, continued instability is likely.

The potential difficulties in accurately measuring growth of chinook, as well as concern over the potential for and effects of forage limitation, should lead us to consider additional indices of growth, condition, and available forage. Measures of stomach fullness or apparent ration of sport caught fish could be an inexpensive and useful index of available forage. Direct estimates of total prey consumption (Noble 1972), using ration data and measurements of evacuation rates, could also provide an additional method to the bioenergetics approach for estimating total forage demand by these salmonine predators. Declines in growth of pelagic piscivores commensurate with the decline in alewife abundance might be expected, but alone do not dictate overabundance of predators or poor predator health. Seasonal measures of lipid content may be good indicators of predator health and condition.

Despite the frequency of diet studies conducted concurrently for different regions of Lake Michigan and for different Great Lakes, differences in collection, in analysis, and in reporting of the data have prevented complete cross-comparison between studies. Although characteristics of the basic diet parameters are well documented (Hyslop 1980, Bowen 1983) and quite universally used as norms for reporting diet data, differences in data stratification and summary often produce large differences in results. Brief and usually inadequate descriptions of methods used, although common, often makes it difficult to assess the comparability of studies and should be a growing concern (Gill 1991). The lack of coordinated or comparable studies allowing whole lake comparisons have resulted in regional characteristics being inappropriately, though unavoidably, applied to whole lake systems. If diet of Great Lakes salmonine predators is to be adequately described, sample collections need to be comprehensive; including collections throughout the year, from many different regions, and from all sizes of each predator species.

With the present increase in coordinated agency assessments and emphasis on an ecosystem approach to management and research, serious consideration should be given to the incorporation of coordinated lakewide diet data into current lakewide assessment and monitoring programs. The combination of lakewide forage assessment; lakewide biological assessment of predator fish from sport, net, and escapement returns; and the lakewide determination of diet of predators could provide a stronger basis from which to assess the status of the Great Lakes ecosystem.

APPENDICES

APPENDIX A

Table 6. Formula used to convert caudal length to total length, digested state and length to wet weight, and volume to wet weight for the various prey types.

Caudal Length (CL) to Total Length (TL):

Alewife: TL = CL * [1.172 + (CL * .000328)]

Bloater: TL = CL * 1.176

Smelt: TL = CL * 1.147

Perch: TL = CL * 1.158

Total Prey Length (TL) to Wet Weight (Wt) given Digested State:

ln WT = ln TL * coeff X - Constant Y

Given:

	Prey Type							
	Alewife		Bloater		Smelt		Perch	
Digested State	X	Y	X	Y	X	Y	X	Y
undigested:	3.15	12.6	2.83	11.1	3.18	13.0	3.32	13.0
< 25% digested:	3.30	13.4	2.83	11.1	3.18	13.0	3.16	12.4
> 25% but < 50%:	3.17	12.8	2.54	9.94	2.87	11.7	2.90	11.4
> 50% but < 75%:	2.76	11.3	1.88	7.13	2.23	8.78	2.67	10.3
> 75%, mostly bones:	.973	4.55	.973	4.55	.973	4.55	.973	4.55

Volume to Wet Weight:

Wet Weight = Volume * 1.075

APPENDIX B

Table 7. Location, date, and number (by sex) of each species of salmonine predator sampled in 1986.

		Chinook			Coho			Steelhead			Lake Trout			Brown Trout		
Port	Date	n	M	F	n	M	F	n	M	F	n	M	F	n	M	F
SJ	04/05	1	0	1	108	50	58	1	0	1				1	0	1
SJ	04/06	2	1	1	53	28	24							1	0	1
SH	04/06				11	5	6									
GH	04/12	2	1	1	3	0	3									
SJ	04/13	16	7	9	20	14	6							1	0	1
SA	04/13	6	2	4	4	2	2									
GH	04/19	11	6	5												
SA	04/20	13	8	5	8	2	6							6	3	3
NB	04/25	9	4	5	9	3	6	1	0	1						
SJ	04/25	34	15	19	22	8	14	1	1	0				1	1	0
NB	04/26	25	12	13	38	19	19									
SJ	04/26													1	0	1
LU	05/01													1	1	0
LU	05/03	75	42	33	2	2	0	1	0	1	1	0	1	10	5	5
GH	05/04	46	23	23							4	3	1			
FR	05/10	2	1	1							5	3	2			
LE	05/10										21	13	7			
LU	05/11	59	31	27										7	4	3
MA	05/11	36	17	19	1	1	0				1	0	1	4	3	1
MU	05/16	26	13	12	1	0	1				1	0	1	3	2	1
SH	05/16	5	3	2												
SJ	05/17	18	7	11	10	6	4	2	1	1	70	35	35	1	0	1
SH	05/17				3	0	2	1	1	0	5	3	2			
MU	05/23	18	9	8	1	0	1	1	1	0	6	2	4	4	2	2
PW	05/24	21	11	10	2	2	0	1	1	0	4	2	2	3	2	1
FR	05/24	5	3	2							6	2	4	2	0	2
LE	05/25										27	18	9			
GH	05/31	43	23	20	2	2	0	14	7	7	46	21	25	1	0	1
SA	06/01	4	3	1				1	1	0	6	4	2			
GH	06/01	32	16	16	3	1	2	22	8	14	31	12	19			
NB	06/06	2	2	0	11	6	5	1	0	1	14	8	6			
NB	06/08	5	3	2	2	1	1	5	1	4	12	9	3			
SJ	06/08				1	0	1				5	2	3			
LU	06/11	5	1	4							2	1	1			
GH	06/12													1	1	0

Table 7. (cont'd)

		Chinook			Coho			Steelhead			Lake Trout			Brown Trout		
Port	Date	n	M	F	n	M	F	n	M	F	n	M	F	n	M	F
LU	06/12	23	6	17										7	3	4
MW	06/13	3	1	2				1	0	1	2	1	1			
LU	06/13				1	1	0	14	4	10	6	3	3			
SA	06/14	14	10	4							45	21	24			
GH	06/18	1	0	1							9	5	4			
SH	06/20	1	0	1							11	2	9			
LE	06/23										10	4	6			
TC	06/23										6	2	3			
LE	06/24	29	15	12												
TC	06/24	5	3	1							38	18	15			
FR	06/25										15	7	8	3	2	1
MC	06/29	2	1	1	1	1	0	1	0	1	34	16	18			
CH	07/02	2	1	1							4	0	1			
MA	07/05	35	20	15	1	0	1	3	1	2	8	5	3	1	1	0
SJ	07/11	22	10	12							18	10	8			
SH	07/12	7	5	2							6	5	1			
SA	07/12	27	10	17				1	0	0	21	10	11	2	1	1
GH	07/13	19	11	8							26	16	10			
PW	07/17	14	8	6							8	7	1			
LU	07/17	30	18	12				2	1	1	19	13	6	1	0	1
LU	07/18	2	1	1	1	1	0									
MA	07/18	91	43	44				2	1	1	47	24	23	2	0	2
LU	07/19	91	40	51	10	5	5	1	0	1	41	28	13	2	2	0
LE	07/21	20	6	14							3	3	0			
LE	07/22	41	11	30	1	0	1	2	0	2	1	0	1			
LE	07/23	28	17	11				1	1	0	1	0	1			
NB	07/24	5	0	5				4	2	2	10	7	3			
TC	07/24	4	1	3							3	2	1			
CH	07/24	7	4	3												
MC	07/25	13	7	6				6	4	2	18	8	10			
NB	07/25							5	4	1						
FR	07/25	29	15	14	2	2	0				13	9	4	1	0	1
MC	07/26	2	1	1				1	0	1	1	1	0			
NB	07/26	9	4	5												
MW	08/01	53	25	26	1	0	1	4	1	3	6	4	2	4	3	1
MW	08/02	15	8	7				2	1	1						
CH	08/08	9	6	3							1	1	0			
SJ	08/09	36	22	14	2	2	0				29	11	18	2	1	1
SH	08/09	7	6	1							1	1	0			
CH	08/09	12	6	5							1	1	0			

Table 7. (cont'd)

Port	Date	Chinook n	Chinook M	Chinook F	Coho n	Coho M	Coho F	Steelhead n	Steelhead M	Steelhead F	Lake Trout n	Lake Trout M	Lake Trout F	Brown Trout n	Brown Trout M	Brown Trout F
SH	08/10	19	8	11							4	2	2			
TC	08/10	2	1	1				1	0	1	17	14	3			
PW	08/15	15	5	10	2	2	0	6	3	3	6	1	5			
FR	08/15	1	1	0												
SA	08/16	54	28	26	1	1	0	1	0	1				5	4	1
GH	08/16													1	0	1
PW	08/16	2	2	0	1	1	0									
LU	08/16	93	43	49	11	3	8	1	1	0				1	0	1
GH	08/17	48	20	28	8	7	1	12	6	6						
MA	08/22	56	26	29	2	1	1	1	1	0						
LE	08/23	29	11	18										1	0	1
LU	08/24				1	0	1									
FR	08/24	55	34	21	7	4	3							3	2	1
LE	08/24	54	32	22	3	2	1							2	1	1
NB	08/30	18	12	6	3	2	1									
SJ	09/06	34	10	24	3	1	2	2	0	2						
TC	09/06	1	0	1												
SH	09/07	26	12	13				2	1	1						
LE	09/08	37	19	18												
TC	09/08	10	6	4												
LU	09/13	13	9	4												
PW	09/14	5	2	3	4	2	2	2	1	1						
LU	09/14				7	4	3	4	2	2						
LU	09/16	21	10	11	3	1	2	4	4	0				1	1	0
LU	09/17				3	1	2	1	0	1						
MU	09/19				1	1	0									
MW	09/19							4	3	1						
SA	09/19	21	10	11												
MU	09/20				1	0	1									
MW	09/20	9	4	5												
GH	09/21	43	20	23	8	5	3	5	0	5						
MA	09/27	18	7	11	12	2	10	7	2	5						
FR	09/27	11	4	6	19	12	7	18	11	7						
FR	09/28	2	2	0	2	2	0									
LE	09/28	4	2	2	1	1	0	4	3	1						
LU	10/05	3	2	1				1	1	0						
LU	10/10	2	1	1	11	7	4									
LU	10/11	16	6	10	25	11	14	15	3	12						
LU	10/25	4	3	1	3	2	1	4	3	1						
Totals:		1955	958	980	477	239	236	197	87	109	756	400	346	87	45	42

APPENDIX C

Table 8. The location, date, and number (by size class and sex) of chinook salmon sampled in 1986.

Port	Date	Total n	Total M	Total F	size 1 n	size 1 M	size 1 F	size 2 n	size 2 M	size 2 F	size 3 n	size 3 M	size 3 F
SJ	04/05	1	0	1	0	0	0	0	0	0	1	0	1
SJ	04/06	2	1	1	0	0	0	0	0	0	2	1	1
SH	04/06	0											
GH	04/12	2	1	1	0	0	0	1	0	1	1	1	0
SJ	04/13	16	7	9	3	3	0	5	2	3	8	2	6
SA	04/13	6	2	4	0	0	0	0	0	0	6	2	4
GH	04/19	11	6	5	0	0	0	3	1	2	8	5	3
SA	04/20	13	8	5	0	0	0	1	0	1	12	8	4
NB	04/25	9	4	5	3	1	2	4	1	3	2	2	0
SJ	04/25	34	15	19	4	1	3	22	13	9	8	1	7
NB	04/26	25	12	13	1	1	0	16	8	8	8	3	5
SJ	04/26	0											
LU	05/01	0											
LU	05/03	75	42	33	2	1	1	24	16	8	49	25	24
GH	05/04	46	23	23	0	0	0	28	13	15	18	10	8
FR	05/10	2	1	1	0	0	0	0	0	0	2	1	1
LE	05/10	0											
LU	05/11	59	31	27	0	0	0	20	13	7	39	18	20
MA	05/11	36	17	19	1	1	0	15	5	10	20	11	9
MU	05/16	26	13	12	2	1	1	20	9	11	4	3	0
SH	05/16	5	3	2	1	0	1	4	3	1	0	0	0
SJ	05/17	18	7	11	0	0	0	12	4	8	6	3	3
SH	05/17	0											
MU	05/23	18	9	8	1	1	0	14	7	6	3	1	2
PW	05/24	21	11	10	0	0	0	17	8	9	4	3	1
FR	05/24	5	3	2	0	0	0	3	2	1	2	1	1
LE	05/25	0											
GH	05/31	43	23	20	7	4	3	31	16	15	5	3	2
SA	06/01	4	3	1	0	0	0	4	3	1	0	0	0
GH	06/01	32	16	16	2	1	1	30	15	15	0	0	0
NB	06/06	2	2	0	1	1	0	1	1	0	0	0	0
NB	06/08	5	3	2	3	2	1	2	1	1	0	0	0
SJ	06/08	0											
LU	06/11	5	1	4	0	0	0	1	0	1	4	1	3
GH	06/12	0											
LU	06/12	23	6	17	1	1	0	19	5	14	3	0	3
MW	06/13	3	1	2	1	0	1	2	1	1	0	0	0
LU	06/13	0											
SA	06/14	14	10	4	10	8	2	4	2	2	0	0	0
GH	06/18	1	0	1	0	0	0	1	0	1	0	0	0
SH	06/20	1	0	1	0	0	0	1	0	1	0	0	0
LE	06/23	0											
TC	06/23	0											
LE	06/24	29	15	12	0	0	0	16	9	5	13	6	7
TC	06/24	5	3	1	1	1	0	2	1	1	2	1	0
FR	06/25	0											
MC	06/29	2	1	1	1	0	1	0	0	0	1	1	0
CH	07/02	2	1	1	0	0	0	2	1	1	0	0	0
MA	07/05	35	20	15	1	1	0	10	7	3	24	12	12
SJ	07/11	22	10	12	1	0	1	16	8	8	5	2	3
SH	07/12	7	5	2	2	1	1	4	3	1	1	1	0
SA	07/12	27	10	17	8	4	4	8	1	7	11	5	6
GH	07/13	19	11	8	9	8	1	4	0	4	6	3	3
PW	07/17	14	8	6	2	2	0	6	4	2	6	2	4
LU	07/17	30	18	12	6	3	3	8	7	1	16	8	8

Table 8. (cont'd)

Port	Date	Total n	Total M	Total F	size 1 n	size 1 M	size 1 F	size 2 n	size 2 M	size 2 F	size 3 n	size 3 M	size 3 F
LU	07/18	2	1	1	0	0	0	1	1	0	1	0	1
MA	07/18	91	43	44	29	14	11	19	9	10	43	20	23
LU	07/19	91	40	51	17	12	5	26	9	17	48	19	29
LE	07/21	20	6	14	0	0	0	5	3	2	15	3	12
LE	07/22	41	11	30	4	2	2	15	6	9	22	3	19
LE	07/23	28	17	11	2	1	1	13	9	4	13	7	6
NB	07/24	5	0	5	0	0	0	2	0	2	3	0	3
TC	07/24	4	1	3	0	0	0	1	0	1	3	1	2
CH	07/24	7	4	3	0	0	0	3	2	1	4	2	2
MC	07/25	13	7	6	0	0	0	6	4	2	7	3	4
NB	07/25	0											
FR	07/25	29	15	14	2	1	1	11	9	2	16	5	11
MC	07/26	2	1	1	0	0	0	1	0	1	1	1	0
NB	07/26	9	4	5	1	0	1	6	3	3	2	1	1
MW	08/01	53	25	26	5	4	1	27	10	16	21	11	9
MW	08/02	15	8	7	3	2	1	6	4	2	6	2	4
CH	08/08	9	6	3	2	2	0	4	2	2	3	2	1
SJ	08/09	36	22	14	7	5	2	14	7	7	15	10	5
SH	08/09	7	6	1	0	0	0	4	3	1	3	3	0
CH	08/09	12	6	5	2	0	1	5	4	1	5	2	3
SH	08/10	19	8	11	2	2	0	10	2	8	7	4	3
TC	08/10	2	1	1	0	0	0	0	0	0	2	1	1
PW	08/15	15	5	10	1	0	1	9	2	7	5	3	2
FR	08/15	1	1	0	0	0	0	0	0	0	1	1	0
SA	08/16	54	28	26	14	7	7	37	19	18	3	2	1
GH	08/16	0											
PW	08/16	2	2	0	0	0	0	0	0	0	2	2	0
LU	08/16	93	43	49	3	1	2	34	17	17	56	25	30
GH	08/17	48	20	28	16	7	9	13	7	6	19	6	13
MA	08/22	56	26	29	3	2	1	20	8	12	33	16	16
LE	08/23	29	11	18	6	2	4	12	4	8	11	5	6
LU	08/24	0											
FR	08/24	55	34	21	6	4	2	18	12	6	31	18	13
LE	08/24	54	32	22	6	4	2	27	14	13	21	14	7
NB	08/30	18	12	6	15	9	6	2	2	0	1	1	0
SJ	09/06	34	10	24	13	7	6	17	3	14	4	0	4
TC	09/06	1	0	1	0	0	0	0	0	0	1	0	1
SH	09/07	26	12	13	13	6	6	10	5	5	3	1	2
LE	09/08	37	19	18	10	7	3	20	10	10	7	2	5
TC	09/08	10	6	4	0	0	0	2	2	0	8	4	4
LU	09/13	13	9	4	4	3	1	6	3	3	3	3	0
PW	09/14	5	2	3	1	1	0	1	0	1	3	1	2
LU	09/14	0											
LU	09/16	21	10	11	2	2	0	3	3	0	16	5	11
LU	09/17	0											
MU	09/19	0											
MW	09/19	0											
SA	09/19	21	10	11	0	0	0	1	1	0	20	9	11
MU	09/20	0											
MW	09/20	9	4	5	2	1	1	4	1	3	3	2	1
GH	09/21	43	20	23	18	8	10	22	11	11	3	1	2
MA	09/27	18	7	11	5	4	1	6	1	5	7	2	5
FR	09/27	11	4	6	2	2	0	5	0	4	4	2	2
FR	09/28	2	2	0	0	0	0	1	1	0	1	1	0
LE	09/28	4	2	2	1	1	0	2	1	1	1	0	1
LU	10/05	3	2	1	2	2	0	0	0	0	1	0	1
LU	10/10	2	1	1	1	1	0	1	0	1	0	0	0
LU	10/11	16	6	10	10	3	7	6	3	3	0	0	0
LU	10/25	4	3	1	4	3	1	0	0	0	0	0	0
Totals:		1955	958	980	308	179	123	839	407	427	808	372	430

APPENDIX D

Table 9. Values of percent feeding, frequency of occurrence, average number, average weight, percent by number, and percent by weight for all chinook and for feeding chinook in 1986.

			Frequency of Prey Occurrence - All Fish									Frequency of Prey Occurrence - Fish With Food								
MONTH/DAYS	n	%W/Food	Total	ALW	BLC	RBS	YLP	INS	ZOOP	OTH	UNID	Total	ALW	BLC	RBS	YLP	INS	ZOOP	OTH	UNID
SIZE 1 - SOUTHERN BASIN																				
4/13	3	33%	0.33	-	-	-	0.33	-	-	-	-	1.00	-	-	-	1.00	-	-	-	-
4/25-26	8	13%	0.13	-	-	-	-	-	-	-	0.13	1.00	-	-	-	-	-	-	-	1.00
5/16-23	4	50%	0.50	-	-	-	-	-	0.50	-	-	1.00	-	-	-	-	-	1.00	-	-
5/31-6/01	8	38%	0.38	-	-	-	-	0.25	0.13	-	-	1.00	-	-	-	-	0.67	0.33	-	-
6/06-08	4	75%	0.75	-	-	-	-	0.50	0.25	-	-	1.00	-	-	-	-	0.67	0.33	-	-
6/13-14	11	91%	0.91	-	0.64	-	0.09	-	-	-	0.18	1.00	-	0.70	-	0.10	-	-	-	0.20
6/29-7/13	21	76%	0.76	-	0.48	-	-	-	-	-	0.29	1.00	-	0.63	-	-	-	-	-	0.38
7/26-8/02	8	75%	0.75	-	0.50	-	-	-	-	-	0.25	1.00	-	0.67	-	-	-	-	-	0.33
8/09-10	9	78%	0.89	-	0.67	0.22	-	-	-	-	-	1.14	-	0.86	0.29	-	-	-	-	-
8/16-17	30	70%	0.77	0.07	0.50	0.07	0.03	-	-	-	0.10	1.10	0.10	0.71	0.10	0.05	-	-	-	0.14
8/30	15	80%	0.93	0.40	0.40	0.07	-	-	-	-	0.07	1.17	0.50	0.50	0.08	-	-	-	-	0.08
9/06-07	23	87%	1.52	0.17	0.57	0.17	0.26	-	0.04	-	0.30	1.75	0.20	0.65	0.20	0.30	-	0.05	-	0.35
9/20-21	20	80%	1.00	0.15	0.35	0.10	-	-	0.10	-	0.30	1.25	0.19	0.44	0.13	-	-	0.13	-	0.38
Average	164	64%	0.71	0.05	0.32	0.03	0.05	0.03	0.09	-	0.14	1.08	0.06	0.40	0.04	0.09	0.06	0.16	-	0.27
SIZE 1 - NORTHERN BASIN																				
5/03-11	3	67%	0.67	0.33	-	0.33	-	-	-	-	-	1.00	0.50	-	0.50	-	-	-	-	-
6/12-7/05	3	33%	0.33	-	-	-	-	-	-	-	0.33	1.00	-	-	-	-	-	-	-	1.00
7/17-19	54	52%	0.61	0.07	0.28	0.02	-	0.02	0.11	-	0.11	1.18	0.14	0.54	0.04	-	0.04	0.21	-	0.21
7/22-25	8	38%	0.50	0.13	0.38	-	-	-	-	-	-	1.33	0.33	1.00	-	-	-	-	-	-
8/08-09	4	75%	1.25	0.25	0.25	0.50	-	-	-	-	0.25	1.67	0.33	0.33	0.67	-	-	-	-	0.33
8/15-16	4	75%	1.25	-	0.75	-	-	-	0.25	-	0.25	1.67	-	1.00	-	-	-	0.33	-	0.33
8/22-24	20	75%	1.25	0.20	0.25	0.55	-	-	0.10	-	0.15	1.67	0.27	0.33	0.73	-	-	0.13	-	0.20
9/08	10	70%	0.80	0.40	0.20	0.10	-	-	-	-	0.10	1.14	0.57	0.29	0.14	-	-	-	-	0.14
9/14-16	7	86%	1.29	0.14	0.29	0.71	-	-	-	-	0.14	1.50	0.17	0.33	0.83	-	-	-	-	0.17
9/27-28	8	75%	1.38	0.25	0.50	0.25	-	-	0.13	-	0.25	1.83	0.33	0.67	0.33	-	-	0.17	-	0.33
10/05-11	13	100%	1.77	0.85	0.31	0.15	-	-	0.31	-	0.15	1.77	0.85	0.31	0.15	-	-	0.31	-	0.15
10/25	4	75%	1.00	-	0.75	-	-	-	0.25	-	-	1.33	-	1.00	-	-	-	0.33	-	-
Average	138	62%	0.87	0.22	0.23	0.19	-	0.00	0.07	-	0.16	1.32	0.29	0.36	0.25	-	0.00	0.09	-	0.33
SIZE 2 - SOUTHERN BASIN																				
4/12-13	6	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/19-20	4	25%	0.75	0.25	0.25	-	0.25	-	-	-	-	3.00	1.00	1.00	-	1.00	-	-	-	-
4/25-26	42	26%	0.26	0.19	-	-	-	0.02	-	-	0.05	1.00	0.73	-	-	-	0.09	-	-	0.18
5/04	28	46%	0.54	0.36	0.07	-	0.07	-	-	-	0.04	1.15	0.77	0.15	-	0.15	-	-	-	0.08
5/16-17	36	36%	0.46	0.18	-	0.03	0.03	-	0.09	-	0.12	1.15	0.50	-	0.05	0.05	-	0.15	-	0.40
5/23	14	86%	0.93	0.21	-	-	0.07	-	0.43	-	0.21	1.08	0.25	-	-	0.08	-	0.50	-	0.25
5/31-6/01	63	41%	0.46	0.19	-	0.03	0.03	-	0.11	-	0.10	1.12	0.46	-	0.08	0.08	-	0.27	-	0.23
6/06-20	11	45%	0.73	0.09	0.45	0.09	-	-	-	-	0.09	1.60	0.20	1.00	0.20	-	-	-	-	0.20
7/11-13	32	50%	0.53	0.06	0.31	-	-	-	-	-	0.16	1.06	0.13	0.63	-	-	-	-	-	0.31
7/24-26	14	43%	0.57	0.07	0.07	-	0.21	-	-	-	0.21	1.33	0.17	0.17	-	0.50	-	-	-	0.50
8/01-02	32	56%	0.59	0.09	0.44	-	0.03	-	-	-	0.03	1.06	0.17	0.78	-	0.06	-	-	-	0.06
8/09-10	27	52%	0.59	0.19	0.26	-	-	-	-	-	0.15	1.14	0.36	0.50	-	-	-	-	-	0.29
8/16-17	50	58%	0.74	0.12	0.42	0.08	0.06	-	-	-	0.06	1.28	0.21	0.72	0.14	0.10	-	-	-	0.10
8/30-9/07	27	85%	1.22	0.07	0.37	0.22	0.41	-	-	-	0.15	1.43	0.09	0.43	0.26	0.48	-	-	-	0.17
9/19-21	26	77%	1.12	0.31	0.38	0.12	0.04	-	0.04	-	0.23	1.45	0.40	0.50	0.15	0.05	-	0.05	-	0.30
Average	412	52%	0.69	0.14	0.25	0.06	0.09	0.00	0.03	-	0.11	1.36	0.32	0.50	0.09	0.17	0.00	0.05	-	0.23
SIZE 2 - NORTHERN BASIN																				
5/03	24	58%	0.67	0.50	-	0.04	-	-	-	-	0.13	1.14	0.86	-	0.07	-	-	-	-	0.21
5/11	35	77%	0.94	0.77	0.06	-	-	-	-	-	0.11	1.22	1.00	0.07	-	-	-	-	-	0.15
5/24	20	100%	1.45	0.40	0.05	0.10	-	-	0.80	-	0.10	1.45	0.40	0.05	0.10	-	-	0.80	-	0.10
6/12-13	20	45%	0.55	0.40	-	-	0.05	-	-	-	0.10	1.22	0.89	-	-	0.11	-	-	-	0.22
6/25	17	65%	0.71	0.65	-	0.06	-	-	-	-	-	1.09	1.00	-	0.09	-	-	-	-	-
7/02-04	12	50%	0.67	0.25	0.17	-	-	-	-	-	0.25	1.33	0.50	0.33	-	-	-	-	-	0.50
7/17-19	60	43%	0.58	0.28	0.08	0.10	-	0.03	0.02	-	0.07	1.35	0.65	0.19	0.23	-	0.08	0.04	-	0.15
7/21-23	33	21%	0.21	0.09	0.06	-	-	-	-	-	0.06	1.00	0.43	0.29	-	-	-	-	-	0.29
7/24-25	15	33%	0.33	0.07	-	0.07	-	-	-	-	0.20	1.00	0.20	-	0.20	-	-	-	-	0.60
8/08-09	8	50%	0.63	0.13	0.13	0.38	-	-	-	-	-	1.25	0.25	0.25	0.75	-	-	-	-	-
8/15-16	43	53%	0.65	0.26	0.19	-	-	0.02	0.07	-	0.12	1.22	0.48	0.35	-	-	0.04	0.13	-	0.22
8/22-24	76	62%	0.76	0.41	0.08	0.16	-	0.01	0.04	-	0.07	1.23	0.66	0.13	0.26	-	0.02	0.06	-	0.11
9/09	22	82%	1.27	0.68	0.18	0.32	-	-	-	-	0.09	1.56	0.83	0.22	0.39	-	-	-	-	0.11
9/14-16	10	90%	1.60	0.50	0.20	0.80	-	-	-	-	0.10	1.78	0.56	0.22	0.89	-	-	-	-	0.11
9/27-28	14	100%	1.36	0.57	0.29	0.14	-	-	0.14	-	0.21	1.36	0.57	0.29	0.14	-	-	0.14	-	0.21
10/10-11	7	100%	1.71	0.86	0.29	0.14	-	-	0.14	-	0.29	1.71	0.86	0.29	0.14	-	-	0.14	-	0.29
Average	416	60%	0.93	0.44	0.11	0.15	0.01	0.00	0.11	-	0.12	1.32	0.64	0.15	0.20	0.01	0.01	0.12	-	0.19
SIZE 3 - SOUTHERN BASIN																				
4/05-06	3	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/12-13	15	7%	0.13	-	-	-	-	0.07	-	-	0.07	2.00	-	-	-	-	1.00	-	-	1.00
4/19-20	20	50%	0.50	0.40	0.05	-	0.05	-	-	-	-	1.00	0.80	0.10	-	0.10	-	-	-	-
4/25-26	18	56%	0.56	0.56	-	-	-	-	-	-	-	1.00	1.00	-	-	-	-	-	-	-
5/04	18	44%	0.61	0.39	0.06	-	0.06	-	-	0.06	0.06	1.38	0.88	0.13	-	0.13	-	-	0.13	0.13
5/16-17	10	50%	0.60	0.40	-	-	-	-	-	-	0.20	1.20	0.80	-	-	-	-	-	-	0.40
5/23	3	67%	0.67	0.67	-	-	-	-	-	-	-	1.00	1.00	-	-	-	-	-	-	-
5/31	5	60%	0.80	0.60	-	0.20	-	-	-	-	-	1.33	1.00	-	0.33	-	-	-	-	-
6/29-7/13	24	46%	0.46	0.25	0.08	-	-	-	-	-	0.13	1.00	0.55	0.18	-	-	-	-	-	0.27
7/24-26	13	46%	0.62	0.08	0.15	-	0.15	-	-	-	0.23	1.33	0.17	0.33	-	0.33	-	-	-	0.50
8/01-02	27	33%	0.44	0.11	0.11	0.07	0.11	-	-	-	0.04	1.33	0.33	0.33	0.22	0.33	-	-	-	0.11
8/09-10	24	50%	0.54	0.21	-	-	-	-	-	-	0.33	1.08	0.42	-	-	-	-	-	-	0.67
8/16-17	22	55%	0.73	0.18	0.41	0.05	0.05	-	-	-	0.05	1.33	0.33	0.75	0.08	0.08	-	-	-	0.08
8/30-9/07	8	75%	1.13	0.25	0.13	0.13	0.50	-	-	-	0.13	1.50	0.33	0.17	0.17	0.67	-	-	-	0.17
9/19-21	26	19%	0.23	0.04	-	0.12	0.04	-	-	-	0.04	1.20	0.20	-	0.60	0.20	-	-	-	0.20
Average	236	48%	0.59	0.28	0.08	0.05	0.08	0.00	-	0.00	0.09	1.25	0.56	0.15	0.11	0.15	0.04	-	0.01	0.23
SIZE 3 - NORTHERN BASIN																				
5/03	49	73%	0.84	0.65	-	0.02	0.02	-	-	0.02	0.12	1.14	0.89	-	0.03	0.03	-	-	0.03	0.17
5/10-11	60	67%	0.77	0.58	0.02	0.07	-	-	-	-	0.10	1.15	0.88	0.03	0.10	-	-	-	-	0.15
5/24	6	50%	0.50	0.17	-	-	-	-	0.33	-	-	1.00	0.33	-	-	-	-	0.67	-	-
6/12-13	7	71%	0.86	0.71	-	0.14	-	-	-	-	-	1.20	1.00	-	0.20	-	-	-	-	-
6/25	15	73%	0.80	0.67	0.07	-	-	-	-	-	0.07	1.09	0.91	0.09	-	-	-	-	-	0.09
7/05	24	50%	0.54	0.33	0.08	0.04	-	-	-	-	0.08	1.08	0.67	0.17	0.08	-	-	-	-	0.17
7/17-19	108	31%	0.36	0.17	0.06	0.04	-	-	0.02	-	0.07	1.16	0.58	0.22	0.09	-	-	0.04	-	0.23
7/21-23	50	32%	0.40	0.20	0.06	0.06	-	-	-	0.02	0.06	1.25	0.63	0.19	0.19	-	-	-	0.06	0.19
7/24-25	23	57%	0.74	0.35	0.17	0.13	-	-	-	-	0.09	1.31	0.62	0.31	0.23	-	-	-	-	0.15
8/08-10	10	70%	1.00	0.20	0.20	0.60	-	-	-	-	-	1.43	0.29	0.29	0.86	-	-	-	-	-
8/15-16	63	63%	0.81	0.48	0.13	0.02	-	-	0.03	-	0.16	1.28	0.75	0.20	0.03	-	-	0.05	-	0.25
8/22-24	94	67%	0.84	0.48	0.05	0.26	-	-	-	0.01	0.04	1.25	0.71	0.08	0.38	-	-	-	0.02	0.06
9/06-09	16	56%	0.88	0.38	0.19	0.19	-	-	-	-	0.13	1.56	0.67	0.33	0.33	-	-	-	-	0.22
9/14-16	22	59%	0.91	0.32	0.14	0.41	-	-	-	-	0.05	1.54	0.54	0.23	0.69	-	-	-	-	0.08
9/27-10/05	14	50%	0.93	0.29	0.14	0.29	-	-	-	-	0.21	1.86	0.57	0.29	0.57	-	-	-	-	0.43
Average	561	59%	0.76	0.40	0.08	0.16	0.00	-	0.04	0.00	0.08	1.31	0.66	0.15	0.27	0.00	-	0.08	0.00	0.14

Table 9. (cont'd)

			Number of Prey - All Chinook									Number of Prey - Chinook With Food								
MONTH/DAYS	n	%W/Food	Total	ALW	BLC	RBS	YLP	IBS	ZOOP	OTH	UNID	Total	ALW	BLC	RBS	YLP	IBS	ZOOP	OTH	UNID
SIZE 1 - SOUTHERN BASIN																				
4/13	3	33%	0.33	-	-	-	0.33	-	-	-	-	1.00	-	-	-	1.00	-	-	-	-
4/25-26	8	13%	0.25	-	-	-	-	-	-	-	0.25	2.00	-	-	-	-	-	-	-	2.00
5/16-23	4	50%	-	-	-	-	-	-	109.3	-	-	-	-	-	-	-	-	218.5	-	-
5/31-6/01	8	38%	-	-	-	-	-	-	0.13	-	-	-	-	-	-	-	-	0.33	-	-
6/06-08	4	75%	-	-	-	-	-	17.50	0.25	-	-	-	-	-	-	-	23.33	0.33	-	-
6/13-14	11	91%	1.36	-	1.09	-	0.09	-	-	-	0.18	1.50	-	1.20	-	0.10	-	-	-	0.20
6/29-7/13	21	76%	1.33	-	1.05	-	-	-	-	-	0.29	1.75	-	1.38	-	-	-	-	-	0.38
7/26-8/02	8	75%	1.00	-	0.75	-	-	-	-	-	0.25	1.33	-	1.00	-	-	-	-	-	0.33
8/09-10	9	78%	1.44	-	1.11	0.33	-	-	-	-	-	1.86	-	1.43	0.43	-	-	-	-	-
8/16-17	30	70%	1.57	0.13	0.80	0.47	0.07	-	-	-	0.10	2.24	0.19	1.14	0.67	0.10	-	-	-	0.14
8/30	15	80%	1.33	0.73	0.47	0.07	-	-	-	-	0.07	1.67	0.92	0.58	0.08	-	-	-	-	0.08
9/06-07	23	87%	4.30	0.17	1.52	0.48	1.74	-	8.74	-	0.39	4.95	0.20	1.75	0.55	2.00	-	10.05	-	0.45
9/20-21	20	80%	2.10	0.25	1.35	0.15	-	-	12.15	-	0.35	2.63	0.31	1.69	0.19	-	-	15.19	-	0.44
Average	164	64%	1.10	0.08	0.63	0.09	0.14	0.73	14.98	-	0.17	1.58	0.10	0.79	0.11	0.20	0.97	28.92	-	0.38
SIZE 1 - NORTHERN BASIN																				
5/03-11	3	67%	1.33	1.00	-	0.33	-	-	-	-	-	2.00	1.50	-	0.50	-	-	-	-	-
6/12-7/05	3	33%	0.33	-	-	-	-	-	-	-	0.33	1.00	-	-	-	-	-	-	-	1.00
7/17-19	54	52%	0.59	0.07	0.35	0.02	-	0.06	28.04	-	0.15	1.14	0.14	0.68	0.04	-	0.11	54.07	-	0.29
7/22-25	8	38%	0.75	0.25	0.50	-	-	-	-	-	-	2.00	0.67	1.33	-	-	-	-	-	-
8/08-09	4	75%	1.25	0.25	0.25	0.50	-	-	-	-	0.25	1.67	0.33	0.33	0.67	-	-	-	-	0.33
8/15-16	4	75%	2.00	-	1.75	-	-	-	12.00	-	0.25	2.67	-	2.33	-	-	-	16.00	-	0.33
8/22-24	20	75%	4.05	0.50	0.25	3.15	-	-	39.65	-	0.15	5.40	0.67	0.33	4.20	-	-	52.87	-	0.20
9/08	10	70%	1.50	1.10	0.20	0.10	-	-	-	-	0.10	2.14	1.57	0.29	0.14	-	-	-	-	0.14
9/14-16	7	86%	6.57	0.14	0.57	5.71	-	-	-	-	0.14	7.67	0.17	0.67	6.67	-	-	-	-	0.17
9/27-28	8	75%	3.00	1.00	1.50	0.25	-	-	13.88	-	0.25	4.00	1.33	2.00	0.33	-	-	18.50	-	0.33
10/05-11	13	100%	8.31	7.46	0.54	0.15	-	-	18.54	-	0.15	8.31	7.46	0.54	0.15	-	-	18.54	-	0.15
10/25	4	75%	2.00	-	2.00	-	-	-	1.25	-	-	2.67	-	2.67	-	-	-	1.67	-	-
Average	138	62%	2.31	1.07	0.46	0.63	-	0.00	6.48	-	0.16	3.03	1.25	0.66	0.79	-	0.00	8.69	-	0.34
SIZE 2 - SOUTHERN BASIN																				
4/12-13	6	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/19-20	4	25%	1.25	0.25	0.50	-	0.50	-	-	-	-	5.00	1.00	2.00	-	2.00	-	-	-	-
4/25-26	42	26%	0.40	0.36	-	-	-	0.19	-	-	0.05	1.55	1.36	-	-	-	0.73	-	-	0.18
5/04	28	46%	0.64	0.46	0.07	-	0.07	-	-	-	0.04	1.38	1.00	0.15	-	0.15	-	-	-	0.08
5/16-17	36	36%	0.66	0.45	-	0.03	0.03	-	69.97	-	0.15	1.90	1.35	-	0.05	0.05	-	112.0	-	0.45
5/23	14	86%	0.50	0.21	-	-	0.07	-	240.6	-	0.21	0.58	0.25	-	-	0.08	-	280.7	-	0.25
5/31-6/01	63	41%	0.41	0.25	-	0.03	0.03	-	11.13	-	0.10	1.00	0.62	-	0.08	0.08	-	26.96	-	0.23
6/06-20	11	45%	1.27	0.09	1.00	0.09	-	-	-	-	0.09	2.80	0.20	2.20	0.20	-	-	-	-	0.20
7/11-13	32	50%	0.72	0.13	0.44	-	-	-	-	-	0.16	1.44	0.25	0.88	-	-	-	-	-	0.31
7/24-26	14	43%	1.14	0.14	0.21	-	0.43	-	-	-	0.36	2.67	0.33	0.50	-	1.00	-	-	-	0.83
8/01-02	32	56%	1.06	0.09	0.88	-	0.06	-	-	-	0.03	1.89	0.17	1.56	-	0.11	-	-	-	0.06
8/09-10	27	52%	1.15	0.26	0.74	-	-	-	-	-	0.15	2.21	0.50	1.43	-	-	-	-	-	0.29
8/16-17	50	58%	1.38	0.22	0.72	0.28	0.08	-	-	-	0.08	2.38	0.38	1.24	0.48	0.14	-	-	-	0.14
8/30-9/07	27	85%	6.41	0.15	0.78	2.78	2.22	-	-	-	0.48	7.52	0.17	0.91	3.26	2.61	-	-	-	0.57
9/19-21	26	77%	2.35	0.81	0.73	0.31	0.04	-	0.88	-	0.46	3.05	1.05	0.95	0.40	0.05	-	1.15	-	0.60
Average	412	52%	1.67	0.24	0.51	0.40	0.35	0.01	14.92	-	0.18	2.90	0.52	1.00	0.52	0.53	0.03	20.75	-	0.32
SIZE 2 - NORTHERN BASIN																				
5/03	24	58%	1.54	1.21	-	0.08	-	-	-	-	0.25	2.64	2.07	-	0.14	-	-	-	-	0.43
5/11	35	77%	3.97	3.80	0.06	-	-	-	-	-	0.11	5.15	4.93	0.07	-	-	-	-	-	0.15
5/24	20	100%	1.45	1.20	0.05	0.10	-	-	303.6	-	0.10	1.45	1.20	0.05	0.10	-	-	303.6	-	0.10
6/12-13	20	45%	1.05	0.85	-	-	0.10	-	-	-	0.10	2.33	1.89	-	-	0.22	-	-	-	0.22
6/25	17	65%	2.88	2.82	-	0.06	-	-	-	-	-	4.45	4.36	-	0.09	-	-	-	-	-
7/02-04	12	50%	3.00	2.00	0.67	-	-	-	-	-	0.25	6.00	4.17	1.33	-	-	-	-	-	0.50
7/17-19	60	43%	0.68	0.35	0.13	0.12	-	0.67	0.13	-	0.08	1.58	0.81	0.31	0.27	-	1.54	0.31	-	0.19
7/21-23	33	21%	0.27	0.09	0.12	-	-	-	-	-	0.06	1.29	0.43	0.57	-	-	-	-	-	0.29
7/24-25	15	33%	0.33	0.07	-	0.07	-	-	-	-	0.20	1.00	0.20	-	0.20	-	-	-	-	0.60
8/08-09	8	50%	1.13	0.25	0.25	0.63	-	-	-	-	-	2.25	0.50	0.50	1.25	-	-	-	-	-
8/15-16	43	53%	1.12	0.37	0.63	-	-	0.02	6.84	-	0.12	2.09	0.70	1.17	-	-	0.04	12.78	-	0.22
8/22-24	76	62%	1.20	0.66	0.09	0.38	-	0.05	5.53	-	0.07	1.94	1.06	0.15	0.62	-	0.09	8.94	-	0.11
9/09	22	82%	3.05	1.77	0.18	0.86	-	-	-	-	0.23	3.72	2.17	0.22	1.06	-	-	-	-	0.28
9/14-16	10	90%	10.90	1.00	0.30	9.50	-	-	-	-	0.10	12.11	1.11	0.33	10.56	-	-	-	-	0.11
9/27-28	14	100%	5.36	4.36	0.50	0.14	-	-	0.86	-	0.36	5.36	4.36	0.50	0.14	-	-	0.86	-	0.36
10/10-11	7	100%	7.43	4.29	2.57	0.14	-	-	24.29	-	0.43	7.43	4.29	2.57	0.14	-	-	24.29	-	0.43
Average	416	68%	2.91	1.66	0.33	0.76	0.01	0.03	33.85	-	0.15	3.79	2.19	0.43	0.91	0.02	0.07	34.32	-	0.24
SIZE 3 - SOUTHERN BASIN																				
4/05-06	3	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/12-13	15	7%	0.07	-	-	-	-	0.27	-	-	0.07	1.00	-	-	-	-	4.00	-	-	1.00
4/19-20	20	50%	1.40	1.30	0.05	-	0.05	-	-	-	-	2.80	2.60	0.10	-	0.10	-	-	-	-
4/25-26	18	56%	1.56	1.56	-	-	-	-	-	-	-	2.80	2.80	-	-	-	-	-	-	-
5/04	18	44%	1.28	1.06	0.06	-	0.06	-	-	0.06	0.06	2.88	2.38	0.13	-	0.13	-	-	0.13	0.13
5/16-17	10	50%	1.30	1.10	-	-	-	-	-	-	0.20	2.60	2.20	-	-	-	-	-	-	0.40
5/23	3	67%	0.67	0.67	-	-	-	-	-	-	-	1.00	1.00	-	-	-	-	-	-	-
5/31	5	60%	1.40	1.20	-	0.20	-	-	-	-	-	2.33	2.00	-	0.33	-	-	-	-	-
6/29-7/13	24	46%	0.50	0.29	0.08	-	-	-	-	-	0.13	1.09	0.64	0.18	-	-	-	-	-	0.27
7/24-26	13	46%	0.92	0.08	0.23	-	0.31	-	-	-	0.31	2.00	0.17	0.50	-	0.67	-	-	-	0.67
8/01-02	27	33%	0.63	0.11	0.19	0.07	0.22	-	-	-	0.04	1.89	0.33	0.56	0.22	0.67	-	-	-	0.11
8/09-10	24	50%	0.83	0.46	-	-	-	-	-	-	0.38	1.67	0.92	-	-	-	-	-	-	0.75
8/16-17	22	55%	1.36	0.18	0.91	0.05	0.18	-	-	-	0.05	2.50	0.33	1.67	0.08	0.33	-	-	-	0.08
8/30-9/07	8	75%	2.13	0.25	0.13	0.38	1.25	-	-	-	0.13	2.83	0.33	0.17	0.50	1.67	-	-	-	0.17
9/19-21	26	19%	0.27	0.04	-	0.15	0.04	-	-	-	0.04	1.40	0.20	-	0.80	0.20	-	-	-	0.20
Average	236	48%	1.01	0.52	0.11	0.08	0.20	0.01	-	0.00	0.10	2.00	1.03	0.23	0.16	0.32	0.17	-	0.01	0.25
SIZE 3 - NORTHERN BASIN																				
5/03	49	73%	3.08	2.61	-	0.02	0.02	-	-	0.02	0.41	4.19	3.56	-	0.03	0.03	-	-	0.03	0.56
5/10-11	60	67%	4.23	4.03	0.02	0.08	-	-	-	-	0.10	6.35	6.05	0.03	0.13	-	-	-	-	0.15
5/24	6	50%	0.17	0.17	-	-	-	-	4.83	-	-	0.33	0.33	-	-	-	-	9.67	-	-
6/12-13	7	71%	2.29	2.14	-	0.14	-	-	-	-	-	3.20	3.00	-	0.20	-	-	-	-	-
6/25	15	73%	2.33	2.20	0.07	-	-	-	-	-	0.07	3.18	3.00	0.09	-	-	-	-	-	0.09
7/05	24	50%	2.75	2.21	0.33	0.08	-	-	-	-	0.13	5.50	4.42	0.67	0.17	-	-	-	-	0.25
7/17-19	100	31%	0.50	0.24	0.14	0.06	-	-	0.09	-	0.07	1.59	0.74	0.49	0.14	-	-	0.25	-	0.23
7/21-23	50	32%	0.44	0.20	0.08	0.08	-	-	-	0.02	0.06	1.38	0.63	0.25	0.25	-	-	-	0.06	0.19
7/24-25	23	57%	1.48	0.78	0.39	0.22	-	-	-	-	0.09	2.62	1.38	0.69	0.38	-	-	-	-	0.15
8/08-10	10	70%	3.30	0.30	0.20	2.80	-	-	-	-	-	4.71	0.43	0.29	4.00	-	-	-	-	-
8/15-16	63	63%	1.40	0.95	0.19	0.02	-	-	2.17	-	0.24	2.20	1.50	0.30	0.03	-	-	3.43	-	0.38
8/22-24	94	67%	2.62	1.40	0.10	1.05	-	-	-	0.01	0.05	3.90	2.10	0.14	1.57	-	-	-	0.02	0.08
9/06-09	16	56%	2.00	1.19	0.19	0.50	-	-	-	-	0.13	3.56	2.11	0.33	0.89	-	-	-	-	0.22
9/14-16	22	59%	6.18	4.50	0.14	1.50	-	-	-	-	0.05	10.46	7.62	0.23	2.54	-	-	-	-	0.08
9/27-10/05	14	50%	3.43	2.14	0.21	0.79	-	-	-	-	0.29	6.86	4.29	0.43	1.57	-	-	-	-	0.57
Average	561	59%	2.44	1.69	0.13	0.51	0.00	-	0.62	0.00	0.10	4.04	2.78	0.24	0.84	0.00	-	1.21	0.00	0.18

Table 9. (cont'd)

MONTH/DAYS	n	%W/Food	Percent of Prey Number - All Chinook: Total	ALW	BLC	RBS	YLP	IBS	ZOOP	OTH	UNID	Percent of Prey Number - Chinook With Food: Total	ALW	BLC	RBS	YLP	IBS	ZOOP	OTH	UNID
SITE 1 - SOUTHERN BASIN																				
4/13	3	33%	100.0	-	-	-	100.0			-	-	100.0	-	-	-	100.0			-	-
4/25-26	8	13%	100.0	-	-	-	-			-	100.0	100.0	-	-	-	-			-	100.0
5/16-23	4	50%	-	-	-	-	-			-	-	100.0	-	-	-	-			-	-
5/31-6/01	8	38%	-	-	-	-	-			-	-	100.0	-	-	-	-			-	-
6/06-08	4	75%	-	-	-	-	-			-	-	100.0	-	-	-	-			-	-
6/13-14	11	91%	100.0	-	80.0	-	6.7			-	13.3	100.0	-	80.0	-	6.7			-	13.3
6/29-7/13	21	76%	100.0	-	78.6	-	-			-	21.4	100.0	-	78.6	-	-			-	21.4
7/26-8/02	8	75%	100.0	-	75.0	-	-			-	25.0	100.0	-	75.0	-	-			-	25.0
8/09-10	9	78%	100.0	-	76.9	23.1	-			-	-	100.0	-	76.9	23.1	-			-	-
8/16-17	30	70%	100.0	8.5	51.1	29.8	4.3			-	6.4	100.0	8.5	51.1	29.8	4.3			-	6.4
8/30	15	80%	100.0	55.0	35.0	5.0	-			-	5.0	100.0	55.0	35.0	5.0	-			-	5.0
9/06-07	23	87%	100.0	4.0	35.4	11.1	40.4			-	9.1	100.0	4.0	35.4	11.1	40.4			-	9.1
9/20-21	20	80%	100.0	11.9	64.3	7.1	-			-	16.7	100.0	11.9	64.3	7.1	-			-	16.7
Average	164	64%	100.0	7.3	56.9	7.9	12.8			-	15.0	100.0	6.4	49.7	7.0	12.7			-	24.2
SITE 1 - NORTHERN BASIN																				
5/03-11	3	67%	100.0	75.0	-	25.0	-			-	-	100.0	75.0	-	25.0	-			-	-
6/12-7/05	3	33%	100.0	-	-	-	-			-	100.0	100.0	-	-	-	-			-	100.0
7/17-19	54	52%	100.0	12.5	59.4	3.1	-			-	25.0	100.0	12.5	59.4	3.1	-			-	25.0
7/22-25	8	38%	100.0	33.3	66.7	-	-			-	-	100.0	33.3	66.7	-	-			-	-
8/08-09	4	75%	100.0	20.0	20.0	40.0	-			-	20.0	100.0	20.0	20.0	40.0	-			-	20.0
8/15-16	4	75%	100.0	-	87.5	-	-			-	12.5	100.0	-	87.5	-	-			-	12.5
8/22-24	20	75%	100.0	12.3	6.2	77.8	-			-	3.7	100.0	12.3	6.2	77.8	-			-	3.7
9/08	10	70%	100.0	73.3	13.3	6.7	-			-	6.7	100.0	73.3	13.3	6.7	-			-	6.7
9/14-16	7	86%	100.0	2.2	8.7	87.0	-			-	2.2	100.0	2.2	8.7	87.0	-			-	2.2
9/27-28	8	75%	100.0	33.3	50.0	8.3	-			-	8.3	100.0	33.3	50.0	8.3	-			-	8.3
10/05-11	13	100%	100.0	89.8	6.5	1.9	-			-	1.9	100.0	89.8	6.5	1.9	-			-	1.9
10/25	4	75%	100.0	-	100.0	-	-			-	-	100.0	-	100.0	-	-			-	-
Average	138	62%	100.0	46.3	19.7	27.1	-			-	6.9	100.0	41.3	21.7	25.9	-			-	11.1
SITE 2 - SOUTHERN BASIN																				
4/12-13	6	0%	-	-	-	-	-			-	-	-	-	-	-	-			-	-
4/19-20	4	25%	100.0	20.0	40.0	-	40.0			-	-	100.0	20.0	40.0	-	40.0			-	-
4/25-26	42	26%	100.0	88.2	-	-	-			-	11.8	100.0	88.2	-	-	-			-	11.8
5/04	28	46%	100.0	72.2	11.1	-	11.1			-	5.6	100.0	72.2	11.1	-	11.1			-	5.6
5/16-17	36	36%	100.0	67.9	-	4.7	4.7			-	22.6	100.0	71.1	-	2.6	2.6			-	23.7
5/23	14	86%	100.0	42.9	-	-	14.3			-	42.9	100.0	42.9	-	-	14.3			-	42.9
5/31-6/01	63	41%	100.0	61.5	-	7.7	7.7			-	23.1	100.0	61.5	-	7.7	7.7			-	23.1
6/06-20	11	45%	100.0	7.1	78.6	7.1	-			-	7.1	100.0	7.1	78.6	7.1	-			-	7.1
7/11-13	32	50%	100.0	17.4	60.9	-	-			-	21.7	100.0	17.4	60.9	-	-			-	21.7
7/24-26	14	43%	100.0	12.5	18.8	-	37.5			-	31.3	100.0	12.5	18.8	-	37.5			-	31.3
8/01-02	32	56%	100.0	8.8	82.4	-	5.9			-	2.9	100.0	8.8	82.4	-	5.9			-	2.9
8/09-10	27	52%	100.0	22.6	64.5	-	-			-	12.9	100.0	22.6	64.5	-	-			-	12.9
8/16-17	50	58%	100.0	15.9	52.2	20.3	5.8			-	5.8	100.0	15.9	52.2	20.3	5.8			-	5.8
8/30-9/07	27	85%	100.0	2.3	12.1	43.4	34.7			-	7.5	100.0	2.3	12.1	43.4	34.7			-	7.5
9/19-21	26	77%	100.0	34.4	31.1	13.1	1.6			-	19.7	100.0	34.4	31.1	13.1	1.6			-	19.7
Average	412	52%	100.0	14.1	30.3	24.1	20.7			-	10.9	100.0	18.0	34.5	18.1	18.3			-	11.1
SITE 2 - NORTHERN BASIN																				
5/03	24	50%	100.0	78.4	-	5.4	-			-	16.2	100.0	78.4	-	5.4	-			-	16.2
5/11	35	77%	100.0	95.7	1.4	-	-			-	2.9	100.0	95.7	1.4	-	-			-	2.9
5/24	20	100%	100.0	82.8	3.4	6.9	-			-	6.9	100.0	82.8	3.4	6.9	-			-	6.9
6/12-13	20	45%	100.0	81.0	-	-	9.5			-	9.5	100.0	81.0	-	-	9.5			-	9.5
6/25	17	65%	100.0	98.0	-	2.0	-			-	-	100.0	98.0	-	2.0	-			-	-
7/02-04	12	50%	100.0	69.4	22.2	-	-			-	8.3	100.0	69.4	22.2	-	-			-	8.3
7/17-19	60	43%	100.0	51.2	19.5	17.1	-			-	12.2	100.0	51.2	19.5	17.1	-			-	12.2
7/21-23	33	21%	100.0	33.3	44.4	-	-			-	22.2	100.0	33.3	44.4	-	-			-	22.2
7/24-25	15	33%	100.0	20.0	-	20.0	-			-	60.0	100.0	20.0	-	20.0	-			-	60.0
8/08-09	8	50%	100.0	22.2	22.2	55.6	-			-	-	100.0	22.2	22.2	55.6	-			-	-
8/15-16	43	53%	100.0	33.3	56.3	-	-			-	10.4	100.0	33.3	56.3	-	-			-	10.4
8/22-24	76	62%	100.0	54.9	7.7	31.9	-			-	5.5	100.0	54.9	7.7	31.9	-			-	5.5
9/09	22	82%	100.0	58.2	6.0	28.4	-			-	7.5	100.0	58.2	6.0	28.4	-			-	7.5
9/14-16	10	90%	100.0	9.2	2.8	87.2	-			-	0.9	100.0	9.2	2.8	87.2	-			-	0.9
9/27-28	14	100%	100.0	81.3	9.3	2.7	-			-	6.7	100.0	81.3	9.3	2.7	-			-	6.7
10/10-11	7	100%	100.0	57.7	34.6	1.9	-			-	5.8	100.0	57.7	34.6	1.9	-			-	5.8
Average	416	68%	100.0	57.1	11.2	26.0	0.4			-	5.3	100.0	57.8	11.3	24.0	0.6			-	6.2
SITE 3 - SOUTHERN BASIN																				
4/05-06	3	0%	-	-	-	-	-			-	-	-	-	-	-	-			-	-
4/12-13	15	7%	100.0	-	-	-	-			-	100.0	100.0	-	-	-	-			-	100.0
4/19-20	20	50%	100.0	92.9	3.6	-	3.6			-	-	100.0	92.9	3.6	-	3.6			-	-
4/25-26	18	56%	100.0	100.0	-	-	-			-	-	100.0	100.0	-	-	-			-	-
5/04	18	44%	100.0	82.6	4.3	-	4.3			4.3	4.3	100.0	82.6	4.3	-	4.3			4.3	4.3
5/16-17	10	50%	100.0	84.6	-	-	-			-	15.4	100.0	84.6	-	-	-			-	15.4
5/23	3	67%	100.0	100.0	-	-	-			-	-	100.0	100.0	-	-	-			-	-
5/31	5	60%	100.0	85.7	-	14.3	-			-	-	100.0	85.7	-	14.3	-			-	-
6/29-7/13	24	46%	100.0	58.3	16.7	-	-			-	25.0	100.0	58.3	16.7	-	-			-	25.0
7/24-26	13	46%	100.0	8.3	25.0	-	33.3			-	33.3	100.0	8.3	25.0	-	33.3			-	33.3
8/01-02	27	33%	100.0	17.6	29.4	11.8	35.3			-	5.9	100.0	17.6	29.4	11.8	35.3			-	5.9
8/09-10	24	50%	100.0	55.0	-	-	-			-	45.0	100.0	55.0	-	-	-			-	45.0
8/16-17	22	55%	100.0	13.3	66.7	3.3	13.3			-	3.3	100.0	13.3	66.7	3.3	13.3			-	3.3
8/30-9/07	8	75%	100.0	11.8	5.9	17.6	58.8			-	5.9	100.0	11.8	5.9	17.6	58.8			-	5.9
9/19-21	26	19%	100.0	14.3	-	57.1	14.3			-	14.3	100.0	14.3	-	57.1	14.3			-	14.3
Average	236	48%	100.0	51.4	11.2	7.9	19.4			0.3	9.7	100.0	51.5	11.5	8.1	16.2			0.4	12.4
SITE 3 - NORTHERN BASIN																				
5/03	49	73%	100.0	84.8	-	0.7	0.7			0.7	13.2	100.0	84.8	-	0.7	0.7			0.7	13.2
5/10-11	60	67%	100.0	95.3	0.4	2.0	-			-	2.4	100.0	95.3	0.4	2.0	-			-	2.4
5/24	6	50%	100.0	100.0	-	-	-			-	-	100.0	100.0	-	-	-			-	-
6/12-13	7	71%	100.0	93.8	-	6.3	-			-	-	100.0	93.8	-	6.3	-			-	-
6/25	15	73%	100.0	94.3	2.9	-	-			-	2.9	100.0	94.3	2.9	-	-			-	2.9
7/05	24	50%	100.0	80.3	12.1	3.0	-			-	4.5	100.0	80.3	12.1	3.0	-			-	4.5
7/17-19	108	31%	100.0	46.9	27.1	11.3	-			-	14.7	100.0	46.4	30.6	8.8	-			-	14.2
7/21-23	50	32%	100.0	45.5	18.2	18.2	-			4.5	13.6	100.0	45.5	18.2	18.2	-			4.5	13.6
7/24-25	23	57%	100.0	52.9	26.5	14.7	-			-	5.9	100.0	52.9	26.5	14.7	-			-	5.9
8/08-10	10	70%	100.0	9.1	6.1	84.8	-			-	-	100.0	9.1	6.1	84.8	-			-	-
8/15-16	63	63%	100.0	68.2	13.6	1.1	-			-	17.0	100.0	68.2	13.6	1.1	-			-	17.0
8/22-24	94	67%	100.0	53.7	3.7	40.2	-			0.4	2.0	100.0	53.7	3.7	40.2	-			0.4	2.0
9/06-09	16	56%	100.0	59.4	9.4	25.0	-			-	6.3	100.0	59.4	9.4	25.0	-			-	6.3
9/14-16	22	59%	100.0	72.8	2.2	24.3	-			-	0.7	100.0	72.8	2.2	24.3	-			-	0.7
9/27-10/05	14	50%	100.0	62.5	6.3	22.9	-			-	8.3	100.0	62.5	6.3	22.9	-			-	8.3
Average	561	59%	100.0	69.4	5.2	21.1	0.0			0.1	4.2	100.0	68.7	5.9	20.8	0.0			0.1	4.5

Table 9. (cont'd)

MONTH/DATE	n	%W/Food	Weight of Prey - All Fish									Weight of Prey - Chinook With Food								
			Total	ALW	BLC	RBS	YLP	INS	ZOOP	OTH	UNID	Total	ALW	BLC	RBS	YLP	INS	ZOOP	OTH	UNID
SITE 1 - SOUTHERN BASIN																				
4/13	3	33%	0.70	-	-	-	0.70	-	-	-	-	2.10	-	-	-	2.10	-	-	-	-
4/25-26	8	13%	0.13	-	-	-	-	-	-	-	0.13	1.00	-	-	-	-	-	-	-	1.00
5/16-23	4	50%	2.71	-	-	-	-	-	2.71	-	-	5.43	-	-	-	-	-	5.43	-	-
5/31-6/01	8	38%	0.01	-	-	-	-	0.01	0.00	-	-	0.02	-	-	-	-	0.02	0.01	-	-
6/06-08	4	75%	2.30	-	-	-	-	2.30	0.00	-	-	3.07	-	-	-	-	3.07	0.00	-	-
6/13-14	11	91%	4.35	-	3.61	-	0.44	-	-	-	0.30	4.78	-	3.97	-	0.48	-	-	-	0.33
6/29-7/13	21	76%	4.50	-	4.13	-	-	-	-	-	0.37	5.91	-	5.43	-	-	-	-	-	0.49
7/26-8/02	8	75%	4.01	-	3.84	-	-	-	-	-	0.18	5.35	-	5.12	-	-	-	-	-	0.23
8/09-10	9	78%	9.63	-	8.88	0.76	-	-	-	-	-	12.39	-	11.41	0.97	-	-	-	-	-
8/16-17	30	70%	4.26	0.04	4.00	0.13	0.07	-	-	-	0.02	6.07	0.05	5.71	0.18	0.10	-	-	-	0.03
8/30	15	80%	4.97	1.18	3.58	0.20	-	-	-	-	0.01	6.21	1.48	4.48	0.25	-	-	-	-	0.01
9/06-07	23	87%	11.60	2.60	5.60	1.09	1.83	-	0.06	-	0.43	13.34	2.99	6.44	1.26	2.11	-	0.06	-	0.49
9/20-21	20	80%	4.07	0.54	2.74	0.64	-	-	0.06	-	0.09	5.08	0.68	3.42	0.80	-	-	0.08	-	0.11
Average	164	64%	3.88	0.27	2.67	0.16	0.20	0.10	0.35	-	0.14	5.30	0.32	3.38	0.20	0.31	0.13	0.69	-	0.27
SITE 1 - NORTHERN BASIN																				
5/03-11	3	67%	0.43	0.17	-	0.27	-	-	-	-	-	0.65	0.25	-	0.40	-	-	-	-	-
6/12-7/05	3	33%	0.70	-	-	-	-	-	-	-	0.70	2.10	-	-	-	-	-	-	-	2.10
7/17-19	54	52%	1.55	0.16	1.17	0.09	-	0.00	0.03	-	0.10	2.99	0.31	2.25	0.18	-	0.00	0.06	-	0.19
7/22-25	8	38%	2.06	0.54	1.53	-	-	-	-	-	-	5.50	1.43	4.07	-	-	-	-	-	-
8/08-09	4	75%	4.80	0.15	3.28	1.05	-	-	-	-	0.33	6.40	0.20	4.37	1.40	-	-	-	-	0.43
8/15-16	4	75%	7.56	-	6.95	-	-	-	0.11	-	0.50	10.08	-	9.27	-	-	-	0.15	-	0.67
8/22-24	20	75%	10.94	3.91	2.01	4.40	-	-	0.40	-	0.23	14.59	5.21	2.67	5.87	-	-	0.53	-	0.30
9/08	10	70%	23.56	20.00	2.77	0.77	-	-	-	-	0.02	33.66	28.57	3.96	1.10	-	-	-	-	0.03
9/14-16	7	86%	23.40	0.07	1.51	21.64	-	-	-	-	0.17	27.30	0.08	1.77	25.25	-	-	-	-	0.20
9/27-28	8	75%	8.67	1.08	7.04	0.23	-	-	0.07	-	0.26	11.56	1.43	9.38	0.30	-	-	0.10	-	0.35
10/05-11	13	100%	11.05	8.89	1.58	0.42	-	-	0.15	-	0.02	11.05	8.89	1.58	0.42	-	-	0.15	-	0.02
10/25	4	75%	4.03	-	4.03	-	-	-	0.01	-	-	5.38	-	5.37	-	-	-	0.01	-	-
Average	138	62%	6.19	2.40	1.80	1.71	-	0.00	0.05	-	0.24	8.39	3.09	2.57	2.07	-	0.00	0.06	-	0.59
SITE 2 - SOUTHERN BASIN																				
4/12-13	6	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/19-20	4	25%	7.75	0.55	4.63	-	2.58	-	-	-	-	31.00	2.20	18.50	-	10.30	-	-	-	-
4/25-26	42	26%	2.60	2.57	-	-	-	0.03	-	-	0.00	9.92	9.81	-	-	-	0.10	-	-	0.02
5/04	28	46%	8.37	7.98	0.19	-	0.19	-	-	-	0.01	18.03	17.18	0.41	-	0.42	-	-	-	0.03
5/16-17	36	36%	2.63	1.57	-	0.37	0.20	-	0.37	-	0.13	8.25	6.52	-	0.59	0.32	-	0.59	-	0.24
5/23	14	86%	2.03	0.13	-	-	0.04	-	1.76	-	0.11	2.37	0.15	-	-	0.04	-	2.05	-	0.13
5/31-6/01	63	41%	3.45	2.96	-	0.05	0.32	-	0.07	-	0.06	8.37	7.18	-	0.11	0.77	-	0.17	-	0.13
6/06-20	11	45%	4.80	0.08	4.27	0.38	-	-	-	-	0.06	10.56	0.18	9.40	0.84	-	-	-	-	0.14
7/11-13	32	50%	4.16	1.80	2.26	-	-	-	-	-	0.11	8.33	3.59	4.52	-	-	-	-	-	0.21
7/24-26	14	43%	11.71	3.52	1.52	-	6.11	-	-	-	0.56	27.33	8.22	3.55	-	14.25	-	-	-	1.32
8/01-02	32	56%	5.44	0.14	4.52	-	0.77	-	-	-	0.01	9.67	0.24	8.04	-	1.37	-	-	-	0.02
8/09-10	27	52%	5.92	0.73	5.06	-	-	-	-	-	0.13	11.41	1.41	9.75	-	-	-	-	-	0.25
8/16-17	50	58%	7.42	2.19	4.80	0.25	0.11	-	-	-	0.07	12.79	3.77	8.27	0.44	0.19	-	-	-	0.12
8/30-9/07	27	85%	8.72	2.28	2.84	1.24	2.19	-	-	-	0.15	10.23	2.68	3.34	1.47	2.57	-	-	-	0.17
9/19-21	26	77%	7.10	2.33	1.97	2.65	0.03	-	0.00	-	0.11	9.23	3.04	2.56	3.45	0.05	-	0.01	-	0.15
Average	412	52%	5.78	1.88	2.42	0.42	0.84	0.00	0.10	-	0.11	12.19	4.21	5.10	0.66	1.87	0.00	0.14	-	0.21
SITE 2 - NORTHERN BASIN																				
5/03	24	58%	7.33	7.06	-	0.08	-	-	-	-	0.18	12.56	12.11	-	0.14	-	-	-	-	0.31
5/11	35	77%	17.38	17.05	0.13	-	-	-	-	-	0.21	22.53	22.10	0.16	-	-	-	-	-	0.27
5/24	20	100%	8.93	4.48	0.62	1.01	-	-	2.73	-	0.09	8.93	4.48	0.62	1.01	-	-	2.73	-	0.09
6/12-13	20	45%	2.82	1.62	-	-	1.08	-	-	-	0.13	6.27	3.59	-	-	2.39	-	-	-	0.29
6/25	17	65%	21.02	20.62	-	0.40	-	-	-	-	-	32.40	31.86	-	0.62	-	-	-	-	-
7/02-04	12	50%	11.38	8.84	2.39	-	-	-	-	-	0.15	22.77	17.68	4.78	-	-	-	-	-	0.30
7/17-19	60	43%	3.44	2.31	0.39	0.47	-	0.10	0.00	-	0.18	7.93	5.32	0.89	1.07	-	0.23	0.00	-	0.41
7/21-23	33	21%	0.92	0.19	0.69	-	-	-	-	-	0.04	4.36	0.89	3.27	-	-	-	-	-	0.20
7/24-25	15	33%	2.30	1.32	-	0.89	-	-	-	-	0.09	6.90	3.96	-	2.68	-	-	-	-	0.26
8/08-09	8	50%	5.66	0.19	2.70	2.78	-	-	-	-	-	11.33	0.38	5.40	5.55	-	-	-	-	-
8/15-16	43	53%	10.15	6.97	3.08	-	-	0.00	0.04	-	0.06	18.97	13.02	5.76	-	-	0.00	0.08	-	0.10
8/22-24	76	62%	14.64	10.84	0.64	2.94	-	0.01	0.18	-	0.02	23.67	17.53	1.03	4.76	-	0.02	0.30	-	0.04
9/09	22	82%	36.10	29.65	1.23	4.95	-	-	-	-	0.27	44.12	36.24	1.50	6.05	-	-	-	-	0.33
9/14-16	10	90%	63.50	6.91	2.14	54.39	-	-	-	-	0.06	70.56	7.68	2.38	60.44	-	-	-	-	0.07
9/27-28	14	100%	13.64	10.62	2.58	0.14	-	-	0.00	-	0.31	13.64	10.62	2.58	0.14	-	-	0.00	-	0.31
10/10-11	7	100%	28.28	17.00	10.59	0.04	-	-	0.19	-	0.46	28.28	17.00	10.59	0.04	-	-	0.19	-	0.46
Average	416	68%	15.55	9.05	1.64	4.29	0.11	0.00	0.31	-	0.14	20.49	12.32	2.21	5.18	0.25	0.01	0.32	-	0.21
SITE 3 - SOUTHERN BASIN																				
4/05-06	3	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/12-13	15	7%	0.17	-	-	-	-	0.03	-	-	0.14	2.62	-	-	-	-	0.52	-	-	2.10
4/19-20	20	50%	9.99	9.84	0.06	-	0.10	-	-	-	-	19.97	19.67	0.11	-	0.19	-	-	-	-
4/25-26	18	56%	19.16	19.16	-	-	-	-	-	-	-	34.48	34.48	-	-	-	-	-	-	-
5/04	18	44%	15.46	14.72	0.11	-	0.16	-	-	0.16	0.31	34.79	33.11	0.25	-	0.36	-	-	0.36	0.70
5/16-17	10	50%	7.99	7.78	-	-	-	-	-	-	0.21	15.98	15.56	-	-	-	-	-	-	0.42
5/23	3	67%	5.47	5.47	-	-	-	-	-	-	-	8.20	8.20	-	-	-	-	-	-	-
5/31	5	60%	4.74	3.40	-	1.34	-	-	-	-	-	7.90	5.67	-	2.23	-	-	-	-	-
6/29-7/13	24	46%	3.65	3.06	0.48	-	-	-	-	-	0.12	7.97	6.67	1.04	-	-	-	-	-	0.26
7/24-26	13	46%	9.77	0.45	1.56	-	7.51	-	-	-	0.25	21.17	0.98	3.38	-	16.27	-	-	-	0.53
8/01-02	27	33%	6.80	1.45	0.99	0.33	4.03	-	-	-	0.01	20.41	4.36	2.96	0.99	12.09	-	-	-	0.02
8/09-10	24	50%	6.83	6.43	-	-	-	-	-	-	0.40	13.67	12.87	-	-	-	-	-	-	0.80
8/16-17	22	55%	9.82	1.02	8.36	0.23	0.17	-	-	-	0.03	18.00	1.88	15.33	0.42	0.32	-	-	-	0.06
8/30-9/07	8	75%	12.63	3.04	1.43	1.11	7.00	-	-	-	0.05	16.83	4.05	1.90	1.48	9.33	-	-	-	0.07
9/19-21	26	19%	1.48	0.02	-	1.18	0.27	-	-	-	0.00	7.68	0.10	-	6.16	1.40	-	-	-	0.02
Average	236	48%	7.33	4.45	0.91	0.37	1.49	0.00	-	0.01	0.10	14.83	9.03	1.77	0.87	2.82	0.02	-	0.02	0.29
SITE 3 - NORTHERN BASIN																				
5/03	49	73%	22.54	21.65	-	0.10	0.02	-	-	0.02	0.74	30.68	29.47	-	0.13	0.03	-	-	0.03	1.01
5/10-11	60	67%	29.90	28.95	0.08	0.60	-	-	-	-	0.27	44.85	43.43	0.12	0.90	-	-	-	-	0.40
5/24	6	50%	1.08	1.03	-	-	-	-	0.05	-	-	2.16	2.07	-	-	-	-	0.10	-	-
6/12-13	7	71%	33.44	33.23	-	0.21	-	-	-	-	-	46.82	46.52	-	0.30	-	-	-	-	-
6/25	15	73%	16.90	16.77	0.13	-	-	-	-	-	0.01	23.05	22.86	0.17	-	-	-	-	-	0.01
7/05	24	50%	16.18	14.59	1.24	0.19	-	-	-	-	0.16	32.37	29.18	2.48	0.38	-	-	-	-	0.32
7/17-19	100	31%	3.40	2.50	0.64	0.19	-	-	0.00	-	0.07	12.82	9.80	2.29	0.47	-	-	0.01	-	0.25
7/21-23	50	32%	3.33	1.73	0.66	0.69	-	-	-	0.02	0.22	10.40	5.40	2.08	2.17	-	-	-	0.07	0.69
7/24-25	23	57%	8.54	4.73	3.00	0.75	-	-	-	-	0.05	15.11	8.38	5.32	1.33	-	-	-	-	0.08
8/08-10	10	70%	26.24	9.11	1.89	15.24	-	-	-	-	-	37.49	13.01	2.70	21.77	-	-	-	-	-
8/15-16	63	63%	25.22	23.73	0.96	0.25	-	-	0.09	-	0.19	39.71	37.38	1.51	0.39	-	-	0.14	-	0.30
8/22-24	94	67%	28.07	21.06	0.45	6.52	-	-	-	0.01	0.04	41.89	31.42	0.67	9.73	-	-	-	0.01	0.06
9/06-09	16	56%	20.01	16.85	0.96	2.19	-	-	-	-	0.01	35.58	29.96	1.71	3.89	-	-	-	-	0.02
9/14-16	22	59%	23.78	13.64	0.32	9.78	-	-	-	-	0.05	40.25	23.08	0.54	16.55	-	-	-	-	0.08
9/27-10/05	14	50%	7.23	1.67	1.64	3.66	-	-	-	-	0.26	14.46	3.34	3.27	7.31	-	-	-	-	0.53
Average	561	59%	17.62	13.94	0.78	2.77	0.00	-	0.01	0.00	0.12	27.91	21.71	1.45	4.51	0.00	-	0.02	0.01	0.21

Table 9. (cont'd)

			Percent of Prey Weight - All Chinook									Percent of Prey Weight - Chinook With Food								
MONTH/DAYS	n	%W/Food	Total	ALW	BLC	RBS	YLP	IBS	ZOOP	OTH	UNID	Total	ALW	BLC	RBS	YLP	IBS	ZOOP	OTH	UNID
SIZE 1 - SOUTHERN BASIN																				
4/13	3	33%	100.0	-	-	-	100.0	-	-	-	-	100.0	-	-	-	100.0	-	-	-	-
4/25-26	8	13%	100.0	-	-	-	-	-	-	-	100.0	100.0	-	-	-	-	-	-	-	100.0
5/16-23	4	50%	100.0	-	-	-	-	-	100.0	-	-	100.0	-	-	-	-	-	100.0	-	-
5/31-6/01	8	38%	100.0	-	-	-	-	76.9	23.1	-	-	100.0	-	-	-	-	76.9	23.1	-	-
6/06-08	4	75%	100.0	-	-	-	-	99.9	0.1	-	-	100.0	-	-	-	-	99.9	0.1	-	-
6/13-14	11	91%	100.0	-	83.1	-	10.0	-	-	-	6.9	100.0	-	83.1	-	10.0	-	-	-	6.9
6/29-7/13	21	76%	100.0	-	91.8	-	-	-	-	-	8.2	100.0	-	91.8	-	-	-	-	-	8.2
7/26-8/02	8	75%	100.0	-	95.6	-	-	-	-	-	4.4	100.0	-	95.6	-	-	-	-	-	4.4
8/09-10	9	78%	100.0	-	92.2	7.8	-	-	-	-	-	100.0	-	92.2	7.8	-	-	-	-	-
8/16-17	30	70%	100.0	0.8	88.5	8.7	1.5	-	-	-	0.5	100.0	0.8	88.5	8.7	1.5	-	-	-	0.5
8/30	15	80%	100.0	23.8	72.1	4.0	-	-	-	-	0.1	100.0	23.8	72.1	4.0	-	-	-	-	0.1
9/06-07	23	87%	100.0	22.4	48.2	9.4	15.8	-	0.5	-	3.7	100.0	22.4	48.2	9.4	15.8	-	0.5	-	3.7
9/20-21	20	80%	100.0	13.3	67.4	15.7	-	-	1.5	-	2.1	100.0	13.3	67.4	15.7	-	-	1.5	-	2.1
Average	164	64%	100.0	7.0	68.4	4.5	5.1	2.5	8.9	-	3.7	100.0	6.1	63.6	4.1	5.8	2.4	12.9	-	5.0
SIZE 1 - NORTHERN BASIN																				
5/03-11	3	67%	100.0	38.5	-	61.5	-	-	-	-	-	100.0	38.5	-	61.5	-	-	-	-	-
6/12-7/05	3	33%	100.0	-	-	-	-	-	-	-	100.0	100.0	-	-	-	-	-	-	-	100.0
7/17-19	54	52%	100.0	10.5	75.3	5.8	-	0.0	2.1	-	6.2	100.0	10.5	75.3	5.8	-	0.0	2.1	-	6.2
7/22-25	8	38%	100.0	26.1	73.9	-	-	-	-	-	-	100.0	26.1	73.9	-	-	-	-	-	-
8/08-09	4	75%	100.0	3.1	68.2	21.9	-	-	-	-	6.8	100.0	3.1	68.2	21.9	-	-	-	-	6.8
8/15-16	4	75%	100.0	-	91.9	-	-	-	1.5	-	6.6	100.0	-	91.9	-	-	-	1.5	-	6.6
8/22-24	20	75%	100.0	35.7	18.3	40.3	-	-	3.6	-	2.1	100.0	35.7	18.3	40.3	-	-	3.6	-	2.1
9/08	10	70%	100.0	84.9	11.8	3.3	-	-	-	-	0.1	100.0	84.9	11.8	3.3	-	-	-	-	0.1
9/14-16	7	86%	100.0	0.3	6.5	92.5	-	-	-	-	0.7	100.0	0.3	6.5	92.5	-	-	-	-	0.7
9/27-28	8	75%	100.0	12.4	81.1	2.6	-	-	0.8	-	3.0	100.0	12.4	81.1	2.6	-	-	0.8	-	3.0
10/05-11	13	100%	100.0	85.6	10.6	2.8	-	-	1.0	-	0.1	100.0	85.6	10.6	2.8	-	-	1.0	-	0.1
10/25	4	75%	100.0	-	99.8	-	-	-	0.2	-	-	100.0	-	99.8	-	-	-	0.2	-	-
Average	138	62%	100.0	42.1	27.4	26.0	-	0.0	0.7	-	3.7	100.0	39.6	29.4	23.6	-	0.0	0.7	-	6.8
SIZE 2 - SOUTHERN BASIN																				
4/12-13	6	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/19-20	4	25%	100.0	7.1	59.7	-	33.2	-	-	-	-	100.0	7.1	59.7	-	33.2	-	-	-	-
4/25-26	42	26%	100.0	98.8	-	-	-	1.0	-	-	0.2	100.0	98.8	-	-	-	1.0	-	-	0.2
5/04	28	46%	100.0	95.3	2.3	-	2.3	-	-	-	0.2	100.0	95.3	2.3	-	2.3	-	-	-	0.2
5/16-17	36	36%	100.0	59.6	-	13.9	7.5	-	14.0	-	5.1	100.0	79.1	-	7.1	3.8	-	7.2	-	2.8
5/23	14	86%	100.0	6.4	-	-	1.8	-	86.5	-	5.3	100.0	6.4	-	-	1.8	-	86.5	-	5.3
5/31-6/01	63	41%	100.0	85.8	-	1.3	9.2	-	2.0	-	1.6	100.0	85.8	-	1.3	9.2	-	2.0	-	1.6
6/06-20	11	45%	100.0	1.7	89.0	8.0	-	-	-	-	1.3	100.0	1.7	89.0	8.0	-	-	-	-	1.3
7/11-13	32	50%	100.0	43.2	54.3	-	-	-	-	-	2.6	100.0	43.2	54.3	-	-	-	-	-	2.6
7/24-26	14	43%	100.0	30.1	13.0	-	52.1	-	-	-	4.8	100.0	30.1	13.0	-	52.1	-	-	-	4.8
8/01-02	32	56%	100.0	2.5	83.1	-	14.1	-	-	-	0.2	100.0	2.5	83.1	-	14.1	-	-	-	0.2
8/09-10	27	52%	100.0	12.4	85.4	-	-	-	-	-	2.2	100.0	12.4	85.4	-	-	-	-	-	2.2
8/16-17	50	58%	100.0	27.2	59.5	11.1	1.4	-	-	-	0.8	100.0	27.2	59.5	11.1	1.4	-	-	-	0.8
8/30-9/07	27	85%	100.0	20.9	26.0	31.8	20.0	-	-	-	1.4	100.0	20.9	26.0	31.8	20.0	-	-	-	1.4
9/19-21	26	77%	100.0	32.9	27.7	37.3	0.5	-	0.1	-	1.6	100.0	32.9	27.7	37.3	0.5	-	0.1	-	1.6
Average	412	52%	100.0	30.8	39.7	12.2	13.8	0.0	1.6	-	1.8	100.0	33.5	40.6	8.3	14.9	0.0	1.1	-	1.7
SIZE 2 - NORTHERN BASIN																				
5/03	24	50%	100.0	96.4	-	1.1	-	-	-	-	2.4	100.0	96.4	-	1.1	-	-	-	-	2.4
5/11	35	77%	100.0	98.1	0.7	-	-	-	-	-	1.2	100.0	98.1	0.7	-	-	-	-	-	1.2
5/24	20	100%	100.0	50.2	6.9	11.3	-	-	30.6	-	1.0	100.0	50.2	6.9	11.3	-	-	30.6	-	1.0
6/12-13	20	45%	100.0	57.3	-	-	38.1	-	-	-	4.6	100.0	57.3	-	-	38.1	-	-	-	4.6
6/25	17	65%	100.0	98.1	-	1.9	-	-	-	-	-	100.0	98.1	-	1.9	-	-	-	-	-
7/02-04	12	50%	100.0	77.7	21.0	-	-	-	-	-	1.3	100.0	77.7	21.0	-	-	-	-	-	1.3
7/17-19	60	43%	100.0	67.1	11.3	13.5	-	2.9	0.0	-	5.2	100.0	67.1	11.3	13.5	-	2.9	0.0	-	5.2
7/21-23	33	21%	100.0	20.3	75.1	-	-	-	-	-	4.6	100.0	20.3	75.1	-	-	-	-	-	4.6
7/24-25	15	33%	100.0	57.4	-	38.8	-	-	-	-	3.8	100.0	57.4	-	38.8	-	-	-	-	3.8
8/08-09	8	50%	100.0	3.3	47.7	49.0	-	-	-	-	-	100.0	3.3	47.7	49.0	-	-	-	-	-
8/15-16	43	53%	100.0	68.6	30.4	-	-	0.0	0.4	-	0.6	100.0	68.6	30.4	-	-	0.0	0.4	-	0.6
8/22-24	76	62%	100.0	74.0	4.3	20.1	-	0.1	1.3	-	0.2	100.0	74.0	4.3	20.1	-	0.1	1.3	-	0.2
9/09	22	82%	100.0	81.5	3.4	14.4	-	-	-	-	0.7	100.0	81.5	3.4	14.4	-	-	-	-	0.7
9/14-16	10	90%	100.0	10.9	3.4	85.7	-	-	-	-	0.1	100.0	10.9	3.4	85.7	-	-	-	-	0.1
9/27-28	14	100%	100.0	77.8	18.9	1.0	-	-	0.0	-	2.3	100.0	77.8	18.9	1.0	-	-	0.0	-	2.3
10/10-11	7	100%	100.0	73.3	25.0	0.1	-	-	0.5	-	1.1	100.0	73.3	25.0	0.1	-	-	0.5	-	1.1
Average	416	68%	100.0	60.4	10.8	26.2	0.7	0.0	1.9	-	0.9	100.0	61.7	10.3	24.3	1.2	0.1	1.5	-	1.0
SIZE 3 - SOUTHERN BASIN																				
4/05-06	3	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/12-13	15	7%	100.0	-	-	-	-	19.8	-	-	80.2	100.0	-	-	-	-	19.8	-	-	80.2
4/19-20	20	50%	100.0	98.5	0.6	-	1.0	-	-	-	-	100.0	98.5	0.6	-	1.0	-	-	-	-
4/25-26	18	56%	100.0	100.0	-	-	-	-	-	-	-	100.0	100.0	-	-	-	-	-	-	-
5/04	18	44%	100.0	95.2	0.7	-	1.0	-	-	1.0	2.0	100.0	95.2	0.7	-	1.0	-	-	1.0	2.0
5/16-17	10	50%	100.0	97.4	-	-	-	-	-	-	2.6	100.0	97.4	-	-	-	-	-	-	2.6
5/23	3	67%	100.0	100.0	-	-	-	-	-	-	-	100.0	100.0	-	-	-	-	-	-	-
5/31	5	60%	100.0	71.7	-	28.3	-	-	-	-	-	100.0	71.7	-	28.3	-	-	-	-	-
6/29-7/13	24	46%	100.0	83.7	13.0	-	-	-	-	-	3.3	100.0	83.7	13.0	-	-	-	-	-	3.3
7/24-26	13	46%	100.0	4.6	16.0	-	76.9	-	-	-	2.5	100.0	4.6	16.0	-	76.9	-	-	-	2.5
8/01-02	27	33%	100.0	21.3	14.5	4.8	59.2	-	-	-	0.1	100.0	21.3	14.5	4.8	59.2	-	-	-	0.1
8/09-10	24	50%	100.0	94.1	-	-	-	-	-	-	5.9	100.0	94.1	-	-	-	-	-	-	5.9
8/16-17	22	55%	100.0	10.4	85.2	2.3	1.8	-	-	-	0.3	100.0	10.4	85.2	2.3	1.8	-	-	-	0.3
8/30-9/07	8	75%	100.0	24.1	11.3	8.8	55.4	-	-	-	0.4	100.0	24.1	11.3	8.8	55.4	-	-	-	0.4
9/19-21	26	19%	100.0	1.3	-	80.2	18.2	-	-	-	0.3	100.0	1.3	-	80.2	18.2	-	-	-	0.3
Average	236	48%	100.0	60.7	12.4	5.0	20.4	0.0	-	0.1	1.4	100.0	60.9	11.9	5.9	19.1	0.1	-	0.2	2.0
SIZE 3 - NORTHERN BASIN																				
5/03	49	73%	100.0	96.1	-	0.4	0.1	-	-	0.1	3.3	100.0	96.1	-	0.4	0.1	-	-	0.1	3.3
5/10-11	60	67%	100.0	96.8	0.3	2.0	-	-	-	-	0.9	100.0	96.8	0.3	2.0	-	-	-	-	0.9
5/24	6	50%	100.0	95.5	-	-	-	-	4.5	-	-	100.0	95.5	-	-	-	-	4.5	-	-
6/12-13	7	71%	100.0	99.4	-	0.6	-	-	-	-	-	100.0	99.4	-	0.6	-	-	-	-	-
6/25	15	73%	100.0	99.2	0.7	-	-	-	-	-	0.0	100.0	99.2	0.7	-	-	-	-	-	0.0
7/05	24	50%	100.0	90.2	7.7	1.2	-	-	-	-	1.0	100.0	90.2	7.7	1.2	-	-	-	-	1.0
7/17-19	100	31%	100.0	73.5	18.8	5.6	-	-	0.1	-	2.0	100.0	76.4	17.9	3.6	-	-	0.1	-	2.0
7/21-23	50	32%	100.0	51.9	20.0	20.9	-	-	-	0.7	6.6	100.0	51.9	20.0	20.9	-	-	-	0.7	6.6
7/24-25	23	57%	100.0	55.4	35.2	8.8	-	-	-	-	0.6	100.0	55.4	35.2	8.8	-	-	-	-	0.6
8/08-10	10	70%	100.0	34.7	7.2	58.1	-	-	-	-	-	100.0	34.7	7.2	58.1	-	-	-	-	-
8/15-16	63	63%	100.0	94.1	3.8	1.0	-	-	0.3	-	0.8	100.0	94.1	3.8	1.0	-	-	0.3	-	0.8
8/22-24	94	67%	100.0	75.0	1.6	23.2	-	-	-	0.0	0.1	100.0	75.0	1.6	23.2	-	-	-	0.0	0.1
9/06-09	16	56%	100.0	84.2	4.8	10.9	-	-	-	-	0.1	100.0	84.2	4.8	10.9	-	-	-	-	0.1
9/14-16	22	59%	100.0	57.3	1.3	41.1	-	-	-	-	0.2	100.0	57.3	1.3	41.1	-	-	-	-	0.2
9/27-10/05	14	50%	100.0	23.1	22.6	50.6	-	-	-	-	3.7	100.0	23.1	22.6	50.6	-	-	-	-	3.7
Average	561	59%	100.0	79.1	4.4	15.7	0.0	-	0.1	0.0	0.7	100.0	77.8	5.2	16.2	0.0	-	0.1	0.0	0.8

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