UNIVERSITY OF ALBERTA

Trout-perch *Percopsis omiscomaycus* (Walbaum) and lake chub *Couesius plumbeus* (Agassiz), as Sentinel Monitoring Species in the Athabasca River, Alberta

BY

Mark D. Spafford ©

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Department of Biological Sciences

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Dedication

This thesis is dedicated to my wife, KellyLynn

and two children, Douglas and Lynsay.

Thank you for giving so much to allow me to complete this work.

ABSTRACT

The life histories and biology of two small-bodied fish, the trout-perch and the lake chub, were examined to determine their suitability as sentinel species to monitor the effects of pulp mill effluents on ecosystem health. The study was carried out in the Athabasca River 40 km upstream to 50 km downstream of a bleached kraft pulp mill in central Alberta.

Trout-perch were found in all habitat types but they preferred tributary/confluence habitats and appear to be batch spawners, spawning at least twice.

Lake chub was the most abundant small bodied-fish collected in the study area. They were also batch spawners with each individual spawning at least twice.

Trout-perch far exceeded lake chub as a sentinel species. Lake chub exhibited a large variance of biological parameters within populations. For those monitoring aquatic systems the trout-perch is a good species that can provide valuable information with the least effort.

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Chapter 1

General Introduction

Small-bodied non-game fish such as trout-perch, *Percopsis omiscomaycus* (Walbaum) and lake chub, *Couesius plumbeus* (Agassiz), have been suggested as sentinel monitoring species for effects of pulp mill effluents on aquatic ecosystems (ECDFO, 1997). There is a lack of information on the life history of trout-perch and lake chub throughout their range that is needed to determine their effectiveness as sentinel monitors.

The concept of sentinel species was developed as a means of monitoring the impact of human activities on ecosystems. Originally, sentinel species represented species valued by local interest groups such as aboriginal people, hunters, anglers and naturalists, were monitored to ensure their sustained supply (eg./ Moose, caribou or walleye). A second and more recent role of a sentinel species is to represent ecological processes and patterns (Alberta Pacific, 1995). In some cases these sentinels may have both an individual value to stakeholders and also indicate ecosystem health. There have been many bioindicators or sentinel monitoring species studied in Canada, including colonial water birds (Weseloh and Collier, 1985) and Coho salmon *Oncorhynchus kisutch* on the West Coast, (Alderdice and McLean, 1982), and the Great-blue Heron, *Ardea herodias,* in British Columbia (Butler, 1997). Karr (1997),compiled examples of U.S. river systems that were in various states of degradation. He reported that $473 billion was spent on water-pollution control facilities between 1970 and 1989 and these systems are still declining. In terrestrial ecosystems there is a movement from single-species (fine filter) to multi-species, landscape level approaches (coarse filter) (Alberta Pacific, 1995).

To monitor the effects on aquatic ecosystems from pulp mill effluents, fish and benthic inverebrate communities were selected as the most likely sentinels (E.C.D.F.O., 1993). Fish species selected must be resident, abundant and have a high reproductive rate, but must also be exposed to effluents and sediments (E.C.D.F.O., 1993).

Native fish species have been used successfully as sentinel monitors for industrial effluents in habitats where their movements were restricted (Munkittrick *et al*, 1991). Small-bodied fish may be suitable sentinel species to determine if pulp mill effluents have an impact on large northern rivers. Environmental monitoring programs conducted by Alberta pulp mills found that large-bodied fish are sometimes migratory and hard to collect in sufficient numbers. Life history parameters of large-bodied fish can also have high variability within a given population (E.C.D.F.O., 1997). Small-bodied fish are less variable, less migratory, and more abundant than large-bodied fish (Gibbons *et* al, 1996).

Responses of wild fish to industrial effluents are reported in central Canada. Most of these occurred where fish movement was restricted by habitat or man-made barriers, (Munkittrick et al., 1991; Hodson et al., 1992). In most cases effects were not detected using large-bodied fish where their movement in the system was not restricted. Examples of fish species used as sentinel monitors include longnose sucker, *Catostomus catostomus* (Forster) (Gibbons *et al.*, 1991; Gibbons *et al.*, 1992; Swanson *et al.*, 1992, 1993); walleye, *Stizostedion vitreum vitreum* (Mitchill) (Swanson *et al.*, 1993 and Sentar, 1994); white sucker *Catostomus commersoni* (Lacepède), (Munkittrick et al., 1991, and McMaster et al., 1992); lake whitefish *Coregonus clupeaformis* (Mitchill), (Munkittrick et al., 1992); and mountain whitefish, *Prosopium williamsoni* (Girard), (Munkittrick et al., 1990; Kilgour and Gibbons, 1991, and Swanson et al., 1992).

Athabasca River pulp mills have examined a variety of large and small-bodied fish species as candidates for sentinel monitors (E.C.D.F.O., 1997). Preference was originally given to large bodied fish such as walleye and longnose sucker (Fraikin, 1996; Alberta-Pacific, 1994). However, both these and other large bodied fish species show extensive movements, which make it difficult to determine if they were exposed to mill effluents. Small-bodied fish tend to be abundant and reside in a variety of habitat types whereas large-bodied fish are more habitat selective and far less abundant (Shelast et al, 1994). Cyprinids and cottids are thought to have limited mobility relative to large-bodied fish, and tend to complete their whole life cycle in a small home range and would reflect changes in the local environment more than large-bodied fish species, (Gibbons et al., 1996). Hence there is a greater probability that any response they show would reflect a change in the local environment.

Pulp mills are required as a condition of their licence by the Federal Environmental Effects Monitoring (E.E.M.) program to select two fish species as sentinel monitors and to sample adults of these species in the waters that receive pulp mill effluents. This adult fish survey is the main component of E.E.M. requirements for pulp and paper mills. "Sentinel monitors" are to be selected from local fish populations which exist in sufficient numbers to allow intensive study in the mill's area of effluent discharge (E.C.D.F.O., 1993).

Criteria for sentinel species set out by E.E.M. scientists (ECDFO, 1993) state that at least one should be a benthivore. Fish species that are resident to the aquatic system under investigation for most or all of their life cycle and exhibit territorial behavior or limited movement relative to the size of the study area are preferred. The greater likelihood that a fish species is exposed to effluent, the greater its value as a sentinel species. Also, consideration should be given to species of relatively small adult size since age-at first maturity and adult natural mortality vary in proportion to adult size (Shuter, 1990). Consequently, adult abundance of small species should respond more rapidly to stressors that affect fecundity and/or larval survival.

The adult fish survey mentioned above is to be conducted every three years where each survey is one cycle. Successive cycles will allow the assessment of temporal changes in the degree and spatial extent of any site-related effects on fish, fish habitat and the use of fisheries resources. Undesirable effects include reduced health, decreased fecundity and recruitment, and reproductive effects such as reduced gonad size and delayed maturity. The intent of the E.E.M. program is not to interpret findings from one cycle but to monitor long term trends that would be seen in three or more cycles (E.C.D.F.O., 1992). The first cycle of studies for E.E.M. were completed in the fall 1995 by four pulp mills on the Athabasca River, namely Alberta -Pacific Forest Industries Inc., Boyle, Alberta Newsprint Company, Whitecourt, Millar Western Pulp Limited, Whitecourt, and Weldwood of Canada Limited, Hinton.

All mills used at least one large-bodied fish species and no mill was able to catch enough adult fish of both sexes in the effluent exposed area and the unexposed reference area to evaluate the effects of the effluent. Other difficulties included movement between reference and exposure sites, variability within species in liver, gonad size and development (E.C.D.F.O., 1997). Millar Western Pulp Limited and Alberta Newsprint Company, successfully used a small bodied species - lake chub, as one of two sentinel monitors (E.C.D.F.O., 1997). Although sufficient numbers of fish were caught, methods used to collect these fish (electroshocking) are not always effective and other methods have been developed in this study which may decrease effort and increase yield.

Trout-perch and lake chub were the two most locally abundant fish species in the Athabasca River near the Alberta-Pacific Pulp Mill. These two species were found to be the most abundant and readily caught species for use as E.E.M. sentinel species (Alberta-Pacific, 1994). Of these two, the trout-perch was the most abundant and yielded the greatest amount of life history information. Subsequently, more effort was expended on sampling and examinations of trout-perch.

Lake chub and trout-perch have been described as occurring widely throughout Canada and in the northern United States (Scott and Crossman, 1973). In Alberta, both fish have been studied in some detail for the Athabasca Oil Sands Environmental Research Program (A.O.S.E.R.P), a 10 year program that researched the potential impacts of development of the oil sands in the area of Fort McMurray. These studies catalogued the presence of all fish species in various areas and touched briefly on their biology. The present study area lies within the section of the Athabasca River that Wallace and McCart (1984), defined as the least understood in terms of population structures, movements, life histories, and spawning habitats of fish. Presently, there still is a lack of knowledge of the general biology of these small-bodied fish. Gibbons et al., (1996) states that " very little information exists on growth rates, reproductive strategies or sampling requirements for using forage fish to monitor impacts of industrial discharges in large rivers". He also mentions that "capture efficiency of small fish species could be increased if their general biology was understood".

In this thesis I will describe the suitability of trout-perch and lake chub as sentinel species using the methods for conducting the adult fish survey required by E.E.M. in the Athabasca River. I will also define growth rates, reproductive strategies and diet to complete a description of trout-perch and lake chub life history.

This thesis has four parts. Chapter 2 defines the study area and methods. Chapter 3 describes the biology of trout-perch collected in the study area. Chapter 4 describes the biology of lake chub collected in the study area. Chapter 5 outlines the general conclusions and an evaluation of the two species of fish using the E.E.M. criteria for a sentinel monitoring species.

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Chapter 2

Study Area and Sample Collection

The Athabasca River is located in central Alberta and flows from the eastern slopes of the Rocky Mountains to Lake Athabasca along the Alberta/Saskatchewan border (Fig. 2-1). The study reach along the Athabasca River extended from 10 km upstream of the town of Athabasca, Alberta, (54°, 44' 59.8" N; 113° 21' 54.8" W) to the mouth of the Calling River (55° 05' 21.5" N; 112° 52' 54.5" W), a distance of 83 km. Two rivers influence the study area, the LaBiche River (54° 00' 51.6" N; 112° 44' 00.7" W) and the Calling River (55° 05' 21.5" N; 112° 52' 54.5" W).

The Athabasca basin is one of the largest drainages in Alberta with an area of 155,000 square km or 22% of the Province of Alberta. The Athabasca River encounters a wide diversity of soil types and urban or industrial developments. Available fish habitat ranges from clear cold mountain brooks to warm, wide silty meanders. Most of the stream flow in the Athabasca River arises in the mountain ranges, as the plains contribution is limited by high evapotranspiration rates. The water quality is variable, as the rate of soil erosion in the plains is high, with high values for dissolved and suspended solids. (Wallace and McCart, 1984).

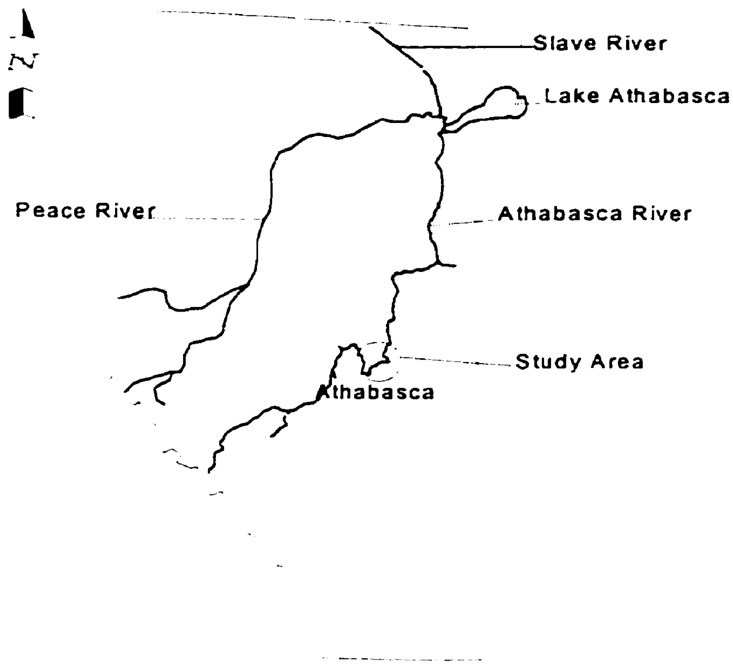

Figure. 2-1. Map of Alberta with study area on the Athabasca River.

The Athabasca River within the study reach is characterised by a single channel occasionally confined by the valley walls. Results from a 1994 study of the Athabasca River near the Alberta-Pacific pulp mill indicated a mean annual water velocity of 0.75 m/s, and mean water depth of <3 m, and a low gradient of 0.44m/km (Alberta-Pacific, 1994). The average wetted width of the river in the study area was 230 m. Water levels during the study period varied considerably (Fig. 2-2). The mean water level was 1.75 m., Maximum was 4.32 m. and minimum level was 0.78 m, (data from Athabasca station 07BE001 at Athabasca).

Sampling for this project occurred from May to October in 1995 and from May to September 1996. Several peak flows during sampling in 1995 and 1996 were present in both years and were related to rainfall events in the upper basin (Fig. 2-2). These events were common for the Athabasca River and fell within the normal range of flows (Environment Canada, 1992). The mean annual discharge was 430 m^3/s (range 299-740 m^3/s), based on historic data (1913-1991) from Athabasca River at Athabasca station no. 07BE001 (Environment Canada, 1992). Mean discharge for open water flow (May-October/September) were 589 m^3/s (range 181-2234) and 895 m^3/s (range 125-2570) for 1995 and 1996 respectively (Environment Canada, unpublished), (Fig. 2-4). The 2-year mean discharge during the study (May to October 1995 and 1996) was 748 m^3/s (range 126-2570 m^3/s) and historical mean discharge (1913 to 1991) from May to October was 714 m^3/s (range 50-5440 m^3/s) (Environment Canada, 1992). All discharge values were calculated from mean daily values provided by Environment Canada from the Athabasca station no. 07BE001 at Athabasca, Alberta.

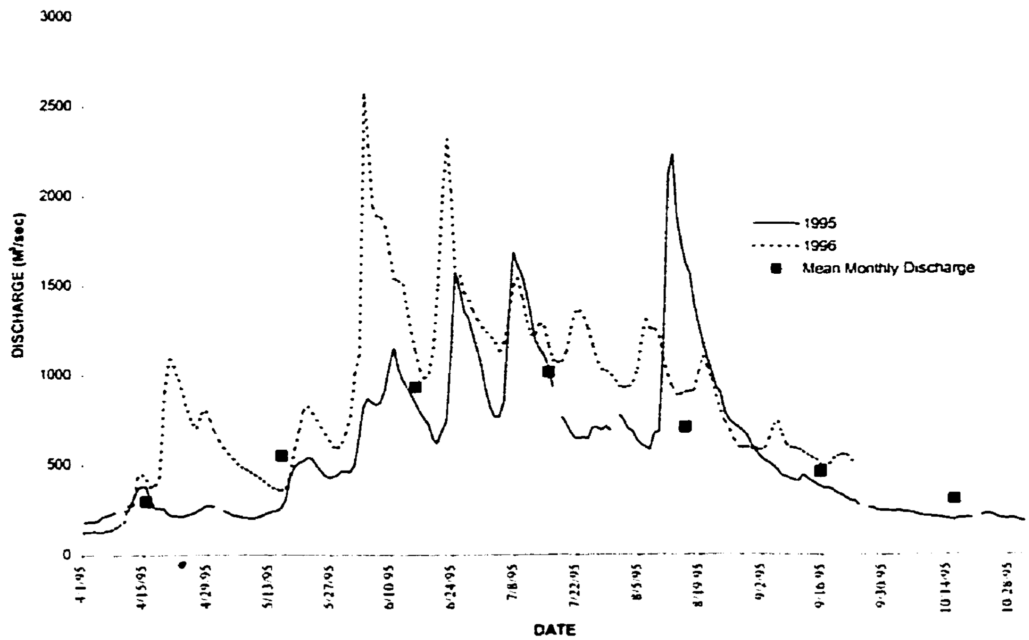

Figure. 2-2 Mean daily discharges (m³/s) for 1995 and 1996 and historical monthly discharge for the Athabasca River at Athabasca station no. 07BE001 located at the upper end of the study area.

The Athabasca River begins in the Rocky Mountains is a torrential high mountain stream and terminates as a silt-laden major river at the delta created by the Peace and Athabasca rivers at the western end of Lake Athabasca. The upper reaches of the river pass through the Alpine, Subalpine and Montane ecoregions before entering the Boreal Foothills and Boreal Uplands ecoregions between Jasper National Park and the Town of Whitecourt, (Mitchell and Prepas 1990). Below Whitecourt, the river flows through the Boreal Mixedwood Ecoregion, which extends all the way to Lake Athabasca.

Wallace and McCart (1984) divided the river into three sub-basins (I, II and III); the study area is within Sub-basin II and is entirely within the Boreal Mixedwood Ecoregion. Athabasca Sub-basin II extends from a point mid-way between the towns of Fort Assiniboine and Athabasca to Fort McMurray and drains an area of more than 6,000 km^2. The river gradually drops in elevation from Fort Assiniboine to Athabasca and then begins a sudden drop in the vicinity of the Pelican River. The last major drops in elevation occur at the Grand, Brule and Boiler rapids. Between Athabasca and Fort McMurray the river declines in elevation from 508 to 238 m, is shallow (3 m on average) and carries a high sediment load. Substrates are gravel mixed with sand and cohesive clays (Kellerhals et al. 1972).

In the southern portion of Sub-basin II, Calling and Rock Island lakes drain into the Athabasca River through the Calling River. The Calling Lake sub-basin covers an area of 1090 km^2. Calling Lake is the largest waterbody within the sub-basin (Mitchell and Prepas, 1990). The main inflow to the lake is locally known as Rock Island River, which originates from Rock Island Lake in the northern part of the watershed. Several smaller streams flow into the lake, contributing to the mean annual inflow of $106 \times 10^6 m^3$. The Calling River is the only outlet, flowing from the south-east end of the lake for a distance of about 25-km to its confluence with the Athabasca River.

The La Biche River flows 80 km from Lac La Biche, one of the largest lakes in the region (246 km^2), joining the Athabasca main stream near the confluence of the Calling River. It drains an area of 8,800 km^2. The La Biche River is a slow flowing stream, with a substrate of muddy clays occasionally interspersed with pebbles and cobbles.

The study area included these two important tributaries, the La Biche and Calling rivers (Fig. 2-3), for a distance of one kilometre above their confluence with the Athabasca River. The upper extent of the study area was 10 km upstream of the Town of Athabasca, a distance of about 45 km upstream of the Alberta-Pacific pulp mill location. This boundary was chosen for practical considerations as well as to reflect conditions in the basin below industrial and municipal effluent discharges and other land uses.

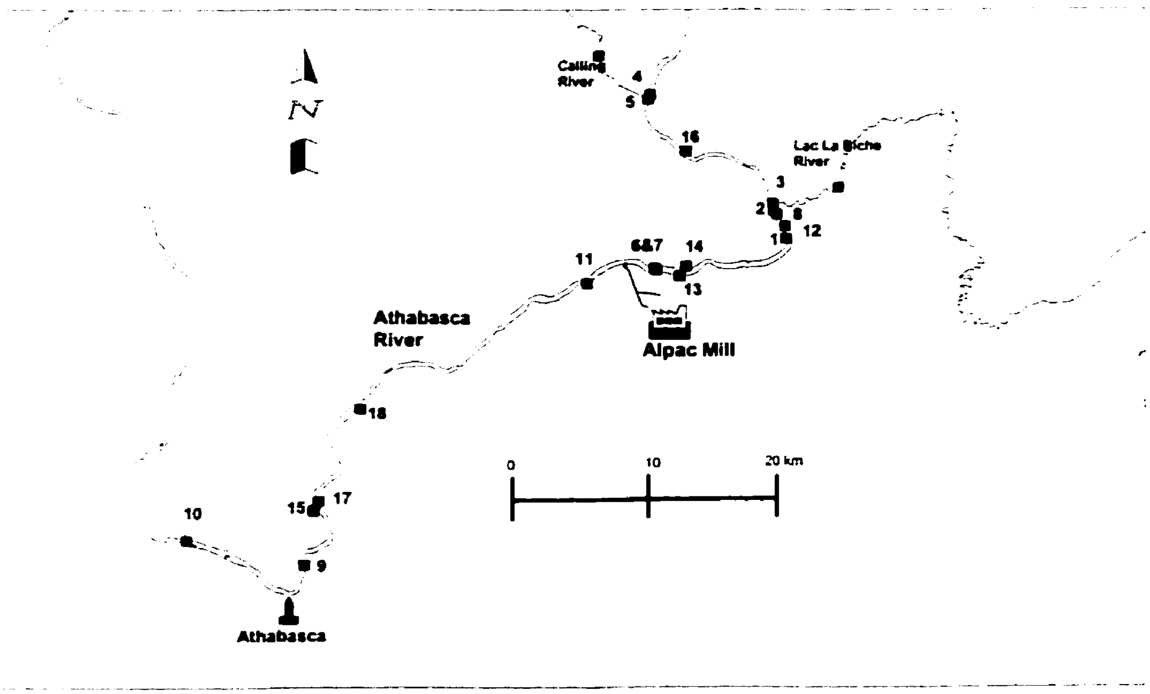

Figure. 2-3 Study area with site locations. The study reach along the Athabasca River extended from 10 km upstream of the town of Athabasca, Alberta, (54°, 44' 59.8" N; 113° 21' 54.8" W) to the mouth of the Calling River (55° 05' 21.5" N; 112° 52' 54.5" W) a distance of 83 km.

Man's activities can affect the water quality of the Athabasca River through both point and non-point sources. Point sources include industrial and municipal discharges. Non-point sources are those resulting from land uses such as forestry, agriculture, mining, and urbanisation.

Resource development is the major land use activity in the Athabasca River basin. Logging is the dominant land use in the upper half of the watershed. Numerous sawmills are located throughout the basin but none have a direct effluent discharge to the river. Coal mining activity in the McLeod and Pembina River sub-basins has resulted in localised water quality effects but has had no detectable effects on the mainstream Athabasca River (Hamilton *et al.* 1985). Conventional oil and gas development in the basin is extensive. None of the gas processing plants have a direct effluent discharge to the river. There are no significant effluent discharges within the study area downstream of the Alberta-Pacific mill. The main users of water and sources of effluents discharged directly or indirectly to the Athabasca River upstream of the study area are pulp mills and municipalities. These are listed in Table 2-1 (taken from Shelast *et al*, 1994).

Table 2-1 Main Water Users and Effluent Sources on the Athabasca River

Water User/Discharger	Effluent Type
Town of Jasper	sewage effluent
Weldwood of Canada	secondary treated, combined bleached kraft mill effluent (95%) and Town of Hinton sewage (5%), at Hinton
Town of Edson	treated municipal sewage (enters via McLeod River)
Alberta Newsprint Company	secondary treated TMP mill effluent, near Whitecourt
Millar Western Pulp Ltd.	secondary treated BCTMP mill effluent, at Whitecourt
Town of Whitecourt	treated municipal sewage
Slave Lake Pulp Corporation	secondary treated BCTMP mill effluent (enters Athabasca River via Lesser Slave River)
Town of Slave Lake	treated municipal sewage (enters via Lesser Slave River)
Town of Athabasca	treated municipal sewage
Alberta-Pacific Forest Products Inc.	secondary treated, combined bleached kraft mill effluent

Hamilton *et al.* (1985) stated that industrial and municipal point source discharges had no broadly based influence on the water quality of the Athabasca River, and this may still be true in terms of "conventional" parameters. However, pulp mills are still recognised as potential sources of fish endocrine disrupters in water, sediments and biota (Bright *et* al, 1997).

Athabasca River Variability

Natural characteristics of the Athabasca River may mask effects from effluent because of their magnitude and variation. These characteristics are flow, water level and sediment load.

Flow

Flow in the Athabasca River is subject to sudden variations. During the peak flow months of April to August historic flows varied from 250 to 5500 m^3/sec (Environment Canada, 1992), (Fig 2-4). These changes correspond to storm events and intense warming of the Athabasca glacier and snow pack (Wallace and McCart, 1984).

Water level

In response to increased flows water levels can rise or fall in a short time period. With large variation in water levels, available habitat for fish can change from loose cobble to riparian in a matter of hours. Spawning fish and fry can be adversely affected by the change in water levels (Allan, 1995). Several large flow events occurred in both study years (Fig 2-2). In 1995, June 10^{th}, July 8^{th} and August 12^{th} and in1996, April 20^{th}, June 3rd and 24^{th}, July 8^{th} and 2^{nd}, 4^{th}, and August 7^{th} all had peak flows. These dramatic increases in flow were associated with large rainfall events in the upper Athabasca basin. Although substantial these peak flow event fell well within the range of flows typical for the basin (Fig 2-4).

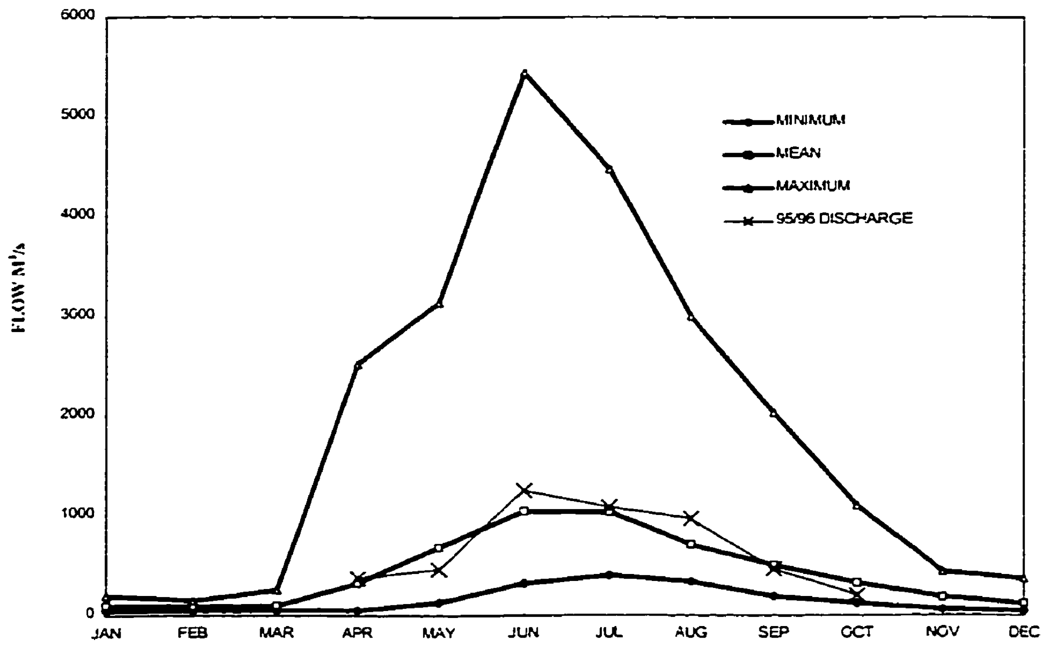

Figure 2-4 Monthly mean, monthly maximum and monthly minimum flows in the Athabasca River from 1913 to 1991. Flows from the study 1995 and 1996 periods are also included. Measurements taken at Athabasca station #07BE001, Athabasca, Alberta.

Sediment load

The turbidity in the river water varied widely over short time periods. Such changes are buffered or may not be seen in backwaters and confluence with tributaries. In an example from the study area, June and July, 1996 turbidities ranged between 60-290 ntu in the mainstem of the Athabasca River and 15 - 100 ntu in tributaries and back waters. Flow and levels of turbidity were directly related (Fig. 2-5).

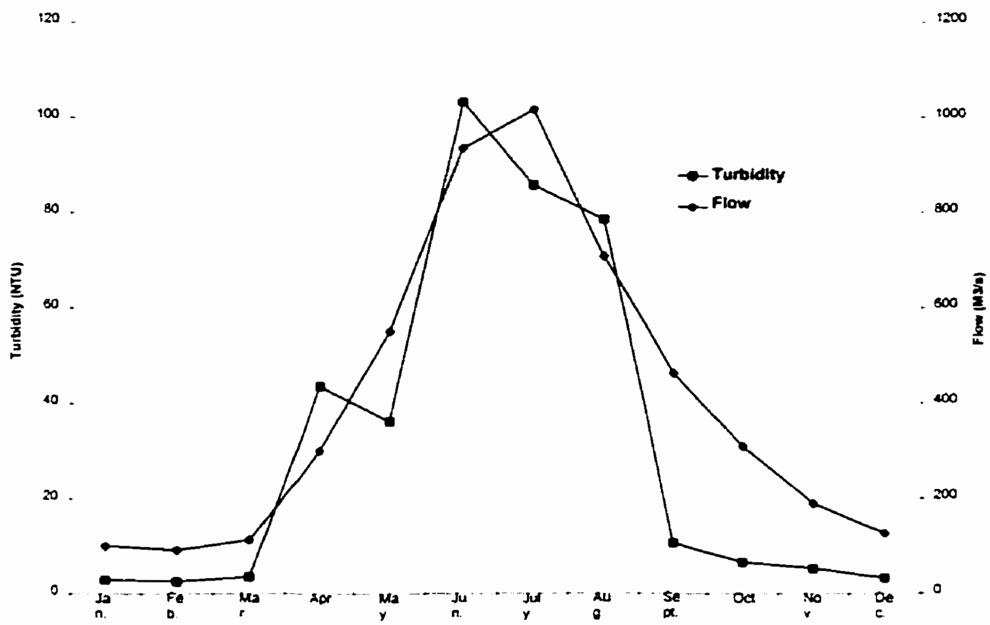

Figure 2-5 Average turbidity (NTU) and flow (M^3/s) in the Athabasca River 1995 and 1996. Values taken from the Alberta-Pacific Pulp Mill raw water monitoring system.

Sample Collection

In the Athabasca River, run , backwater and confluence/tributary habitats were sampled for small-bodied fish (Table 2-2). Individual site locations and substrate descriptions are in appendix 1. Run habitats were straight stretches of the river that had finer substrates and flows consistent with the mainstem flow. These were also the longest sites ranging from 50 to 1000 m. (Figure 2-6a). Back water habitats tended to be less than 100 m in length and were formed when a still water area was formed in the lee of a point bar (Fig. 2-6b). These tended to have a cobble substrate overlain by silt. The two tributary/confluence areas (La Biche River (LR) and Calling River (CR)), were approximately 500 m each in length and encompassed the downstream bank of the Athabasca River that was in contact with the tributary river and immediately upstream from the confluence site (Figure 2-6c). The Calling River has a flow control structure that reduces large increases in flow and the La Biche River is a small river that is mostly low gradient channel that has a dampening effect on large flows. The LR site had substrates of cobble, sand and silt and the CR site had substrates of gravel, and sand.

Table 2-2 Individual sample site grouping by habitat type for 1995 and 1996. Sites 2, 10 and 11 were dropped in 1996 and sites 12-18, CR (Calling River) and LR (La Biche River) were added.

Habitat Type	1995 Sites	1996 Sites
Run	1,6,7,9,10	1,6,7,9,13,18
Back water	2,8,11	8,12,14,15,16,17
Tributary/Confluence	3,4,5	3,4,5,CR,LR

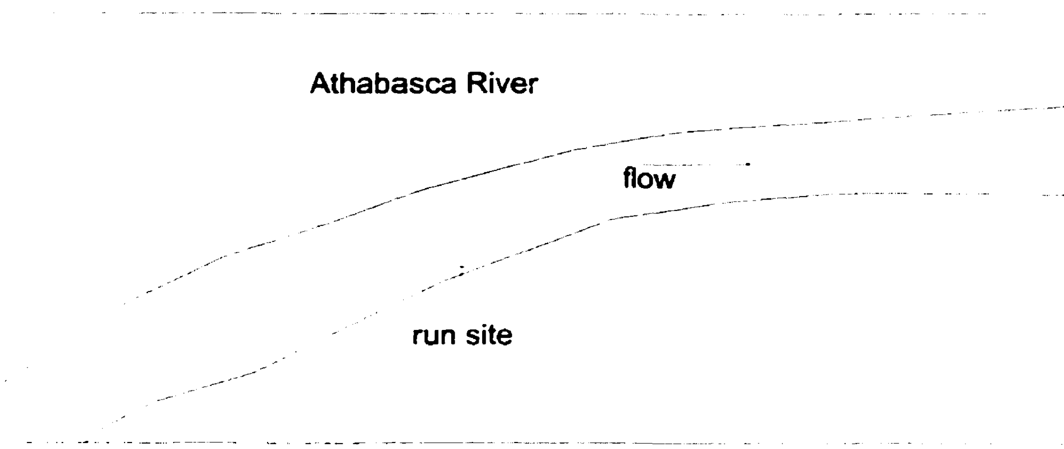

Figure 2-6a. Depiction of a typical run site

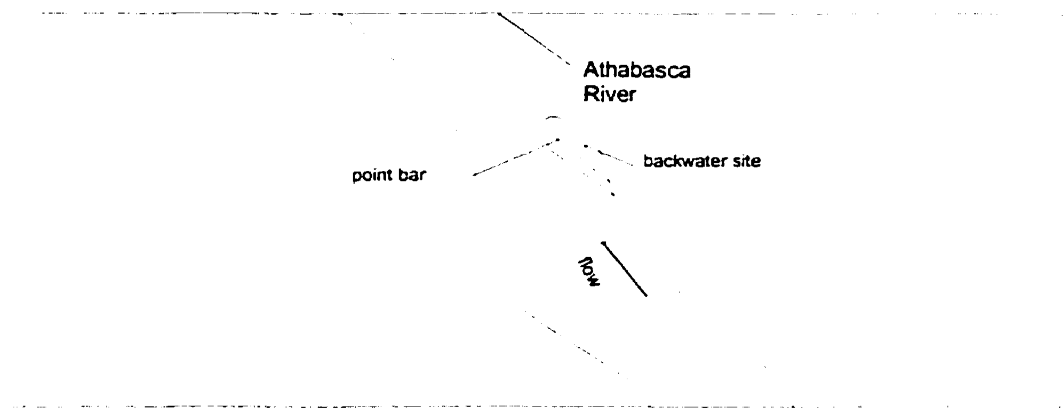

Figure 2-6b. Depiction of a typical backwater site.

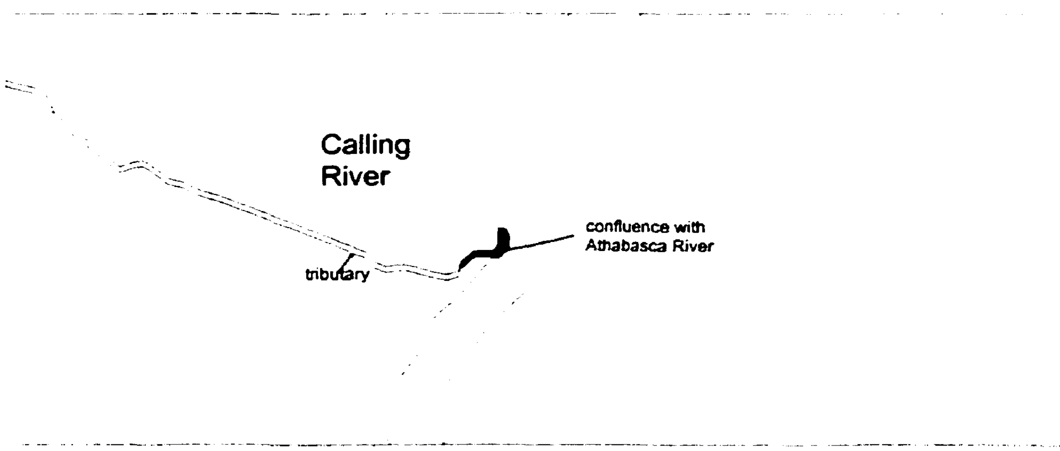

Figure 2-6c Depiction of Calling River tributary/confluence site.

Capture

Seining is effective for small-bodied, slow moving or schooling fish whose normal habitat is shallow water (E.C.D.F.O., 1993). Seining has been previously demonstrated to be effective as a capture technique for trout-perch (Alberta-Pacific, 1994).

The beach seine used was 5 m long by 1.2 m in height consisting of three panels of equal size; the two outsides with 1.5 square cm mesh and the centre with 0.5 square cm mesh. In the centre panel a 30 cm diameter by 45 cm long "sock" was added (Fig. 2-7). This centre small-sized meshed "sock" ensured capture of the smallest size classes of fish. Seine hauls were normally pulled upstream against the current and were between 30 and 60 m in length. Collections were done in 0.1 to 1.2 meters of water with an average depth of 0.5 meters.

Trout-perch and lake chub were collected from May to October during 1995 and May to September in 1996. Sampling was conducted at 11 sites in 1995 and 17 sites in 1996. Sampling periods consisted of five-day sessions every second week. Thunderstorms and mechanical problems affected the schedule for a five-day period in 1995. Trout-perch and lake chub were examined for total length in mm, mass in grams to two decimal places, and external condition in the field. Also, a portion of the collected fish from each site were euthenized, examined for sexual maturity (egg diameter (mm), gonad weight (g)); diet (gut contents as percentage of prey by volume), age (scales) and condition of organs and tissues. Scales were stored in small, labeled envelopes for age determination in the laboratory. Tissues were placed in labeled vials and fixed with 5% buffered formalin and later stored in 5% ethanol for long - term preservation as in Haedrich (1983).

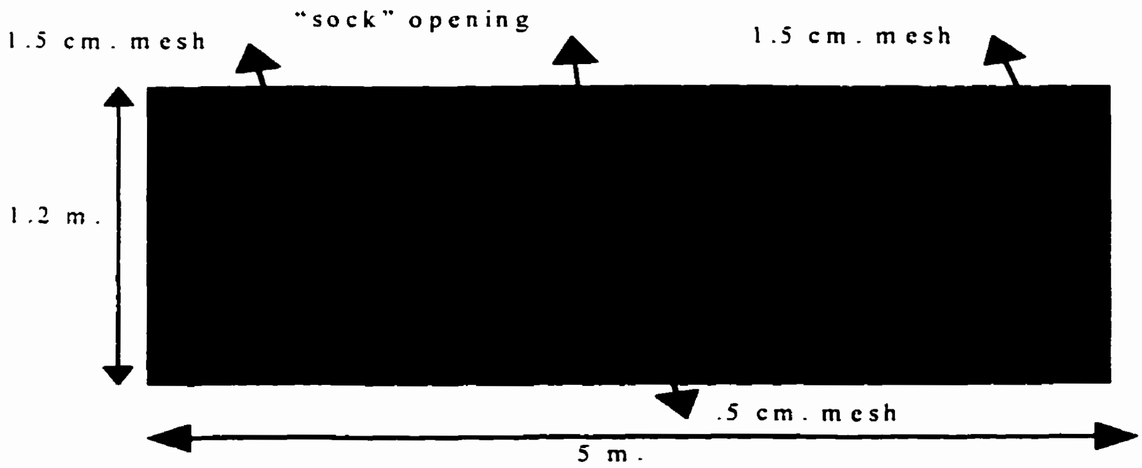

Figure 2-7. Seine net used for collection of trout-perch and lake chub in the study area. The centre sock opening was 30 cm in diameter and extended 45 cm out from the centre panel.

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Chapter 3

Biology of the trout -perch in the Athabasca River, Alberta

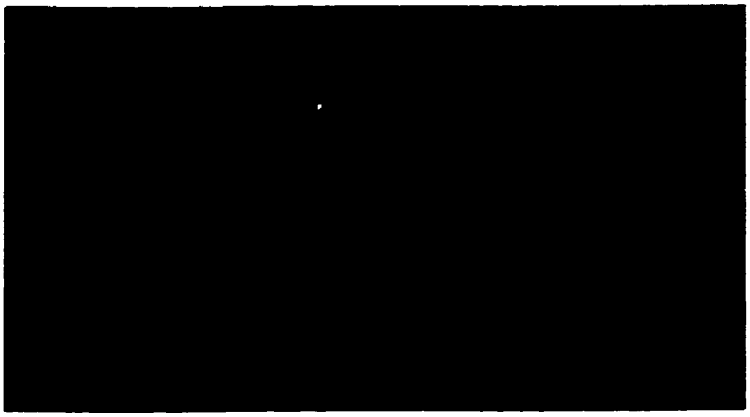

Plate 3-1 Trout-perch collected from the Athabasca River near Athabasca, Alberta, 1996.

Introduction

A large consideration in the selection of a species for environmental effects monitoring is that the life history be well understood. In Alberta, Gibbons et al. (1996), studied trout-perch at Hinton and Whitecourt on the Athabasca River. They recommended trout-perch as a good candidate for use as sentinel monitor. However, there is little known about its general biology, natural variability, and mobility.

Trout-perch have been described as occurring widely throughout Canada and in the northern United States (Scott and Crossman, 1973). In Canada, trout-perch are distributed from northeastern British Columbia to Quebec. They are common in all the major river systems in Alberta (Nelson and Paetz, 1992). In Alberta, trout-perch have been studied in the Athabasca Oil Sands Environmental Research Program (A.O.S.E.R.P), a 10 year program that researched the potential impacts of development of the oil sands in the area of

Fort McMurray. These studies catalogued presence of all fish species in various areas and touched briefly on their biology.

Presently, there is a lack of knowledge of the general biology of small-bodied fish (Gibbons et al., 1996). Biology of trout-perch is briefly described for central Canada and Midwestern United States (Magnuson and Smith, 1963). Spawning there begins in May and continues into August in lower reaches of streams and lakes. Trout-perch live up to four years and can spawn after their first year. Males tend to mature at a smaller size and earlier age than females (Bond and Berry (1990), Machniak et al. (1980), Magnuson and Smith (1963), and House and Wells (1973). Insect larvae of midges (Chironomidae) and mayflies (Ephemeroptera) are reported as the most preferred item in the diet, (Machniak et al, 1980).

Ages were successfully obtained to determine growth rates using methods such as: standard lengths (Kinney, 1950 and Lawler, 1954), scales (Magnuson and Smith, 1963), and Mackay et al (1990) recommends otoliths. In this study scales and standard lengths were used to age trout-perch.

In this chapter, the life history of trout-perch will be discussed. This will include reproduction, age and growth, body condition, diet, and habitat use. The life history information for the sentinel species requirements of the EEM program: gonad weight, liver weight, length, mass and age will be discussed also.

Methods

Trout-perch were assessed for EEM biological aspects as well as other related life history parameters. The EEM parameters described in this section are age, length at age, mass at age, gonadal somatic index (GSI), body condition factor (K) and liver somatic index (LSI). Other parameters assessed included: movement, abundance, habitat preference, growth, reproduction, fecundity, sexual maturity, and diet.

Residency

In the 1995 study, fin clipping as in Wydoski and Emery (1992) was employed to obtain residency information. Success in 1995 was poor (4 recaptures out of 900 marked fish) and marking was not continued in 1996. An alternate approach to mark-recapture was the observance of age classes at the three habitat types during the complete sampling period for both years using length-frequency data (Appendix 2). These fish were deemed resident if all age classes were present during the sampling events in 1995 and 1996.

Fish captured during each seine haul were sorted with all trout-perch being retained in a 20 litre pail and the other species being identified, counted and released. In 1994, 900 trout-perch were collected and marked with single and double fin clips. Fluorescent dye injection was attempted, but the dye was not easily injected into the fish causing too much stress and some mortalities. After clipping they were placed in a pail of fresh river water for recovery before release. Mortality from handling and clipping was low (> 2%). Individuals that did not recover after 30 minutes were sacrificed and examined.

An alternate criterion of residency used was the presence of all age classes at all habitat types sampled for spawning and post spawning seasons. This was evaluated using length frequency as a measure of age at the three habitat types during the spawning and post spawning season.

Catch per unit effort (C.P.U.E.)

Catch per unit effort was calculated as

C.P.U.E. = number of fish caught/
(length of seine haul X seine width)

where length of seine haul and seine width are in metres.

Environmental Effects Monitoring

Environmental Effects Monitoring (EEM) requires that six adult fish parameters be measured to determine the sample size needed to detect differences at a reference site from a site exposed to effluents. All six parameters are to be included for a fish species to considered as a sentinel species (ECDFO, 1995). These parameters are: length at age, mass at age, age, liver somatic indices (LSI), gonadal somatic indices (GSI) and condition factor (K). The original data is found in Appendix 3.

Ageing

Scales were used to determine age. Scales were removed from a sacrificed fish between the lateral line and dorsal fin. Three of these scales were viewed under a stereo microscope and examined for annuli at the anterior and lateral portion of the scale, similar to Mackay et al (1990). Ages were verified by post-comparison to length-frequency data. A subset of scales was reread to check the reproducibility/consistency of counting annuli. In the case of discrepancies a third read was conducted and a consensus reached between the two readers. Otoliths were not used for aging, as they were difficult to extract, preserve and handle in the field.

Condition factor

Condition factor (K) is a reflection of the health of individual fish (Bagenal and Tesch, 1978) and is one of the indices used by E.E.M.

It was calculated as

$$K = \text{mass}/(\text{length})^3 X\ 10^5$$

Mass was total body mass (in grams) and length was total length of the fish (in millimeters) and 10^5 was a scaling factor.

Liver somatic index (LSI)

Liver somatic index (LSI) is another index used by E.E.M. and can be associated with nutritional state and growth rate of the fish (Busacker *et* al, 1990). LSI was calculated as

$$LSI = (\text{liver mass}/\text{body mass})\ X\ 100.$$

Where body mass was total body mass. Mass was measured in grams.

Growth Rates

Specific and absolute growth rates were estimated similar to Busacker et al (1990) by calculating the change in length of a cohort of fish per unit time, usually a year. Specific growth rate defines growth as percentage increase and was calculated as

$$G = (\log_e Y_2 - \log_e Y_1)/(t_2\text{-}t_1)\ X\ 100$$

Absolute growth rate defines growth by the incremental value in mm/year. This is derived from

$$\text{Absolute growth rate} = (Y_2 - Y_1)/(t_2\text{-}t_1)$$

where t_2-t_1 is the change in time and $Y_2 - Y_1$ is the change in total length of the cohort during that time.

Sexual Maturity

Sexual maturity was determined in the field on recently sacrificed fish. Immature females were identified by their two small thread-like ovaries, found below the air bladder, which were also translucent and had no visible oocytes. Immature males were identified by their small translucent triangular shaped gonads located on either side and anterior to the air bladder. Sexual maturity was determined by viewing the reproductive state of the gonads, size and color of eggs or testis, and degree of vascularization. Ripe eggs were larger and yellow in color than the maturing, small, white eggs seen in non spawning trout-perch. Female fish were classified to one of five categories and male fish had four (Tables 3-1a and 3-1b).

Gonadosomatic Indices (GSI)

Gonadosomatic index or GSI was used to indicate the reproductive state of fish (Bagenal, 1978). GSI was calculated as in Crim and Glebe, (1990), where:

GSI = gonad mass/total body mass X 100%

Mass was in grams. GSI was calculated for adult trout-perch in 1995 and 1996. E.E.M. also requires GSI in its determination of appropriate sample size based on natural variability.

Eggs

Ovaries were selected from 109 adult trout-perch collected in 1995 and 1996. All eggs were viewed after fixing in 5 % ethanol to minimize any size variation due to differing fixative fluids. Preservation tended to create a minimal amount of shrinkage in the egg diameter (< 5%), when placed in the 5% alcohol solution the difference was minimized even further (<3%). Total egg counts and diameter measurements were conducted on one mature ovary. Individual egg diameters were measured using an optical micrometer with a dissecting microscope at 16X (Appendix 4). Diameters were converted to millimeters from micrometer units.

For those fish not lethally sampled, observations of spawning condition (expressing milt, distended abdomen and/or releasing eggs) were recorded at the time of examination.

Fecundity

Absolute fecundity in fish such as trout-perch and lake chub is defined as the number of maturing eggs present in the ovary just before spawning (Bagenal, 1978). For these fish, being batch or repeat spawners, fecundity will include all maturing oocytes which will develop further before being released later in the same spawning season (Mann and Mills, 1979). Fecundity of individual adult female trout-perch was determined as in Crim and Glebe, (1990) where a mass of 30 eggs taken from the ovary was used to derive a mean egg weight which was then used to determine the total number of eggs in both ovaries. In some cases fecundity was determined by total egg count of one ovary to obtain a mean egg weight then dividing the mean egg weight into the total ovary weight.

Table 3-1a. Female trout-perch reproductive condition

Maturity level	Reproductive condition
1	Immature (clear ovary)
2	Maturing (small, white eggs-won't spawn this year)
3	Mature (large yellow eggs-will spawn this year)
4	Expressing eggs (spawning)
5	Spent (spawning completed)

Table 3-1b. Male trout-perch reproductive condition

Maturity level	Reproductive condition
1	Immature (small clear gonad)
2	Maturing (gonad larger and whitish in colour - will spawn this year)
3	Expressing (spawning)
4	Spent (spawning completed)

Diet

Diet analysis was required to ensure that trout-perch were indeed benthivores or had a diet that included benthic organisms as part of the total diet. A benthic exposure is one criteria for the sentinel species selection in EEM (ECDFO, 1993), and is also useful for the understanding of the biology of the species. Stomach contents from 92 trout-perch were examined. Stomachs contents were examined and recorded as a percentage of prey by volume (Appendix 5). These stomachs were selected from 270 stomachs collected in 1995 and 1996. The selection of number of stomachs was based on cost and equal number of representatives from habitat, season and gut fullness. Samples were collected from both sexes from May to September 1995 and 1996 and were selected to evaluate seasonal and habitat prey preferences, by a Kruskal-Wallace one-way analysis of variance.

All prey was identified to lowest possible category. All taxa were identified to family using the keys from Usinger (1956), Brooks and Kelton (1967), Edmunds et al. (1976), Baumann et al. (1977), Wiggins (1977), Pennak (1978), McAlpine et al. (1981), Bode (1983), Oliver and Roussel (1983), Wiederholm (1983), Merritt and Cummins (1984), Wiederholm (1986), Stewart and Stark (1988) and Clifford (1991).

Data Analysis

Systat 7.0 was used to analyze fish and habitat data. Lilieforte tests were used to test for normality. Most univariate normal distribution-based statistical methods are very robust under moderate violations of the assumptions, with the exceptions of very small (< 11 d.f. for error) and unequal sample sizes and/or one tailed tests (E.C.D.F.O., 1995). If data were visibly not normally distributed, Kolmogorov-Smirnov non-parametric tests were used.

Kruskal-Wallis one-way analysis of variance tests were used in the evaluations of habitat use, catch per unit effort, body condition, and diet. Analysis of variance tests were used in the evaluations of body condition factor and gonadosomatic index. For the EEM estimation of variability (in age, length at age, mass at age, liver somatic index, gonadosomatic index, body condition), analysis of covariance was used as in ECDFO, (1995)

Results

Abundance

Trout-perch was the most abundant fish sampled in the study area prior to 1995. The 1991-1993 Alberta-Pacific baseline survey of the Athabasca River included trout-perch and lake chub accounted for 59% (N=4552) of sample size based on fish collections by seining from 1991 to 1993 (Shelast *et al*, 1994). In a preliminary survey in 1994, trout-perch accounted for 57% (N=884), (Fig. 3-1). Trout-perch was the second most abundant fish captured in the study reach in 1995 (14%; N=3867) and 1996 (23%; N=4492) (Fig. 3-2).

Sampling methods for the 1991 to 1993 surveys selected mostly mainstem and backwater sites as tributary and confluence sites were avoided (Shelast, 1994). The preliminary survey was conducted for twelve sampling days between the 16th of July and 19th of August in 1994 and used the same methods and habitat types as the 1995 and 1996 collections. Trout-perch and other small bodied fish were collected for this project in the study area from May to October, 1995 and from May to September, 1996.

Three major habitat types sampled were run, backwater and tributary/confluence. These habitat types were described in chapter 2. Kruskal-Wallis one-way analysis of variance tests were used in the evaluations of habitat use. In 1996, there were significantly ($P<0.05$, N= 4440) more trout-perch captured in tributary/confluence habitats than the other two habitats (Fig. 3-3). In 1995, there was no difference in the number of trout-perch captured in the three habitat types ($P>0.05$, N = 3887).

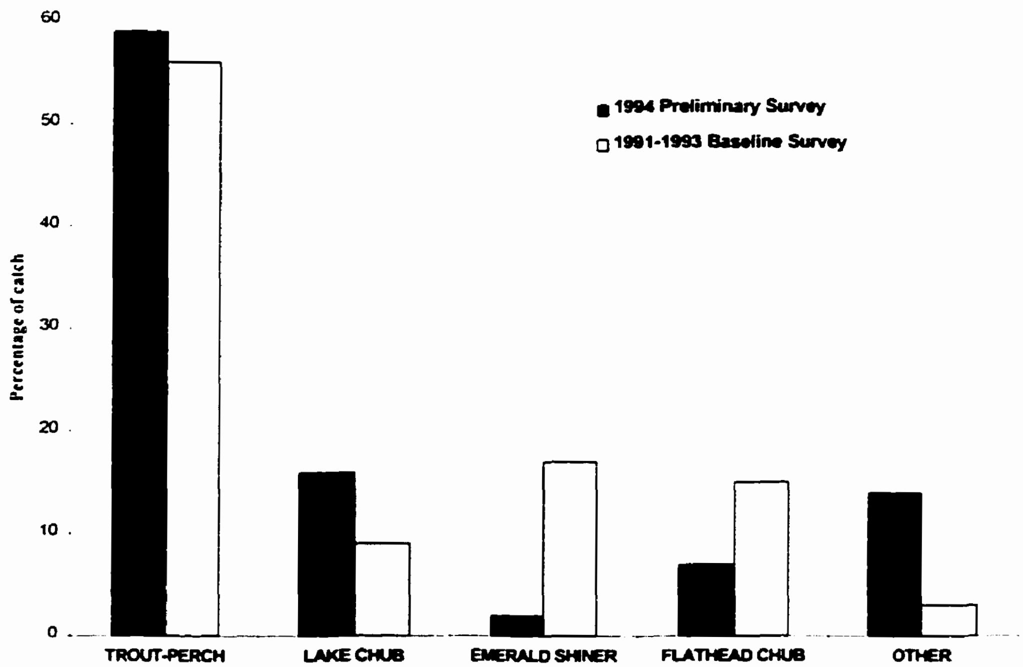

Figure 3-1. Catch summary results for abundant small-bodied fish species captured by seining in the study area. 1991-1993 Baseline survey (N = 7715) and 1994 preliminary survey (N = 1551).

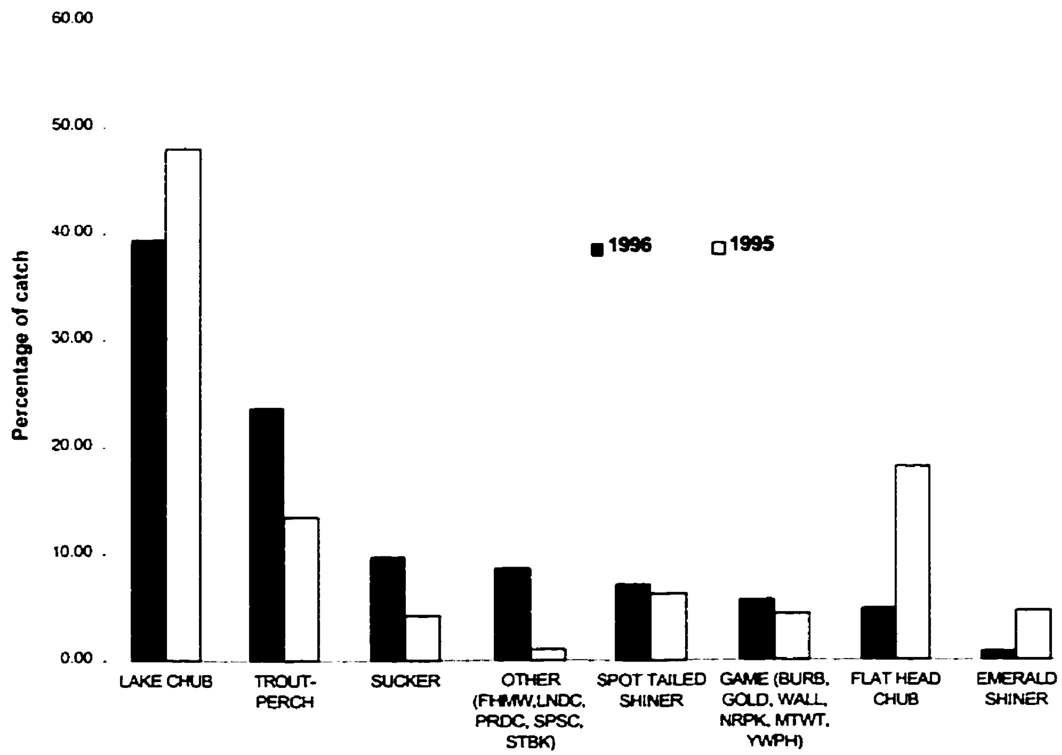

Figure 3-2 1995 (N = 27,622) and 1996 (N = 19,529) catch summary results for all species by seining in the study area. Abbreviations as in Mackay et al (1990): FHMW = fathead minnow, LNDC = long nose dace, PRDC = pearl dace, SPSC = spoonhead sculpin, STBK = stickleback spp., BURB = burbot, GOLD = goldeye, WALL = walleye, NRPK = northern pike, MTWT = mountain whitefish, YWPH = yellow perch.

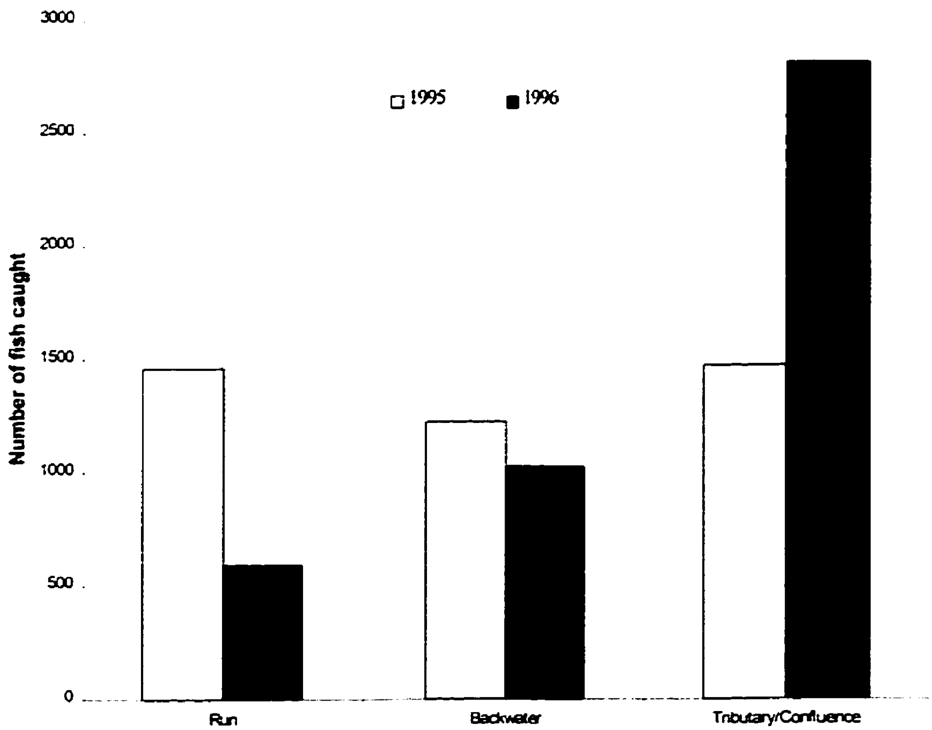

Figure 3-3. Number of fish caught by seining in run, backwater and tributary/confluence habitats of the Athabasca River in 1995 (N=3887) and 1996 (N=4440) for trout-perch.

Catch per unit effort

Numbers of fish collected in 1996 were compared to determine if preference existed for tributary/confluence or mainstem river sites. Kruskal-Wallis one-way analysis of variance tests were used in the evaluations of in catch per unit effort. Similar effort was expended at the three habitat types and the same seines were also used. In 1996, backwater and run sites were combined and classed as mainstem river sites as there was no significant difference (P>. 05, N=50) in catch per unit effort (#fish/m^2) for small-bodied fish between them. Catch per unit effort for trout-perch and all other fish was higher at confluence/tributary sites using a (P<0.05, N = 84) than at mainstem river sites (Table 3-2).

1995 catch per unit efforts were not evaluated because the tributary/confluence habitat sites had not been included in the study.

Table 3-2. Mainstem and confluence/tributary catch per unit efforts (CPUE) (in number of fish/m^2) for trout-perch (trph) and all fish species combined. Catch by seining in the Athabasca River near Athabasca, Alberta, 1996.

	Seine hauls N	Average distance (m)	no. trph /haul	trph CPUE	all fish total catch	all fish CPUE
Mainstem	50	131.1	30.9	0.07	120.58	0.33
Conf/tribs	34	167.1	81.3	0.23	340.47	0.83

Movement

Results from the mark-recapture experiment in 1994 yielded no evidence ofmovement. An alternate criterion of residency used was the presence of all age classes at all habitat types sampled for spawning and post spawning seasons. Trout-perch in 1995 and in 1996 were present at the three habitat types sampled for the spawning and post spawning season (Appendix 2).

Age

Ages for female trout-perch ranged from young of the year to five years. There was considerable overlap of lengths for females at age 2, 3 and 4 years (Fig. 3-4a). Mass at age was not evaluated as reproductive condition and gut fullness would skew the results.

Ages for male trout-perch ranged from young of the year to four years. There was considerable overlap of lengths at age 2 and 3 years (Fig. 3-5). Mass at age was not evaluated as reproductive condition and gut fullness would confound the results.

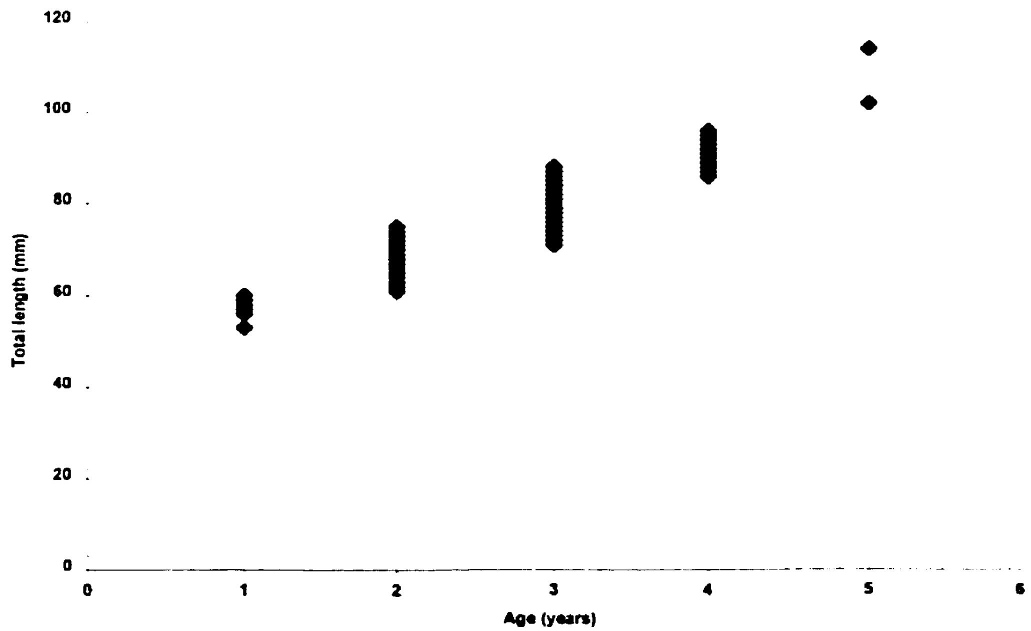

Figure 3-4a 1996 female trout-perch length at age. N=195 fish.

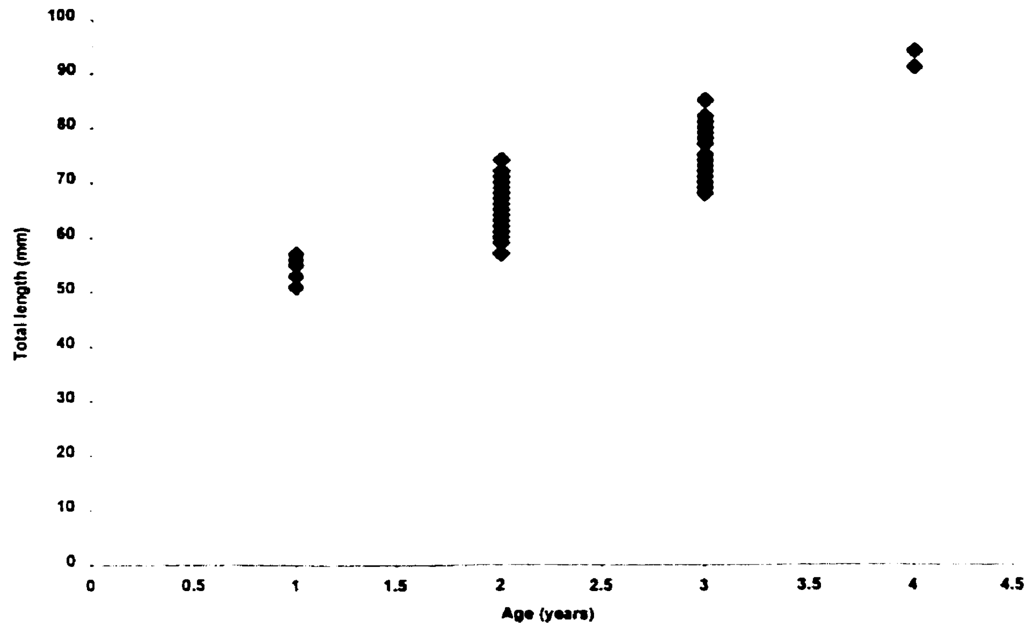

Figure 3-4b 1996 male trout-perch length at age. N = 88 fish.

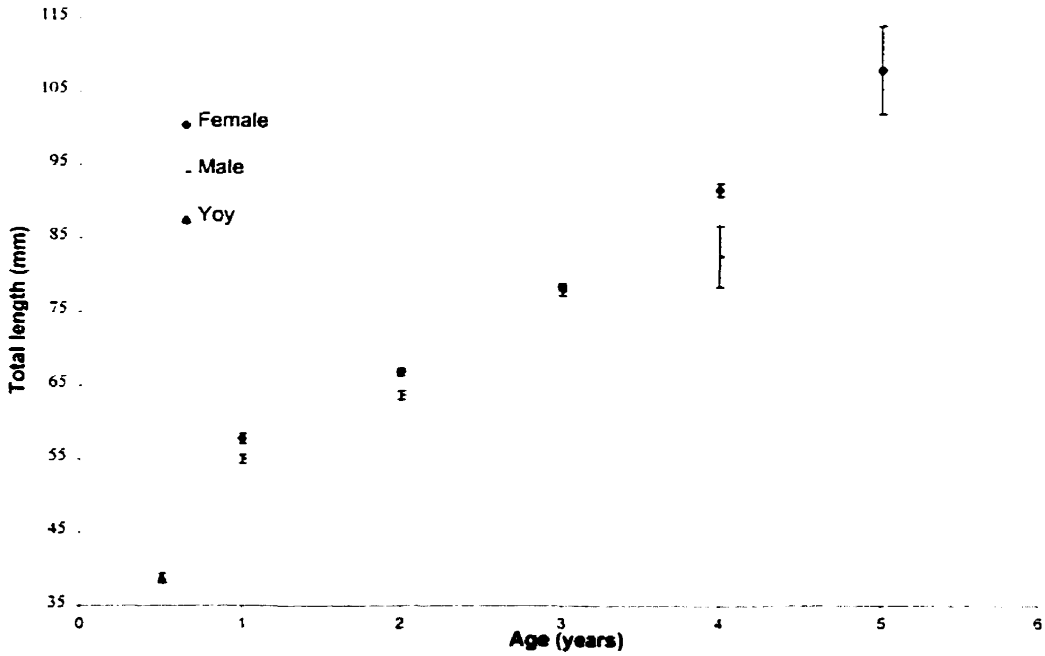

Figure 3-5 1995 and 1996 mean total lengths (mm), (with standard error) at age for trout-perch. Young of the year (yoy) (N = 232), females (N = 278) and males (N = 140) are presented for respective year classes. Standard error was plotted with the mean.

Growth Rates

Based on scale age measurements and length-frequency data from collections in 1995 and 1996, six age classes of female trout-perch were observed: young of the year (yoy), one, two, three, four and five year old cohorts. Five age classes were seen of males (yoy to four years), (Table 3-3a and 3-3b). Growth rates were larger for the young of the year to one-year-old cohort and decreased with the age of the cohort in females. (Table 3-3b). In males, growth rates were larger for the young of the year to one-year-old cohort, but did not decrease with cohort age (Table 3-3a).

Table 3-3a Specific annual growth rates of male trout-perch by year class from 1995 to 1996 collections. (I.e. G_{1-2} would be the specific annual growth rate for 1 year old trout-perch to reach the age of 2 years). All age classes were determined by scale reading and verified by length frequency. Young of the year were unsexed and were aged by length frequency.

Year class increment	Absolute Growth (mm)	Specific Growth %	N
G_{yoy-1}	17.5	34.4	246
G_{1-2}	9.8	16.3	52
G_{2-3}	14.6	21.5	56
G_{3-4}	19.4	23.5	17

Table 3-3b Specific annual growth rates of female trout-perch by year class from 1995 to 1996 collections. (I.e. G_{1-2} would be the specific annual growth rate for 1 year old trout-perch to reach the age of 2 years). All age classes were determined by scale reading and verified by length frequency. Young of the year were unsexed and were aged by length frequency.

Year class increment	Absolute Growth (mm)	Specific Growth %	N
G_{yoy-1}	18.8	39.6	250
G_{1-2}	12.8	20.9	71
G_{2-3}	13.4	18.8	125
G_{3-4}	12.9	15.3	61
G_{4-5}	9	8.7	5

Body Condition Factor

Body Condition Factor or "K" is another body measurement used for EEM and compared the spawning season (S1) and the post spawning season (S2) using Kruskal-Wallis one-way analysis of variance tests. It was found that the condition of males ($P < 0.0262$, $N = 93$) and females ($P < 0.0000$, $N = 112$) in 1995 and the females in 1996 ($P < 0.0000$, $N = 103$) was significantly greater in the spawning season as compared to the post-spawning season. Males in 1996 ($P > 0.05$, $N = 106$) did not show a significant difference in body condition between the two seasons.

Reproduction

Spawning commenced in early May prior to sampling in both 1995 and 1996. Spawning lasted until mid-July when both sexes had greatly reduced gonad mass and no observations of spawning trout-perch occurred. Spawning and near-spawning fish were collected in all sites sampled. Available substrates ranged from silt and sand to large cobble.

Age at Maturity

Females

In 1995, no female trout-perch aged were in spawning condition before age 1 (YOY), 65% at age 1, 79% at age 2 and 100% were in spawning condition at age 3. In 1996, no female trout-perch aged were in spawning condition before age 1, 84% at age 1, 96% at age 2 and 100% were in spawning condition at age 3 (Table 3-4).

Males

In 1995, no males were in spawning condition before age one, 95% of male trout-perch aged were in spawning condition at age 1 and 100% at age 2 and older. In 1996, no males were in spawning condition before age one, 88% of male trout-perch aged were in spawning condition at age 1, and 100% at age 2 and older (table 3-4).

Table 3-4 Number of mature and immature male and female trout-perch by age class for the 1995 and 1996 collections. Ages were determined by scale annulus formation and verified by length frequency.

	1995 Male		1996 Male		Male Total		1995 Female		1996 Female		Female Total	
Age Class*	M	I	M	I	M	I	M	I	M	I	M	I
YOY**	0	3	0	4	0	7	0	5	0	16	0	21
1	30	3	43	6	73	9	24	13	51	10	75	23
2	14	0	32	0	46	0	30	8	84	4	114	12
3	3	0	2	0	5	0	3	0	23	0	26	0
4	0	0	0	0	0	0	0	0	3	0	2	0

* M, I – mature and immature respectively

** YOY- young of the year 1995 and 1996 pooled data

Length at Maturity/ Sex ratio

Length at maturity and sex ratios were listed for trout-perch in 1995 (Table 3-5) and in 1996 (Table 3-6). 1995 Females began maturing at 51 - 55 mm total length and in 1996 females began maturing at 56-60 mm. In 1995 all females were mature at 81 - 85 mm an in 1996 all females were mature at 91-95 mm. Male trout-perch began maturing at 46 - 50 mm in 1995 and in 1996 no samples were taken smaller than 51 mm but 75% of males were mature at 51-55 mm. All males were mature at 66 - 70 mm in 1995 and 96% of males in 1996 were mature at 66-70mm. The sex ratio for the 1995 fish collection was 42% male and 58% female and in the 1996 collection was 33% male and 67% female.

Gonadosomatic Indices

The GSI results in 1995 were variable for both male and female trout-perch and no significant changes in GSI were observed over monthly intervals (Fig 3-6). In 1996, there was a significant decrease ($P< 0.005$, $N=55$) as GSI was approximately 10% for males and 15% for females, until mid July after which the GSI was approximately 1% and 3% respectively (Fig 3-7). Both 1995 and 1996 GSI results were evaluated using Kruskal-Wallis one-way analysis of variance tests. From the 1996 collections individual trout-perch with gonads in full spawning condition were found in early May.

Table 3-5 Length at maturity and sex ratios for 318 trout-perch captured during 1995 collections. No sample collected is referred as "ns".

Total Length (mm)	N	Sex Ratio	Males		Females	
		%Female	%Immature	%Mature	%Immature	%Mature
31-35	2	50	100	0	100	0
36-40	4	75	100	0	100	0
41-45	5	80	100	0	100	0
46-50	11	55	60	40	100	0
51-55	25	36	31	69	89	11
56-60	74	27	8	92	60	40
61-65	53	53	4	96	61	39
66-70	50	82	0	100	27	73
71-75	43	77	0	100	24	76
76-80	24	58	0	100	14	86
81-85	18	94	0	100	0	100
86-90	6	100	ns	ns	0	100
91-95	2	100	0	100	0	100
96-100	0	ns	ns	ns	ns	ns
101-105	0	ns	ns	ns	ns	ns
106-110	1	100	ns	ns	0	100
Totals	318	58				

Table 3-6 Length at maturity and sex ratios for 389 trout-perch captured during 1996 collections. No sample collected is referred as "ns".

Total Length (mm)	N	Sex Ratio	Males		Females	
		%Female	%Immature	%Mature	%Immature	%Mature
31-35	0	ns	ns	ns	ns	ns
36-40	0	ns	ns	ns	ns	ns
41-45	0	ns	ns	ns	ns	ns
46-50	0	ns	ns	ns	ns	ns
51-55	14	14	25	75	100	0
56-60	49	49	32	68	96	4
61-65	52	63	32	68	73	27
66-70	69	62	4	96	81	19
71-75	88	72	4	96	35	65
76-80	47	72	0	100	21	79
81-85	36	78	0	100	11	89
86-90	17	94	0	100	6	94
91-95	12	100	ns	ns	0	100
96-100	3	100	ns	ns	0	100
101-105	1	100	ns	ns	0	100
106-110	0	ns	ns	ns	ns	ns
111-115	1	100	ns	ns	0	100
Totals	389	67				

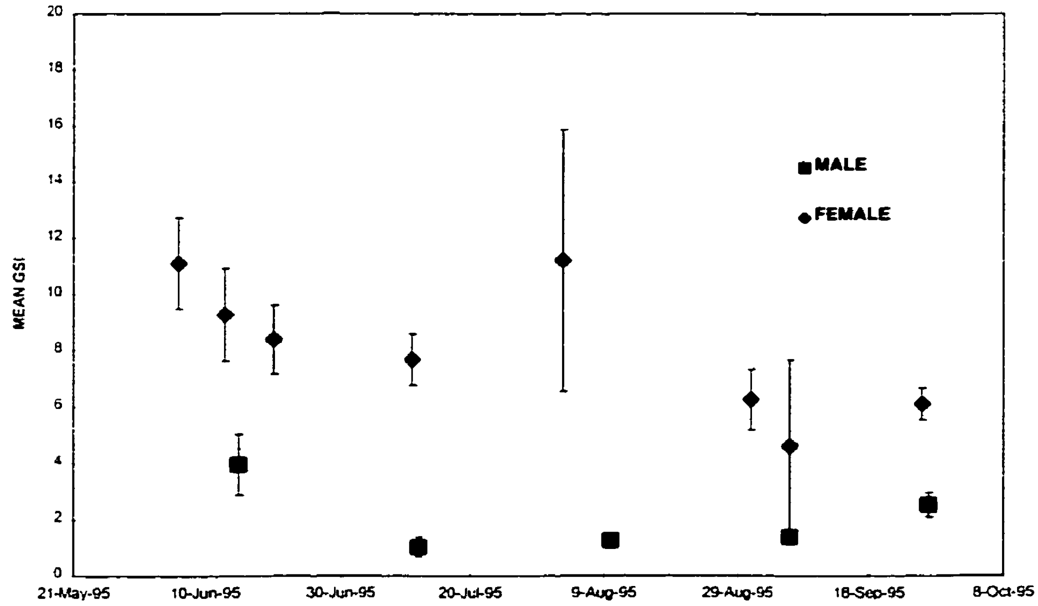

Figure 3-6. Trout-perch mean (with standard error) Gonadal Somatic Index (GSI) for mature males (N = 25) and mature females (N = 85) collected from the study reach of the Athabasca River in 1995.

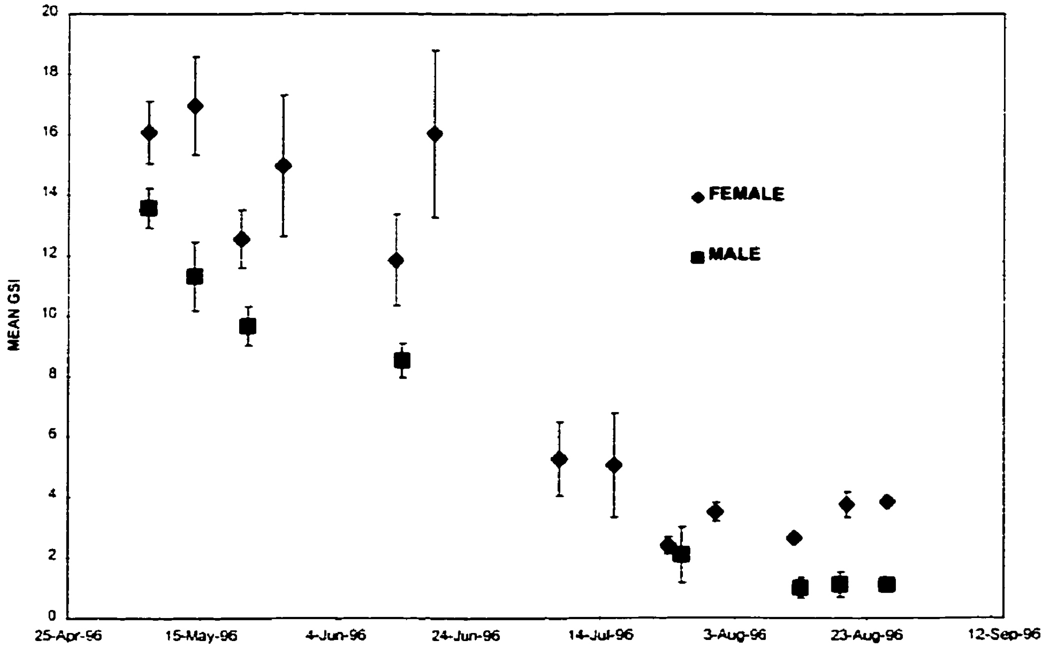

Figure 3-7. Trout-perch mean (with standard error) Gonadosomatic Index for males and females from the 1996 survey (N=92 male and 195 female fish).

Spawning Observations

The largest number of observations of trout-perch in spawning condition was from late May until mid July for both years (Fig 3-8). No observations of trout-perch in spawning condition were noted after August 13.

Fecundity

Fecundities were compared by age class over the spawning season, early May to July 16, 1996. There was a direct correlation ($r^2 = 0.46$) between increase in fecundity with increase in age from the one to five year class (Fig 3-9). After the spawning season fecundities remained higher ($r^2 = 0.25$) for the older age classes of trout-perch (Fig 3-10) as older fish tended to retain more immature eggs.

Egg Diameters

Egg diameters were compared for individual trout-perch collected in 1996 (Appendix 2). Bimodal distributions of egg diameters were observed, where eggs in the larger diameter distributions were yellow in colour and eggs in the smaller distributions were white. Large and small egg diameter distributions were separate with the small diameter eggs being white in colour and the larger diameter eggs being yellow during the spawning season (fig. 3-11a to 3-11d).

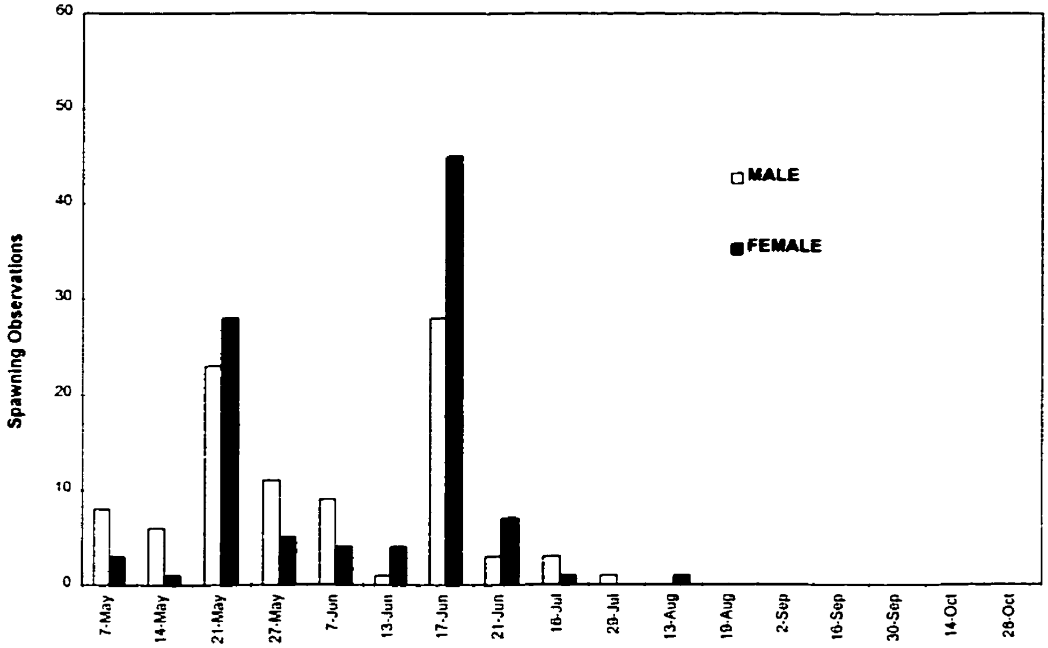

Figure 3-8. Frequency of male (N=93) and female trout - perch (N=99) in spawning condition from 1995 and 1996 pooled observations.

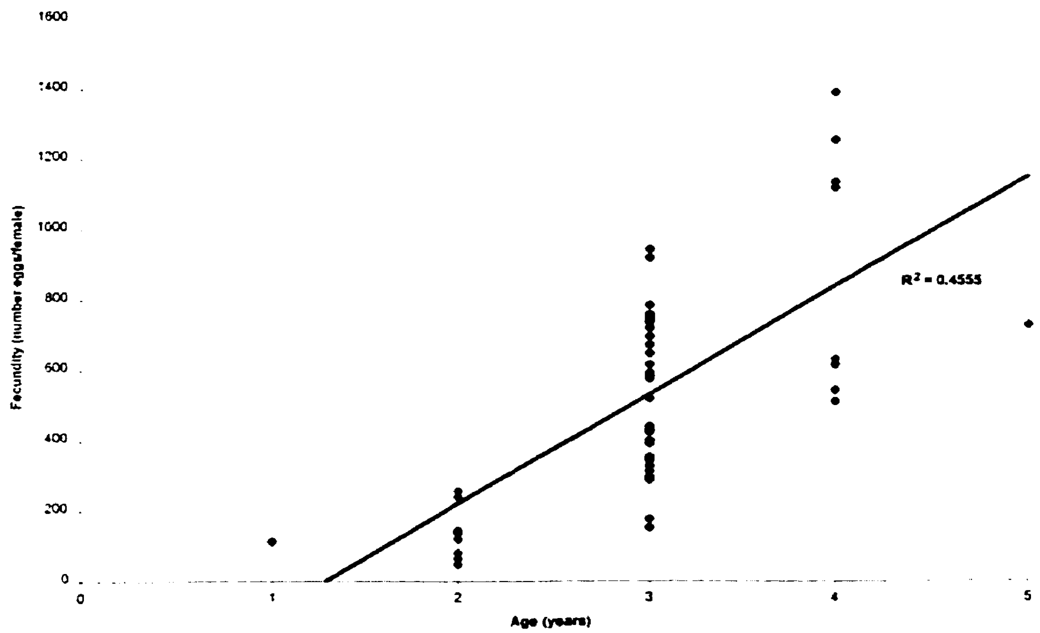

Figure 3-9 Fecundity of Trout-perch collected in 1996 by age class for the spawning season (from April 28 to July 16th). N = 173 fish. Fecundity was determined by total egg count of one ovary to obtain a mean egg weight then dividing the mean egg weight into the total ovary weight.

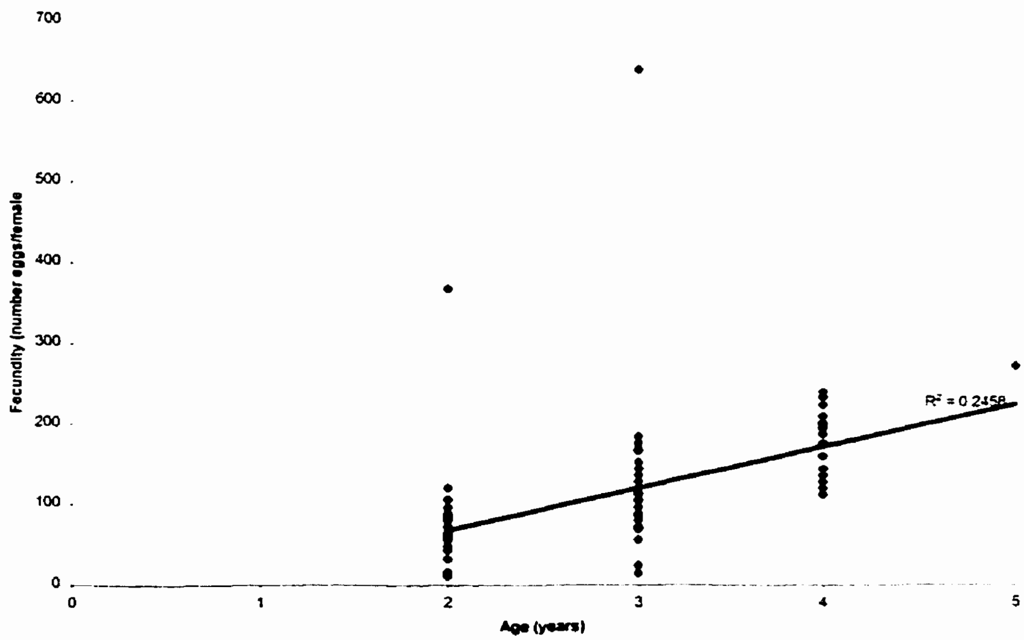

Figure 3-10 Fecundity of trout-perch collected in 1996 by age class for the post spawning season (from July 18th to August 31). N = 113 fish. Fecundity was determined by total egg count of one ovary to obtain a mean egg weight then dividing the mean egg weight into the total ovary weight.

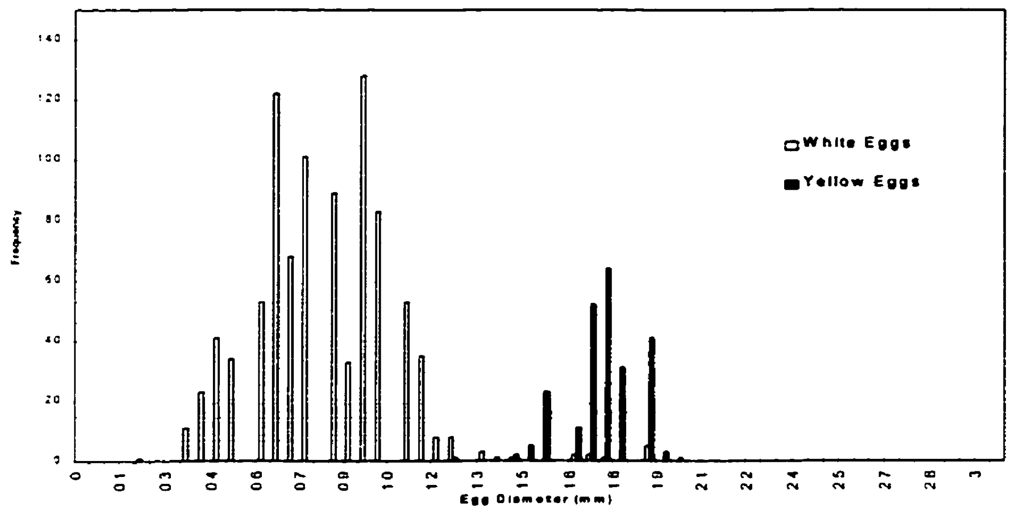

Figure 3-11a. Frequency distribution of n = 571 trout-perch egg diameters taken from a single ovary during spawning. May 14, 1996.

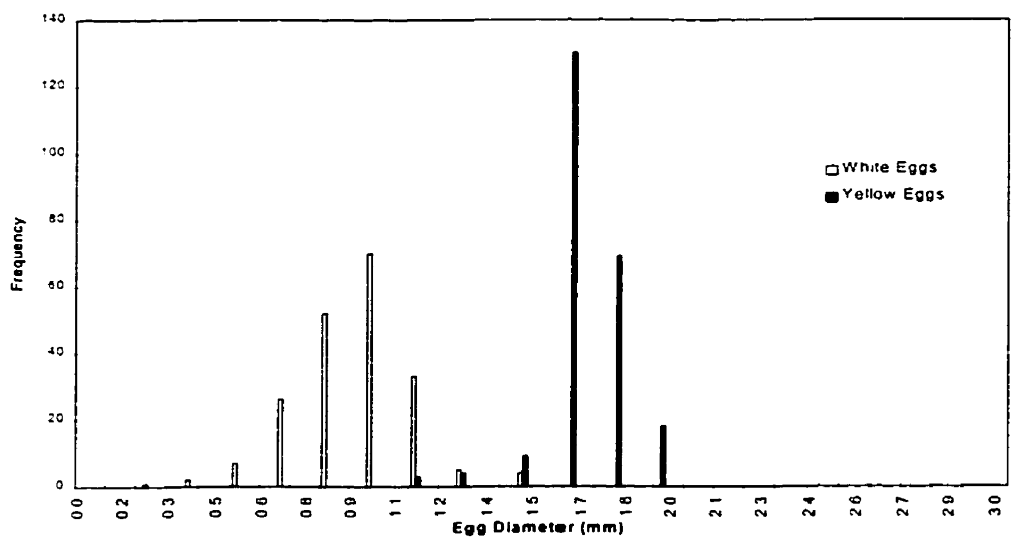

Figure 3-11b Frequency distribution of n = 433 trout-perch egg diameters taken from a single ovary during spawning. June 14, 1996.

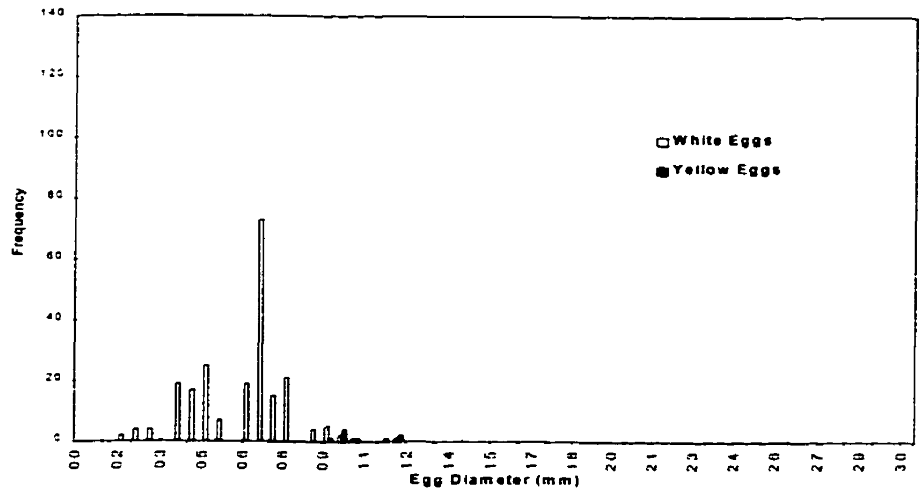

Figure 3-11c. Frequency distribution of n = 228 trout-perch egg diameters taken from a single ovary after spawning. July 25, 1996.

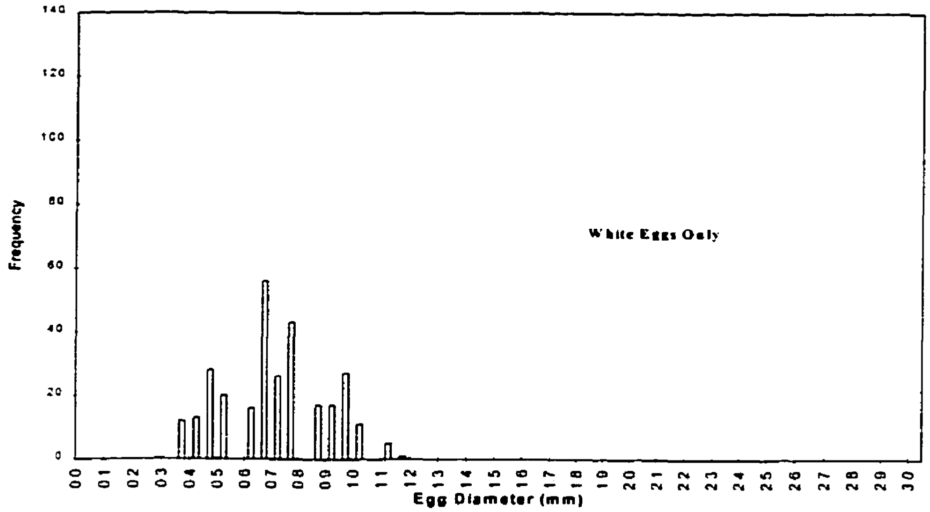

Figure 3-11d. Frequency distribution of n = 293 trout-perch egg diameters taken from a single ovary after spawning. August 21, 1996.

Environmental Effects Monitoring

Environmental Effects Monitoring (EEM) requires that six adult fish parameters be measured to determine the sample size needed to detect differences at a reference site from a site exposed to effluents. These parameters are: length at age, mass at age, age, liver somatic indices (LSI), gonadal somatic indices (GSI) and condition factor (K). The original data are found in Appendix 4.

These parameters were calculated for adult trout-perch in 1995 (Table 3-7) and 1996 (Table 3-8). Based on power analysis calculations, it could take as little as a sample size of 3 males and 4 females/site to detect a 20% difference between sites (with the length at age parameter at a power of 90), or it could be as high as 160 males and 162 females/site to detect a 20% difference between sample sites with the GSI parameter at a power of 90% (Table 3-9).

The larger the variability the larger the estimated sample size will be for a given body metric. In the trout-perch for both years GSI had the most variance during the spawning season, then LSI, then age and mass at age, K was next and length at age had the least variance.

Table 3-7 Number of trout-perch needed to detect significant differences in fish parameters between two populations in the study area, 1995. Samples sizes were calculated for a range of effect sizes (δ) with power = 0.80 and power = 0.90, and a = 0.05.

Parameter	Sex	N	Estimated Sample Size (# of fish/area)					
			δ=20		δ=25		δ=30	
			P=0.80	P=0.90	P=0.80	P=0.90	P=0.80	P=0.90
Length-at-age	M	47	3	4	3	3	2	3
	F	56	6	7	4	5	4	4
Weight-at-age	M	47	26	34	18	23	13	17
	F	56	36	47	24	32	18	24
Age	M	47	56	91	46	62	34	45
	F	58	27	44	23	30	17	22
LSI	M	25	26	42	22	29	16	21
	F	34	56	91	46	61	34	45
GSI	M	27	259	426	213	285	155	207
	F	55	65	106	53	71	39	52
Condition (K)	M	93	7	10	6	7	4	6
	F	112	5	8	5	6	4	5

Table 3-8 Number of trout-perch needed to detect significant differences in fish parameters between two populations in the study area, 1996. Samples sizes were calculated for a range of effect sizes (δ) with power = 0.80 and power = 0.90, and a = 0.05.

			Estimated Sample Size (# of fish/area)					
			δ=20		δ=25		δ=30	
Parameter	Sex	N	P=0.80	P=0.90	P=0.80	P=0.90	P=0.80	P=0.90
Length-at-age	M	31	3	3	2	3	2	2
	F	54	3	4	3	3	2	3
Weight-at-age	M	31	12	16	9	11	7	8
	F	54	18	47	12	32	9	24
Age	M	31	62	83	42	56	31	41
	F	112	35	47	24	32	18	23
LSI	M	31	36	47	24	32	18	24
	F	99	67	89	45	60	33	44
GSI	M	31	120	160	81	107	59	78
	F	69	122	162	82	109	60	79
Condition (K)	M	31	5	6	4	4	3	4
	F	103	5	7	4	5	3	4

Diet

Stomach contents were examined from 92 trout-perch collected in 1996 from May to September in the three habitat types in the study area. Trout-perch from the study area had fed predominantly on immature forms of Ephemeroptera, Diptera, Plecoptera and Trichoptera (Fig 3-12). Results of these examinations were evaluated using Kruskal-Wallis one-way analysis of variance tests.

Trichoptera (P =0.038, N=27) and Chironomidae (P= 0.03, N= 78) were the most selected for tributary/confluence habitats, while in run habitats Diptera (Chironomidae) were the most abundant by volume in the diet. (Fig 3-13).

Seasonal differences in prey selection also occurred. In the spawning season (May to mid July 1996), Chironomidae (p=. 0067, N=78), and Emphemeropterans (p=. 0057, N=64), were preferred (Fig 3-14). Trout-perch selected various prey types at different times of the year.

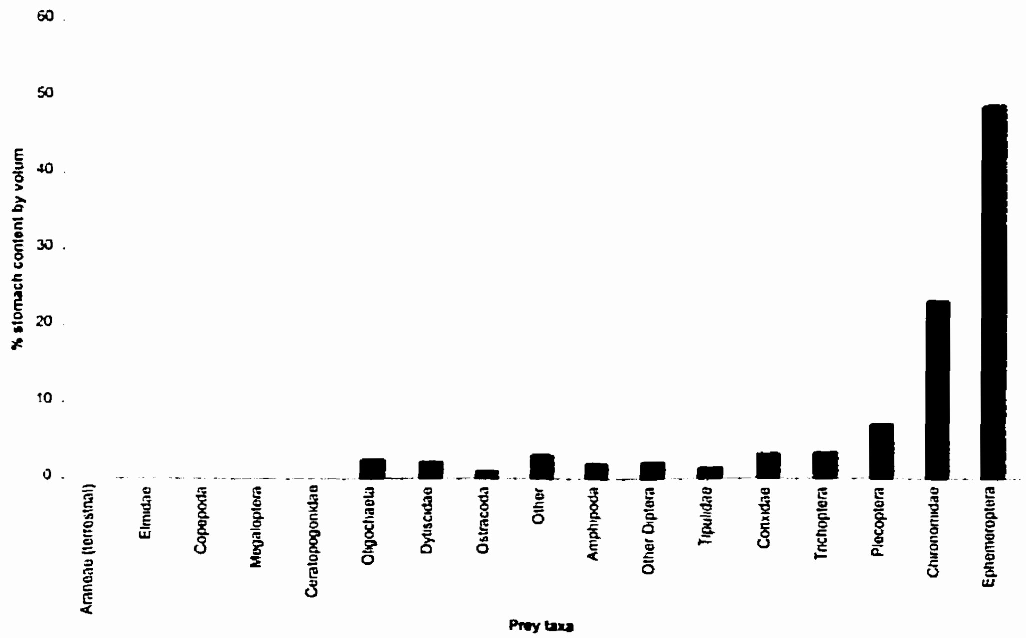

Figure 3-12 Relative importance of prey taxa by volume for trout-perch in all habitats. Stomach contents of trout-perch captured in May to Late August, 1996 from tributary/confluence, backwater and run habitats. Insect taxa is plotted by percentage stomach content by volume. N = 92 stomachs.

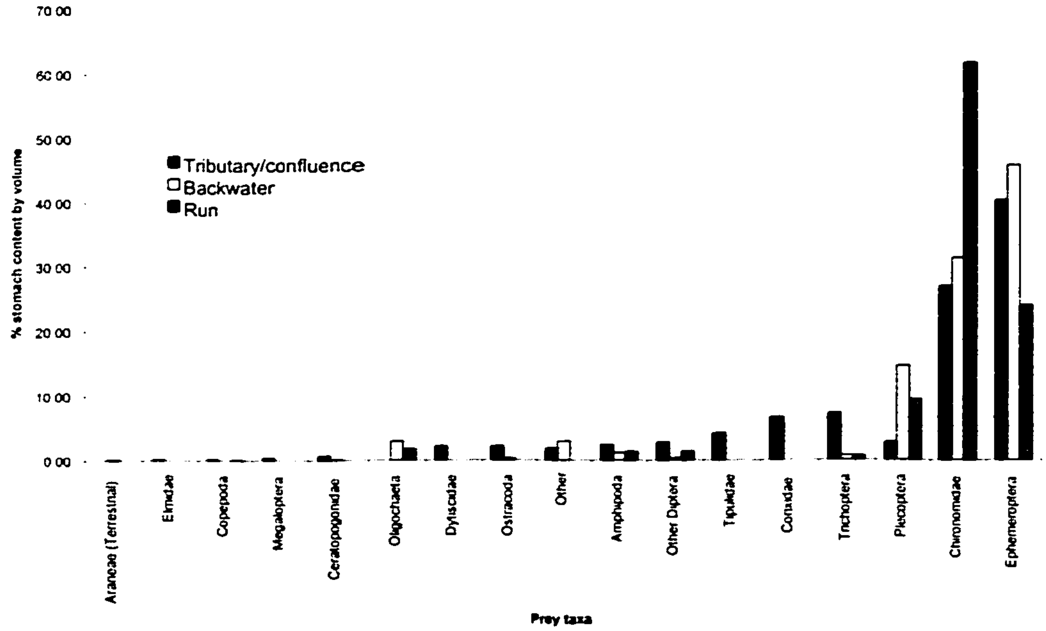

Figure 3-13 Relative importance of prey taxa by volume for trout-perch between habitats. Stomach contents of trout-perch captured in May to Late August, 1996 from tributary/confluence, backwater and run habitats. Insect taxa is plotted by percentage stomach content by volume. N = 92 stomachs.

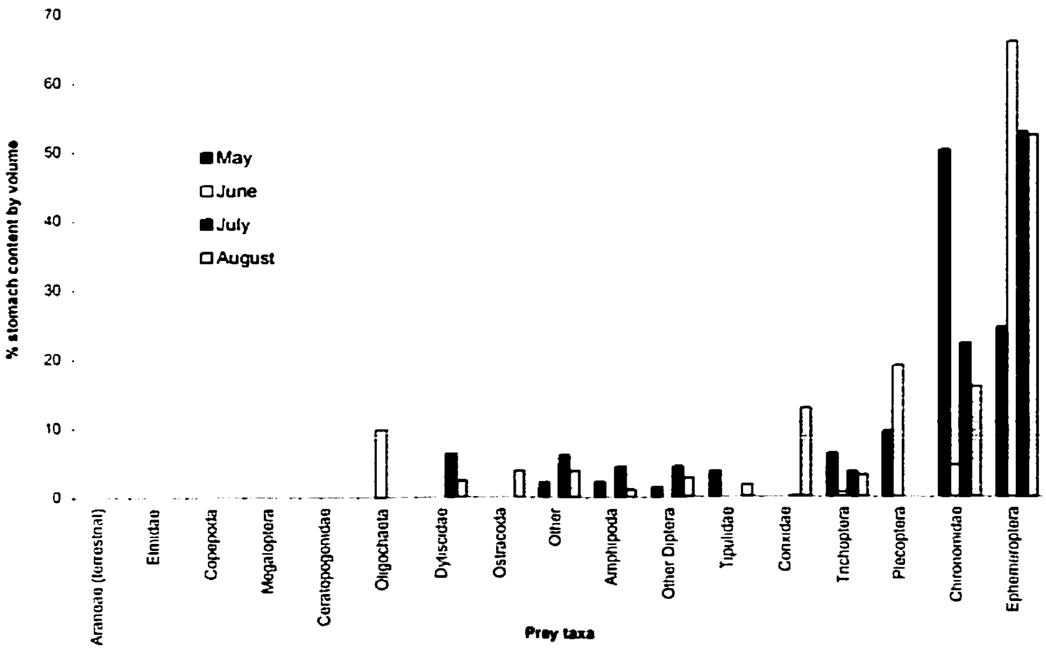

Figure 3-14 Relative importance of prey taxa by volume for trout-perch between months of collection. Stomach contents of trout-perch captured for May to late August, 1996 from tributary/confluence, backwater and run habitats. Insect taxa is plotted by percentage stomach content by volume. N = 92 stomachs.

Discussion

Spawning

In the study area trout-perch have an extended spawning period from early May to mid July of about 70 days. In 1996, a marked decline was observed in GSI over the summer from relatively high levels in May to low levels in mid July respectively. This decline took place over a two-week period commencing June 24. Observations of trout-perch in or near spawning condition were also recorded for both sexes in the 1995 and 1996 collections. Again, the observance of fish in or near spawning condition was from the beginning of the collections in early May to mid July of both years. It is believed that these fish would have been spawning previous to this time but were unavailable to sampling due to ice being in the river until early May. Based on 1996 GSI and observations for 1995 and 1996, spawning was concluded in mid-July.

1995 GSI results for males were variable and could not indicate a distinct end to the spawning season. The female GSI results indicated an end to the spawning season completed in August similar to what occurred in 1996. Some of the reasons why these male data were variable could have been due to smaller sample size than in the 1996 collection and that the majority of the fish were collected outside of the spawning season.

Rowes (1994) found trout-perch had an extended spawning period of 72 days (May to mid July) in Dauphin Lake, Manitoba. Other authors have found a shorter spawning season of approximately 45 days (May to mid-June) for trout-perch at various locations within Alberta (McCart et al. 1978; Machniak and Bond, 1979; Bond and Berry, 1980 and Machniak et al. 1980). In eastern Canada, Muth (1975) found that spawning was noted to take place from mid-April to the end of May (approximately 45 days).

Spawning Strategy

Multiple or batch spawning is a common strategy for most fishes, where ovaries contain asynchronously developing oocytes are released in several batches over the same spawning season (Mance, 1987).

Batch or multiple spawners typically have extended spawning seasons (Heins and Rabito, 1986), similar in duration to the elevated GSI period seen for trout-perch. All observations of spawning were during this same period. Egg diameters of trout-perch exhibited bimodal distributions as is typical for multiple spawning fishes such as the genus *Notropis* (Heins and Rabito, 1986) and other cyprinids (Bagenal and Braum, 1978), or the logperch, *Percina caprodes* (Rafinesque), and johnny darter, *Etheostoma nigrum* Rafinesque, (Rowes, 1994). The larger egg diameter distribution was present from May 8 until mid-July and it is believed these eggs are shed not in during one spawning event but over the whole spawning period. The use of trout-perch as sentinel monitoring species is possible but will be difficult to infer effects on gonad size and development during the spawning period.

Length at Maturity

Maturity was achieved at shorter lengths in males than female trout-perch in 1995 and the 1996 collections. Others (Bond and Berry (1990), Machniak et al. (1980), House and Wells (1973) and Magnuson and Smith (1963), reported similar findings.

Sex Ratio

The sex ratio for the 1995 collections was 58% female. This finding was based on 318 fish examinations from May to late October in 1995 (Table 3-5). The sex ratio for the 1996 collections was 67% female, based on 389 examinations of fish collected from May to September in 1996 (Table 3-6). Machniak et al, (1980), found a 54% female sex ratio in the MacKay River in 1978. Machniak and Bond (1979) found sex ratios during spawning were skewed towards males and outside of the spawning season females dominated the catch as in this collection. A possible explanation of the differing sex ratios can be attributed to the duration of sampling in this study and the large sample size compared to the other authors.

Age at Maturity

Male trout-perch matured earlier than females. Ninety percent of age 2 and 100% of age 3 females and, 89% of males aged 1 and 100% of age 2 were sexually mature from the 1995 and 1996 collections of trout-perch (Table 3-5). Bond and Berry (1990) also found that male trout-perch matured earlier than females in the Athabasca River. Other authors have reported that male trout-perch matures earlier than females in various drainages (Machniak et al, 1980; Magnuson and Smith, 1963; and House and Wells, 1973). This was also seen in Alberta by Mance (1987) in yellow perch, *Perca flavescens* Mitchill), where he observed trade-offs between egg number and size and egg number and lifespan. These adaptations were due to the latitudinal and local habitat characteristics of the fish.

Body Condition Factor

Body condition factor (K) of female and male trout-perch tended to be larger in the spawning season for females in 1995 and 1996 and males in 1995. This is a normal occurrence, as fish in spawning condition tend to be larger with ripe gonads, which will inflate the result for K. In the 1996 collection, males did not show a significant difference between the spawning season and the post-spawning season. Male GSI did not fluctuate as much as female GSI in 1996, which may explain the similarity between seasons.

Abundance

Based on fish collections from 1991 to 1994 (N =9352), trout-perch were the most abundant fish in the study area (58%). During the study in 1995 and 1996 (N = 47,151) trout-perch were the second most abundant fish in the study area (18%). Considerably more effort was used and the seine was modified in 1995 and 1996, which resulted in a more confident estimation with the increased sample size.

Movement

Results from the mark-recapture experiment in 1994 yielded no evidence on movement as it was not an appropriate test for small-bodied fish mobility. An alternate criterion of residency was the presence of all age classes at all habitat types sampled. Trout-perch in 1995 and in 1996 were present at the three habitat types sampled during May to October 1995 and May to September 1996. To be present at all habitats during all sampling events suggests trout-perch are not highly mobile and meet the criteria as a resident fish species for EEM.

Habitat preference

The majority of trout-perch were caught in confluence/tributary habitats. Machniak and Bond (1979) found similar preference for confluence habitat in the Steepbank River. In 1996 confluence/tributary habitats were significantly preferred from backwater and run habitat types that were not significantly different from each other. But in 1995 there was no preference for habitat type. The difference between 1995 and 1996 may have been due to the addition of confluence/tributary sites LR and CR in 1996.

Diet

A variety of aquatic and some terrestrial insects were found in the stomach contents. Diptera (Chironomidae) and Ephemeropterans were the most abundant prey in the stomach samples. The abundance of prey in the diet varied with habitat and season. Trichopterans and Chironomidae were preferred in the tributary/confluence habitat only. During the spawning season from May to mid-July, Chironomidae and Ephemeropterans were preferred. These prey preferences were also the same for trout-perch studied in other similar watersheds such as the Mackay River (Machniak et al, 1980), Steepbank River (Machniak and Bond, 1979) and the Mildred Lake and Athabasca River Delta area (Bond, 1980).

Trout-perch appear to be opportunistic feeders. The selection of prey by trout-perch was possibly more affected by the abundance of prey than by preference for a particular prey item. Kinney (1950) studied trout-perch in Lake Erie and noted that the extent to which trout-perch would feed on any particular bottom organism varied with the availability of that organism.

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Chapter 4

Biology of the lake chub in the Athabasca River, Alberta

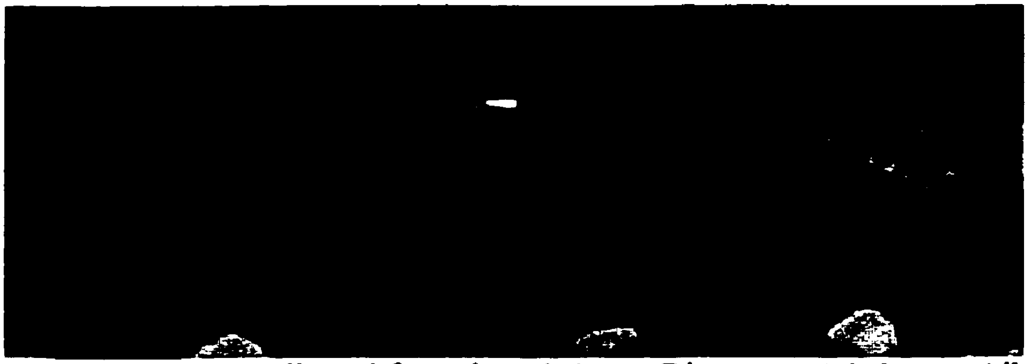

Plate 4-1 Lake chub collected from the Athabasca River near Athabasca, Alberta, 1996.

Introduction

Lake chub have been suggested as a possible sentinel species for Athabasca River pulp mills. In Alberta, Gibbons (1996), studied lake chub at Hinton and Whitecourt on the Athabasca River. He recommended lake chub as a good candidate for use as sentinel monitor. However, there is little known about its life history, natural variability, and mobility.

Lake chub are distributed throughout North America from British Columbia to Nova Scotia northward in the Yukon and Mackenzie river system and southward to Colorado. They are common in all major river systems in Alberta (Nelson and Paetz, 1992).

Spawning is dependant on latitudinal controlled processes such as temperature degree days and photoperiod; Lake Ontario populations spawn in late April while in the Northwest Territories spawning occurs in July or August (Scott and Crossman, 1973). Spawning migrations have been documented in Eastern Quebec, where lake chub move from main rivers to tributary streams to spawn in June (Montgomery et al, 1983). Post spawning mortality has also been observed in a southwestern Quebec stream (Scott and Crossman, 1973).

McPhail and Lindsey (1970), found terrestrial insects and zooplankton as part of the diet of lake chub in British Columbia. In Alberta, immature insects of the orders Diptera, Ephemeroptera, and Trichoptera, with some Crustacea, Arachnida and Nematoda, were included in the diet (Machniak et al, 1980).

In Alberta, lake chub are found in lakes, rivers and small creeks and are often abundant. Spawning occurs from June to mid-August. Maturity is thought to be at age three or four. Few live more than five years (Nelson and Paetz, 1992).

Life history information required to meet the sentinel species requirements of the EEM program includes: gonad mass, liver mass, length, mass and age. These parameters are used to calculate an appropriate sample size based on an effect size using the range of natural variability in the fish being studied (ECDFO, 1995).

In this chapter reproduction, age and growth, body condition, diet, and habitat preference of lake chub are discussed.

Methods

Lake chub were assessed for EEM biological aspects as well as other related life history parameters. The EEM parameters described in this section are Gonadal Somatic Index (GSI), Body Condition Factor (K) and Liver Somatic Index (LSI). The other parameters were abundance, habitat preference, age, growth, reproduction, fecundity, sexual maturity, and diet.

Residency

The observance of age classes at the three habitat types during the complete sampling period for both years was used as a determinant of residency (Appendix 6). Fish would be deemed resident if all age classes were present during the sampling events in 1995 and 1996.

Environmental Effects Monitoring

Environmental Effects Monitoring (EEM) requires that six adult fish parameters be measured to determine the sample size needed to detect differences at a reference site from a site exposed to effluents (ECDFO, 1995). These parameters are: length at age, mass at age, age, liver somatic indices (LSI), gonadal somatic indices (GSI) and condition factor (K). The original data is found in Appendix 7. When using length frequency to assign age no true ages were assigned to individual fish, which is necessary for length at age, weight at age and age assessment in EEM. As a result, only LSI, GSI and K were reported for lake chub.

Aging

In this study age was determined by length frequency analysis as in Mackay et al (1990). Age data were not generated due to difficulties in reading the ageing structures. Opercle bones, fin rays and scales did not yield annuli with any confidence. Other authors successfully used otoliths (Machniak and Bond, 1979, and Bond, 1980), but given field conditions and time constraints they were not used in this study.

Size classes for lake chub were determined from length frequency analysis as suggested from Mackay et al. (1990). The modal distribution of size classes was used to correspond to a particular age class.

Condition factor

Condition factor (K) is a reflection of the health of individual fish (Bagenal and Tesch, 1978). K is a measure of "fatness" or the mass at a given length. It was calculated as:

$$K = \text{mass} /(\text{length})^3 X\ 10^5$$

Where mass was total body mass (in grams) and length was total length of the fish (in millimeters) and 10^5 was a scaling factor.

Growth Rates

Specific and absolute annual growth rates were calculated similar to Busacker *et al* (1990) by calculating the change in length of a cohort of fish per unit time, usually a year. Specific growth rate defines growth as percentage increase and was calculated as:

$$G = (\log_e Y_2 - \log_e Y_1)/(t_2\text{-}t_1)\ X\ 100.$$

Absolute growth rate defines growth by the incremental value in mm/year. This is derived from:

$$\text{Absolute growth rate} = (Y_2 - Y_1)/(t_2\text{-}t_1).$$

Where t_2-t_1 is the change in time and $Y_2 - Y_1$ is the change in total length (in mm) of the cohort during that time.

Absolute growth rates were calculated by calculating the change in length of a size class of fish per unit time, usually a year as in Busacker et al., (1990).

Sexual Maturity

Immature females were identified by their small thread like ovary, found below the air bladder, which was translucent and had no visible oocytes. The immature or non-spawning male gonad appears very similar to the ovary in an immature female. Immature males could only be identified as such after viewing males that had begun to have the gonad whiten (whitening was observed in several specimens beginning at the anterior end). In the female, ripe eggs were larger and yellow in color than the maturing, small, white eggs seen in non-spawning lake chub. Female fish were given five categories and male fish had four (tables 4-1a and 4-1b). In 1996, spawning coloration was checked (primarily red-orange) at the base of the pectoral fins for both sexes at time of sacrifice.

Table 4-1a. Female lake chub sexual maturity level rating based on reproductive condition

Maturity level	Reproductive condition
1	Immature (clear ovary)
2	Maturing (evidence of eggs-won't spawn this year)
3	Mature (will spawn this year)
4	Expressing eggs (spawning)
5	Spent (spawning completed)

Table 4-1b. Male lake chub sexual maturity level rating based on reproductive condition

Maturity level	Reproductive condition
1	Immature (small clear gonad)
2	Maturing (gonad larger and whitish in colour-will spawn this year)
3	Expressing (spawning)
4	Spent (spawning completed)

Gonadosomatic Indices

Gonadosomatic Indices or GSI can be used to indicate the reproductive state of fish. GSI was calculated for adult lake chub as in Crim and Glebe, (1990), in 1995 and 1996:

$$GSI = \text{gonad mass/total body mass} \times 100\%$$

Mass was measured in grams. GSI was calculated for adult lake chub in 1995 and 1996. E.E.M. also requires GSI in its determination of appropriate sample size based on natural variability.

Eggs

Ovaries were selected from 38 adult lake chub collected in 1995 and 1996. All eggs were viewed after preservation in 5 % ethanol to minimize any size differences due to differing fixative fluids. Preservation tended to create a minimal amount of shrinkage in the egg diameter (< 5%), when placed in the 5% alcohol solution the difference was minimized even further (<3%). Total egg counts and diameters from both ovaries in lake chub were conducted (Appendix 7). Individual egg diameters were measured using an optical micrometer with a dissecting microscope at 16X. Diameters were converted to millimeters from micrometer units.

For those fish not lethally sampled, observations of spawning condition (expressing milt, distended abdomen and/or releasing eggs) were recorded at the time of examination.

Fecundity

Absolute fecundity in fish such as lake chub is defined as the number of maturing eggs present in the ovary just before spawning (Bagenal and Tesch, 1978). As these fish appear to be batch or repeat spawners, fecundity will include all maturing oocytes which will develop further before being released later in the same spawning season (Mann and Mills, 1979). Fecundity of individual adult female lake chub was determined from total egg counts and as in Crim and Glebe, (1990) where a weight of 30 eggs taken from the ovary was used to derive a mean egg weight which was then used to determine the total number of eggs in both ovaries.

Liver somatic index (LSI)

Liver somatic index (LSI) is another index used by E.E.M. and can be associated with nutritional state and growth rate of the fish (Busacker *et* al, 1990). LSI was calculated as:

$$LSI = (\text{liver mass} / \text{body mass}) \times 100.$$

Where body mass was total body mass. All mass was measured in grams.

Diet

Diet analysis was required to ensure that lake chub were indeed benthivores or had a diet that included benthic organisms as part of the total diet. Benthic exposure is one criteria for the sentinel species selection in EEM (ECDFO, 1993), and is also useful for the understanding of the biology of the species. Fifty-five lake chub stomachs were examined for their contents and recorded as a percentage of prey by volume (Appendix 9). All prey were identified to lowest possible category. Samples from both sexes from May to September were selected to represent the possible seasonal prey preferences, if any. Stomach contents were based on material collected in 1995 and 1996. Samples were collected from both sexes from May to September 1995 and 1996 and were selected to evaluate seasonal and habitat prey preferences, by a Kruskal-Wallace one-way analysis of variance.

All taxa were identified using the keys from the references of Usinger (1956), Brooks and Kelton (1967), Edmunds *et al.* (1976), Baumann *et al.* (1977), Wiggins (1977), Pennak (1978), McAlpine *et al.* (1981), Bode (1983), Oliver and Roussel (1983), Wiederholm (1983, 1986), Merritt and Cummins (1984), Stewart and Stark (1988) and Clifford (1991).

Data Analysis

Systat 7.0 was used to analyze fish and habitat data. Lilieforte tests were used to test for normality. Most univariate normal distribution-based statistical methods are very robust under moderate violations of the assumptions, with the exceptions of very small (< 11 d.f. for error) and unequal sample sizes and/or one tailed tests (E.C.D.F.O., 1995). If data were visibly not normally distributed, Kolmogorov-Smirnov non-parametric tests were used.

Kruskal-Wallis one-way analysis of variance tests were used in the evaluations of habitat use, catch per unit effort, and diet. Analysis of variance tests were used in the evaluations of body condition factor and gonadosomatic index. For the EEM estimation of variability (in liver somatic index, gonadosomatic index, and body condition), analysis of covariance was used as in ECDFO, (1995).

Results

Abundance

Based on fish collections from 1991 to 1993 (Shelast *et al*, 1994), (N= 694, 9%) and 1994 (N=248, 16%) lake chub was the second most abundant fish in the study area (Fig 4-1). Lake chub was the most abundant fish in the study area during this study in 1995 (N= 13,259, 48 %) and 1996 (N= 7,616, 39 %), (Fig 4-2).

The three major habitat types sampled were run, backwater and tributary/confluence. Catch per unit efforts were significantly higher for lake chub captures at tributary/confluence sites over the other two habitat types in 1995 (P>.05, N=10,668), and 1996 (P>.05, N=6235),(Fig 4-3).

Movement

Movement of lake chub was evaluated by comparing the presence of year classes at each habitat type over the sampling periods in 1995 and 1996. Sampling in 1995 indicated a large use of tributary/confluence habitats by young of the year in 1995. The other habitat types, run and backwater had similar use by all age classes collected but in far smaller numbers. In 1996, tributary/confluence habitats were again the most utilized by all size classes of lake chub and there was limited usage of the other two habitat types during the sampling period from May to September (Appendix 6).

Catch per unit effort

Fish collections compared confluence sites with mainstem river sites. Backwater and run sites were combined and classed as mainstem river sites as they were not different (p>. 05) from each other. Catch per unit effort (CPUE), for lake chub was higher at confluence sites in 1996 (p> .002, N=84) than at mainstem river sites (Table 4-2); in 1995 CPUE did not differ significantly (p> .05) among habitats.

Age

Based on the length-frequency from fish collections in 1995 (Fig 4-4a) and 1996 (Fig 4-4b) four major age classes were observed in lake chub: young of the year, one, two and three year old cohorts. The third year class was less apparent than the rest as numbers of fish declined after the second year class.

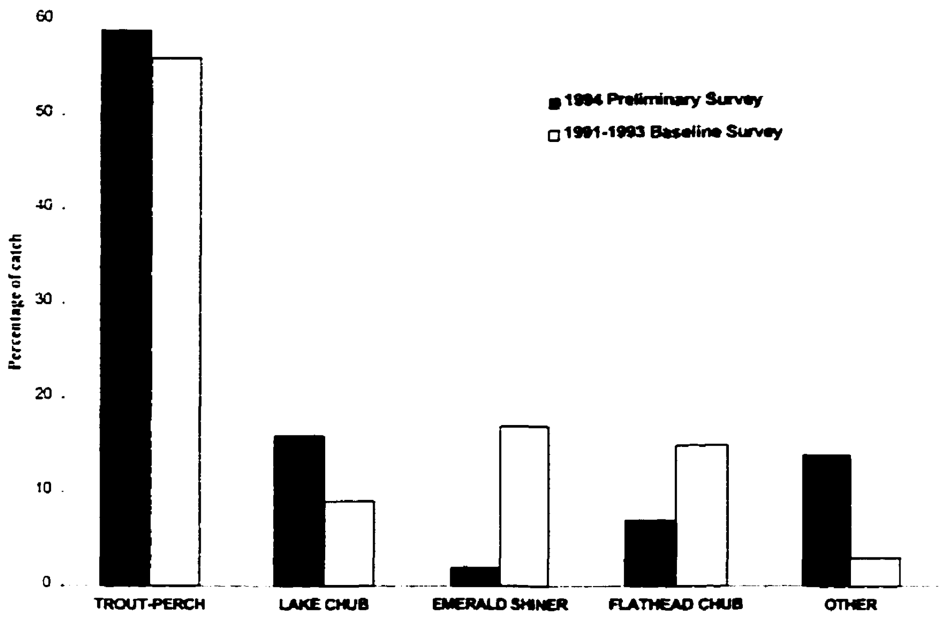

Figure 4-1. Catch summary results for abundant small-bodied fish species captured by seining in the study area. 1991-1993 Baseline survey (N = 7715) and 1994 preliminary survey (N = 1551).

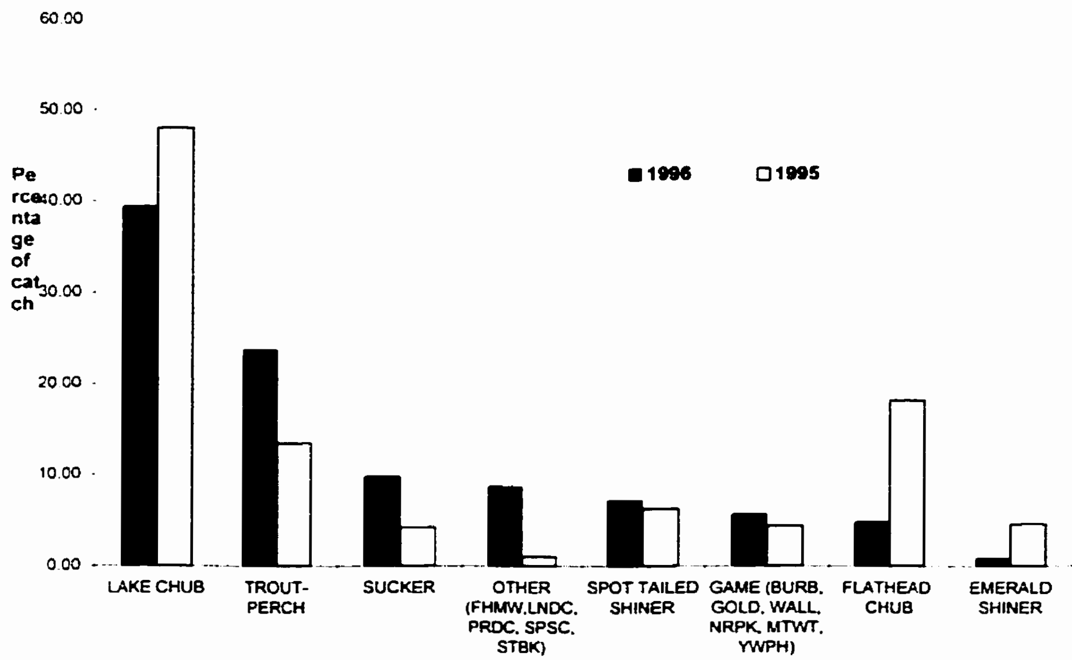

Figure 4-2 1995 (N = 27,622) and 1996 (N = 19,529) catch summary results for all species by seining in the study area. Abbreviations as in Mackay et al (1990): FHMW = fathead minnow, LNDC = longnose dace, PRDC = pearl dace, SPSC = spoonhead sculpin, STBK = stickleback spp., BURB = burbot, GOLD = goldeye, WALL = walleye, NRPK = northern pike, MTWT = mountain whitefish, YWPH = yellow perch.

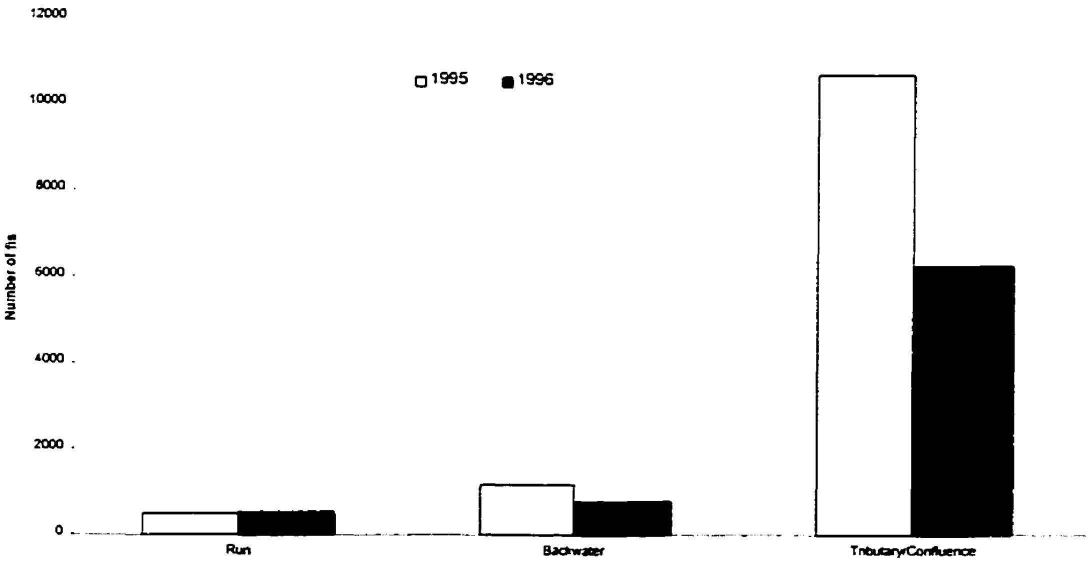

Figure 4-3. Number of lake chub caught in run, backwater and tributary/confluence habitats in 1995 (N= 11,976) and 1996 (N= 7,522).

Table 4-2 1996 Catch per unit effort (C.P.U.E.) (in number of fish/m^2) for lake chub (lkcb) and all fish collected in the study area in the Athabasca River near Athabasca, Alberta. Mainstem habitats included run and backwater habitat types.

habitat	number of seine hauls	average distance (m)	no. lkcb /haul	lkcb CPUE	all fish total catch	all fish CPUE
Mainstem	50	131.1	29.88	0.09	121	0.33
Confluence	34	167.1	160.53	0.36	340	0.83

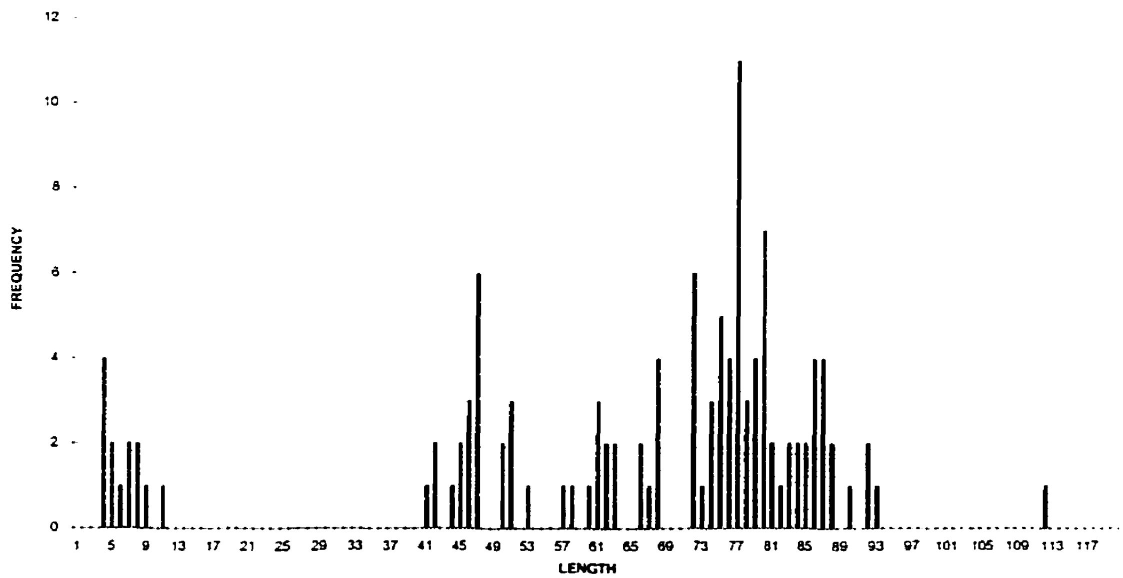

Figure 4-4a Length-frequency distribution of lake chub with peaks at young of the year, age 1 and age 2 respectively. Age 3 fish were observed in small numbers. Fish were captured June 11-24, 1995. N =119.

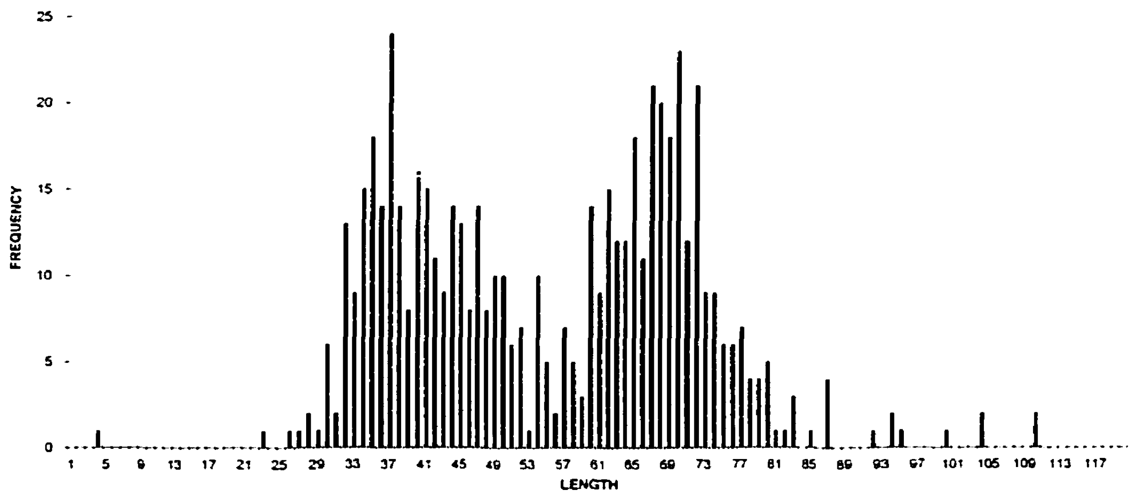

Figure 4-4b Length-frequency distribution of lake chub with peaks at age 1 and age 2 respectively. Fish were captured June 9-22, 1996. N = 579.

Growth

Based on length-frequency data, absolute and specific growth rates were calculated from lake chub cohorts collected in 1995 and 1996. Growth rates were larger for the young of the year to one year old cohort and decreased with the age of the cohort. (Table 4-3).

Table 4-3 Specific annual growth rates of lake chub by year class for the 1995 and 1996 collections. (I.e. G_{1-2} would be the specific annual growth rate for 1 year old lake chub to reach the age of 2 years). All age classes were determined by length frequency and were unsexed.

Year class increment	Absolute Growth (mm)	Specific Growth %	N
G_{yoy-1}	28.4	74.1	780
G_{1-2}	41.7	39.4	888
G_{2-3}	40.8	23.8	191
G_{3-4}	30.0	13.9	114

Body Condition Factor

Body Condition Factor or "K" was evaluated between the spawning season (S1) and the post spawning season (S2) and the three habitat types (run, backwater and tributary/confluence). Kruskal-Wallis one-way analysis of variance tests were used in the evaluations of "K". It was found that the body condition of females in 1996 was not significantly different between habitats ($P > 0.05$, $N = 122$) and between seasons ($P > 0.05$, $N = 122$). Females in 1995 were also not significantly different between habitats ($P > 0.05$, $N = 15$). Seasons could not be compared, as there was not enough post spawning data. Males in both 1995 and 1996 tended to be caught in small numbers during the spawning season at confluence/tributary habitats only. After spawning it was extremely difficult to differentiate a post-spawning male from an immature female.

Length at Maturity/ Sex ratio

Length at maturity and sex ratios were listed for lake chub in 1995 (Table 4-4) and in 1996 (Table 4-5). 1995 Females began maturing at 71-75 mm total length and in 1996 females began maturing at 66-70 mm. In 1995 all females were mature at 91 - 95 mm an in 1996 all females were mature at 96-100 mm. Male lake chub began maturing at 66 - 70 mm in 1996 in 1995 only 6 males were collected of various lengths and were not used to determine length at maturity. All males were mature at 91-95 mm in 1996. The sex ratio for the 1995 fish collection was 6% male and 94% female and in the 1996 collection was 38% male and 62% female.

Reproduction

From the 1996 collections individual female lake chub with gonads in full spawning condition were found in early May till late July. Mean Gonadal Somatic Index (GSI), vs. time (Fig 4-5a) was plotted to reflect when the female gonad mass reverted to a resting cindition. These fish apparently have been spawning previous to this time but sampling could not commence until river conditions permitted in early May. Spawning concluded at the end of July.

Few mature male lake chub were captured in 1995. GSI for females was variable and did not show any change over time. In 1995, mature males were caught on only two occasions near-spawning on July 14 and spent on August 3. Female GSI indicated a decline late in July similar to that as seen in local populations of trout-perch (Fig 4-5b). Length of lake chub did not correlate strongly with female GSI in 1995 (Fig 4-6a) or in 1996 (Fig 4-6b). Male GSI was not plotted due to small sample sizes.

Spawning Observations

For those fish not lethally sampled, observations of spawning condition (expressing milt, distended abdomen and/or releasing eggs) were recorded at the time of examination. Orange-red coloring at the bases of the pectoral fins was present in both sexes during spawning in some cases (N=21) but, the majority of spawning fish exhibited no coloration changes (N = 343). The largest number of observations of lake chub in spawning condition was late May till mid June (Fig 4-7). Spawning lake chub were observed only in tributary/confluence habitats on sand and silt substrates with low water velocity.

Table 4-4 Length at maturity and sex ratios for 117 lake chub taken during 1995 collections. No sample taken is denoted as "ns".

Length (mm)	N	Female	Males		Females	
		%	% Immature	% Mature	% Immature	% Mature
46-50	2	100	ns	ns	100	0
51-55	3	100	ns	ns	100	0
56-60	2	100	ns	ns	100	0
61-65	12	100	ns	ns	100	0
66-70	9	89	100	0	100	0
71-75	14	100	ns	ns	86	14
76-80	23	100	ns	ns	43	57
81-85	22	86	33	67	42	58
86-90	11	91	0	100	30	70
91-95	11	91	0	100	0	100
96-100	5	100	ns	ns	0	100
101-105	0	ns	ns	ns	ns	ns
106-110	1	100	ns	ns	0	100
111-115	1	100	ns	ns	0	100
116-120	1	100	ns	ns	0	100
Total	117	94				

Table 4-5 Length at maturity and sex ratios for 325 lake chub taken during 1996 collections. No sample taken is denoted as "ns".

Length (mm)	N	Female %	Males % Immature	% Mature	Females % Immature	% Mature
46-50	0	ns	ns	ns	ns	ns
51-55	0	ns	ns	ns	ns	ns
56-60	0	ns	ns	ns	ns	ns
61-65	2	50	100	ns	100	0
66-70	14	57	67	33	50	50
71-75	61	67	65	35	63	37
76-80	73	63	37	63	54	46
81-85	72	46	38	62	21	79
86-90	43	65	47	53	14	86
91-95	32	75	0	100	4	96
96-100	13	62	0	100	0	100
101-105	10	90	0	100	0	100
106-110	6	67	0	100	0	100
111-115	1	100	ns	ns	0	100
116-120	0	ns	ns	ns	ns	ns
Total	325	62				

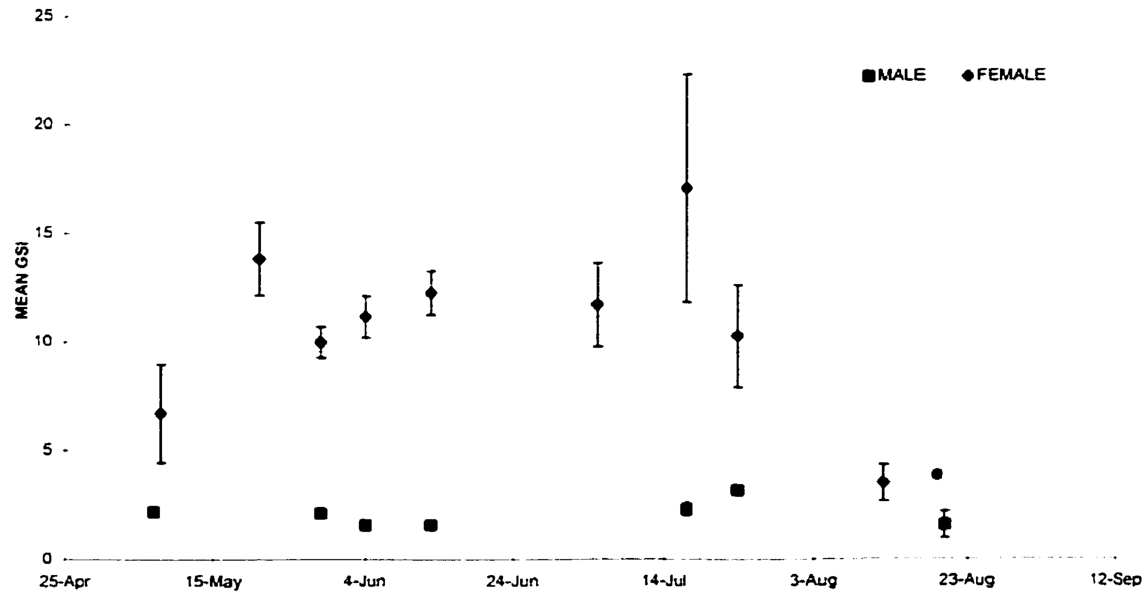

Figure. 4-5a Mature male and female lake chub mean GSI (with standard error) collected from May to September 1996. N = 74 male and 125 female lake chub.

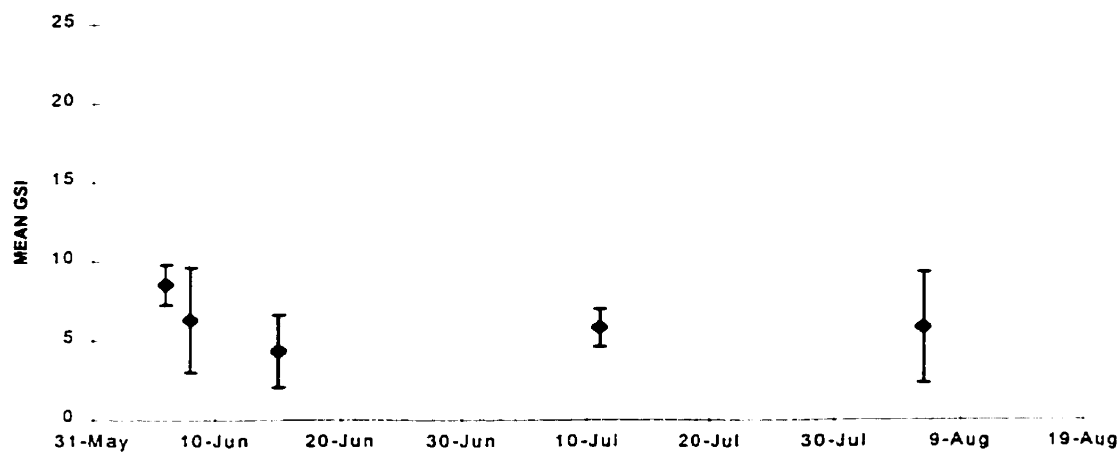

Figure 4-5b Mature female lake chub mean GSI (with standard error) collected from May to September 1995. N = 50 female lake chub. Male lake chub were caught on only two occasions and were not included.

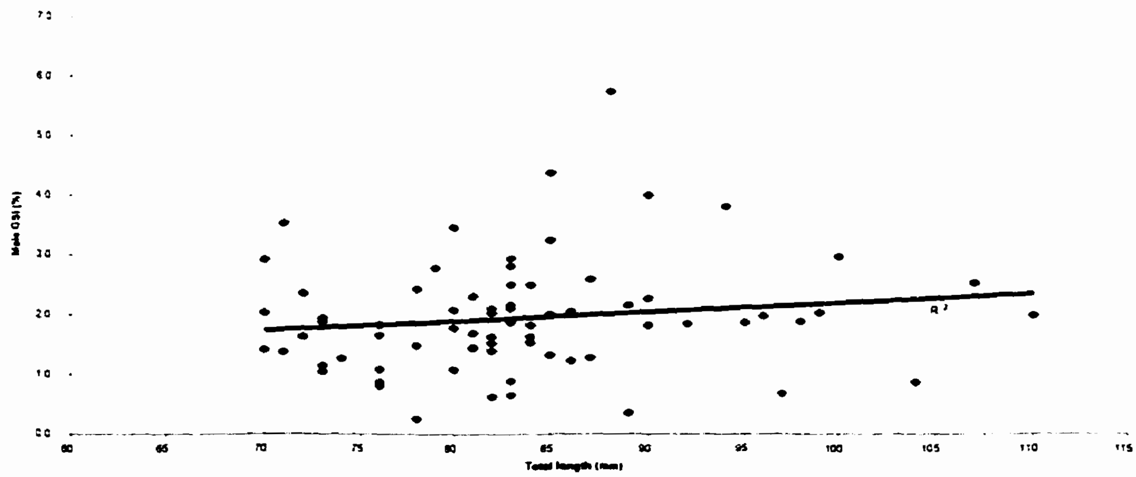

Figure 4-6a Mature female lake chub GSI and total length (mm) for the 1996 collection. N = 125 fish.

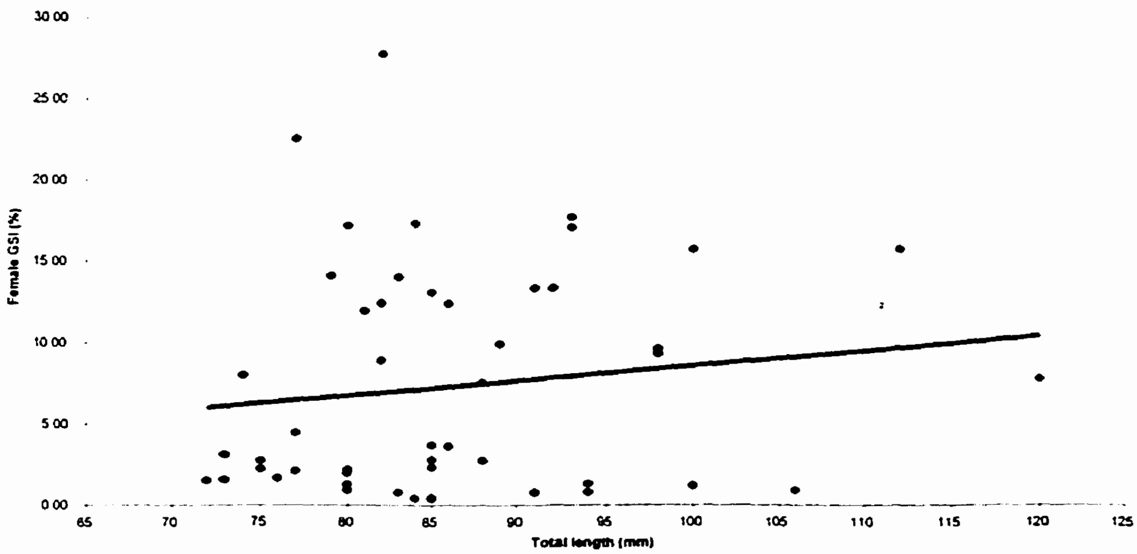

Figure 4-6b Mature female lake chub GSI and total length (mm) for the 1995 collection. N= 49 fish.

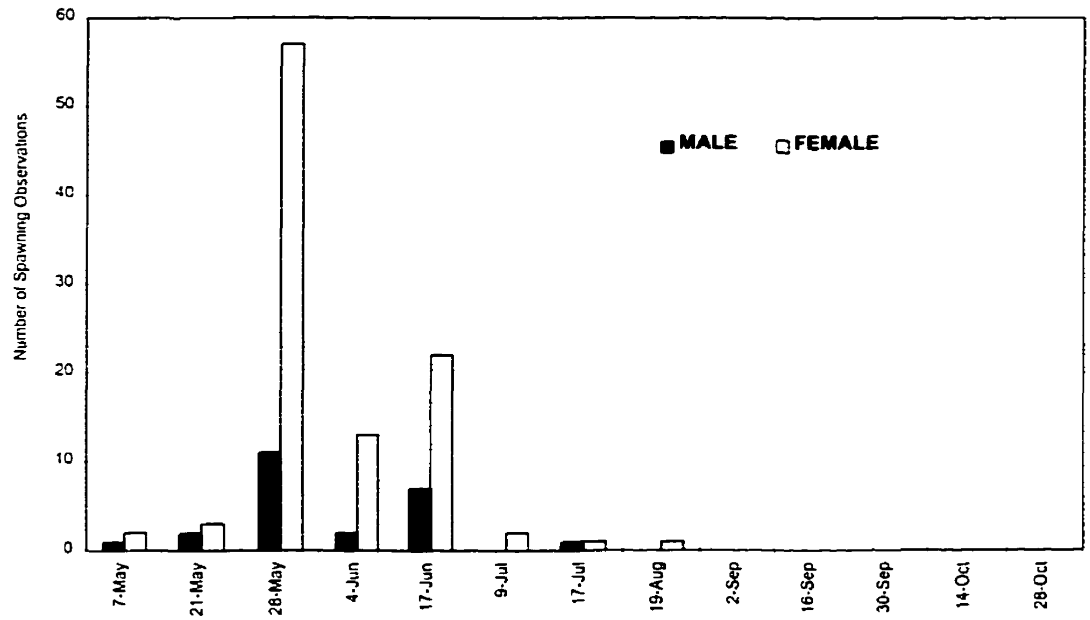

Figure 4-7. Pooled frequency of observations of male and female lake chub in spawning condition from 1995 and 1996 (male N= 24 and female N=101).

Egg Diameters

Lake chub had extended spawning periods (Early May to mid July) for 1995 and 1996. Egg diameters in most specimens showed two distinct distributions during spawning.

Egg diameters were compared for individual lake chub collected in 1996. Bimodal distributions of egg diameters were observed for lake chub during the spawning season (Fig. 4-8a to 4-8c). Eggs in the larger diameter distributions were yellow in colour and eggs in the smaller distributions were white in all cases. After the spawning period, egg diameters were found only in a single distribution of the smaller diameter class and were all white in colour (Fig. 4-8d). Ten frequency distribution plots of egg diameter are shown in Appendix 7.

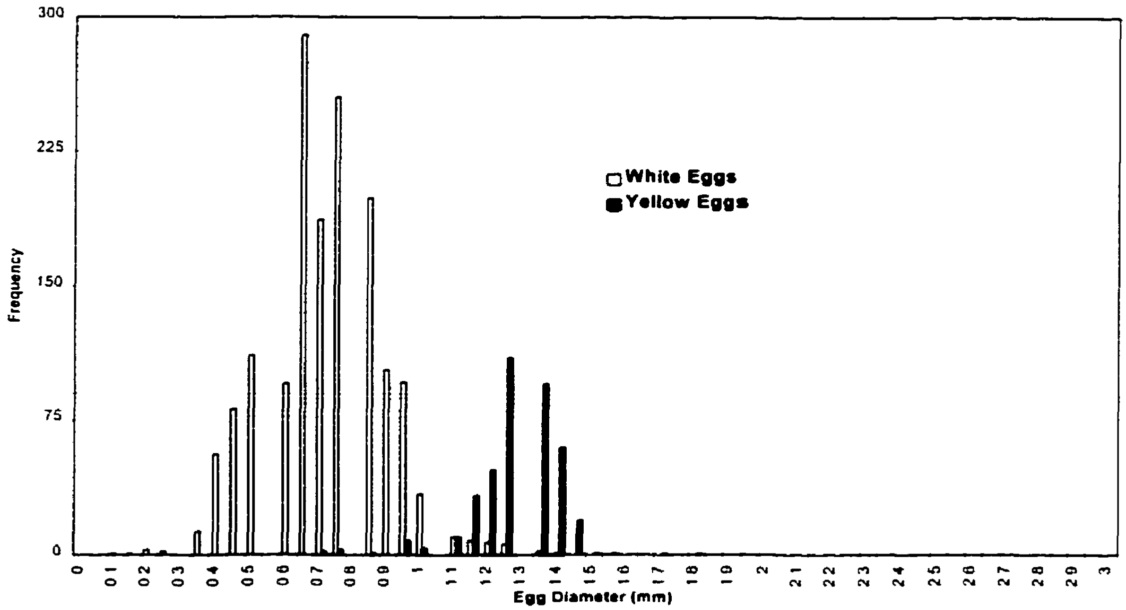

Figure 4-8a. Frequency distribution of n = 1957 lake chub egg diameters taken from both ovaries in May of 1996.

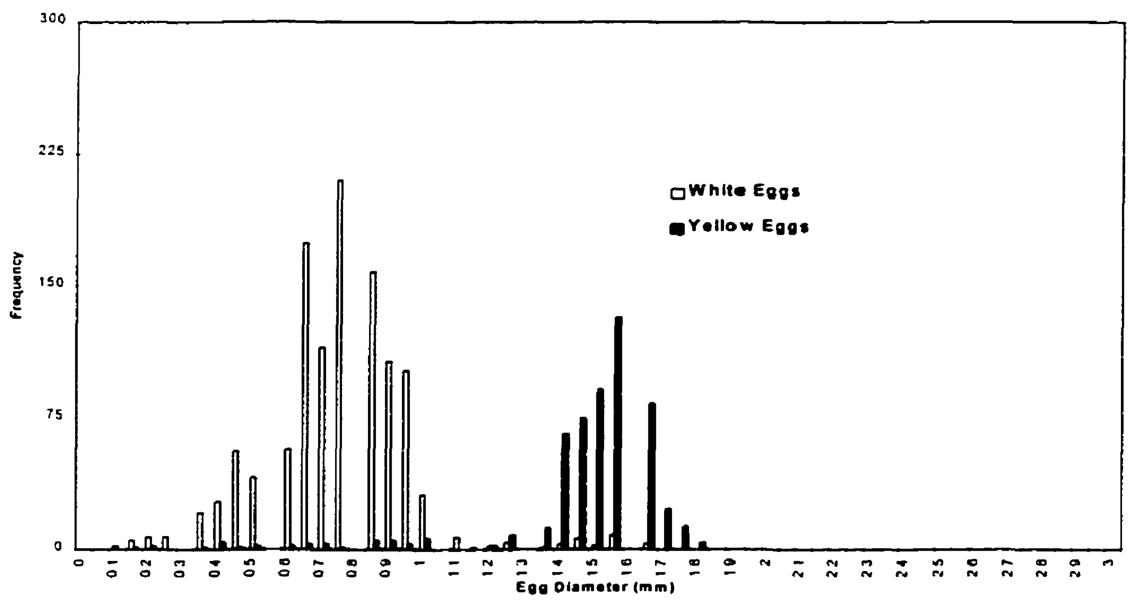

Figure 4-8b. Frequency distribution of n = 1705 lake chub egg diameters taken from both ovaries in June of 1996.

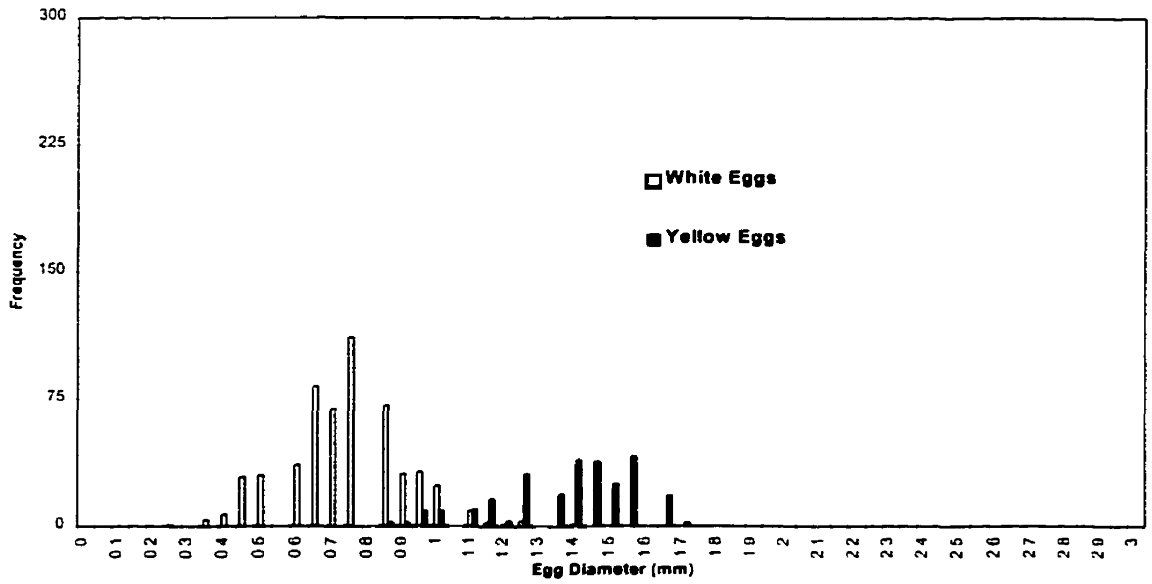

Figure 4-8c. Frequency distribution of n = 807 lake chub egg diameters taken from both ovaries in July of 1996.

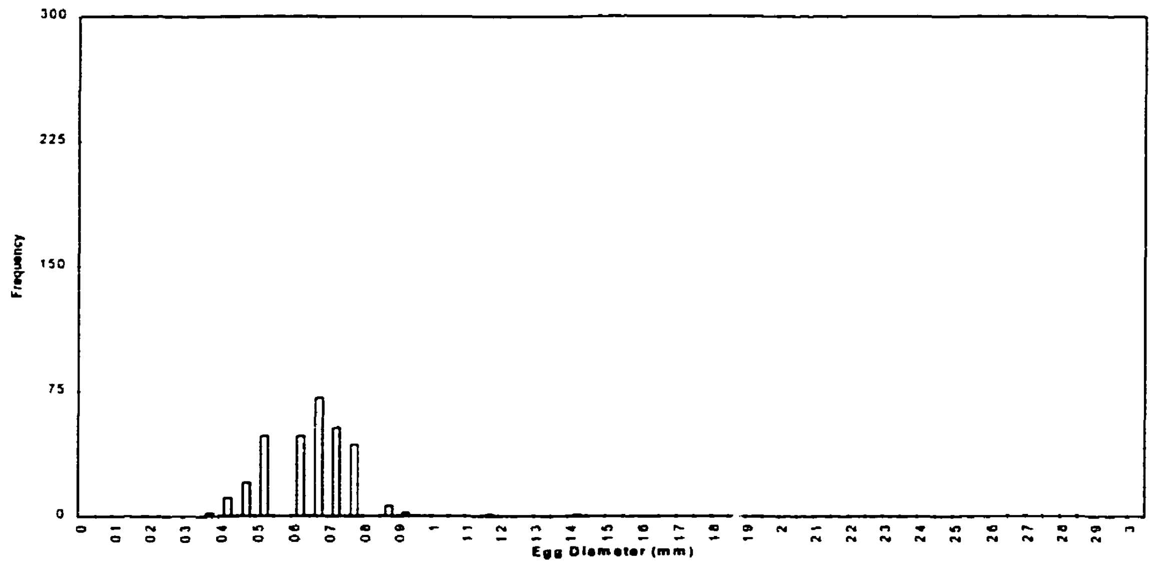

Figure 4-8d. Frequency distribution of n = 306 lake chub egg diameters taken from both ovaries in August of 1996. All eggs were white.

Environmental Effects Monitoring

Based on the EEM power analysis of the 1996 parameters it could take as little as 2 males and 7 females/site to detect a 20% difference between sites with the K parameter at a power of P=0.90, (Table 4-6b). Conversely if the GSI parameter was used 249 adult males and 246 adult females/site would be needed to detect the same difference of 20%. In 1995 LSI was calculated in 15 adult females and was found to need a very large sample size (408 adult females/site) at a power of P=0.90 to detect a 20% difference between a reference and exposed site (Table 4-6a). LSI was not repeated in 1996 as it was difficult to extract livers in the field. The original data for power analysis is given in Appendix 8.

The larger the estimated sample size the larger the variability will be for a given body metric. In the lake chub for both years GSI had the largest variance for females, then LSI was next for the 1995 and K had the least variance.

Lake chub have been shown to prefer the tributary/confluence habitats over run and/or backwater habitats. The use of tributary/confluence habitats in an EEM program is unlikely as this type of habitat would not be affected much or at all from an upstream effluent source. As a reference site it again would be far too different from any other habitat than another tributary/confluence habitat.

The absence of males and difficulty of sexing males in the post-spawning season in 1995 and 1996 made it difficult to assess GSI and K.

Table 4-6a Number of lake chub needed to detect significant differences in fish parameters between reference and effluent exposed populations in the study area, 1995. Samples sizes were calculated for a range of effect sizes (δ) with power = 0.80 and power = 0.90, and a = 0.05. Few adult male lake chub were collected in 1995 and could not be assessed in this evaluation.

		Estimated Sample Size (# of fish/area)					
		δ=20		**δ=25**		**δ=30**	
Parameter	**Sex**	**P=0.80**	**P=0.90**	**P=0.80**	**P=0.90**	**P=0.80**	**P=0.90**
LSI	Male	0	0	0	0	0	0
	Female	248	408	205	273	148	198
GSI	Male	0	0	0	0	0	0
	Female	346	570	285	381	207	276
Condition (K)	Male	0	0	0	0	0	0
	Female	4	6	4	4	3	4

Table 4-6b Number of lake chub needed to detect significant differences in fish parameters between reference and effluent exposed populations in the study area, 1996. Samples sizes were calculated for a range of effect sizes (δ) with power = 0.80 and power = 0.90, and a = 0.05.

		Estimated Sample Size (# of fish/area)					
		δ=20		**δ=25**		**δ=30**	
Parameter	**Sex**	**P=0.80**	**P=0.90**	**P=0.80**	**P=0.90**	**P=0.80**	**P=0.90**
GSI	Male	186	249	125	167	91	121
	Female	122	246	82	165	60	120
Condition (K)	Male	2	2	2	2	2	2
	Female	5	7	4	5	3	4

Diet

Stomach contents from 43 lake chub were examined. Lake chub from the study area had fed predominantly on immature forms of Ephemeroptera making up almost 45% of the diet. Heteroptera, Trichoptera, Diptera and organic material were the bulk of the remainder (fig 4-9). Prey selections varied monthly as different prey were selected in individual months (Appendix 9). Ephemeroterans were most prevalent in the diet in May and June and were replaced by Heteropterans (Corixidae) in July.

Kruskal-Wallis one-way analysis of variance tests were used in the evaluations of diet. Habitat type did not affect prey selection ($P > 0.05$). Emphemeropterans remained the most prevalent prey item when classed by the three habitat types; run, backwater and confluence/tributary. Other prey selection was variable (Appendix 9).

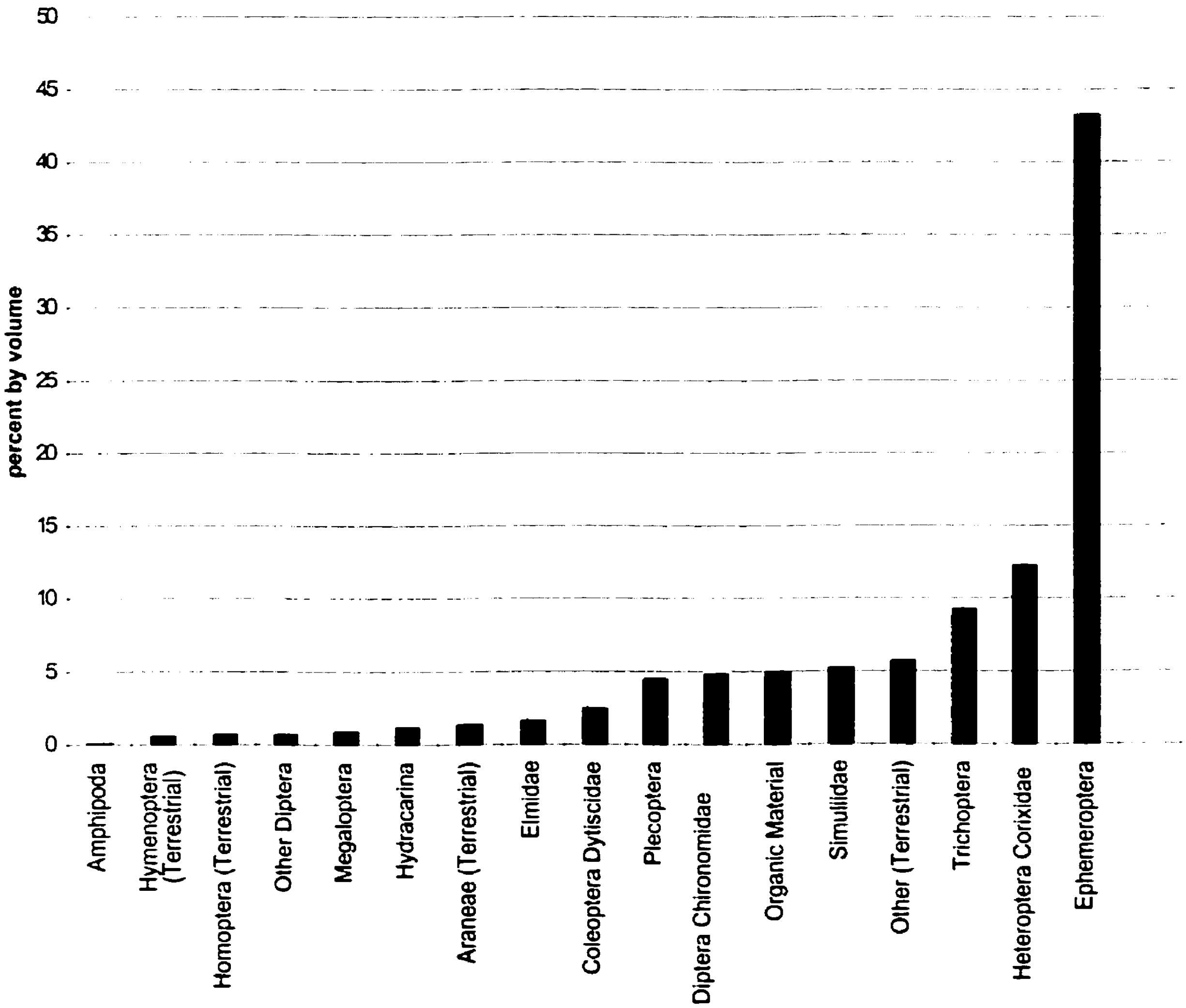

Figure 4-9 Volumetric composition of lake chub diet in all habitats May to August 1995 based on contents of 43 stomachs.

Discussion

Spawning

Batch or multiple spawners typically have extended spawning seasons (Heins and Rabito, 1986), similar in duration to the elevated GSI period seen for lake chub. Observations of spawning during this same period were also more prevalent. Egg diameters of lake chub exhibited bimodal distributions as is typical for multiple spawning fishes such as the genus *Notropis* (Heins and Rabito, 1986) and other cyprinids (Bagenal and Braum, 1978), or the logperch, *Percina caprodes* (Rafinesque), and johnny darter, *Etheostoma nigrum* Rafinesque, (Rowes, 1994). The larger egg diameter distribution was present from May until mid-July and it is believed these eggs are shed not in during one spawning event but over the whole spawning period.

1996 female GSI results indicated a marked decline from relatively high levels (10-20%) during spawning to low levels (4-5%) after spawning. This decline took place over a three-week period commencing July 21. Observations of lake chub in spawning condition were also recorded for both sexes in the 1995 and 1996 collections. Again, the observance of fish in or near spawning condition was from the beginning of the collections in early May to mid July of both years.

1995 female GSI results were variable and could not indicate a distinct end to the spawning season. Some of the reasons why this data was variable could have been due to smaller sample size than in the 1996 collection and that the majority of the fish were collected outside of the spawning season.

Environmental Effects Monitoring

The use of lake chub as sentinel monitoring species is not possible with their preference for confluence/tributary habitats and lack of adult males. Assessment of the parameters GSI and LSI indicated a very large sample size would be needed to determine effects from effluents using this method. The sample size needed for body condition (K), was far less, but the method cannot stand on one parameter and needs to address all. Given the low catch success of male lake chub and the species preference for tributary/confluence habitats, it is unlikely that sufficient numbers of adult lake chub could be obtained in this study area to satisfy the EEM requirements.

Habitat preference

The majority of lake chub were caught in confluence/tributary habitats. Backwater and run habitat types were less preferred but not significantly different from each other. Machniak and Bond (1979) found similar preference for confluence habitat in the Steepbank River.

Abundance

In 1995 and 1996 lake chub was the most abundant small bodied-fish collected in the study area. In 1991 to 1994 lake chub was second most abundant in the study area. Young of the year dominated the catch in both years. This was seen for lake chub at other northeastern Alberta locations such as: the Steepbank River by Machniak and Bond (1979), the Muskeg River (Bond and Machniak, 1977 and 1979) and in the Mackay River (Machniak *et al*, 1980).

Growth

Growth in lake chub decreased with age. Growth was most prevalent in the young of the year to age 1 at 74.1%, declining to 13.9% in the age 3 to 4 cohort (Table 4-3). This decline with age is similar to that found in trout-perch (Table 3-5).

Length at Maturity

Males tended to mature at a shorter length than females. In the 1995 collection, all female lake chub at 96-100 mm were mature. In the 1996 collection, all female lake chub at 91-95 mm and all 1996 males at 91-95 mm were mature. This was also documented in Labrador by Bruce and Parsons, (1976) where smaller males age 2 were mature and females 3 were also mature. Older age classes found eastern Canadian lake populations (Scott and Crossman, 1973) were not represented in collections for this study and others at similar latitudes, (Bond and Machniak, 1977 and 1979) (Machniak and Bond, 1979) and (Machniak *et al*, 1980).

A possible reason for the lack of older year classes is that there are not any. At northern latitudes the majority of lake chub may mature earlier at a smaller size than in fish from eastern Canada. This has also been seen in yellow perch (*Perca flavsecens* Mitchill), in Alberta by Mance, (1987) were he observed trade-offs between egg number and size and egg number and lifespan. These adaptations may be due to the latitudinal and local habitat characteristic of the fish.

Sex Ratio

The 1996 collections were 62% female. This finding was based on 325 fish examinations over the course of May to late August in 1996. Machniak and Bond, (1979), found an even sex ratio in the MacKay River in 1978. Machniak et al (1980) found the female sex ratio was 56%. In 1995 only six male lake chub were collected out of 117. The 1995 collection was not focussed on lake chub as was the 1996 collection and the results from that probably do not reflect the true population. Time of collection is important as the presence of the two sexes on the spawning grounds has been found to be much longer for males (Brown, 1969). This may have influenced this study, as there were few adult male captures in 1995 and a small number in 1996.

Diet

Stomach contents from 43 lake chub were examined. A variety of aquatic and some terrestrial insects were found. Ephemeroptera and diptera (Chironomidae) and were the most selected prey. These prey are also much the same for lake chub studied in other watersheds such as the Mackay River (Machniak et al, 1980), Steepbank River (Machniak and Bond, 1979) and the Mildred Lake and Athabasca River Delta area (Bond, 1980). Bond and Berry (1980) found similar results with Athabasca River lake chub. The abundance of prey in the diet varied with habitat and season, but selection of prey was not different between habitats.

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Chapter 5

General Conclusions

This study represents the most comprehensive assessment of trout-perch and lake chub in a large northern river to date.

Lake chub were the most abundant fish in the study area and trout-perch were second to them in 1995 and 1996. Both trout-perch and lake chub exist in all available habitats. Lake chub were more abundant in the confluence/tributary habitats as were trout-perch in 1996. The Athabasca River exhibits large sudden changes in flow and water levels, which can limit fish in terms of spawning and rearing habitat, and reproductive success. Tributary and confluence habitats are sheltered from the changes that affect the Athabasca River and provide refugia for many fish species including trout-perch and lake chub.

Both fish species were multiple spawners and had extended spawning periods. Egg diameters in both fish species showed two distinct distributions during the spawning season. It is likely that these fish spawn two to three times in a given year. The larger egg diameter distribution was present from May until mid-July and it is believed these eggs are shed not in during one spawning event but over the whole spawning period.
Based on GSI and observations in the field for 1995 and 1996, trout-perch began spawning in April and concluded in mid July, lake chub also began in April and concluded in late July. Rowes (1994) observed that many small-bodied fish tend to have repeated spawning events. This permits small-bodied fish to produce a large number of eggs and increase their chances of survival in an environment with large variation in available habitat and water quality.

Survival in large rivers for small-bodied species is difficult. Flows, sedimentation and variation in water level were the major disturbances in the system. Species such as trout-perch and lake chub have the best chance for survival in this dynamic system by producing many young. Spawning of both trout-perch and lake chub was done in batches. This strategy increases the chances of survival of young to the next year class, as the environment in which the eggs are released is so variable. These also fish maximise their success by selecting tributary/confluence habitats of the Calling and La Biche Rivers that were more stable in terms of flow and provide less turbid water for most of the season. The Calling River has a flow control structure that minimises large increases in flow and the La Biche River is a small river that originates from a large lake that is mostly low gradient channel that has a dampening effect on large flows. Lake chub are shown to prefer the tributary/confluence habitats over run and/or backwater habitats. Trout-perch also prefer these habitats to a lesser extent but are also found in run and backwater habitats.

Age classes found in trout-perch were young of the year (yoy) to four years. In lake chub ages were yoy to four years. Older age classes found in other populations (Scott and Crossman, 1973) were not represented in collections for this study. Observed trade-offs between egg number and size and egg number and lifespan are most likely due to the latitudinal and local habitat characteristics of these fish.

Growth for both fish is substantial in the first year and slower as the age class increases. Maturity of trout-perch and lake chub females was later than males. As ages of lake chub could only be estimated from length frequency analysis lake chub lengths at maturity were used to assess maturity.

Sex ratios for both species were skewed towards females. Trout-perch sex ratios were 76% female and lake chub were 70% female for all sexed fish. The abundance of females may be an artifact of only sampling with a seine at depths not much over 1 m.

Diets of both fish species were comprised primarily of ephemeropteran insects with variations seasonally and in differing habitat types. Prey selection appears to be related more to the abundance of prey than a particular preference. Trout-perch were abundant during daylight hours. It has also been noted that trout-perch move into the shallows at night to feed in eastern Canada lakes and streams (Magnuson and Smith, 1963). This is thought to be a light dependant process. The Athabasca River is turbid and light penetration is poor, this provided a suitable light intensity during the day. Sampling was not carried out at night for safety concerns.

Refugia

Tributaries and confluence areas were preferred by both species during the 1995 and 1996 collection and in the 1991-1993 Alberta-Pacific baseline survey of the Athabasca River which included trout-perch and lake chub (except mountain whitefish) (Shelast *et al*, 1996 (a, b, and c). The Athabasca River, being glacially fed, has unique hydroperiods, which can exhibit large sudden fluctuations in flow and water levels. Tributaries and confluence areas may act as refugia for fish and other organisms as they are considerably more stable than the Athabasca river in terms of flow, water levels, turbidity, and temperature.

Sediment Load

With increased flow there is a proportional increase in turbidity. Fish feeding rates depend on prey observation and available light, which are minimized during turbid conditions. High levels of suspended sediments may cause a reduction in feeding. Reduction in feeding as a result of turbidity has been reported in four species, trout - perch, lake chub, slimy sculpin and longnose sucker, which inhabit the Athabasca river (Porter *et al*, 1974).

The stress caused by increases of sediment load in the water column can cause physiological changes in fish and benthic invertebrates (Anderson et al, 1995). The physiological effects reported in fish include impaired growth, histological changes to gill tissue, alterations in blood chemistry, an overall decrease in health and resistance to parasitism and disease. Some fish (lake chub) were found to be tolerant of high suspended sediment levels and others (trout-perch, walleye) were moderate and intolerant.

Effects reported in invertebrates include a loss of species diversity; decreased abundance and increased downstream drift (Anderson et al, 1995). These changes were also dependent on the duration of exposure and sediment concentration.

How do these fish rate as Sentinel Species?

The six parameters evaluated (age, length at age, weight at age, LSI, GSI, and K), were used in a power analysis recommended by The Department of Fisheries and Oceans to evaluate the number of trout-perch and lake chub needed to detect an effect of a given effect size (i.e./ 20% or 30%), (ECDFO,1995). A successful species would have a relatively low variance in all parameters to be considered with the power analysis method (ECDFO, 1995). Trout-perch and lake chub life history and description for sentinel species criteria are in table 5-1.

Trout-perch

Trout-perch were found to be the most suited to the EEM criteria as a sentinel species. The 1996 results indicate the largest sample size of adult trout-perch needed for estimating effects would be 106 females and 426 males per site for GSI, then 89 females and 47 males per site for LSI. The number of fish needed to be collected decreases as size of the effect (or difference between populations) increases. These sample sizes are achievable with a large amount of effort but could possibly deplete local populations.

The other parameters, (age, length at age, weight at age and K) have achievable sample sizes and could be easily collected in 3 to 4 days.

Table 5-1 Comparison of life history and EEM criteria findings for lake chub and trout-perch from the 1995 and 1996 collection.

Life history	**Trout-perch**	**Lake chub**
Abundant in study area	Yes	Yes
Batch spawners	Yes	Yes
Spawning duration	Extended (70-80 days)	Extended (70-80 days)
Habitat preference	Present at all habitats sampled	Tributary/confluence not abundant at other habitats
Local population	Yes	Yes
Sex ratio (% female)	58% 1995, 67% 1996	62% 1996
EEM criteria		
Local population	Yes	Yes
Abundance (adults of both sexes)	Yes	No
Sample sizes required	Achievable	Not achievable
Habitat preference suitability for EEM	Yes	No

Lake chub

Lake chub did not meet the requirements for an EEM sentinel species. Three of the six parameters required were evaluated in this study. These were LSI, GSI and K. Age was determined through length frequency analysis and was not specific enough to assign to individual fish. The age related parameters, (age, length at age and mass at age) were not used as a result.

Other researchers have successfully used LSI in lake chub (Shelast *et al*, 1996b). In this study only 15 adult female lake chub liver weights were collected due to low abundance of adult females and difficulty of removing the livers in the field. A large variance was seen in the LSI, that equated to a sample size of 408 adult females per site needed to detect an effect. This large sample size would make LSI an unreliable metric to use as an indicator of effects. A larger sample size may have decreased variance and resulted in a slightly smaller sample size needed to determine effects. GSI had a similar large variance an again would be of little use. The only parameter with a lower variance was body condition (K) that indicated a relatively small sample size was needed to determine effects.

To obtain a large enough sample size of adult male (and female) lake chub would require more effort than for trout-perch in this reach of the Athabasca River. There is concern that collecting such a large sample size would reduce local populations drastically. Also, the number of adult lake chub captured was not sufficient at any location to support the numbers of adult fish required by EEM. Lake chub were only abundant in tributary/confluence habitats. In an EEM program this type of habitat would not be suitable to sample as it is not affected much or at all from an upstream effluent source. As a reference site it again would be far too different from any other habitat other than another tributary/confluence habitat. The exclusion of this habitat type would drastically increase the effort required to capture enough fish to meet the sampling requirements. Based on these factors, lake chub were not judged as a suitable sentinel monitoring species.

Juveniles dominated catches of both fish species in 1995 and 1996. Only adult fish are used in the current method employed for EEM. There are opposing views to using single adult indicator taxa as in the EEM approach. Schaeffer (1988) wrote that indicator species may be effective only for general, qualitative evaluations and the single species approach may be used to monitor effects at the individual level and population level, but is not powerful enough to reflect community or ecosystem level effects.

Other methods of fisheries assessment exist that also take into account all the aspects of the community and do not require such a large sample size to be statistically reliable. Two such methods are the health assessment index (HAI), and the index of biotic integrity (IBI), which look at the total catch of fish intensively in a given section of stream or river. The HAI evaluates closely at individual fish health through external and internal examination of the fish in the field (Goede and Barton, 1990). The IBI integrates communities, populations and individual organisms on the basis of relative abundance (Fausch et al, 1990). These two methods are currently being compared in the field with the adult fish survey method used by EEM in Quebec and Alberta by the Pulp and Paper Research Institute of Canada.

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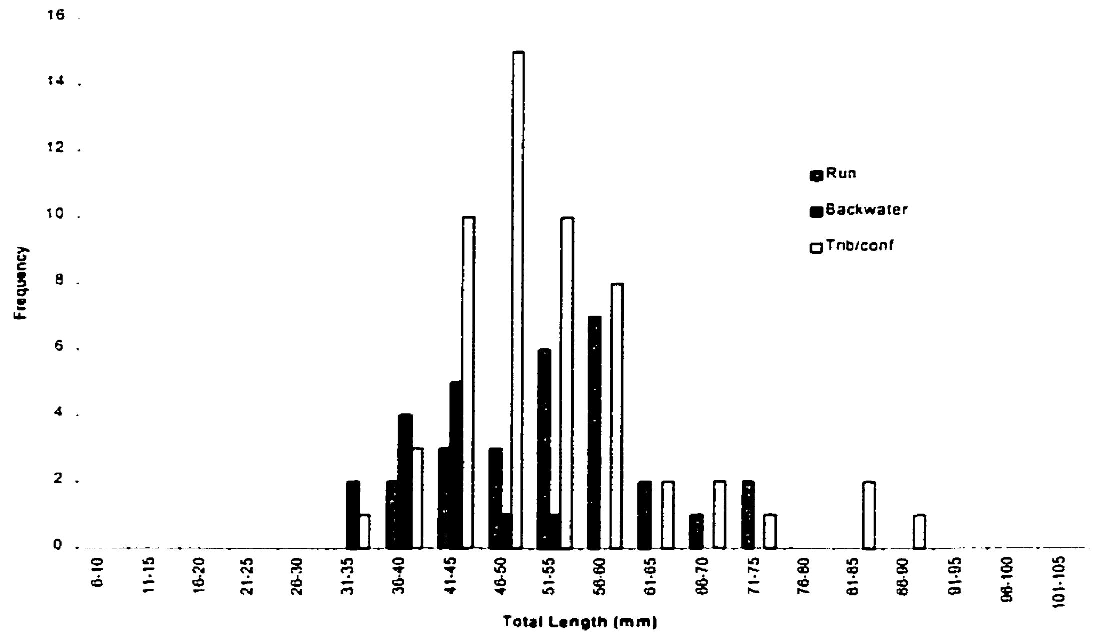
Appendix 1

Table of site descriptions and location for the 1995 and 1996 study.

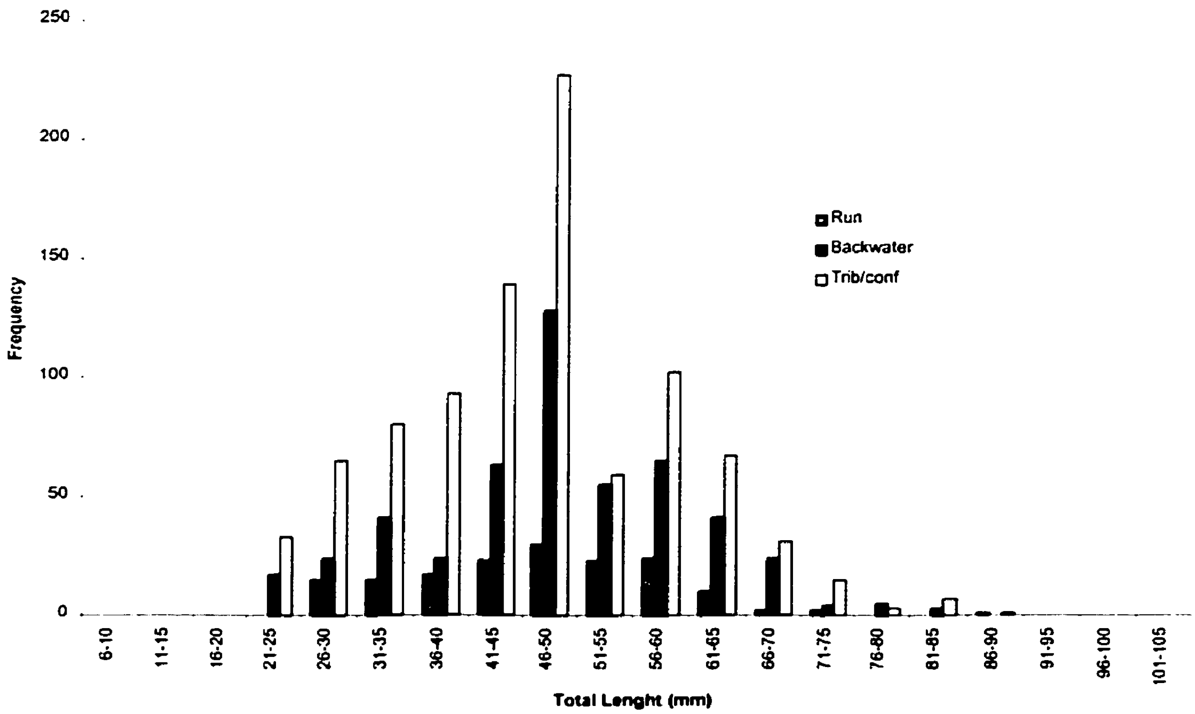
SITE	DESCRIPTION	GPS LOCATION	
		N:	W:
1	North bank upstream of La Biche River, sand point	54.989	112.715
2	North bank upstream of La Biche River, back channel	55.009	112.733
3	Confluence of La Biche River and downstream	55.014	112.734
4	Confluence of Calling River and downstream	55.089	112.882
5	Upstream of Calling River	55.089	112.882
6	North bank of second island upstream of Poachers Landing	54.966	112.871
7	South bank of second island upstream of Poachers Landing	54.966	112.871
8	South bank upstream of La Biche River	55.006	112.730
9	South bank upstream of mill outfall	54.746	113.277
10	2 ND island upstream of Athabasca	54.750	113.365
11	Mid-channel sand bar upstream of bridge	54.965	112.880
12	South bank upstream of LaBiche River near Dwayne's hole	54.996	112.719
13	Poachers Landing	54.962	112.829
14	Across from Poachers Landing and area	54.965	112.835
15	South west corner of island across from Marks creek	54.785	113.260
16	Bay on south bank between La Biche and Calling River	55.057	112.853
17	Marks creek	54.787	113.255
18	South bank downstream of new pipeline	54.853	113.223
LR	LaBiche River interior	55.013	112.719
CR	Calling River interior	55.089	112.888

Appendix 2

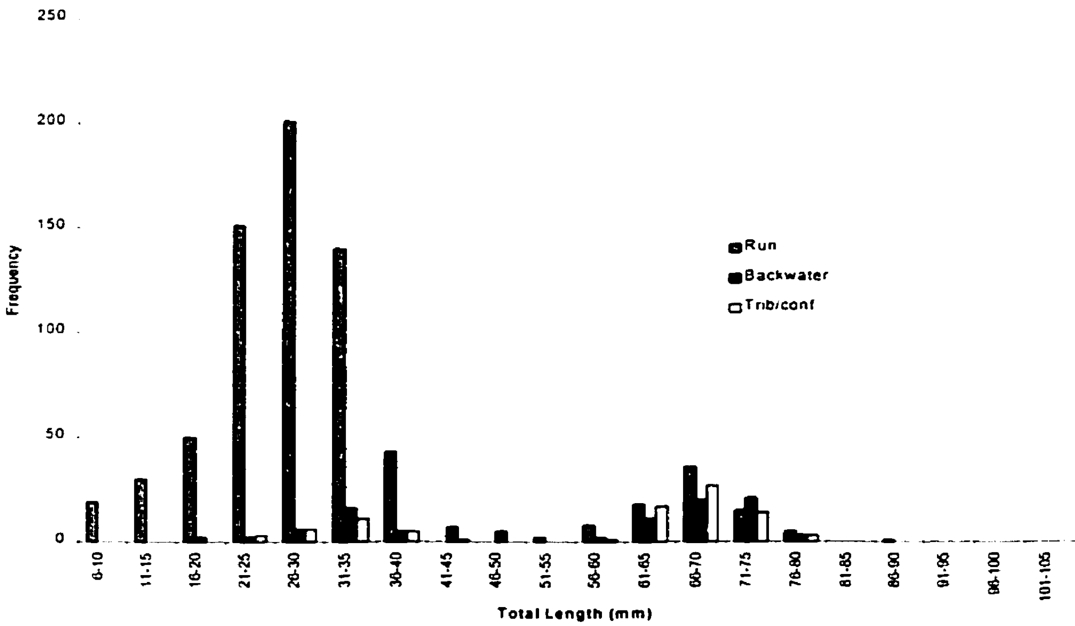
Trout-perch length frequency by habitat in all months of collection 1995 and 1996.



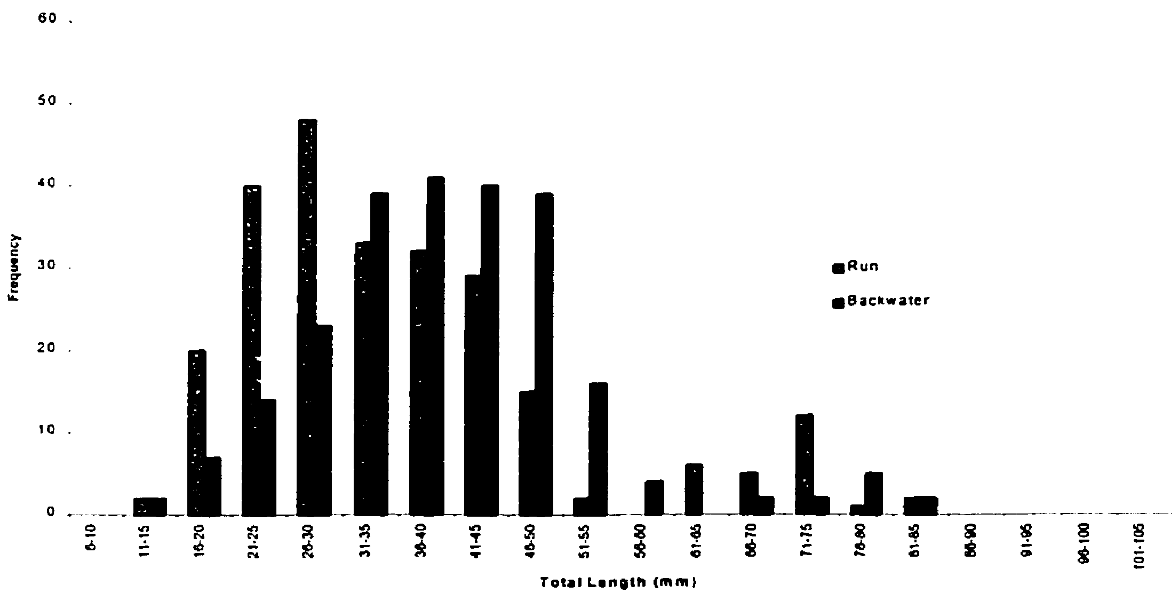
Appendix 2 Figure 1 Total length (mm) frequency of trout-perch at the three habitat types sampled. May, 1995. N = 94 fish.



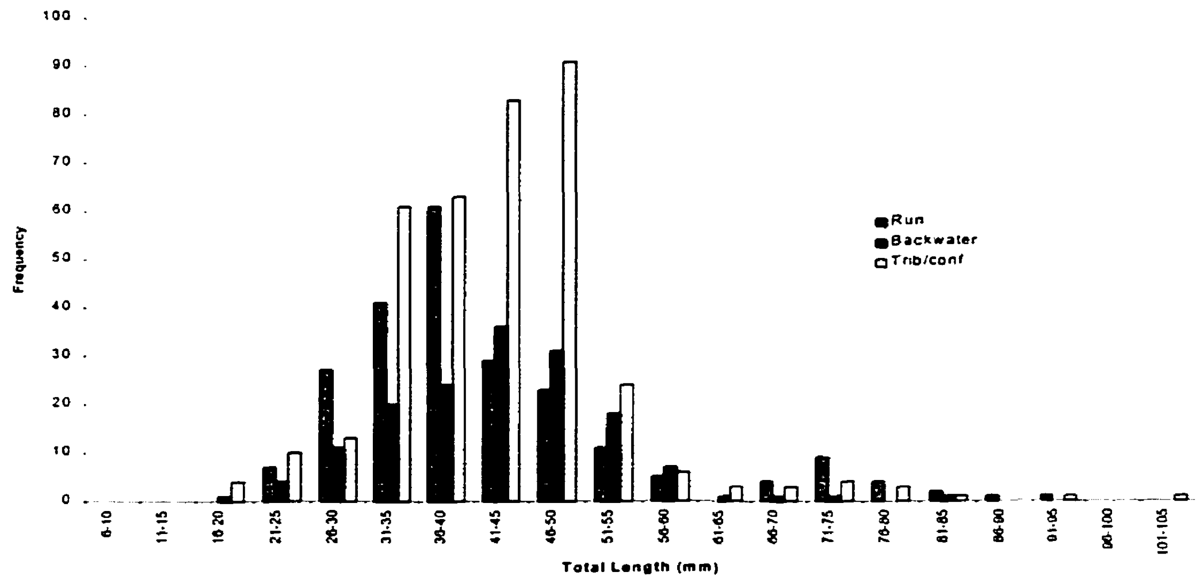
Appendix 2 Figure 2 Total length (mm) frequency of trout-perch at the three habitat types sampled. June, 1995. N = 1578 fish.



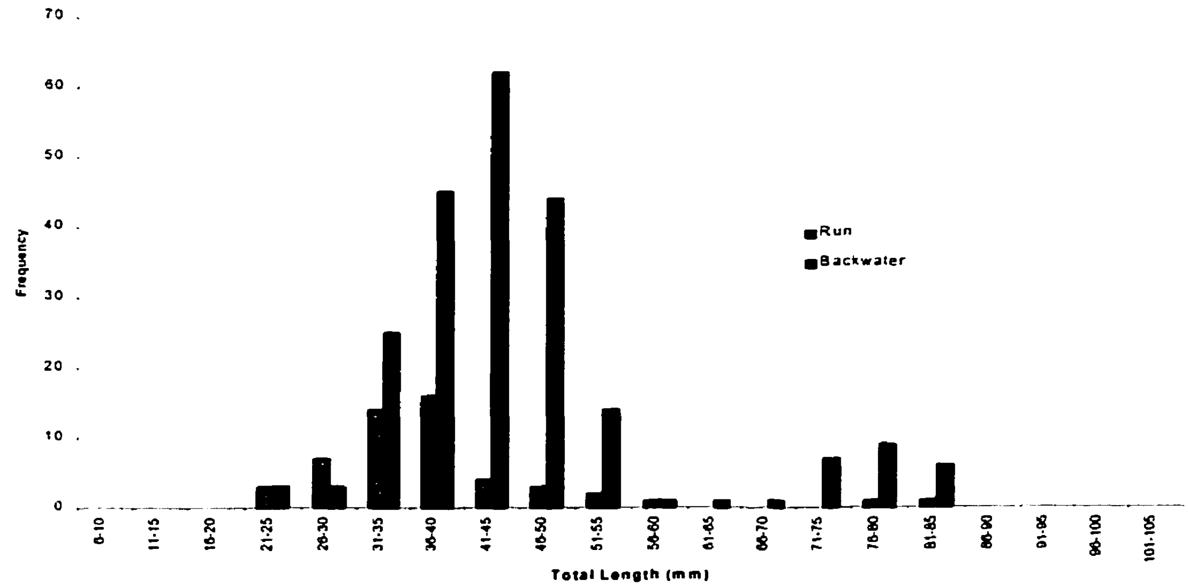
Appendix 2 Figure 3 Total length (mm) frequency of trout-perch at the three habitat types sampled. July, 1995. N = 907 fish.



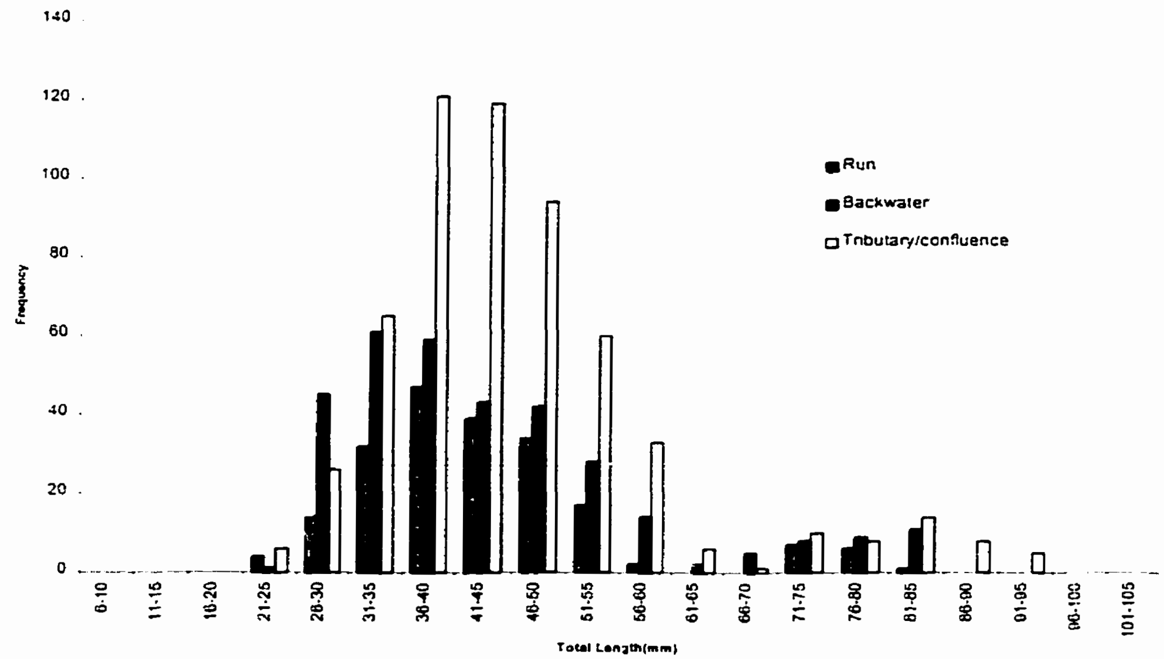
Appendix 2 Figure 4. Total length (mm) frequency of trout-perch collected at run and backwater habitat types. August, 1995. N = 483 fish.



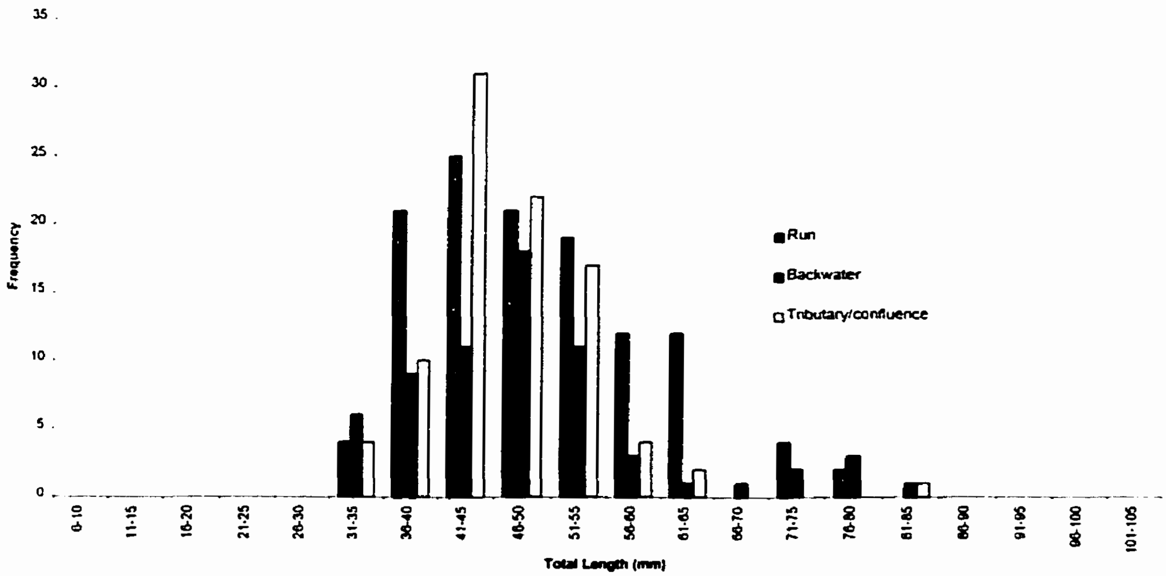
Appendix 2 Figure 5 Total length (mm) frequency of trout-perch collected at the three habitat types sampled. September, 1995. N = 752 fish.



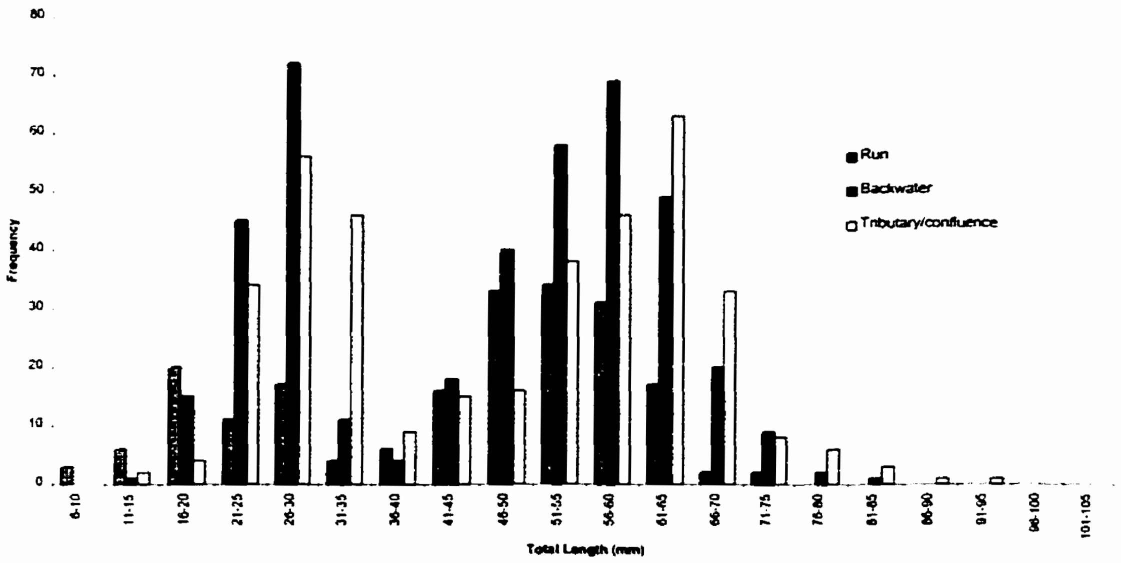
Appendix 2 Figure 6. Total length (mm) frequency of trout-perch collected at run and backwater habitat types. October, 1995. N = 273 fish.



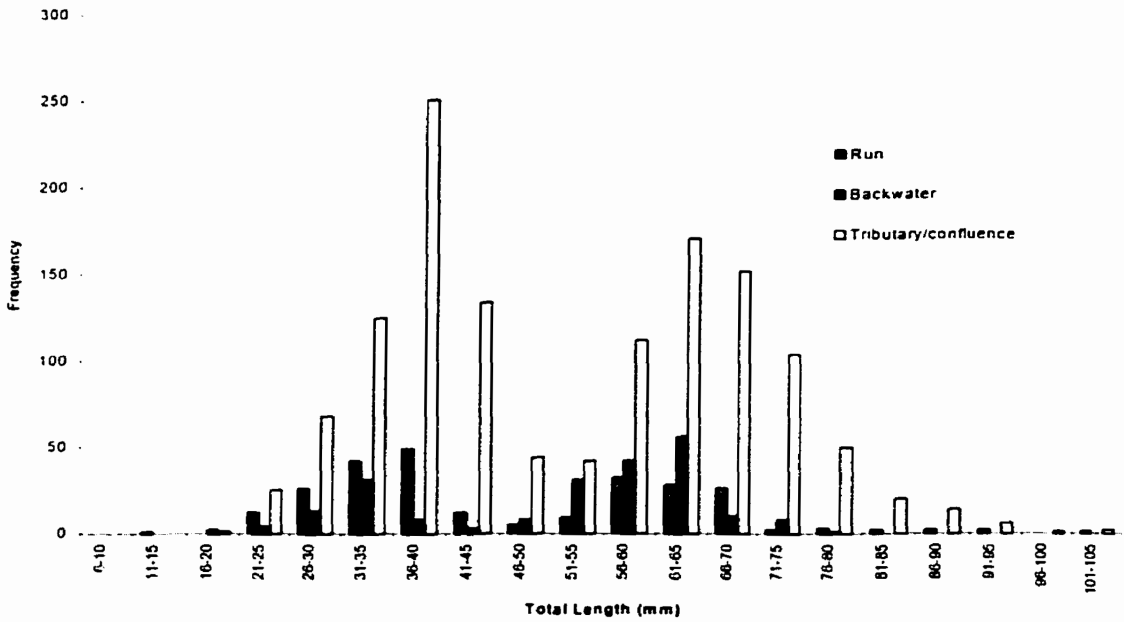
Appendix 2 Figure 7 Total length (mm) frequency of trout-perch collected at the three habitat types sampled. May, 1996. N = 1107 fish.



Appendix 2 Figure 8 Total length (mm) frequency of trout-perch collected at the three habitat types sampled. June, 1996. N = 277 fish.



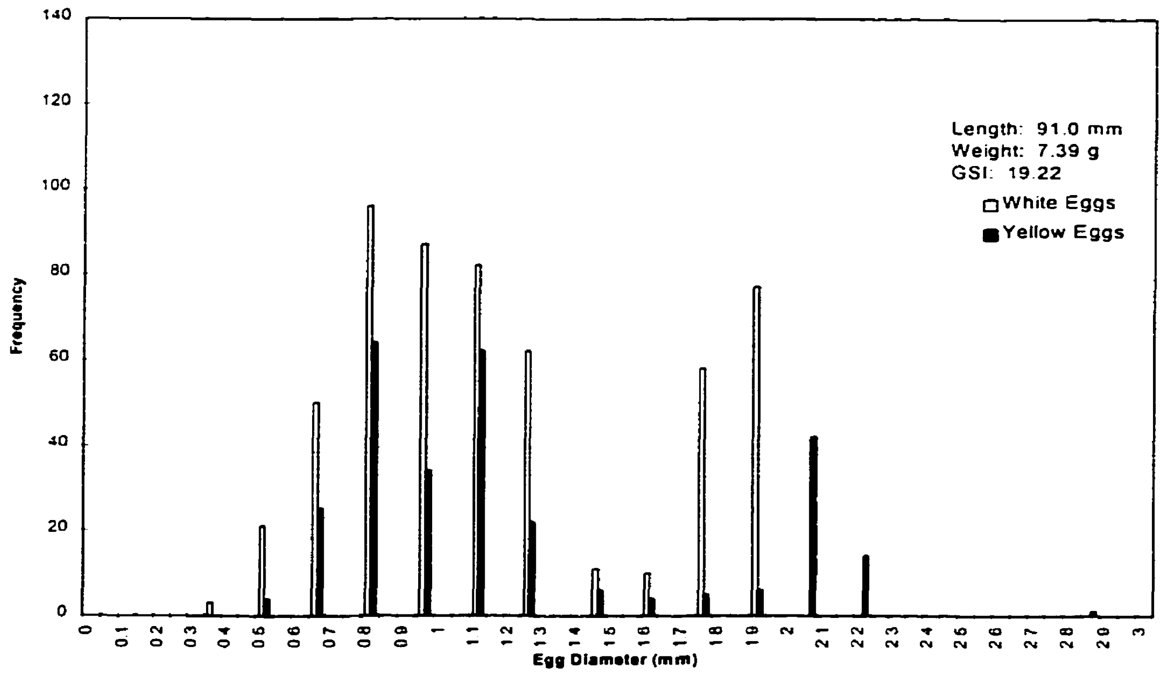
Appendix 2 Figure 9 Total length (mm) frequency of trout-perch collected at the three habitat types sampled. July, 1996. N = 997 fish.



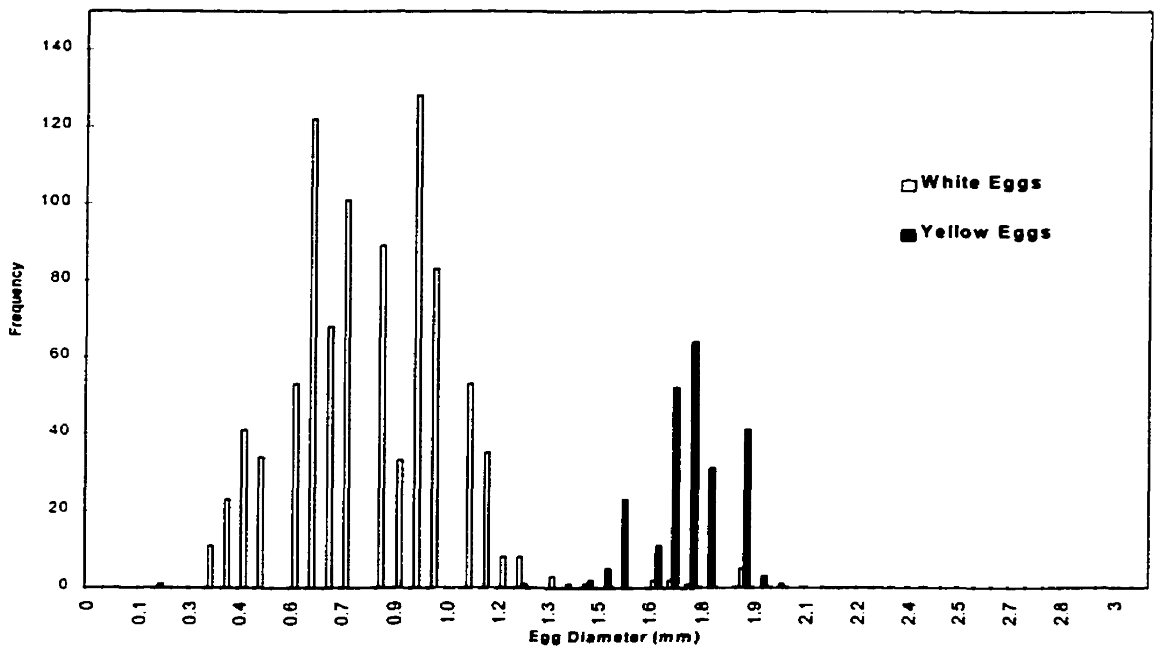
Appendix 2 Figure 10 Total length (mm) frequency of trout-perch collected at the three habitat types sampled. August, 1996. N = 1793 fish.

Appendix 3

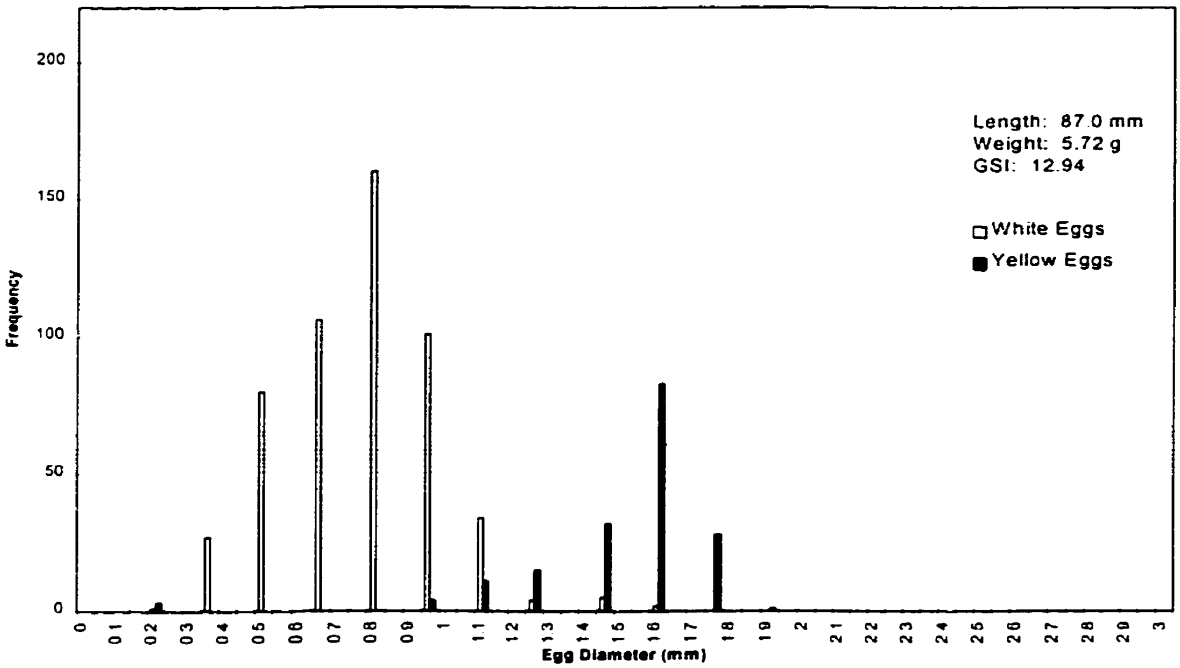
Trout-perch frequency distributions of egg diameters taken from both ovaries, 1996.



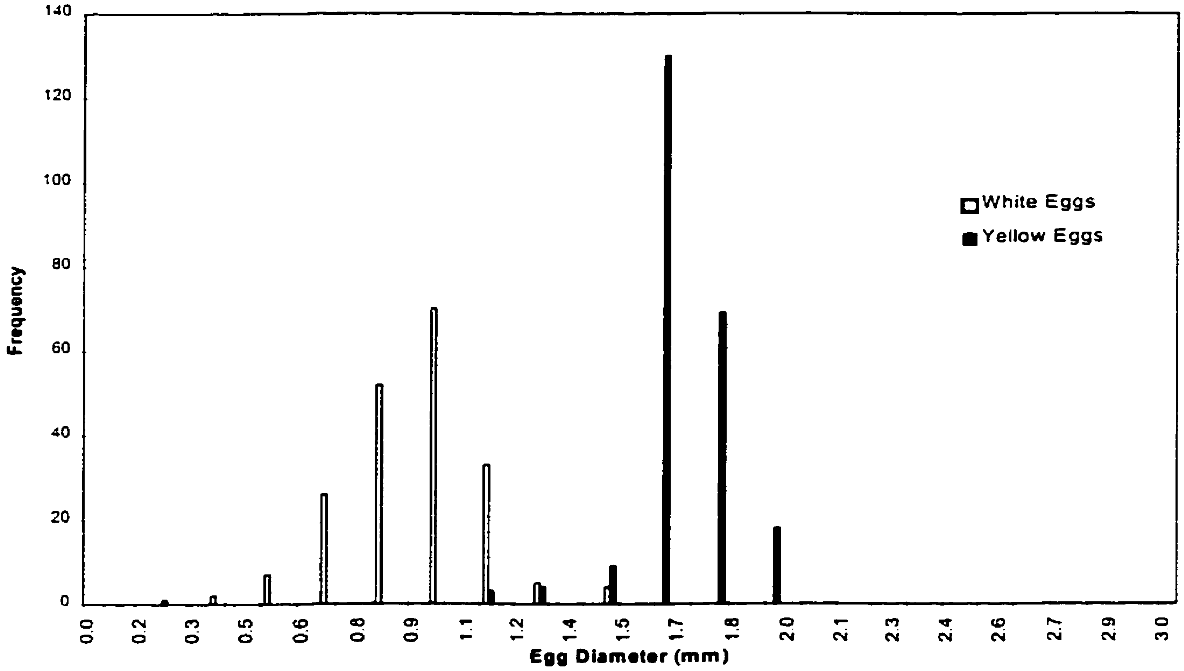
Appendix 3 Figure 1. Frequency distribution of n = 846, trout-perch egg diameters. Taken from a single ovary during spawning. May 7, 1996.



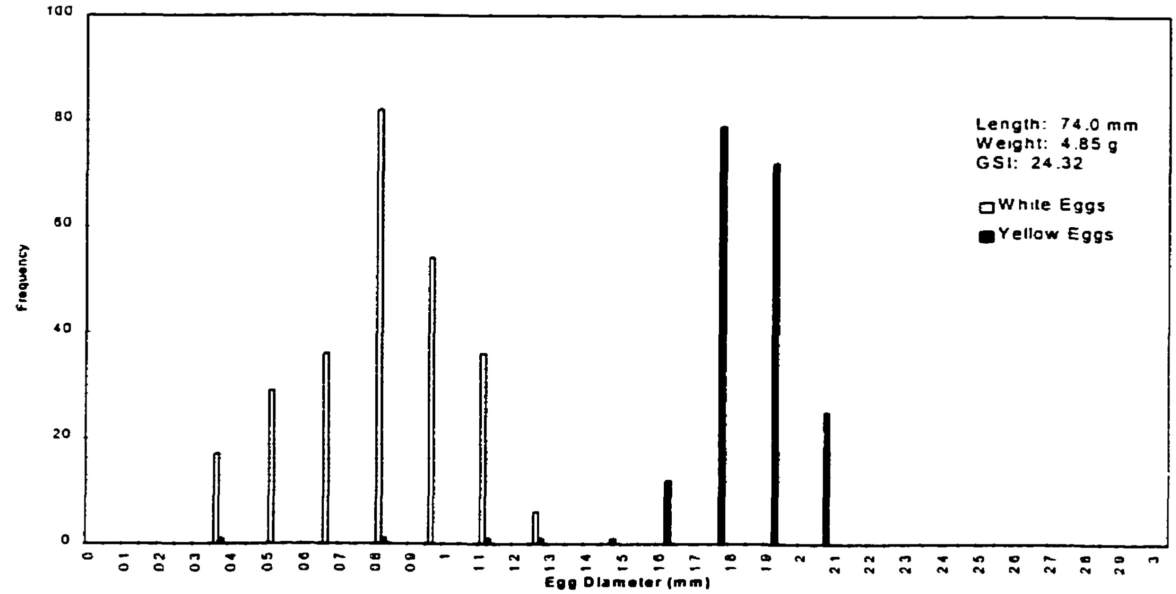
Appendix 3 Figure 2. Frequency distribution of n =1142, trout-perch egg diameters. Taken from a single ovary during spawning. May 14, 1996.



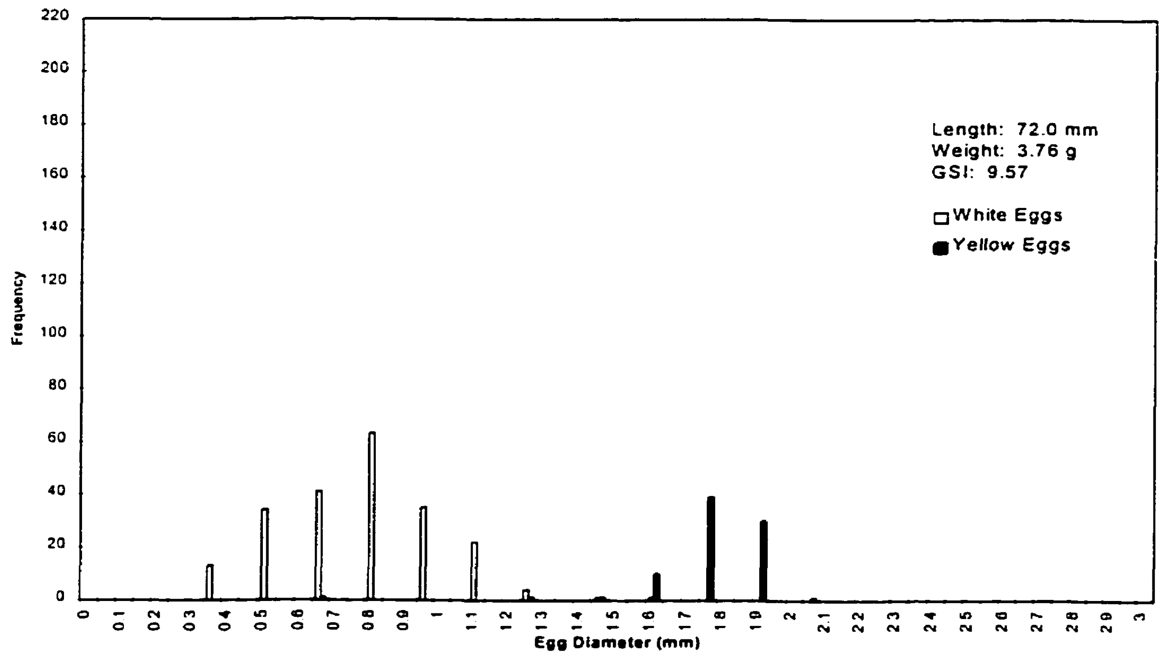
Appendix 3 Figure 3. Frequency distribution of n = 967, trout-perch egg diameters. Taken from a single ovary during spawning. May 24, 1996.



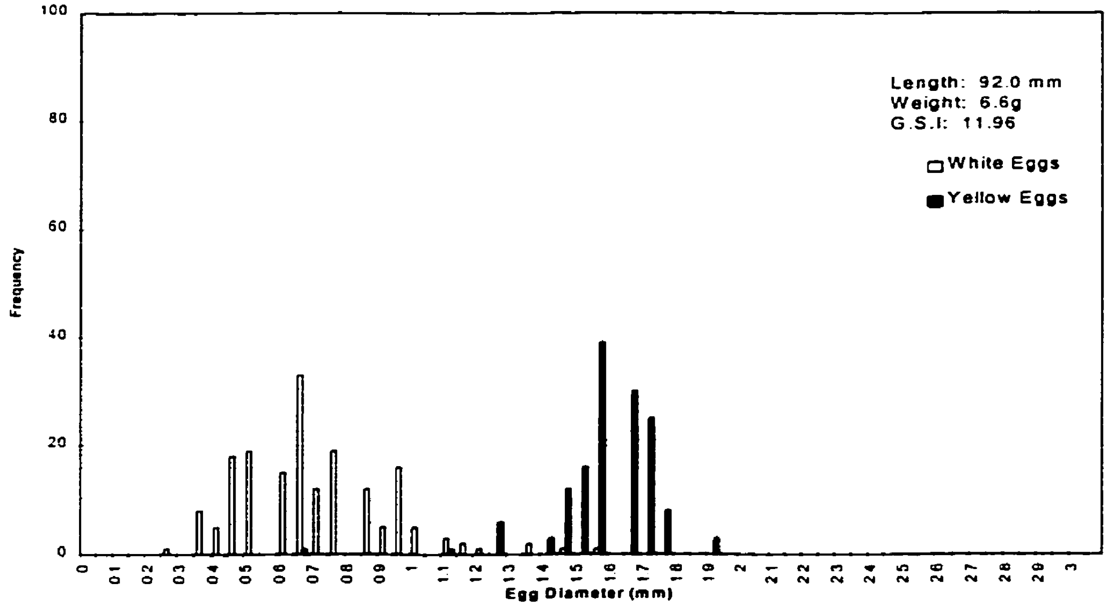
Appendix 3 Figure 4. Frequency distribution of n = 433, trout-perch egg diameters. Taken from a single ovary during spawning. June 14, 1996.



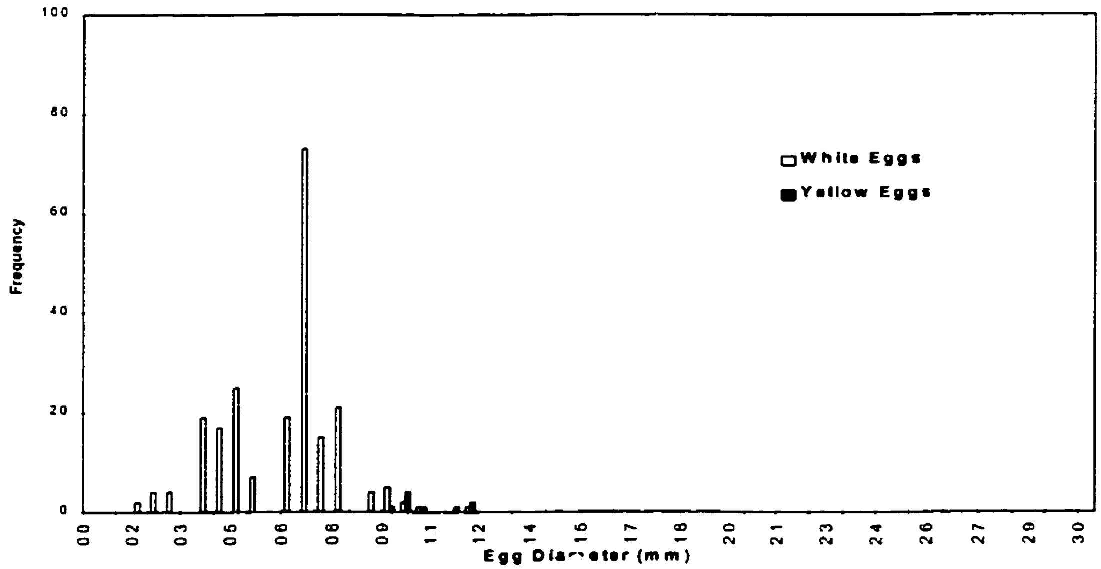
Appendix 3 Figure 5. Frequency distribution of n = 453, trout-perch egg diameters. Taken from a single ovary during spawning. June 20, 1996.



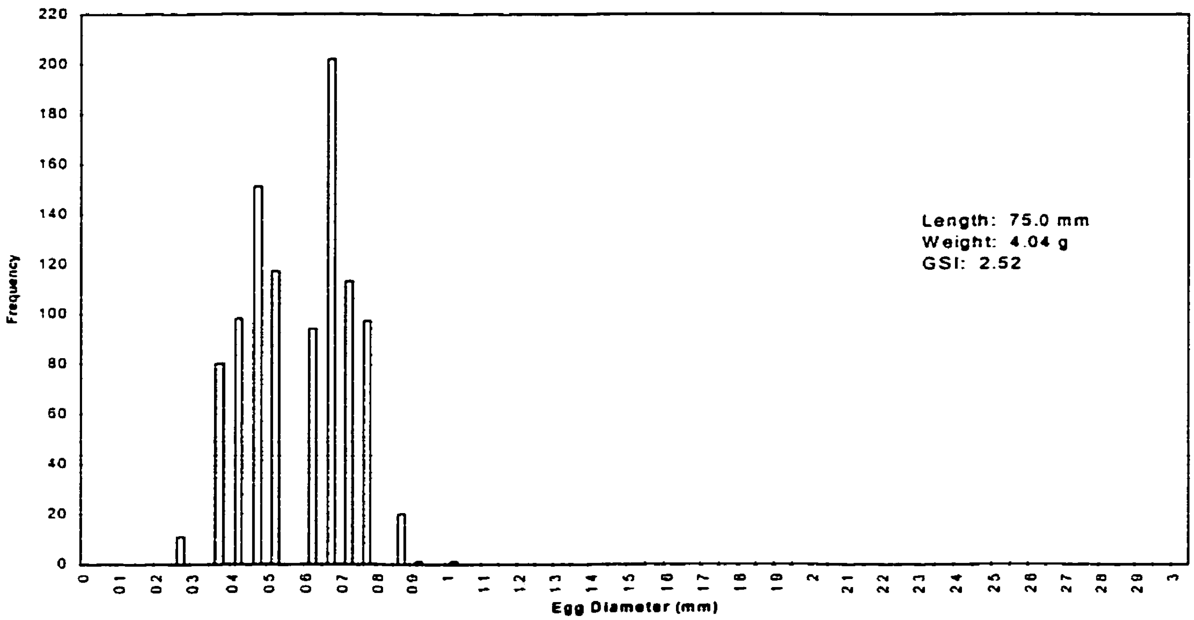
Appendix 3 Figure 6. Frequency distribution of n = 297, trout-perch egg diameters. Taken from a single ovary during spawning. July 7, 1996.



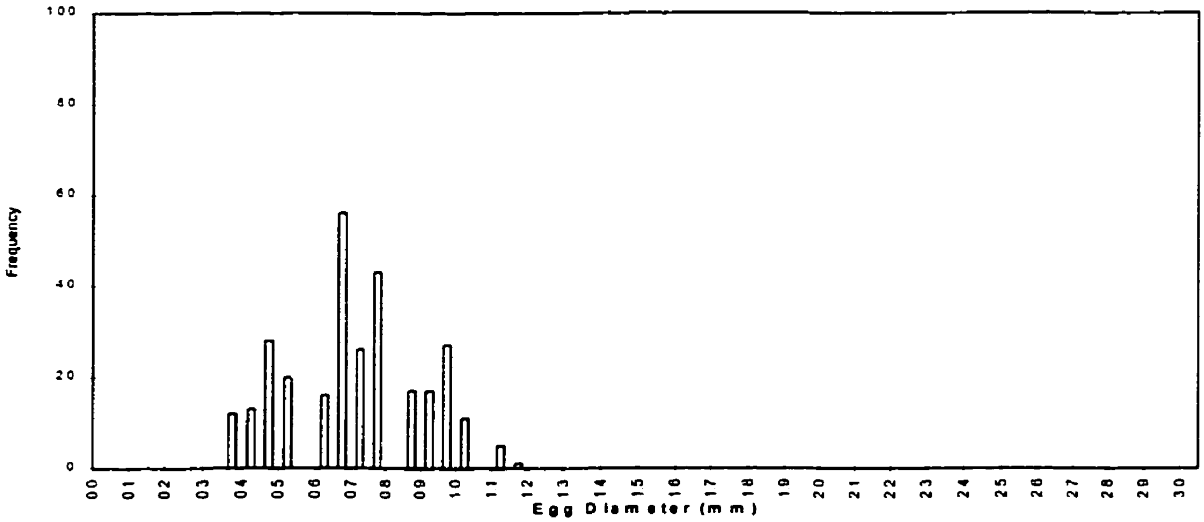
Appendix 3 Figure 7. Frequency distribution of n = 324, trout-perch egg diameters. Taken from a single ovary during spawning. July 16, 1996.



Appendix 3 Figure 8. Frequency distribution of n = 228, trout-perch egg diameters. Taken from a single ovary during spawning. July 25, 1996.



Appendix 3 Figure 9. Frequency distribution of n = 985, trout-perch egg diameters. Taken from a single ovary during spawning. August 12, 1996. All eggs were white in colour.



Appendix 3 Figure 10. Frequency distribution of n = 293 , trout-perch egg diameters. Taken from a single ovary during spawning. August 21, 1996. All eggs were white in colour.

Appendix 4

Trout-perch raw data used in power analysis for Environmental Effects Monitoring evaluation.

MALE 95

MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
5	17	1	2	1	8	1.4	55	0.84		3	3	M			1
5	17	1	2	1	10	0.8	45	0.88		3	3	M			1
5	18	1	2	1	26	2.0	59	0.97		4	3	M			3
5	18	1	2	1	27	1.9	57	1.03		4	3	M			1
5	18	1	2	1	29	1.0	46	1.03		4	3	M			1
5	18	1	2	1	30	0.9	48	0.81		4	3	M			1
5	18	1	2	1	38	2.2	62	0.92		5	3	M			3
5	19	1	2	1	49	1.7	57	0.92		6	1	M			1
5	30	1	3	1	110	1.3	53	0.87		2	2	M			1
5	31	1	3	1	141	2.3	61	1.01		3	3	M			3
5	31	1	3	1	143					3	3	M			3
5	31	1	3	1	144	1.3	50	1.04		3	3	M			1
5	19	1	2	1		1.9	60	0.88		6	1	M			3
6	6	1	3	1	242	2.18	58	1.12		8	2	M		0.04	2
6	6	1	3	1	248	1.49	53	1.00		8	2	M		0.01	1
6	6	1	3	1	249	1.55	54	0.98		8	2	M		0.05	1
6	7	1	3	1	278	2	55	1.20		3	3	M		0.18	2
6	14	1	4	1	349	1.9	61	0.84	2	3	3	M			3
6	14	1	4	1	350	2.1	61	0.93	1	3	3	M			3
6	14	1	4	1	351	2	61	0.88	2	3	3	M			3
6	14	1	4	1	360	1.99	59	0.97	2	3	3	M			3
6	14	1	4	1	361	1.86	56	1.06	2	3	3	M			3
6	14	1	4	1	362	1.76	55	1.06	1	3	3	M			3
6	14	1	4	1	363	1.9	57	1.00	2	3	3	M			3
6	14	1	4	1	364	1.93	59	0.94	2	3	3	M			3
6	14	1	4	1	365	1.41	55	0.85	1	3	3	M			3
6	14	1	4	1	366	1.94	58	0.99	2	3	3	M			3
6	14	1	4	1	367	1.12	50	0.90	1	3	3	M			3
6	14	1	4	1	368	2.35	60	1.09	2	3	3	M			3
6	14	1	4	1	369	2.18	59	1.06	1	3	3	M			3
6	14	1	4	1	370	2.1	58	1.08	1	3	3	M			3
6	14	1	4	1	371	2.1	57	1.13	2	3	3	M			3
6	14	1	4	1	373	1.38	50	1.10	1	3	3	M			3
6	14	1	4	1	374	1.92	59	0.93	2	3	3	M			3
6	14	1	4	1	375	2.1	61	0.93		3	3	M			3

MALE 95

MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
6	14	1	4	1	386	2	58	1.03		3	3	M			3
6	15	1	4	1	399	2.48	62	1.04	2	5	3	M		0.18	2
6	20	1	4	1	508	2.6	65	0.95		1	1	M			2
6	20	1	4	1	537	2.1	61	0.93	1	8	2	M		0.160	2
6	20	1	4	1	541	3	64	1.14	2	8	2	M			2
6	21	1	4	1	545	2.2	59	1.07	2	3	3	M			1
6	21	1	4	1	549	2.4	64	0.92	2	3	3	M	0.032	0.084	2
6	21	1	4	1	572	2.6	57	1.40	1	3	3	M			3
6	21	1	4	1	578	1.7	55	1.02	2	3	3	M			3
6	21	1	4	1	580	2.1	60	0.97	2	3	3	M			3
6	22	1	4	1	612	1.9	58	0.97	2	4	3	M	0.026	0.058	1
6	22	1	4	1	615	3.0	66	1.04	3	4	3	M	0.104	0.038	2
6	22	1	4	1	623	2.0	65	0.73	2	4	3	M	0.042	0.034	2
6	22	1	4	1	626	2.8	63	1.12	3	4	3	M	0.056	0.03	2
6	7	1	3	1		5.5	82	1.00		3	3	M			3
6	7	1	3	1		2.01	54	1.28		3	3	M			3
6	7	1	3	1		2	60	0.93		3	3	M			3
6	7	1	3	1		1.99	55	1.20		3	3	M			3
6	1	1	3	1		3.7	76	0.84		4	3	M			3
6	1	1	3	1		2.2	62	0.92		4	3	M			3
6	1	1	3	1		2.9	69	0.88		4	3	M			3
6	1	1	3	1		3.1	70	0.90		4	3	M			3
6	1	1	3	1		2.3	64	0.88		4	3	M			3
6	1	1	3	1		2.6	66	0.90		4	3	M			3
6	1	1	3	1		2.2	65	0.80		4	3	M			3
6	1	1	3	1		1	53	0.67		4	3	M			3
6	1	1	3	1		2	63	0.80		4	3	M			3
6	1	1	3	1		2.1	60	0.97		4	3	M			3
6	1	1	3	1		1.8	60	0.83		4	3	M			3
6	1	1	3	1		1.8	59	0.88		4	3	M			3
6	1	1	3	1		1.7	56	0.97		4	3	M			3
6	1	1	3	1		2	58	1.03		4	3	M			3
6	1	1	3	1		2.2	59	1.07		4	3	M			3
6	1	1	3	1		1.7	55	1.02		4	3	M			3
6	1	1	3	1		1.4	53	0.94		4	3	M			3

MALE 95

MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
6	1	1	3	1		2.2	63	0.88		4	3	M			3
6	1	1	3	1		1.8	58	0.92		4	3	M			3
6	1	1	3	1		2	61	0.88		4	3	M			3
6	1	1	3	1		1.8	57	0.97		4	3	M			3
6	1	1	3	1		2	58	1.03		4	3	M			3
6	1	1	3	1		1.8	60	0.83		4	3	M			3
6	1	1	3	1		1.8	59	0.88		4	3	M			3
6	1	1	3	1		0.4	36	0.86		4	3	M			1
6	1	1	3	1		0.5	35	1.17		4	3	M			1
6	1	1	3	1		2.6	67	0.86		5	3	M			3
6	5	1	3	1		2.22	60	1.03		6	1	M			3
6	5	1	3	1		2.12	60	0.98		6	1	M			3
6	7	1	3	1		2.24	59	1.09		3	3	M			3
6	7	1	3	1		2.27	61	1.00		3	3	M			3
6	7	1	3	1		1.79	55	1.08		3	3	M			3
6	13	1	4	1		2.2	59	1.07		8	2	M			3
6	13	1	4	1		2	61	0.88		8	2	M			3
7	12	1	6	1	1000	3.07	69	0.93	3	1	1	M	0.026	0.04	2
7	12	1	6	1	1004	3.42	71	0.96	3	1	1	M	0.050	0.084	2
7	12	1	6	1	1008	2.16	65	0.79	2	1	1	M	0.030	0.028	2
7	12	1	6	1	1011	2.24	64	0.85	2	1	1	M	0.024	0.014	2
7	11	1	6	1	1022	3.02	67	1.00	3	8	2	M	0.048	0.25	2
7	11	1	6	1	1023		59			8	2	M	0.036	0.010	1
7	12	1	6	1	1031	3.39	70	0.99	2	3	3	M	0.072	0.008	2
7	12	1	6	1	1039	2.32	61	1.02	2	3	3	M	0.020	0.006	1
7	13	1	6	1	1057	2.58	65	0.94		9	1	M	0.034		2
8	10	1	8	2	1342	2.4	67	0.80	2	10	1	M	0.034		2
8	10	1	8	2	1343	3.5	74	0.86	3	10	1	M	0.038	0.018	2
8	31	1	9	2	1602	3.53	75	0.84	4	8	2	M	0.046	0.38	2
8	31	1	9	2	1603	3.79	76	0.86	3	8	2	M	0.036	0.044	2
8	31	1	9	2	1604	3.78	79	0.77	4	8	2	M	0.038	0.054	2
8	31	1	9	2	1605	3.96	77	0.87	3	8	2	M	0.042	0.084	2
8	31	1	9	2	1607		77			8	2	M	0.036	0.04	2
9	6	1	10	2	1625	1.57	56	0.89	1	9	1	M	0.012	0.01	1
9	6	1	10	2	1627	1.12	52	0.80	1	9	1	M	0.16	0.012	1

MALE 95

MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
9	6	1	10	2	1629	4.04	77	0.88	3	9	1	M	0.046	0.064	2
9	6	1	10	2	1638	3.1	73	0.80	3	9	1	M	0.042	0.04	2
9	12	1	10	2	1659	4.1	74	1.01	4	5	3	M	0.05	0.076	2
9	12	1	10	2	1660	3.89	77	0.85	3	5	3	M	0.03	0.05	2
9	12	1	10	2	1661	3.22	74	0.79	3	5	3	M	0.036	0.03	2
9	27	1	11	2	1720	4.21	80	0.82	3	3	3	M	0.066	0.096	2
10	11	1	12	2	1800	4.12	79	0.84	3	9	1	M	0.06	0.115	2
10	11	1	12	2	1802	1.34	57	0.72	2	9	1	M	0.022	0.012	2
10	11	1	12	2	1803	1.1	52	0.78	1	9	1	M	0.02	0.024	2
10	13	1	12	2			75			11	2	M			2
10	13	1	12	2			72			11	2	M			2
10	13	1	12	2			76			11	2	M			2
10	13	1	12	2			73			11	2	M			2
10	13	1	12	2			73			11	2	M			2

FEMALE 95

MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
5	17	1	2	1	9	1.6	55	0.96		3	3	F			1
5	17	1	2	1	11	0.9	45	0.99		3	3	F			1
5	17	1	2	1	12	0.9	46	0.92		3	3	F			1
5	18	1	2	1	28	1.5	55	0.90		4	3	F			1
5	18	1	2	1	31	0.4	36	0.86		4	3	F			1
5	18	1	2	1	32	2.8	69	0.85		5	3	F			4
5	18	1	2	1	34	5.7	82	1.03		5	3	F			4
5	18	1	2	1	35	5.3	82	0.96		5	3	F			4
5	18	1	2	1	37	6.8	87	1.03		5	3	F			4
5	18	1	2	1	39	3.3	68	1.05		5	3	F			4
5	18	1	2	1	40	2	59	0.97		5	3	F			1
5	19	1	2	1	46	3.6	73	0.93		6	1	F			4
5	19	1	2	1	47	2.9	66	1.01		6	1	F			4
5	19	1	2	1	48	3.2	71	0.89		6	1	F			4
5	19	1	2	1	52	2.0	61	0.88		7	1	F			3
5	30	1	3	1	100	1.3	44	1.53		1	1	F			1
5	30	1	3	1	101	1.5	57	0.81		1	1	F			1
5	30	1	3	1	102	1.8	58	0.92		1	1	F			1
5	30	1	3	1	103	1.2	53	0.81		1	1	F			1
5	30	1	3	1	104	1.2	57	0.65		1	1	F			1
5	30	1	3	1	105	0.7	44	0.82		1	1	F			1
5	30	1	3	1	113	0.7	43	0.88		2	2	F			1
5	30	1	3	1	119	0.6	40	0.94		2	2	F			1
5	30	1	3	1	120	0.6	39	1.01		2	2	F			1
5	30	1	3	1	121	0.7	49	0.59		2	2	F			1
5	31	1	3	1	142	1.7	55	1.02		3	3	F			1
5	31	1	3	1	145	0.8	48	0.72		3	3	F			1
5	31	1	3	1	146	0.8	47	0.77		3	3	F			1
5	19	1	2	1		1.5	55	0.90		6	1	F			1
6	5	1	3	1	201	2.19	60	1.01		6	1	F			1
6	5	1	3	1	202	2.41	64	0.92		6	1	F			2
6	5	1	3	1	203	2.27	60	1.05		6	1	F			1
6	6	1	3	1	222		57			1	1	F			1
6	6	1	3	1	223	1.56	53	1.05		1	1	F			1
6	6	1	3	1	230	6.22	84	1.05		8	2	F		0.76	3

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
6	6	1	3	1	232	3.03	66	1.05		8	2	F		0.3	3
6	6	1	3	1	234	3.16	68	1.00		8	2	F		0.17	2
6	6	1	3	1	235	3.53	71	0.99		8	2	F		0.3	3
6	6	1	3	1	237	3.1	67	1.03		8	2	F		0.21	3
6	6	1	3	1	239	3.96	72	1.06		8	2	F		0.59	3
6	6	1	3	1	241	3.25	69	0.99		8	2	F		0.26	3
6	6	1	3	1	243	3.15	68	1.00		8	2	F		0.45	3
6	6	1	3	1	244	3.52	69	1.07		8	2	F		0.39	3
6	6	1	3	1	246	5.57	83	0.97		8	2	F		0.51	3
6	6	1	3	1	247	5.82	81	1.10		8	2	F		1.05	4
6	6	1	3	1	262	4.4	76	1.00		8	2	F		0.51	3
6	7	1	3	1	270	5.74	84	0.97		3	3	F		0.46	3
6	7	1	3	1	272	3.92	75	0.93		3	3	F		0.24	3
6	7	1	3	1	276	2.83	65	1.03		3	3	F			
6	7	1	3	1	285	2.63	67	0.87		3	3	F		0.12	2
6	7	1	3	1	287	4	66	1.39		3	3	F		0.59	3
6	8	1	3	1	292	2.25	64	0.86		4	3	F		0.04	2
6	8	1	3	1	297	3.77	68	1.20		5	3	F		0.57	3
6	8	1	3	1	298	2.7	68	0.86		5	3	F		0.12	2
6	13	1	4	1	301	2.47	64	0.94		1	1	F		0.07	2
6	13	1	4	1	302	2.92	69	0.89		1	1	F		0.18	2
6	13	1	4	1	303	2.78	67	0.92		1	1	F		0.24	3
6	13	1	4	1	309	2.4	62	1.01	2	8	2	F			4
6	13	1	4	1	310	3.1	68	0.99	2	8	2	F			4
6	13	1	4	1	311	3.1	68	0.99	2	8	2	F			4
6	13	1	4	1	316	1.9	60	0.88	2	8	2	F			4
6	13	1	4	1	318	2.4	63	0.96	2	8	2	F			4
6	13	1	4	1	319	1.6	52	1.14	2	8	2	F			4
6	13	1	4	1	323	5.1	80	1.00	3	8	2	F		0.85	3
6	14	1	4	1	352	3.7	71	1.03	3	3	3	F			4
6	14	1	4	1	353	2.6	67	0.86	2	3	3	F			4
6	14	1	4	1	354	5.6	89	0.79	3	3	3	F		0.42	3
6	14	1	4	1	372	3.02	69	0.92	2	3	3	F			4
6	14	1	4	1	382	2.8	68	0.89		3	3	F			4
6	14	1	4	1	383	5.8	84	0.98	3	3	3	F		0.36	3

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
6	14	1	4	1	384	3.8	74	0.94	2	3	3	F			4
6	14	1	4	1	385	2.1	62	0.88	1	3	3	F			2
6	15	1	4	1	402	1.95	65	0.71	2	5	3	F			4
6	15	1	4	1	405	2.24	59	1.09	2	5	3	F			4
6	13	1	4	1	436	3.44	72	0.92		1	1	F		0.36	3
6	20	1	4	1	535	2.6	63	1.04		8	2	F			4
6	20	1	4	1	540	3.6	75	0.85		8	2	F			5
6	20	1	4	1	542	2.8	67	0.93	2	8	2	F		0.3	3
6	21	1	4	1	546	3.6	73	0.93	3	3	3	F	0.138	0.442	3
6	21	1	4	1	548	3.5	71	0.98	3	3	3	F	0.09	0.33	3
6	21	1	4	1	550	4.68	75	1.11	3	3	3	F	0.14	0.23	3
6	21	1	4	1	551	4.7	81	0.88	3	3	3	F	0.134	0.358	3
6	21	1	4	1	552	3.5	73	0.90	3	3	3	F	0.060	0.052	2
6	21	1	4	1	553	5.4	83	0.94	3	3	3	F	0.17	0.49	3
6	21	1	4	1	554	3.7	75	0.88	3	3	3	F	0.114	0.216	3
6	21	1	4	1	555	1.84	56	1.05	2	3	3	F	0.034	0.010	2
6	21	1	4	1	556	1.7	60	0.79	2	3	3	F	0.044	0.020	2
6	21	1	4	1	558	3.4	72	0.91	2	3	3	F			4
6	21	1	4	1	559	1.9	60	0.88	2	3	3	F	0.040		2
6	21	1	4	1	565	4.7	76	1.07	3	3	3	F			4
6	21	1	4	1	573	1.8	55	1.08	2	3	3	F			4
6	21	1	4	1	582	2.6	62	1.09	2	3	3	F			4
6	21	1	4	1	584	4.5	80	0.88	2	3	3	F			4
6	21	1	4	1	587	2.4	62	1.01	1	3	3	F			4
6	22	1	4	1	610	1.86	75	0.44	2	4	3	F	0.11	0.39	3
6	22	1	4	1	611	5.8	85	0.94	3	4	3	F	0.148	0.896	3
6	22	1	4	1	613	4.6	80	0.90	2	4	3	F	0.106	0.26	3
6	22	1	4	1	614	2.71	65	0.99	2	4	3	F	0.038	0.166	3
6	22	1	4	1	617	3.14	67	1.04	2	4	3	F	0.066	0.032	2
6	22	1	4	1	627	3.45	66	1.20	2	4	3	F	0.16	0.456	3
6	22	1	4	1	629	3.6	70	1.05	2	4	3	F	0.082	0.082	2
6	22	1	4	1	631	3.65	69	1.11	2	4	3	F	0.074	0.124	2
6	22	1	4	1	635	1.38	47	1.33	1	4	3	F	0.034		1
6	22	1	4	1	656	2.7	65	0.98	2	5	3	F	0.06	0.132	2
6	13	1	4	1		2.5	65	0.91		1	1	F			4

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
6	13	1	4	1		3.6	72	0.96		1	1	F			4
6	7	1	3	1		3.5	71	0.98		3	3	F			4
6	8	1	3	1		2.8	64	1.07		5	3	F			4
6	15	1	4	1		1.68	55	1.01		5	3	F			4
6	15	1	4	1		2.2	62	0.92		5	3	F			4
6	15	1	4	1		2.2	60	1.02		5	3	F			4
6	15	1	4	1		2.1	60	0.97		5	3	F			4
6	13	1	4	1		4.5	80	0.88		8	2	F			4
6	7	1	3	1		2.83	66	0.98		3	3	F			4
6	7	1	3	1		1.54	55	0.93		3	3	F			1
6	7	1	3	1		1.8	55	1.08		3	3	F			1
6	15	1	4	1		2.23	61	0.98		5	3	F			4
6	15	1	4	1		2.01	59	0.98		5	3	F			4
6	15	1	4	1		4.87	75	1.15		5	3	F			4
6	15	1	4	1		2.51	61	1.11		5	3	F			4
6	13	1	4	1		3	69	0.91		8	2	F			4
6	13	1	4	1		2.7	64	1.03		8	2	F			4
6	13	1	4	1		2.1	59	1.02		8	2	F			4
6	13	1	4	1		3	66	1.04		8	2	F			4
6	13	1	4	1		2.5	64	0.95		8	2	F			4
6	13	1	4	1		2.5	66	0.87		8	2	F			4
6	13	1	4	1		3.4	70	0.99		8	2	F			4
6	13	1	4	1		2.4	64	0.92		8	2	F			4
6	13	1	4	1		2.2	67	0.73		8	2	F			4
6	13	1	4	1		2.7	66	0.94		8	2	F			4
6	13	1	4	1		1.9	56	1.08		8	2	F			4
6	13	1	4	1		2.8	67	0.93		8	2	F			4
6	13	1	4	1		2.6	63	1.04		8	2	F			4
6	22	1	4	1	624	3.2	68	1.02		4	3	F	0.068	0.075	2
7	12	1	6	2	1002	2.91	70	0.85	3	1	1	F	0.114	0.260	3
7	12	1	6	2	1003	2.49	66	0.87	2	1	1	F	0.046	0.206	3
7	12	1	6	2	1009	3.07	70	0.90	3	1	1	F	0.058	0.058	2
7	12	1	6	2	1012	1.86	58	0.95	1	1	1	F	0.022	0.014	2
7	11	1	6	2	1019	3.68	74	0.91	2	8	2	F	0.120	0.284	3
7	11	1	6	2	1024	5.65	80	1.10	3	8	2	F	0.138	0.64	3

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
7	12	1	6	2	1030	4.54	77	0.99	3	3	3	F	0.094	0.060	2
7	12	1	6	2	1032	2.8	66	0.97	2	3	3	F	0.0052	0.034	2
7	12	1	6	2	1033	4.5	76	1.02	3	3	3	F	0.108	0.330	3
7	12	1	6	2	1034	3.58	74	0.88	3	3	3	F	0.056	0.016	2
7	12	1	6	2	1035	3.6	72	0.96	3	3	3	F	0.072	0.048	2
7	12	1	6	2	1036	2.36	65	0.86	2	3	3	F	0.046	0.020	2
7	12	1	6	2	1037	2.57	63	1.03	2	3	3	F	0.042	0.028	2
7	12	1	6	2	1038	2.4	62	1.01	2	3	3	F	0.052	0.020	2
7	12	1	6	2	1046	1.77	57	0.96	2	5	3	F	0.042	0.014	2
7	12	1	6	2	1047	3.1	70	0.90	3	5	3	F	0.074	0.216	3
7	13	1	6	2	1053	6.2	86	0.97	3	9	1	F	0.196	0.564	3
7	13	1	6	2	1055	4.08	75	0.97	3	9	1	F	0.042	0.070	2
8	3	1	7	2	1204	2.0	64	0.76	2	9	1	F	0.122	0.118	2
8	3	1	7	2	1205	3.17	74	0.78	3	9	1	F	0.104	0.702	3
8	3	1	7	2	1206	5.9	87	0.90	3	9	1	F	0.156	0.158	2
8	3	1	7	2	1207	4.0	74	0.99	3	9	1	F	0.038	0.098	2
8	10	1	8	2	1344	3.75	77	0.82	3	10	1	F	0.050	0.86	3
8	31	1	9	2	1600	3.94	85	0.64	3	8	2	F	0.052	0.34	3
8	31	1	9	2	1601	2.06	73	0.53	3	8	2	F	0.038	0.154	3
8	31	1	9	2	1606	3.69	77	0.81	3	8	2	F	0.052	0.15	3
8	31	1	9	2	1608	4.17	81	0.78	3	8	2	F	0.06	0.204	3
8	3	1	7	2		3.6	74	0.89		9	1	F			2
8	3	1	7	2		2.0	62	0.84		9	1	F			2
8	3	1	7	2		0.8	46	0.82		9	1	F			1
8	3	1	7	2		3.5	74	0.86		9	1	F			2
8	3	1	7	2		3.2	71	0.89		9	1	F			2
8	3	1	7	2		2.8	68	0.89		9	1	F			2
9	6	1	10	2	1616	0.35	34	0.89	1	9	1	F			1
9	6	1	10	2	1626	1.66	59	0.81	1	9	1	F	0.022	0.38	3
9	6	1	10	2	1628	5.36	86	0.84	3	9	1	F	0.07	0.22	3
9	6	1	10	2	1632	4.1	79	0.83		9	1	F			
9	6	1	10	2	1633	7.2	95	0.84	4	9	1	F	0.096	0.326	3
9	12	1	10	2	1662	3.38	75	0.80	3	5	3	F	0.034	0.18	3
9	12	1	10	2	1663	3.63	75	0.86	3	5	3	F	0.042	0.184	3
9	12	1	10	2	1664	2.8	68	0.89	2	5	3	F	0.028	0.114	3

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
9	26	1	11	2	1704	2.2	63	0.88	1	8	2	F	0.04	0.08	2
9	26	1	11	2	1705	3.15	75	0.75	3	8	2	F	0.067	0.2	3
9	26	1	11	2	1705-1	5.44	86	0.86	3	8	2	F	0.106	0.388	3
9	27	1	11	2	1718	6.96	94	0.84	4	3	3	F	0.158	0.43	3
9	27	1	11	2	1719	5.27	85	0.86	3	3	3	F	0.094	0.362	3
10	11	1	12	2	1801	4.16	81	0.78	3	9	1	F	0.122	0.272	3
10	15	1	13	2	1827	10.8	108	0.86	4	3	3	F	0.267	0.86	3
10	13	1	12	2			76			11	2	F			2
10	13	1	12	2			85			11	2	F			3
10	13	1	12	2			80			11	2	F			3
10	13	1	12	2			78			11	2	F			3
10	13	1	12	2			83			11	2	F			3
10	13	1	12	2			74			11	2	F			3
10	13	1	12	2			84			11	2	F			3

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
5	7	2	1	1	96005	2.44	64	0.93	2	3	3	M	0.05	0.22	1
5	7	2	1	1	96010	4.78	79	0.97	3	3	3	M	0.07	0.61	2
5	7	2	1	1	96014	7.24	91	0.96	4	3	3	M	0.12	1.08	2
5	8	2	1	1	96017	1.54	55	0.93	1	5	3	M	0.04	0.2	3
5	8	2	1	1	96018	4.6	78	0.97	3	5	3	M	0.11	0.64	2
5	8	2	1	1	96019	1.7	56	0.97	1	5	3	M	0.05	0.18	2
5	8	2	1	1	96021	4.24	75	1.01	3	8	2	M	0.05	0.72	2
5	9	2	1	1	96022	4.86	79	0.99	3	9	1	M	0.09	0.82	3
5	9	2	1	1	96025	4.31	79	0.87	3	9	1	M	0.08	0.55	3
5	9	2	1	1	96027	3.8	73	0.98	3	9	1	M	0.07	0.55	3
5	9	2	1	1	96028	4.7	79	0.95	3	9	1	M	0.08	0.66	3
5	9	2	1	1	96031	3.77	72	1.01	3	9	1	M	0.06	0.51	3
5	14	2	2	1	96038	3.19	71	0.89	3	3	3	M	0.05	0.16	1
5	14	2	2	1	96041	3.33	74	0.82	3	3	3	M		0.46	3
5	14	2	2	1	96042	3.41	73	0.88	3	3	3	M	0.04	0.44	3
5	14	2	2	1	96045	1.84	57	0.99	1	3	3	M	0.03	0.21	3
5	15	2	2	1	96048	1.74	59	0.85	2	1	1	M	0.03	0.18	3
5	15	2	2	1	96049	1.32	53	0.89	1	1	1	M	0.03	0.17	3
5	15	2	2	1	96050	1.32	55	0.79	1	1	1	M	0.02	0.17	3
5	22	2	2	1	96064	4.26	80	0.83	3	8	2	M	0.06	0.46	3
5	22	2	2	1	96065	3.63	73	0.93	3	8	2	M	0.08	0.41	3
5	22	2	2	1	96067	4.25	77	0.93	3	8	2	M	0.06	0.42	3
5	22	2	2	1	96068	4.53	81	0.85	3	8	2	M	0.1	0.37	3
5	22	2	2	1	96069	4.77	85	0.78	3	8	2	M	0.07	0.39	3
6	14	2	4	1	96198	4.08	74	1.01	3	12	2	M	0.06	0.29	3
6	17	2	4	1	96209	2.2	60	1.02	2	9	1	M	0.02	0.13	3
6	17	2	4	1	96210	1.86	59	0.91	2	9	1	M	0.01	0.15	
6	17	2	4	1	96211	2.05	61	0.90	2	9	1	M	0.02	0.14	3
6	20	2	4	1	96236	3.62	74	0.89	3	13	1	M	0.06	0.32	3
6	20	2	4	1	96238	1.25	51	0.94	1	13	1	M	0.02	0.12	3
6	20	2	4	1	96240	1.61	55	0.97	1	13	1	M	0.02	0.18	3
6	20	2	4	1	96241	1.54	55	0.93	1	13	1	M	0.02	0.11	3
6	20	2	4	1	96243	1.65	55	0.99	1	13	1	M	0.02	0.16	3
6	20	2	4	1	96244	1.75	56	1.00	1	13	1	M	0.02	0.19	3
7	9	2	6	1	96267	2.7	66	0.94	2	LR	3	M			1

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
7	16	2	6	2	96272		64		2	20	2	M			4
7	26	2	7	2	96308	6.34	94	0.76	4	13	1	M	0.13	0.19	
7	31	2	7	2	96310		64			15	2	M			1
7	31	2	7	2	96311		59			15	2	M			1
7	31	2	7	2	96312		59			15	2	M			1
7	31	2	7	2	96313		58			15	2	M			1
8	13	2	8	2	96362	3.42	75	0.81	3	12	2	M	0.044	0.0234	4
8	14	2	8	2	96368	2.73	64	1.04	2	4	3	M		0.01	2
8	14	2	8	2	96372	3.42	68	1.09	2	4	3	M	0.06	0.03	2
8	14	2	8	2	96379	2.36	60	1.09	2	4	3	M	0.03	0.02	2
8	14	2	8	2	96387	3.07	69	0.93	2	4	3	M	0.03	0.02	2
8	15	2	8	2	96402	2.69	68	0.86	2	3	3	M	0.03	0.02	2
8	15	2	8	2	96404	3.38	73	0.87	3	3	3	M	0.03	0.02	2
8	15	2	8	2	96405	2.28	65	0.83	2	3	3	M	0.04	0.014	2
8	15	2	8	2	96406	3.08	70	0.90	3	3	3	M	0.04	0.02	2
8	15	2	8	2	96408	2.85	68	0.91	2	3	3	M	0.04	0.03	2
8	15	2	8	2	96412	2.91	69	0.89	2	3	3	M	0.04	0.02	2
8	15	2	8	2	96413	3.12	75	0.74	3	3	3	M	0.04	0.01	2
8	15	2	8	2	96414	3.12	72	0.84	2	3	3	M	0.05	0.02	2
8	15	2	8	2	96416	2.64	66	0.92	2	3	3	M	0.04	0.02	2
8	15	2	8	2	96417	2.92	71	0.82	2	3	3	M	0.04	0.02	2
8	15	2	8	2	96422	3.4	72	0.91		LR	3	M	0.08	0.2	2
8	19	2	9	2	96422	2.06	63	0.82		16	2	M	0.032	0.004	2
8	20	2	9	2	96436	2.07	61	0.91		15	2	M			1
8	20	2	9	2	96437	2.33	65	0.85		15	2	M		0.016	1
8	21	2	9	2	96448	2.4	67	0.80	2	CR	3	M	0.02	0.02	2
8	21	2	9	2	96450	2.4	68	0.76	2	CR	3	M	0.02	0.02	2
8	21	2	9	2	96458	2	62	0.84	2	CR	3	M	0.01	0.008	1
8	21	2	9	2	96468	2.4	67	0.80	2	CR	3	M	0.03	0.02	2
8	21	2	9	2	96473	2.7	67	0.90	2	5	3	M	0.02	0.02	2
8	21	2	9	2	96474	3	69	0.91	2	5	3	M	0.03	0.03	2
8	21	2	9	2	96475	3.2	74	0.79	2	5	3	M	0.04	0.02	2
8	21	2	9	2	96476	2.2	63	0.88		5	3	M	0.02	0.01	2
8	21	2	9	2	96478	2.9	70	0.85	2	5	3	M	0.04	0.2	2
8	21	2	9	2	96479	3.3	74	0.81	3	5	3	M	0.03	0.03	2
8	21	2	9	2	96481	2.4	65	0.87	2	5	3	M	0.03	0.02	2

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
8	21	2	9	2	96484	1.2	57	0.65	2	5	3	M	0.2	0.01	1
8	21	2	9	2	96485	1.5	57	0.81	1	5	3	M	0.01	0.01	1
8	26	2	9	2	96503	2.11	63	0.84	2	3	3	M	0.036	0.026	2
8	26	2	9	2	96504	2.35	67	0.78	2	3	3	M	0.022	0.02	2
8	26	2	9	2	96507	1	51	0.75	1	LR	3	M	0.014	0.001	1
8	26	2	9	2	96511	2.8	69	0.85	3	LR	3	M	0.036	0.03	2
8	26	2	9	2	96512	4.6	81	0.87	3	LR	3	M	0.05	0.036	2
8	26	2	9	2	96513	2.2	65	0.80	2	LR	3	M	0.032	0.026	2
8	26	2	9	2	96517	2.6	68	0.83	2	LR	3	M	0.032	0.028	2
8	26	2	9	2	96525	2.5	66	0.87	2	LR	3	M	0.048	0.028	2
8	26	2	9	2	96526	2.5	66	0.87	2	LR	3	M	0.034	0.024	2
8	26	2	9	2	96528	1.6	55	0.96	1	LR	3	M	0.018	0.072	1
8	26	2	9	2	96529	3.6	73	0.93	3	LR	3	M	0.032	0.042	2
8	26	2	9	2	96530	3.9	75	0.92	3	LR	3	M	0.062	0.08	2
8	26	2	9	2	96531	4.7	82	0.85	3	LR	3	M	0.07	0.038	2
8	26	2	9	2	96532	2.7	67	0.90		LR	3	M			2
8	26	2	9	2	96533	3.9	77	0.85	3	LR	3	M	0.056	0.076	2
8	26	2	9	2	96534	2.7	68	0.86	3	LR	3	M	0.04	0.02	2
8	26	2	9	2	96535	3.2	72	0.86	3	LR	3	M	0.054	0.01	2
8	26	2	9	2	96536	3.2	71	0.89	3	LR	3	M	0.054	0.016	2
8	27	2	9	2	96540	1.5	57	0.81		6	1	M		0.018	1
8	27	2	9	2	96543	1.94	61	0.85	2	6	1	M		0.018	1
8	27	2	9	2	96544	1.86	60	0.86	2	6	1	M		0.01	1
8	27	2	9	2	96546	2.8	69	0.85	2	6	1	M		0.018	2
8	27	2	9	2	96547	1.39	53	0.93	1	6	1	M		0.014	1
8	27	2	9	2	96550	2.71	66	0.94	2	6	1	M		0.026	2
8	27	2	9	2	96551	2.29	62	0.96	2	6	1	M		0.022	2
8	27	2	9	2	96558	2.34	65	0.85	2	6	1	M		0.028	2
7	29	2	7	2	96309	1.7	60	0.79		6	1	M	0.03	0.02	3
5	22	2	2	1		2.5	66	0.87		8	2	M			3
5	22	2	2	1		2.29	62	0.96		8	2	M			3
5	22	2	2	1		2.48	66	0.86		8	2	M			3
5	22	2	2	1		3.43	71	0.96		8	2	M			3
5	22	2	2	1		4.53	79	0.92		8	2	M			3
5	22	2	2	1		4.7	82	0.85		8	2	M			3

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MONTH	DAY	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
5	22	2	2	1		3.4	73	0.87		8	2	M			3
5	22	2	2	1		4.9	82	0.89		8	2	M			3
5	22	2	2	1		2.5	67	0.83		8	2	M			3
5	22	2	2	1		1.5	54	0.95		8	2	M			3
5	22	2	2	1		3.7	77	0.81		8	2	M			3
5	22	2	2	1		3.1	74	0.77		8	2	M			3
5	22	2	2	1		1.5	56	0.85		8	2	M			3
5	22	2	2	1		1.6	60	0.74		8	2	M			3
5	22	2	2	1		3.3	77	0.72		8	2	M			3
5	28	2	3	1		4.3	79	0.87		LR	3	M			3
5	28	2	3	1		3.4	79	0.69		LR	3	M			3
5	28	2	3	1		2.0	60	0.93		LR	3	M			3
5	28	2	3	1		4.3	81	0.81		LR	3	M			3
5	28	2	3	1		1.3	52	0.92		LR	3	M			3
5	28	2	3	1		3.2	75	0.76		LR	3	M			3
5	28	2	3	1		1.6	57	0.86		LR	3	M			3
5	28	2	3	1		4.6	82	0.83		LR	3	M			3
5	28	2	3	1		2	60	0.93		LR	3	M			3
5	28	2	3	1		1.7	58	0.87		LR	3	M			3
5	28	2	3	1		2	60	0.93		LR	3	M			3
5	28	2	3	1		1.5	57	0.81		LR	3	M			1
6	20	2	4	1			57			12	2	M			3
7	16	2	6	2			60			20	2	M			3
7	16	2	6	2			57			20	2	M			3
7	18	2	6	2		2.3	65	0.84		LR	3	M			4

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
5	7	2	1	1	96001	5.51	83	0.96	3	3	3	F	0.21	0.9	4
5	7	2	1	1	96002	7.39	91	0.98	4	3	3	F	0.27	1.42	3
5	7	2	1	1	96003	4.5	78	0.95	3	3	3	F	0.13	0.9	3
5	7	2	1	1	96004	6.2	86	0.97	3	3	3	F	0.25	0.92	3
5	7	2	1	1	96006	6.25	85	1.02	3	3	3	F	0.23	0.95	3
5	7	2	1	1	96008	4.62	77	1.01	3	3	3	F	0.16	0.84	4
5	7	2	1	1	96009	4.78	76	1.09	3	3	3	F	0.2	0.94	3
5	7	2	1	1	96013	3.69	72	0.99	3	3	3	F	0.11	0.39	3
5	8	2	1	1	96015	3.35	73	0.86	3	5	3	F	0.09	0.49	4
5	8	2	1	1	96016	1.99	61	0.88	2	5	3	F	0.06	0.17	1
5	9	2	1	1	96026	3.94	71	1.10	3	9	1	F	0.16	0.72	3
5	9	2	1	1	96029	5	79	1.01	3	9	1	F	0.19	0.87	3
5	14	2	2	1	96034	5.4	82	0.98	3	3	3	F	0.24	0.95	3
5	14	2	2	1	96035	6.74	92	0.87	4	3	3	F	0.23	0.77	3
5	14	2	2	1	96036	7.2	91	0.95	4	3	3	F	0.23	1.57	3
5	14	2	2	1	96039	3.55	72	0.95	3	3	3	F	0.12	0.65	3
5	14	2	2	1	96043	4.83	81	0.91	3	3	3	F	0.16	0.77	3
5	14	2	2	1	96044	5.69	85	0.93	3	3	3	F	0.2	0.94	4
5	22	2	2	1	96061	5.16	83	0.90	3	8	2	F	0.25	0.54	4
5	21	2	2	1	96062	6.31	86	0.99	4	3	3	F	0.29	0.68	4
5	22	2	2	1	96062a	5.23	82	0.95	3	8	2	F	0.23	0.64	4
5	22	2	2	1	96063	3.85	77	0.84	3	8	2	F	0.18	0.37	4
5	22	2	2	1	96066	5.88	83	1.03	3	8	2	F	0.17	1.15	4
5	22	2	2	1	96070	4.27	79	0.87	3	8	2	F	0.22	0.55	4
5	22	2	2	1	96071	5.01	82	0.91	3	8	2	F	0.22	0.49	4
5	24	2	2	1	96072	4.43	74	1.09	3	9	1	F	0.19	0.43	4
5	24	2	2	1	96073	5.72	87	0.87	3	9	1	F	0.22	0.74	4
5	24	2	2	1	96074	4.41	74	1.09	3	9	1	F	0.1	0.84	4
5	24	2	2	1	96075	5.5	82	1.00	3	9	1	F	0.25	0.84	4
5	24	2	2	1	96076	3.77	78	0.79	3	9	1	F	0.12	0.36	4
5	24	2	2	1	96077	3.9	75	0.92	3	9	1	F	0.16	0.44	4
5	27	2	3	1	96079	4.27	74	1.05	3	7	1	F	0.21	0.53	4
5	29	2	3	1	96134	9.9	95	1.15	4	3	3	F	0.52	1.74	4
5	29	2	3	1	96137	7	90	0.96	4	3	3	F	0.25	1.4	4
5	29	2	3	1	96140	5.1	81	0.96	3	3	3	F	0.24	0.5	4

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
6	13	2	4	1	96190	2.08	57	1.12	1	5	3	F	0.06	0.14	4
6	14	2	4	1	96195	5.11	79	1.04	3	12	2	F	0.29	0.74	4
6	14	2	4	1	96197	4.28	79	0.87	3	12	2	F	0.24	0.37	3
6	14	2	4	1	96199	6.0	84	1.01	3	12	2	F	0.3	0.93	3
6	14	2	4	1	96200	2.99	64	1.14	2	12	2	F	0.14	0.32	3
6	14	2	4	1	96201	4.88	75	1.16	3	12	2	F	0.2	0.73	4
6	19	2	4	1	96233	5.3	83	0.93	3	5	3	F	0.12	0.982	4
6	20	2	4	1	96235	4.85	74	1.20	3	13	1	F	0.09	1.18	4
6	20	2	4	1	96237	3.26	71	0.91	3	13	1	F	0.13	0.41	3
6	20	2	4	1	96239	4.83	80	0.94	3	13	1	F	0.13	0.81	3
6	20	2	4	1	96242	2.27	63	0.91	2	13	1	F	0.06	0.18	4
7	8	2	6	1	96256	3.76	72	1.01	3	9	1	F	0.1	0.36	3
7	9	2	6	1	96262	4.3	80	0.84	3	LR	3	F	0.13	0.22	2
7	9	2	6	1	96263	3.7	72	0.99	2	LR	3	F	0.07	0.1	2
7	9	2	6	1	96264	3.6	70	1.05	2	LR	3	F	0.08	0.08	2
7	9	2	6	1	96265	3.2	69	0.97	2	LR	3	F	0.1	0.3	2
7	9	2	6	1	96266	3.2	68	1.02	2	LR	3	F	0.05	0.06	2
7	9	2	6	1	96268	2.3	64	0.88	2	LR	3	F			1
7	9	2	6	1	96269	2.5	63	1.00		LR	3	F	0.04	0.15	1
7	16	2	6	2	96273		69	0.00	2	20		F		0.176	1
7	16	2	6	2	96274		74	0.00	3	20		F		0.19	2
7	16	2	6	2	96275	6.6	92	0.85	4	20		F	0.246	0.79	5
7	16	2	6	2	96276	10.8	114	0.73	5	20		F	0.282	0.91	3
7	18	2	6	2	96284	5.14	87	0.78	4	LR	3	F	0.128	0.2	5
7	24	2	7	2	96294	3.22	68	1.02	2	5	3	F	0.07	0.04	2
7	24	2	7	2	96295	5.51	83	0.96	3	5	3	F	0.11	0.19	2
7	24	2	7	2	96296	3.68	72	0.99	3	5	3	F	0.06	0.09	2
7	24	2	7	2	96297	2.81	69	0.86	2	5	3	F	0.03	0.04	2
7	24	2	7	2	96298	2.6	65	0.95	2	5	3	F	0.04	0.09	2
7	24	2	7	2	96299	3.3	70	0.96	2	5	3	F	0.03	0.09	2
7	25	2	7	2	96301	5.94	94	0.72	4	3	3	F	0.06	0.17	2
7	25	2	7	2	96305	3.6	74	0.89		LR	3	F	0.07	0.08	2
7	25	2	7	2	96306	5.05	80	0.99	3	LR	3	F	0.09	0.09	2
7	31	2	7	2	96315	4.7	83	0.82	3	17	2	F		0.15	5
7	31	2	7	2	96317	2.9	68	0.92	2	17	2	F	0.05	0.11	2

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	12	2	8	2	96350	3.45	73	0.89	3	16	2	F	0.054	0.018	2
8	12	2	8	2	96351	3.95	75	0.94	3	16	2	F	0.088	0.106	2
8	12	2	8	2	96352	3.11	71	0.87	3	16	2	F	0.05	0.088	2
8	12	2	8	2	96353	2.98	68	0.95	2	16	2	F	0.054	0.072	2
8	12	2	8	2	96354	2.23	63	0.89	2	16	2	F	0.032	0.014	2
8	12	2	8	2	96355	4.04	75	0.96	2	16	2	F	0.056	0.102	2
8	12	2	8	2	96356	2.13	62	0.89	2	16	2	F	0.038	0.054	2
8	13	2	8	2	96358	4.71	87	0.72	3	20		F	0.05	0.07	2
8	13	2	8	2	96359	2.76	69	0.84	2	12	2	F	0.04	0.076	2
8	13	2	8	2	96361	3.99	76	0.91	3	12	2	F	0.04	0.13	5
8	14	2	8	2	96363	6.97	88	1.02	3	4	3	F	0.12	0.23	2
8	14	2	8	2	96364	3.52	72	0.94	2	4	3	F	0.05	0.1	2
8	14	2	8	2	96365	5.72	84	0.97	3	4	3	F	0.07	0.15	2
8	14	2	8	2	96366	5.97	84	1.01	3	4	3	F	0.09	0.13	2
8	14	2	8	2	96367	4.02	75	0.95	3	4	3	F	0.06	0.14	2
8	14	2	8	2	96369	3.92	74	0.97	3	4	3	F	0.05	0.09	2
8	14	2	8	2	96370	3.6	71	1.01	2	4	3	F	0.05	0.15	2
8	14	2	8	2	96371	4.01	73	1.03	2	4	3	F	0.08	0.11	2
8	14	2	8	2	96373	3.51	71	0.98	2	4	3	F	0.05	0.12	2
8	14	2	8	2	96374	5	80	0.98	3	4	3	F	0.06	0.21	2
8	14	2	8	2	96375	3.7	71	1.03	2	4	3	F	0.05	0.09	2
8	14	2	8	2	96376	3.32	70	0.97	2	4	3	F	0.03	0.06	2
8	14	2	8	2	96377	3.84	73	0.99	3	4	3	F	0.06	0.13	2
8	14	2	8	2	96378	3.7	74	0.91	2	4	3	F	0.04	0.1	2
8	14	2	8	2	96380	4.11	76	0.94	3	4	3	F	0.05	0.18	2
8	14	2	8	2	96381	2.9	68	0.92	2	4	3	F	0.03	0.06	2
8	14	2	8	2	96382	2.12	65	0.77	2	4	3	F	0.02	0.1	2
8	14	2	8	2	96383	3.26	69	0.99	2	4	3	F	0.03	0.09	2
8	14	2	8	2	96384	2.65	66	0.92	2	4	3	F	0.02	0.02	2
8	14	2	8	2	96385	2.95	69	0.90	2	4	3	F	0.02	0.06	2
8	14	2	8	2	96386	3.05	67	1.01	2	4	3	F	0.03	0.08	2
8	14	2	8	2	96388	3.48	68	1.11	2	4	3	F	0.04	0.1	2
8	14	2	8	2	96389	5.37	87	0.82	3	4	3	F	0.09	0.11	2
8	14	2	8	2	96390	3.3	72	0.88	2	4	3	F	0.03	0.11	2
8	14	2	8	2	96391	8.19	100	0.82		4	3	F		0.52	5

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	14	2	8	2	96392	2.58	67	0.86		4	3	F	0.02	0.014	2
8	14	2	8	2	96394	3.5	69	1.07	2	4	3	F	0.02	0.09	2
8	15	2	8	2	96395	4.66	82	0.85	3	3	3	F	0.07	0.12	2
8	15	2	8	2	96396	4.3	76	0.98	3	3	3	F	0.07	0.11	2
8	15	2	8	2	96397	5.33	86	0.84	3	3	3	F	0.13	0.03	5
8	15	2	8	2	96398	4.45	80	0.87	3	3	3	F	0.06	0.09	2
8	15	2	8	2	96399	3.13	70	0.91	2	3	3	F	0.02	0.07	2
8	15	2	8	2	96400	3.97	77	0.87	3	3	3	F	0.06	0.1	2
8	15	2	8	2	96401	5.9	87	0.90	4	3	3	F	0.12	0.22	2
8	15	2	8	2	96403	5.34	85	0.87	3	3	3	F	0.12	0.15	2
8	15	2	8	2	96407	6	91	0.80	4	3	3	F	0.08	0.14	2
8	15	2	8	2	96409	6.2	89	0.88	4	3	3	F	0.16	0.2	2
8	15	2	8	2	96410	4.16	80	0.81	3	3	3	F	0.07	0.12	2
8	15	2	8	2	96411	6.6	90	0.91	4	3	3	F	0.11	0.16	2
8	15	2	8	2	96415	4.7	79	0.95	3	3	3	F	0.06	0.12	2
8	15	2	8	2	96418	2.55	67	0.85	2	3	3	F	0.04	0.04	2
8	15	2	8	2	96419	3.8	77	0.83	3	3	3	F	0.04	0.07	2
8	15	2	8	2	96421	3.16	71	0.88	3	LR	3	F	0.03	0.8	3
8	20	2	9	2	96427	1.4	72	0.38		15	2	F	0.1	0.122	2
8	20	2	9	2	96432	2.47	65	0.90	2	15	2	F	0.02	0.46	2
8	20	2	9	2	96433	3.05	72	0.82	2	15	2	F	0.008	0.12	2
8	20	2	9	2	96434	2.08	66	0.72	2	15	2	F	0.024	0.04	2
8	20	2	9	2	96435	3.21	72	0.86	2	15	2	F		0.106	2
8	21	2	9	2	96439	2.1	63	0.84	2	CR	3	F	0.03	0.06	2
8	21	2	9	2	96440	3.7	77	0.81	3	CR	3	F	0.05	0.1	2
8	21	2	9	2	96441	3.2	75	0.76	3	CR	3	F	0.03	0.12	2
8	21	2	9	2	96442	2.5	68	0.80	2	CR	3	F	0.03	0.09	2
8	21	2	9	2	96443	2.5	65	0.91	2	CR	3	F	0.03	0.09	2
8	21	2	9	2	96444	1.5	59	0.73	1	CR	3	F	0.02	0.04	1
8	21	2	9	2	96445	2.2	64	0.84	2	CR	3	F	0.02	0.09	2
8	21	2	9	2	96446	2.2	63	0.88	2	CR	3	F	0.02	0.06	2
8	21	2	9	2	96447	3	74	0.74	3	CR	3	F	0.02	0.09	2
8	21	2	9	2	96449	2.8	69	0.85	2	CR	3	F	0.03	0.1	2
8	21	2	9	2	96451	3.6	77	0.79	3	CR	3	F	0.05	0.15	2
8	21	2	9	2	96452	2.2	67	0.73	2	CR	3	F	0.03	0.09	2

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	21	2	9	2	96453	2	62	0.84	2	CR	3	F	0.02	0.06	2
8	21	2	9	2	96454	3	70	0.87	2	CR	3	F	0.05	0.06	2
8	21	2	9	2	96455	4.5	83	0.79	3	CR	3	F	0.05	0.11	2
8	21	2	9	2	96456	2.8	70	0.82	2	CR	3	F	0.03	0.09	2
8	21	2	9	2	96457	4	79	0.81	3	CR	3	F	0.05	0.16	2
8	21	2	9	2	96459	1.6	56	0.91	1	CR	3	F	0.02	0.04	1
8	21	2	9	2	96460	3	71	0.84	2	CR	3	F	0.03	0.08	2
8	21	2	9	2	96461	4.2	81	0.79	3	CR	3	F	0.05	0.14	2
8	21	2	9	2	96462	3.2	73	0.82	3	CR	3	F	0.03	0.11	2
8	21	2	9	2	96463	3	74	0.74	3	CR	3	F	0.02	0.07	2
8	21	2	9	2	96464	3	70	0.87	2	CR	3	F	0.04	0.09	2
8	21	2	9	2	96465	1.7	58	0.87	1	CR	3	F	0.01	0.04	1
8	21	2	9	2	96466	7.7	102	0.73	5	CR	3	F	0.1	0.34	2
8	21	2	9	2	96469	4.3	83	0.75	3	5	3	F	0.06	0.13	2
8	21	2	9	2	96470	5.9	87	0.90	4	5	3	F	0.09	0.18	2
8	21	2	9	2	96471	7.9	94	0.95	4	5	3	F	0.11	0.25	5
8	21	2	9	2	96472	7.9	93	0.98	4	5	3	F	0.08	0.15	2
8	21	2	9	2	96477	3.8	80	0.74	3	5	3	F	0.07	0.17	2
8	21	2	9	2	96480	1.8	59	0.88	1	5	3	F	0.02	0.06	1
8	21	2	9	2	96482	4.4	80	0.86	3	5	3	F	0.06	0.15	2
8	21	2	9	2	96483	4	80	0.78	3	5	3	F	0.06	0.22	2
8	21	2	9	2	96486	1.5	56	0.85	1	5	3	F	0.02	0.04	1
8	21	2	9	2	96487	1.4	57	0.76	1	5	3	F	0.02	0.04	1
8	26	2	9	2	96500	2.87	75	0.68	3	3	3	F	0.052	0.132	2
8	26	2	9	2	96501	4.54	82	0.82	3	3	3	F	0.07	0.208	2
8	26	2	9	2	96502	3.1	72	0.83	2	3	3	F	0.048	0.132	2
8	26	2	9	2	96505	7.2	92	0.92	4	LR	3	F	0.11	0.234	2
8	26	2	9	2	96506	5.6	88	0.82	4	LR	3	F	0.088	0.262	2
8	26	2	9	2	96508	6.7	91	0.89	4	LR	3	F	0.17	0.244	2
8	26	2	9	2	96509	2.1	63	0.84	2	LR	3	F	0.026	0.074	2
8	26	2	9	2	96510	3.2	74	0.79	3	LR	3	F	0.054	0.086	2
8	26	2	9	2	96514	4.3	78	0.91	3	LR	3	F	0.06	0.142	2
8	26	2	9	2	96516	2.6	68	0.83	2	LR	3	F	0.036	0.078	2
8	26	2	9	2	96518	6.2	88	0.91	4	LR	3	F	0.088	0.252	2
8	26	2	9	2	96519	7	95	0.82	4	LR	3	F	0.12	0.3	2

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	26	2	9	2	96520	4.2	73	1.08	3	LR	3	F	0.068	0.15	2
8	26	2	9	2	96521	4	79	0.81	3	LR	3	F	0.072	0.16	2
8	26	2	9	2	96522	4	75	0.95	3	LR	3	F	0.092	0.132	2
8	26	2	9	2	96523	5.5	85	0.90	3	LR	3	F	0.08	0.22	2
8	26	2	9	2	96524	8	96	0.90	4	LR	3	F	0.134	0.292	2
8	26	2	9	2	96527	5.8	88	0.85	4	LR	3	F	0.12	0.28	2
8	27	2	9	2	96537	1.7	57	0.92	1	6	1	F			1
8	27	2	9	2	96538	1.8	59	0.88	1	6	1	F			1
8	27	2	9	2	96539	1.6	58	0.82	1	6	1	F			1
8	27	2	9	2	96541	1.54	56	0.88	1	6	1	F			1
8	27	2	9	2	96542	3.08	69	0.94	2	6	1	F			2
8	27	2	9	2	96545	2.62	67	0.87	2	6	1	F			2
8	27	2	9	2	96548	2.85	70	0.83	2	6	1	F			2
8	27	2	9	2	96549	1.43	53	0.96	1	6	1	F			1
8	27	2	9	2	96552	1.99	62	0.83	2	6	1	F			2
8	27	2	9	2	96553	2.97	69	0.90	2	6	1	F			2
8	27	2	9	2	96554	1.96	59	0.95	1	6	1	F			1
8	27	2	9	2	96555	1.79	58	0.92	1	6	1	F			1
8	27	2	9	2	96556	1.85	59	0.90	1	6	1	F			1
8	27	2	9	2	96557	1.66	57	0.90	1	6	1	F			1
8	27	2	9	2	96559	2.02	60	0.94	1	6	1	F			1
8	14	2	8	2	96381A	3.31	68	1.05		4	3	F		0.08	2
5	22	2	2	1		4.19	75	0.99		8	2	F			4
5	22	2	2	1		5.3	82	0.96		8	2	F			4
5	22	2	2	1		3.8	75	0.90		8	2	F			4
5	22	2	2	1		2.4	65	0.87		8	2	F			4
5	22	2	2	1		5.3	84	0.89		8	2	F			4
5	23	2	2	1			98	0.00		20		F			5
5	28	2	3	1		5.2	83	0.91		LR	3	F			4
5	28	2	3	1		6.2	85	1.01		LR	3	F			4
7	17	2	6	2		1.1	52	0.78		5	3	F			1
7	17	2	6	2		2.6	67	0.86		16	2	F		0.038	5
7	17	2	6	2		3.17	70	0.92		16	2	F		0.06	5
7	17	2	6	2		3.39	73	0.87		16	2	F		0.09	5
7	17	2	6	2		3.27	74	0.81		16	2	F			5

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
7	17	2	6	2		3.45	76	0.79		16	2	F			5
7	25	2	7	2		3.39	73	0.87		3	3	F			5
7	25	2	7	2		2.8	66	0.97		3	3	F			5
7	25	2	7	2		2.88	76	0.66		LR	3	F			5
7	25	2	7	2		2.66	65	0.97		LR	3	F			5
7	25	2	7	2		3.83	77	0.84		LR	3	F			5
7	25	2	7	2		3.02	65	1.10		LR	3	F			5
7	25	2	7	2		4.6	78	0.97		LR	3	F			5
7	25	2	7	2		3.18	70	0.93		LR	3	F			5
7	25	2	7	2		5.1	83	0.89		LR	3	F			5
7	25	2	7	2		3.66	71	1.02		LR	3	F			5
7	25	2	7	2		3.01	68	0.96		LR	3	F			5
7	25	2	7	2		2.8	65	1.02		LR	3	F			5
7	25	2	7	2		4.5	80	0.88		LR	3	F			5
7	25	2	7	2		5.15	82	0.93		LR	3	F			5
7	25	2	7	2		3.67	72	0.98		LR	3	F			5
7	29	2	7	2		1.91	61	0.84		6	1	F			1
7	29	2	7	2		2	62	0.84		6	1	F			1
7	29	2	7	2		2.07	63	0.83		6	1	F			1
7	31	2	7	2			64	0.00		15	2	F			2
7	31	2	7	2			57	0.00		15	2	F			2
7	31	2	7	2			57	0.00		15	2	F			2
7	31	2	7	2			57	0.00		15	2	F			2
7	31	2	7	2			59	0.00		15	2	F			2
7	31	2	7	2			60	0.00		15	2	F			2
7	31	2	7	2			63	0.00		15	2	F			2
7	31	2	7	2			60	0.00		18	1	F			2
7	31	2	7	2			59	0.00		18	1	F			2
8	1	2	7	2		2.63	66	0.91		20		F			5
8	1	2	7	2		2.49	65	0.91		CR	3	F			5
8	1	2	7	2		2.69	68	0.86		CR	3	F			5
8	1	2	7	2		3.44	72	0.92		CR	3	F			5
8	12	2	8	2		2.3	63	0.92		16	2	F			5
8	12	2	8	2		2	61	0.88		16	2	F			2
8	14	2	8	2		3.72	73	0.96		4	3	F	0.04	0.02	5

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	14	2	8	2		2.15	61	0.95		4	3	F	0.02	0.04	5
8	14	2	8	2		3.37	72	0.90		4	3	F	0.03	0.08	5
8	14	2	8	2		3.71	72	0.99		4	3	F	0.03	0.09	5
8	14	2	8	2		3.64	70	1.06		4	3	F	0.04	0.09	5
8	14	2	8	2		3.94	74	0.97		4	3	F		0.092	5
8	14	2	8	2		2.14	70	0.62		4	3	F	0.04	0.094	2
8	14	2	8	2		2.68	73	0.69		4	3	F	0.04	0.1	5
8	14	2	8	2		4.17	74	1.03		4	3	F	0.03	0.13	5
8	14	2	8	2		3.84	75	0.91		4	3	F	0.03	0.13	5
8	14	2	8	2		3.83	73	0.98		4	3	F	0.03	0.13	5
8	14	2	8	2		4.31	75	1.02		4	3	F	0.02	0.14	5
8	14	2	8	2			73	#VALUE!		4	3	F			
8	14	2	8	2		3.65	74	0.90		4	3	F			5
8	14	2	8	2		2.43	63	0.97		4	3	F			5
8	14	2	8	2		2.18	60	1.01		4	3	F			2
8	14	2	8	2		3.26	76	0.74		4	3	F			5
8	14	2	8	2		3.89	72	1.04		4	3	F			5
8	14	2	8	2		4.19	76	0.95		4	3	F			5
8	15	2	8	2			76	0.00		LR	3	F			
8	15	2	8	2			68	0.00		LR	3	F			
8	15	2	8	2			68	0.00		LR	3	F			
8	15	2	8	2			65	0.00		LR	3	F			
8	15	2	8	2			79	0.00		LR	3	F			
8	15	2	8	2			70	0.00		LR	3	F			
8	15	2	8	2			72	0.00		LR	3	F			
8	15	2	8	2			73	0.00		LR	3	F			
8	15	2	8	2			71	0.00		LR	3	F			
8	15	2	8	2			74	0.00		LR	3	F			
8	15	2	8	2			75	0.00		LR	3	F			
8	20	2	9	2		2.25	65	0.82		15	2	F		0.056	2
8	21	2	9	2		3.3	72	0.88		5	3	F			
8	21	2	9	2		3.5	75	0.83		5	3	F			
8	21	2	9	2		3.4	73	0.87		5	3	F			
8	21	2	9	2		3.4	73	0.87		5	3	F			
8	21	2	9	2		3.5	74	0.86		5	3	F			

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	21	2	9	2		5	78	1.05		5	3	F			
8	21	2	9	2		3.9	74	0.96		5	3	F			
8	21	2	9	2		3.9	76	0.89		5	3	F			
8	21	2	9	2		3.6	75	0.85		5	3	F			
8	21	2	9	2		2.3	63	0.92		5	3	F			
8	21	2	9	2		3	68	0.95		5	3	F			
8	21	2	9	2		3.5	74	0.86		5	3	F			
8	21	2	9	2		3.9	72	1.04		5	3	F			
8	21	2	9	2		3.8	76	0.87		5	3	F			
8	21	2	9	2		3.4	75	0.81		5	3	F			
8	21	2	9	2		3.4	73	0.87		5	3	F			
8	21	2	9	2		2.4	66	0.83		5	3	F			
8	21	2	9	2		2.1	62	0.88		5	3	F			
8	21	2	9	2		2.7	70	0.79		5	3	F			
8	21	2	9	2		3.4	75	0.81		5	3	F			
8	21	2	9	2		3.3	74	0.81		5	3	F			
8	21	2	9	2		3.2	73	0.82		5	3	F			
8	21	2	9	2		2.5	67	0.83		5	3	F			
8	21	2	9	2		3.2	72	0.86		5	3	F			
8	21	2	9	2		2.5	67	0.83		5	3	F			
8	26	2	9	2		2.3	64	0.88		LR	3	F			
8	26	2	9	2		4.1	78	0.86		LR	3	F			
8	26	2	9	2		4.1	78	0.86		LR	3	F			
8	26	2	9	2		4.4	79	0.89		LR	3	F			
8	26	2	9	2		4.3	75	1.02		LR	3	F			
8	26	2	9	2		5.7	86	0.90		LR	3	F			
8	26	2	9	2		3.8	73	0.98		LR	3	F			
8	26	2	9	2		4.5	79	0.91		LR	3	F			
8	26	2	9	2		5.8	86	0.91		LR	3	F			
8	26	2	9	2		5.5	84	0.93		LR	3	F			
8	26	2	9	2		5.4	85	0.88		LR	3	F			
8	26	2	9	2		4	79	0.81		LR	3	F			
8	26	2	9	2		2.7	70	0.79		LR	3	F			
8	26	2	9	2		4.1	78	0.86		LR	3	F			
8	26	2	9	2		4.3	78	0.91		LR	3	F			

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	26	2	9	2		3.9	75	0.92		LR	3	F			
8	26	2	9	2		1.1	52	0.78		LR	3	F			
8	26	2	9	2		3.6	73	0.93		LR	3	F			
8	26	2	9	2		2.8	68	0.89		LR	3	F			
8	26	2	9	2		2.3	65	0.84		LR	3	F			
8	26	2	9	2		1.9	62	0.80		LR	3	F			
8	26	2	9	2		4.4	77	0.96		LR	3	F			
8	26	2	9	2		2.8	70	0.82		LR	3	F			
8	26	2	9	2		5.8	86	0.91		LR	3	F			
8	26	2	9	2		3.7	73	0.95		LR	3	F			
8	26	2	9	2		4	75	0.95		LR	3	F			
8	26	2	9	2		3	68	0.95		LR	3	F			
8	26	2	9	2		2.7	69	0.82		LR	3	F			
8	26	2	9	2		6	84	1.01		LR	3	F			
8	26	2	9	2		4.6	80	0.90		LR	3	F			
8	26	2	9	2		3.9	77	0.85		LR	3	F			
8	26	2	9	2		6	88	0.88		LR	3	F			
8	26	2	9	2		1.2	51	0.90		LR	3	F			
8	26	2	9	2		4.8	82	0.87		LR	3	F			
8	26	2	9	2		4.1	76	0.93		LR	3	F			
8	26	2	9	2		4.8	82	0.87		LR	3	F			
8	26	2	9	2		4.7	80	0.92		LR	3	F			
8	26	2	9	2		4.3	77	0.94		LR	3	F			
8	26	2	9	2		4.9	84	0.83		LR	3	F			
8	26	2	9	2		4.8	79	0.97		LR	3	F			
8	26	2	9	2		4	78	0.84		LR	3	F			
8	26	2	9	2		4.6	72	1.23		LR	3	F			
8	26	2	9	2		2.9	68	0.92		LR	3	F			
8	26	2	9	2		3.8	78	0.80		LR	3	F			
8	26	2	9	2		4.5	78	0.95		LR	3	F			
8	26	2	9	2		3.7	76	0.84		LR	3	F			
8	26	2	9	2		3.6	74	0.89		LR	3	F			
8	26	2	9	2		3.2	70	0.93		LR	3	F			
8	26	2	9	2		4.1	76	0.93		LR	3	F			
8	26	2	9	2		5.4	82	0.98		LR	3	F			

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MONTH	DAY	YEAR	ESSIO	SEASO	LAB	WEIGHT	LENGTH	K	AGE	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
8	26	2	9	2		4.6	80	0.90		LR	3	F			
8	26	2	9	2		3.4	72	0.91		LR	3	F			
8	26	2	9	2		3.4	71	0.95		LR	3	F			
8	26	2	9	2		4.3	77	0.94		LR	3	F			
8	26	2	9	2		3.5	73	0.90		LR	3	F			
8	26	2	9	2		3	71	0.84		LR	3	F			
8	26	2	9	2		3	72	0.80		LR	3	F			
8	26	2	9	2		4.8	81	0.90		LR	3	F			
8	26	2	9	2		3.3	72	0.88		LR	3	F			
8	26	2	9	2		2.2	67	0.73		LR	3	F			
8	26	2	9	2		3.2	72	0.86		LR	3	F			
8	26	2	9	2		2.9	70	0.85		LR	3	F			
8	26	2	9	2		1.6	61	0.70		LR	3	F			
8	26	2	9	2		1.4	54	0.89		LR	3	F			
8	26	2	9	2		3	70	0.87		LR	3	F			
8	26	2	9	2		1.3	55	0.78		LR	3	F			
8	26	2	9	2		3	65	1.09		LR	3	F			
8	27	2	9	2			65			7	1	F			

Appendix 5

Trout-perch diet analysis as percent by volume of stomach contents, 1995 and 1996.

TROUT-PERCH DIET

Sample No.		96001	96002	96003	96004	96005	96006	96008	96009	96010	96013
Date		05/07/96	05/07/96	05/07/96	05/07/96	05/07/96	05/07/96	05/07/96	05/07/96	05/07/96	05/07/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta											
Copepoda					1						
Ostracoda					1						
Amphipoda			25				19				2
Ephemeroptera			20	90	25	30	40	15	60		3
Plecoptera											
Trichoptera		10	10		24		1	10			
Megaloptera											
Heteroptera	Corixidae										
Coleoptera	Dytiscidae										
	Elmidae										
Diptera	Chironomidae	5	25	10	25	70	20	75	40	40	90
	Ceratopogonidae						1				
	Tipulidae	85	20				19			60	
	Other Diptera				24						5
Araneae	(Terrestrial)										
Other											

TROUT-PERCH DIET

Sample No.		96014	96015	96017	96018	96019	96021	96022	96025	96026	96027
Date		05/07/96	05/08/96	05/08/96	05/08/96	05/08/96	05/08/96	05/09/96	05/09/96	05/09/96	05/09/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta											
Copepoda											
Ostracoda											
Amphipoda					2						
Ephemeroptera		35			3					30	
Plecoptera			60		5	90	95	30		35	
Trichoptera		30		20		1	3				
Megaloptera		5									
Heteroptera	Corixidae										
Coleoptera	Dytiscidae										
	Elmidae										
Diptera	Chironomidae	30	40	80	90	9	2	70	100	35	90
	Ceratopogonidae										
	Tipulidae										
	Other Diptera										10
Araneae	(Terrestrial)										
Other											
											p. 2

TROUT-PERCH DIET

Sample No.		96028	96034	96035	96036	96038	96039	96041	96043	96045	96048
Date		05/09/96	05/14/96	05/14/96	05/14/96	05/14/96	05/14/96	05/14/96	05/14/96	05/14/96	05/15/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta											
Copepoda							1		1		1
Ostracoda			1				1	1		5	1
Amphipoda			5			5	10				
Ephemeroptera			35	50	30	59	20		49		5
Plecoptera											
Trichoptera			25	20	40		30		30	30	5
Megaloptera					15						
Heteroptera	Corixidae										
Coleoptera	Dytiscidae										
	Elmidae										
Diptera	Chironomidae	100	34	25	15	30	34	99	10	50	78
	Ceratopogonidae			5		1	2		10	15	
	Tipulidae						2				
	Other Diptera					5					10
Araneae	(Terrestrial)										
Other											

TROUT-PERCH DIET

Sample No.		96049	96050	96051	96061	96062	96062	96063	96064	96065	96067
Date		05/15/96	05/15/96	05/15/96	05/22/96	05/21/96	05/22/96	05/22/96	05/22/96	05/22/96	05/22/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta											
Copepoda											
Ostracoda								1			1
Amphipoda								18			
Ephemeroptera					7	90			100	15	5
Plecoptera		10			1		1	40		3	
Trichoptera		1		5		5					
Megaloptera											
Heteroptera	Corixidae										
Coleoptera	Dytiscidae										
	Elmidae										
Diptera	Chironomidae	79	100	90	90	5	99	40		82	94
	Ceratopogonidae							1			
	Tipulidae										
	Other Diptera	10		5							
Araneae	(Terrestrial)				2						
Other											
											p. 3

TROUT-PERCH DIET

Sample No.		96069	96070	96071	96072	96073	96074	96075	96076	96077	96079
Date		05/22/96	05/22/96	05/22/96	05/24/96	05/24/96	05/22/96	05/24/96	05/24/96	05/24/96	05/27/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta	Lumbricidae							20		10	
Copepoda	Cyclopoida									1	
Ostracoda		1									
Amphipoda						14		5	5		
Ephemeroptera		13	99	80	35	85	15	30	20	35	2
Plecoptera		3		10	35		10	30		14	4
Trichoptera				5							4
Megaloptera											
Heteroptera	Corixidae										
Coleoptera	Dytiscidae										
	Elmidae										
Diptera	Chironomidae	80	1	5	30	1	75	15	75	40	90
	Ceratopogonidae										
	Tipulidae										
	Other Diptera	3									
Araneae	(Terrestrial)										
Other											

TROUT-PERCH DIET

Sample No.		96198	96199	96200	96201	96210	96262	96266	96276	96284	96295
Date		06/14/96	06/14/96	06/14/96	06/14/96	06/17/96	07/09/96	07/09/96	07/16/96	07/18/96	07/24/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta				49							
Copepoda											
Ostracoda											
Amphipoda										10	
Ephemeroptera		70	60	40	80	80	99		99		100
Plecoptera		30	40	10	15						
Trichoptera					3					29	
Megaloptera											
Heteroptera	Corixidae									1	
Coleoptera	Dytiscidae							40		10	
	Elmidae										
Diptera	Chironomidae			1	2	20	1	60	1	15	
	Ceratopogonidae										
	Tipulidae										
	Other Diptera									35	
Araneae	(Terrestrial)										
Other											
											p. 4

TROUT-PERCH DIET

Sample No.		96306	96308	96315	96359	96362	96363	96364	96365	96367	96368
Date		07/25/96	07/26/96	07/31/96	08/13/96	08/14/96	08/14/96	08/14/96	08/14/96	08/14/96	08/14/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta											
Copepoda											1
Ostracoda						1		1	5	1	5
Amphipoda		25				2					
Ephemeroptera		75		50	90	69	99	19	22		
Plecoptera											1
Trichoptera									60		
Megaloptera											
Heteroptera	Corixidae								5	98	5
Coleoptera	Dytiscidae										
	Elmidae										
Diptera	Chironomidae		100	1	7	28	1	30	3	1	50
	Ceratopogonidae										
	Tipulidae							50			
	Other Diptera				3				5		38
Araneae	(Terrestrial)										
Other				49							

TROUT-PERCH DIET

Sample No.		96369	96370	96372	96373	96376	96377	96378	96399	96401	96409
Date		08/14/96	08/14/96	08/14/96	08/14/96	08/14/96	08/14/96	08/14/96	08/15/96	08/15/96	08/15/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta											
Copepoda											
Ostracoda			1			1		1			
Amphipoda			1								
Ephemeroptera		100		24		97	100	99	100	100	99
Plecoptera											
Trichoptera											
Megaloptera											
Heteroptera	Corixidae		96	15		1					
Coleoptera	Dytiscidae										
	Elmidae			5							
Diptera	Chironomidae		2	25	1	1					1
	Ceratopogonidae										
	Tipulidae										
	Other Diptera			30							
Araneae	(Terrestrial)										
Other				1	99						
											p. 5

TROUT-PERCH DIET

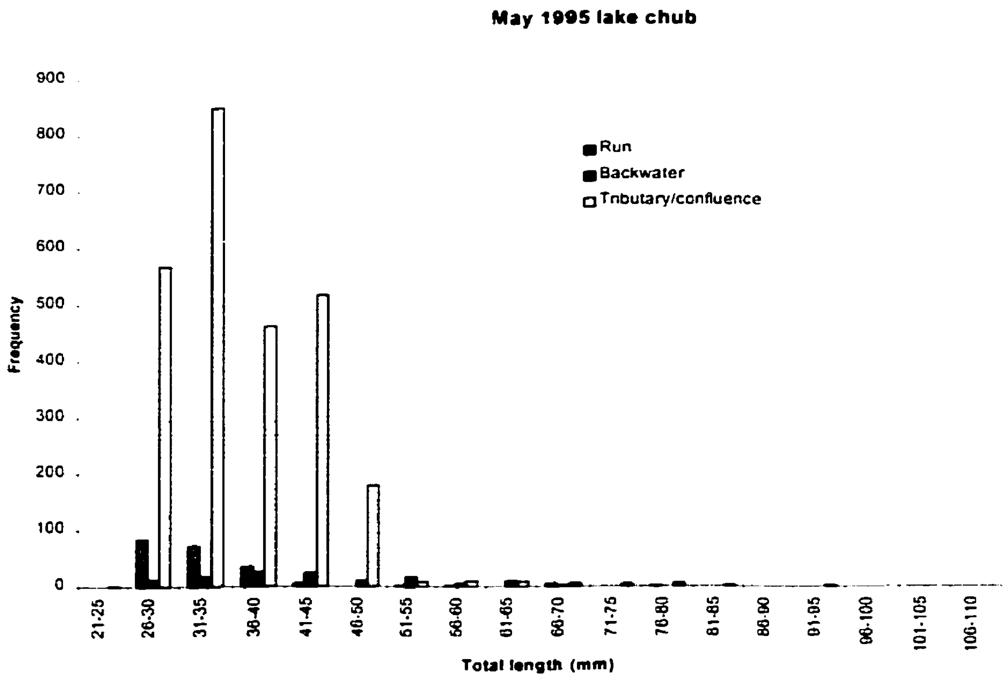
Sample No.		96411	96412	96443	96456	96458	96460	96464	96481	96482	96500
Date		08/15/96	08/15/96	08/21/96	08/21/96	08/21/96	08/21/96	08/21/96	08/21/96	08/21/96	08/26/96
Species		TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH	TRPH
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Oligochaeta											
Copepoda					1					1	
Ostracoda				28		55	1		1		
Amphipoda										1	
Ephemeroptera		98	100	25				100	30	1	99
Plecoptera											
Trichoptera									10	1	
Megaloptera											
Heteroptera	Corixidae	2		40	1		98		10		
Coleoptera	Dytiscidae				69						
	Elmidae										
Diptera	Chironomidae			5	28	45	1		48	96	1
	Ceratopogonidae			1	1						
	Tipulidae								1		
	Other Diptera			1							
Araneae	(Terrestrial)										
Other											

TROUT-PERCH DIET

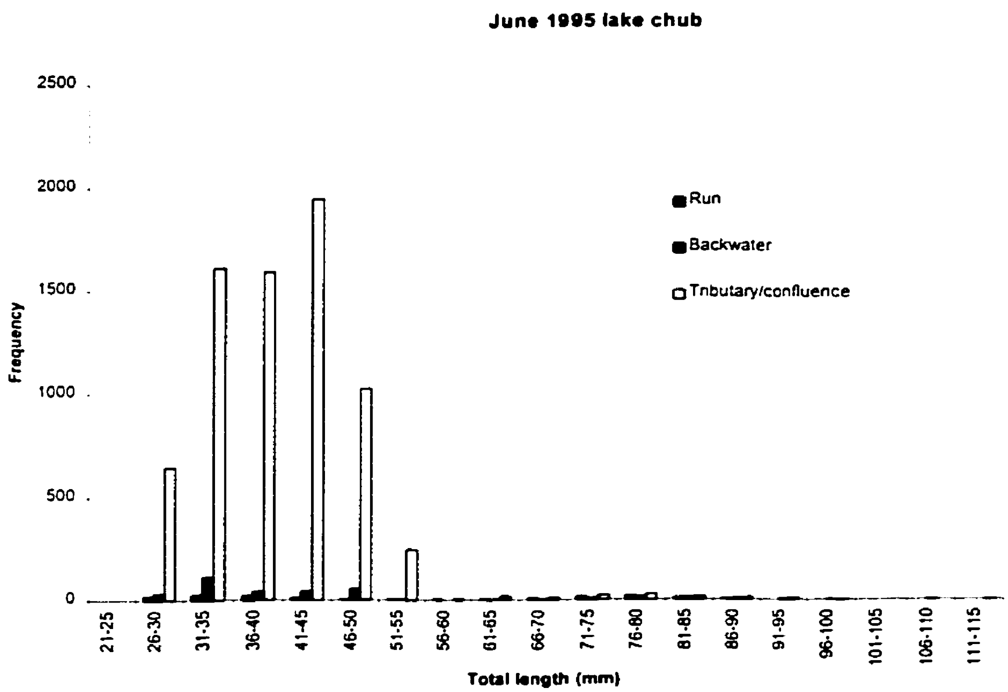
Sample No.	96507	96513								
Date	08/26/96	08/26/96								
Species	TRPH	TRPH								
Taxa Percent by Volume	%	%								
Oligochaeta										
Copepoda										
Ostracoda		10								
Amphipoda	27									
Ephemeroptera	50									
Plecoptera										
Trichoptera	20									
Megaloptera										
Heteroptera Corixidae										
Coleoptera Dytiscidae										
Elmidae										
Diptera Chironomidae		90								
Ceratopogonidae										
Tipulidae										
Other Diptera	3									
Araneae (Terrestrial)										
Other										

Appendix 6

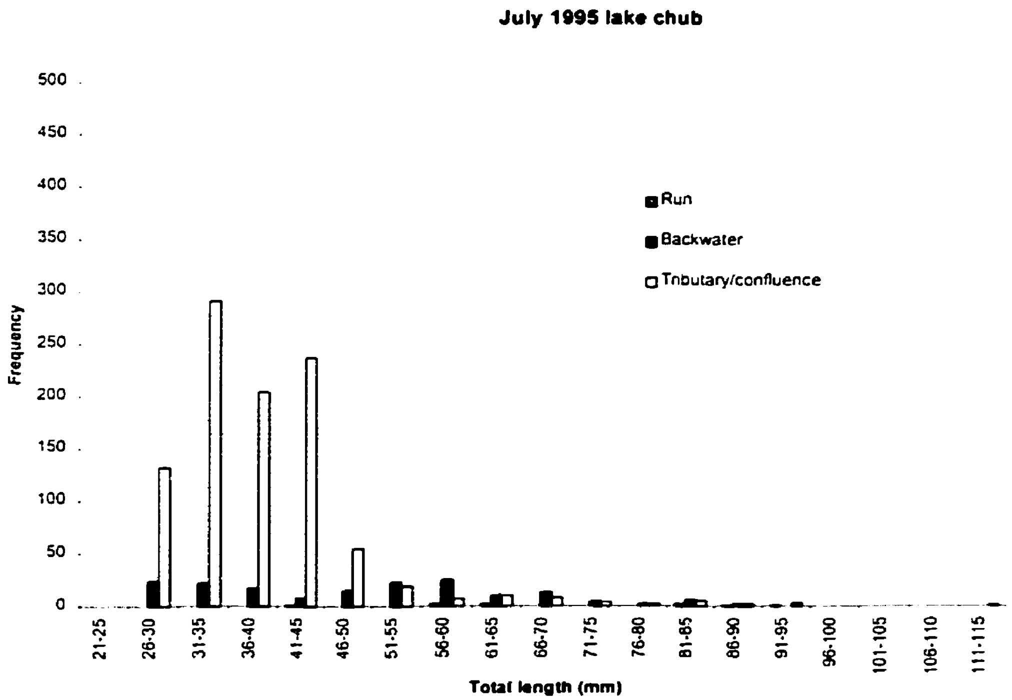
Lake chub length frequency by habitat in all months of collection 1995 and 1996.



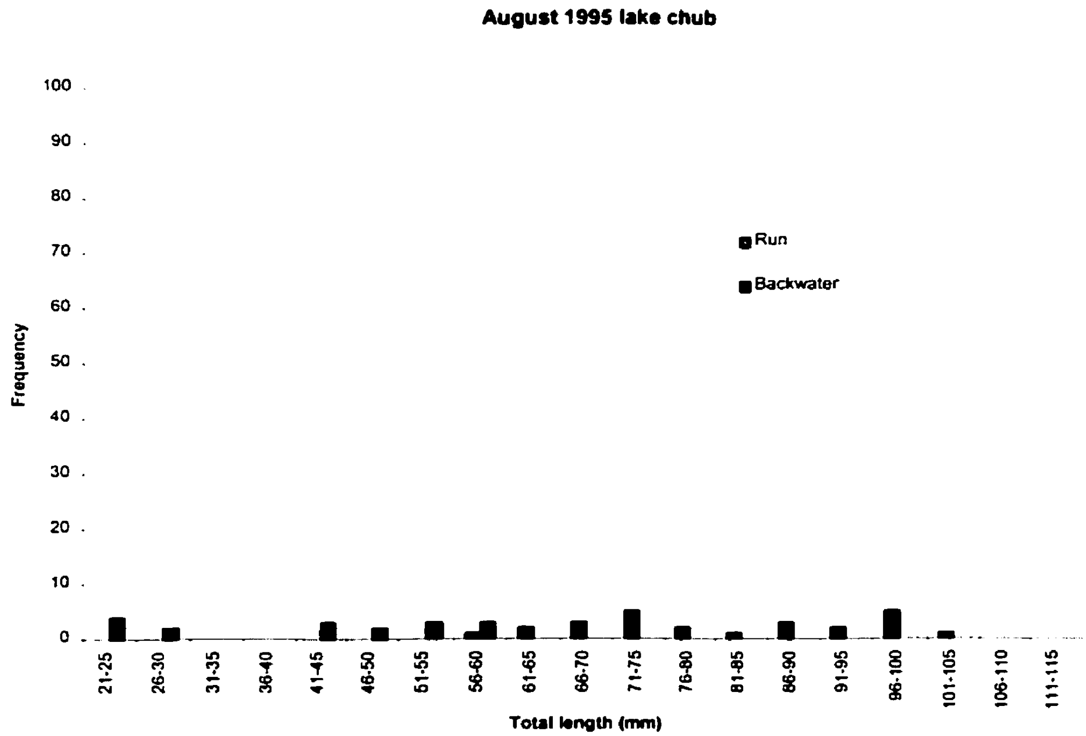
Appendix 6 Figure 1 Total length (mm) frequency of lake chub at the three habitat types sampled. May, 1995. N= 2942 fish.



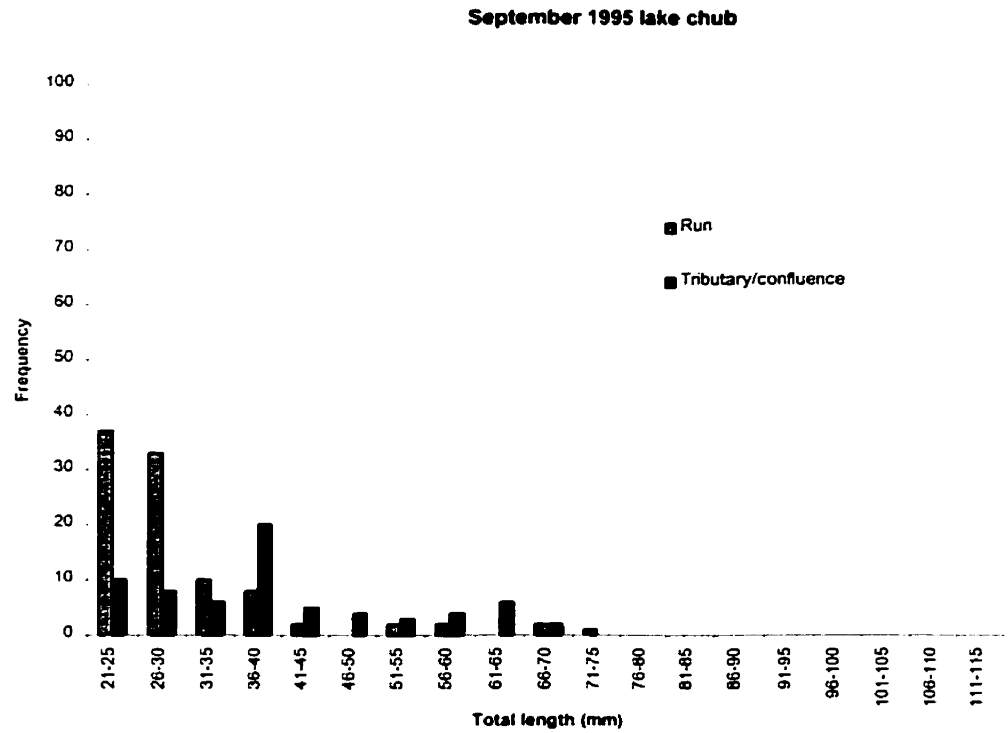
Appendix 6 Figure 2 Total length (mm) frequency of lake chub at the three habitat types sampled. June, 1995. N= 7602 fish.



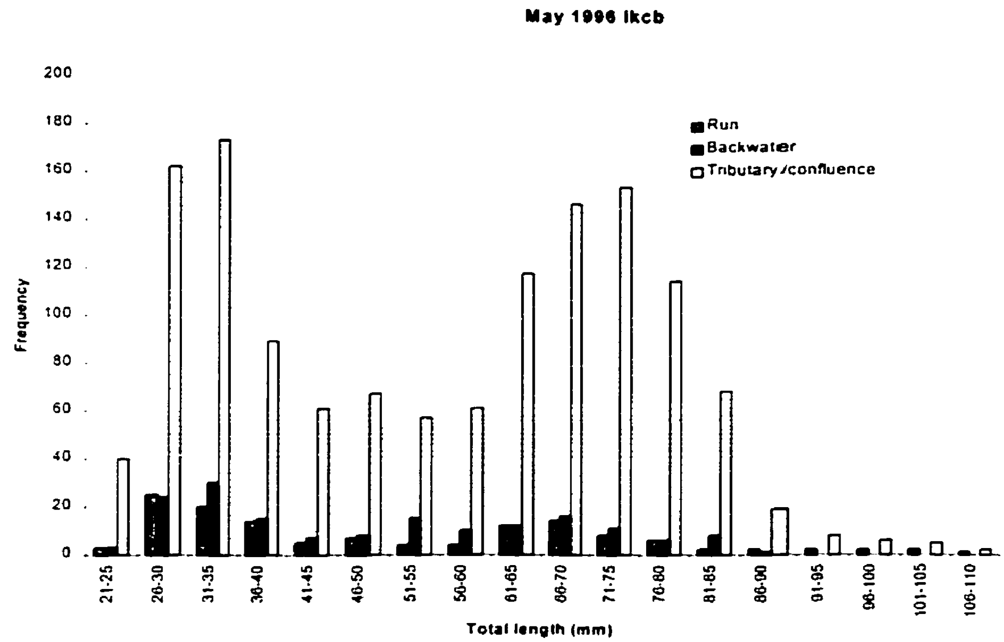
Appendix 6 Figure 3 Total length (mm) frequency of lake chub at the three habitat types sampled. July, 1995. N = 1160 fish.



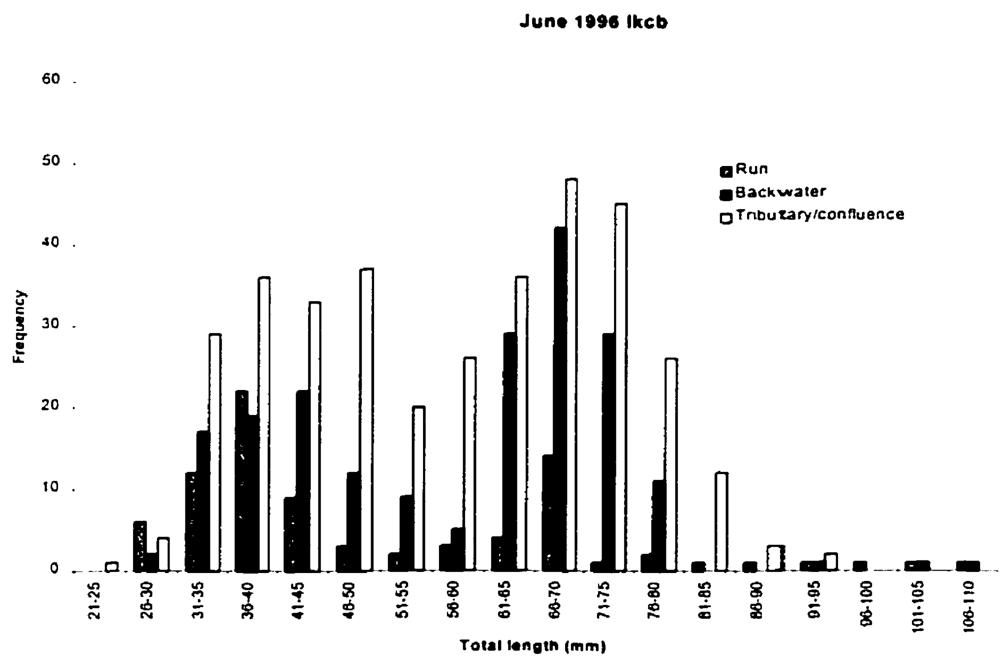
Appendix 6 Figure 4 Total length (mm) frequency of lake chub collected at run and backwater habitat types only. August, 1995. N = 42 fish.



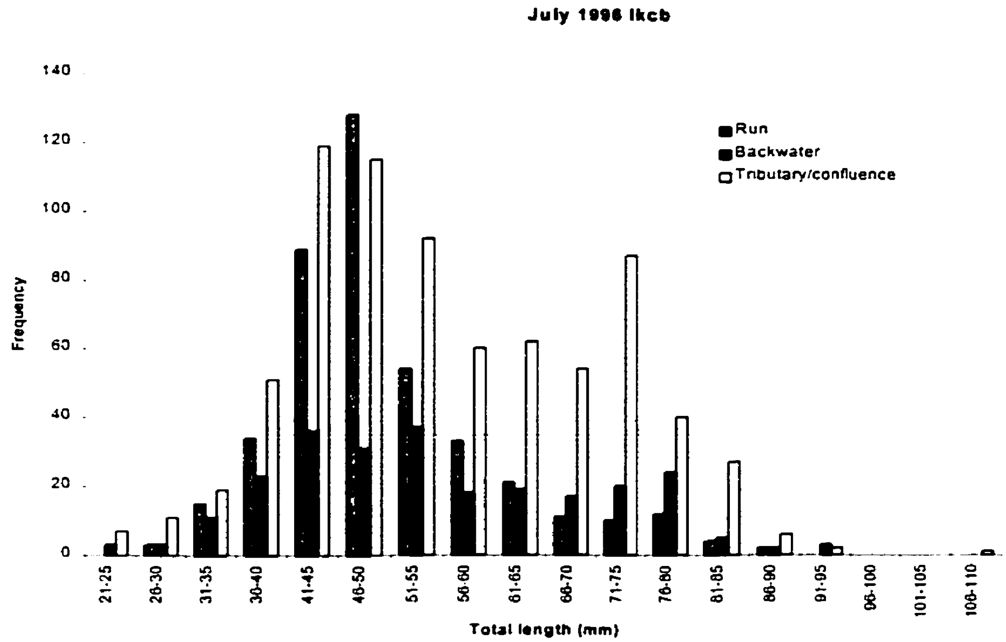
Appendix 6 Figure 5 Total length (mm) frequency of lake chub collected at run and tributary/confluence habitat types only. September, 1995. N = 165 fish.



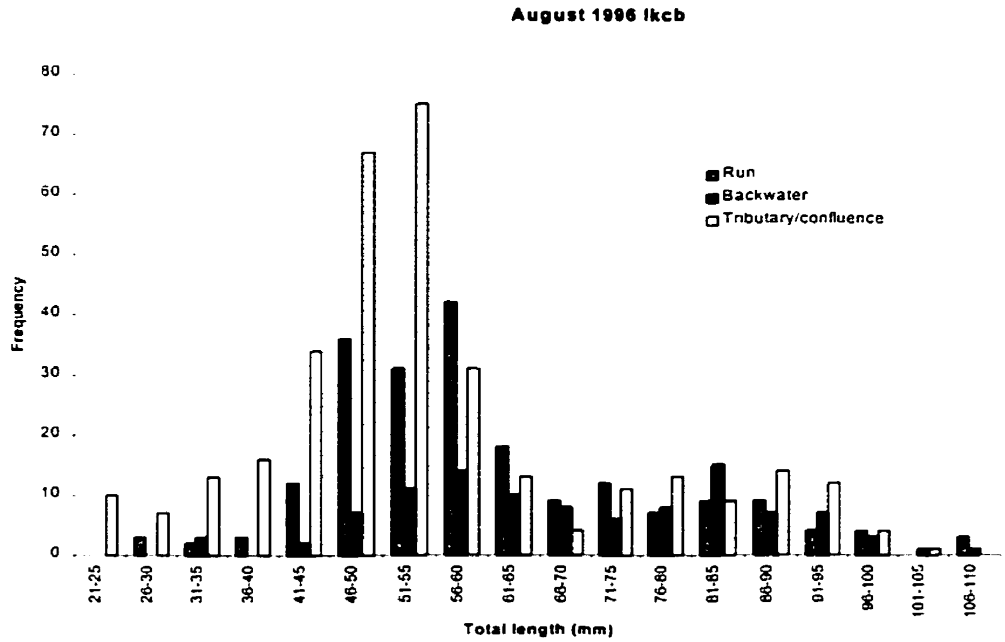
Appendix 6 Figure 6 Total length (mm) frequency of lake chub at the three habitat types sampled. May, 1996. N = 1647 fish.



Appendix 6 Figure 7 Total length (mm) frequency of lake chub at the three habitat types sampled. June, 1996. N = 642 fish.



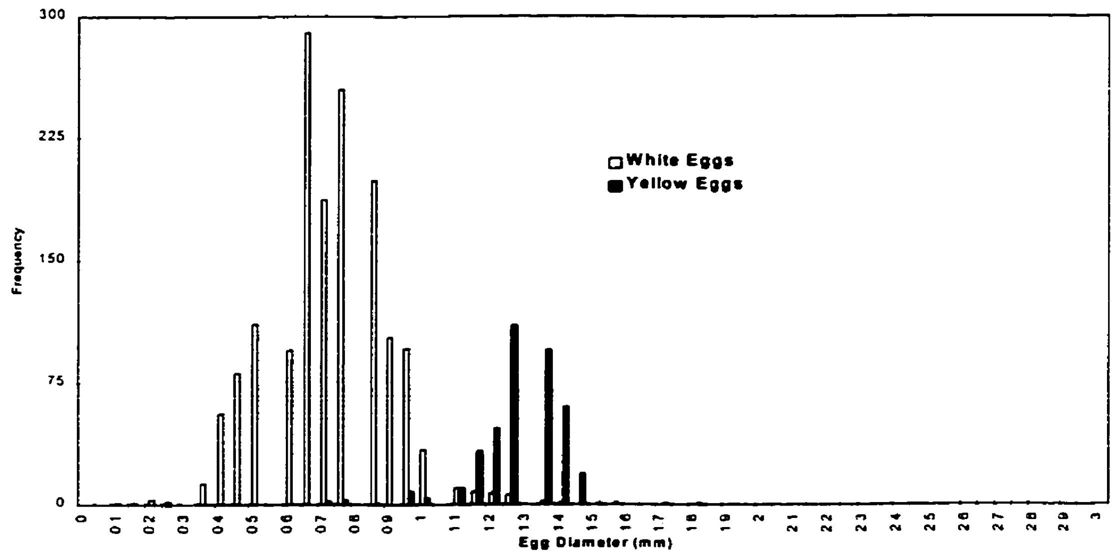
Appendix 6 Figure 8 Total length (mm) frequency of lake chub at the three habitat types sampled. July, 1996. N = 1421 fish.



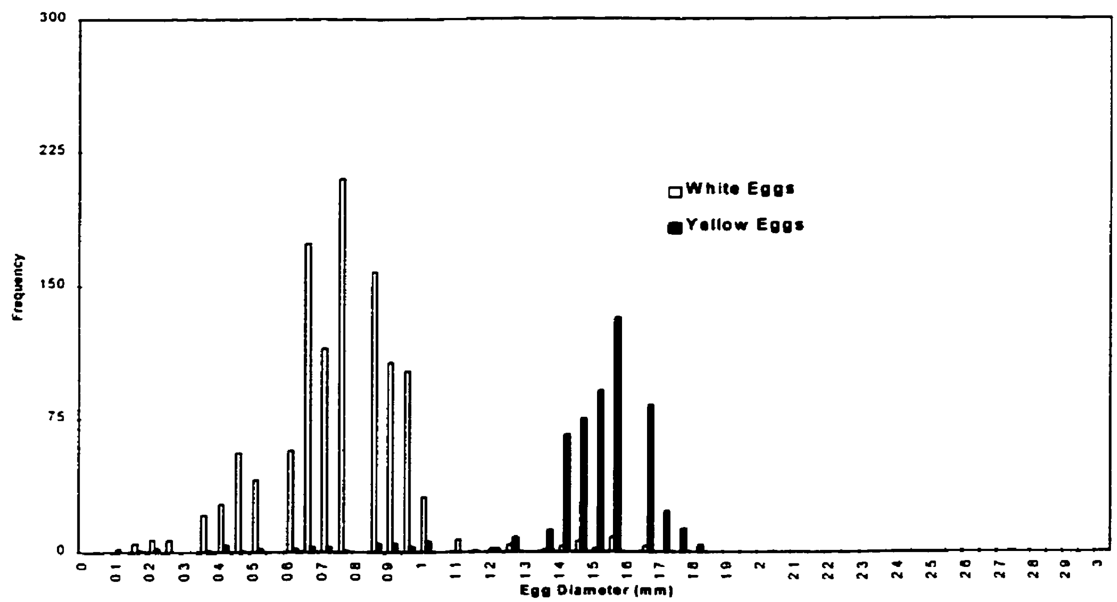
Appendix 6 Figure 9 Total length (mm) frequency of lake chub at the three habitat types sampled. August, 1996. N = 641 fish.

Appendix 7

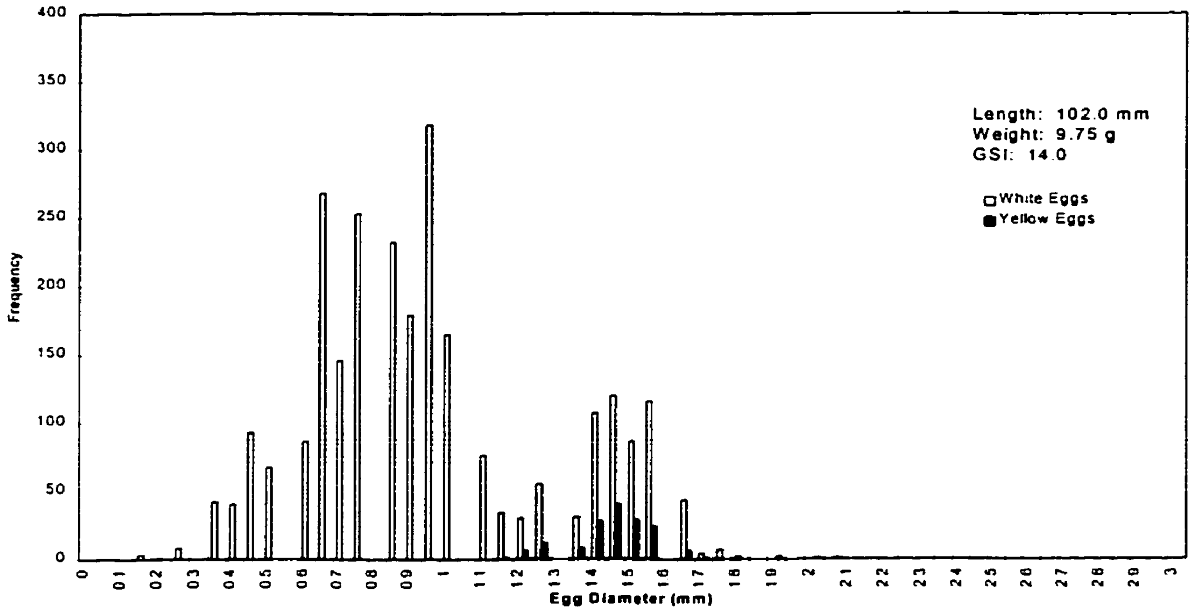
Lake chub frequency distributions of egg diameters taken from both ovaries, 1996.



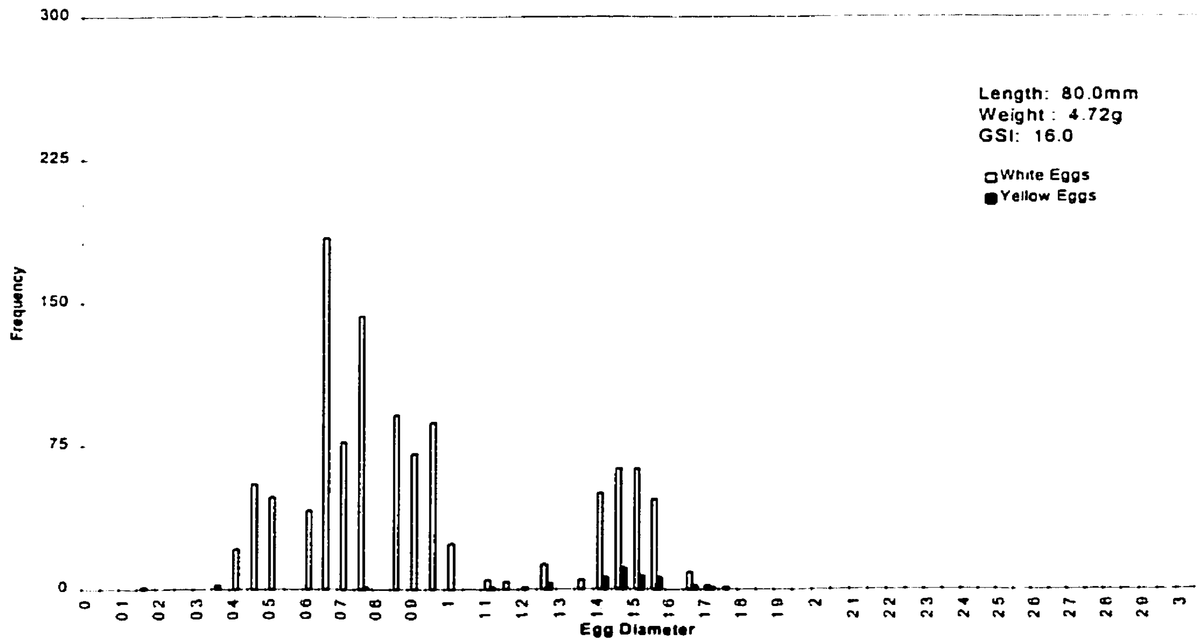
Appendix 7 Figure 1. Frequency distribution of n = 1957, lake chub egg diameters. Taken from both ovaries. May 9, 1996.



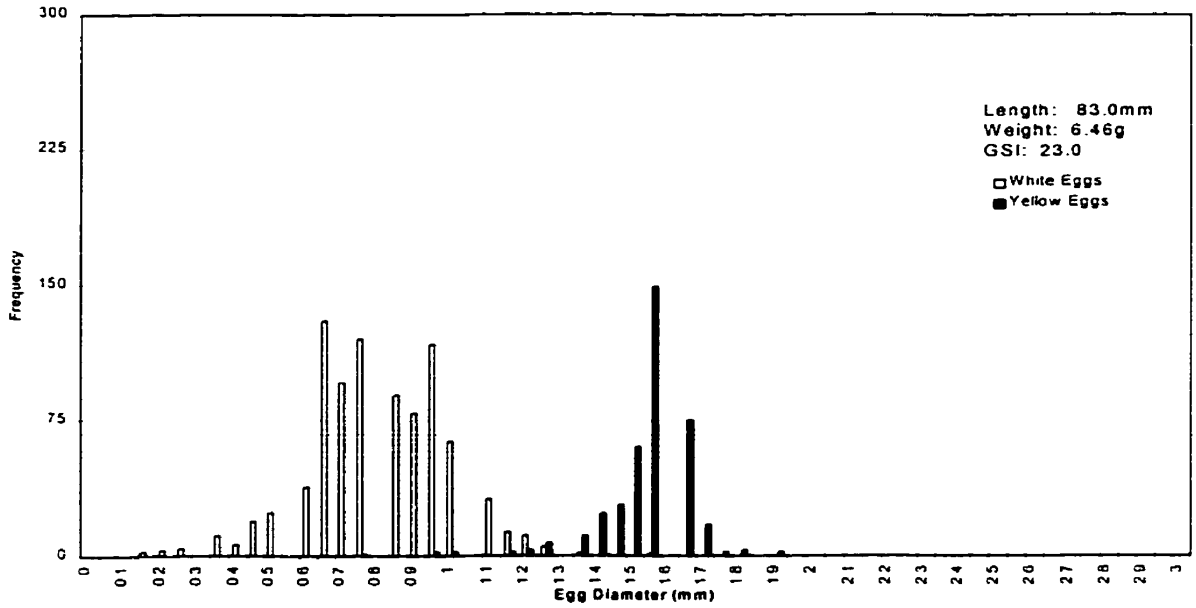
Appendix 7 Figure 2. Frequency distribution of n = 1705, lake chub egg diameters. Taken from both ovaries. May 13, 1996.



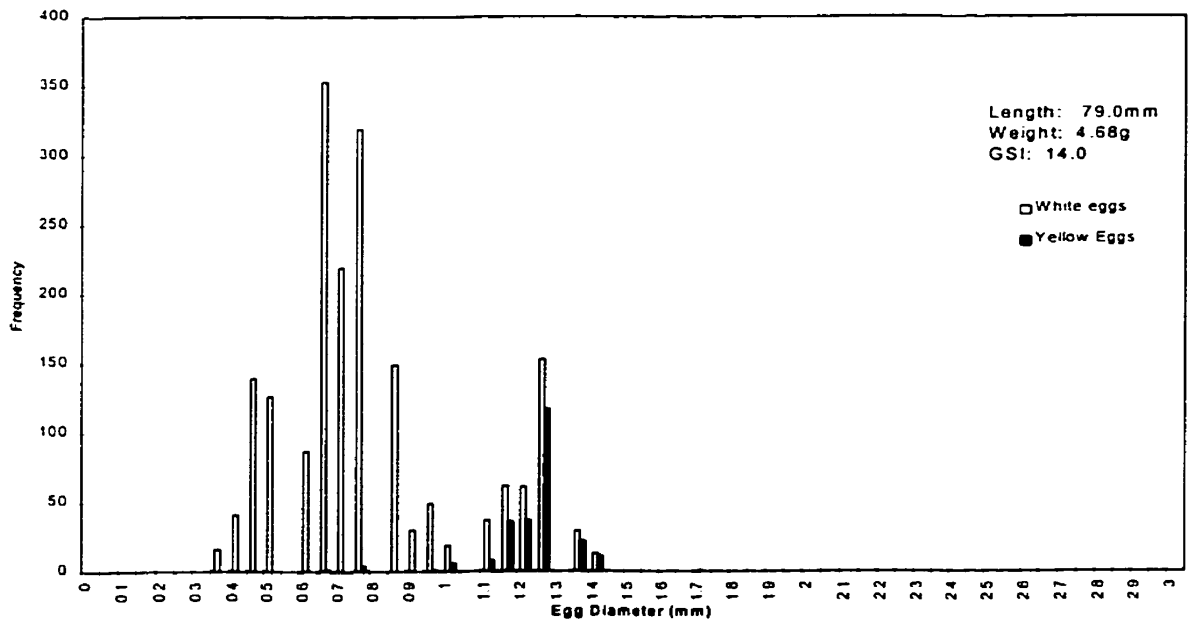
Appendix 7 Figure 3. Frequency distribution of n = 2776, lake chub egg diameters. Taken from both ovaries. May 30, 1996.



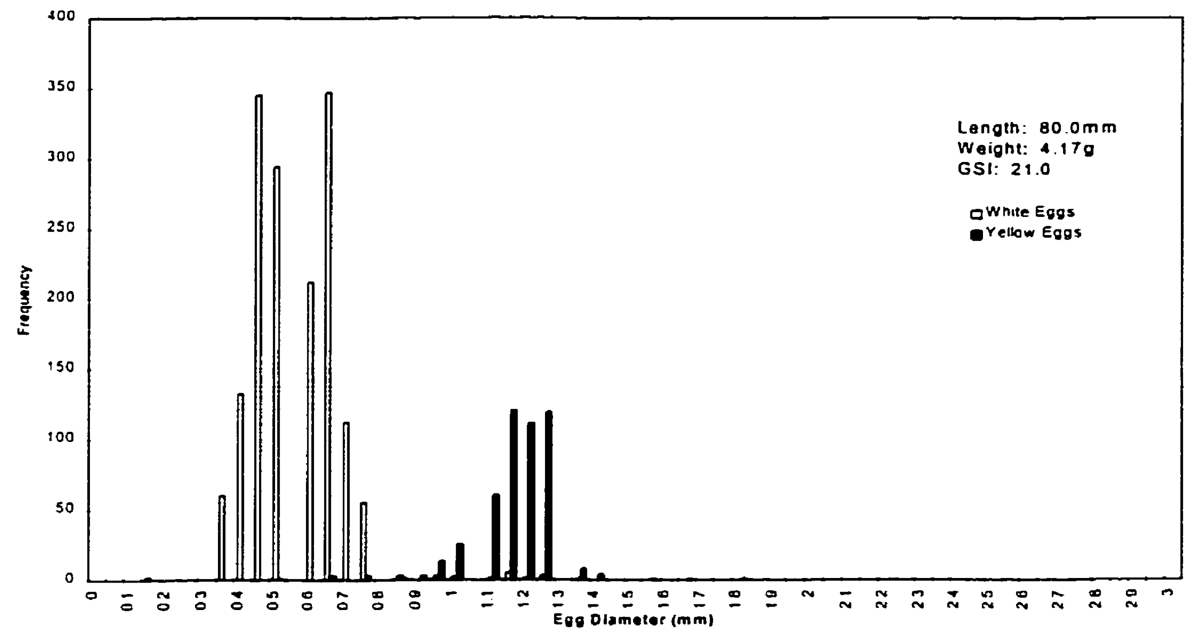
Appendix 7 Figure 4. Frequency distribution of n = 1146, lake chub egg diameters. Taken from both ovaries. June 4, 1996.



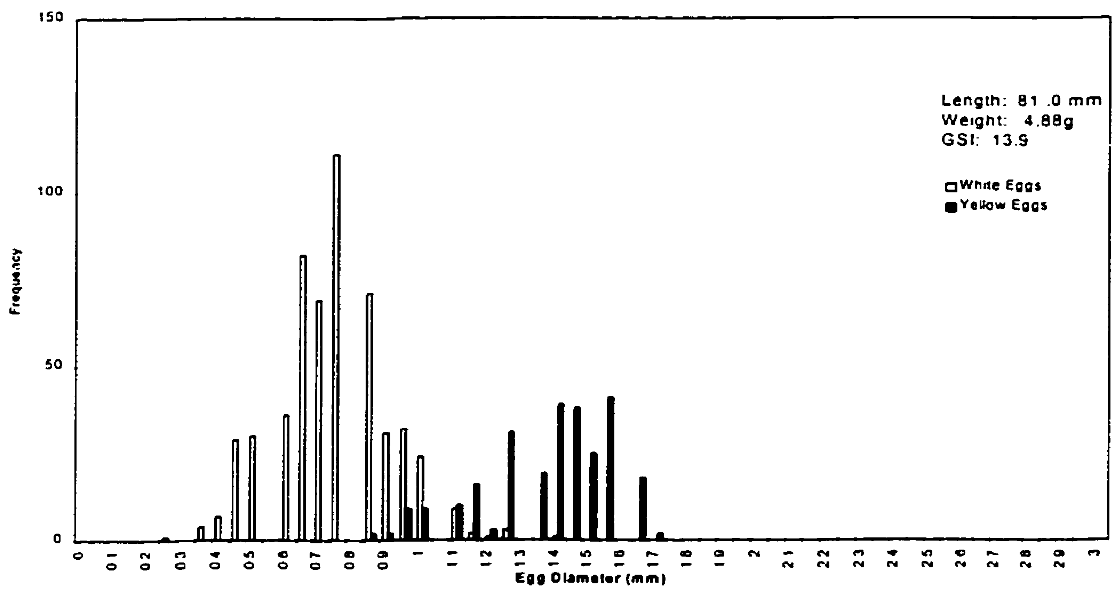
Appendix 7 Figure 5. Frequency distribution of n = 1250, lake chub egg diameters. Taken from both ovaries. June 13, 1996.



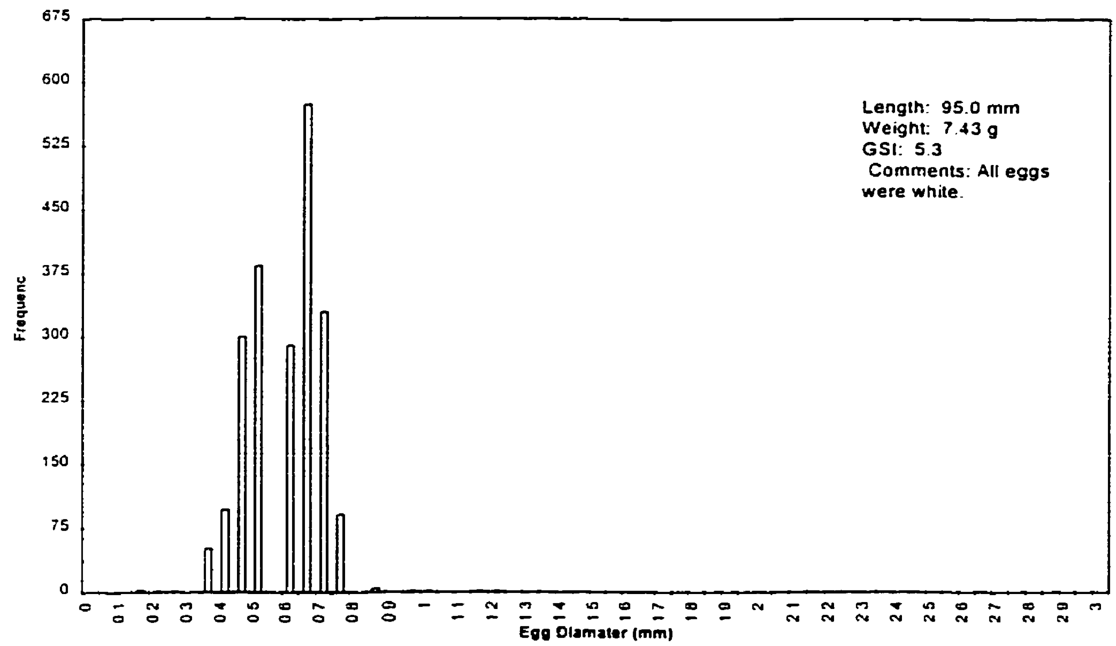
Appendix 7 Figure 6. Frequency distribution of n = 2147, lake chub egg diameters. Taken from both ovaries. June 19, 1996.



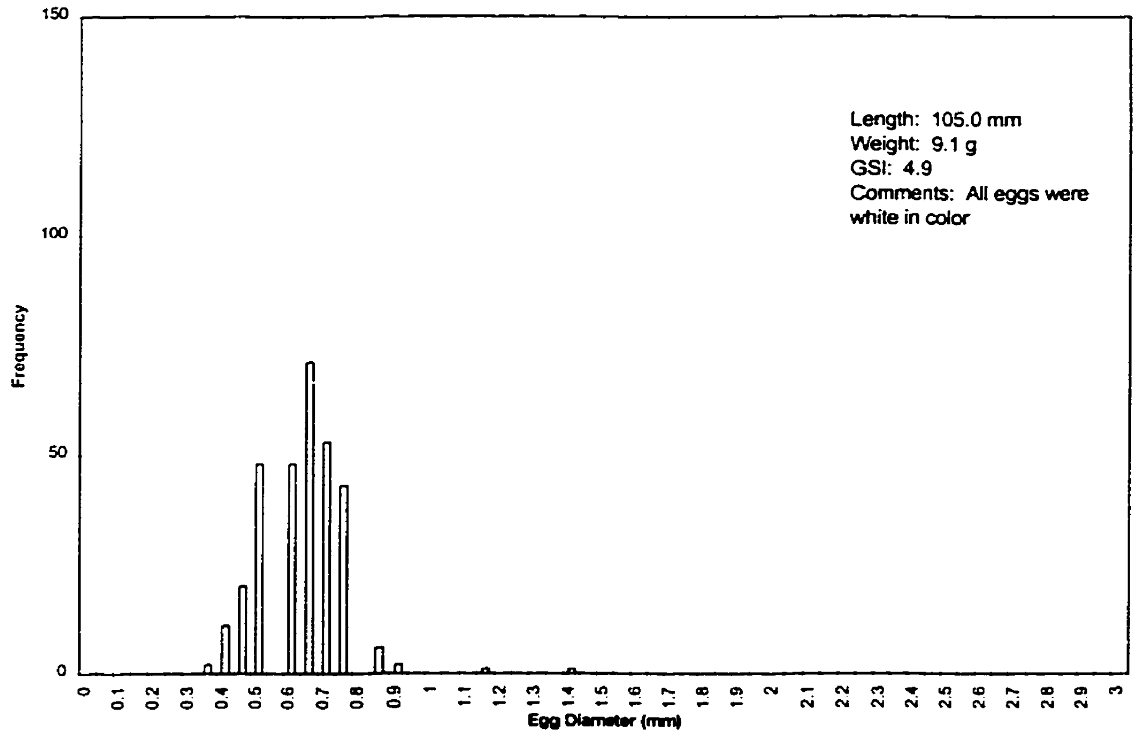
Appendix 7 Figure 7. Frequency distribution of n = 2072, lake chub egg diameters. Taken from both ovaries. July 19, 1996.



Appendix 7 Figure 8. Frequency distribution of n = 807, lake chub egg diameters. Taken from both ovaries. July 25, 1996.



Appendix 7 Figure 9. Frequency distribution of n = 2130, lake chub egg diameters. Taken from both ovaries. August 13, 1996.



Appendix 7 Figure 10. Frequency distribution of n = 306, lake chub egg diameters. Taken from both ovaries. August 21, 1996.

Appendix 8

Lake chub raw data used in power analysis for Environmental Effects Monitoring evaluation.

95 MALE

MONTH	DAY	Year	Session	Season	Lab	Weight	LENGT	Site	Habitat	Sex	Liver	Testes	Maturity
6	7	1	3	1		5.8	85	3	3	M			3
6	7	1	3	1	275	8.2	90	3	3	M		0.010	3
6	11	1	6	1	1018	5.02	81	8	2	M	0.058		1
6	13	1	6	1	1059	5.5	91	9	1	M	0.074	0.132	2
7	21	1	4	1	570	2.8	68	3	3	M	0.082		1
7	21	1	4	1	562	4.7	81	3	3	M	0.114	0.21	2

95 FEMALE

MONTH	DAY	Year	Session	Season	Lab	Weight	LENGTH	Site	Habitat	Sex	Ovary	Liver	Maturity
5	17	1	2	1	1	4.6	80	3	3	F			3
5	17	1	2	1	3	2.0	65	3	3	F			1
5	18	1	2	1	41	6.7	92	5	3	F			3
5	19	1	2	1	51	2.5	67	6	1	F			1
5	19	1	2	1	53	3.3	76	7	1	F			2
5	19	1	2	1	54	2.6	67	7	1	F			1
5	19	1	2	1	55	2.5	67	7	1	F			1
5	19	1	2	1	56	2.5	68	7	1	F			1
5	19	1	2	1	57	2.3	67	7	1	F			1
5	30	1	3	1	107	1.9	65	2	2	F			1
5	30	1	3	1	108	1.5	54	2	2	F			1
5	30	1	3	1	109	2	64	2	2	F			1
5	31	1	3	1	127	4.5	79	3	3	F			3
5	31	1	3	1	128	3.8	75	3	3	F			1
5	31	1	3	1	129	5.3	81	3	3	F			3
5	31	1	3	1	130	4.2	77	3	3	F			1
5	31	1	3	1	131	1.4	56	3	3	F			1
5	31	1	3	1	132	1.9	61	3	3	F			1
5	31	1	3	1	133	3.7	75	3	3	F			1
5	31	1	3	1	134	2.1	63	3	3	F			1
5	31	1	3	1	135	3.4	74	3	3	F			1
5	31	1	3	1	136	1.5	55	3	3	F			1
5	31	1	3	1	137	1.6	55	3	3	F			1
5	31	1	3	1	138	2.4	63	3	3	F			1
5	31	1	3	1	139	4.3	78	3	3	F			3
5	31	1	3	1	140	4.7	80	3	3	F			3
5	31	1	3	1	148	3.2	70	3	3	F			1
5	31	1	3	1	149	3.4	69	3	3	F			1
6	1	1	3	1	154	2.6	62	5	3	F			1
6	5	1	3	1	205	4.14	79	6	1	F			1
6	5	1	3	1	206	5.34	81	6	1	F			1
6	5	1	3	1	207	4.83	82	6	1	F			1
6	5	1	3	1	208	4.15	77	6	1	F			1
6	5	1	3	1	209	6.17	88	6	1	F			1
6	5	1	3	1	210	3.66	75	6	1	F			1
6	5	1	3	1	217	5.7	85	6	1	F			1

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MONTH	DAY	Year	Session	Season	Lab	Weight	LENGTH	Site	Habitat	Sex	Ovary	Liver	Maturity
6	5	1	3	1	219	5.95	85	6	1	F			1
6	5	1	3	1	220	4.44	76	6	1	F			2
6	6	1	3	1	225	4.1	77	1	1	F			1
6	6	1	3	1	227	5.83	84	8	2	F	1.01		3
6	6	1	3	1	228	4.67	82	8	2	F	0.58		3
6	6	1	3	1	229	5.73	86	8	2	F	0.71		3
6	6	1	3	1	231	3.65	75	8	2	F	0.1		1
6	6	1	3	1	233	4.76	79	8	2	F	0.67		1
6	6	1	3	1	236	8.23	98	8	2	F	0.79		3
6	6	1	3	1	238	2.02	65	8	2	F			1
6	6	1	3	1	240	4.77	81	8	2	F	0.57		3
6	6	1	3	1	245	4.93	82	8	2	F	0.44		3
6	7	1	3	1	273	4.15	81	3	3	F			2
6	7	1	3	1	277	4.42	75	3	3	F			1
6	7	1	3	1	279	4.81	80	3	3	F			1
6	7	1	3	1	280	4.26	73	3	3	F			1
6	7	1	3	1	281	2.36	63	3	3	F			1
6	7	1	3	1	282	5.92	83	3	3	F	0.83		3
6	7	1	3	1	284	5	80	3	3	F	0.1		2
6	7	1	3	1	288	5.83	80	3	3	F	1		3
6	7	1	3	1	289	6.95	89	3	3	F	0.69		3
6	7	1	3	1		3.89	80	3	3	F			3
6	8	1	3	1	293	6.4	91	4	3	F	0.86		4
6	8	1	3	1	294	10.5	100	4	3	F	1.65		4
6	8	1	3	1	299	5.1	85	5	3	F	0.12		1
6	8	1	3	1	300	8.9	93	5	3	F	1.52		3
6	8	1	3	1		5.4	86	5	3	F			1
6	13	1	4	1	324	10.4	106	8	2	F	0.97		3
6	13	1	4	1	325	6.9	94	8	2	F	0.75		3
6	13	1	4	1	326	8.71	100	8	2	F	1.2		3
6	13	1	4	1	327	7.1	91	8	2	F	0.73		3
6	13	1	4	1	328	7.7	94	8	2	F	1.23		3
6	13	1	4	1		4.3	77	8	2	F			4
6	13	1	4	1		5.7	87	8	2	F			4
6	13	1	4	1		6.9	88	8	2	F			4
6	13	1	4	1		6.8	92	8	2	F			4

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MONTH	DAY	Year	Session	Season	Lab	Weight	LENGTH	Site	Habitat	Sex	Ovary	Liver	Maturity
6	14	1	4	1	355	5.3	82	3	3	F	1.47		3
6	14	1	4	1	393	6.34	85	3	3	F	0.83		3
6	15	1	4	1	421	6.6	92	5	3	F	0.88		3
6	15	1	4	1	422	2.81	68	5	3	F			1
6	15	1	4	1	423	7.8	93	5	3	F	1.38		3
6	21	1	4	1	557	13.1	112	3	3	F	2.06	0.102	3
6	21	1	4	1	586	3.4	75	3	3	F	0.076	0.080	1
6	21	1	4	1	592	3.5	74	3	3	F	0.28	0.50	1
6	21	1	4	1	599	2.3	61	3	3	F	0.034	0.012	1
6	21	1	4	1	603	0.99	47	3	3	F		0.028	1
6	21	1	4	1	608	0.89	47	3	3	F	0.018	0.008	1
6	22	1	4	1	648	6.07	90	5	3	F			5
6	22	1	4	1	649	4.1	77	5	3	F	0.086	0.62	5
6	22	1	4	1	650	4.26	80	5	3	F	0.094	0.028	5
6	22	1	4	1	651	4.13	77	5	3	F	0.184	0.078	5
6	22	1	4	1	652	4.84	80	5	3	F	0.062	0.042	5
6	22	1	4	1	654	3.51	72	5	3	F	0.054	0.028	5
6	22	1	4	1	657	3.9	73	5	3	F	0.122	0.054	5
6	23	1	4	1	697	4.8	77	6	1	F	1.08	0.056	3
7	11	1	6	1	1001	4.94	85	1	1	F	0.020	0.052	1
7	11	1	6	1	1013	1.57	57	1	1	F	0.014	0.026	1
7	11	1	6	1	1014	2.05	63	1	1	F		0.020	1
7	11	1	6	1	1016	5.58	88	8	2	F	0.154	0.146	2
7	11	1	6	1	1017	5.28	85	8	2	F	0.148	0.052	2
7	11	1	6	1	1020	3.62	75	8	2	F		0.048	1
7	11	1	6	1	1021	3.29	73	8	2	F	0.052	0.128	1
7	11	1	6	1	1025	4.91	80	8	2	F	0.046	0.054	5
7	11	1	6	1	1026	6.01	85	8	2	F	0.224	0.084	5
7	11	1	6	1	1027	6.12	88	8	2	F	0.462	0.124	5
7	12	1	6	1	1042	13.5	120	3	3	F	1.048	0.292	5
7	12	1	6	1	1043	3.7	76	3	3	F	0.062	0.054	1
7	12	1	6	1	1044	1.75	62	3	3	F			1
7	12	1	6	1	1050	6.7	91	5	3	F	0.052	0.062	5
7	12	1	6	1	1051	5.1	84	5	3	F	0.022	0.078	5
7	12	1	6	1	1052	3	85	5	3	F	0.014	0.09	5

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MONTH	DAY	Year	Session	Season	Lab	Weight	LENGTH	Site	Habitat	Sex	Ovary	Liver	Maturity
7	13	1	6	1	1058	5.17	86	9	1	F	0.188	0.052	5
7	13	1	6	1	1061	4.53	83	9	1	F	0.036	0.034	2
8	3	1	8	2	1202	3.4	71	9	1	F			1
8	10	1	8	2	1317	8.1	98	10	1	F	0.754	0.0148	1

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
7	5	2	1	1	96007	8.99	98	3	3	M		0.17	1
21	5	2	2	1	96060	8.41	100	3	3	M		0.25	1
21	5	2	2	1	96065	7.51	95	3	3	M	0.08	0.14	3
21	5	2	2	1	96066	7.86	99	3	3	M		0.16	3
21	5	2	2	1	96068	5.36	86	3	3	M		0.11	1
21	5	2	2	1	96069	6.18	90	3	3	M	0.04	0.14	1
28	5	2	3	1	96097	1.6	68	LR	3	M			2
28	5	2	3	1	96098	5.3	85	LR	3	M			2
28	5	2	3	1	96099	3.6	78	LR	3	M			2
28	5	2	3	1	96100	6.2	95	LR	3	M			2
28	5	2	3	1	96101	4.3	80	LR	3	M			2
28	5	2	3	1	96102	4.9	85	LR	3	M			2
28	5	2	3	1	96103	3.8	76	LR	3	M			2
28	5	2	3	1	96106	3.2	75	LR	3	M			2
29	5	2	3	1	96109	7.04	96	3	3	M		0.14	2
29	5	2	3	1	96110	9.5	107	3	3	M		0.24	2
29	5	2	3	1	96112	4.97	86	3	3	M		0.1	2
29	5	2	3	1	96114	4.11	81	3	3	M		0.06	1
29	5	2	3	1	96115	6.5	92	3	3	M		0.12	2
29	5	2	3	1	96116	5.3	85	3	3	M		0.07	1
29	5	2	3	1	96117	4.92	84	3	3	M		0.09	1
29	5	2	3	1	96119	5	85	3	3	M		0.1	1
29	5	2	3	1	96120	3.83	76	3	3	M		0.07	1
29	5	2	3	1	96123	5.2	84	3	3	M		0.08	1
29	5	2	3	1	96124	5.5	90	3	3	M		0.1	1
29	5	2	3	1	96125	4.91	84	3	3	M		0.08	1
29	5	2	3	1	96126	5	82	3	3	M		0.07	1
29	5	2	3	1	96127	4.8	84	3	3	M		0.12	1
29	5	2	3	1	96130	4.3	82	3	3	M		0.07	1
29	5	2	3	1	96131	4.62	83	3	3	M		0.13	1
29	5	2	3	1	96136	4.8	83	3	3	M		0.09	1
29	5	2	3	1	96138	4.63	83	3	3	M		0.1	1
30	5	2	3	1	96150	5..21	83	4	3	M		0.11	3
30	5	2	3	1	96154	4.7	88	CR	3	M		0.27	2
30	5	2	3	1	96155	3.2	73	CR	3	M		0.06	1
4	6	2	3	1	96177	4.26	81	LR	3	M		0.072	2

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
4	6	2	3	1	96178	5.23	82	LR	3	M		0.11	3
4	6	2	3	1	96183	4.72	82	LR	3	M		0.72	1
13	6	2	4	1	96185	3.09	70	5	3	M		0.09	1
13	6	2	4	1	96191	5.8	87	5	3	M		0.15	1
13	6	2	4	1	96193	4.51	83	5	3	M		0.04	1
17	6	2	4	1	96207	9.18	104	9	1	M		0.08	3
17	6	2	4	1	96208	8.56	110	9	1	M		0.17	2
17	6	2	4	1	96212	4.7	87	9	1	M		0.06	3
19	6	2	4	1	96215	5.07	80	CR	3	M		0.09	3
19	6	2	4	1	96231	2.98	72	5	3	M		0.07	3
19	6	2	4	1	96232	4.81	82	5	3	M		0.03	2
17	7	2	6	2	96278	4.456	80	5	3	M		0.154	1
17	7	2	6	2	96279	4.39	82	5	3	M		0.89	2
17	7	2	6	2	96283	4.58	81	5	3	M		0.066	2
17	7	2	6	2	96284	4.43	80	5	3	M		0.092	2
24	7	2	7	2	96287	5.59	83	5	3	M		0.14	2
24	7	2	7	2	96289	4.32	79	5	3	M		0.12	2
24	7	2	7	2	96291	5.55	85	5	3	M		0.18	2
24	7	2	7	2	96292	5.26	85	5	3	M		0.23	2
24	7	2	7	2	96293	5.1	83	5	3	M		0.15	2
20	8	2	9	2	96429	5.71	89	15	2	M		0.02	1
20	8	2	9	2	96430	5.37	86	15	2	M		0.066	1
21	8	2	9	2	96489	4.6	83	5	3	M		0.03	1
21	8	2	9	2	96491	4	78	5	3	M		0.01	1
21	8	2	9	2	96492	6.3	94	5	3	M		0.24	4
21	8	2	9	2	96493	7.4	97	5	3	M		0.05	1
21	8	2	9	2	96494	5.5	90	5	3	M		0.22	2
30	5	2	3	1		3.1	73	4	3	M			2
30	5	2	3	1		3.7	76	4	3	M			2
30	5	2	3	1		3.3	74	4	3	M			2
30	5	2	3	1		4	77	4	3	M			2
30	5	2	3	1		7.1	93	4	3	M			2
30	5	2	3	1		4.4	82	4	3	M			2
30	5	2	3	1		6.04	89	4	3	M		0.13	3
14	5	2	2	1			29	3	3	M			
30	5	2	3	1		2	63	5	3	M			1

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
30	5	2	3	1		2.4	67	5	3	M			3
4	6	2	3	1		3.51	73	LR	3	M		0.04	1
4	6	2	3	1		2.84	71	LR	3	M		0.1	1
4	6	2	3	1		3.96	74	LR	3	M		0.05	1
4	6	2	3	1		3.84	73	LR	3	M		0.04	1
4	6	2	3	1		3.69	72	LR	3	M		0.06	1
4	6	2	3	1		3.89	83	LR	3	M			1
4	6	2	3	1		4.27	80	LR	3	M		0.046	1
4	6	2	3	1		4.45	76	LR	3	M		0.048	1
4	6	2	3	1		3.26	70	LR	3	M		0.046	1
4	6	2	3	1		3.63	76	LR	3	M		0.06	1
4	6	2	3	1		3.5	76	LR	3	M		0.28	1
4	6	2	3	1		4.31	78	LR	3	M		0.064	1
4	6	2	3	1		3.47	75	LR	3	M			1
4	6	2	3	1		4.77	84	LR	3	M			1
4	6	2	3	1		3.5	775	LR	3	M			1
4	6	2	3	1		3.48	73	LR	3	M			1
19	6	2	4	1		3.1	73	CR	3	M		0.06	1
19	6	2	4	1		2.91	71	CR	3	M		0.04	1
19	6	2	4	1		3.97	78	5	3	M			1
4	6	2	3	1		3.45	70	LR	3	M		0.07	2
19	6	2	4	1		3.69	76	5	3	M		0.04	2
4	6	2	3	1		3.31	75	LR	3	M			3
20	6	2	4	1			78	12	2	M			3
20	6	2	4	1			77	8	2	M			3
19	6	2	4	1		4.6	76	5	3	M		0.04	4
18	7	2	6	2		4.33	81	3	3	M			1
17	7	2	6	2		3.87	78	5	3	M		0.094	1
17	7	2	6	2		4.33	81	5	3	M		0.1	1
15	7	2	6	1		5.35	85	12	2	M			1
25	7	2	7	2		5.6	84	3	3	M			1
24	7	2	7	2		5.05	83	5	3	M			1
24	7	2	7	2		3.84	75	5	3	M			1
24	7	2	7	2		5.15	82	5	3	M			1
26	7	2	7	2		5.28	89	13	1	M			1
24	7	2	7	2		4.09	75	5	3	M			1

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	TESTES	MATURITY
24	7	2	7	2		5.89	82	5	3	M			1
17	7	2	6	2		4.66	82	5	3	M			2
17	7	2	6	2		4.67	79	5	3	M			2
17	7	2	6	2		4.28	80	5	3	M			2
17	7	2	6	2		4.94	83	5	3	M			2
17	7	2	6	2		3.86	77	5	3	M			2
17	7	2	6	2		3.45	72	5	3	M			2
17	7	2	6	2		3.95	78	5	3	M			2
24	7	2	7	2		6.26	92	5	3	M			2
21	8	2	9	2		6.4	94	5	3	M			4
21	8	2	9	2		5.2	87	5	3	M			4
21	8	2	9	2		6	88	5	3	M			4
21	8	2	9	2		6	91	5	3	M			4
21	8	2	9	2		2.7	70	5	3	M			4
21	8	2	9	2		6	89	5	3	M			4
21	8	2	9	2		3.5	75	5	3	M			4
21	8	2	9	2		3.7	80	5	3	M			4

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
7	5	2	1	1	96012	10.1	105	3	3	F			1
8	5	2	1	1	96020	8.53	99	5	3	F		0.71	3
9	5	2	1	1	96023	8.5	102	9	1	F		1.14	3
9	5	2	1	1	96024	12	113	9	1	F		1.37	3
9	5	2	1	1	96030	8.72	95	9	1	F		0.26	5
9	5	2	1	1	96032	8.4	97	9	1	F		0.17	5
9	5	2	1	1	96033	8.7	102	9	1	F		0.18	1
21	5	2	2	1	96063	9.5	105	3	3	F	0.27	1.62	4
21	5	2	2	1	96064	8.98	105	3	3	F		1.25	4
21	5	2	2	1	96067	5.46	88	3	3	F	0.09	0.5	5
24	5	2	2	1	96078	8.97	96	9	1	F		1.36	3
28	5	2	3	1	96090	5.7	90	LR	3	F			3
28	5	2	3	1	96091	3.7	79	LR	3	F			3
28	5	2	3	1	96092	5.3	88	LR	3	F			3
28	5	2	3	1	96093	3.4	75	LR	3	F			3
28	5	2	3	1	96094	3.1	75	LR	3	F			1
28	5	2	3	1	96095	4.4	80	LR	3	F			1
28	5	2	3	1	96096	3	72	LR	3	F			3
29	5	2	3	1	96108	10.3	109	3	3	F		0.8	3
29	5	2	3	1	96111	9.2	103	3	3	F		1.3	3
29	5	2	3	1	96113	6.5	90	3	3	F		0.88	3
29	5	2	3	1	96118	5.4	86	3	3	F		0.64	3
29	5	2	3	1	96121	6.4	90	3	3	F		0.92	3
29	5	2	3	1	96128	4.07	78	3	3	F		0.47	3
29	5	2	3	1	96129	4.9	85	3	3	F		0.37	2
29	5	2	3	1	96139	3.11	72	3	3	F		0.24	2
30	5	2	3	1	96141	5.89	84	4	3	F		0.64	3
30	5	2	3	1	96142	3.8	76	4	3	F		0.28	2
30	5	2	3	1	96143	4.99	83	4	3	F		0.62	3
30	5	2	3	1	96144	7	94	4	3	F		1	3
30	5	2	3	1	96145	9.75	102	4	3	F		1.46	3
30	5	2	3	1	96146	4.9	85	4	3	F		0.58	3
30	5	2	3	1	96147	4.38	77	4	3	F		0.55	4
30	5	2	3	1	96148	4.5	80	4	3	F		0.19	3
30	5	2	3	1	96149	3.2	72	4	3	F		0.12	1
30	5	2	3	1	96151	5	83	4	3	F		0.56	3

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
30	5	2	3	1	96153	4.4	83	CR	3	F		0.468	3
30	5	2	3	1	96156	3.9	80	CR	3	F		0.31	1
30	5	2	3	1	96157	5.36	84	CR	3	F		0.39	1
30	5	2	3	1	96158	3.2	74	CR	3	F		0.19	2
30	5	2	3	1	96159	2.92	74	CR	3	F		0.16	1
4	6	2	3	1	96162	3.94	77	LR	3	F		0.32	3
4	6	2	3	1	96163	4.03	76	LR	3	F		0.35	3
4	6	2	3	1	96164	3.25	72	LR	3	F		0.23	3
4	6	2	3	1	96165	4.16	78	LR	3	F		0.75	3
4	6	2	3	1	96167	4.72	80	LR	3	F		0.78	3
4	6	2	3	1	96172	3.51	81	LR	3	F		0.33	3
4	6	2	3	1	96174	4.35	80	LR	3	F		0.66	3
4	6	2	3	1	96179	4.68	81	LR	3	F		0.7	3
4	6	2	3	1	96180	3.37	70	LR	3	F		0.55	4
4	6	2	3	1	96181	2.61	80	LR	3	F		0.234	2
4	6	2	3	1	96182	3.58	71	LR	3	F		0.24	2
4	6	2	3	1	96184	4.15	75	LR	3	F		0.49	2
13	6	2	4	1	96186	6.46	83	5	3	F		1.53	3
13	6	2	4	1	96187	3.83	76	5	3	F		0.34	2
13	6	2	4	1	96188	4.6	80	5	3	F		0.75	3
13	6	2	4	1	96189	7.11	92	5	3	F		0.74	3
13	6	2	4	1	96192	4.8	80	5	3	F		0.43	2
14	6	2	4	1	96196	4.67	77	12	2	F		0.6	3
14	6	2	4	1	96202	9.59	104	12	2	F		0.87	3
14	6	2	4	1	96203	11.9	110	12	2	F		2.13	3
17	6	2	4	1	96204	7.5	95	9	1	F		1.44	4
17	6	2	4	1	96205	8.76	100	9	1	F		1.34	3
17	6	2	4	1	96206	4.5	85	9	1	F		0.73	3
19	6	2	4	1	96216	3.1	72	CR	3	F		0.4	2
19	6	2	4	1	96217	4.68	79	CR	3	F		0.69	3
19	6	2	4	1	96219	6.28	87	5	3	F		0.69	3
19	6	2	4	1	96220	7.41	94	5	3	F		1.41	3
19	6	2	4	1	96221	2.83	75	5	3	F		0.43	4
19	6	2	4	1	96222	2	75	5	3	F		0.07	2
19	6	2	4	1	96223	4.4	75	5	3	F		0.61	3
19	6	2	4	1	96224	3.87	73	5	3	F		0.48	3

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
19	6	2	4	1	96225	6.6	87	5	3	F		0.97	3
19	6	2	4	1	96226	4.48	83	5	3	F			2
19	6	2	4	1	96227	3.9	74	5	3	F		0.61	3
19	6	2	4	1	96228	3.11	72	5	3	F		0.08	2
19	6	2	4	1	96229	4.28	79	5	3	F		0.15	2
19	6	2	4	1	96230	4.39	80	5	3	F		0.43	3
5	7	2	5	1	96252	3.4	72	8	2	F		0.236	2
5	7	2	5	1	96253	4.1	80	8	2	F		0.32	2
8	7	2	6	1	96254	4.59	80	9	1	F		0.56	3
8	7	2	6	1	96255	5.17	82	9	1	F		0.16	1
9	7	2	6	1	96258	5.4	82	LR	3	F		1	3
9	7	2	6	1	96259	8.5	95	LR	3	F			5
9	7	2	6	1	96260	4.7	75	LR	3	F		0.82	3
9	7	2	6	1	96261	4.09	77	LR	3	F		0.48	3
9	7	2	6	1	96271	5.13	85	8	2	F		0.81	3
17	7	2	6	2	96277		89	5	3	F		1.8	4
17	7	2	6	2	96280	4.71	80	5	3	F		1.76	3
17	7	2	6	2	96281	4.53	80	5	3	F		0.68	3
17	7	2	6	2	96282	4.83	84	5	3	F		0.43	3
18	7	2	6	2	96285	4.5	83	LR	3	F		0.42	3
18	7	2	6	2	96286	5.86	87	3	3	F		0.86	3
24	7	2	7	2	96288	7.1	90	5	3	F		0.64	3
24	7	2	7	2	96290	13.9	109	5	3	F		3.01	3
24	7	2	7	2	96300	4.27	76	5	3	F		0.72	3
25	7	2	7	2	96302	4.88	81	3	3	F		0.68	3
25	7	2	7	2	96303	4.52	80	3	3	F		0.4	3
25	7	2	7	2	96304	4.29	81	3	3	F		0.19	2
25	7	2	7	2	96307	6.9	92	12	2	F		0.32	2
31	7	2	7	2	96316	7.2	93	17	2	F		0.2	2
12	8	2	9	2	96357	4.36	82	16	2	F		0.148	2
13	8	2	9	2	96360	7.43	95	12	2	F		0.392	2
14	8	2	9	2	96393	5.7	91	4	3	F		0.28	3
19	8	2	9	2	96423	10.6	108	20	1	F		0.442	5
19	8	2	9	2	96424	4.92	87	20	1	F		0.118	2
20	8	2	9	2	96425	3.34	92	15	2	F		0.13	2
20	8	2	9	2	96426	3.41	90	15	2	F		0.177	2

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
20	8	2	9	2	96428	6.98	96	15	2	F		0.25	2
20	8	2	9	2	96431	6.88	94	15	2	F		0.226	2
21	8	2	9	2	96488	8.3	95	5	3	F		0.33	2
21	8	2	9	2	96490	5.3	92	5	3	F		0.27	2
21	8	2	9	2	96495	8.2	98	5	3	F		0.38	2
21	8	2	9	2	96496	7.4	98	5	3	F		0.23	2
21	8	2	9	2	96497	3.8	79	5	3	F		0.1	1
21	8	2	9	2	96498	6.8	94	5	3	F		0.32	2
21	8	2	9	2	96499	9.1	105	5	3	F		0.45	2
30	5	2	3	1		2.81	71	4	3	F			1
30	5	2	3	1		4	80	CR	3	F			1
28	5	2	3	1		1.8	62	LR	3	F			1
28	5	2	3	1		2.4	66	LR	3	F			1
30	5	2	3	1		4.03	82	CR	3	F			2
28	5	2	3	1		3.2	75	LR	3	F			2
28	5	2	3	1		3.2	73	LR	3	F			3
28	5	2	3	1		3.1	75	LR	3	F			3
28	5	2	3	1		3	75	LR	3	F			3
4	6	2	3	1		4.03	77	LR	3	F		0.32	1
13	6	2	4	1		3.12	68	5	3	F			1
13	6	2	4	1		3.6	74	5	3	F			1
13	6	2	4	1		3.2	76	5	3	F			1
13	6	2	4	1		4.6	81	5	3	F			1
13	6	2	4	1		4.77	78	5	3	F			1
14	6	2	4	1			72	12	2	F			1
14	6	2	4	1			67	12	2	F			1
14	6	2	4	1			72	12	2	F			1
14	6	2	4	1			72	12	2	F			1
4	6	2	3	1		3.57	71	LR	3	F		0.4	2
4	6	2	3	1		3.95	76	LR	3	F		0.29	2
19	6	2	4	1		3.3	72	CR	3	F		0.41	2
19	6	2	4	1		3.05	71	5	3	F		0.12	2
13	6	2	4	1		2.93	67	5	3	F			2
13	6	2	4	1		2.92	70	5	3	F			2
20	6	2	4	1			94	12	2	F			2
20	6	2	4	1			79	12	2	F			2

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
4	6	2	3	1		3.87	74	LR	3	F		0.39	3
3	7	2	5	1		2.8	68	3	3	F			1
3	7	2	5	1		3.5	74	3	3	F			1
3	7	2	5	1		3.8	75	3	3	F			1
3	7	2	5	1		3.7	76	3	3	F			1
15	7	2	6	1		4.03	77	12	2	F			1
15	7	2	6	1		3.14	71	12	2	F			1
9	7	2	6	1		4.7	82	8	2	F			1
25	7	2	7	2		5.01	89	3	3	F			1
31	7	2	7	2		5.6	86	17	2	F			1
25	7	2	7	2		7.32	93	12	2	F			1
25	7	2	7	2		6.28	90	12	2	F			1
25	7	2	7	2		5.14	84	12	2	F			1
15	7	2	6	1		3.45	74	12	2	F			2
31	7	2	7	2			78	18	1	F			2
31	7	2	7	2			70	15	2	F			2
1	8	2	7	2		3.91	75	5	3	F			1
1	8	2	7	2		4.71	82	5	3	F			1
1	8	2	7	2		4.08	78	CR	3	F			1
1	8	2	7	2		2.64	88	CR	3	F			1
15	8	2	8	2			75	3	3	F			1
15	8	2	8	2			77	3	3	F			1
14	8	2	8	2		3.19	75	4	3	F			1
14	8	2	8	2		5.24	89	4	3	F			1
14	8	2	8	2		4.88	83	4	3	F			1
13	8	2	8	2		6.78	92	12	2	F			1
13	8	2	8	2		6.06	88	12	2	F			1
12	8	2	8	2		4.02	78	16	2	F		0.136	1
15	8	2	8	2		4.22	80	LR	3	F			1
15	8	2	8	2			90	3	3	F			1
21	8	2	9	2		4.4	80	5	3	F		0.16	1
21	8	2	9	2		3	74	5	3	F			1
21	8	2	9	2		3.7	75	5	3	F			1
20	8	2	9	2		4.73	84	15	2	F			1
19	8	2	9	2		6.01	89	20	1	F			1
19	8	2	9	2		2.6	84	20	1	F			1

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DAY	MONTH	YEAR	SESSION	SEASON	LAB	WEIGHT	LENGTH	SITE	HABITAT	SEX	LIVER	OVARY	MATURITY
1	8	2	7	2		5.67	84	8	2	F			2
1	8	2	7	2		6.41	88	CR	3	F			2
1	8	2	7	2		5.43	86	CR	3	F			2
14	8	2	8	2		5.07	84	4	3	F			2
15	8	2	8	2			93	3	3	F			2
15	8	2	8	2			86	3	3	F			2
15	8	2	8	2			80	3	3	F			2
20	8	2	9	2		5.54	91	15	2	F		0.176	2
20	8	2	9	2		3.9	90	15	2	F		0.16	2
26	8	2	9	2		2.87	80	3	3	F	0.052	0.13	2
21	8	2	9	2		5.5	87	5	3	F		0.18	2
21	8	2	9	2		6.5	92	5	3	F		0.25	2
21	8	2	9	2		4.7	84	5	3	F		0.21	2
21	8	2	9	2		4.5	84	5	3	F		0.12	2
21	8	2	9	2		6.7	94	5	3	F		0.24	2
15	8	2	8	2		7.06	95	LR	3	F		0.037	5
21	8	2	9	2		8.6	100	5	3	F			5
21	8	2	9	2		6.6	90	5	3	F			5
21	8	2	9	2		5.2	90	5	3	F			5
21	8	2	9	2		6	92	5	3	F			5
21	8	2	9	2		4	78	5	3	F		0.14	5

Appendix 9

Lake chub diet analysis as percent by volume of stomach contents, 1995 and 1996.

Lake chub diet

Sample No.		3	4	6	41	108	112	115	116	117	124
Date		05/17/95	05/17/95	05/17/95	05/18/95	05/30/95	05/30/95	05/30/95	05/30/95	05/30/95	05/30/95
Species		LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Amphipoda											
Ephemeroptera			5		50		80	100	95	70	39
Plecoptera											30
Trichoptera					49		19			30	30
Megaloptera											
Heteroptera	Corixidae										
Homoptera	(Terrestrial)										
Coleoptera	Dytiscidae										
	Elmidae	10	5								
	Other (Terr.)										
Diptera	Chironomidae	1			1	100	1		5		1
	Simuliidae	30	90	100							
	Other Diptera										
Hymenoptera	(Terrestria)										
Araneae	(Terrestrial)	59									
Hydracarina											
Organic Material											

Lake chub diet

Sample No		131	139	148	154	206	275	282	289	326	421
Date		05/31/95	05/31/95	05/31/95	06/01/95	06/05/95	06/07/95	06/07/95	06/07/95	06/13/95	06/15/95
Species		LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Amphipoda											
Ephemeroptera		45	100	99	90	80	100	95	100	40	40
Plecoptera								3		20	
Trichoptera		10			9						
Megaloptera											
Heteroptera	Corixidae										
Homoptera	(Terrestrial)									30	
Coleoptera	Dytiscidae										
	Elmidae										
	Other (Terr.)										
Diptera	Chironomidae	45		1	1	20		2		10	
	Simuliidae										
	Other Diptera										
Hymenoptera	(Terrestrial)										
Araneae	(Terrestrial)										
Hydracarina											
Organic Material											60

Lake chub diet

Sample No.		557	650	654	1001	1013	1014	1016	1017	1018	1020
Date		06/21/95	06/22/95	06/22/95	07/11/95	07/11/95	07/11/95	07/11/95	07/11/95	07/11/95	07/11/95
Species		LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Amphipoda				5	empty			empty			empty
Ephemeroptera		20	60	60							
Plecoptera							100				
Trichoptera		30								15	
Megaloptera											
Heteroptera	Corixidae									50	
Homoptera	(Terrestrial)										
Coleoptera	Dytiscidae	50		25							
	Elmidae										
	Other (Terr.)		40			100			100		
Diptera	Chironomidae			10						5	
	Simuliidae										
	Other Diptera									30	
Hymenoptera	(Terrestrial)										
Araneae	(Terrestrial)										
Hydracarina											
Organic Material											

Lake chub diet

Sample No.		1021	1025	1026	1027	1042	1043	1050	1051	1052	1058
Date		07/11/95	07/11/95	07/11/95	07/11/95	07/12/95	07/12/95	07/12/95	07/12/95	07/12/95	07/13/95
Species		LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	%
Amphipoda											empty
Ephemeroptera					30			50	100	100	
Plecoptera											
Trichoptera				100	20						
Megaloptera											
Heteroptera	Corixidae	100	100		50		100	50			
Homoptera	(Terrestrial)										
Coleoptera	Dytiscidae										
	Elmidae										
	Other (Terr.)										
Diptera	Chironomidae										
	Simuliidae										
	Other Diptera										
Hymenoptera	(Terrestrial)										
Araneae	(Terrestrial)										
Hydracarina											
Organic Material						100					

Lake chub diet

Sample No.		1059	1061	96032	96033	96064	96068	96175	96205	96316	
Date		07/13/95	07/13/95	05/09/96	05/09/96	05/21/96	05/21/96	06/04/96	06/17/96	07/31/96	
Species		LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	LKCB	
Taxa	Percent by Volume	%	%	%	%	%	%	%	%	%	
Amphipoda				Stomach	Stomach				Stomach		
Ephemeroptera			45	missing	missing	60		55	missing	9	
Plecoptera								38			
Trichoptera			50			2		5		20	
Megaloptera						38					
Heteroptera	Corixidae	20	5							40	
Homoptera	(Terrestrial)										
Coleoptera	Dytiscidae	30									
	Elmidae						50			5	
	Other (Terr.)										
Diptera	Chironomidae									1	
	Simuliidae							2			
	Other Diptera										
Hymenoptera	(Terrestrial)									25	
Araneae	(Terrestrial)										
Hydracarina							50				
Organic Material		50									