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Bull Trout Exotic Fish Removal
Project Completion Report

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Threatened and Endangered Species Report
Project E-20 (Segments 1-3)
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Findings in this report are preliminary in nature and not for publication without permission of the Director of the Idaho Department of Fish and Game.

PROJECT COMPLETION REPORT

GRANT TITLE: Bull Trout Exotic Fish Removal
GRANT NUMBER: E-20
SEGMENT NUMBER: 1-3
AGREEMENT PERIOD: July 1, 1998-June 30, 2001

PROJECT DESCRIPTION

This study focused on reducing threats to bull trout and cutthroat trout populations posed by exotic brook trout and lake trout. In 1998, we removed nearly 1,000 lake trout from Upper Priest Lake by gillnetting. We believed we made significant progress in reducing the lake trout population. However, the ratio of tagged to untagged fish in our nets, combined with continued sonic telemetry and angler tag returns are further evidence that emigration to and immigration from Priest Lake is common, and that Upper Priest Lake cannot be treated as a closed system. We concluded that long-term suppression of the lake trout population in Upper Priest Lake is impractical and likely impossible unless immigration from Priest Lake could be minimized.

Based on the results of the 1998 study, in 1999 and 2000 we directed our efforts at determining the feasibility of blocking lake trout migration in the Thorofare, which connects Priest Lake and Upper Priest Lake. We used a variety of fish collection equipment to evaluate daily and seasonal migration patterns of lake trout and native species through the Thorofare. In addition, we collected physical habitat characteristics of the Thorofare to help determine the types of barriers or fish avoidance equipment that might be effective in restricting lake trout migration.

PROJECT RESULTS AND CONCLUSIONS

A complete report of the Thorofare migration evaluation study follows.

Diel and seasonal movement of lake trout, cutthroat trout, and bull trout between Upper Priest Lake, and Priest Lake, Idaho

Project Completion Report
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ABSTRACT

The diel and seasonal movement of lake trout, bull trout, and cutthroat trout between Upper Priest Lake and Priest Lake, Idaho was studied in 1999 and 2000. Gillnets, fyke-nets, electrofishing, and radio telemetry were used to determine fish movements. Gillnetting was the only successful capture method. Lake trout were caught in the Thorofare in the spring and fall, but not in July or August. Lake trout were primarily caught at night (92% in 1999, 94% in 2000). Cutthroat trout were captured in the Thorofare from April to October and during both day and night periods. In 1999, 42% of cutthroat trout were caught at night, but 74 % were caught at night in 2000. Bull trout used the Thorofare in small numbers relative to lake trout and cutthroat trout, but their seasonal and diel use of the Thorofare was similar to lake trout.

Fifty lake trout were equipped with surgically implanted radio tags, with 25 of these fish released in Upper Priest Lake, and 25 released in Priest Lake. Fish were tracked from October 24, 2000 to March 29, 2001 using a fixed receiver located on the Thorofare. None of the 50 fish were detected.

The results indicate that lake trout migration through the Thorofare is common. In order to reduce the lake trout population in Upper Priest Lake a fish barrier is necessary to minimize immigration of lake trout into Upper Priest Lake. However, a fish barrier may prevent native cutthroat trout and bull trout from migrating to their natal spawning streams.

INTRODUCTION

Bull trout *Salvelinus confluentus* in the Columbia River basin were listed as threatened by the U.S. Fish and Wildlife Service on June 5, 1998. Despite the wide distribution of bull trout in the Columbia River basin, declines and local extinctions have occurred (Rieman et al. 1997). Causes of decline include habitat loss and fragmentation, interactions with introduced species, and overfishing (Rieman et al. 1997). The declines have generated much interest in developing conservation and management plans to protect and rebuild populations (Watson and Hillman 1997).

The introduction of nonnative species can have detrimental consequences for native species such as bull trout (Thurow et al. 1997). Species with similar ecological niches compete for limited resources, potentially leading to competitive exclusion or extirpation of one of the species (Schoener 1982). This exclusion can occur through direct predation by the introduced species or through competition for resources.

Although many species may interact with bull trout, lake trout *Salvelinus namaycush* are of particular concern. Both bull trout and lake trout are top piscivores, having similar food habits and growth rates, resulting in niche overlap and potential competition. Because of this ecological overlap, lake trout and bull trout do not commonly occur sympatrically in lakes. Bull trout are commonly displaced by lake trout as a result of direct predation or superior competitive ability with respect to food utilization and growth (Donald and Alger 1992). However, competition for food and space between the two species is difficult to verify in the field (Bjornn 1957).

Native bull trout historically were abundant and provided a trophy fishery in Upper Priest Lake and Priest Lake, Idaho. In the 1950s, annual catch approached 1,800 fish, with fish as large as 11 kg (Bjornn 1957). Priest Lake supported a successful bull trout fishery prior to 1978 when a sharp decline in the fishery was first noticed (Rieman and Lukens 1979). Bull trout harvest was eliminated in 1984, but no positive response in the fishery ensued (Mauser et al. 1988). Although bull trout were historically abundant, the Priest Lake population is now nearly extirpated and the Upper Priest Lake population depleted and at risk for extinction. The current population estimate for Upper Priest Lake and its tributaries is 116 adult fish. Introduced lake trout are considered as a possible cause of the decline (Fredericks 1999).

The Priest Lake bull trout population is adfluvial, with most fish maturing at age-5 or age-6, and entering spawning tributaries as early as May to spawn in September (Bjornn 1957). Bull trout generally rear in the tributary streams for two to three years before migrating to the lakes, and have a life expectancy of 10 or more years. During August and September when surface temperatures reach 20°C, bull trout in Upper Priest Lake and Priest Lake occupy the lower portion of the metalimnion at depths of 12-18 m where temperatures range from 7-13°C (Bjornn 1957). When surface temperatures are below or near 13°C in the spring and fall, the bull trout can be found closer to the surface.

Native westslope cutthroat trout *Oncorhynchus clarki lewisi* were also historically abundant in Priest Lake and provided a highly desired fishery (Bjornn 1957). Most cutthroat trout in Upper Priest Lake and Priest Lake are adfluvial and mature at age-5 (Bjornn 1957). Spawning begins in April and generally ends by mid-June. Most juvenile cutthroat trout in the Priest drainage remain in the streams two or three years before migrating to a lake. During the warm summer months, cutthroat trout also avoid the warmer, epilimnial water, and are primarily found in the upper portion of the metalimnion.

The cutthroat trout population was declining as early as the 1950s (Bjorn 1957) and has not recovered to historical levels (personal communication, Jim Fredericks, Regional Fisheries Biologist, Idaho Department of Fish and Game, Region 1, Coeur d' Alene, Idaho). Factors contributing to the decline include over-harvest, interspecific and intraspecific competition, and degradation of spawning habitat (Bjornn 1957). Cutthroat trout catches remained relatively constant from the 1950s to the mid-1980s at approximately 2,500 fish annually (Mauser and Ellis 1985).

Lake trout were first introduced to Priest Lake in 1925, but contributed little to the fishery until the early 1950s when anglers caught fish weighing up to 23 kg (Bjornn 1957). Lake trout remained at relatively low numbers in Priest Lake until the late 1970s, at which time annual harvest of lake trout increased from 5,700 fish to about 14,000 fish by 1994 (Davis et al., 2000). This increase in lake trout numbers has been speculatively attributed to increased juvenile survival rates caused by the introduction of mysis shrimp *Mysis relicta* in 1965 (Mauser et al. 1988).

Studies indicate that lake trout typically avoid warmer epilimnial temperatures during the summer and concentrate in the lower metalimnion and upper hypolimnion (Martin1957; Bjornn 1957). Lake trout are rarely found in water warmer than 15°C (Snucins and Gunn 1995) and select temperatures within their preferred range by moving to areas with warmer or colder waters (Olsen et al. 1988). The depth distribution of lake trout in Priest Lake is similar to that for bull trout. Bjornn (1957) reported that from mid-July to mid-September when surface water temperatures are above optimum, lake trout are found at depths of 12-18 m where water temperatures are 7-13°C. Martin (1957) also reported that in 2 lakes in Algonquin Park, Ontario, lake trout were observed at depths between 1.5 and 9 m, but were primarily distributed between 9 and 15 m deep where temperatures are between 7°C and 10°C in early June.

Lake trout were not known to be present in Upper Priest Lake until the mid-1980s, at which time they are thought to have begun migrating from Priest Lake (Mauser 1986). By 1998, the Upper Priest Lake population was estimated at 859 fish (± 22%, 95% C.I.; Fredericks 1999). In response to this observed population growth, the Idaho Department of Fish and Game (IDFG) experimentally attempted to reduce lake trout numbers in Upper Priest Lake in 1998 by gillnetting (Fredericks 1999). Although 912 lake trout were removed from Upper Priest Lake and the gillnet catch rate and lake trout:bull trout ratio declined throughout the summer, the effects were not still apparent the following year (Fredericks and Venard 2000).

Data from 10 sonic-tagged and 112 spaghetti-tagged lake trout indicated that lake trout migrate freely between Upper Priest Lake and Priest Lake through a narrow, 3 km long channel known as the Thorofare (Fredericks 1999). In the fall of both 1997 and 1998 one of the sonic-tagged lake trout was located in Upper Priest Lake early in the fall, and later found near West Twin Island in Priest Lake, a movement of approximately 16 km. Another sonic-tagged lake trout that initially was in Upper Priest Lake was found in Priest Lake near Pinto Point in June 1998, a movement of approximately 19 km from its last location in Upper Priest Lake. Additionally, anglers have reported eight spaghetti-tagged lake trout caught in Priest Lake that had been tagged and released in Upper Priest Lake.

Knowledge of seasonal water temperature trends in the Upper Priest Lake, Priest Lake, and the Thorofare is important in understanding the timing of fish movement between the two lakes. Because the epilimnial water temperatures rise above optimal for cutthroat trout, bull trout, and lake trout, these fish seek cooler metalimnial waters from mid-July to early-September (Bjornn 1957). During this period of warm epilimnial water temperatures cutthroat trout, bull trout, and lake trout may not use the Thorofare.

For lake trout to be successfully suppressed in Upper Priest Lake, lake trout movement through the Thorofare must be obstructed. However, construction of a fish barrier could affect native westslope cutthroat trout, bull trout, and other native fishes by also inhibiting their movement between Upper Priest and Priest Lake, and excluding them from spawning tributaries. Because of these considerations, this management action requires knowledge of seasonal and diel movement patterns of introduced lake trout, and native cutthroat trout and bull trout. Currently no information is available on the movement patterns of these species between Upper Priest Lake and Priest Lake. In addition, more information is needed on how the movements of these species are affected by the physical habitat parameters including the lake water temperatures and water clarity, and Thorofare water temperature, depth, mean velocity, and discharge. The objectives of this study are 1) to determine diel and seasonal movement patterns of lake trout, bull trout and cutthroat trout between Upper Priest Lake and Priest Lake; and 2) compare the movement patterns of these species between Upper Priest Lake and Priest Lake in relation to physical habitat parameters.

STUDY AREA

Upper Priest Lake is a 567 ha natural lake located in extreme northern Idaho, approximately 30 km south of the Idaho-British Columbia border and 90 km north of the city of Coeur d'Alene. Upper Priest and Priest Lakes are situated in the Selkirk Mountains amid a coniferous forest watershed of 1550 km^2. Upper Priest Lake has a mean depth of 13 m and a maximum depth of 32 m. Upper Priest Lake is connected to 9,454 ha Priest Lake by a river channel known as the Thorofare (Figure 1). The elevation of both lakes is maintained at the 743 m in elevation from the end of runoff until mid October by a small dam at the outlet of Priest Lake. In October, water is slowly released from Priest Lake until it reaches its natural low elevation in mid-November.

The Thorofare is 3 km long, 70 m wide, and generally 2–3 m deep. At its outlet into Priest Lake, the Thorofare is 1 m deep at summer pool level. When the lake levels reach low pool level depth of the Thorofare at its outlet is <15 cm deep, impeding nearly all boat traffic. At the outlet of the Thorofare, a 200 m x 3 m wooden picket fence breakwater extends into Priest Lake protecting the shoreline from erosion. During summer months the Thorofare receives heavy boat traffic. For example, on August 22, 2000, a typical week day, 47 motorboats, 3 canoes, and 5 kayaks were counted entering Upper Priest Lake through the Thorofare. Boat traffic is much heavier on the weekends.

Upper Priest Lake is bathymetrically bathtub-shaped, being long and narrow with steep walls and a flat bottom, and has a shoreline of 13 km and a shoreline development index of 1.3. Priest Lake has a 100 km shoreline and a shoreline development index of 3.0. Summer surface temperatures of Upper Priest are consistently lower than Priest Lake, with maximum temperatures of 21C° and 24°C, respectively. A thermocline is present by mid-July in both lakes, although it is shallower in Upper Priest Lake. Thermal stratification can still be evident in early October, but by early November, both lakes are homothermous. Upper Priest Lake and areas of Priest Lake commonly freeze over, with ice cover usually lasting from January through late April.

In addition to bull trout and cutthroat trout, other native species found in Upper Priest and Priest Lakes include native mountain whitefish *Prosopium williamsoni*, redside shiner *Richardsonius balteatus*, peamouth chub *Milocheilus caurinus*, largescale sucker *Catostomus macrocheilus*, and northern pikeminnow *Ptychocheilus oregonensis*. In addition to lake trout, other introduced species include brook trout *Salvelinus fontinalis*, largemouth bass *Micropterus salmoides*, yellow perch *Perca flavescens*, and tench *Tinca tinca*. Brook trout were introduced prior to the 1920s and are concentrated in tributaries to the lakes (Bjornn 1957). Rainbow trout *Oncorhynchus mykiss* have been introduced, but did not remain in the fishery. Kokanee *Oncorhynchus nerka* were introduced in 1942, 1943, and 1944, and constituted 95 percent of the total catch of game fish in the 1950s. As the survival of juvenile lake trout increased with the introduction of mysis shrimp, kokanee declined to near extinction by the early 1980s (Mauser et al. 1988).

MATERIALS AND METHODS

Capture

1999

Thorofare Gillnetting-From June to October 1999, a two-person crew used gillnets to capture fish moving through the Thorofare. A site was selected for gillnetting approximately 1 km downstream from the outlet of Upper Priest Lake. At this site, the Thorofare was approximately 75 m wide, 2 m deep, a flat streambed and free of debris. Experimental, monofilament, sinking gillnets (45.7 x 1.8 m with six panels ranging from 1.8 to 6.4 cm bar measure mesh) were set perpendicular to the current.

Since the gillnets were shorter than the width of the Thorofare, the nets were staggered, effectively fishing the entire width of the Thorofare. Gillnets were also alternated so that same net mesh size was not fished consecutively along the stream bank. Nets were set for approximately 1 h to minimize incidental mortality. Gillnets were only fished when velocities allowed the nets to remain upright in the water column.

Typically, three gillnets were set at a time and only two during the day due to boat traffic. Since boat traffic was heaviest in July through September only two nets were set during the daytime. Also in July through September, no gillnets were set between 1000 hours and 1800 hours because of extremely high boat activity at that time of day. In June and October, reduced boat traffic allowed for setting gillnets between 1000 hours and 1800 hours. In June, nets were set only in daylight hours. With each set, we recorded the set and pull times, and the surface water temperature.

Gillnet sets were divided into day and night categories. The day category was defined as the period between sunrise and sunset, and the night category as the period between sunset and sunrise.

Electrofishing-On August 19, 1999 a two-person crew electrofished the Thorofare using a Smith-Root electrofishing boat. DC current was used, pulsed at 120 pulses/second. A transect beginning at the mouth of Caribou Creek and ending at the head of the Thorofare was sampled once in daylight, and once at night. A single pass of the transect was performed along the shoreline of the Thorofare, concentrating the effort to the deeper stream bank. We recorded the start and end time of each pass, and the surface water temperature. All captured fish were identified to species, weighed, and measured.

2000

Upper Priest Lake Gillnetting-From April 21 to June 21 2000, we used experimental, monofilament, sinking gillnets to capture fish in the outlet area of Upper Priest Lake. We used 91.4 x 2.4 m experimental nets with 3 panels of 2.5, 3.8, and 5.1 cm mesh. From sunset to 1000 hours 3 gillnets were set end-to-end, essentially blocking the outlet of Upper Priest Lake. From 10:00 to sunset the middle of the 3 gillnets was moved near shore, and positioned perpendicular to the shoreline, allowing boat passage. Gillnets were set in water no deeper than 3 m deep.

Upper Priest Lake Fyke-netting-Four fyke-nets were set along the shoreline of Upper Priest Lake near the outflow of the lake in water < 2 m deep from May 22 to May 30, 2000. Pairs of nets were set on opposite shorelines 200 m from the head of the Thorofare. Within each pair, the two nets were set facing the opposite directions so that they would intercept fish moving in opposite directions along the shoreline.

A net was positioned with the pot parallel to the shoreline and the wings angled at approximately 45°, with one wing approaching the shore and the other away from shore.

The fyke-nets were constructed of #15 nylon netting and had 2.54 cm square mesh. Each net consisted of a 4.88 m long hoop net portion with a 1.22 m diameter front hoop and two 15.25 x 1.83 m wings. The fyke-net leads spanned half the width of the Thorofare, allowing boat passage and sampling to occur simultaneously. Fyke-nets were checked 1-2 times per day.

Thorofare Gillnetting-From June to October 1999, the last week of June 2000, and the first week of July 2000, experimental, monofilament, sinking gillnets 45.7 m x 1.8 m with six panels ranging from 1.8 to 6.4 cm bar measure mesh were used. After the first week of July, gillnets 54.9 m x 1.8 m with 5 panels of 2.5, 3.8, 5.1, 6.4, and 7.6 cm bar measure mesh were used. 2000 Thorofare gillnetting protocol followed the 1999 Thorofare protocol. Because varying sizes of gillnets were used in the study, gillnetting catch rates were standardized into catch per unit effort (CPUE). CPUE was calculated as fish/h/100 m^2 gillnet.

Thorofare Fyke-netting-The fyke-nets used in Upper Priest Lake were moved to the Thorofare on June 12, 2000. Two fyke-netting locations were selected in the Thorofare, each fitting the criteria of having little debris, depth no deeper than 2 m, and a stream width sufficient to fish the nets while allowing boat traffic to pass. The first fyke-netting location was 0.5 km upstream from Priest Lake and the second 0.75 km downstream from Upper Priest Lake. The fyke-nets used were the same four fyke-nets used in Upper Priest Lake.

At each of the two locations two nets were along the west shoreline. One net was set with the mouth and wings directed upstream and the other oppositely facing downstream. Fish captured in a fyke-net with the mouth and wings facing upstream were recorded as moving downstream, and the opposite for fish captured in fyke-nets facing the reverse direction. Fyke-netting CPUE was calculated as the number of fish captured/24 h fishing effort.

Electrofishing-On June 25 and Aug 15, 2000 a 3-person crew electrofished the Thorofare, using the 1999 protocol.

Conventional Tagging

Captured fish were placed in a live well, identified to species, weighed (g) and measured (mm total length). Fish captured by electrofishing were not weighed. For future identification and information purposes, lake trout were marked with individually coded spaghetti tags and their adipose fins removed. The spaghetti tags were inserted just below the dorsal fin by thrusting a hypodermic needle and attached spaghetti tag through the musculature so that the tag is anchored between the pterygiophores. Following withdrawal of the hypodermic needle, the tag was secured by tying the tubing with an overhand knot, and the knot left lying along the middle axis of the body.

Captured bull trout and cutthroat trout were examined for marks indicating previous capture. Bull trout and cutthroat trout that were not recaptured were individually marked with a visual implant (VI) tag, and the associated code recorded. VI tags were inserted in the transparent tissue near the eye using a hand-operated VI tag injector. Pressure was applied with the injector tip until the injector tip entered and incised an accommodating fissure in the transparent tissue. The tag was then implanted upon slight withdrawal of the injector tip. Bull trout and cutthroat trout were marked with secondary mark by removing the adipose fin. Cutthroat trout that did not receive a VI tag were marked by removing the adipose fin. Cutthroat trout less than 315 mm were not VI tagged because there was not sufficient adipose tissue around the eye to insert the injector. Cutthroat trout captured in 1999 were not marked with VI tags.

One hundred and seventeen lake trout that survived the capture procedures were tagged with spaghetti tags in 2000. Thirty-eight cutthroat trout and 11 bull trout were tagged with VI tags in 2000. In addition, 44 bull trout had been previously VI tagged in Upper Priest Lake by the IDFG, yielding a total of 55 VI tagged bull trout in the Priest Lake drainage.

Radio Telemetry

In October 2000, a 4-6 person crew captured 25 lake trout from the Upper Priest Lake and 25 lake trout from Priest Lake for radio telemetry purposes. Lake trout were captured using 2-5 experimental, monofilament, sinking gill nets (91.4 x 2.4 m with 3 panels of 2.5, 3.8, and 5.1 cm mesh). Gill nets were set throughout Upper Priest Lake and in the north end of Priest Lake. Sets were 45 – 60 minutes in duration to minimize stress on the lake trout. Following capture, fish were placed in a live well then transported to live wells at the fish tagging station located on shore.

Fish were chosen for radio tagging such that the radio tags did not exceed 2% of the body weight of the fish. The fish were implanted with individually coded model MCFT-7A (7-volt, 8 x 1.6 cm, 31 g) Lotek radio tags using the following methods. Fish were individually anesthetized with 1-2 ml clove oil/12 l of water. When the fish appeared properly anesthetized, it was moved to a V-shaped trough for surgery. During surgery, water containing clove oil was passed over the gills. An incision was then made slightly to one side of the midventral line and anterior to the pelvis, just large enough for the radio transmitter to be inserted. A 14-gauge needle was then inserted into the body cavity of the fish, posterior to the pelvis, while taking care not to insert the needle far enough to damage internal organs. Next, a scalpel guide was used to guide the needle to the initial incision anterior to the pelvis. The transmitter antenna was then slid back through the needle until it protruded out of the needle, posterior to the pelvis. The needle and scalpel guide were then removed and the radio tag was inserted into the body cavity. The incision was sutured using 3-4 surgeon's knots and iodine applied to the sutured area and antenna exit site. For future identification and informational purposes, the lake trout were also marked with individually-coded spaghetti tags. When all handling procedures were completed the lake trout were released into the lake they were captured in. Six of the radio-tagged lake trout were captured in the Thorofare and released in Upper Priest Lake.

Lake trout were tracked from October 24, 2000 until March 29, 2001 using a fixed radio receiver equipped with a six-filament yagi antenna and data logger located near the Portage Trail to the Thorofare. The data logger recorded the date and time of each fish that passed the receiver. Two 12-volt marine deep cycle batteries were used and replaced on a two-week interval. A test radio tag was used each time the batteries were changed to verify that the receiver was operating correctly. The objective of the use of the telemetry was to detect radio tagged fish as they pass through the Thorofare during the winter months when conventional sampling was not feasible.

Physical Characteristics

1999

Temperature-Thorofare surface water temperature was measured hourly with a hand-held thermometer during gillnet sets.

Turbidity-Water clarity was measured weekly in Upper Priest Lake and once in Priest Lake using a Secchi disk. The disk was lowered into the water at mid-day on the shady side of the boat until it was no longer visible, then raised until visible. The Secchi depth was determined by averaging the depths of disappearance and reappearance.

2000

Temperature-The thermal profile of Upper Priest Lake, Priest Lake, and the Thorofare was determined using a YSI model 50 dissolved oxygen meter. The profile was first obtained on April 22, 2000 and thereafter at least biweekly from May 9, 2000 to November 7, 2000. In Upper Priest Lake, measurements were recorded in the middle of the lake, approximately 1 km from its outlet. Windy conditions prevented recording the thermal profile in Priest Lake until June 14, 2000. Measurements were recorded in the middle of Priest Lake 1 km from the outlet of the Thorofare. In Upper Priest Lake and Priest Lake temperature was recorded every 0.5 m from the surface to 10m deep, then every meter to 20 m depth or until the substrate was reached. In the Thorofare, the thermal profile was determined at two locations, 0.7 km downstream from Upper Priest Lake and 0.7 km upstream from Priest Lake. At each location, temperature and dissolved oxygen were recorded every 0.5 m from the surface to the bottom.

Two Hobotemp ™ thermographs were deployed in the Thorofare from May 23, 2000 to November 8, 2000, recording the water temperature every two hours. One thermograph was placed 0.3 km downstream from Upper Priest Lake and the second placed 0.5 km upstream from Priest Lake.

Thorofare Discharge, Velocity and Depth-A transect site was established near the midpoint of the Thorofare for measuring depth and velocity as a measure of calculating discharge. The site met the criteria of having a relatively uniform depth and little large woody debris. A cross section was established at this location by stretching a 0.95 cm braided nylon rope across the Thorofare, perpendicular to stream flow. The rope was tied to one tree, lengthened across the Thorofare using the johnboat, pulled tight enough that the rope did not sag into the water, tied to another tree, and the wetted width of the stream channel marked on the rope. The same trees were used each time measurements were taken, ensuring that the transect was in the same location. The rope was re-stretched on land, the wetted width measured with a tape measure, and 21 equidistant intervals with duct tape.

Discharge was measured and recorded weekly from May 9, 2000 to July 26, 2000. Velocities throughout the water column of the Thorofare became very low by the end of July, therefore collecting these data was ceased because of impracticality. The procedure was conducted by stretching the marked rope across the Thorofare and at each interval measuring and recording the depth and velocity by lowering the flow meter from the boat with a graduated rope. Velocities were measured at 0.2 and 0.8 of the depth if the depth was > 1m and at 0.6 of depth if the depth was less than or equal to 1 m.

Discharge was calculated through each segment with the formula:

$$q = [(\bar{v}_1 + \bar{v}_2)/2] \times [(d_1 + d_2)/2] \times b$$

where q is the discharge through the segment; $\bar{v}_1$ is the mean velocity in the first vertical; $\bar{v}_2$ is the mean velocity in the second vertical; d_1 is the depth at the first vertical; d_2 is the depth at the second vertical; and b is the width of the segment. This calculation was repeated for each segment, and the sum of these calculations produced the total discharge.

Thorofare depth was recorded weekly from May through November in 2000 with a depth gauge located on a private dock near the outlet of the Thorofare. This location was the shallowest area of the entire length of the Thorofare so that the depth measurement indicated by this gauge was representative of the minimum depth of the Thorofare.

Turbidity-As in 1999, water clarity was measured weekly in Priest and Upper Priest Lakes.

RESULTS

Capture

1999

Thorofare Gillnetting-The total lake trout catch in the Thorofare in 1999 was 12 fish(Table 1). Lake trout ranged from 279 to 850 mm total length (TL). The largest lake trout caught weighed 9.5 kg. This fish had been previously jaw tagged by the IDFG in 1980 in southern portion of Priest Lake, and had grown 5 kg in the 19 years since being tagged. One lake trout was caught on August 3 during daylight hours; the other eleven lake trout were captured in October, all at night. Surface water temperatures when lake trout were caught were 20°C in August, and 8°C in October.

The total cutthroat trout catch in the Thorofare in 1999 was 29 fish (Table 2). The catch was highest in August and lowest in June (Table 2). Fifty-nine percent of the cutthroat trout were captured during the daytime. CPUE was highest for both day and night in August (Figure 2). Daytime CPUE was higher than night CPUE in July-September. Cutthroat trout ranged from 188 to 429 mm total length and averaged 283 mm total length (Figure 3).

Only one bull trout was caught during the 1999 gillnetting effort. This fish was caught on September 20 during daylight hours when the Thorofare surface water temperature was 16° C. The fish was 312 mm TL length and weighed 310 g.

Electrofishing-The two passes of the established transect were performed with an electrofishing boat on August 19, 1999. One pass was conducted during the daylight for 57 minutes of effort and one pass at night for 58 minutes of effort. No salmonids were captured in either effort. The water temperature was 19.5°C during both passes.

2000

Upper Priest Lake Gillnetting-Thirty-four lake trout were captured in Upper Priest Lake between April 21, 2000 and June 21, 2000 (Table 1). Six of the 34 lake trout captured died, an incidental mortality rate of 18%. Three lake trout were captured in April, 17 in May, and 14 in June. Twenty-seven (79%) of the lake trout were captured at night and seven (21%) during the day. Both daytime and night mean monthly CPUE were highest in May (Figure 4). Daytime sampling did not occur in April.

Twenty-two cutthroat trout were captured in Upper Priest Lake between April 21 and June 21, 2000 (Table 2). Two of the 22 cutthroat trout captured died, an incidental mortality rate of 9%. No cutthroat trout were caught in April, one was caught in May, and 21 were caught in June. Fifteen (68%) of the cutthroat trout were captured at night and seven (32%) were captured during the day. Cutthroat trout were captured more consistently at night than during the day; mean monthly night CPUE was higher than mean monthly day CPUE in May and June. (Table 2). Mean monthly CPUE was highest in June (Figure 2).

Five bull trout were captured in Upper Priest Lake between April 21, 2000 and June 21, 2000 (Table 3). There were no incidental bull trout mortalities. Four of the five were caught in May, and one was caught in June. All of the bull trout were captured at night. Mean monthly CPUE was highest in May (Figure 5).

Upper Priest Lake Fyke-netting-The four nets set in Upper Priest Lake from May 22 to May 30, 2000 accumulated 389.35 hours of effort. No salmonids were captured.

Thorofare Gillnetting-Gillnets sampled in the Thorofare from the last week in June to the conclusion of sampling on November 8, 2000. During this time 73 lake trout were gillnetted in the Thorofare (Table 1). Eleven of these lake trout died, an incidental mortality rate of 15%. Numbers captured was highest in October (n = 39), followed by November (n = 25), and September (n = 9). No lake trout were captured in the months of June, July, and August. Mean monthly CPUE was highest in November with October only slightly lower (Figure 4). All of the lake trout gillnetted in the Thorofare in 2000 were captured at night.

A total of 33 cutthroat trout were gillnetted in the Thorofare in 2000 (Table 2). Six of the cutthroat trout died, resulting in an 18% incidental mortality rate. Numbers captured were highest in July (n = 20). Eighty-two percent (n = 27) of the cutthroat trout were caught at night and 18 % (n = 6) were caught during the day. Both daytime and night mean monthly CPUE was highest in July (Figure 2). Neither daytime nor night mean monthly CPUE was consistently higher each month.

Four bull trout were gillnetted in the Thorofare in 2000 (Table 3). One bull trout was caught in July, one in September, and two in November. Two of the bull trout were caught at night and two during the day. Bull trout mean monthly CPUE was low for all months (Figure 5).

Thorofare Fyke-netting-Fyke-nets set in the Thorofare from June 12, to November 7, 2000. accumulated 6,368 hours of effort. Two lake trout were captured. One fish (565 mm, 1250 g) was captured on June 14 moving upstream and the other was captured on November 1. The latter fish was a recapture that had been initially captured the same night in a gillnet and released near the fyke-net.

Seventeen cutthroat trout were captured in the fyke-nets. The highest weekly numbers captured and CPUE were recorded in July (Table 4). All of the cutthroat trout captured in the fyke-nets were found wedged in the mesh of the net, resulting in 100 % incidental mortality. Eleven (69%) of the cutthroat trout were captured in nets indicating they were moving upstream, although this result may be due to the fish orienting themselves into the current. No cutthroat trout were captured in the fyke-nets in June, October, and November. The lengths of the cutthroat trout caught in the fyke-nets ranged from 211 mm to 269 mm, indicating size selectivity by the fyke-nets. One bull trout was captured on June 19, 2000; it had been moving downstream.

Electrofishing-On June 26, 2000, 60 minutes of daylight electrofishing resulted in the capture of two cutthroat trout. Sixty minutes of night time effort resulted in the capture of seven cutthroat trout and one brook trout. The same day and night sampling was conducted on August 15, and no salmonids were captured.

Conventional Tagging

A total of 117 lake trout were tagged with individually coded spaghetti tags. Recaptures were classified into two categories: fish recaptured within 1 day of initial capture (29 fish) and fish recaptured more than 1 day following initial capture (three fish). Among immediate recaptures, fish were recaptured multiple times during the same sampling effort. For example, one fish was captured five times in the same night. Fish number 2495 was initially captured on September 11 in the Thorofare, then recaptured on October 18 in the Thorofare. Fish number 2500 was first captured in the outlet of Upper Priest Lake on June 20 and recaptured on October 2 in the Thorofare. Fish number 2958 was tagged by the IDFG on August 15, 2000 in Upper Priest Lake, and then recaptured in the Thorofare on September 26. Another lake trout was captured in a gillnet in the outlet of Upper Priest Lake in May and fitted with a spaghetti tag, then caught by an angler near Twin Islands in Priest Lake two months later.

Thirty-eight cutthroat trout were tagged with VI tags in 2000. None of these fish were recaptured. One of 55 VI tagged bull trout was recaptured at the outlet of Upper Priest Lake on May 29, 2000. This fish had been tagged previously in Upper Priest Lake in 1999. A second bull trout was initially tagged on May 29, 2000 in the outlet of Upper Priest Lake and recaptured on June 19, 2000 at the same location. No bull trout were recaptured in the Thorofare.

Radio Telemetry

The fixed radio receiver and data logger located on the Thorofare operated continuously from October 24, 2000 to March 29, 2001. During these five months, the receiver detected none of the 50 radio-tagged lake trout. However, the data logger did record detections of the test tag when the test tag was used, confirming that the receiver and data logger had been operating correctly.

Length Frequency

Length frequencies were determined for all lake trout, cutthroat trout, and bull trout that both lengths and weights were recorded. The length of lake trout ranged from 279 to 930mm TL (mean, 633 mm) (Figure 6). The lake trout length distribution was a normal distribution with the majority of the fish between 520 mm and 730 mm TL. Lake trout weights ranged from 220 to 9500 g. The length-weight relationship was expressed as the equation (Figure 7):

$$W = 0.0000082L^{3.01}$$

where:

W = fish weight (g)
L = fish length.

Cutthroat trout length ranged from 140 to 440 mm TL (mean, 300 mm). The cutthroat trout length distribution was relatively uniform through all the size classes except for an absence of fish in the 270-300 mm in length. Weights ranged from 45 to 850 g. The length-weight relationship is expressed as the equation (Figure 8):

$$W = 0.0000012L^{2.95}$$

Length was only recorded on seven bull trout. Recorded bull trout lengths ranged from 300-770 mm TL and weights ranged from 115-1650 g. The length-weight relationship is expressed by the equation (Figure 9):

$$W = 0.0000089L^{3.00}$$

Physical Characteristics

1999

Temperature-Surface water temperatures in the Thorofare were 7.0° C in the second week of June (Figure 10). Temperature increased to 15° C on July 21 and 22.8° C, the highest recorded surface temperature of the summer on August 3. Water temperatures then cooled to 15° C in mid-September, and 8° C by mid-October.

Water Clarity-In 1999 the mean Secchi depth was 5.9 m and ranged from 4.0 m in July to 7.3 m in September (Figure 11). On September 19 the Secchi depth in Priest Lake was 8.0 m.

2000

Temperature-Figure 12 demonstrates the thermal profile of Upper Priest Lake in each month from April to November. The displayed profile for each month is a profile from one of the two middle weeks of the month. In late April, the coldest surface temperatures recorded during the study were recorded at 5° C and the water column was homothermous. The water column showed a warming trend in the following weeks with stratification of the water column becoming evident mid-June. When the lake was firmly stratified the top of the thermocline was found at approximately 5 m deep. On June 27 the water temperatures in the upper two meters of the water column were approximately 15.5° C. The following week cold, windy weather cooled the surface water temperatures to 14.8°. By July 11, surface temperatures warmed to 16.3° and continued to warm until the highest recorded surface temperature of 21.5° was recorded on July 31. In the following weeks the water temperatures steadily cooled. Surface temperatures remained above 15°C until September 27 when the temperature was recorded at 13.5°C. Upper Priest Lake was homothermous on October 25 with water temperatures recorded at approximately 10° C. On November 7 Upper Priest Lake was homothermous at 8.2°C. Temperatures below 14 m depth never exceeded 8° C.

In Priest Lake, on June 14 the surface temperature was 12.8° C and stratification of the water column was beginning to develop (Figure 13). By June 20 the surface temperatures warmed to 15.5° C. Firm stratification of the water column was evident in early July and was present through the third week in September. During stratification the top of the thermocline was found at approximately 9 m depth. The highest recorded surface temperature was 23.4 on August 9. Surface water temperatures remained above 15° C until September 27 when the surface temperature was 14.5° C. Priest Lake was homothermous on October 10 at 12.5° C. The coldest surface water temperature of 9.0° C was recorded on November 7.

In May, when the thermographs were deployed, the temperature of the Thorofare was 9.0° C. From this time temperatures steadily increased, rising above 15° C on July 7, and peaking at 20.8° C on August 6. Water temperatures cooled steadily after this date, to around 15° C in mid-September, then falling to 6.6° C on November 7, the day the thermographs were removed (Figure 14).

Thorofare Discharge, Velocity and Depth-Thorofare flows ranged from 51.77 m^3/s on May 23 to 3.94 m^3/s on July 26 (Figure 15). Discharge decreased steadily through June and continued to decrease at a slower rate in July. The mean velocity in the Thorofare was calculated for each week that discharge was determined. Mean velocities ranged from 0.39 m/s May 23 to 0.04 m/s on July 26 (Figure 16). Mean velocity trends follow the same pattern as Thorofare discharge.

The depth of the Thorofare remained reasonably constant, at approximately 1 m depth from May through the third week in October (Figure 17). Beginning in the end of October, the dam at the outlet of Priest Lake began releasing water, lowering the elevation of Priest Lake and reducing the depth of the Thorofare. This continued until the lake reached its natural low water elevation in November. By November 6 the depth of the Thorofare had decreased to 0.38 m. The following week the depth had decreased further to 0.12 m, becoming impassable for most boats.

Water Clarity-Secchi depth in Upper Priest Lake and Priest Lake was recorded weekly in 2000. The mean Secchi depth in Priest Lake for 2000 was 7.4 m and measurements ranged from 5.3-9.3 m (Figure 11.

DISCUSSION

The results indicate that lake trout move through the Thorofare between the lakes much more in the fall than during the summer months. The capture of only one lake trout in the Thorofare in August 1999, and none in July indicates that they rarely move through the Thorofare during these months. Furthermore, no lake trout were caught in July or August 2000.

In contrast, the highest capture rates recorded in October and November indicate that lake trout use the Thorofare more during the spawning time than other times. Lake trout spawning typically occurs in October and early November (Weatherley et al. 1996), coincident with the highest weekly gillnetting CPUE. Some of the lake trout captured on November 6-8 were still full of eggs or milt, indicating that the fish had not yet finished spawning.

Within a season, there were also distinct patterns of diel movements. Lake trout were captured moving through the Thorofare more at night (94%) than during the day (6%). Numbers captured and gillnetting CPUE were consistently higher at night than during the day in both 1999 and 2000 (Table 1). These results are similar to other studies that suggest that lake trout are more active at night (Martin 1957) and usually only enter shallow areas of lakes at night (Martin 1957; Loftus 1958; Walch and Bergersen 1982; Sellers et al. 1988). Movement into shallow areas by lake trout is believed to be a nocturnal habit related to fish pursuing prey (Martin 1957). Nocturnal movement into shallow areas has also been related to spawning movements. For example, Loftus (1958) reported that lake trout spawning in the Montreal River, a tributary to Lake Superior, were found in much greater numbers at night than during the day. Fish remained in the lake in deep water off the mouth of the river during the day, entered the river at night to spawn, and returned to the lake by midnight. Martin (1957) reported that daytime gillnet efforts in Lake Louisa and Redrock Lake, Ontario were much less successful than nighttime efforts and concluded that lake trout were less active during the day than at night.

The seasonal variations in gillnet CPUE were also strongly associated with water temperatures in the Thorofare and adjacent shallow areas of both lakes. During times of warm water temperatures, lake trout seldom used the Thorofare. In 2000, lake trout captures ceased when Thorofare temperature rose above 15°C and resumed when temperatures fell below 15°C in September (Figure 18). In contrast, lake trout were frequently caught in the Thorofare if the water temperatures were 15°C or less. These results are consistent with other studies suggesting that 15°C is the upper temperature threshold limiting vertical movement by lake trout (Kennedy 1941; Elrod and Schneider 1987; Snucins and Gunn 1995). Snucins and Gunn (1995) reported that lake trout in Whitepine Lake, Ontario were frequently found in the epilimnion when temperatures were <13°C, and movements into the epilimnion were rare when temperatures were >15°C.

Although none of the 50 radio-tagged fish moved through the Thorofare from October 24, 2000 to March 29, 2001, these data are insufficient to form conclusions. There is an estimated 85,000 lake trout in the Priest Lake system (Nelson et al. 1997), and the 50 radio-tagged lake trout represent a very small proportion of the population. Overlap between conventional sampling techniques and radio telemetry only occurred during the first three weeks of the 4-month telemetry effort. Two of these three weeks had the two highest weekly nighttime gillnetting CPUEs observed during the study (Table 1), however, none of the radio-tagged lake trout were detected then. By November 13, 2000 the Thorofare depth at its outlet had decreased to <15 cm, and remained this shallow through the remainder of the telemetry effort. It is likely that these shallow depths prevented lake trout movement through the Thorofare, and the lack of detections by the radio receiver is representative of lake trout movement through the Thorofare during winter water levels. In this study, the inability to effectively sample in the winter makes it difficult to ascertain the importance of winter movements.

In contrast to lake trout, the 1999 and 2000 gillnetting and fyke-netting results confirmed that cutthroat trout used the Thorofare frequently in the spring, summer, and fall. In 2000, fish were frequently captured from May to mid-October (Table 2). However, cutthroat trout were not caught in April, late October, or in November. In the spring and early summer, cutthroat may be using the Thorofare as a migration corridor to spawning streams. Andrusak and Northcote (1971) reported that cutthroat trout in three lakes in southwestern British Columbia were commonly caught in shallow depths in May through September, but were caught in deeper water in November. Insect hatches were frequently observed in the evenings, and it is reasonable to suggest that cutthroat trout are using the Thorofare for feeding. Furthermore, this may be the reason for the highest recorded CPUEs in early July (Table 2), as there was a very large emergence of mayflies at this time.

Cutthroat trout catch results also indicated diel variation movements, but the difference in day and night movements was not as pronounced as for lake trout. Although 74% of cutthroat trout caught in gillnets in 2000 were caught at night, the CPUE was not consistently higher at night than during the day (Table 2). Similar movement patterns have been observed in other lakes. Andrusak and Northcote (1971) reported that cutthroat trout catch rates in three southwestern British Columbia lakes were similar in both diel periods.

The 1999 and 2000 gillnetting results confirmed that bull trout do move through the Thorofare. Bull trout numbers and catch rates were much lower than for lake trout or cutthroat trout. Although the number of bull trout captured was much fewer than for lake trout, roughly a 10:1 lake trout to bull trout ratio, the timing of captures followed a similar pattern as for lake trout. Fish were primarily caught in the cooler spring and fall months, and not in July and August. Bull trout were expected to have a similar seasonal Thorofare use pattern as lake trout, since the thermal preferences of the two species are similar (Bjornn 1957).

Bull trout movements through the Thorofare may have been from pursuing prey or related to spawning. Since lake trout and bull trout have similar ecological niches (Donald and Alger 1992) it is reasonable to expect that bull trout pursue prey in shallow water when temperatures are cool. Donald and Alger (1992) reported that bull trout in Canadian mountain lakes fed on insects, indicating feeding in shallow areas. Ratliff et al. (1996) reported that bull trout began entering spawning tributaries in May, and continued until spawning concluded in October.

Although an estimate of numbers of fish using the Thorofare was not developed, the results indicate that a significant number of lake trout and cutthroat use the Thorofare. Lake trout movement rates appear to be highest in the fall, coinciding with the timing of spawning (Weatherley et al. 1996). Cutthroat trout and bull trout also use the Thorofare, possibly as a migration corridor to spawning tributaries.

It is evident that lake trout movement through the Thorofare must be prevented in order to control the numbers of lake trout in Upper Priest Lake. However, blocking the Thorofare also creates a risk for the bull trout, cutthroat trout, and other native fish populations. Both cutthroat trout and bull trout use the Thorofare, possibly en route to spawning streams. Therefore, eliminating fish movement through the Thorofare could cut off native cutthroat trout and bull trout from spawning in their natal streams. For these reasons, the potential risk of isolating a portion of the cutthroat trout and bull trout populations must be evaluated before implementing a fish barrier.

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Table 1. Number of lake trout caught in gillnets and CPUE in 1999 and 2000 in the Thorofare and Upper Priest Lake, Idaho. Dates April 21 – June 21, 2000 indicate values for Upper Priest Lake; all other values are for the Thorofare.

Sample week	Dates	Capture	Day		Night	
			Capture	CPUE	Capture	CPUE
1999						
1	Jun 9-11	0	0	0	-	-
2	Jul 19-22	0	0	0	0	0
3	Aug 2-4	1	1	0.09	0	0
4	Aug 9-11	0	0	0	0	0
5	Sep 19-21	0	0	0	0	0
6	Oct 17-19	11	0	0	11	0.38
1999 Totals		12	1		11	
2000						
7	Apr 21-22	3	-	-	3	0.08
8	May 22-24	11	4	0.06	7	0.15
9	May 29-30	5	0	0	5	0.11
10	Jun 13-14	6	1	0.02	5	0.12
11	Jun 19-21	8	1	0.02	7	0.17
12	Jun 27-28	0	-	-	0	0
13	Jul 5-7	0	0	0	0	0
14	Jul 10-12	0	0	0	0	0
15	Jul 18-20	0	0	0	0	0
16	Jul 24-26	0	0	0	0	0
17	Jul 31-Aug 2	0	0	0	0	0
18	Aug 7-9	0	0	0	0	0
19	Aug 14-16	0	0	0	0	0
20	Aug 21-24	0	0	0	0	0
21	Aug 28-30	0	0	0	0	0
22	Sep 6-7	1	0	0	1	0.06
23	Sep 11-13	3	0	0	3	0.14
24	Sep 18-20	1	0	0	1	0.03
25	Sep 25-27	4	0	0	4	0.12
26	Oct 2-3	5	-	-	5	0.11
27	Oct 10-11	6	-	-	6	0.19
28	Oct 17-18	10	-	-	10	0.40
29	Oct 23-25	18	0	0	18	0.64
30	Oct 31-Nov 1	9	0	0	9	0.32
31	Nov 6-8	16	0	0	16	0.48
2000 Totals		106	6		100	

- Gillnetting did not occur.

Table 2. Number of cutthroat trout caught in the Thorofare and CPUE in 1999 and 2000 in the Thorofare and Upper Priest Lake, Idaho. Dates April 21 – June 21, 2000 indicate values for Upper Priest Lake; all other values are for the Thorofare.

Sample week	Dates	Capture	Day		Night	
			Capture	CPUE	Capture	CPUE
1999						
1	Jun 9-11	0	0	0	-	-
2	Jul 19-22	7	6	0.24	1	0.09
3	Aug 2-4	8	5	0.44	3	0.17
4	Aug 9-11	8	4	0.24	4	0.16
5	Sep 19-21	4	2	0.14	2	0.09
6	Oct 17-19	2	0	0	2	0.07
1999 Totals		29	17		12	
2000						
7	Apr 21-22	0	-	-	0	0
8	May 22-24	1	0	0	1	0.02
9	May 29-30	0	0	0	0	0
10	Jun 13-14	7	4	0.07	3	0.07
11	Jun 19-21	14	3	0.06	11	0.26
12	Jun 27-28	0	-	-	0	0
13	Jul 5-7	9	3	0.59	6	0.48
14	Jul 10-12	9	4	0.74	5	0.22
15	Jul 18-20	0	0	0	0	0
16	Jul 24-26	1	0	0	1	0.04
17	Jul 31-Aug 2	0	0	0	0	0
18	Aug 7-9	2	0	0	2	0.07
19	Aug 14-16	0	0	0	0	0
20	Aug 21-24	2	0	0	2	0.08
21	Aug 28-30	0	0	0	0	0
22	Sep 6-7	4	1	0.35	3	0.19
23	Sep 11-13	2	0	0	2	0.09
24	Sep 18-20	1	0	0	1	0.03
25	Sep 25-27	1	0	0	1	0.03
26	Oct 2-3	5	-	-	5	0.11
27	Oct 10-11	0	-	-	0	0
28	Oct 17-18	0	-	-	0	0
29	Oct 23-25	0	0	0	0	0
30	Oct 31-Nov 1	0	0	0	0	0
31	Nov 6-8	0	0	0	0	0
2000 Totals		58	15		43	

- Gillnetting did not occur.

Table 3. Number of bull trout caught in gillnets and CPUE in 1999 and 2000 in the Thorofare and Upper Priest Lake, Idaho. Dates April 21 – June 21, 2000 indicate values for Upper Priest Lake; all other values are for the Thorofare.

Sample week	Dates	Capture	Day Capture	Day CPUE	Night Capture	Night CPUE
1999						
1	Jun 9-11	0	0	0	-	-
2	Jul 19-22	0	0	0	0	0
3	Aug 2-4	0	0	0	0	0
4	Aug 9-11	0	0	0	0	0
5	Sep 19-21	1	1	0.07	0	0
6	Oct 17-19	0	0	0	0	0
1999 Totals		1	1		0	
2000						
7	Apr 21-22	0	-	-	0	0
8	May 22-24	0	0	0	0	0
9	May 29-30	4	0	0	4	0.09
10	Jun 13-14	0	0	0	0	0
11	Jun 19-21	1	0	0	1	0.02
12	Jun 27-28	0	-	-	0	0
13	Jul 5-7	0	0	0	0	0
14	Jul 10-12	1	0	0	1	0.04
15	Jul 18-20	0	0	0	0	0
16	Jul 24-26	0	0	0	0	0
17	Jul 31-Aug 2	0	0	0	0	0
18	Aug 7-9	0	0	0	0	0
19	Aug 14-16	0	0	0	0	0
20	Aug 21-24	0	0	0	0	0
21	Aug 28-30	0	0	0	0	0
22	Sep 6-7	0	0	0	0	0
23	Sep 11-13	0	0	0	0	0
24	Sep 18-20	0	0	0	0	0
25	Sep 25-27	1	1	0.09	0	0
26	Oct 2-3	0	-	-	0	0
27	Oct 10-11	0	-	-	0	0
28	Oct 17-18	0	-	-	0	0
29	Oct 23-25	0	0	0	0	0
30	Oct 31-Nov 1	0	0	0	0	0
31	Nov 6-8	2	1	0.04	1	0.03
2000 Totals		9	2		7	

- Gillnetting did not occur.

Table 4. Numbers of cutthroat trout caught in fyke-nets and CPUE, 2000.

Sample week	Dates	Capture	Number up	Number down	CPUE
10	Jun 13-14	0	0	0	0.00
11	Jun 19-21	0	0	0	0.00
12	Jun 27-28	0	0	0	0.00
13	Jul 5-7	0	0	0	0.00
14	Jul 10-12	2	0	2	0.19
15	Jul 18-20	5	1	4	0.47
16	Jul 24-26	4	4	0	0.38
17	Jul 31-Aug 2	2	0	2	0.19
18	Aug 7-9	1	0	1	0.10
19	Aug 14-16	1	0	1	0.10
20	Aug 21-24	1	0	1	0.09
21	Aug 28-30	0	0	0	0.00
22	Sep 6-7	0	0	0	0.00
23	Sep 11-13	1	1	0	0.04
24	Sep 18-20	0	0	0	0.00
25	Sep 25-27	0	0	0	0.00
26	Oct 2-3	0	0	0	0.00
27	Oct 10-11	0	0	0	0.00
28	Oct 17-18	0	0	0	0.00
29	Oct 23-25	0	0	0	0.00
30	Oct 31-Nov 1	0	0	0	0.00
31	Nov 6-8	0	0	0	0.00
Totals		17	6	11	

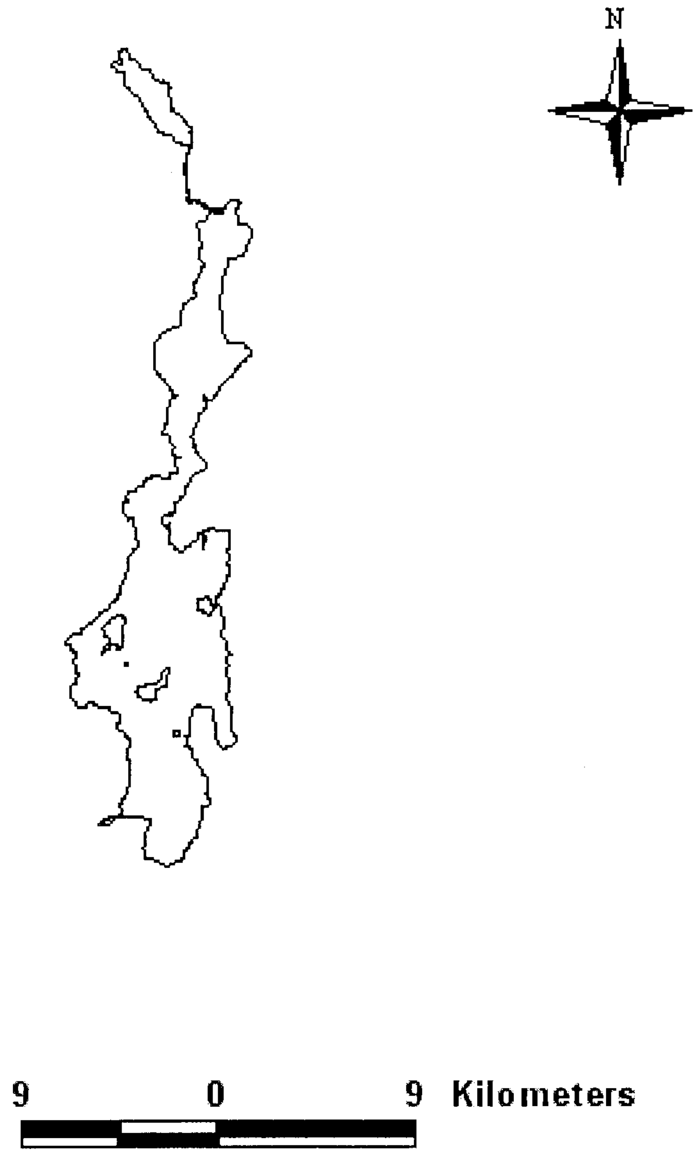


Figure 1. Priest Lake, Upper Priest Lake, and the Thorofare.

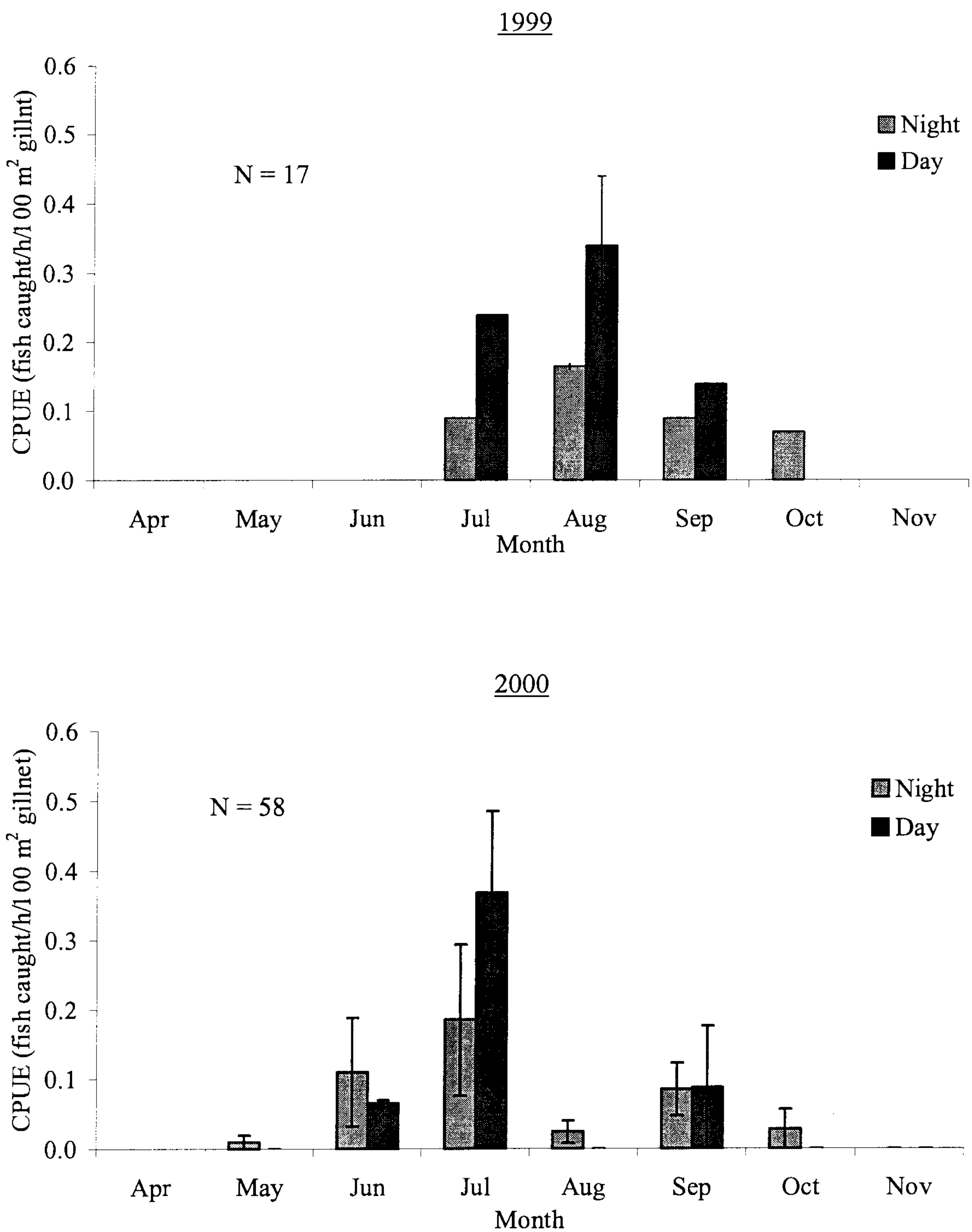


Figure 2. Monthly mean CPUE and standard error for cutthroat trout captured with gillnets in Upper Priest Lake and the Thorofare, 1999 and 2000.

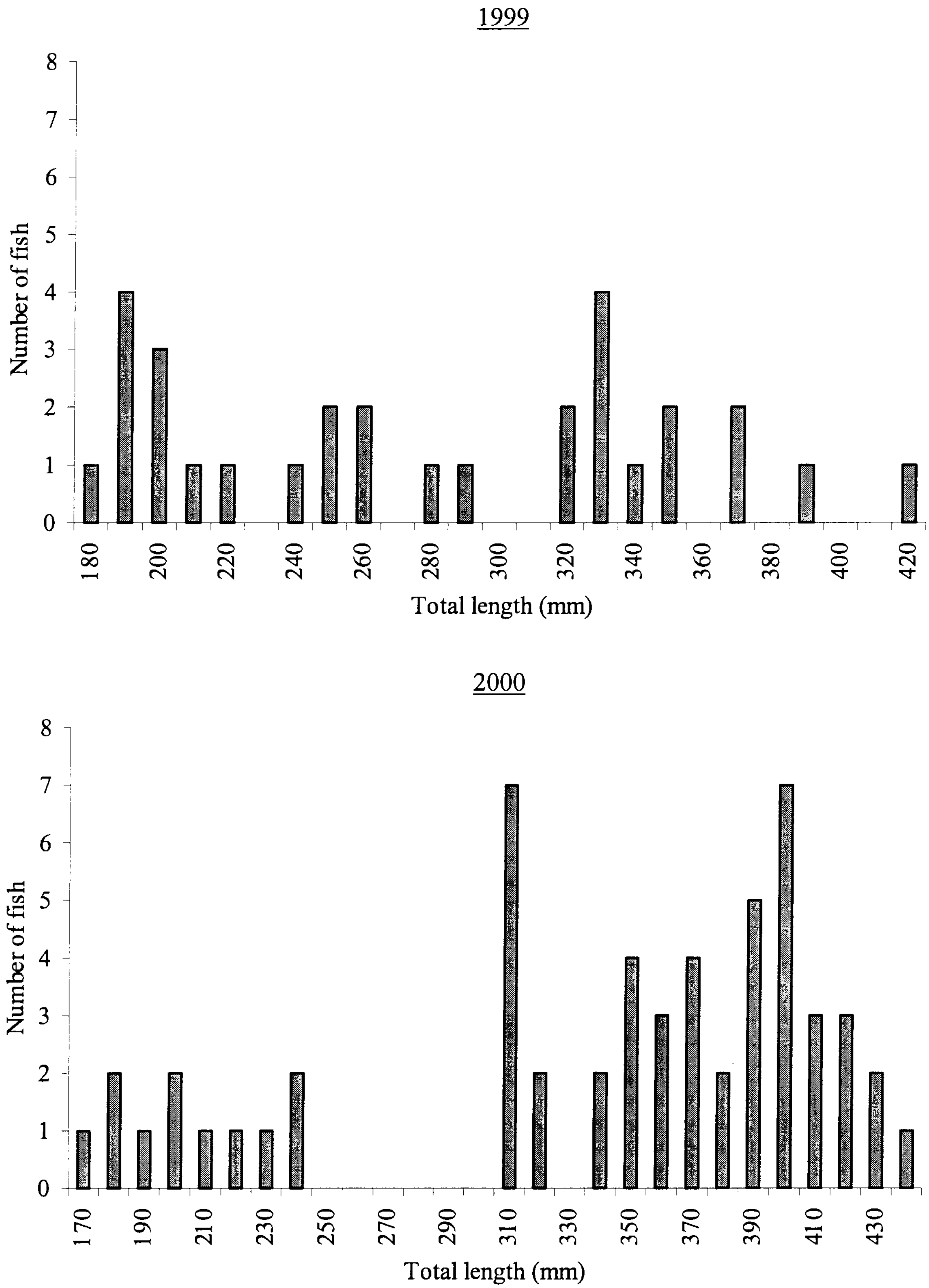


Figure 3. Length distribution of cutthroat trout captured with gillnets in Upper Priest Lake and the Thorofare, 1999 and 2000.

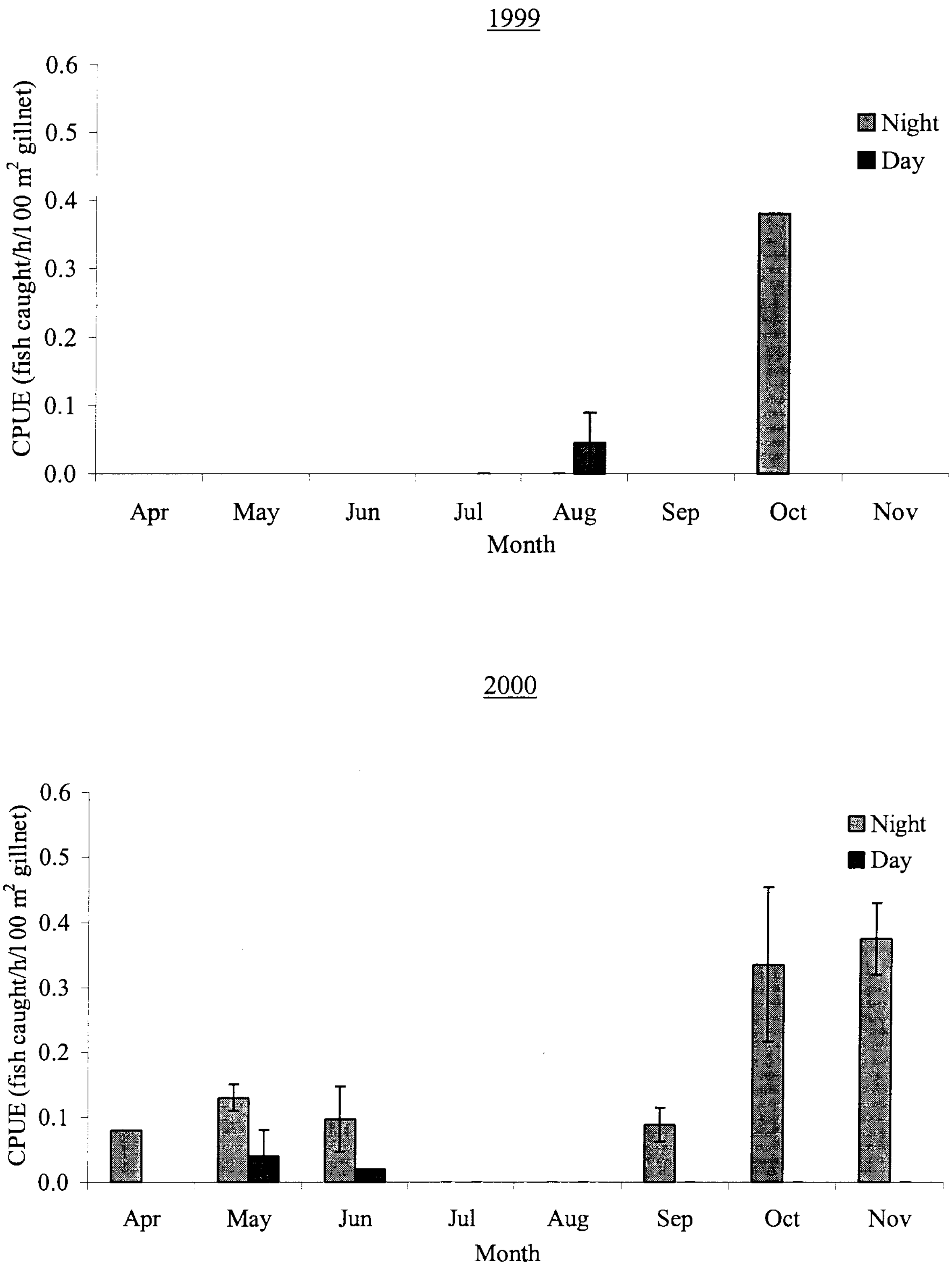


Figure 4. Monthly mean CPUE and standard error for lake trout captured in gillnets in Upper Priest Lake and the Thorofare, 1999 and 2000.

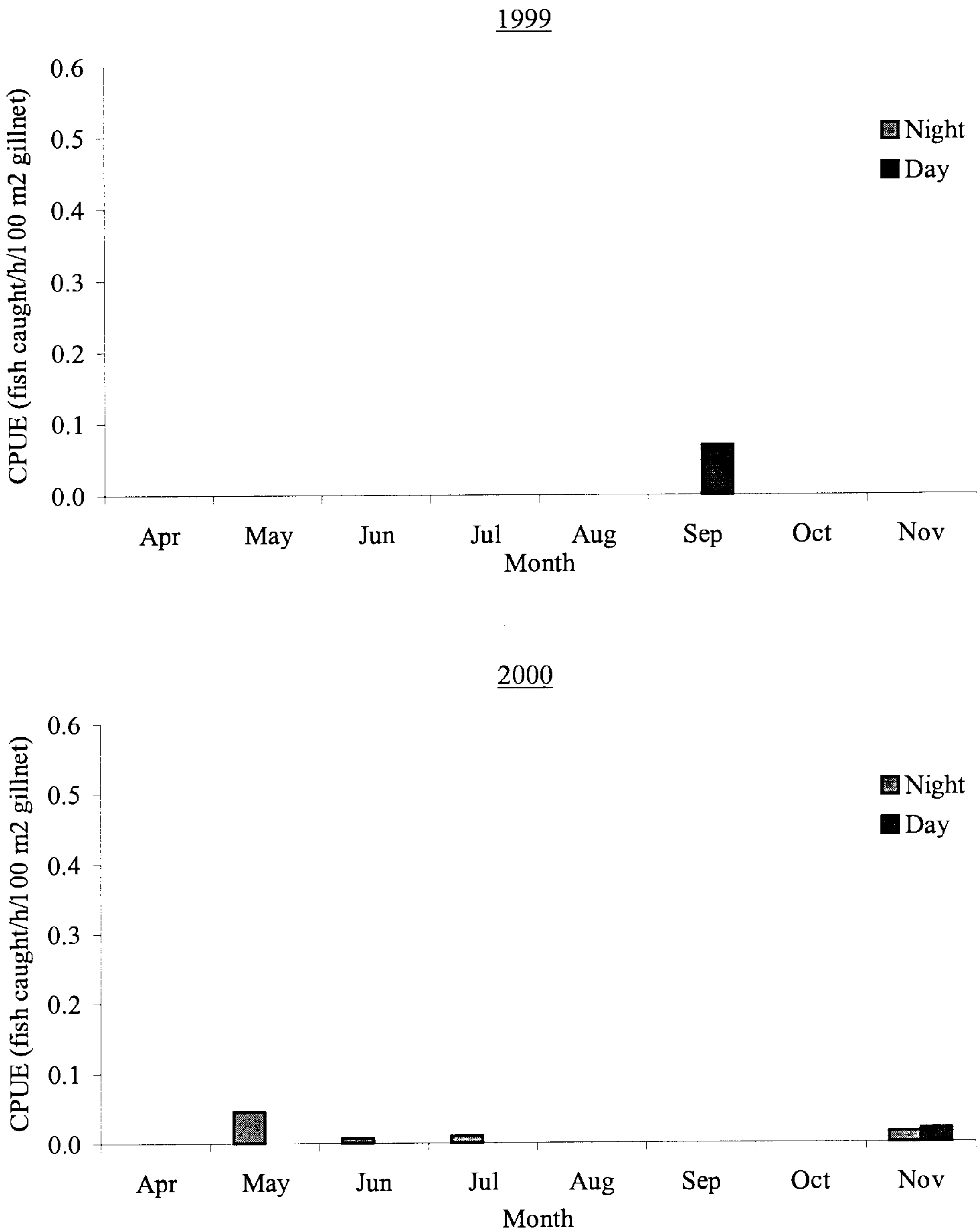


Figure 5. Monthly mean CPUE and standard error for bull trout captured with gillnets in Upper Priest Lake and the Thorofare, 1999 and 2000.

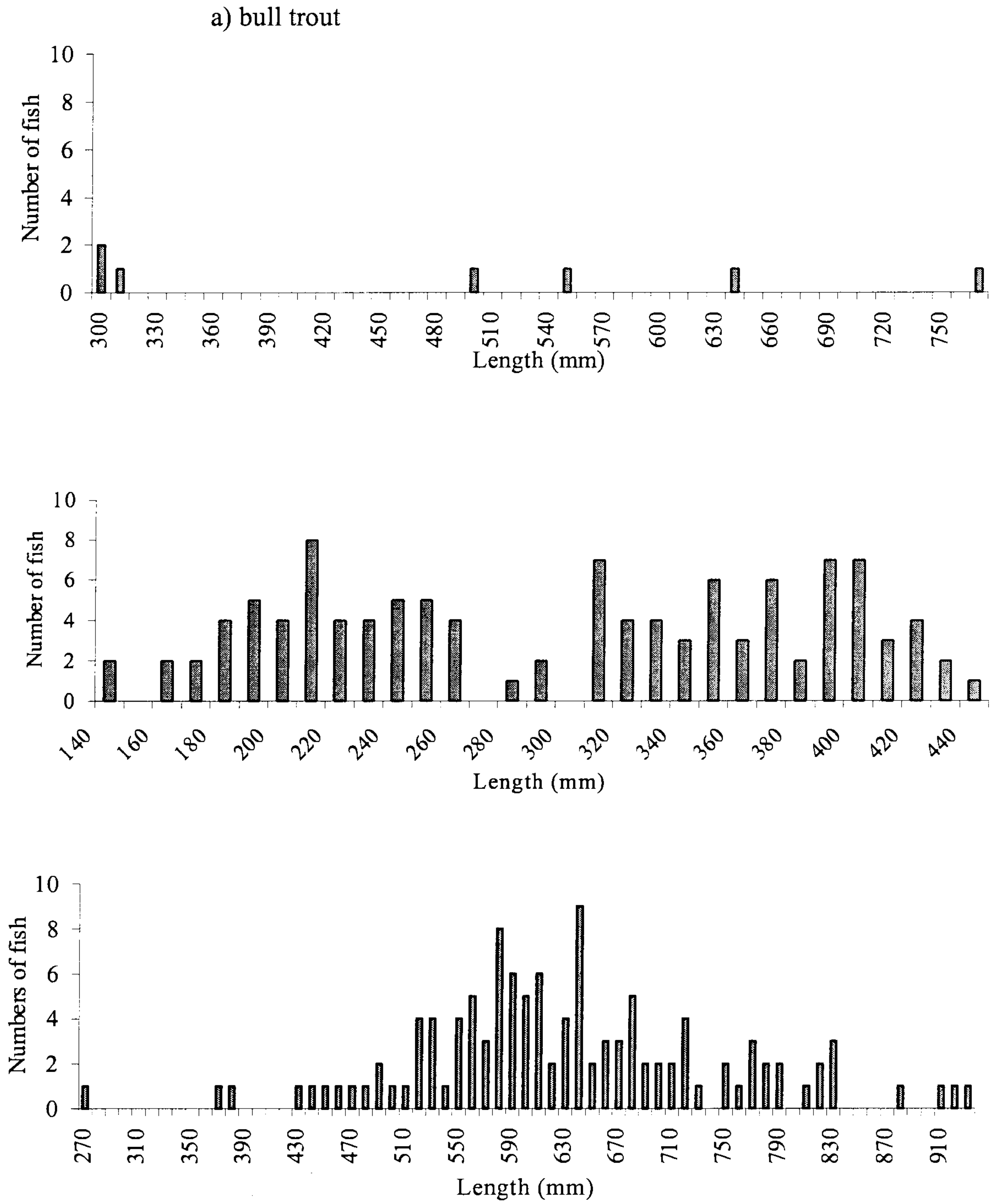


Figure 6. Length distribution of a) bull trout, b) cutthroat trout, and c) lake trout captured in Upper Priest Lake and the Thorofare, 1999 and 2000.

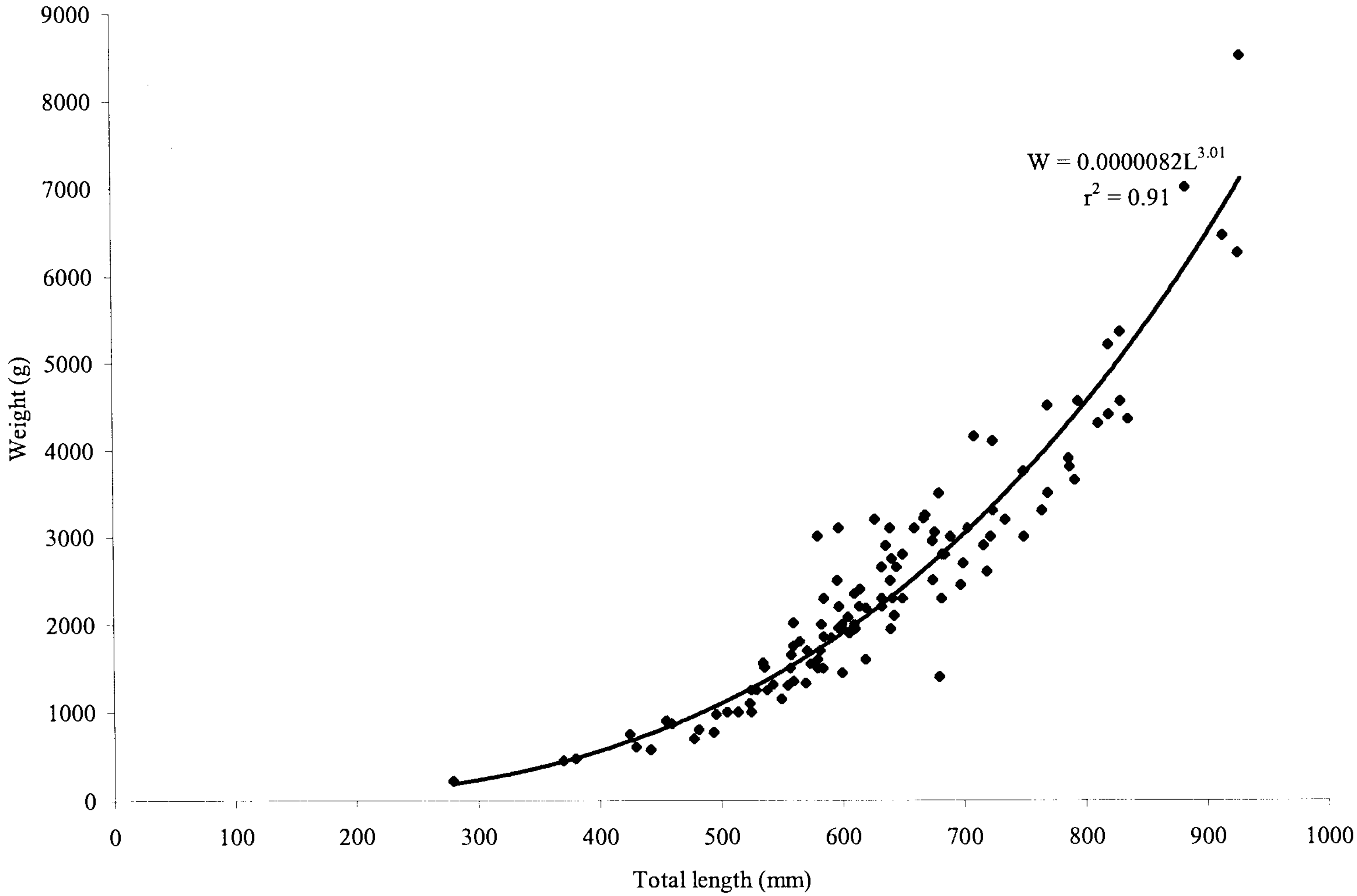


Figure 7. Length-weight relationship for lake trout captured in Upper Priest Lake and the Thorofare, 1999 and 2000.

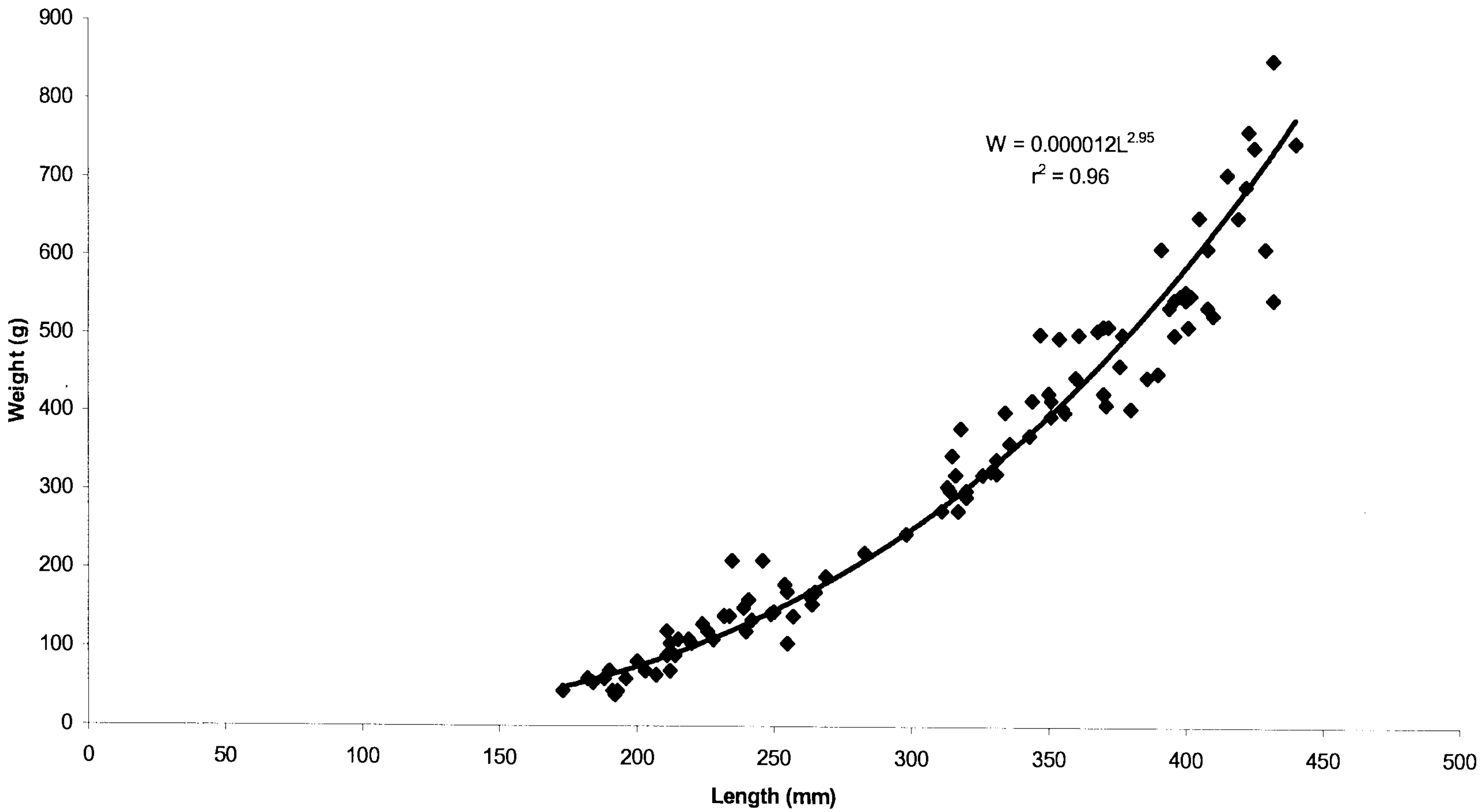


Figure 8. Length-weight relationship for cutthroat trout captured in Upper Priest Lake and the Thorofare in 1999 and 2000.

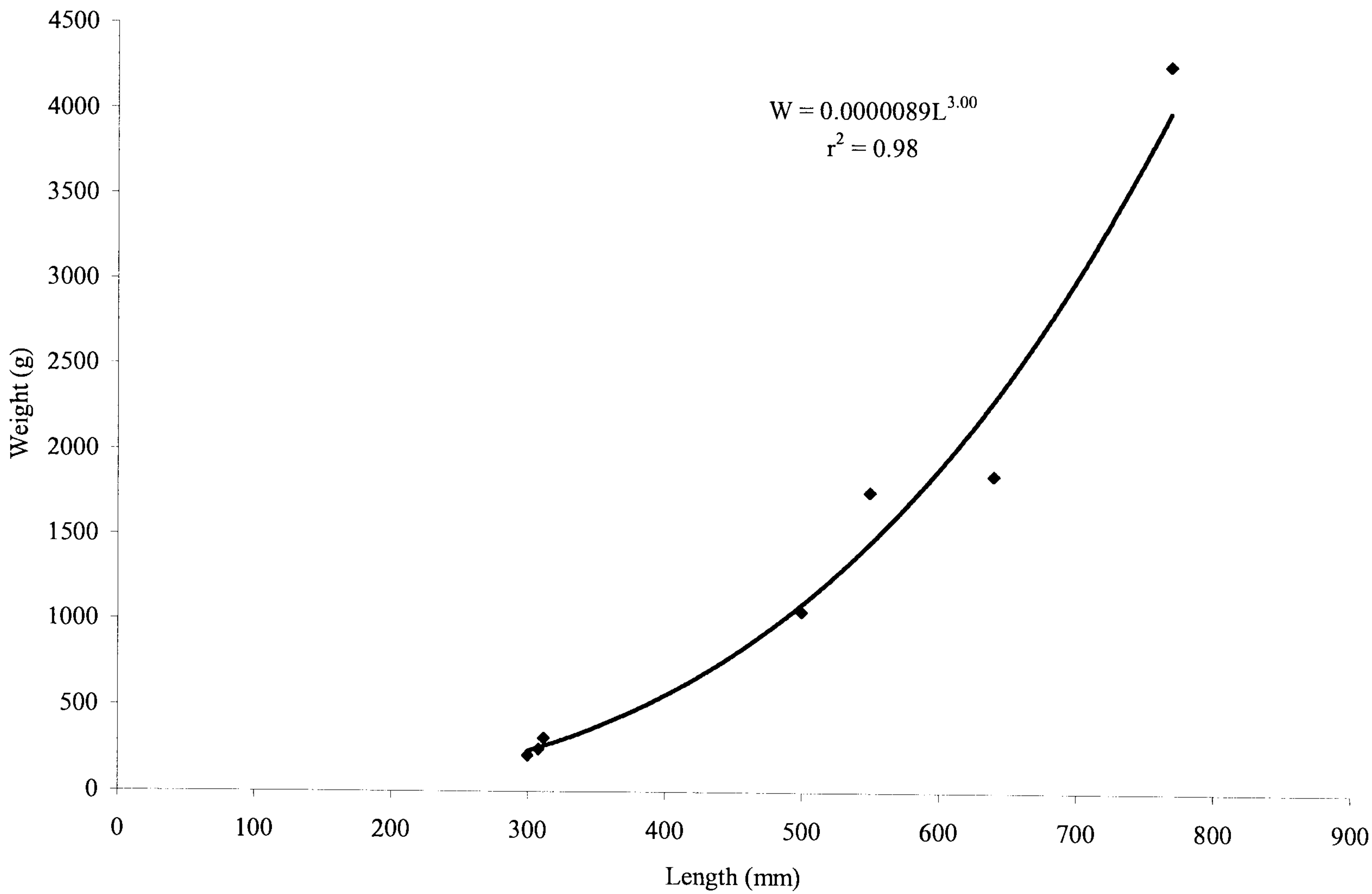


Figure 9. Length-weight relationship for bull trout captured in Upper Priest Lake and the Thorofare in 1999 and 2000.

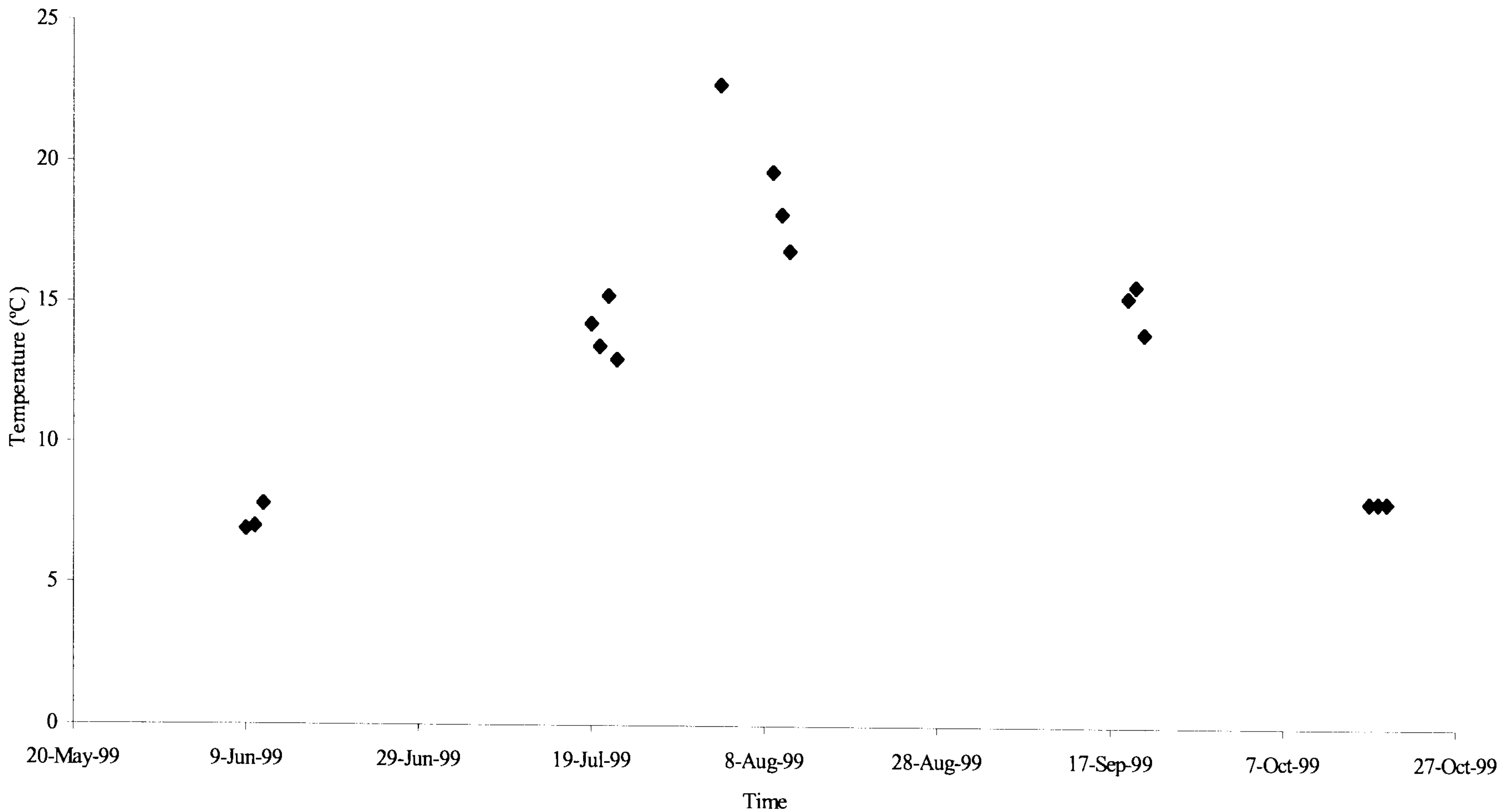
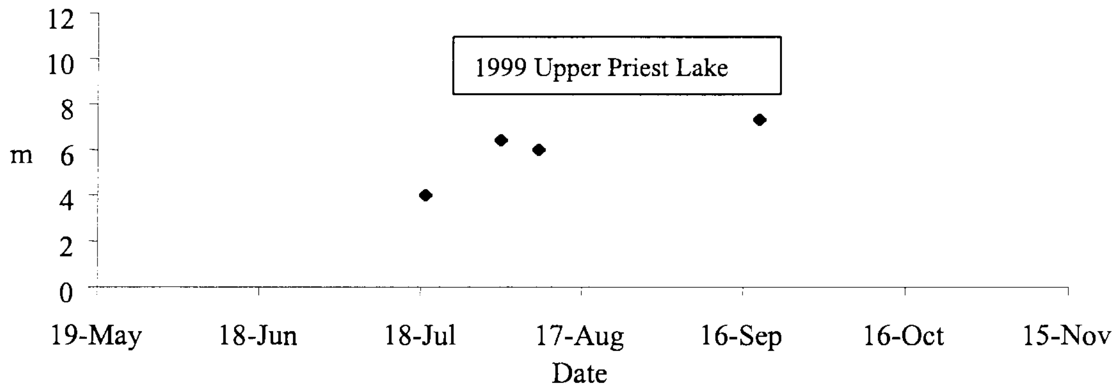
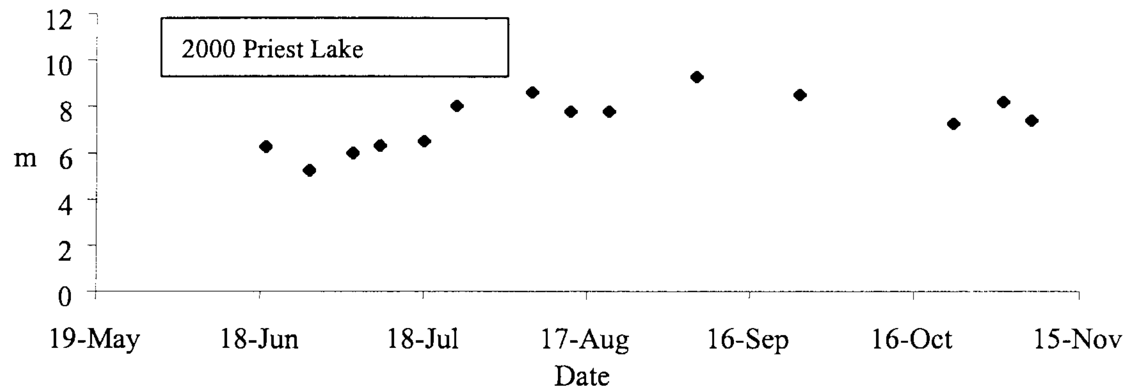


Figure 10. Temperature trends in the Thorofare, 1999.





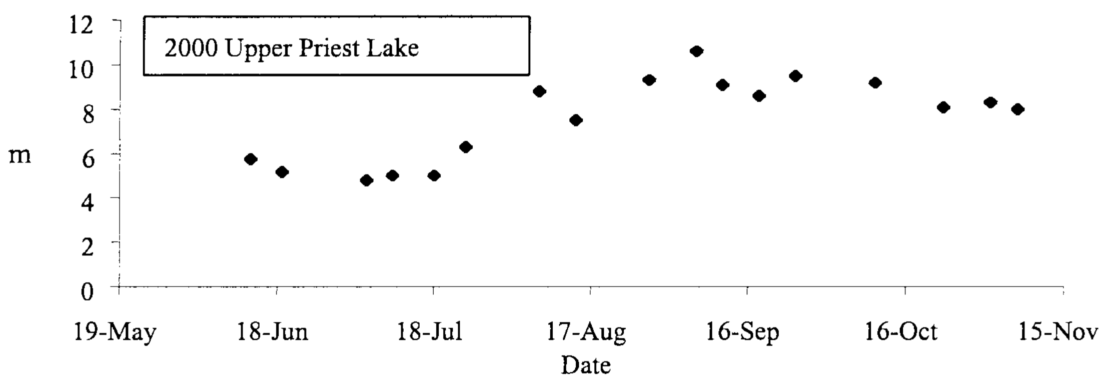


Figure 11. Priest Lake and Upper Priest Lake Secchi depth trends, 1999 and 2000.

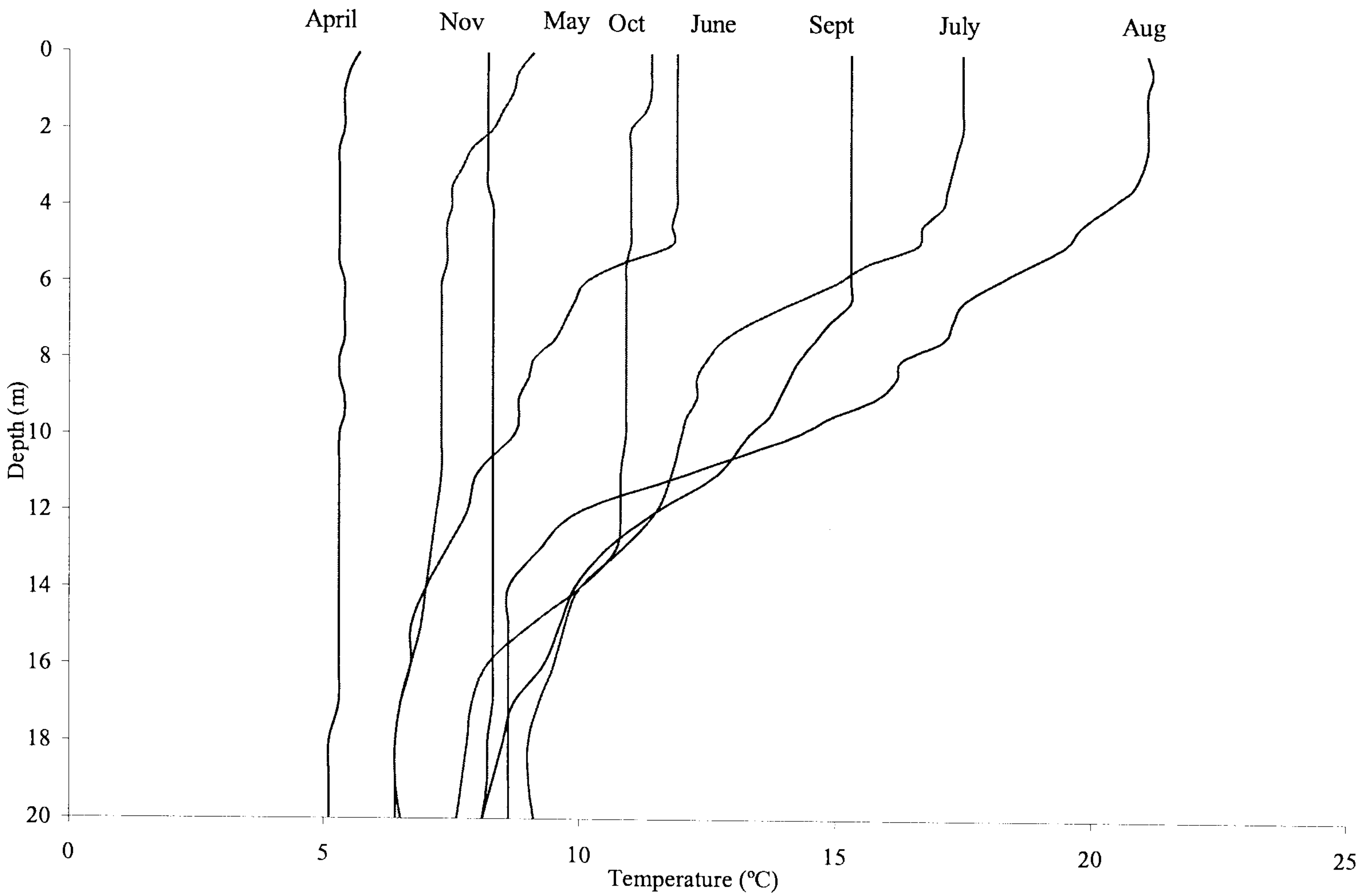


Figure 12. 2000 Upper Priest Lake thermal profile. The represented monthly thermal profiles are the profiles recorded in the middle of each month.

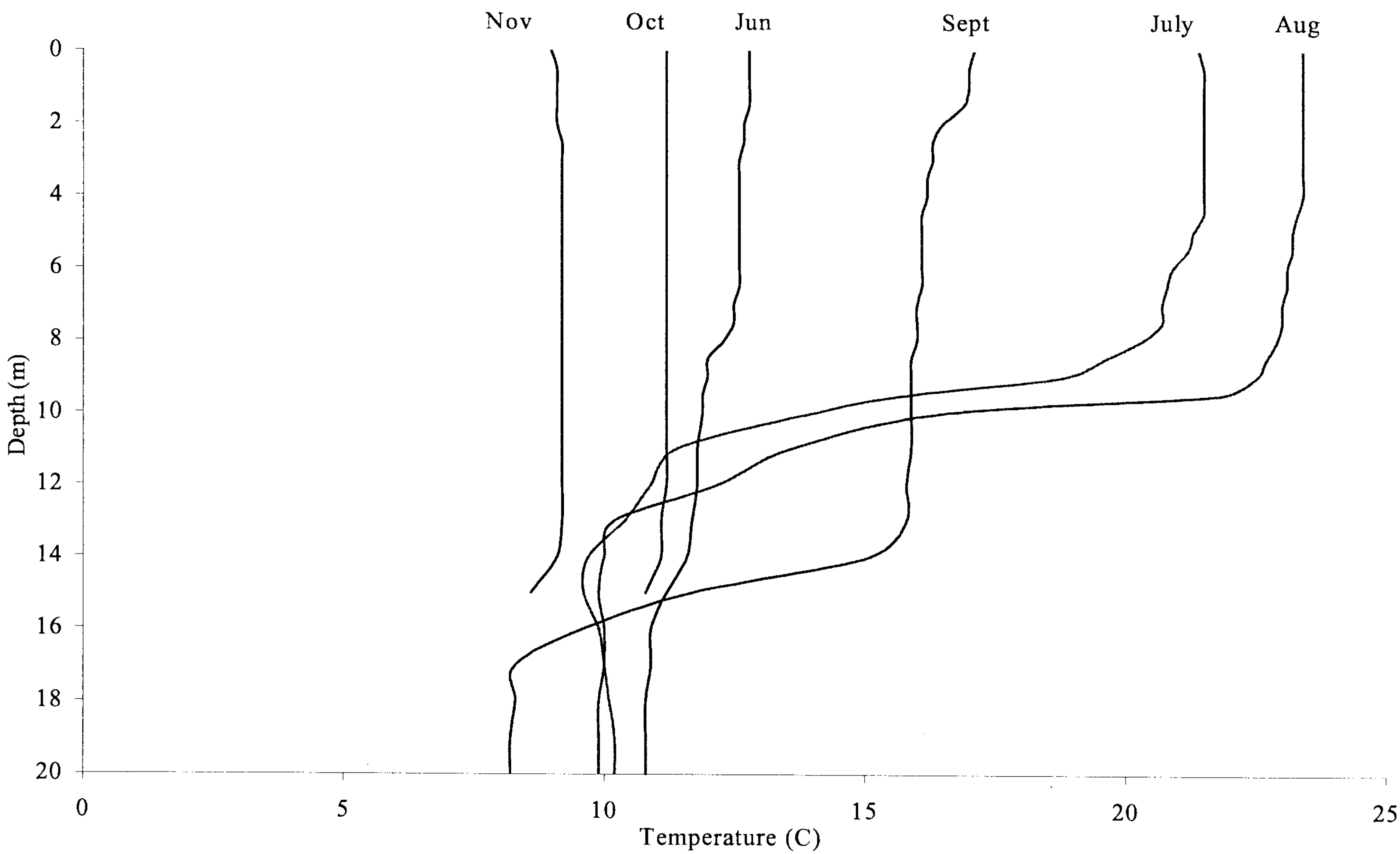


Figure 13. 2000 Priest Lake thermal profile. The represented monthly thermal profiles are the profiles recorded in the middle of each month.

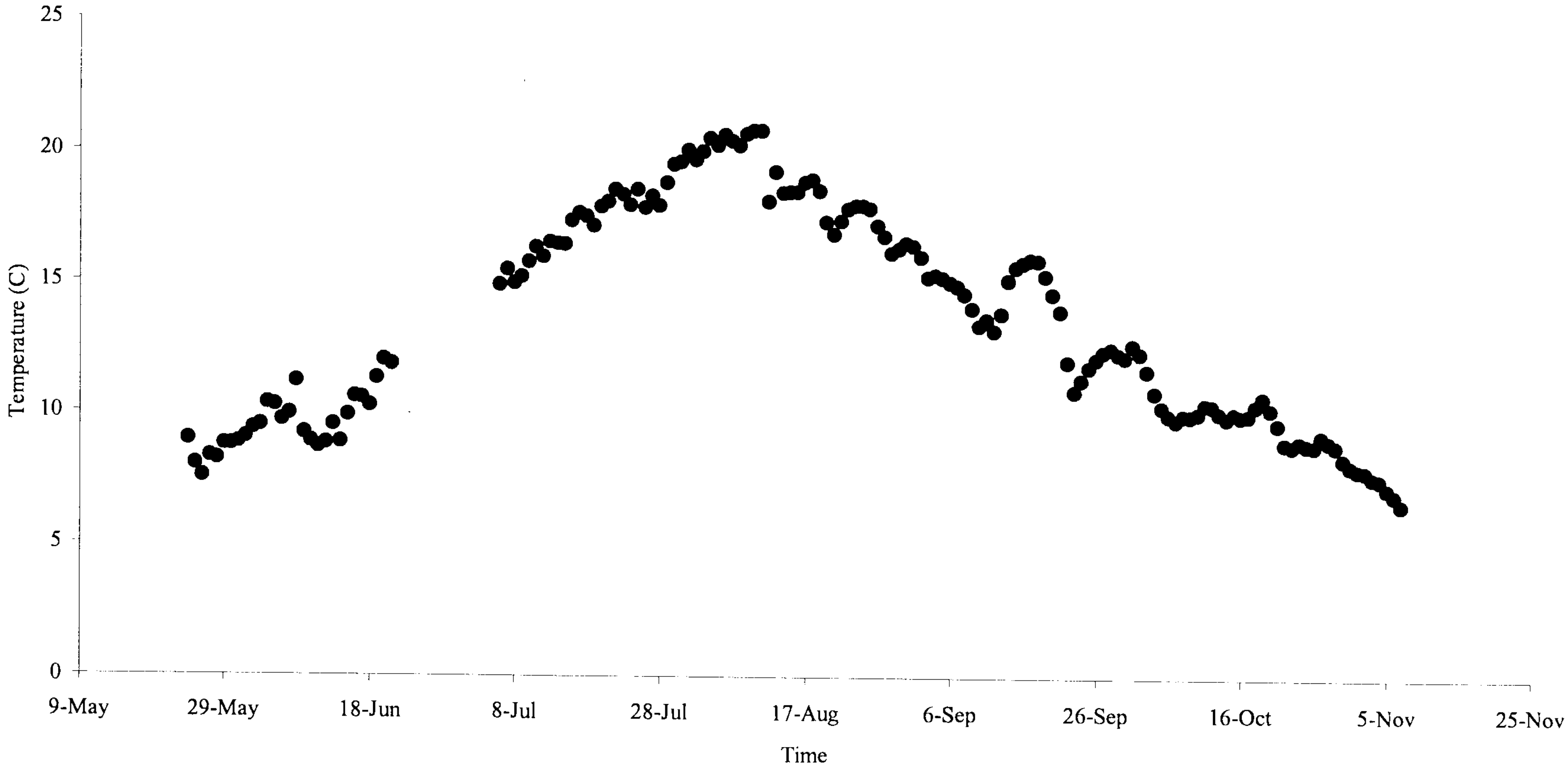


Figure 14. Thorofare daily mean temperature (°C) trends in 2000.

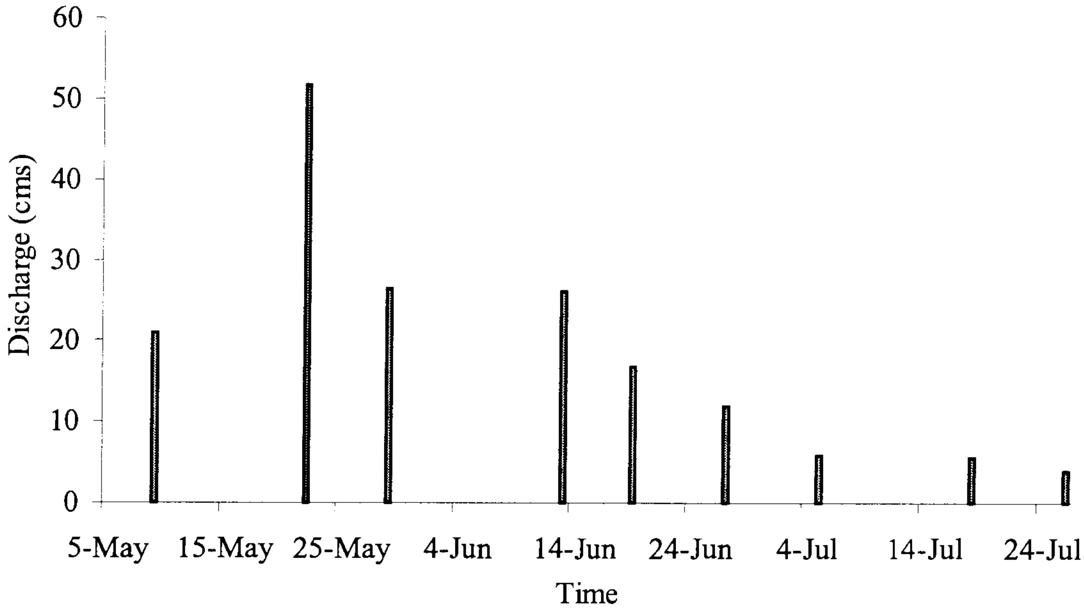


Figure 15. Thorofare discharge trends, 2000.

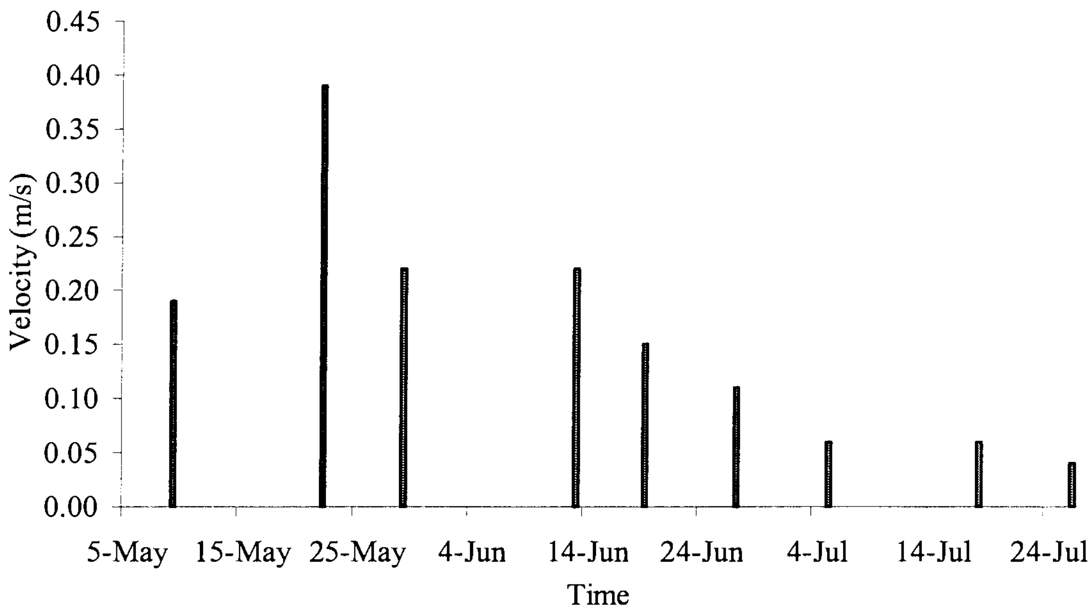


Figure 16. Thorofare mean velocity trends, 2000.

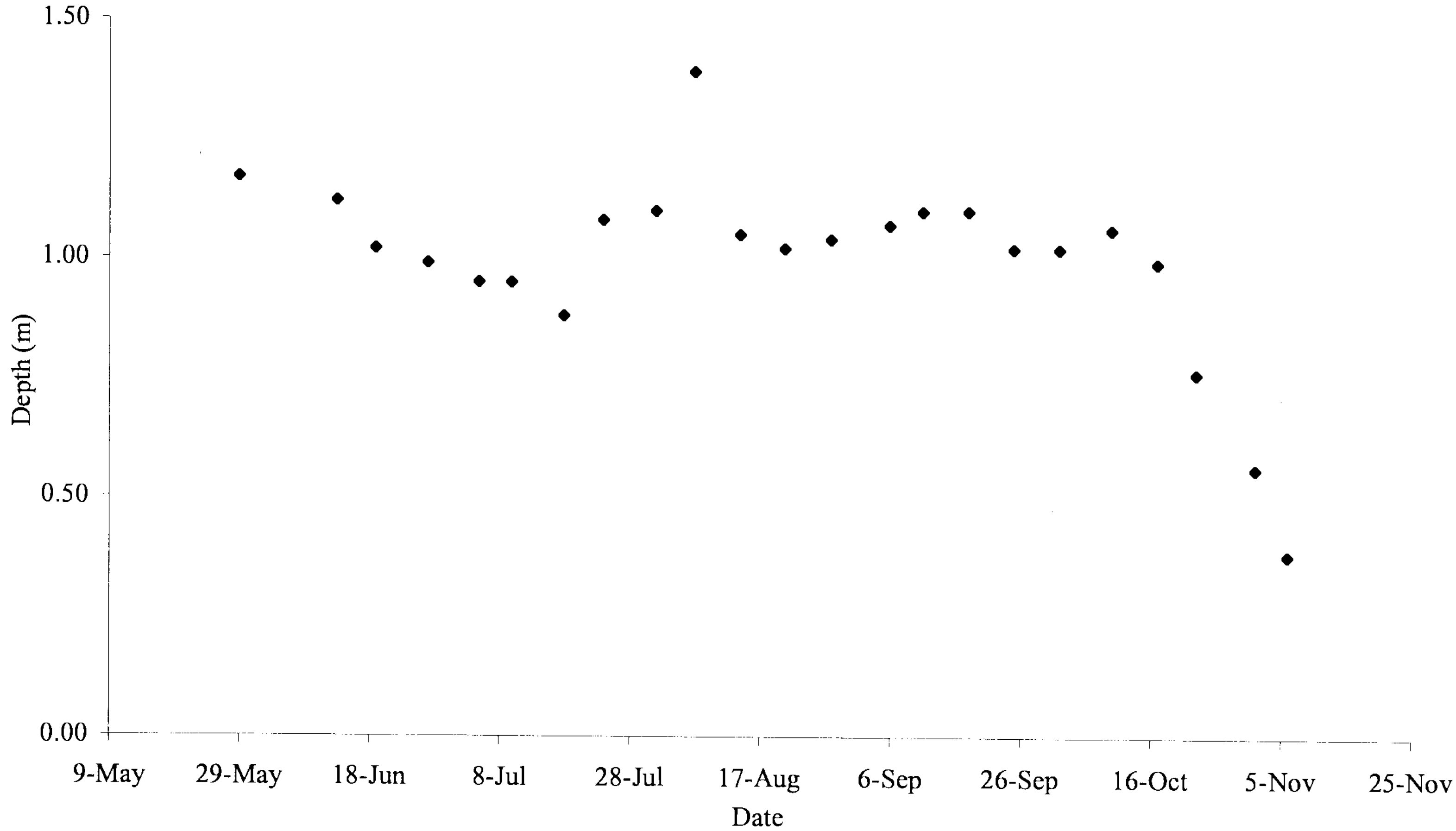


Figure 17. Thorofare depth measured at the outlet of the Thorofare, by date, 2000.

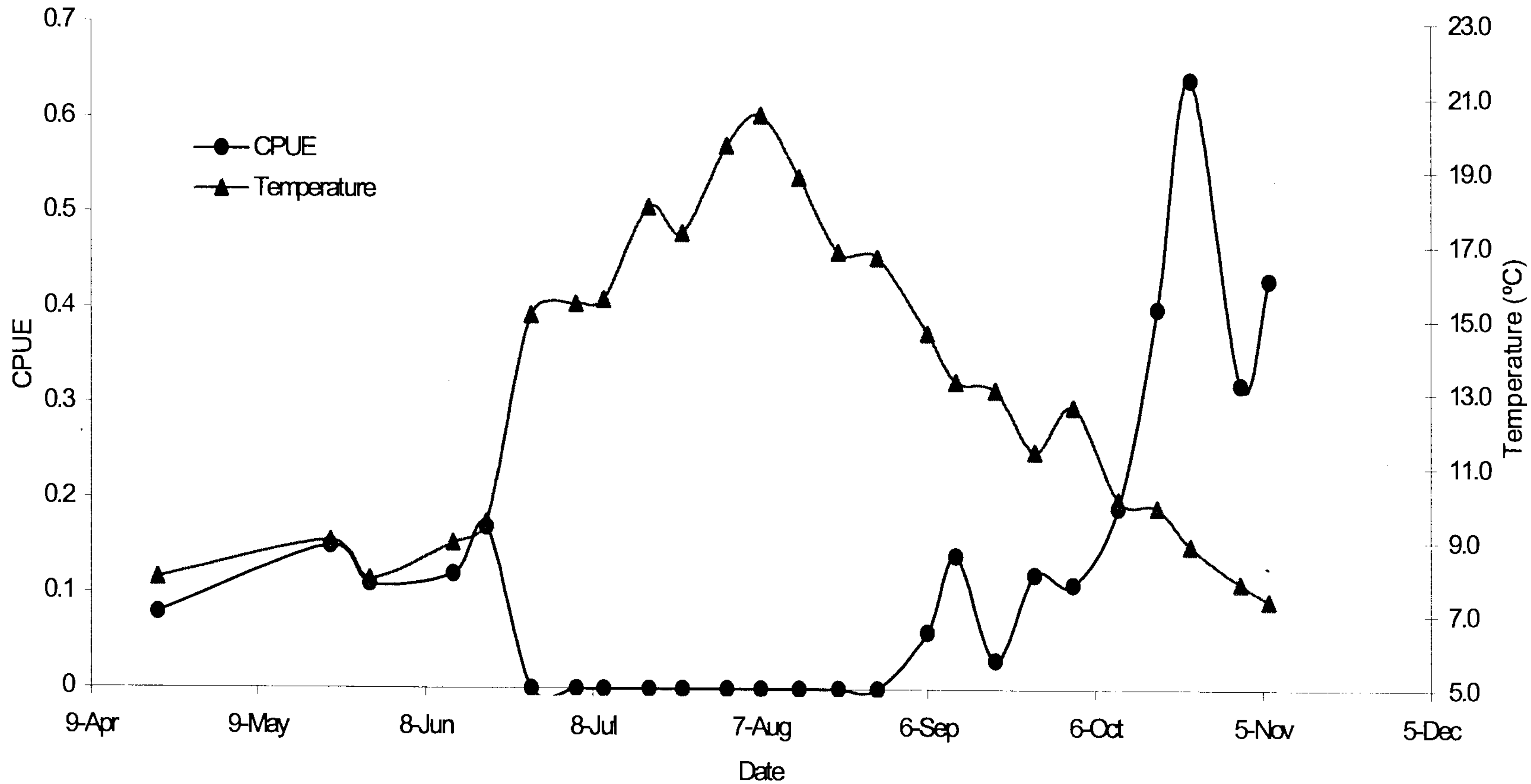


Figure 18. Lake trout weekly CPUE (fish captured/h/100 m^2

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