FISHERY RESEARCH

Upper Priest Lake Lake Trout Removal and Priest Lake Thorofare Strobe Light Evaluations

COMPLETION REPORT
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Upper Priest Lake Lake Trout Removal and Priest Lake Thorofare Strobe Light Evaluations

Completion Report

2002 Annual Report

By

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ABSTRACT

In 2002, 836 lake trout were removed from Upper Priest Lake, Idaho in an attempt to restore bull trout abundance. This was the fifth year of lake trout removal. Unfortunately, the situation appeared to worsen for bull trout. The ratio of lake trout to bull trout increased from 10:1 in 1997 to 93:1 in 2002. The catch rate of lake trout in gillnets did not decline in 2002, indicating lake trout remain abundant. Apparently, lake trout recolonized Upper Priest Lake by migrating through the Thorofare from Priest Lake. We, therefore, conducted *in situ* strobe light tests in the Thorofare to see if lake trout could be repelled in their attempts to move upstream. In paired testing between strobe lights turned on and strobe lights turned off, three out of four lake trout appeared to have been blocked by the lights. Results were highly statistically significant; $p = 0.004$. These findings suggested that a program of lake trout removal from Upper Priest Lake coupled with a behavioral barrier in the Thorofare could benefit the bull trout population.

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INTRODUCTION

This two-part study focused on reducing threats to bull trout *Salvelinus confluentus* and cutthroat trout *Oncorhynchus clarki* by exotic lake trout in Upper Priest Lake, Idaho. Native bull trout historically were abundant and 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).

Lake trout have been shown to contribute to the decline of bull trout and cutthroat populations in other systems (Donald and Alger 1993) and are very likely a threat to the persistence of these two populations in Upper Priest Lake. From June through November 1998, Idaho Department of Fish and Game removed nearly 1,000 lake trout from Upper Priest Lake by gillnetting. During this time the ratio of lake trout to bull trout improved from 80:1 to 22:1 (Fredericks et al. 1999). This project demonstrated that the lake trout population in Upper Priest Lake could be significantly reduced by gillnetting, thereby reducing the predation threat to bull trout and cutthroat trout. In this investigation, we removed lake trout from Upper Priest Lake with gillnets; however, lake trout could recolonize the upper lake by emigrating from Priest Lake. Therefore, the second part of this study was to evaluate the use of strobe lights as a lake trout migration barrier to reduce immigration from Priest Lake through the Thorofare.

STUDY AREA

Project area includes Upper Priest Lake, which provides rearing habitat for adfluvial bull trout and cutthroat trout, Upper Priest River and tributaries, which provide spawning and early rearing habitat for westslope cutthroat trout and bull trout and the Thorofare. Upper Priest Lake is a 567 ha natural lake located in northern Idaho, approximately 30 km south of the Idaho-British Columbia border and 90 km north of the city of Coeur d'Alene, Idaho. 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 743 m in elevation from the end of spring runoff until mid October by a small dam at the outlet of Priest Lake.

The Thorofare is 3 km long, about 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. During winter drawdown, the Thorofare at its outlet is $<$15 cm deep, impeding nearly all boat traffic. The Thorofare receives heavy boat traffic during summer months. For example, on August 22, 2000, a typical weekday, 47 motorboats, 3 canoes, and 5 kayaks were counted entering Upper Priest Lake through the Thorofare. Boat traffic is much heavier on the weekends (Fredericks and Venard 2001).

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 21°C and 24°C, respectively.

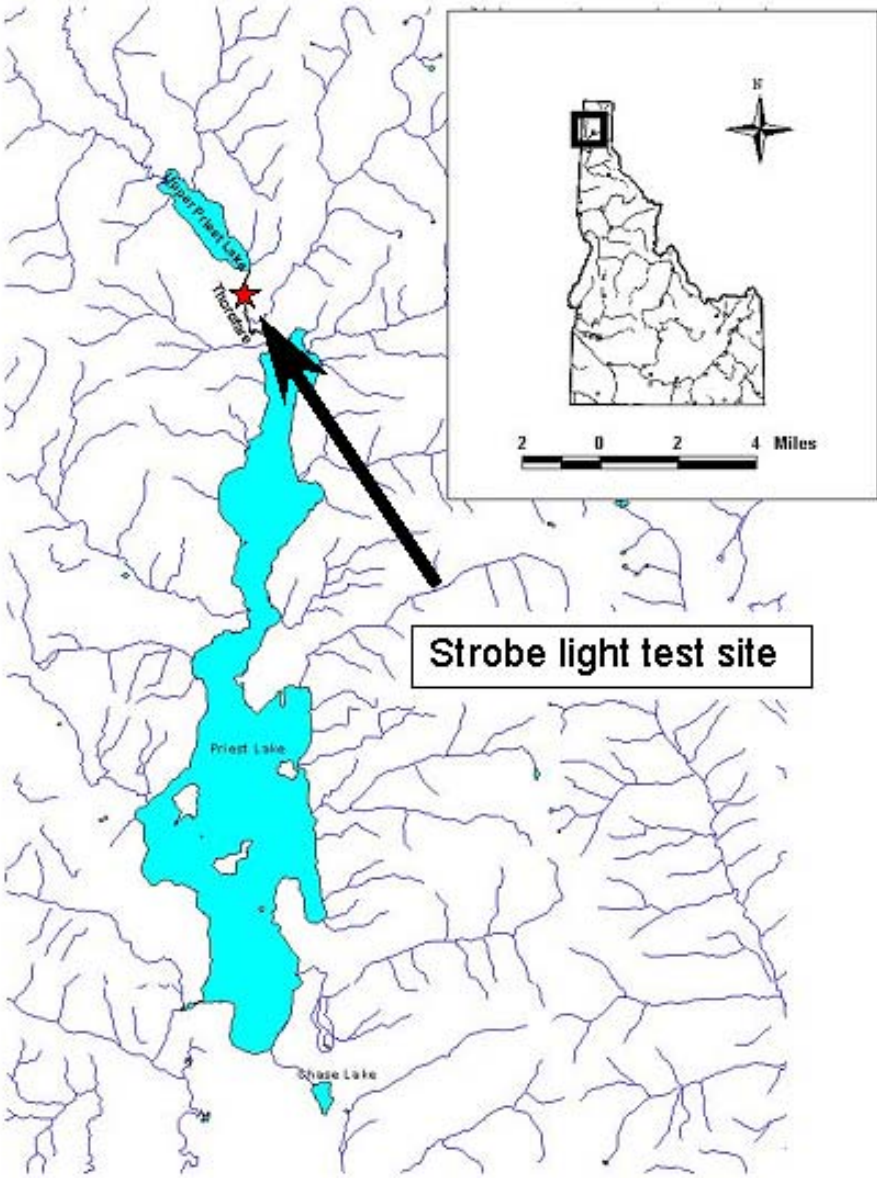

Figure 1. Map of Priest Lake, Upper Priest Lake, and Thorofare. Star indicates the location of the site used for strobe light testing.

Bull trout harvest was eliminated in 1984; however, no positive response in the fishery was realized (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 of extinction. The population estimate for Upper Priest Lake and its tributaries was 116 adult fish in 1999. Introduced lake trout are considered the primary cause of the decline (Fredericks 1999).

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 (Fredericks 1999). This increase in lake trout numbers has been speculatively attributed to increased juvenile survival rates caused by the introduction of opossum shrimp *Mysis relicta* in 1965 (Mauser et al. 1988).

Idaho Department of Fish and Game has documented the movement of lake trout through the Thorofare (Fredericks and Venard 2001). Lake trout were captured in gillnets in the Thorofare in the spring and fall but not in July or August. Greater than 90% of the lake trout captured over two years were caught at night.

METHODS

Upper Priest Lake Gillnetting

Lake trout were removed from Upper Priest Lake using four 91.4 x 2.4 m experimental, monofilament, sinking gillnets with three panels of 2.5, 3.8, and 5.1 cm mesh. Sampling occurred on June 3-6, June 24-27, July 8-10, and August 12-15, 2002. A concerted effort was made to avoid incidental bull trout *S. confluentus* captures. Gillnets were set perpendicular to shore at depths ranging from 20 to 33 m. Nets were set during daylight hours only and were pulled every 45-50 minutes. We standardized catch to a unit of sampling effort (fish/hr/100 m^2 of gillnet) to allow comparison with previous netting efforts. Netted lake trout were measured, examined for tags, and filleted. All processed lake trout were given to various food banks throughout the Idaho Panhandle for distribution to the indigent.

Strobe Light Testing

Strobe light testing was conducted within the Priest Lake Thorofare from September 24-October 2, 2002. We built a net pen that was 182 m long by about 14 m wide then positioned the strobe lights near the center of the pen and pointed them downstream (Figure 2). Buoys with reflective tape marked the perimeter of the net pen as a warning to boaters. In addition, two buoys with yellow flashing lights were placed above and below the net pen. These lights were shielded so that they did not flash toward the net pen. We constructed the pen out of 2.5 cm bar mesh netting (beach seine). The top of the net (float line) was held above the water surface by tying it to fence posts approximately 5 m apart. The lead line of the net was also secured to the bottom using fence posts spaced at 10 m intervals. The pen was parallel to the shoreline and reached into water 1.2 m in depth.

Strobe lights used in this study were built by Flash Technology of Franklin, Tennessee and were their shallow water model. Two strobe light flash heads were secured to fence posts

within the net pen and were pointed downstream. Power converters and a 4,000 watt generator were placed on the bank near the lights (Figure 2).

The lake trout used in the tests were gillnetted in Upper Priest Lake, mostly at depths between 20 and 30 m. Fish were held up to three days in net pens in the upper lake prior to their use. The lake trout averaged 498 mm in total length and ranged from 287 mm to 750 mm (Figure 3). We then placed colored Floy spaghetti tags through the dorsal musculature of the lake trout and released 5 to 10 fish at the downstream end of the net pen in the evening of the test. Different color tags were used in the control (lights off) and test (lights on) groups.

Five tests were conducted between September 24, 2002 and October 3, 2002. Each test consisted of one night with the lights flashing and one night with the lights turned off. Whether the lights were on or off during the first night of each paired test was determined by a coin flip. Different lake trout were used in each trial.

All fish were released at the downstream end of the net pen except during the first test when half of the fish were released upstream of the lights and half released below the lights. A block net was strung across the net pen during the day from one hour before daylight until the test began after dark. This prevented fish from passing the area of the strobe lights during daylight hours. During each night of testing, the block net was removed and the fish were free to swim within the net pen. The block net was reset before daylight. During the day, we searched the net pen, removed the lake trout, and recorded their tag color and total length. Any fish that died during the test were not included in the analysis. Control and test samples were compared using a paired Student's t-test.

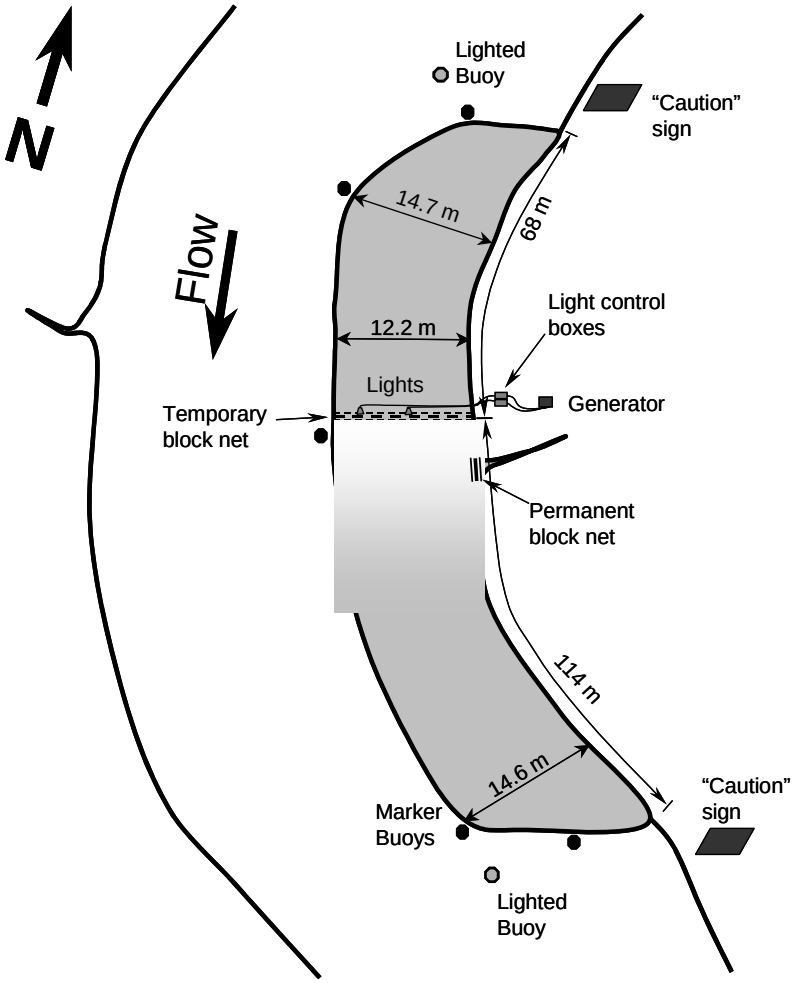

Figure 2. Diagram of net enclosure (shaded area) and strobe light setup used in the Priest Lake Thorofare, Idaho, during September 2002.

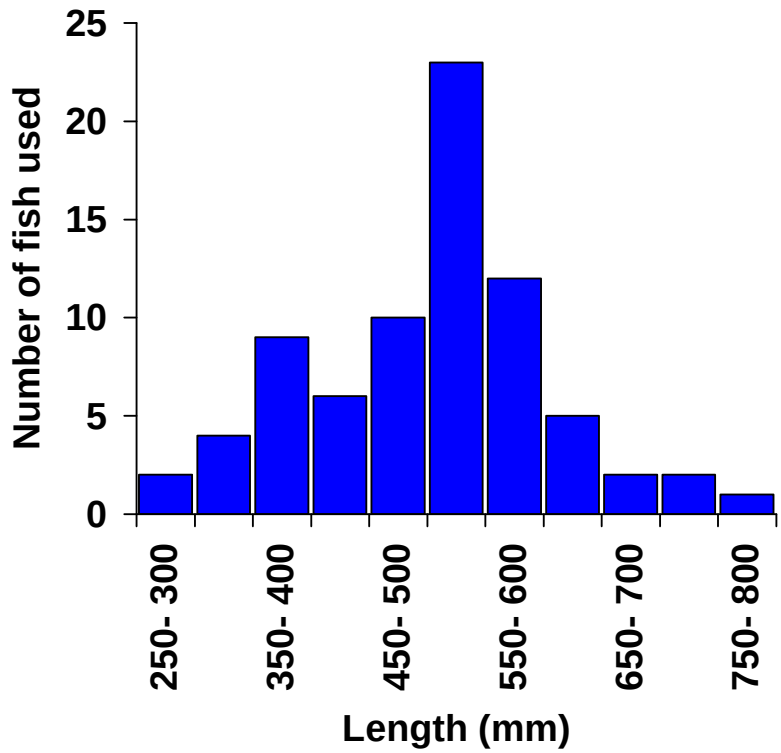

Figure 3. Lengths of lake trout used in the strobe light test. All fish were netted in Upper Priest Lake, Idaho.

RESULTS

Upper Priest Lake Gillnetting

We netted and removed a total of 836 lake trout in four netting efforts. Catches ranged from 297 lake trout in our June 3-6 effort to 165 fish in our June 24-27 effort. Standardized catch rates ranged from 0.77 to 1.47 fish/hr/100 m^2, with no apparent trend or evidence of depletion. Mean catch rate throughout the 2002 effort was 1.02 fish/hr/100 m^2 of gillnet compared to 1.8 fish/hr/100 m^2 in 2001, 0.95 fish/hr/100 m^2 in 1999 and 1.1 fish/hr/100 m^2 in 1998 (Figure 6). Size of lake trout ranged from 175 to 890 mm (TL), with a modal size of 510 mm, which is identical to 2001 (Figure 4).

We incidentally netted and immediately released nine bull trout during the lake trout netting efforts, and no known bull trout mortality occurred. The ratio of bull trout to lake trout was 1:93 compared to 1:67 in 2001, 1:21 in 1999, and 1:10 in 1997 (Figure 5).

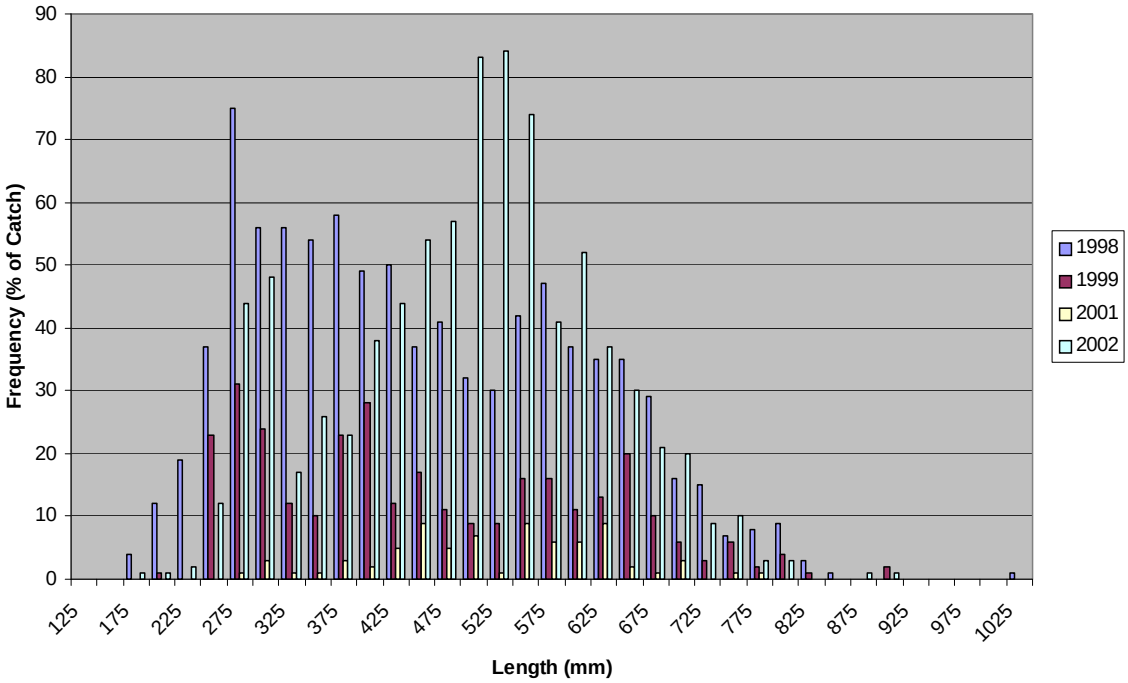

Figure 4. Length frequency of lake trout collected in gillnets in 1998-2002 from Upper Priest Lake, Idaho.

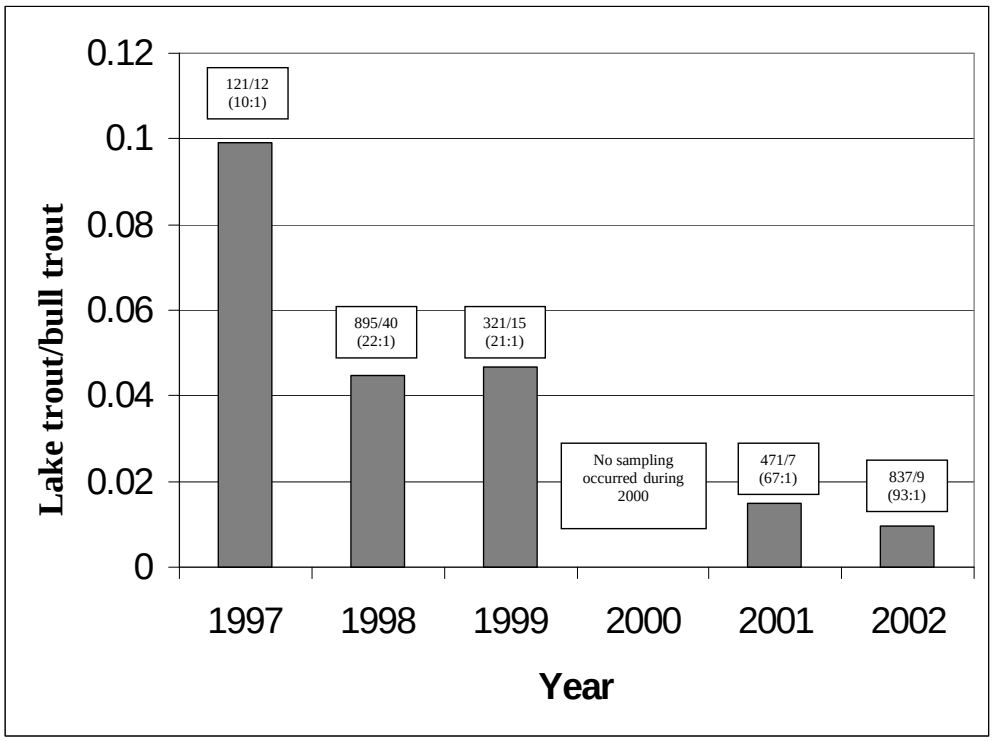

Figure 5. Ratio of lake trout to bull trout collected in gillnets in 1997-2002 from Upper Priest Lake, Idaho.

Strobe Light Testing

During the paired tests, an average of 41% of the lake trout in the control groups (lights off) were found the next morning in the opposite side of the net pen, upstream of the strobe lights (Table 1). Only an average of 10% of the lake trout were found upstream of the flashing strobe lights in the test group. This difference was statistically significant at the 95% confidence level ($p = 0.004$, $df = 4$, $t = 6.159$). Therefore, three out of four lake trout appeared to have been blocked by the strobe lights.

Ten lake trout died out of the 78 that were used in the experiment. This may have indicated considerable stress in the test fish.

Table 1. Results of testing strobe lights in the Priest Lake Thorofare.

Test Number	Control or test group	Date	Number of fish released below lights	Number of fish released above lights	Number that passed the strobe light location	Percent that passed the strobe lights excluding dead/lost fish
1	Control	9/24/02	5		1	33%
1	Control	9/24/02		5	2	50%
1	Test	9/25/02	5		0	0%
1	Test	9/25/02		5	1	50%
2	Test	9/26/02	10		0	0%
2	Control	9/27/02	10		3	43%
3	Test	9/28/02	9		1	12.5%
3	Control	9/29/02	5		1	25%
4	Control	9/30/02	10		4	44.4%
4	Test	10/1/02	10		1	11.1%
5	Test	10/2/02	10		2	28.6%
5	Control	10/3/02	5		3	60%

DISCUSSION

Upper Priest Lake Gillnetting

Our 2002 gillnetting efforts confirm the presence of an expanding lake trout population in Upper Priest Lake. The ratio of lake trout to bull trout comparing 1957, 1998, 2001, and 2002 indicate a progressive increase in the relative abundance of lake trout and a decreasing relative abundance of bull trout. The ratio of lake trout to bull trout was 93:1 in 2002 compared to 67:1 in 2001, 21:1 in 1999 and 10:1 in 1997 (Figure 6). We collected nine bull trout in 2002. Bull trout ranged in size from 600 to 760 mm. No juvenile bull trout were collected, and comparison with gillnet data from 1956 may suggest this portion of the population is absent (Figure 7).

This expanding lake trout population is the greatest threat to the persistence of bull trout in Upper Priest Lake. The increasing lake trout population in Upper Priest Lake and evidence that lake trout contribute to the decline of bull trout and cutthroat populations in other systems

(Donald and Alger 1993) strongly suggested that some means of controlling the lake trout population will be necessary to insure the persistence of bull trout. However, the lake cannot be treated as a closed system, and in order for lake trout reduction in Upper Priest Lake to be successful, immigration from Priest Lake must be controlled. A fish barrier is necessary to minimize immigration of lake trout into Upper Priest Lake. Immigration of lake trout from Priest Lake has been well documented (Fredericks et al. 2000).

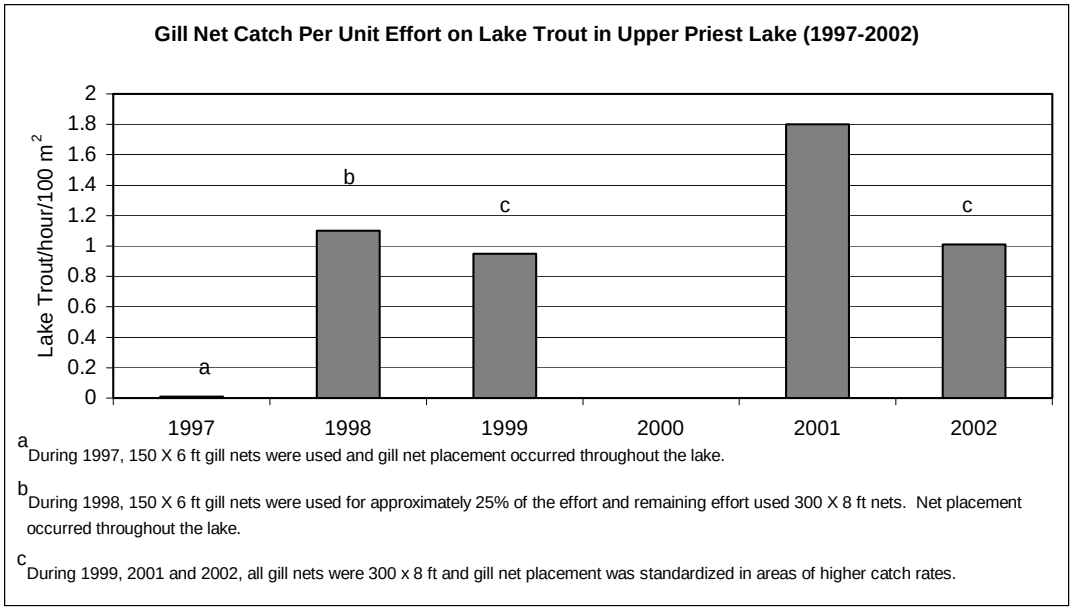

Figure 6. Standardized catch rates (fish/hour/100m^2 of gillnet) of lake trout from Upper Priest Lake, Idaho in 1997-2002.

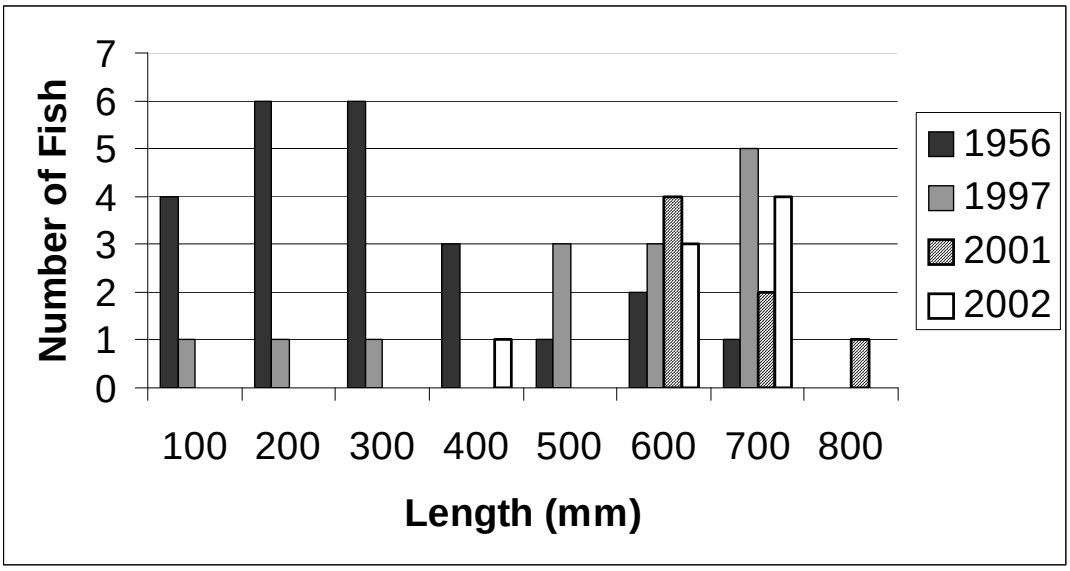

Figure 7. Length frequency of bull trout captured with gillnets in Upper Priest Lake, Idaho 1956-2002.

Strobe Light Testing

Our results demonstrated that lake trout were repelled by strobe lights. Strobe lights appeared to be 75% effective in stopping the upstream movements of lake trout in the Thorofare. Thus, the lights could be an effective tool to reduce the recolonization of Upper Priest Lake by lake trout.

Strobe lights have been shown to repel other species of fish such as kokanee *Oncorhynchus nerka* (Maiolie et al. 2001), coho salmon *Oncorhynchus kisutch* and chinook salmon *O. tshawytscha* (Nemeth and Anderson 1992), coho salmon (Fields and Finger 1956), American shad *Alosa sapidissima* (Taft 1990), alewife *A. pseudoharengus,* smelt *Osmerus mordax*, gizzard shad *Dorosoma cepedianum*, white perch *Morone americana*, spot *Leiostomus xanthurus*, and menhaden *Brevoortia tyrannus* (Patrick and Christie 1985). Considering the deep water generally inhabited by lake trout, it was not unexpected that lake trout would also be repelled.

The lake trout used in this test had been gillnetted, placed in holding pens, tagged, and moved into the large net pen. Likely, they were stressed. Possibly the effectiveness of the strobe lights would have been better on unhandled, free ranging fish. Maiolie et al. (2001) had good results testing strobe lights on free-ranging kokanee and considered that much of the effectiveness of the test was due to the fact that the fish were unhandled.

RECOMMENDATIONS

1. We recommend that a permanent strobe light installation be considered for the Priest Lake Thorofare. A possible site would be near the lower end of the Thorofare close to electrical power but away from any homes or cabins.

2. Continued annual removal of lake trout from Upper Priest Lake is also recommended. Gillnetting or trapnetting should continue until permanent strobe light installation is complete.

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