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BANKS LAKE KOKANEE BARRIER DEVELOPMENT AND EVALUATION

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PROGRESS REPORT

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Background and Need

The Fisheries Research Institute (FRI), University of Washington, has conducted a comprehensive environmental study of the operational effects of irrigation and pumped storage on the ecology of Banks Lake. A portion of this study was designed to determine the magnitude of the fish loss through the irrigation canal. During the 1975 irrigation season, 16 species were caught in net gear while passing through the outlet works, amounting to a total estimated loss of 432,608 fish weighing 103,215 kg. The estimated loss was dominated by yellow perch, 241,528 (10,748 kg); kokanee, 128,397 (59,210 kg); and lake whitefish, 19,326 (12,272 kg). In 1976 the estimated entrainment of these species was 115,146 yellow perch, 50,007 kokanee, 23,731 lake whitefish. The loss of kokanee consisted primarily of adult 3- and 4-year old fish and had the greatest impact on the sport fishery of any species lost through the canal. The entrainment of kokanee in 1976, even though much less than in 1975, was particularly harmful to the 1976 spawning population because very few remained in Banks Lake to spawn. The spawning population was estimated from extensive shoreline surveys to be 153. This number of spawners was far too small to supply the brood necessary to support a sport fishery at maturity two years hence. Thus, the year when the 1977 brood matures and becomes the main support of the kokanee fishery (in 1979) will be a year of poor kokanee fishing.

A creel census conducted during 1975-76 found that kokanee was the most abundant species occurring in the sport catch and that this species

was primarily sought by the troll fishery in the lake. During 1975 a total of 75,035 kokanee was caught by the sport fishery in spite of the large numbers leaving through the canal. One can only speculate on how much better the lake fishery might have been if these fish had remained available to the troll sport fishery. In addition, during a year in which the kokanee spawning population is reduced in number either due to natural or artificial causes (i.e., drawdown), the possibility of retaining the mature fish in the lake which would otherwise be lost would probably increase the number of beach spawning kokanee.

This study was therefore designed to develop and test a practical and economical means of reducing the irrigation canal fish losses from Banks Lake. The entrainment of fish through the irrigation canal is related to the quantity of water being drafted as well as to the life-history stages and behavior of the species of concern. Kokanee are primarily entrained from the lake during May through October, increasing as the fall spawning season approaches. It can be expected that the planned increase in the drafting rates to more than twice the present capacity, following construction of the second Bacon Siphon, will increase the rate of fish entrainment in the future. A means of retaining the adult kokanee in the lake would be extremely desirable in maintaining a viable sport fishery which has shown a 21 percent increase in total fishing effort from 1971-72 to 1975-76, as determined by comparable creel census estimates.

It was proposed that a net barrier be established from the rock point on the south dam to Sliver Island, another from Main Island to the spit enclosing the Coulee City Boat Basin, and a third net between Sliver

Island and Main Island (Figure 1). These nets would be installed at the beginning of the kokanee entrainment period (June) and maintained through the end of irrigation drafting (mid-October). This approach would avoid extensive engineering design, construction and maintenance of a massive traveling screen or louver structure which may in fact be less practical. This net barrier would be specifically designed to lead adult 3- and 4-year old kokanee away from the outlet structure. These age classes are the principal ones entrained and those most desired by the angler. They are also vital to maintenance of an adequate spawning population in the lake for reproduction of the next year class.

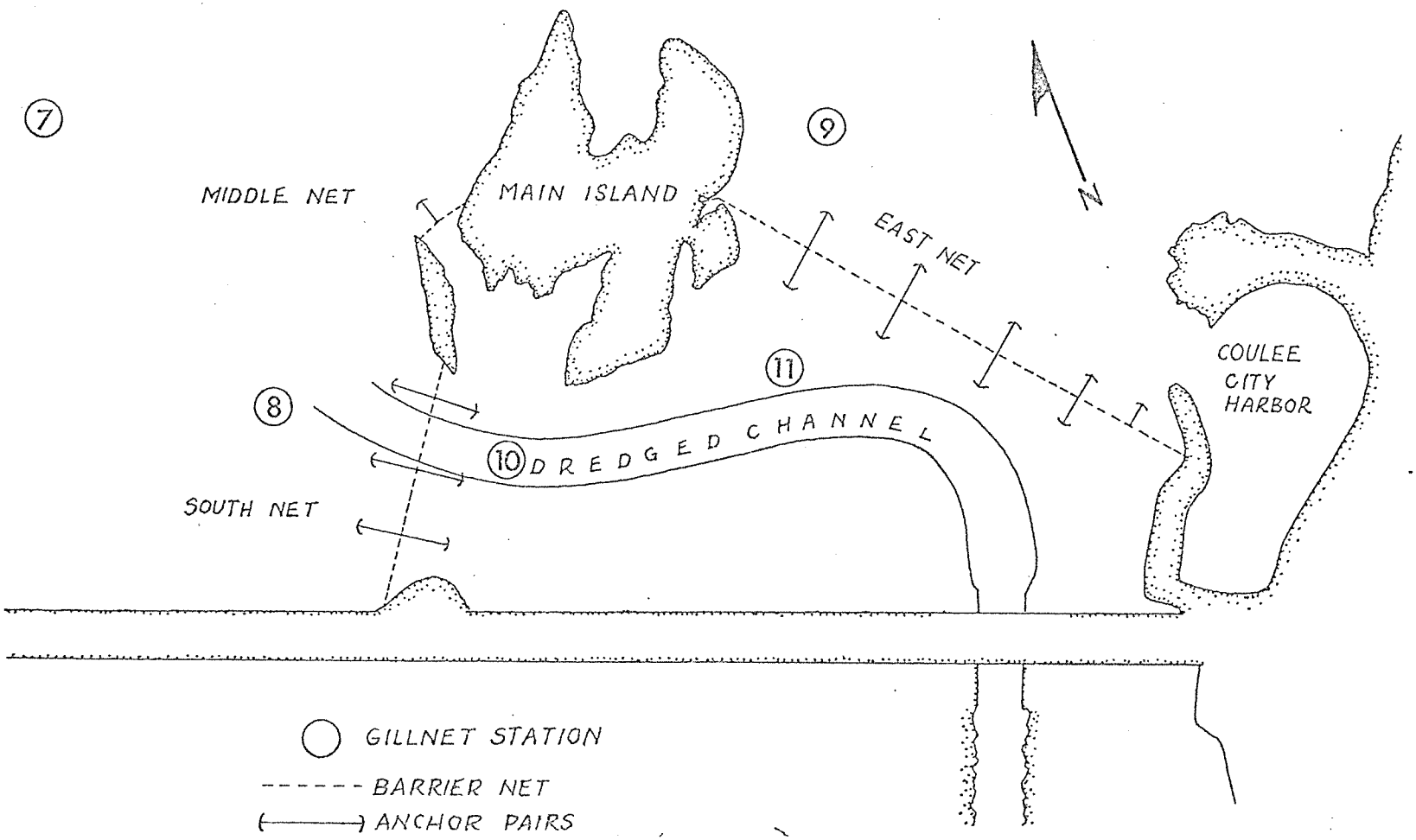

Figure 1. Southeast corner of Banks Lake showing locations of barrier nets, anchors and gillnet sampling sites.

Methods

Site Seclection

The selection of the net sites was a compromise between factors which favored maximizing the distance from the outlet and others which favored minimizing the distance. Those favoring maximum distance were current velocity, anchoring security, regularity of bottom contour. Those favoring minimum distance were length and depth of the net, and interference with boat traffic from Coulee City harbor and with shoreline anglers on Dry Falls Dam.

Soundings of the proposed net site and vicinity were made using a recording fathometer during October, 1976, to determine the suitability of the bottom contour. The east net site was determined to be highly suitable because of its moderate depth (35 ft. max.) and uniform gradient without ledges or abrupt depth changes. The south net site was less suitable because of its greater depth (55 ft. max.), presence of a dredged channel, and because of 15-ft. ledges near both ends. The contour between Sliver Island and Main Island was shallow and uniform as long as the net was set with a slight westerly bow in order to follow a shoal between the islands.

The bottom was re-sounded and distances were measured by lining across the ice during February, 1977, in order to check the accuracy of the earlier acoustical sounding. Detailed contour maps of the three net sites were made from these soundings for use by the net builder in fitting the net to the bottom contour.

Shoreline attachment points for the ends of the nets were emplaced by the Bureau of Reclamation at specified locations. The attachment points on Dry Falls Dam, Sliver Island and Main Island consisted of holes drilled into bedrock into which 3/4-inch eye bolts were set with epoxy plastic.

The attachment point on the jetty at Coulee City Harbor consisted of a deadman embedded in the east slope of the jetty with a cable running through the jetty and emerging on the west slope.

Large, highly visible steel buoys were emplaced by the Bureau of Reclamation immediately outside the barrier net site at 200-ft. intervals across the east and south channels as a warning to boaters. A 4200-ft. cork line strung with 6-in. diameter by 8-in. polystyrene floats was stretched between the steel floats from shore to shore as an additional deterrent to boaters.

Net Design and Construction

The net was designed to fit the bottom contour. An additional 10% in depth was added to insure surface-to-bottom fit. An additional 5% was added uniformly to the length of the east and south nets to insure short-to-shore fit. The net was constructed of 3 1/4-in. (stretched measure) 16-thread knotless dacron netting. This relatively large mesh size was selected because of its low resistance to current and low fouling rate compared with smaller mesh. Preliminary measurements of kokanee determined that the largest of age 2 kokanee and age 3 and 4 kokanee could not physically pass through 3 1/4-in. mesh, but that if they entered the mesh they could be caught and held (gilled) anterior to the dorsal fin. However, gilling was not anticipated because of the tendency of salmonids to lead along a visible net and not attempt to pass through the mesh even though capable of doing so. It was therefore essential that the barrier net be highly visible. Since kokanee are among the most pelagial of salmonids before maturity, we assumed that gilling would not occur as long as the net remained visible.

The visibility of the net was enhanced by maintaining the natural white color of the dacron fiber by treating it before use with a clear net preservative rather than the standard pigmented preservative. The white appearance was maintained by washing any accumulations of periphyton from the mesh at regular intervals.

The net was hung with 1/2-in. diameter double-braid nylon cork and lead lines. Weight was added by attaching 3/16-in. chain along the entire length of the lead line. Polystyrene corks measuring 3-in. diameter by 4-in. long were spaced at 1-ft. centers in the length of the cork line, except along a 150-ft. section of the south net which spanned the dredged channel. Corks in this section were spaced at 6-in. centers to provide extra flotation where the current was predicted to be strongest.

The net was held in position by the shoreline attachments and by anchors attached at intervals to the lead line (Figure 1). These anchors were 60-lb. kedges placed in pairs, with one anchor of the pair upstream, and the other anchor downstream from the barrier net and joined by 5/8-in. polypropylene lines. The joining lines varied in length from 100 to 200 ft. depending on the water depth at the point of installation. Greater length was used at greater depth. A ring attached mid-way in the joining lines served as a means of connecting and disconnecting the anchor pairs to the lead line. This feature and the wide spacing between paired anchors was necessary to permit the net to be lifted out of the water for washing. The anchor lines were positioned at intervals of 275 ft. along the south net (three pairs) and of 540 ft. along the east net (four pairs). The anchors were each stabilized against dragging by adding 20 ft. of 1/2-in. anchor chain between the anchors and the joining lines. The initial placement of the anchors and subsequent adjustment of their positions was facilitated by surface-buoyed lines attached to one fluke of each anchor.

Net Washing Gear

The net washing gear consisted basically of a 25-h.p. gas engine coupled directly to a hydraulic pump which circulated oil to three hydraulic motors. One motor powered a V-notch roller near the bow which lifted the net and pulled the barge along the net. A second motor powered a flat, stern-mounted roller which moved the net down the length of the barge to the stern where it was released to fall back into barrier position. A third motor powered a water pump which delivered water for washing the net.

A 26- by 8-ft. fiberglass work boat was provided by the Bureau of Reclamation in place of a barge originally proposed for the net handling and washing operation (Figure 2). The boat proved unsuitable for the washing operation because of inadequate freeboard of the deck and poor drainage of wash water and debris through the scuppers. An auxilliary barge measuring 9 ft. by 13 ft. was therefore constructed of styrofoam, lumber, and plywood and attached astern of the work boat for the net washing.

Irrigation Canal Sampling

Weekly samples of entrained fish were taken from the irrigation canal starting two weeks before installation of the barrier net and continuing throughout the irrigation season to determine the effectiveness of the barrier net. Standard 12 x 12-ft. nets of 1-in. mesh (stretched measure) were fished in Gates 1 and 4 of the irrigation canal headworks and a 6 x 6-ft. net of 1/2-in. mesh was fished in Gate 6. The small net was used to sample small or juvenile fish not retained by the large nets. These nets and method of employment have been described in detail in Annual Reports 3 and 4.

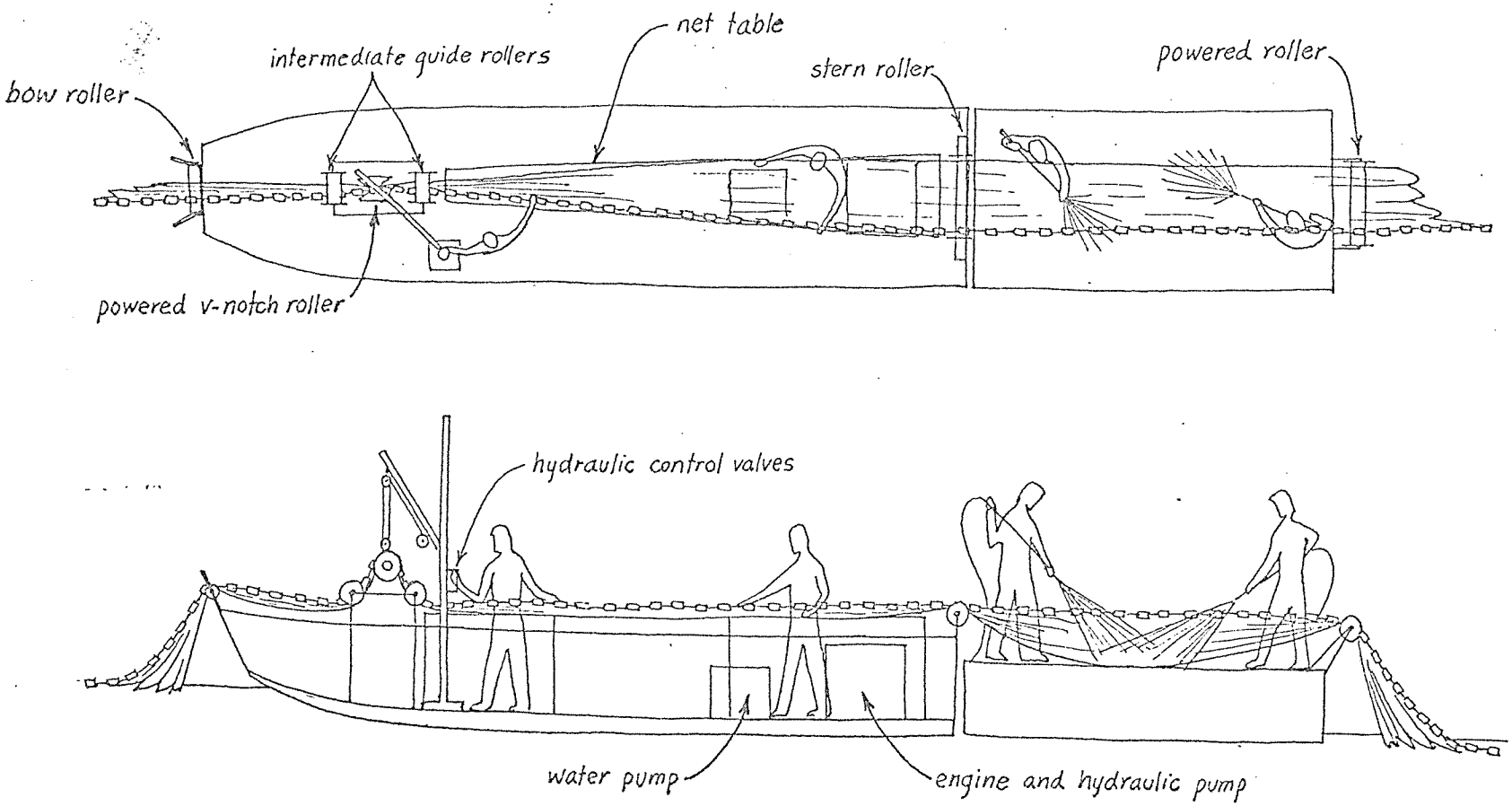

Fig. 2 Diagram of the arrangement and use of equipment used in lifting and washing the barrier net.

Gillnet Sampling

The fish densities immediately inside and outside the barrier net were determined by means of gillnetting. Standard, variable-mesh nets were set horizontally at the surface and bottom inside and outside the east and south barrier nets (Stations 8, 9, 10 and 11, Fig. 1). The gillnets were fished bi-weekly for 48-hr. periods throughout the period of installation of the barrier net. An additional gillnet site was established at Station 7 (Fig. 1) and fished on the same schedule to provide information on fish density in the general vicinity of the barrier net.

In order to compare the size of the fish populations in 1977 with populations in recent years of study we also conducted gillnet sampling at Stations 4, 5 and 6 on weeks alternate to those sampled at Stations 7-11.

Acoustic Surveys

Detailed acoustic surveys of the area inside and immediately outside of the barrier net were made monthly as a means of determining the distribution and abundance of fishes relative to the barrier net.

The acoustic equipment and its application have been described in detail in a June 30, 1977, report to the Bureau of Reclamation entitled "Survey of Fishery Resources in the Forebay of Franklin D. Roosevelt Reservoir, 1976-77" and will not be described here. The pattern of acoustic transects is shown in Figure 3.

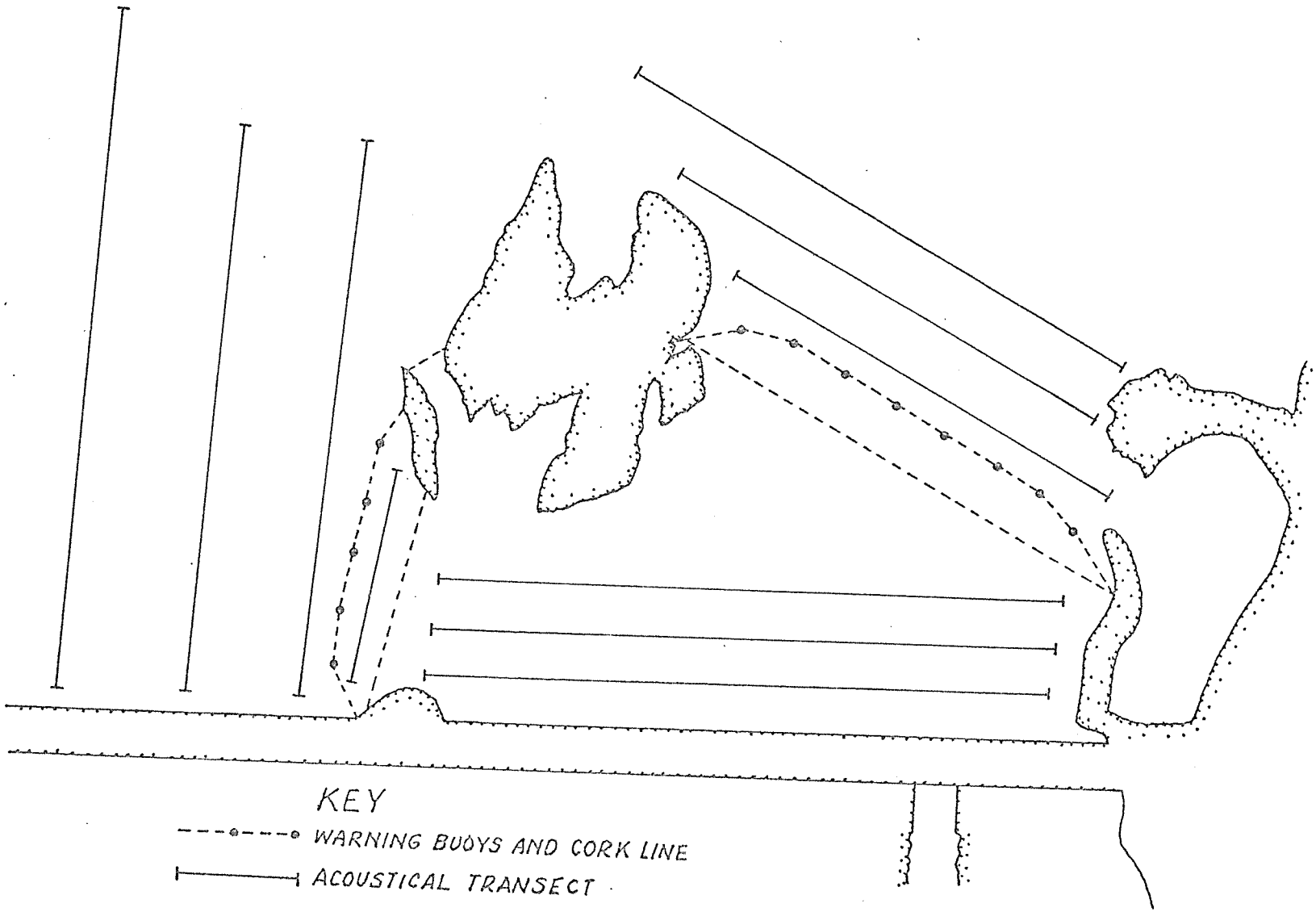

Fig. 3 Locations of acoustical transects.

Results

Installation of the Barrier Net

The barrier net was installed on June 23 and 24. Inspection shortly thereafter by SCUBA determined that the east net completely screened the east access to the irrigation canal, but that the south net needed lengthening in order to span the opening. A 100-ft. section of net was added near the middle of the south net two weeks later. A re-inspection of the south net revealed gaps at the steep bluffs near the north and south ends and at both edges of the dredged channel. These gaps occurred because the lead line was under tension and did not conform to abrupt changes in the slope of the bottom.

The length and depth of the gaps was observed to vary depending on the amount of tension on the net. Greater tension, resulting from fouling by algae and from wind-generated current, caused the net to bag downstream and the lead line to lift at the gaps. Occasional strong north winds created a visible east-flowing surface current along Dry Falls Dam which caused the lead line to lift. During calm weather the surface current was barely discernable. Fouling by periphyton prior to the bi-weekly net cleaning was suspected of contributing to tension on both south and east nets. During August, streamers of periphyton hanging from the meshes grew to about three inches long between net washings.

The gaps were filled eventually by suspending curtains of weighted netting from the lead line. Because the current was negligible along the bottom these curtains hung vertically without tension and conformed well to irregularities in the bottom.

Gilling Rate

Fish which were found in the barrier net during washing were identified by species, weighed and measured. In all, eight species were caught including kokanee, chinook, longnose sucker, lake whitefish, mountain whitefish, yellow perch, peamouth, largemouth bass. Some fish were unidentifiable because they had gilled early in the two week period between washings and decomposed.

The peak gilling rate occurred during early September, at which time the catch per week approximated 14.0 kokanee, 4.2 mountain whitefish, 0.3 perch, 0.1 crappie, and 0.1 largemouth bass. Kokanee was the predominate species gilled during late August and September. During July and early August the principal species gilled was chinook. The peak gilling rate for chinook was approximately seven per week.

The greater water depth of the south net apparently was more attractive to fish than was the shallower depth of the east net. No fish were gilled in the 600-ft. portion of the east net which traversed water less than 10 ft. deep. The gilling rates of south and east nets were nearly equal despite the 1.7 times greater area of the east net.

Gilling rate appeared to be related to depth, with the highest rate occurring within 10 ft. of the surface. Few fish were gilled deeper than 25 ft. This difference may have resulted from variation in water current which was fastest at the surface and almost negligible below 25 ft., or it may simply have been the preferred swimming depth of fish irrespective of current.

Gilling rate did not appear to be related to differences in water current along the net. The fastest water currents were encountered mid-way along the east net in water depths ranging from 20 to 25 ft. The gilling rate in this section of net was no greater than in adjacent

net sections of equal or greater depth.

Surprisingly few yellow perch were gilled despite their tendency to concentrate along the net and to swim through the meshes unhesitatingly. Schools numbering in thousands were observed repeatedly passing through the net.

Canal Catches

The canal catches are providing the best measure of the effectiveness of the barrier net. Sampling in the canal was begun in late May before installation of the barrier net to establish the pre-barrier entrainment of fish. Sampling has been conducted from 3 to 5 days per week since, and is continuing. Although the data have not been analyzed, the catches of most species, particularly kokanee, have been much smaller than the catches in 1975 and 1976. During June and July the catches of small age 1 perch were very large, and the catches of age 1 chinook were moderately large, compared with previous years.

The kokanee catches increased suddenly on several occasions when the barrier net was lifted for washing and when circumstances of current and fouling caused large gaps to form along the lead line of the south net. The increased catch rate did not occur longer than two consecutive sampling periods (24 hrs.) and equaled, but did not exceed, the catches obtained during similar sampling periods in 1976.

Gillnet Catches

The gillnetting has been maintained on a bi-weekly schedule except during several weeks when samples were omitted because of equipment breakdown or because unscheduled work of higher priority diverted the effort elsewhere.

The catches to date indicate that the abundance of age 3 kokanee in 1977 is similar to the abundance observed in 1976.

Comparison of gillnet catches inside and outside the barrier net showed no significant differences during July and early August but have shown greater numbers outside during late August and September. These data have not been analyzed in detail.

Acoustic Survey

The acoustic surveys have been made monthly in the vicinity of the barrier net since June and are continuing. The echograms have not yet been analyzed in detail but preliminary inspection shows the greatest density of targets in the immediate vicinity of the barrier net and low density elsewhere.