USE OF DREDGED MATERIAL TO ENHANCE FISH HABITAT IN LOWER GRANITE RESERVOIR, IDAHO-WASHINGTON

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Abstract

This paper discusses a field demonstration project involving the use of dredged material to enhance habitat for salmonid fishes in Lower Granite Reservoir, Idaho-Washington. Deposition of sediment at the confluence of the Snake and Clearwater rivers, near Lewiston, Idaho threatens the integrity of a levee system used for flood control. Experimental dredging and disposal of the material about 32km downstream at a mid-depth disposal (3-8m) site has been preliminarily evaluated for beneficial uses to fishery resources. Water quality was not affected about 100m downstream from the dumping site shortly after disposal at the surface and mid-column but increased suspended solids and turbidity were measured on the bottom. A total of 4,100 fish were collected during spring 1988. Sixteen species of fish were collected at the disposal site compared to 16 at a mid-depth reference and 19 at a shallow water reference site. Catches of target fishes at the dsiposal site appear to fall between the most productive shallow water sites and the mid depth reference sites. Recolonization of benthos occurred 4 months after deposition of dredged material although standing crops of chironomids and oligochaetes were lower than reference sites.

INTRODUCTION

This paper discusses a field demonstration project involving the use of dredged material to enhance habitat for salmonid fishes. The U.S. Army Corps of Engineers is evaluating habitat enhancement as part of their long-term alternative to resolving the sediment deposition problem in Lower Granite Reservoir, Idaho-Washington.

Use of dredged material to enhance habitat for fish and wildlife is fairly widespread (Landin and Smith 1987). To date, most uses have been to benefit wildlife resources or coastal fish habitat (McKern and Iadanza 1987). Anderson (1985) reported that islands created in the Campbell River, B.C. provided valuable feeding habitat for wild chinook salmon (Oncorhynchus tshawytscha). Abundance of food organisms for salmon was as high as in the natural marsh. McConnell et al. (1978) reported that the Miller Sands, Columbia River, Oregon habitat development sites created by dredged disposal were used extensively by juvenile chinook salmon for feeding. However, both the Campbell River and Miller Sands studies dealt with estuarine systems. Estuarine systems have historically received a high deposition of sediment. Because of this natural deposition, substrates are generally smaller in composition which produce a different benthic fauna compared to larger substrates more common in "up-river" systems. Therefore, biotic responses to the deposition of dredged materials may be totally different than in the lower river systems or estuary. The key to successful use of dredged material for habitat enhancement in any system is identifying habitat requirements of the target species and then creating habitat attributes that are limiting to the target species.

BACKGROUND INFORMATION

Sediment deposition in the upstream end of Lower Granite Reservoir, Idaho-Washington, was originally projected prior to reservoir impoundment in 1975. Since then, the US Army Corps of Engineers have been monitoring sediment deposition and presently estimate that 1,529,200 m^3 (2,000,000 yd^3) of sediment enters the reservoir annually. A majority of this material moves downstream and out of the reservoir but approximately 611,680 m^3 (800,000 yd^3) deposits in the vicinity of the confluence of the Snake and Clearwater rivers near Lewiston, Idaho and Clarkston, Washington. Deposition of this material threatens the flood control and navigational purposes of the reservoir. The integrity of the levee system constructed as part of the Lower Granite project to protect portions of Lewiston, Idaho is the greatest concern followed by navigational access to local ports. A number of possible alternatives to increase freeboard on the levees are being examined. It appears that any long-term solution will involve some level of dredging and in-water disposal appears feasible because of the limited upland sites available as a result of the steep, talus cliffs. Disposal of dredged material at least 33km downstream of the confluence in the lower reservoir is feasible without affecting the flood control profile at the confluence.

To provide information on the distribution and abundance of fish and benthics, several studies have been conducted in Lower Granite Reservoir. Initial studies focused on use of deep (>20m) and shallow (<6.6m) habitats by fish and benthic communities (Bennett and Shrier 1986). These findings suggested that the benthic community was dominated by dipterans and oligochaetes. Benthos abundance was similar among sites but varied seasonally. Shallow waters were important resting and feeding areas for migrating chinook salmon and rainbow (steelhead) trout (Oncorhynchus mykiss) juveniles. Deep water fish communities were dominated primarily by nongame fishes although white sturgeon (Acipenser transmontanus) were present. Initial dredging and land disposal was monitored in 1986. Results indicated that water quality from dredging and disposal was not significantly altered during the winter dredging (Bennett and Shrier 1987). In 1987 research monitoring was expanded to include proposed in-water sediment disposal at mid-depth (>6.6-<19.8m) sites. Preliminary data collection for fishes and benthos was conducted at mid-depth sites and a more extensive data base was developed on shallow and deep water sites continued. In 1988, the Corps began the first year of the test of in-water disposal. The second year of flood control dredging was conducted and for the first time experimental placement of dredged material in-water was made at selected mid-depth and deep sites. Interest in mid-depth disposal was the potential for creation of shallow water habitat. Disposal specifications indicated that water depth at the disposal site would be decreased to about 4m. Desired characteristics of the disposal were based on recommendations from an Adaptive Environmental Assessment Management (AEAM) workshop held in 1987 to resolve technical issues among resource agencies (Webb et al. 1988). At the workshop, three disposal strategies were recommended; disposal a mid-depth underwater plateau, creation of an island, and deep water disposal. This report summarizes findings at the mid-depth disposal site (underwater plateau).

STUDY AREA

Lower Granite Reservoir is a 3602 ha impoundment on the Snake River. The Snake River originates in southwestern Wyoming, flows west through southern Idaho, cuts north to Lewiston and flows west into the Columbia River in Washington. Four lower Snake River dams have created about 210km of slack water to Lewiston (RM 139). Lower Granite is formed by the uppermost dam (RM 107) on the lower Snake River. The reservoir is approximately 63 km long and averages 643 m in width. Depth averages 17 m but ranges from shallow sandy shorelines to a maximum of 42 m. Shallow water habitat (< 6.6m) comprises less than 8% of the total surface area and most of that occurs in the upper end of the reservoir.

As part of the 1988 survey, eight study stations were established in Lower Granite Reservoir from about RM 110 to RM 127. Three of the eight stations will be discussed for purposes of this paper. The site at RM 127 was the shallow water reference site. A mid-depth reference (RM 111) site was selected for comparison with the mid-depth disposal site (RM 120). A thorough description of these sites is given by Bennett et al. (1988).

METHODS

We evaluated fish community structure at all three with an 8m shrimp (bottom) trawl, a 3.3m surface trawl, and 66x2m gillnets. A 165x5m purse seine was also used at the mid-depth and shallow reference sites; shallowness of the mid-depth disposal site precluded its use. At least 3 hauls were taken on each of 5 days during May and June with the bottom trawl. Similarly, at least 3-5 hauls were taken on each of 2 days during June with the surface trawl. Trawling speed varied with wind and water velocity, ranging from 0.6-2.6 m/sec (mean of 1.3 m/sec) for bottom trawling and 0.3-1.1 m/sec (mean of 0.8 m/sec) for surface trawling. Eight multi- and monofilament horizontal gillnets with 3.1, 4.1, and 5.1 bar mesh were fished on the bottom for 5-6 days at each site. Nets were set 3 hours before sunset, checked at 2 hour intervals to minimize mortalities, and fished until 3 hours after sunset.

We sampled benthic community structure and abundance (standing crop $-g/m^2$) in June, 1988 using a Shipek dredge. A total of 12 dredge samples were collected at each site. Samples were sieved in the field, preserved in 5% formalin, and sorted, identified, and enumerated in the laboratory. Wet weights were taken on groups of preserved organisms, and summed by groups.

RESULTS

Water Quality

Results of in-water disposal indicate that measurable impacts were limited to the bottom of the water column (Army Corps of Engineers 1988). No significant increases in turbidity or suspended solids were recorded in surface or mid-depth water samples. In bottom samples, a peak increase in suspended solids and turbidity occurred from 10 to 30 minutes following disposal, then gradually decreased to near background. Differences in the magnitude of the "peak" was related to the size of sediment being disposed.

Disposal of dredged materials in Lower Granite Reservoir resulted only in a temporary increase in turbidity. The overall increase in turbidity was of short duration and restricted to a plume noticeable downstream about 17km from the air. However, following completion of disposal, turbidity returned to ambient levels. No increase in ambient turbidity levels has been observed as a result of the experimental deposition of dredged material at the mid-depth site.

Fish Community

We collected a total of 4,100 fish during the 1988 spring season at the three stations in Lower Granite Reservoir (Table 1). Highest total catches were for steelhead trout, largescale suckers (Catostomus macrocheilus), bluegill (Lepomis macrochirus) and chinook salmon.

We collected 16 species from the mid-depth disposal site compared to 19 at the shallow reference site and 16 at the mid-depth reference site. The six species of interest, chinook salmon, steelhead trout, white sturgeon, northern squawfish (Ptychocheilus oregonensis), smallmouth bass (Micropterus dolomieui), and channel catfish (Ictalurus punctatus) all were collected at the three sites, excepting white sturgeon which was not collected at the mid-depth reference site.

Comparison of catch rates among gear types provided preliminary insight into habitat use. Catches at the reference sites generally were similar between 1987 and 1988. Catch rates of gillnets at the mid-depth disposal site indicate that the abundance of species of interest prior to (1987) and immediately after (1988) deposition of dredged material was similar (Figure 1). Catches of steelhead at the disposal site were slightly higher in 1988 than in 1987 prior to the disposal. Catch rates of northern squawfish at the disposal site were generally similar in both years. The most noticeable difference between pre- and post-disposal fish catches, possibly related to decreased depth, is the appearance of chinook salmon and smallmouth bass in post-disposal catches where none were captured in pre-disposal sampling.

Results from surface and bottom trawling suggest the abundance of chinook salmon and steelhead differs at each of the study sites (Figure 2). Catch rates from surface trawling were considerably higher for steelhead than chinook although surface trawling was initiated in June following the peak of the chinook emigration. Highest catch rates were observed at the shallow reference followed by the mid-depth disposal and then lowest at the mid-depth reference. Overall trends in catch rates from bottom trawling (May-June sampling) were similar to those from surface trawling, although chinook salmon were more abundant and steelhead were captured only at the mid-depth disposal site. Differences in catches between bottom ans surface trawls suggest a pelagic orientation for steelhead compared to a more benthic orientation by chinook salmon.

Benthic Abundance

Benthic community structure was similar among the three sites although standing crops were considerably different. Chironomids and oligochaetes dominated the community and accounted for nearly 100% of organisms sampled. Benthic community standing crops ranged from 1.27g/m^2 (wet weight) at the mid-depth disposal site to 10.4g/m^2 at the mid-depth reference site (Table 2). Biomass of chironomids four months after deposition of the dredged material was about half that of the other sites while biomass of oligochaetes was about 20 times lower at the mid-depth disposal site than at other sites.

Estimates of benthic standing crops were similar between 1987 and 1988 at the shallow water reference site but about an order of magnitude different at the mid-depth reference site from 1987 to 1988 (Table 2). Estimates of benthic standing crops in 1987 at the mid-depth disposal site, prior to disposal were similar to the other sites although variances were dramatically higher. Preliminary results from the June sampling in 1988, 4 months after disposal, indicate that colonization of chironomids was about 50% of the "expected" biomass while that of oligochaetes was considerably below other sites or years in biomass.

DISCUSSION

Preliminary results of the use of dredged materials to enhance habitat for salmonid fishes in Lower Granite Reservoir appear promising. While we stress the preliminary nature of our results, they do seem to indicate increased salmonid use of the mid-depth disposal site compared to results from pre-disposal sampling. Salmonids emigrate through Lower Granite Reservoir during the spring (Bennett and Shrier 1986; Bennett et al. 1988), and an estimated 5 million more chinook emigrated in 1988 than in 1987 (unpublished data Fish Passage Center, Portland, Oregon). Despite the millions of chinook passing through Lower Granite on their out migration, none were collected at the pre-disposal site in 1987. However, only gillnetting was used in 1987. In 1988, however, after site construction, chinook were captured. Whether chinook appearance at the disposal site reflects increased attractiveness of the site, or is merely a reflection of the increased size of the out-migration is unclear. However, the fact that no chinook salmon were captured prior to disposal strongly suggest lack of use. Interpreting a single season of data requires caution, but initial results suggest a change in salmonid use in response to the disposal of dredged material.

Results of the AEAM workshop indicated that fall chinook salmon were of main interest for habitat improvement although potential existed for other juvenile salmonids for overwintering habitat. Other anadromous salmonids such as steelhead and spring and summer chinook salmon migrate through the reservoir so quickly that most workshop participants saw little potential for habitat improvement although quality could be improved. In 1985, Bennett and Shrier (1986) reported that some chinook salmon over-wintered in Lower Granite Reservoir. Their presence in Lower Granite coincided with fall releases from upstream hatcheries. In contrast, no chinook salmon were captured during winter 1987 sampling.

We believe that the newly created shallow water site could be ideal habitat for fall chinook salmon. Bennett et al. (1988) demonstrated that abundance of chinook smaller than 75mm (fall chinook) in Lower Granite Reservoir habitats was highly correlated with low cover, low gradient shorelines, and fine substrate. At this time we do not know whether the disposal site will be utilized by fall chinook even though the habitat created at the mid-depth disposal site may have similar characteristics to habitat that fall chinook salmon are currently using. Few fall chinook salmon were collected in 1988 at the disposal site. However, very cursory sampling in 1988 indicated that fall chinook were not abundant in habitats used in previous years. We believe that low recruitment to the area upstream of Lower Granite

Reservoir was probably one reason why no fall chinook were captured at the disposal site during 1988. Several years of additional sampling will be necessary to assess the value of the newly created habitat to fall chinook salmon.

Potential for increased predator use of newly created habitat is another important consideration, especially if salmonid use increases. The two predators of highest concern in Lower Granite Reservoir are northern squawfish and smallmouth bass. Squawfish catches in gillnets during 1988 were higher at the disposal site than at the mid-depth reference site, but lower than at the shallow reference site (Bennett et al. 1988). Squawfish catches in 1987 were similar between the pre-disposal and reference mid-depth sites, both of which were lower than at the shallow reference site. These data suggest a possible increased use of the post-disposal area by squawfish, although the differences are relatively small and may not reflect trends related to habitat. Also, preliminary trawling results during the summer have not demonstrated an abundance of young-of-the-year squawfish suggesting that the disposal site may not be attractive for spawning and/or rearing. Appearance of smallmouth bass after and their absence before disposal may indicate increased use by this predator. This pattern coincided with that of chinook salmon, although it is premature to suggest that smallmouth bass changed their habitat use in response to chinook salmon distribution, especially since few salmon were consumed by bass sampled in

1987 (Bennett et al. 1988).

Characteristics of the disposal make sampling the mid-depth disposal area difficult. Soundings indicate a highly irregular bottom varying in depth between 2-4m below full pool elevation. This type of surface is very difficult to effectively sample by bottom trawl and thus, some of our estimates of salmonid abundance at that site represent a minimum level of abundance. We anticipated purse seining the disposal site but because of the shallow depth were unable to effectively sample it with this gear type. Even though sampling is difficult and some of our estimates of use may be minimal, the resulting habitat actually may be more suitable for fishes than the broad, flat under water plateau believed the easiest to create.

Preliminary results indicate recolonization by benthos occurred 4 months after deposition of the dredged material. As of the first sampling, however, both chironomid and oligochaete standing crops were lower than reference sites. Substantially lower oligochaete biomass at the disposal site suggests more rapid colonization for chironomids than oligochaetes. Further increases in benthos standing crop will probably increase the attractiveness of the site to fish as a feeding station. Chironomids are an important food item to both chinook salmon and steelhead trout in Lower Granite Reservoir (Bennett and Shrier 1986).

At present, catches of target fish at the disposal site appear to fall between the most productive sites in shallow water and the mid-depth reference site. Sampling 4 months after disposal indicated that benthic colonization has started although standing crops were considerably lower than reference sites. Further seasonal sampling is planned to enhance understanding of the use of newly created habitat and the potential for beneficial use.

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Table 1. Summary of all fish captured by gear types used during spring, 1988 sampling in Lower Granite Reservoir, Washington. Gear type abbreviations are: BT - bottom trawling, ST - surface trawling, and GN - gillnetting. Expressions of effort vary with gear type: bottom and surface trawling are expressed as number of hauls, and gill netting effort refers to number of net hours. Species codes are: ATR - white sturgeon, ONE - sockeye salmon, OTS - chinook salmon, PWI - mountain whitefish, SGA - rainbow trout, AAL - chiselmouth, CCA - common carp, MCA - peamouth, POR - northern squawfish, RBA - redside shiner, CCO - bridgelip sucker, INE - brown bullhead, IPU - channel catfish, NGY - tadpole madtom, LGI - pumkinseed sunfish, LMA - bluegill sunfish, MDO - smallmouth bass, PAN - white crappie, PNI - black crappie, PFL - yellow perch.

Gear Type	River Mile	Total Spring Effort	Total Numbers by Species																				
			ATR	ONE	OTS	PWI	SGA	AAL	CCA	MCA	POR	RBA	CCO	CMA	INE	IPU	NGY	LGI	LMA	MDO	PAN	PNI	PFL	Totals
BT	120	15	0	0	11	8	6	0	0	0	0	0	0	18	0	0	0	0	0	6	0	0	1	50
	127	16	0	0	35	12	0	3	6	2	19	0	4	241	5	0	0	66	105	4	40	0	14	556
	111	17	0	2	2	5	0	2	6	0	6	0	33	2401	1	1	1	0	9	5	19	1	0	2494
Total		48	0	2	48	25	6	5	12	2	25	0	37	2660	6	1	1	66	114	15	59	1	15	3100
ST	120	7	0	0	6	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54
	127	5	0	0	14	0	163	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	180
	111	6	0	0	7	0	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86
Total		18	0	0	27	0	290	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	320
GN	120	306.2	3	0	10	0	44	1	11	1	20	2	4	59	1	7	0	0	0	9	5	0	5	182
	127	247.0	3	1	6	0	17	9	32	3	34	4	6	188	9	4	0	8	0	10	16	0	38	388
	111	310.4	0	0	2	0	52	0	20	0	10	0	0	17	0	2	0	0	0	4	3	0	0	110
Total		863.6	6	1	18	0	113	10	63	4	64	6	10	264	10	13	0	8	0	23	24	0	43	680
	Grand Total		6	3	93	25	409	15	75	6	89	6	48	2924	16	14	1	74	114	38	85	1	58	4100

Table 2. Abundance of chironomid and oligochaetes from dredge samples in Lower Granite Reservoir during July, 1988. Mean (n=12) biomass estimates and variances are shown based on a per m^2 area. During 1988 abundance estimates were made using a Shipek dredge whereas in 1987 a Ponar dredge was used.

River Mile	Year	Chironomids Mean Biomass	Chironomids S2	Oligochaetes Mean Biomass	Oligochaetes S2	Total Biomass
111	1987	2.1	3.18	2.64	0.78	4.83
111	1988	2.24	0.43	8.16	24.32	10.40
120	1987	3.03	17.50	4.34	12.13	7.37
120	1988	1.10	1.67	0.17	0.03	1.27
127	1987	3.63	6.40	2.86	3.63	6.49
127	1988	4.76	4.99	3.10	4.80	7.86

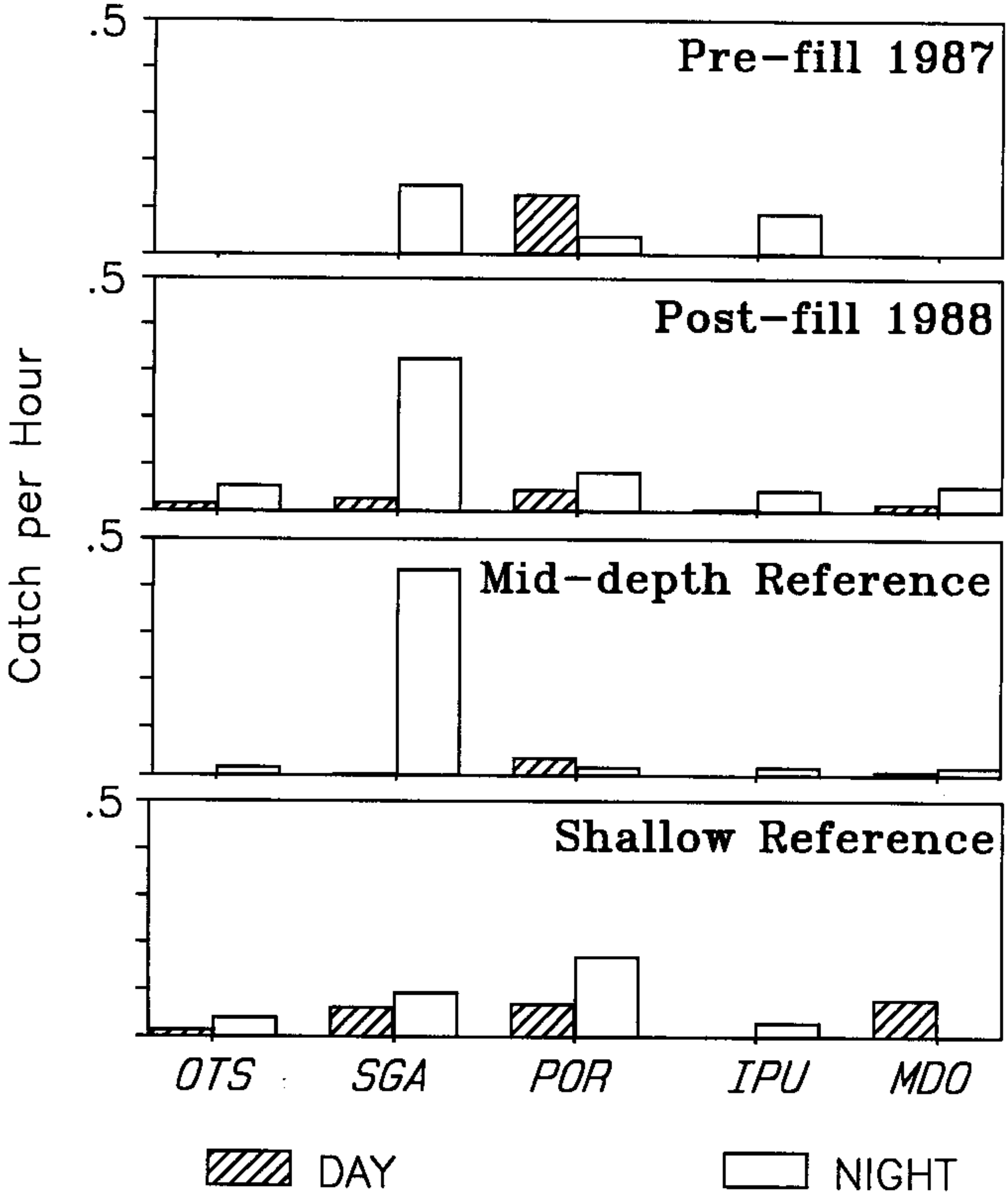

Figure 1. Catch per hour for mono and multifilament gill nets from Lower Granite Reservoir , Washington. Species codes are: OTS-chinook salmon; SGA-steelhead trout; POR-northern squawfish; IPU- channel catfish; and, MDO-smallmouth bass.

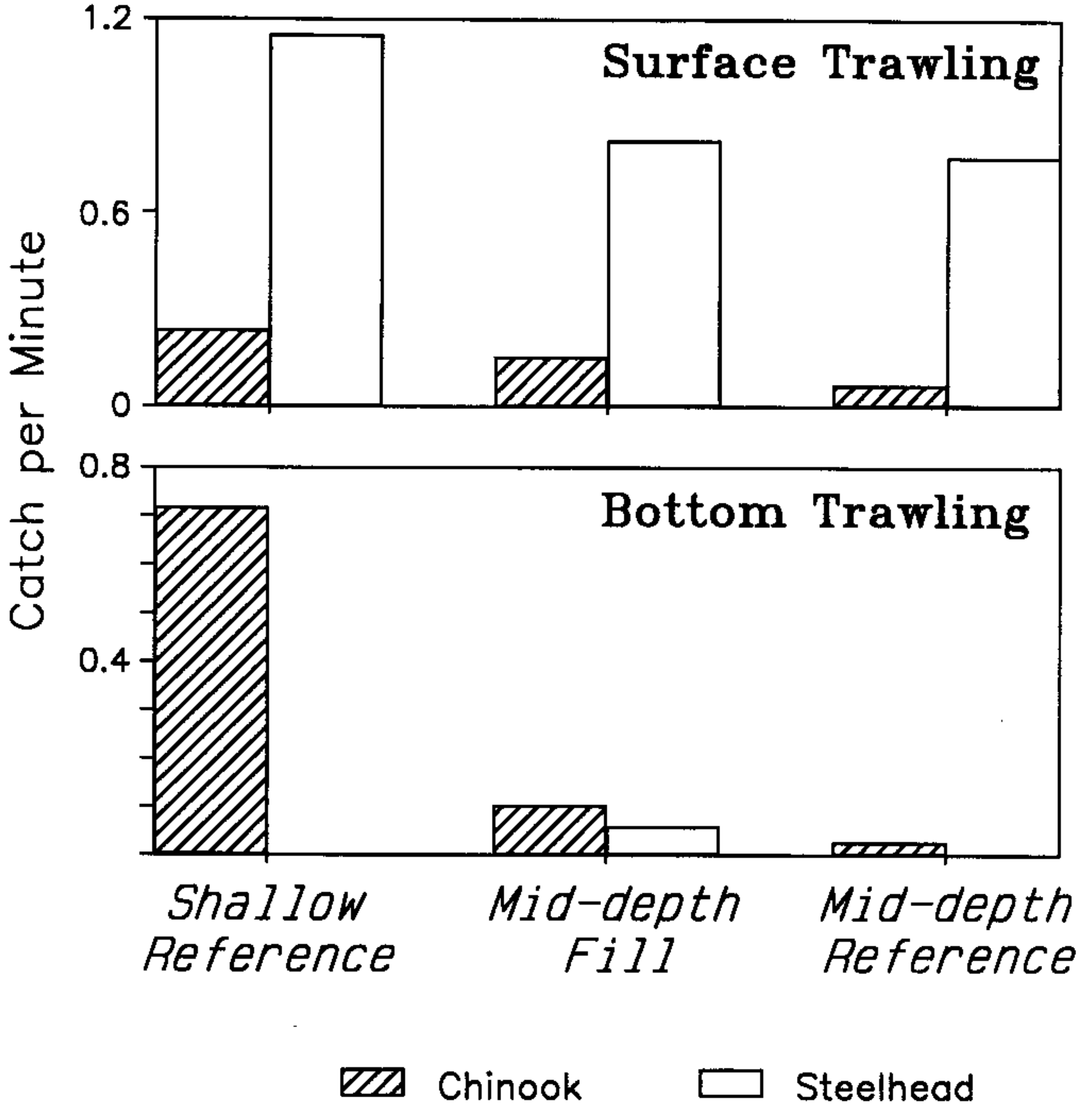

Figure 2. Catch per minute for chinook salmon and steelhead trout by surface and bottom trawling in Lower Granite Reservoir, Washington.