FHR CURRENTS...

R-5's FISH HABITAT RELATIONSHIP TECHNICAL BULLETIN

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FHR CURRENTS... Purpose

The Fish Habitat Relationship (FHR) Program of R-5 USFS has been established to research and develop information on fish ecology and to coordinate effective applications of this knowledge in managing and protecting our fisheries. By relating life stage requirements of specific species to physical habitat parameters, we are aiming at our main objective: developing a methodology to manage fisheries through the management of habitat.

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Seasonal Utilization of Instream Boulder Structures by Anadromous Salmonids in Hurdygurdy Creek, California

This study examined the seasonal responses of juvenile salmonids to the placement of instream boulder structures. Instream boulder structures have been used extensively in efforts to increase the amount of suitable rearing habitat for juvenile salmonids when this habitat may be limiting.

Instream structures alter channel hydraulics and can influence important habitat components such as water velocity and depth, amount of cover, and distribution of stream substrate. The goal of these habitat manipulations has been to increase fish productions. However, specific habitat requirements of juvenile salmonids vary with size, species, and season and have not been thoroughly studied or defined (Reiser and Bjornn 1979).

Although much effort has been focused on placing boulder structures into streams, few efforts have been made to evaluate their effectiveness. Past efforts have employed electrofishing techniques at summer low-flow conditions to quantify fish abundance. Ward and Slaney (1981), Overton et al. (1981), Moreau (1984), West (1984), House and Boehne (1985) and Brock (1986) have reported substantial increases in fish abundance in stream sections modified by instream structures compared to either pre-project data or control reaches.

In this study, the distribution and abundance of salmonids in these two stream sections were compared to two control reaches during winter, spring, summer and fall using direct underwater observation techniques. Habitat improvement structures were placed into two sections of Hurdygurdy Creek in 1981 by Six Rivers National Forest. Boulder wing deflectors and boulder clusters

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were used to modify wide, shallow homogeneous stream sections into narrower, deeper more complex habitat favorable for rearing age 1+ and age 2+ steelhead parr.

Study Site

Hurdygurdy Creek is a third order tributary to the South Fork Smith River in Del Norte County, California, that drains a 78 sq. km watershed composed of mountainous Douglas Fir forest. Mean annual rainfall is approximately 250 cm and stream discharge ranges from 0.5 cubic meters per second (cms) to peaks of 140 cms. Mean daily stream temperature ranges from 5.0 degrees C to 21.0 degrees C (U.S. Forest Service 1979).

The stream supports populations of steelhead trout (*Oncorhynchus mykiss*), chinook salmon (*O. tshawytscha*), and cutthroat trout (*O. clarki*). All habitat improvements have been located on the lower 7 km of the stream which has a mean gradient of 1.7%.

Two reaches modified by boulder structures were 50 m and 31 m long. Structures were placed into these sections beginning in 1981. Both reaches contained a series of wing deflectors and boulder clusters. Prior to boulder placement both reaches were described as broad, shallow, low gradient riffles (Moreau 1984). At the time of this study both reaches were classified as pocket water and run with edgewater and backwater habitat types located on the margins (McCain et al. 1990).

Two unmodified control sections were 28 m and 40 m long. Both sections were classified as a combination of low gradient riffle and run.

Methods

Data were collected during five sampling periods in January, March, May, August and October 1987. Two reaches modified by boulder structures and two control reaches were studied. Control reaches were randomly selected from a stream habitat type inventory (Decker et al. in progress).

Planar maps of the active channel were constructed incorporating major channel features for each sampling period. Cross-sectional velocity and depth measurements were taken for each sampling period and plotted onto map overlays.

Distrubution and abundance of fish were determined by direct underwater observation using techniques modified from Hankin and Reeves (1988). Paired divers observed and recorded fish species, location, total length, and behavior (feeding, holding, or cruising) onto underwater slate maps as they moved slowly upstream. The locations of each fish or group of fishes were plotted onto map overlays for each sampling period. A compensating polar planimeter was used to determine wetted surface areas from maps. Fish numbers were tabulated and fish densities were calculated. Comparing fish densities allows for direct comparison of fish abundance in unequal-sized study sections.

Results and Discusion

Physical Stream Conditions

The highest stream discharge, swiftest water velocities, and greatest surface area volume occured during the March sampling period following a storm event. Streamflow steadily decreased through May and August and was lowest in October. This was an exceptionally dry year producing notably low streamflows all along the Pacific coast. Water temperatures were: 6.0 degrees C. in January, 10.0 degrees C. in March, 17.0 degrees C. in May, 19.0 degrees C. in August, and 13.5 degrees C. in October.

Treated sections contained well defined, deep thalwegs. Relatively large areas of low water velocity (edgewater and backwater habitat types) were found along the margins along the downstream edge of wing deflectors during all sampling periods.

Control sections contained no defined thalwegs. During the January and March sampling pe-

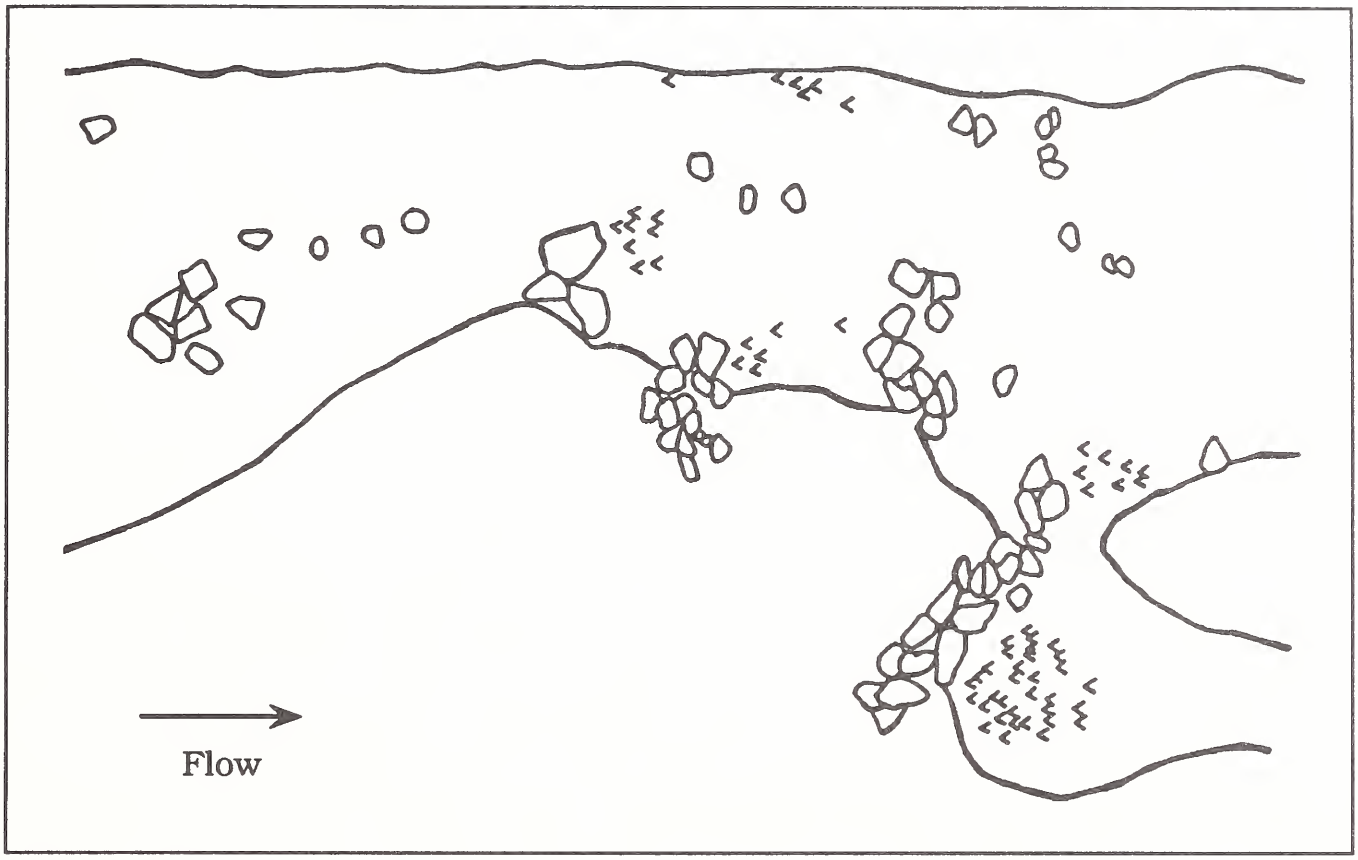

Figure 1. *Distribution of juvenile chinook salmon (<) in a treated reach in Hurdygurdy Creek, Ca. in May 1987.*

riods the control sections contained very little low velocity area which was limited to narrow strips less than a meter wide along the stream-bank.

Chinook Salmon

Although these stream improvement structures were originally placed into the stream to increase suitable rearing habitat for juvenile steelhead, juvenile chinook salmon were found to utilize the slow water velocity margin habitat created by the structures. Chinook salmon began emerging from the streambed during March and were observed most abundantly in the shallow edgewater and backwater habitat found along wing deflectors. Everest and Chapman (1972) and McCain (1989) have described this type of habitat to be highly selected by newly emerged chinook salmon. Chinook salmon were observed in these areas usually in groups of 20 or more individuals (Figure 1). Chinook salmon were five times as abundant in the treated reaches than in control reaches during the March and May sampling periods (Figure 2) and were observed in very low frequency after May. Areas of low water velocity were limited in the control reaches during March and May providing little suitable habitat for chinook rearing during that time. Chinook salmon were observed only in a narrow strip of area along the stream margin in control sections.

Steelhead

Young-of the-year (age 0+) steelhead began emerging from the streambed in May and were observed in the study sections through October. Relative abundance of age 0+ steelhead in both treated and control sections were similar.

Steelhead parr (age 1+ and age 2+) were the target age class for these habitat improvement

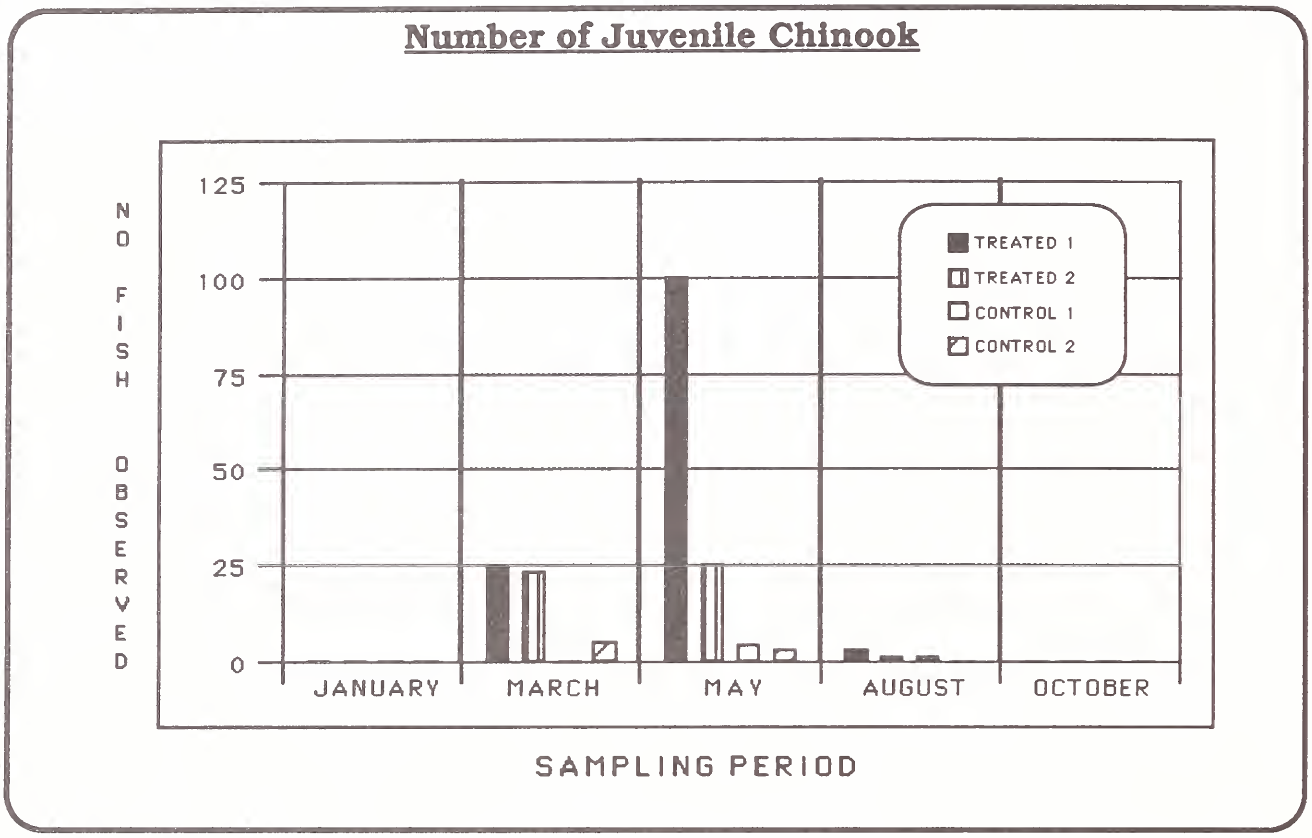

Figure 2. *Number of juvenile chinook salmon in two treated and two control reaches in Hurdygurdy Creek during five sampling periods in 1987.*

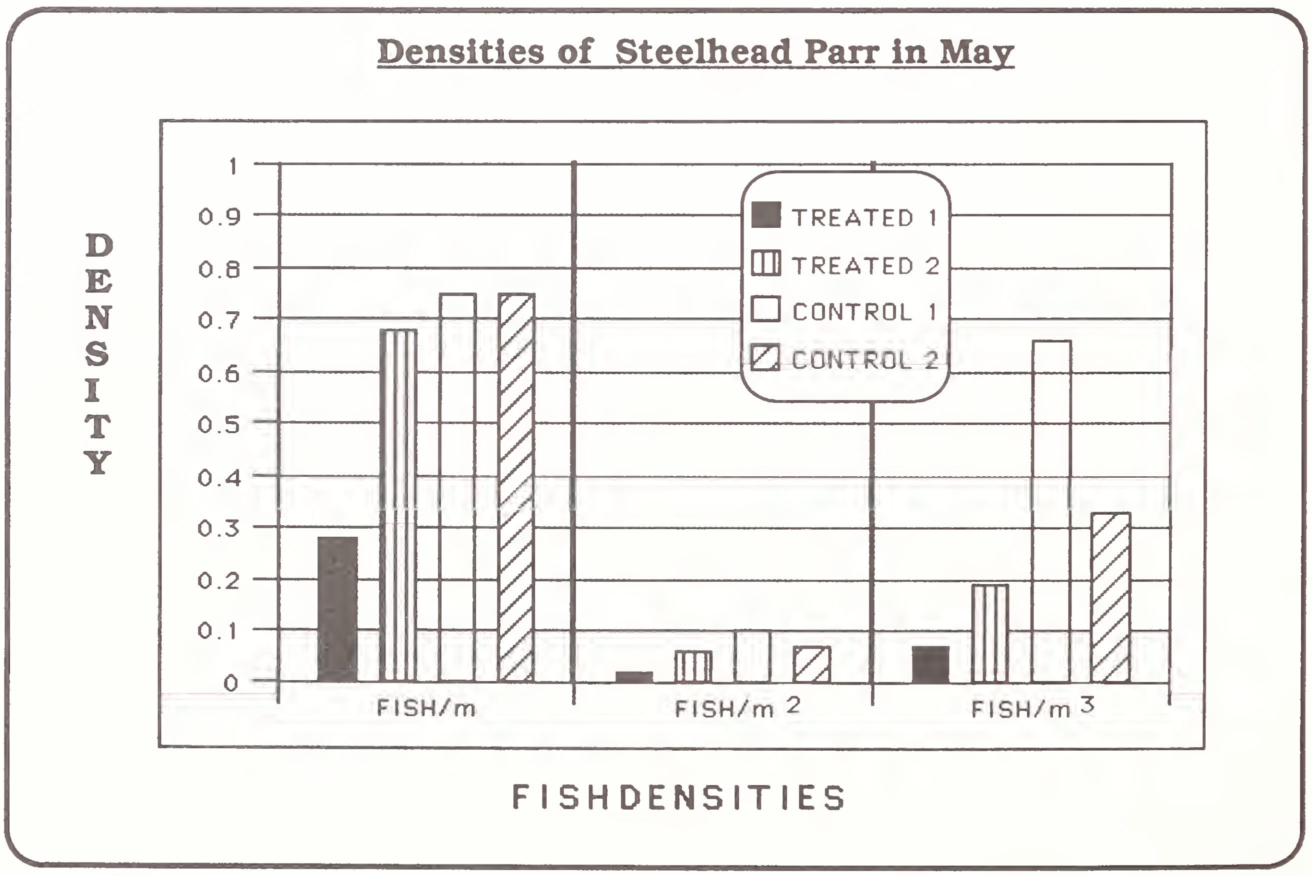

Figure 3. *Densities of steelhead parr in two treated and two control reaches in Hurdygurdy Creek in May 1987.*

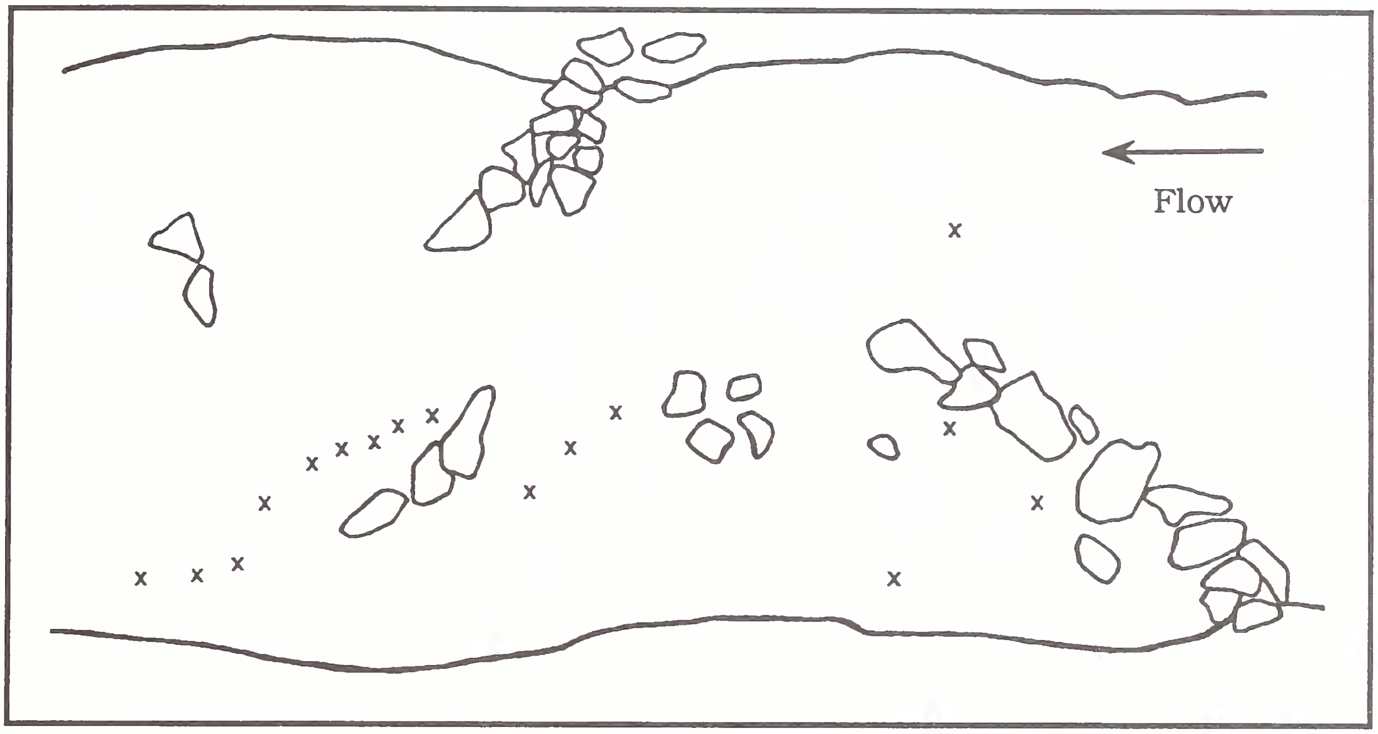

Figure 4. *Distribution of steelhead parr (X) in a treated reach in Hurdyurdy Creek during May 1987.*

structures and were observed during all sampling periods. Very few steelhead parr were observed during January and March when water temperatures were low and streamflows were relatively high. Juvenile steelhead occupy interstitial spaces in the streambed under winter conditions and thus are generally not observable by divers. All of the steelhead observed during January and March were in close association with boulder structures or large boulders. During the May sampling period steelhead parr were found in greater abundance and higher density (fish per meter, fish per square meter, and fish per cubic meter) in control reaches (Figure 3).

Streamflows in May were moderately high, so the control sections were much deeper than during summer low-flow conditions and steelhead parr were observed throughout the control sections generally associated with large boulders. Steelhead parr observed in the treated sections during May were found only near wing deflectors and boulder clusters and absent from the thalweg zones (Figure 4). Wing deflectors focus the streamflow into the thalweg, resulting in deeper, swifter habitat. Thalweg zone water velocities during the May sampling period were too great (in some areas in excess of 2.0 m/s) to be usable habitat for steelhead parr.

During the August sampling period steelhead parr were twice as numerous in the treated sections as in control sections. This is in agreement with previous studies of juvenile steelhead utilization of stream habitat improvement structures during summer low-flow conditions. Ward and Slaney (1981) examined the effectiveness of various boulder structures in the Keogh River in British Columbia. They found a favorable comparison of steelhead parr and juvenile coho salmon (O. kisutch) densities between treated reaches and reaches identified as prime rearing habitat. Overton et al. (1981) found a 100% increase in numbers of juvenile steelhead rearing in a boulder enhanced reach compared to an adjacent unenhanced reach in Aikens Creek, California, one year after boulder placement. Boulder structures placed in the South Fork of the Salmon River, California, resulted in a ten-fold increase in numbers of yearling steelhead trout per 100 linear feet two years after placement (West 1984). House and Boehne (1985) evaluated instream gabions and boulder clusters placed into East Fork Lobster Creek, Oregon, and found substantial increases in

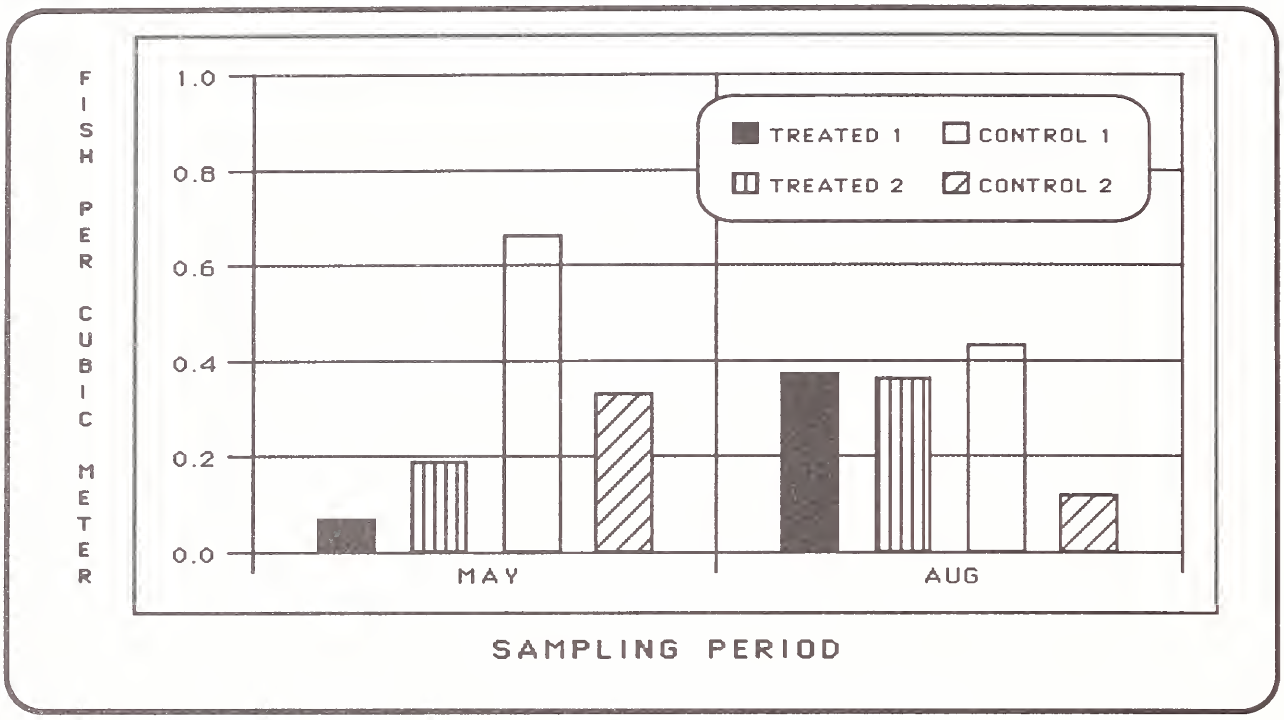

Figure 5. *Number of steelhead parr per cubic meter observed in two treated and two control reaches in Hurdygurdy Creek, CA in May and August 1987.*

the number of rearing coho salmon and steelhead trout. Brock (1986) compared pre and post treatment numbers and biomass of 0+ and 1+ steelhead trout in an enhanced vs. an unenhanced reach in Red Cap Creek, California. Brock found a 300% increase in numbers and a 146% increase in relative biomass of yearling steelhead trout, as well as increased numbers and biomass of sub-yearling steelhead trout in the enhanced reach, while the control reach showed a slight decrease in the number of yearling steelhead trout and an 89% increase in the biomass of sub-yearling steelhead trout.

Habitat improvement structures acted to increase the depth and volume. Unfortunately, exact pre-project volumes were not available for this study. Brock (1986), House and Boehne (1985), and Ward and Slaney (1981) all reported an increase in water volume after placement of boulder structures. Although steelhead parr were twice as numerous in treated sections during August, fish per cubic meter densities were nearly equal with control reaches (Figure 5). This suggests that greater water depth and volume were important parameters in increasing steelhead utilization of treated reaches.

Relatively few steelhead were observed in the study sections during October. Low streamflows during this time resulted in fish remaining in the stream to occupy pool habitat.

Summary

Sampling on a seasonal basis provided an examination of temporal shifts in fish utilization of habitat improvement structures, as well as the hydraulic response of treated reaches, as stream discharge fluctuated.

Results show that newly emerged juvenile chinook salmon utilize the low velocity habitat area created by wing deflectors during the spring (March-May) when such habitat is possibly limited. Steelhead parr use the deeper thalweg zones created by the deflectors in late summer and early fall.

Direct underwater observation was effective throughout the year in Hurdygurdy Creek because of good water clarity. Direct underwater observation allowed the distribution of fish to be documented within each reach, providing information on usage of boulder structures by fish.

Acknowledgements

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Anyone wishing to submit a paper for publication in the FHR CURRENTS, call Kerry Overton or Stephanie Gomes (707) 442-1721 or write to Six Rivers National Forest, Fisheries, 500 5th Street, Eureka, CA 95501 for guidelines and/or information.

Literature Cited

Brock, W.A. 1986. Enhancement of rearing habitat for juvenile steelhead trout (*Salmo gairdneri*) by boulder placement in a tributary to the Klamath River. M. S. Thesis. Humboldt State University, Arcata, California.

Decker, L.M., D.D. Fuller, and M.E. McCain (in progress). Seasonal habitat utilization by anadromous salmonids in Hurdygurdy Creek, California. Pacific Southwest Forest and Range Experiment Station, Arcata, California.

Everest, F.H. and D.W. Chapman 1972. Habitat selection and spatial interaction by juvenile chinook salmon and steelhead trout in two Idaho streams. Journal of the Fisheries Research Board of Canada 29(1) : 91-100.

Hankin, D.G. and G.H. Reeves 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834-844.

House, R.A. and P.L. Boehne 1985. Evaluation of instream enhancement structures for salmonid spawning and rearing in a coastal Oregon stream. North American Journal of Fisheries Management 5(2B) : 283-295.

McCain, M.E., D.D. Fuller, L.M. Decker, and C.K. Overton 1990. Stream habitat classification and inventory procedures for northern California. *FHR Currents* Number One, U.S. Forest Service Region 5 Fish-Habitat Relationships program publication.

McCain, M.E. 1989. Natal stream rearing habitat of juvenile chinook salmon in Hurdygurdy Creek, California. in Proceedings of the 1988 Northeast Pacific Chinook and Coho Workshoop, October 2-4, Nendels Inn, Bellingham, Washington.

Moreau, J.K. 1984. Anadromous salmonid enhancement by boulder placement in Hurdygurdy Creek, California. pp. 97-116 in T. Hassler (ed.), Proceedings: Pacific Northwest Stream Habitat Management Workshop, October 10-12, 1984. Humboldt State University, Arcata, California.

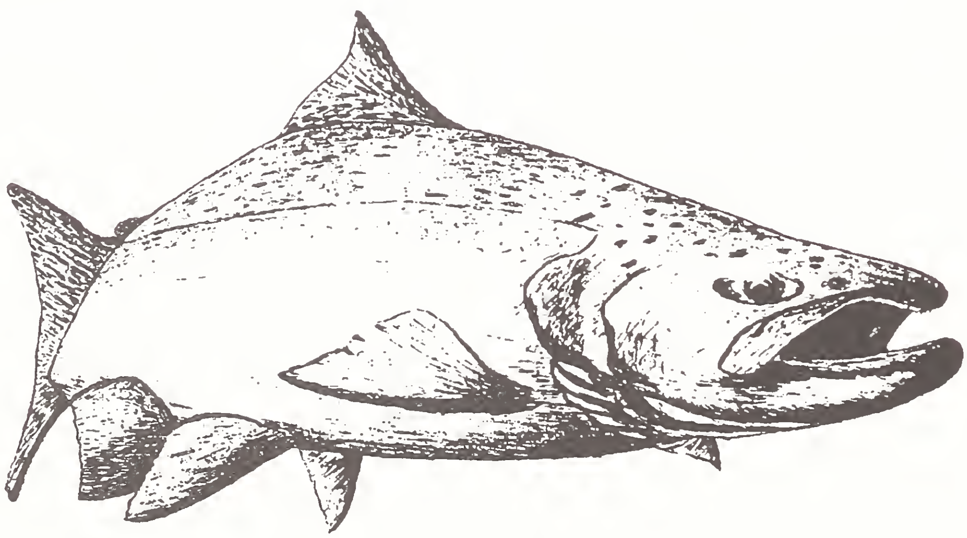
Overton, K., W. Brock, J.Moreau, and J. Boberg 1981. Restoration and enhancement program of anadromous fish habitat and populations on Six Rivers National Forest. T. Hassler (ed.), Proceedings: Propagation, Enhancement, and Rehabilitation of Anadromous Salmonid Populations and Habitat Symposium, October 15-17, 1981. Humboldt State University, Arcata, California.

Reiser, D.D. and T.C. Bjornn 1979. Habitat requirements of anadromous salmonids. General Technical Report PNW-96, USDA Forest Service, Portland, Oregon.

U.S. Forest Service 1979. Water resource inventory for USDA Forest Service, Six Rivers National Forest, Eureka, California. Prepared by Ott Water Engineers, Redding, California, under contract number 53-9A47-9-28.

West, J.R. 1984. Enhancement of salmon and steelhead spawning and rearing conditions in the Scott and Salmon Rivers, California. pp. 117-127 in T. Hassler (ed.), Proceedings: Pacific Northwest Stream Habitat management Workshop, October 10-12, 1984. Humboldt State University, Arcata, California.

Ward, Br. and Slaney, P.A. 1981. Further evaluations of structures for the improvement of salmonid rearing habitat in coastal streams of British Columbia. In T. Hassler (ed.) Proceedings: Propagation, Enhancement and Rehabilitation of Anadromous Salmonid Populations and Habitat Symposium. October 15-17, 1981 Humboldt State University, Arcata, CA 168 pp.



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