PROJECT PROGRESS REPORT

State : California Project No.: AFS-16-2
Project Type: Research - Anadromous Fish
Project Title: Coastal Steelhead Study
Period Covered: July 1, 1973 to June 30, 1974
Project Objective: Evaluation and development of methods to meet coastal steelhead angling demands.

Job Reports

Job Title: Evaluation of Stocking Artificially Reared Steelhead Smolts in Coastal Rivers.
Job No.: 1 of 3
Job Objectives: 1) To determine river sport catch and escapement of artificially reared winter-run steelhead released in the Gualala, Garcia and Mad Rivers;
2) To determine costs of artificially producing a sport caught, adult winter-run steelhead.

Report:

Marking. Mad River Hatchery is the only source of steelhead available for planting in coastal rivers. A furunculosis outbreak forced clearance and treatment of the facility in November; no yearling steelhead were raised at Mad River Salmon and Steelhead Hatchery during this period. To insure continuation of this job, 50,000 fingerlings were received from the hatchery in November and were reared by this Project (with Region 1 feed) to yearlings. Rearing occurred in a section of the pond proper being used in the Project's cage rearing experiment (see following Job Report No. 3 for rearing results).

A total of 8,532 of the yearlings raised were marked RV and planted in the Gualala River at Valley Crossing, the confluence of the North Fork Gualala and the confluence of Pepperwood Creek between April 17 and May 16. Most were released April 23 and 24, 16.9 km (10.5 mi.) upstream from the mouth at Valley Crossing. They averaged 20.7/kg (9.4/lb) at time of planting. All 7,102 yearling steelhead raised in this Project's cage rearing experiment were marked LV and were planted in the Gualala River along with the RV fish These fish also averaged 20.7/kg (9.4/lb).

Region 1 raised 50,000 yearling steelhead in a private rearing pond this season. Assisted by student volunteers from Humboldt State University, 20,391 (40.8%) of these fish were marked Ad on March 30 and 31 and were released on the same days in Mad River at Mad River Hatchery. These fish averaged 37.5/kg (17/lb). A random sample of 90 fish showed 11% were equal to or greater than 160 mm (6.3 inches.) FL. Individual fish ranged from 91 to 174 mm (3.6 to 6.9 inches).

Downstream Migrant Sampling. Sampling for residualizing hatchery steelhead (marked RP) released in the Gualala River in spring, 1973, continued from July through September. During July and August a 2.4 x 4.6 m (8 x 15 ft), 1.3 cm (½ inch) bar measure riffle net and live trap were fished Monday through Thursday nights, 30 nights total. The trap was located 5.6 km (3½ mi.) upstream from the mouth immediately below the confluence of the North Fork Gualala River. No hatchery steelhead and a total of 120 wild steelhead were captured.

During August and September a 45.7 x 2.4 m (150 x 8 ft), 1.3 cm (½ inch) bar-mesh beach seine was used five days to sample the Gualala between the mouth and about 3.2 km (2 mi.) upstream from the mouth (Thompson or Park Hole). No hatchery steelhead and 805 wild steelhead were captured.

On April 17 three riffle nets, with live traps attached at the cod ends, were placed in Gualala River about 200 m (219 yd) downstream from the confluence of the North Fork (Switchville) to measure the rate and success of emigration of the cage- and pond-reared steelhead that were subsequently released April 23 and 24 at Valley Crossing. This site was approximately 11.5 km (7.1 mi.) downstream from Valley Crossing and 5.4 km (3.4 mi.) upstream from the mouth.

The three nets were set side-by-side, stretching from the north bank to about mid-stream. The river narrowed at this point to form a 16 m (17½ yd) wide riffle. The near shore and mid-stream nets measured 0.9 x 1.5 m (3 x 5 ft) at the mouth ("small nets"); the middle net measured 2.4 x 4.6 m (8 x 15 ft) at the mouth ("large net"). Net meshes near the live traps were 1.3 cm (½ inch) bar measure. The nets appeared to sample about 40% of the flow.

The netting site used last year (located at the confluence of the North Fork) to measure the emigration of the spring 1973 release was not used this year as originally planned. The Gualala had widened considerably at this point, and the North Fork had split into two channels at the mouth causing the Gualala to eddy and flow in different directions.

Net site selection actually began April 1 but high river flows precluded net installation until flows dropped to below about 20 m^3/sec (707 cfs). At this flow it was feasible to wade out about 1/3 of the way across lower river riffles to check live traps. An outboard powered boat was necessary to cross the river until flows dropped to below about 15 m^3/sec (530 cfs).

No U.S. Geological Survey stream gauge has been in operation on Gualala River since Water Year 1972. This years' Gualala flows were estimated based on the relationship established last year between Water Year 1972 Garcia River and Gualala River (South Fork near Valley Crossing) flows, and preliminary Water Year 1974 Garcia River flows. The now inoperative South Fork Gualala Station measured an estimated 54% of the Gualala River runoff. From April 1 to April 16, the Gualala River below the confluence of the North Fork dropped from about 700 to 21 m^3/sec (24,735 to 742 cfs) Table 1). On April 17 flows dropped to about 20 m^3/sec (707 cfs) and net installation was feasible.

Table 1

Daily Catch Record. Downstream Trapping, Gualala River, April-May, 1974

Date *1	Wild steelhead	Planted steelhead	Silver salmon	Cottids	Roach	Adult lamprey	Stickleback	Surface water temp.(C)*2	River flow sampled (m^3/sec)*3
Switchville									
Apr 18	6	4 *4	2	1	0	1	0	-	19.5
19	5	0	2	13	5	3	0	-	18.2
20	1	0	0	11	12	2	13	15.6	16.7
21	1	0	2	10	49	15	14	15.0	14.7
22	12	0	3	25	79	5	16	15.0	13.5
Pepperwood Creek									
23	8	0	0	2	1	6	1	15.0	8.7
24	4	6	7	66	10	8	2	14.4	8.1
25	4	0	3	23	4	6	1	13.9	7.8
26	3	1	2	20	0	7	1	13.9	7.5
27	-	_	-	—	-	-	-	13.9	8.9
28	-	-	-	_	-	—	-	14.4	7.1
29	0	0	0	0	0	6	2	15.6	6.6
30	1	5 *4	4	148	114	16	2	16.1	6.1
May 1	0	0	0	62	42	18	2	16.1	5.6
2	0	0	0	0	0	1	1	15.6	5.4
3	2	0	0	5	1	2	0	15.6	5.1
4	-	-	-	_	-	-	—	15.6	4.8
5	-	-	-	-	-	-	-	16.1	4.7
6	-	-	-	-	-	-	-	16.1	4.4
7	0	0	0	0	0	0	1	16.7	4.3
8	5	0	0	37	20	9	0	17.2	4.1
9	0	0	0	13	5	3	0	17.2	4.0
10	1	0	0	11	0	5	0	17.2	3.9
11	1	0	0	19	11	6	0	17.2	3.6
12	0	0	0	10	8	0	1	17.2	3.5
13	0	0	0	21	7	2	0	16.7	3.4
14	1	0	2	14	10	2	1	16.7	3.3
15	0	0	0	7	2	0	0	17.2	3.1
16	0	0	0	6	8	0	0	17.2	3.1
17	0	0	0	11	22	3	0	17.2	3.0
18	4	0	0	11	21	1	0	17.2	3.0
19	1	0	0	24	18	2	0	17.2	3.0
20	-	-	-	-	-	—	-	17.8	2.8
21	5	0	0	7	38	2	0	17.8	2.8
22	6	0	0	10	43	1	0	18.3	2.7
23	9	0	0	13	21	0	0	18.9	2.6
24	2	0	0	20	10	0	0	18.9	2.6
25	1	0	0	10	19	0	0	-	2.5
26	-	-	-	-	-	-	—	-	2.4
27	0	0	0	37	5	2	0	-	2.3
28	1	0	0	17	24	0	0	-	2.2
29	1	0	0	6	15	0	0	-	2.2
30			- - - - - net removed - - - - -						2.2
31									2.1
TOTALS	85	16	27	690	624	134	58		

*1 Morning trap(s) checked
*2 A.M. reading
*3 (sic)
*4 (sic)

At 1300 hours April 17, 2,007 marked (upper caudal nip plus LV or RV) steelhead were released 200 m (219 yd) upstream from the nets. Soon after their release, small schools of these fish were observed immediately above the nets. They were successful in avoiding the nets, however, as only four (0.19%) were captured in 5 nights and 4 days of continuous sampling (Table 1).

On April 22, the netting site was moved about 400 m (437 yd) upstream from the confluence of the North Fork to a section of the Gualala which formed two channels (near Pepperwood Creek). Approximately 70% of the entire Gualala River flowed past this point. The western channel was screened at the upstream end using 1.9 cm (3/4 inch) aviary wire and metal fence stakes to divert emigrating fish into the eastern channel. The large riffle net was installed near the downstream end of the eastern channel where it narrowed to about 8 m (8.7 yd) and formed a riffle. Approximately 70% of the Gualala flowed through the eastern channel. The net appeared to sample approximately 60% of the eastern channel flow. This netting site was about 10.9 km (6.8 mi) downstream from Valley Crossing and about 6.0 km (3.7 mi) upstream from the mouth.

Plans were to hold the pond- and cage-reared steelhead to be released into the Gualala until May 1. Rapidly rising water temperatures and increasing mortalities in the holding cages forced their release on April 23 and 24. Holding area surface water temperatures went from 10.6 C (51 F) on April 3 to 13.3 C (56 F) on April 23. On April 30 the temperature was 15.6 C (60 F). Morning river surface temperatures had reached 15.6 C (60 F) by April 20.

A total of 7 (0.05%) of the 12,766 LV and RV steelhead planted at Valley Crossing on April 23 and 24 were captured at Pepperwood Creek in 4 continuous nights and days of sampling; 6 were recovered the morning of the 24th and 1 two mornings later (Table 1).

A test release of 218 marked (lower caudal nip plus LV or RV) steelhead was made the morning of April 29 approximately 40 m (44 yd) above the Pepperwood Creek net. The next morning, 5 (2.29%) of these fish were recovered but all were extremely weak and not representative of healthy fish. Additional steelhead were not available for further net efficiency testing. Almost continuous netting through May revealed no more planted steelhead and very few (40) wild steelhead. The net was removed May 29.

Creel Censuses. Creel censuses were conducted on the Gualala, Garcia and Mad Rivers during the 1973-74 adult steelhead runs. This completed the second consecutive season of censusing the Gualala and Garcia River fisheries, and marked the first year of anticipated returns (grilse only) to the Gualala and Mad Rivers of Project fin-clipped hatchery-origin steelhead. Specific marking and planting data were given last year.

Mad River was sampled from September 15 through February 28; the Gualala and Garcia fisheries were sampled from November 1 through February 28. The time periods sampled effectively covered the respective steelhead fisheries

with the exception of the March Mad River steelhead fishery. Sampling on the Mad was discontinued after February due to high automobile fuel prices. The Gualala and Garcia Rivers were legally closed to angling after February 28. Synopses of the respective censuses as they relate to steelhead follow. Creel census data for all species encountered are given in Table 2.

Mad River: Total angler effort for salmon and steelhead combined was an estimated 30,990 angler hours; 28,392 (91.6%) by shore anglers and 2,598 (8.4%) by boat anglers. Humboldt County residence dominated the fishery, comprising 97% of all anglers canvased. The steelhead (rainbow trout ?33 cm (13 inches) FL) catch was an estimated 788 fish, and the steelhead catch per angler-hour was 0.025 fish. An estimated 1.3% of the steelhead landed were released (10 fish). None of the 60,761 LP (30,484 at 22.0/kg) and RP (30,277 at 41.9/kg) marked Mad River Hatchery steelhead released last spring into Mad River were observed or reported in the fishery. Five LP fish entered Mad River Hatchery. Two were too large (67 and 68 cm FL) to have been in the ocean only one summer. The three valid recoveries were 39 (2) and 41 cm FL.

Effort and salmonid catch-per-unit-of-effort were found to decrease with increasing turbidity, particularly when turbidity rose above 30 JTU (measured on a Hach 2100A turbidimeter).

Compared to the only previous Mad River salmon and steelhead censuses conducted during the 1956-57 and 1957-58 runs, indications are Mad River fishing effort has increased by over 350% over the past 16 seasons, while salmon and steelhead catch has not increased at all. In the earlier years, the majority (80%) of steelhead were caught during the period November through February; essentially all (96.7%) were caught this season during September and October.

Exceptionally high river turbidity was the probable cause for the relatively low 1973-74 winter steelhead catch. Based on Mad River turbidity data available since 1957, the Mad River winter turbidity situation has apparently worsened since the December 1964 flood.

Gualala River: Salmon and steelhead angler effort was an estimated 13,218 angler-hours (3,048 angler-days). Sonoma and Mendocino County residents comprised 64% of all anglers contacted; the balance were from San Francisco Bay Area Counties and Sacramento.

The steelhead catch was an estimated 1,700 fish and the steelhead catch-per-angler-hour was 0.129 fish. An estimated 36.2% of the steelhead landed were released, usually because the fish was spent or was small. Thirty-seven RP marked steelhead of the spring 1973 release were estimated caught by anglers, and 19 (51%) were estimated released. Conversations with local anglers revealed anglers had released RP marked steelhead because of their relatively small size. Five creel checked marked fish ranged in size from

Table 2

Creel Census Summary; 1973-74 Adult Steelhead Fisheries; Mad, Gualala and Garcia Rivers

Parameter estimated	Item	Steelhead fishery		
		Mad River	Gualala River	Garcia River
Effort:	Angler-hours	30,990	13,218	3,600
	Angler-days	(not determined)	3,048	1,063
	Average Angler-day (hours)	2.71 *1	4.34	3.39
Catch:	Steelhead *2	788(1.3) *4	1,700 *5 (36.2)	216(6.5)
	King salmon	915(0.0)	0	0
	Silver salmon	0	52(0.0)	0
	Trout *3	5,931(82.2)	380(100.0)	162(42.6)
	Cottids	48(100.0)	83(100.0)	0
	Suckers	81(100.0)	0	160(14.4)
	Flounders	0	13(100.0)	41(56.1)
Success:	Steelhead catch-per-angler-hour	0.025	0.129	0.060

*1 Average shore angler day: average boat angler day not determined.
*2 Rainbow trout ? 33cm (13 inches) FL.
*3 Salmonids <33 cm (13 inches) FL.
*4 Percent estimated released in parentheses.
*5 Includes 37 RP marked. 1972 brood Mad River Hatchery origin steelhead.

34 to 46 cm FL and averaged 38.2 cm. Scales analysis revealed all five fish had spent one summer in the ocean. The RP release totaled 20,405 fish and averaged 15.2/kg (6.9/lb).

Turbidity and high river flows did not appear to be the problems they were last year. Substantial numbers of steelhead were taken every month steelhead were available and the season was open (November through February). Total effort was about the same as last year, but catch was up considerably (590%).

The average length of all sport caught steelhead sampled (n = 84) was 60.0 FL; and ranged from 34 to 88 cm. A 60 cm fish last year weighed about 2.27 kg (5 lb), round weight.

Garcia River: Angler effort for steelhead and salmon was an estimated 3,600 angler-hours (1,063 angler days). Sonoma and Mendocino County residents comprised 74.2% of all anglers contacted. An estimated 216 steelhead were landed, and the steelhead catch-per-angler-hour was 0.06 fish. Approximately six percent (14 fish) of the steelhead landed were estimated released.

No marked hatchery steelhead have been released by this Project into the Garcia River and no marked strays from any other streams were observed this year. Stream fishing conditions appeared much improved this year over last, but effort and catch remained about the same. Garcia River steelhead sampled averaged 63.4 cm FL and ranged from 34 to 85 cm. Last year a 63.4 cm Garcia steelhead weighed about 2.6 kg (5.8 lb), round weight.

Adult tagging. Three capture methods were tried this period for adult Gualala River steelhead: beach seining, electrofishing and fyke traps.

Beach seining: In October and November a 91.4 x 6.1 m (300 x 20 ft) beach seine with 2.5 cm (1 inch) bar mesh was tried in the estuary near the mouth. The seine was adapted to mechanized operation similar to the operation reported by Giger (1972)1/. Harness rings were attached to the lead line at 1.8 m (6 ft) intervals. A separate 106.7 m (350 ft) rope (a purseline) was strung through the rings. After the seine was set the ends were pulled to the beach by hand. The upstream end of the purseline was then retrieved using a portable winch while the downstream end was tied off on a stationary post located on shore. A 12-volt anchor winch bolted to a 3 m (10-ft) aluminum boat was used as a power source.

Mechanized seining worked well in the estuary, but restacking of the net and restringing of the purseline were tedious and time consuming jobs. Worse yet, very few (2) steelhead were captured in 4 days of effort (Table 3).

Manual seining was tried in December using the same net, 2.8 km (1 3/4 mi) upstream from the river mouth (Miner Hole). Fishing was more successful (6 steelhead in 2 days) but snags and floating debris made continued seining in the area unfeasible.

1/ Giger, Richard D. 1972. Ecology and management of coastal cutthroat trout in Oregon. Fishery Research Report No. 6. Oregon State Game Commission. 61 pp.

Table 3

Monthly Adult Steelhead Tagging Data by Capture Method

Month	Method	River area	Steelhead tagged		Days Fished	Tags subsequently recovered
			Fresh	Spent		
October	Beach seine	Estuary	0	0	1	-
November	"	"	2	0	2	0
December	"	"	0	0	1	-
December	"	Miner Hole	6 *1	0	2	2
January	Electrof.	Mill Bend	0	0	2	-
January	Fyke traps	"	12	0	3	2
February	"	"	14	12	28	1
March	"	"	3 *2	18	31	0
April	"	"	0	3	4	0
TOTALS			37	33	74	5

*1 Includes 1 RP steelhead and 2 regenerated dorsals.

*2 Includes 1 RP steelhead.

Electrofishing: In January, Region 2's Smith-Root boat shocker was tried in the river about 1.6 km (1 mi) upstream from the river mouth (Mill Bend Hole). Several hours of fishing over a 2-day period produced no fish. One steelhead was stunned but escaped. The river was found unnavigable and unreachable to this unit above or below the area sampled. Mill Bend is the only feasible trailer boat launching area in the lower river. A "jet" equipped outboard would have probably opened up at least three more holes to electrofishing. Unfortunately none was available.

Fyke traps: Three hexagonal fyke traps were borrowed from Region 3 and placed in the upper estuary at Mill Bend in late January and were removed in early April. Traps were lowered and raised with Region 3's trap lifting barge equipped with hand winches. An outboard powered boat was used to maneuver the barge.

Anchor cables (6 mm or ¼ inch) were attached to the upstream end of each trap and secured with clamps to large rocks on the river bank. The position of each submerged trap was marked with two floats secured to the two trap lifting cables. A door in the forward trap chamber allowed fish to be removed.

Traps were serviced every other day except weekends and during high water. Captured fish were tagged, measured, sexed, condition noted and released. Three men were needed for this operation, as opposed to two for electro-fishing and four for beach seining.

Trap location was important to fishing success. Trapping success was highest in areas were river flow exceeded 0.3 m (1 ft) per second, and were situated on the bottom at the foot of a steep bank. The more successful areas fished were 5-6 m (16-20 ft) deep.

On February 22 one trap became silted in and was later lost. Snorkel diving in May revealed the large rock (estimated 1 metric ton) to which this trap was secured had tumbled into the river. Part of the trap nose cable remained secured to the rock. A second trap, nose cable and all, was lost March 30 during heavy flooding (apparently 250 m^3/sec or 8,834 cfs). A ball of wire mesh found near the river mouth was all that was found of either trap. The surviving trap suffered moderate damage but is repairable.

A total of 70 adult steelhead was captured by all three methods: 62 by fyke traps and 8 by beach seining. Two captured steelhead were from the spring 1973 hatchery plant (marked RP): two others showed deformed dorsals indicating hatchery origin.

The total fyke trap catch sex ratio was 7:1, females to males. A 3:1 female-to-male catch ratio appeared in the Gualala creel census for the same period (January-February). The substantial difference in sex ratios is perhaps due to the selection of unspawned steelhead by the anglers. Traps caught steelhead migrating from the ocean as well as spent individuals returning to the sea. Spent steelhead accounted for 48% (30 fish) of the trap catch, and all were females. Trap catches probably better reflect the population structure in the lower river than angler creel samples.

The average number of steelhead caught per service day was approximately 3 fish. This average does not represent number of fish per trap because all three traps were not always fishing or serviceable. The projected 3-trap catch rate had all 3 traps been fishing continuously is 69 steelhead per month.

Fork length was taken of all captured steelhead. Compared to angler-caught steelhead, it appeared that steelhead under 40 cm (16 inches) escaped the traps and that generally larger steelhead (over 75 cm or 30 inches) escaped the anglers.

All except two captured steelhead were tagged with $5 reward, Floy FD-68B internal anchor tags. Anesthetic (MS-222) was used to quiet the fish during tagging. Six tagged steelhead were recovered: five by anglers and one by an angler who found the fish unspawned, apparently dying in the river shallows. No tagged spent fish were recaptured.

Representative sampling of the incoming steelhead population was not achieved. Most of the fresh steelhead tagged were caught in late January and February. A substantial run occurred during November, December and early January as evidenced by the relatively high angler catches during those same months 901 steelhead or 53% of the season catch. No reasonable estimate of the river population could be generated.

Scales Analysis. Francis Sumner, formerly of the Oregon State Game Commission (retired), assisted in analyzing the scales from 31 Mad River sport-caught steelhead sampled this period. Agreement was reached on 30 samples.

Sample ages ranged from one plus to 5 years. The two smallest fish (14.0 and 18.5 cm; 5.5 and 7.3 inches, respectively) had not been to the ocean: all the larger steelhead (29 to 81 cm; 11.4 to 31.9 inches, respectively) had been. All except perhaps one were on their maiden journeys into fresh water. The one exception had a "false spawning" check similar to the ones Sumner had observed in Klamath and Rogue River steelhead.

The 29.0 to 43.0 cm (11.4 to 16.9 inch) samples (19 total or 68%) had spent part or most of a year in the ocean: all the larger fish (9 fish, 52 to 81 cm; 20.5 to 31.9 inches) had spent one plus to two years in the ocean. The majority (17 or 61%) of samples had spent one year in fresh water. The longest period of freshwater residence was 3 years (3 fish). The high percentage of one year freshwater rearing steelhead may indicate many were of hatchery origin.

The presence of small, fall-entering steelhead that have spent only a few months in the ocean suggests the Mad River may support a run of steelhead similar to the ones studied and documented from the Klamath and Rogue River Systems (half-pounders). The gonads of none of these fish was examined. Klamath and Rogue River half-pounders are mostly immature.

Scales from approximately 300 Gualala and Garcia River stream-rearing steelhead, and 150 Gualala and Garcia River adult sport-caught steelhead were mounted, but have yet to be analyzed.

Target Date for Achievements

Existing Project Agreement extends through December, 1975. This will afford marking of one more brood (1974) of hatchery steelhead destined for the three study rivers, and will complete a 3 consecutive broodyear marking program on the Gualala and Mad Rivers and one year on the Garcia. Creel censusing on study streams and adult tagging on the Gualala and Garcia Rivers will be possible for one more season (1974-75). Extension of Project Agreement through April, 1977, will be necessary to assess the contributions of all 3 brood releases when they return to the respective fisheries as 2, 3, and 4 year old adults. An additional 8 months (through December, 1977) will be needed to prepare Project Completion Report.

Significant Deviations

1) The Mad River Salmon and Steelhead Hatchery furunculosis problem eliminated one brood year (1973) of hatchery-reared steelhead smolts available for study by this Project.

2) The rate and success of emigration of the steelhead planted in the Gualala this year were not determined. We have observed that planted steelhead tend to school while moving downstream and that movement occurs during daylight as well as nighttime hours. Last year and this year we observed schools of planted steelhead moving into and out of the mouths of riffle nets during daylight hours, and the daylight catches of either wild or planted steelhead were always negligible in comparison to nighttime catches. Almost certainly the fish could see and avoid the nets during daylight hours, and probably to some degree during nighttime hours. We believe, based on visual observations of planted steelhead, that many and perhaps most of them did in fact move quite rapidly to the estuary and out to sea, but netting data do not confirm our observations.

3) High fuel prices and a State order to reduce automobile mileage, prompted the decision not to sample the Mad River steelhead fishery in March. Prior to March, the Mad had been unfishable essentially every day since November 5. It was gambled the river would continue to be unfishable through March. Reports received from Mad River contacts, however, indicated the river did clear near month's end and perhaps as many as 200 steelhead were caught immediately below the hatchery.

Remarks

Creel census and turbidity data continue to substantiate that the critical water clarity for desirable and effective winter steelhead angling is ?30 JTU. Analysis of past years' Mad River turbidity data indicate usually poor conditions for winter steelhead angling in this stream.

Two potential methods of enhancing the Mad River steelhead fishery include (1) propagation of native fall-entering steelhead and (2) opening of certain lower river, clear-water tributaries to winter angling.

In light of recent year's work with parr-smolt transformation in steelhead, it appeared the Gualala River was already too warm in April for successful steelhead smolting. That so few wild steelhead were captured in riffle nets during late April and May, may indicate the native smolt migration was already complete when the planted fish were liberated and the riffle nets were installed. A May 1 target date for planting may in some years be too late. A flexible planting date depending on river temperature and the smolting condition of the fish would seem more appropriate. As will be shown under Job Report No. 3, the cage- and pond-reared steelhead liberated in the Gualala this period began smolting in early March and appeared to be losing their smolt characteristics in late April.

Next spring's riffle netting operations will be geared to reduce the net avoidance problem, which we believe can be overcome somewhat by increasing water velocity through the net. The lower Gualala has a very low gradient and late April-May river velocities over the riffles at flows under 20 m^3/sec (707 cfs) generally do not exceed 1.1 m/sec (3½ ft/sec). To speed up the flow, the river will be constricted with sandbags at a point immediately above the estuary and a net will be placed in the opening. The desired minimum velocity through the opening will be 1.5 m/sec (5 ft/sec).

Steelhead Management Recommendations

None.

Cost

Total	$57,990
Federal	28,995
State	28,995

Job Title: Steelhead Rearing Pond Reconnaissance
Job No: 2 of 3
Job Objective: To locate and determine suitability of existing ponds and potential pond sites for production of steelhead smolts in north coast drainages.

Report:

Smith River drainage — Crescent City area ponds, and one pond on the coast near Big Lagoon were surveyed for steelhead pond rearing potential. Most ponds were located in "Land and Water Use in Smith River Hydrographic Unit". California Department of Water Resources Bulletin No. 94-4. All the diversions listed in Table 5 of this report were considered except:

i) those in the Winchuck River and Illinois River subunits which empty into Oregon;

ii) those where no dam is indicated: and

iii) those used for municipal and domestic purposes. This left a total of 12 diversions; 8 log ponds, two irrigation ponds, one power diversion, and one fish cultural diversion.

The fish cultural diversion (Trout Haven) was not in operation. The new owners of the facility were in the process of refurbishing for commercial trout production. The power diversion (Fletcher and Tuttle) was found to be no longer in existence. One of the two irrigation ponds (Hastings and Stanhurt) was too small (200 m^3; 7,067 ft^3, estimated) to be considered. The other irrigation pond (Hussey Ranch Corporation) was sampled (Table 4).

Four log pond diversions were visited. One was dry (Dutton Lumber) and one was in use and could not be sampled (Medford Veneer). The other two ponds (Cal-Ore Veneer: Standard Veneer) were almost completely overgrown by weeds and were cluttered by bark, chips and logs. No attempt was made to sample them.

It is noteworthy that mechanical deck loaders have all but replaced conventional log pond sorting operations in the Crescent City area and all along the north coast. Reportedly most of the existing log ponds are no longer in use for log sorting. Use of existing unused log ponds for steelhead rearing in open water would in general require considerable renovation to remove logs, bark and weeds, besides installation of a large outlet drain. Poor water quality is suspected in most cases at present.

Three additional ponds were located by map search or were encountered during travel. Two were log ponds: one was sampled (Louisiana Pacific) and the other was choked with weeds and logs and was not sampled (HB and M; T18N/R1W-35). The third pond was a Federal recreation pond (Dry Lake) and was sampled.

None of the ponds surveyed were immediately suitable for open water steelhead rearing. The major drawback in every case was the lack of a feasible method of draining the pond, a feature which has been concluded necessary if the fish reared must be translocated to important steelhead streams.

Table 4
North Coast Steelhead Rearing Pond Reconnaissance;
Summary, 1973-74 Fiscal Year

1. Hussey Ranch Corporation Diversion

Location: HB and M; T17N/R1E-30 (Del Norte Country Club).

Drainage: Small tributary to Smith River.

Ownership: Del Norte Country Club.

Dimensions: 18.5×10^3 m^3 divided in two sections; one section about 3 times larger than the other. Two meters deep.

Diversion Construction: Earth dam, 3.7 m high x 518 m long.

Drainage Feasibility: None.

Sampled	Inflow (est.)	C (F)		D.O.	pH
(small section)					
8/22/73	14×10^{-3} m^3/sec.	20.8 (69.5)	Surface (S)	10.8 ppm	8.0
		20.3 (68.5)	Bottom (B)		
(large section)					
8/22/73	same	22.8 (73.0)	S	10.9 ppm	7.7
		21.1 (70.0)	B	10.8 ppm	7.7

Species present:	Remarks
Rainbow trout Mosquito fish]	Pond planted with 200 trout 3 years ago. Three 36 cm (14 inch) trout observed swimming in shallows. Electricity available. Good access roads. Relatively undisturbed. In middle of golf course. Used to water grass.

Table 4 (continued)

2. Louisiana Pacific Pond

Location:	HB and M; T19N/R1E-19 (adjacent to Big Lagoon).
Drainage:	Gray Creek which flows into Big Lagoon.
Ownership:	Louisiana Pacific.
Dimensions:	962 x 10^3 m^3 (790 acre-feet); 3.75 m deep near spillway.
Diversion Construction:	Earth dam 4.5 m high x 539 m long.
Drainage Feasibility:	Can be mostly drained, but enormity of present water volume would preclude annual draining and filling.

Sampled	Inflow (est.)	C (F)	D.O.	PH
8/24/73	0.1-0.2 m^3	18.9 (66) S	10.6	7.0
		18.3 (65) B	6.1	6.5

Species present	Remarks
Rainbow and cutthroat trout, reportedly	Currently not being used for anything significant. Originally built for log sorting.

Table 4 (continued)

3. Dry Lake

Location: HB and M; T16N/R3E-31.

Drainage: Near Hurdy Gurdy Creek which flows into the S. F. Smith River.

Ownership: Six Rivers National Forest.

Dimensions: 4 hectares (2 acres) surface; 2 m deep (est.).

Diversion Construction: Earthen dam.

Drainage Feasibility: None; no outlet structure.

Sampled	Inflow (est.)	C (F)	D.O.	pH
8/27/73	Springs	18.3 (65) s	10.4	8.0
		18.3 (65) B	9.8	8.0

Species present	Remarks
Regularly stocked with rainbow trout	Choked with weeds. USFS campground. Trout abundant in weeds .

Target Date for Achievement
Project Agreement extends through December 1975.

Significant Deviations
None.

Remarks

Two important recent developments may necessitate job termination after July 1974 : (1) lack of requests for steelhead pond site information from private and governmental organizations, and (2) the Department's tightening monetary situation which may preclude further expansion of the Department's coastal steelhead rearing program for many years. In light of more pressing coastal steelhead problems (e.g., effect of summer "trout" fishing in steelhead streams), no reconnaissance will be conducted during fiscal year 1974-75.

Cost

Total	$2,000
Federal	1,000
State	1,000

Job Title: Cage Rearing of Juvenile Steelhead

Job No.: 3 of 3

Job Objective: To evaluate cage rearing of juvenile steelhead in north coast ponds.

Report:

Pond Selection. The pond chosen for the cage rearing experiment is located in Mendocino County, 4 km (2.5 mi) south of Point Arena, on the H-H Ranch. The pond was formed in 1970 by an earthen dam across Ross Creek, a small tributary to the Pacific Ocean. There is about 1.6 km (1 mi) of stream below the dam. The volume of water impounded by the earthen dam is about 58,000 m^3 (47 acre-feet) with a surface area of about 2 ha. (4.9 A.). The pond is used privately by the owners, primarily for recreation.

A small (½ ha.; 1 A.) section of pond is divided from the main pond by a levee (access road) and is connected to the main pond by a 1.2 m (4 ft) diameter culvert. This section was used to rear fingerling steelhead received by this Project to insure continuation of the Project's hatchery steelhead contribution study, as described under Job Report No. 1. Maximum depth in this section is about 3.7 m (12 ft).

Cage Construction. Two cages were constructed; one in August, that was used almost exclusively for the rearing experiment, and a second in February, to facilitate fish marking.

Both cages were structured of 2.5 x 2.5 cm (1 x 1 inch) angle iron, covered with 6 mm (¼ inch) galvanized hardware cloth. The cloth was pop-riveted to the frames. The frames were sprayed with rust retardant paint before applying the cloth.

The original cage was made in three sections and bolted together to form a 9.1 x 3.0 x 1.5 m (30 x 10 x 5 ft) rearing area (41 m^3; 55.6 yd^3). The second cage consisted of 14 panels, bolted together to form a 9.1 x 2.4 x 1.2 m (30 x 8 x 4 ft) transfer-rearing area (26.2 m^3; 35.6 yd^3). Angle iron ends were cut at a 45 degree angle and welded together to form panel or section corners.

Both cages were suspended in the water from a floating dock. Twelve 0.9 x 3.0 m (3 x 10 ft) dock sections were arranged rectangularly to surround the original rearing cage, thereby creating a walkway all around the cage. One long side of the second cage was suspended from one side of the dock and the side opposite was buoyed with styrofoam floats. The tops of both cages were about 8 cm (3.1 inch) out of the water.

The entire facility was anchored to the shore with ropes and anchors and was easily movable to any desired location in the pond.

Electricity was available. An aeration system was installed for emergency aeration. The system consisted of 2.5 cm (1 inch) PVC pipe drilled with 2 mm (3/32 inch) holes every 1.2 m (4 ft). The pipe was laid in the bottom

of the rearing cage. An air pump was made from an automobile smog pump (1965 Ford) and a 1/3 h.p. electric motor. The pump was connected to the aeration pipe with plastic garden hose, when the system was in use. Emergency aeration was not required this year.

Rearing and Planting. Mad River Salmon and Steelhead Hatchery delivered 10,000 fingerling steelhead averaging 201/kg (91/lb) to the cage facility September 12. An additional 50,000 Mad River Hatchery steelhead averaging 73/kg (33/lb) were introduced into the small pond section November 19. These fish had been exposed to furunculosis at the hatchery, but had been treated immediately prior to our receiving them and appeared quite healthy. Both lots were South Fork Eel River strain.

Dead fish were removed from the cages daily. Pond mortalities were estimated based on cage mortalities.

Oregon Moist Pellet was fed to both the pond- and cage-rearing fish by hand 3 times daily, except in January when turbid water conditions affected feeding activity. During periods of moderate turbidity feed was dispensed in early morning and late evening. During periods of extreme turbidity feeding activity essentially stopped and feeding was curtailed.

Daily feed allotments were the same as those used at Mad River Hatchery. The cage- and pond-reared fish received 1,729 kg (3,812 lb) total (Table 5).

In March unseasonably late and heavy flooding dislocated the culvert screen retaining the pond-rearing fish. At that time the fish were smolting. The majority (25,000 estimated) escaped to the main pond and down Ross Creek to the ocean (Table 6). They were observed jumping for a short while in the main pond and in the creek below the dam. Attempts to capture them in Ross Creek with a 0.9x1.5m (3x5 ft) riffle net failed.

In February 7,102 (71% of the original plant) cage-reared steelhead were marked LV and transferred to the newly built cage. In March, 9,577 (19.2% of the original plant) pond-reared steelhead were seined from the pond, marked RV and placed in the original rearing cage. In early April, 1,045 (10.9%) of the marked pond-reared fish jumped out of the rearing cage, apparently during early morning and late evening hours. It was not known they were doing so until mid-April. A beach seine was draped over the cage to prevent further losses.

On April 23 and 24, 12,766 of the 15,634 pond- and cage-reared fish were released in the Gualala River at Valley Crossing. The remaining 2,868 fish were released in the Gualala between April 17 and May 16 at various points downstream from Valley Crossing. Most of these (2,375) were used April 18-29 to test the efficiency of riffle nets installed in the river in an effort to determine the success and rate of emigration of the pond- and cage-reared fish released at Valley Crossing. The balance (493) were residuals removed from the cages when they were lifted from the pond for cleaning on May 16 (Table 6).

Table 5
Monthly Feed Totals Given Cage- and Pond-reared Steelhead

Month	Kg of Oregon Moist Pellet		
	Cage	Pond	Total
September	42.2	-	42.2
October	83.2	-	83.2
November	81.6	84.	166.4
December	81.2	237.5	318.7
January	55.3	218.2	273.5
February	101.8	283.5	385.3
March	81.0	240.4	321.4
April	64.6	73.7	138.3
TOTALS	590.9 (1,303 lb)	1,138.1 (2,509 lb)	1,729.0 (3,812 lb)

Table 6
Planting Data, Cage- and Pond-reared Steelhead

	Mark	Number	Kg	Month	Release site
Cage-reared	LV	7,102	342.7	April	Gualala River
Pond-reared	RV	8,532	411.7	April	"
Subtotals		15,634	754.4		
Pond-reared	RV	1,045	50.4	April	Ross Creek *1
"	-	25,000	1,134.0 (est.)	March	" " *2
Subtotals		26,045	1,184.4		
GRAND TOTALS		41,679	1,938.8 (4,274.3 lb.)		

*1 Unintentional plant; jumped out of cage.

*2 Unintentional plant; culvert screen dislodged.

Weight of fish planted in Gualala River was 754.4 kg (1,633.1 lb). An additional estimated 1,184.4 kg (2,611.1 lb) of fish escaped holding facilities and emigrated down Ross Creek.

At the time of planting, food conversion of the cage-reared fish was 2.0:1 (2 kg moist pellet fed : 1 kg flesh gained). On February 28 (prior to the onset of smolting) the conversion factor was 1.7:1. Pond-fish food conversion was not previsely (sic) known.

Observed cage mortalities totaled 187 fish. The balance of missing cage-reared fish (2,711) either escaped by jumping out or were eaten by birds. Kingfishers and green herons were the only observed bird predators in the cage. Great blue herons and western grebes were frequently observed feeding in the pond. No solution was found to controlling bird predation in the pond; a hardward (sic) cloth canopy eliminated the bird problem in the cage.

There were no apparent disease problems until after marking in March. Fungus was noted on several fish at that time. Malachite Green seemed to reduce, but not eliminate this problem. Furunculosis was indicated in 10 fish on April 22. Planting was initiated April 23. All fish appeared healthy on April 23 and 24 when most were planted. May 1 was the original target date for planting.

Sampling. Monthly weight counts were used to estimate fish growth throughout the rearing period. The cage- and pond-reared fish were the same average size when the pond-reared fish were introduced November 19 (73/kg or 33/lb; Table 7). At time of planting on April 23 and 24 both groups averaged 2lkg (9.4/lb).

Fork lengths were taken of 95 cage- and 102 pond-reared fish March 19. The samples averaged 16.1 and 15.6 cm (6.3 and 6.1 inches), respectively. The cage fish ranged from 10 to 19 cm (3.9 to 7.5 inches) and the pond fish 9 to 22 cm (3.5 to 8.7 inches). It is noteworthy that 83% of the cage fish were ?16 cm (6.3 inches) as compared to 63% of the pond fish.

Coefficient of condition (K) of cage-reared steelhead was measured at 2-week intervals starting March 5 and ending April 26. Sample size each time was 25 fish. External smolt characteristics and K values indicated smolt metamorphosis began in early March, soon after K-value sampling began as indicated below:

Date	K (100 x gm/cm FL^3)		Water temperature
March 5	1.13	} Smolting began	9.5 C (49 F)
March 19	1.02		11.1 C (52 F)
April 10	0.95		11.1 C (52 F)
April 26	0.97		13.9 C (57 F)

Table 7
Monthly Average Size of Cage- and Pond-reared Steelhead

Date	Cage (NO. /kg)	Pond
9/12/73	201	-
10/10/73	115	-
11/19/73	73	73
12/19/73	42	44
1/25/74	37	37
2/28/74	29	29
3/22/74	21	21
4/24/74	21	21

Target Date for Achievement

The project is funded through December 1975; thus one more season of experimentation will be possible. Rearing technology should be substantially advanced at that time; the eventual fisheries and spawning escapement contributions of cage-reared steelhead, however, cannot be assessed until after the 1977-78 Gualala River fishing season.

Significant Deviations

Half of the cage-reared fish were not released into the pond proper as originally planned. The receipt in November of 50,000 unscheduled fish afforded comparison of cage rearing with pond rearing.

The cage-reared fish were released in the Gualala River rather than the Garcia River as originally planned. The unavailability of fish to plant in the Gualala from Mad River Salmon and Steelhead Hatchery this year prompted this decision.

The potential for catching and tagging a substantial number of adults in the Gualala has been demonstrated; hence the potential for estimating planted fish return rates to the fishery and spawning escapement appears, at this time, much greater for the Gualala than the Garcia. We did not want to divide the pond- and cage-reared fish between the two streams, because of the low numbers of fish involved compared with their average size at planting. At 20.7/kg (9.4/lb) a low (less than 2%) return rate is anticipated; thus chances for not sampling any returning adults will be high, particularly if the fish were divided between the two rivers.

Remarks

None of the cage-rearing problems experienced appears insurmountable. Compared to pond rearing, cage rearing appeared to distribute the feed more uniformly and probably more efficiently to the fish. Cage-reared fish were noticeably more uniform in size than the pond-reared fish. Furthermore, cage-reared fish could be removed for planting much easier and more efficiently than the pond-reared fish. Elsewhere pond-reared fish have been efficiently removed for planting by trapping voluntary emigrants at the pond outlet. The cost of such a structure at Hay Pond and annual treatment of the pond to remove residuals would be considerable. Complete drainage of Hay Pond, like most of the existing ponds on the north coast, is not feasible. Treatment for disease would be much easier for cage rearing as opposed to pond rearing.

Further experimentation with cage rearing is recommended to i) determine optimum cage-rearing density and ii) determine survival of cage-reared fish to adults. The maximum rearing density achieved this year was 13.1 kg/m^3: 342.7 kg of steelhead in the 9.1 x 2.4 x 1.2 m cage (26.2 m^3). Commercial

rainbow trout cage-rearing studies have achieved successful rearing densities of in excess of 30 kg/m3 (Tatum, 1973).2/ The Project's hatchery fish evaluation study (Job No. 1) is aimed at determining the adult return rate of cage-reared steelhead.

Cage-rearing methods can be improved by i) constructing smaller, more rigid cages that can be lifted mechanically from the water and ii) covering each cage with a hardward cloth or net canopy.

May 1 was the target date for planting. Indications were the fish were ready to emigrate in mid-March. At that time they were crowding and jumping at the section of cage nearest the spillway, were very silvery in color, and their K value was the lowest than at any other time between early March and late April. A more flexible planting date depending on the smolting condition of the fish will be followed in future cage-rearing experiments.

Steelhead Management Recommendations

Cage-rearing technology has not been adequately developed and tested to recommend a production scale operation. Its potential, however, has been demonstrated. Cage rearing may prove to be a valuable management tool, particularly to fill the rising demand from private sportsmens clubs for a relatively low cost yet effective method of rearing steelhead to yearlings for release into local rivers and streams.

Cost

Total	$14,390
Federal	7,195
State	7,195

Prepared by: _____, September 23, 1974
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2/ Tatum, Walter M. 1973. Brackish water cage culture of rainbow trout (Salmo gairdneri) in south Alabama. Trans. American Fish Soc. 102(4): 826-828.