

The Resources Agency of California
DEPARTMENT OF FISH AND GAME

COMPARISON OF THE YIELDS OF DOWNSTREAM MIGRANT SALMONIDS
BEFORE AND AFTER LOGGING ROAD CONSTRUCTION ON THE
SOUTH FORK CASPAR CREEK, MENDOCINO COUNTY^{1/}

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SUMMARY

Yields of juvenile steelhead rainbow trout *Salmo gairdnerii gairdnerii*) and silver salmon (*Oncorhynchus kisutch*) emigrants were compared in South Fork Caspar Creek, a small coastal stream in Mendocino County, California, before and after construction of a logging road along the stream in the summer of 1967. Numbers, lengths, and age class structures were compared.

There were 138% more steelhead smolts and 41% fewer silver salmon smolts in 1968 (first spring following road construction) than there had been in 1964 (preroad construction). Increased emigration of steelhead smolts in 1968 was probably caused by a decrease in favorable living space. The decrease in salmon smolts accompanied high mortalities during road construction. Eighty-three percent of the total salmon population and 86% of the total steelhead population died or emigrated from the affected area during the road construction from June to October 1967. The combined populations of steelhead and salmon smolts decreased 20%. This combined decrease is within the range of natural fluctuation reported from other California streams; however, there is no doubt that road construction contributed to the decrease in Caspar Creek.

Steelhead and salmon fry were more numerous in 1968 than in 1964. No steelhead fry were trapped in 1964, while 72% of the migrants trapped in 1968 were fry. The age composition of the salmon also shifted markedly from 1964; fry comprised 5% of the total in 1964 and 81% in 1968. This increase in numbers of emigrating fry in 1968 could have resulted from poor environmental conditions.

Steelhead smolts were smaller in 1968 than in 1964, while salmon smolts were larger. Salmon fry were smaller in 1968. Steelhead fry cannot be compared as none was trapped in 1964. The increase in length of the salmon smolts may have resulted from a decrease in competition due to higher mortality in 1967. The fry may have been smaller due to unfavorable intragravel conditions during incubation. Comparison of steelhead smolts is difficult because of the emigration of more than one year class. The decrease in average length, however, supports the hypothesis of premature emigration due to unfavorable habitat.

1/Submitted February 1970.

Inland Fisheries Administrative Report No. 70-3.

This work was performed as part of Dingell-Johnson Project California F-10-R, "Coastal Salmon and Steelhead", supported by Federal Aid to Fish Restoration funds.

Two large ponds, formed by streamflow and sediment gaging facilities and a fish ladder upstream from the emigrant traps, obscured the impact of stream habitat destruction by providing refuge for fish during road construction and right-of-way logging. Moreover, the ponds made up about 20% of the total salmonid habitat above the fish counting facilities.

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INTRODUCTION

Yields of juvenile steelhead rainbow trout and silver salmon emigrants were compared in South Fork Caspar Creek, a small coastal stream in Mendocino County, California, before and after construction of a logging road along the stream. The possible effects of the stream disturbance on the size of migrants were also investigated.

This study was conducted as part of an interagency program to determine the effects of road construction and right-of-way logging on water yield, water chemistry, stream sedimentation, fish habitat, and fish and insect populations in South Fork Caspar Creek.

Study Area and Logging Operations

Caspar Creek lies within Jackson State Forest, 5 miles south of Fort Bragg, California. The South Fork's 425-hectare (1,050-acre) watershed supports dense stands of second growth Douglas fir and redwoods averaging about 85 years old. Streamflow generally ranges from 0.002 to 11.9 cubic meters per second or 0.06 to 42 cfs (Ziemer, Kojan, and Thomas, 1965). Silver salmon, steelhead rainbow trout, and three-spined stickleback (Gasterosteus aculeatus) inhabit the stream up to 3,183 meters (10,442 feet) above the streamflow gaging weir. Spawning escapement prior to road construction ranged from 33 to 111 silver salmon and from 15 to 22 steelhead (Kabel and German, 1967).

Road building, right-of-way logging, and stream cleanup were conducted on the South Fork from May 22 through September 12, 1967. About 76,400 cubic meters (100,000 cubic yards) of road material were moved and 10,000 cubic meters (4,300,000 board feet) of timber harvested along 5.96 kilometers (3.7 miles) of road right-of-way construction. Large quantities of trees and rocks fell into the stream and approximately 79 meters (260 feet) of stream were relocated. Bulldozers operated through 41% of the stream's length. Upon completion of stream clearance (logging debris removal) over 99% of the 3,183 meters of study section had been disturbed (Burns, 1970).

ACKNOWLEDGMENTS

We wish to thank Paul M. Hubbell and Ted Vande Sande for designing the downstream trap used in 1968. Fredric R. Kopperdahl and Paul Hubbell erected the trap and supervised the seasonal personnel collecting data.

METHODS

Preroad construction studies on downstream migrants were made by the California Department of Fish and Game in 1964 (Kabel and German, 1967). Modified Cranberry traps located downstream from the streamflow gaging weir collected downstream migrants from March 13 to July 1 in 1964 and 1968. These traps were only slightly modified from the 1964 design.

All emigrants were counted and measured to the nearest millimeter in 1968, while in 1964 fish were counted and measured to the nearest 0.1 inch. Emigrants were separated into two classes by length-frequency methods and designated as either (1) fry, or (2) smolts (yearling and older fish).

SOURCES OF ERROR

Parental stocks producing downstream migrants for each year of the study were not known; however, spawning runs can be quite variable and still produce the same number of emigrants (Salo and Bayliff, 1958; Chapman, 1962).

A few emigrants in 1964 may have escaped during periods of low flow, since the traps were sometimes inoperative due to leaks in the control dams (Babel and German, 1967). This loss was probably small since few fish migrate downstream during low flow. No emigrating fish escaped the traps during the 1968 operation. However, a few fish probably moved downstream before the traps were operating in both years. Freshets prior to trap installation may have stimulated some emigration. From January 1 to March 12, 1968, there were twice as many days with streamflow over 0.14 cubic meters per second (5 cfs) than for the same period in 1964 (Jay S. Krammes, U. S. Forest Service, pers. comm.; Ziemer, et al., 1965). Any error from this source, therefore, could have been greater in 1968. Three percent of the silver salmon and 14% of the steelhead in Waddell Creek, California, moved downstream prior to March 17 in 9 years of study (Shapovalov and Taft, 1954).

A more serious error resulted from the presence of two large ponds formed behind a fish ladder and the streamflow gaging weir. The combined surface area of these ponds (0.109 hectares or 0.27 acres) adds about 20% to the total area of salmonid habitat upstream from the migrant traps. Downstream movement may have been delayed as fish entered these ponds, thus affecting the size and condition of emigrants. The ponds also provided refuge for fish during the stream disturbances in 1967. Salmonid populations in the ponds were not seriously disturbed by road building and logging. In August 1969 the ponds were supporting 120 salmonids (2.8 kilograms or 6.2 pounds), or about 1% of the stream's total salmonid population (about 14% of the biomass).

RESULTS AND DISCUSSION

Numbers and Age Composition of Migrants

Smolts

There were 138% more steelhead and 41% fewer silver salmon smolts in 1968 than in 1964 (Figures 1 and 2). The increased emigration of steelhead smolts in 1968 probably resulted from premature emigration caused by a decrease in favorable living space. Although premature emigration would increase steelhead smolt yields in 1968, it would cause a decrease in yields in 1969. Smolt yields were not censused in 1969 because of a 20% loss in habitat caused by the draining of the weir pool to remove sediments in the summer of 1968. The residual population of yearling and older steelhead declined from 673 in June 1967 to 176 in June 1968 (Burns, MS). This decrease supports the hypothesis of premature emigration. The decrease in salmon smolts was probably due to mortality caused by the road construction. Eighty-three percent of the total salmon population and 86% of the total steelhead population died or emigrated to the weir pools during the road construction from June to October 1967 (Burns, MS). The combined populations of steelhead and salmon smolts decreased 20% (Table 1). This decrease is within the range of natural fluctuation reported from other California streams (Shapovalov and Taft 1954). There is no doubt, however, that road construction decreased smolt yields.

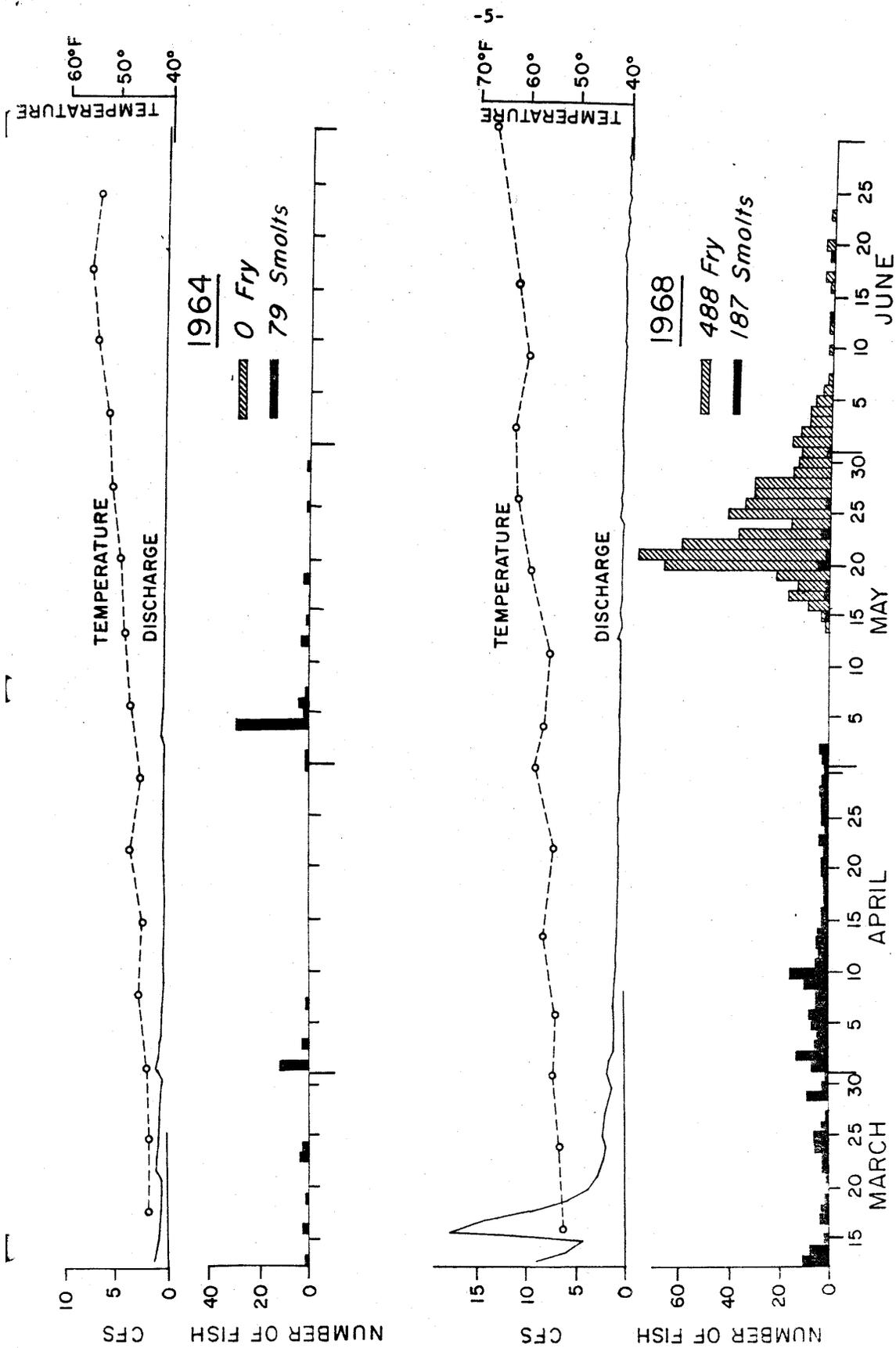


FIGURE 1. Downstream movement of juvenile steelhead rainbow trout, stream discharge and stream temperatures in South Fork Caspar Creek, 1964 and 1968.

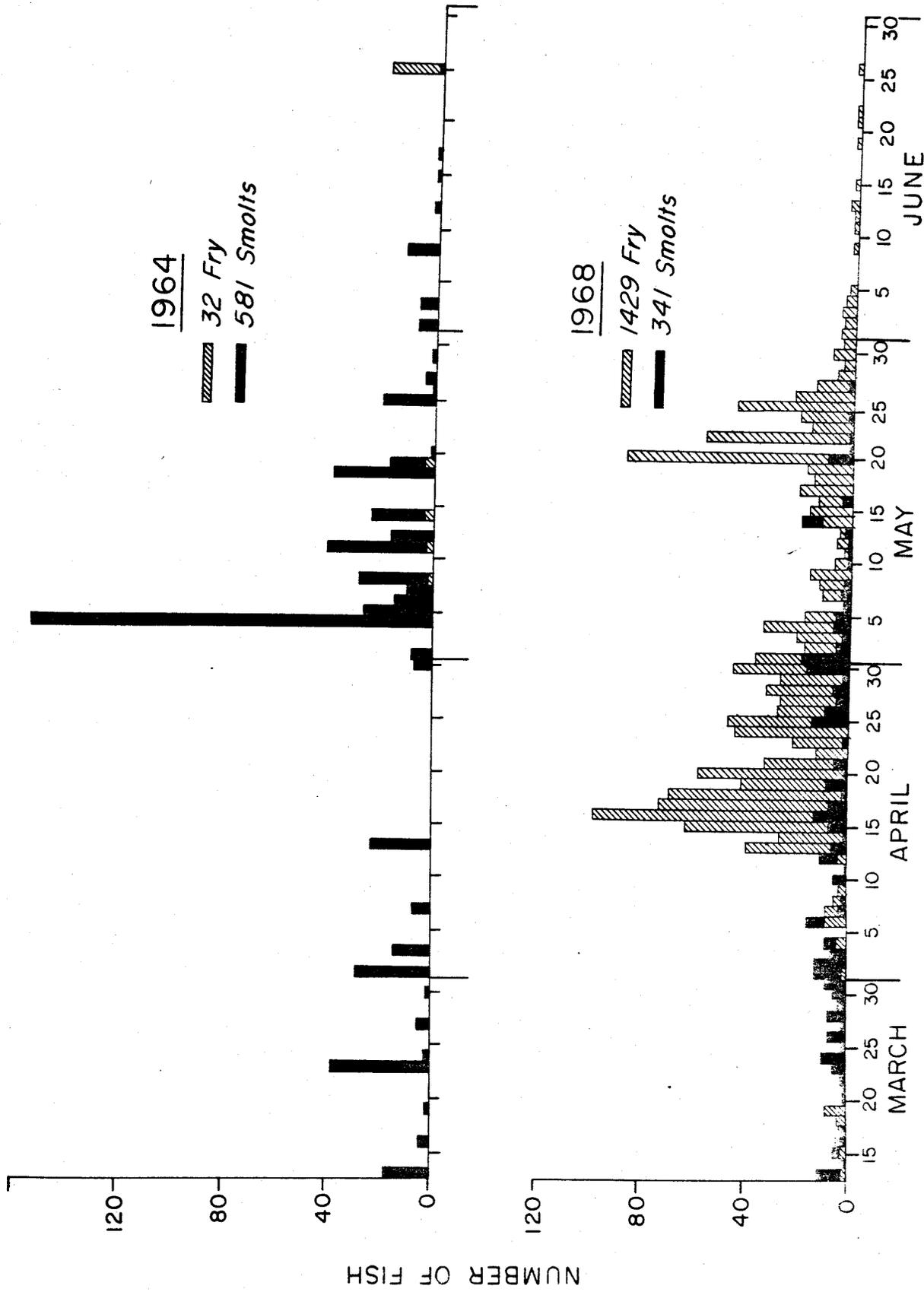


FIGURE 2. Downstream movement of juvenile silver salmon in South Fork Caspar Creek, 1964 and 1968.

TABLE 1

South Fork Caspar Creek Downstream Migrant Counts
March 13 Through July 1

	<u>Smolts</u>		<u>Fry</u>		<u>Total</u>	
	1964	1968	1964	1968	1964	1968
Steelhead trout	79	187	0	488	79	675
Silver salmon	581	341	32	1,429	613	1,770
Total	660	528	32	1,917	692	2,445

Emigrating Fry

Steelhead and salmon fry emigrants were more numerous in 1968 than in 1964 (Table 1). No steelhead fry were trapped in 1964, while 72% of the emigrants trapped in 1968 were fry. The age composition of the emigrant salmon also shifted markedly from 1964; fry comprised 5% of the total in 1964 and 81% in 1968 (Figures 1 and 2).

This large increase in numbers of emigrating fry in 1968 could have resulted from road construction. Spawning bed sediments increased significantly after road construction. The percentage of fines in the spawning beds returned to predisturbance levels by June 1968, but may not have returned to that level during spawning in 1967-68 (Burns, 1970). Hypoxial stress, accompanying low oxygen concentrations prior to emergence, may have resulted from streambed sedimentation in 1967. Silver salmon fry subjected to low oxygen during incubation are prone to prematurely emigrate as fry (Mason, 1969). The emigrating fry probably suffer high mortality in the downstream areas where earlier emerging fry have become established and are defending territories (Chapman, 1962).

A large egg deposition with favorable environmental conditions during incubation could also have produced an increase in the numbers of fry. Increased competition for food and space would force excess fry downstream (Mason and Chapman, 1964). This was probably not the case, since the numbers of steelhead and salmon fry occupying the stream decreased after logging; from 10,183 steelhead and 6,001 salmon fry in June 1967 to 6,580 steelhead and 2,490 salmon fry in June 1968 (Burns, MS).

Length at Migration

Steelhead smolts were smaller in 1968 than they were in 1964, while salmon smolts were larger (Table 2). Salmon fry were smaller in 1968. Steelhead fry cannot be compared as none was trapped in 1964. The increase in length of the salmon smolts may have resulted from a decrease in competition due to higher mortality in 1967. The fry may have been smaller due to unfavorable intragravel conditions during incubation. Comparison of steelhead smolts is difficult because of the emigration of more than one year class. The decrease in average length, however, supports the hypothesis of premature emigration due to unfavorable habitat.

CONCLUSIONS AND RECOMMENDATIONS

Logging road construction decreased the survival of salmonids in South Fork Caspar Creek in 1967 and 1968 and, consequently, probably reduced yields of smolts to the ocean in 1968 and 1969. The 20% reduction in the 1968 smolt yield was within the natural range of variation reported from other coastal streams; however, there is little doubt that road construction contributed to the decrease. The effects of road construction were obscured by the presence of two large ponds upstream from the smolt traps. The ponds provided refuge during upstream disturbances in 1967 and made downstream migrant census infeasible in 1969 because the pools had to be drained to remove sediments.

TABLE 2

Mean Fork Lengths of Salmonid Emigrants in
South Fork Caspar Creek, Mendocino County, California

	Year	Fork length (millimeters) ^{1/}
Steelhead smolts	1964	114 (108-121)
	1968	102 (99-106)
Steelhead fry	1964	None
	1968	41 (40-42)
Silver salmon smolts	1964	84 (83-85)
	1968	94 (92-95)
Silver salmon fry	1964	48 (46-51)
	1968	40 (39-41)

^{1/} 95% confidence intervals in parentheses.

Future studies of the effects of watershed use on the yield of downstream migrants should consider the location and design of fish trapping and streamflow-sediment gaging facilities. These facilities should not dramatically alter the fish habitat within the study area.

REFERENCES

- Burns, J. W. 1970. Spawning bed sedimentation studies in northern California streams. Calif. Fish and Game, 56 (4). (In press.)
- Chapman, D. W. 1958. Studies on the life history of Alsea River steelhead. Jour. Wildl. Mangt., 22 (2) : 123-134.
- 1961. Factors determining production of coho salmon, Oncorhynchus kisutch, in three Oregon streams. Ore. State Univ., Ph.D. Thesis, 214 p.
- 1962. Aggressive behavior in juvenile coho salmon as a cause of emigration. Jour. Fish. Res. Bd. Canada, 19 (6) : 1047-1080.
- Kabel, C. S., and E. R. German. 1967. Caspar Creek study completion report. Calif. Dept. Fish and Game, Marine Resources Branch, Admin. Rept. 67-4 27 p.
- Mason, J. C. 1969. Hypoxial stress prior to emergence and competition among coho salmon fry. Jour. Fish. Res. Bd. Canada, 26 : 63-91.
- Mason, J. C., and D. W. Chapman. 1964. Significance of early emergence, environmental rearing capacity, and behavioral ecology of juvenile coho salmon in stream channels. Jour. Fish. Res. Bd. Canada, 22 (1) : 173-190.
- Pintler, H. E. 1956. The results of a fish population sampling program on the San Lorenzo River, Santa Cruz County, California, 1954-55. Calif. Dept. Fish and Game, Inland Fish. Admin. Rept. 56-26 : 19 p.
- Salo, Ernest O., and William H. Bayliff. 1958. Artificial and natural production of silver salmon, Oncorhynchus kisutch, at Minter Creek, Washington. Wash. Dept. Fish., Res. Bull. No. 4, 76 p.
- Shapovalov, Leo, and Alan C. Taft. 1954. The life histories of the steelhead rainbow trout and silver salmon. Calif. Dept. Fish and Game, Fish Bull. 98 : 375 p.
- Ziemer, R. R., E. Kojan, and R. B. Thomas. 1965. Third progress report, 1965, cooperative watershed management research in the lower conifer zone of California. U. S. Dept. Agric., Forest Service, Pacific Southwest Forest and Range Expt. Sta., 33 p.