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FOOD HABITS OF JUVENILE WILD AND HATCHERY STEELHEAD TROUT, ONCORHYNCHUS MYKISS, IN THE TRINITY RIVER, CALIFORNIA

by

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Department of Water Resources
Red Bluff District Office

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ABSTRACT

Stomach contents were examined from one-year-old and two-year-old wild steelhead trout, Oncorhynchus mykiss, and hatchery-reared steelhead that had been released into the Trinity River a few weeks prior to capture. Significant differences were found in prey composition of stomachs between wild and hatchery fish. Hatchery fish ingested a greater variety of taxa than either age group of wild fish, but contained fewer organisms per fish. Differences in prey ingested by the two age groups of wild steelhead were not significant. Prey of all three groups of fish were dominated by ants, mayflies, caddisflies, and true flies.

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INTRODUCTION

Salmon, Oncorhynchus spp., and steelhead rainbow trout, O. mykiss, reared in Pacific Coast hatcheries are usually released immediately at or downstream of the facilities during the normal emigration periods for the respective species. Following release, and until the fish reach the sea, competition for food may take place with any wild [3] salmonids present in the stream. Competition for food between wild and hatchery-reared fish has been examined for several salmon and trout species (Needham and Slater 1945, Fenderson, Everhart, and Muth 1968, Ware 1971, Sosiak, Randall, and McKenzie 1979, O'Grady 1983), but not for Pacific Coast anadromous species.

Adult returns of steelhead to the Trinity River Hatchery in northern California have been extremely low since it began operations in the early 1960s. Several hypotheses have been presented to explain the low returns, including disease, and time and size at release of the juvenile fish (Hubbell 1973). Other possibilities include competition of juveniles with wild fish for food or their inability to convert to natural feeding. This study had two objectives: 1) determine the ability of recently released hatchery-reared steelhead to adjust to natural feeding in the Trinity River and 2) compare food habits of hatchery and wild fish in the river.

METHODS

Yearling steelhead reared at the Trinity River Hatchery at Lewiston were fin-clipped a few days before being released between 1 and 23 April 1976 as part of emigration studies being conducted by the California Department of Fish and Game. Emigrating, hatchery-reared as well as wild steelhead were captured at Big Bar, approximately 74 km downstream from the hatchery, with fyke nets fitted with live boxes. Fish for this study were obtained 6 May 1976.

Fish were identified as either hatchery-reared or wild, and measured to the nearest millimeter, FL. Stomachs were excised at the esophageal sphincter and the pylorus, and placed in plastic bottles containing formalin by 1-cm size group of both hatchery-reared and wild fish. Contents of individual stomachs were later (1982) identified and enumerated to the lowest possible level using standard taxonomic guides. Only whole or essentially whole animal bodies were counted. Volumes or weights of organisms were not determined due to the often significant digestion that had occurred between ingestion of organisms by the fish and preservation of stomachs immediately following capture.

Dietary differences between groups of fish for proportions of prey ingested were analyzed for statistical significance with the R X C test of independence using the

[3] "Wild" salmonids or steelhead are herein defined as any salmonids or steelhead present in the stream that are not identifiable as ever having lived in an artificial propagation facility.

G-statistic (Sokal and Rohlf 1981). Relative differences between groups of fish were further compared using the index of diet overlap (Morisita 1959) as modified by Horn (1966):

$$C = 2\sum_{i=1}^{s} x_i y_i / \sum_{i=1}^{s} x_i^2 + \sum_{i=1}^{s} y_i^2 \qquad (1)$$

where,

C = Index of diet overlap (ranging from 0 for no similarity to 1.0 for complete overlap),

s = total number of food categories, and

x_i, y_i = proportion of the total diet of species x and y contributed by food category i.

Breadth of the food niche for each fish group was calculated with Simpson's index of diversity (MacArthur 1972) as standardized by Glova (1984):

$$B = 1 / s\sum_{i=1}^{s} p_i^2 \qquad (2)$$

where,

b = Food niche breadth (ranging up to 1.0 for fish with most varied diets),

s = total number of food categories, and

Pi = proportion of the total diet contributed by food category i.

RESULTS

Of the 157 steelhead captured for this study, 109 were wild and 48 were hatchery-reared. Wild fish tended to cluster into two distinct size groups (Figure 1) representing one-year-old and two-year-old fish (AFB 1977). The modal size group for the assumed 60 one-year-old wild fish was 11-12 cm, while that for the assumed 49 two-year-old wild fish was 16-17 cm. The hatchery-reared steelhead were all one-year-olds and had a modal size group of 19-20 cm.

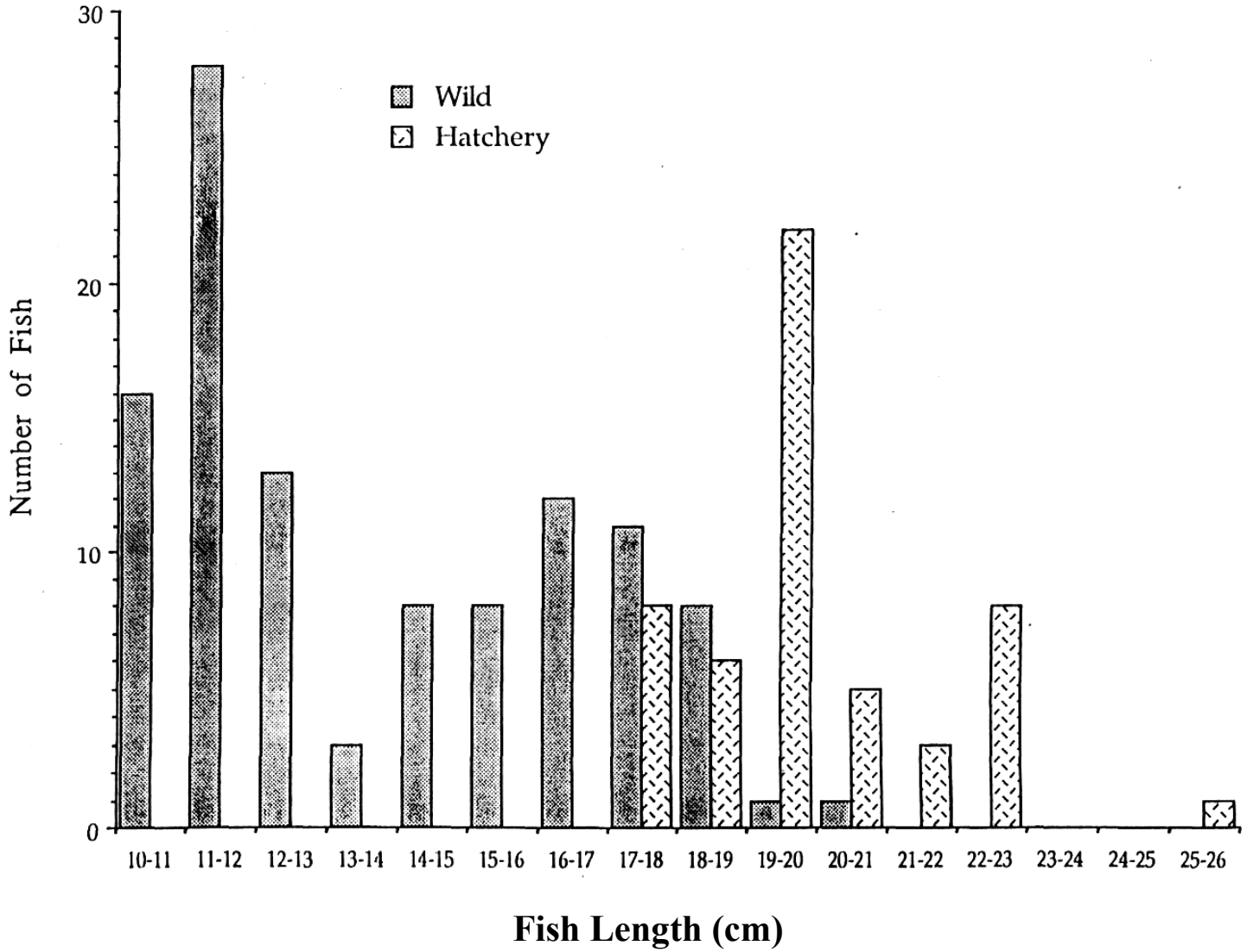

FIGURE 1. Size Distributions of Wild and Hatchery-reared Steelhead Netted from the Trinity River.

Thirty-seven taxa were identified from the fish stomachs. The number of taxa ingested by each fish group were: 17 for one-year-old wild fish, 25 for two-year-old wild fish, and 29 for hatchery-reared fish. Four taxa were responsible for over half the prey composition in the fish. Ants (Formicidae) were the most important prey to all fish groups, constituting 39.8%, 47.6%, and 19.8% of the total diet in one-year-old wild, two-year-old wild, and hatchery-reared steelhead, respectively (Table 1). Other major prey for the one-year-old wild steelhead were the mayfly Ephemerella spp. (11.9%) and the caddisfly Hydropsyche spp. (6.6%). The dipteran Atherix spp. (4.9%) and Ephemerella spp. (4.6%) were other major prey for two-year-old wild fish. Atherix spp. (12.1%) and Hydropsyche spp. (17.8%) composed other major prey in the diet of hatchery-reared steelhead. The average number of prey in the stomachs of fish in each group was 3.7 for one-year-old wild steelhead, 7.1 for two-year old wild steelhead, and 2.9 for hatchery-reared steelhead.

Differences in the proportions of prey comprising the diets of the two age groups of wild steelhead were not significant. However, differences were significant between hatchery-reared fish and both one-year-old ($P < 0.01$) and two-year-old ($P < 0.001$) wild fish. Diet overlap was high between one-year-old and two-year-old wild fish ($C = 0.94$), but was lower between hatchery-reared fish and either one-year-old wild fish ($C = 0.73$) or two-year-old wild fish ($C = 0.66$). Food niche breadth was similar for both one-year-old ($B = 0.11$) and two-year-old ($B = 0.09$) wild steelhead, but was much greater for hatchery-reared steelhead ($B = 0.21$).

DISCUSSION

The principal prey groups for steelhead in the Trinity River are similar to those of congeneric populations of trout in other streams, with mayflies (Ephemeroptera), caddisflies (Trichoptera), and true flies (Diptera) the most important groups (Jenkins, Feldmeth, and Elliott 1970, Bisson 1978, Johnson and Ringler 1980). The ants (Formicidae) apparently form a seasonally or locally important food group in the Trinity River.

Recently released hatchery-reared steelhead in the Trinity River fed on a wider variety of prey than either age group of wild fish. Ware (1971), however, found that wild rainbow trout possessed a more varied diet than hatchery-reared fish, and concluded that the wild trout acquire a searching image based on familiarity with a prey item which facilitates future searches for that prey. The wild steelhead in the Trinity River may feed selectively on prey that can be most efficiently handled, while hatchery fish attempt to capture a wider variety of prey to compensate for a decreased efficiency of capture. Hatchery-reared fish may be less efficient in capturing prey because of their i) lack of natural feeding experience (Jenkins et al. 1970, Confer and

TABLE 1. Percentage in Numbers of Major Prey Items in Stomachs of Wild and Hatchery-reared Trinity River Steelhead

	Wild		Hatchery-reared
	One-Year-Old	Two-Year-Old	
Coleoptera			
Elmidae	3.1	0.0	0.0
Others	9.3	4.8	8.7
Diptera			
Chironomidae	0.4	0.0	2.3
Atherix spp.	0.6	4.9	12.1
Simulium spp.	0.6	0.3	1.1
Others	1.8	6.3	0.2
Ephemeroptera			
Ephemerella spp.	11.9	4.6	2.2
Heptageniidae	2.3	2.4	2.3
Others	0.8	0.3	2.8
Hemiptera			
Unidentified sp.	0.0	0.3	0.0
Homoptera			
Unidentified sp.	0.0	0.0	0.2
Hymenoptera			
Formicidae	39.8	47.6	19.8
Lepidoptera			
Parargyractis spp.	3.4	2.4	0.7
Odonata			
Gomphidae	0.0	0.2	1.0
Others	0.0	2.6	0.2
Plecoptera			
Calineuria spp.	0.0	0.0	2.4
Hesperoperla spp.	0.0	0.0	1.6
Pteronarcys spp.	0.3	2.7	0.8
Others	3.8	3.0	4.4
Trichoptera			
Helicopsyche spp.	0.0	0.0	2.7
Hydropsyche spp.	6.6	2.4	17.8
Dicosmoecus spp.	0.0	0.3	0.9
Others	13.3	10.2	14.4
Arachnida			
Unidentified sp.	0.0	0.5	0.0
Nematoda			
Unidentified sp.	2.3	4.0	0.0
Salmonidae			
Oncorhynchus tshawytscha	0.1	0.3	1.4
Totals	100.4	100.1	99.3

Blades 1975), ii) lethargic feeding behavior stemming from hatchery feeding on pelleted food (Vineyard et al. 1982), and iii) inability to discriminate between prey items (Fenderson et al. 1968). Hatchery conditioning in which fish develop a searching pattern for food from overhead may also lead to differences with wild steelhead, which tend to prefer substrate-oriented prey (Johnson and Ringler 1980). Fish feeding on drifting insects are exposed to more varied food than are fish feeding on the more stable and less varied bottom fauna. I suspect the hatchery fish, which were probably actively migrating to the ocean, were most likely to forage on drifting organisms and less likely to forage on the stream bottom, while the wild fish were mixed in this regard. That is, some were actively migrating to the ocean, along with the hatchery fish, and were probably primarily foraging on drift organisms, while some of the wild fish, particularly the one-year-olds, were behaving as resident fish with considerable foraging on the stream bottom.

Feeding differences between one-year-old and two-year-old wild steelhead may be due to fish size-dependent territorial differences, as well as physical attributes of the fish that determine the size and number of prey that can be ingested. Larger wild fish also tend to become more specialized in prey selection than do smaller fish (Bisson 1978).

Competition for food between recently released hatchery-reared and wild steelhead in the Trinity River appeared to be reduced due to differences in both types and number of prey ingested. Hatchery-reared steelhead quickly adjust to natural feeding, though feeding may be at least temporarily less efficient than in wild steelhead.

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