apparently well adaptable to a wide range of habitats; the occurrence of ringtails has been documented in almost every habitat type in California. Apparently, the only types of habitat in which ringtails have not been found are the Northern Juniper Woodlands (as defined by Munz and Keck 1959) and the highly developed agricultural portions of the San Joaquin Valley.

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INFLUENCE OF MATURITY ON STRAYING RATES OF SUMMER STEELHEAD INTO THE ROGUE RIVER, OREGON[1]

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We captured large numbers of stray summer steelhead, *Salmo gairdneri,* in the Rogue River, Oregon, from 1977 through 1982. More than 95% of the marked strays originated from Iron Gate and Trinity River hatcheries in the Klamath River basin of northern California. Immature steelhead (half-pounders) strayed at significantly higher rates than mature adults. Returning to the natal stream is probably of less adaptive value for half-pounders as compared with maturing adults.

INTRODUCTION

The tendency of Pacific salmon, *Oncorhynchus* spp., and steelhead, *Salmo gairdneri,* to return to natal streams for spawning is widely known. Precise homing may increase survival rates of progeny because distinct stocks of anadromous salmonids appear genetically adapted to the particular characteristics of their environment (Helle 1981). However, some adults stray to spawn in non-natal streams. Straying is most pronounced for transplanted stocks (Ricker 1972), but has also been noted in native stocks (Quinn and Fresh 1984).

Everest (1973) observed a substantial interchange of summer steelhead between the Rogue River in southern Oregon and streams in northern California. These strays were primarily small steelhead 28 to 38 cm in length, known locally as "half-pounders". Half-pounders have a unique life history among steelhead and are limited in distribution to the Eel and Klamath river basins of northern California and the Rogue River in southern Oregon (Figure 1). Other streams in close proximity to these rivers contain steelhead that return as adults only during the winter. Half-pounders return to freshwater during the late summer after spending about 4 months in the ocean (Kesner and Barnhart 1972). Most do not mature, but migrate to the ocean during spring of the succeeding year. Maturing adults return to the Rogue River mostly as summer steelhead, but some also return as winter steelhead (Cramer and McPherson 1982).

In this note, I assess the influence of maturity stage on the straying rate of summer steelhead into the Rogue River and discuss the ecological implications of the differential straying rates of half-pounders and adults.

METHODS

From 1977 through 1982, crews collected summer steelhead at Huntley Park (River Kilometer 13) with a 90 x 3.2-m beach seine. Two wing panels 23 m in

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length, with 7.6 cm square mesh, bracketed a center panel 44 m in length, with 3.5 cm square mesh. We seined 3 days weekly (Monday, Wednesday, and Friday) with a three or four person crew from 10 July through 21 October. Seining began 30 min after sunrise and continued until we completed 15 sets (16 in 1978).

Personnel segregated steelhead by length and hatchery marks. Based on findings by Everest (1973), we classified steelhead smaller than 40.5 cm as half-pounders and larger steelhead as adults. Steelhead were examined for fin clips, brands, or other identifying marks and were measured to the nearest 0.5 cm (fork length) prior to release.

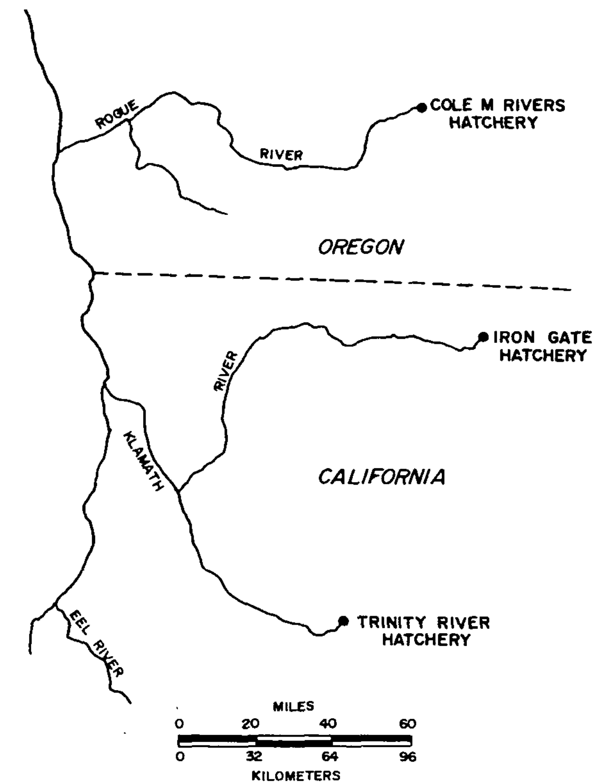

FIGURE 1. River basins with runs of half-pounders in southern Oregon and northern California.

RESULTS

We observed fin clips and cold brands on 2,876 of the 23,058 summer steelhead seined at Huntley Park from 1977 through 1982. Most (83%) of these marked fish originated from juveniles released into the Rogue River from Cole M. Rivers Hatchery. However, 17% of the marked steelhead were released from hatcheries outside of the Rogue River basin. More than 95% of these strays originated from Iron Gate and Trinity River hatcheries in the Klamath River basin of northern California (Table 1).

TABLE 1. Number of Marked Summer Steelhead Released From Various Hatcheries and Recaptured By Seining At Huntley Park, 1977–1982.

				Number seined at Huntley Park	
Hatchery	*Release year*	*Fin clip*	*Number released*	*Half-pounders*	*Adults* [a]
Iron Gate (Klamath River)	1977	D-Ad, ADLP, ADRP	483,742	25	1
	1978	LVRV	200,000	24	2
	1978	D-Ad, LV, RV	345,491	6	3
	1980	Ad	170,117	94	4
	1981	LV	235,730	18	2
Trinity River	1977	LVRP, RVLP, AdLVRP, ADRVLP	370,295	82	4
	1978	ADLVRV	152,876	15	1
	1979	LP, RP, AdLV, AdRV	437,575	59	8
	1980	RVLP, LVRP, AdLP, AdRP	314,689	66	4
	1981	AdRVLP, LVRV, AdLVRP AdRV, AdLV, RV	226,518	49	4
Other	1977–1981	numerous [b]	unknown	21	3
Cole M. Rivers (Rogue River)	1977–1981	numerous	506,549	2,131	262

[a] Captured 1 and 2 years after release.
[b] Includes marks of unknown origin.

From 1977 through 1981, strays originating from hatcheries in the Klamath basin composed an average of 2.8% of the annual returns of half-pounders to the Rogue River. Their importance in the runs varied considerably, ranging from a low of 1.2% in 1981 to a high of 5.8% in 1979. In contrast, marked adults from Klamath basin hatcheries composed an average of 0.8% of the annual returns of adults in 1978 through 1982 and ranged from 0.5% in 1979 to 1.4% in 1980.

Comparisons of the relative abundance of strays within returns of marked half-pounders and subsequent adult returns indicated that half-pounders strayed at higher rates than adults (Table 2). For example, Klamath strays composed 20% of the marked half-pounders seined in 1977, but only 7% of the marked adults seined in 1978. This degree of change implies that half-pounders strayed at a 183% higher rate than cohorts that strayed as adults. The decrease in straying as steelhead matured was significant ($p < 0.05$) in the 1977/1978, 1979/1980, and 1980/1981 returns (Table 2). Changes in run composition within the five half-pounder and subsequent adult returns suggested that straying rates of half-pounders were 87% higher (95% CI = ±71%) than the straying rates of adults.

TABLE 2. Percentage of Marked Klamath Steelhead in the Seine Catches of Marked Steelhead at Huntley Park on the Rogue River, 1977–1982.

Half-pounders		Adults		
Return year	*Percentage Klamath ± 95% CI* [a]	*Return year*	*Percentage Klamath ± 95% CI* [a]	*P for difference*
1977	20.1 ± 3.6	1978	7.1 ± 6.8	0.004
1978	5.8 ± 2.0	1979	3.4 ± 4.4	0.173
1979	72.3 ± 10.4	1980	40.0 ± 22.6	0.002
1980	18.7 ± 2.6	1981	11.2 ± 6.8	0.048
1981	17.9 ± 3.8	1982	11.9 ± 11.4	0.164

[a] $95\%\ CI = \pm t_{.05,\,n-1} \cdot (\sqrt{pq/n-1} + \frac{1}{2}n)$

DISCUSSION

Most biologists recognize the proclivity of anadromous salmonids to return to natal streams with the onset of maturity. However, we found that large numbers of steelhead from the Klamath River basin strayed 100 km north to enter the Rogue River. Marked steelhead released from hatcheries in the Klamath basin composed 3% of the half-pounders seined in the Rogue from 1977 through 1981. During the same years, their cohorts accounted for 10% of the half-pounders seined from the Klamath River (Calif. Dept. Fish and Game, Arcata, unpubl. data). Assuming the runs in both rivers were of similar magnitude, then about 23% (3% ÷ 3%+10%) of the half-pounders originating from Klamath basin hatcheries strayed into the Rogue River.

Wild half-pounders also stray between rivers; possibly to the same degree as hatchery half-pounders. Everest (1973) tagged wild half-pounders in the Rogue River that surveyors found spawning 1 year later in the Klamath River basin. Our tagging studies in 1977 and 1978 confirmed his findings that wild-summer steelhead stray between river basins (Oregon Dept. of Fish and Wildl., unpubl. data).

The entry of immature individuals from saltwater into non-natal streams is not a unique characteristic among anadromous salmonids. Jones (1977) found maturing adults composed less than 50% of the anadromous cutthroat trout, *Salmo clarki,* entering an Alaskan stream. He tagged immature cutthroat as they returned to the ocean. Later, some of these individuals were recaptured as mature adults in other streams 1 to 44 km from the tagging site. Johnston (1981) outlined similar migrational patterns of anadromous cutthroat in some tributaries of Puget Sound and the Columbia River. He felt that the movement of immature cutthroat into non-natal streams represented a complex behavior pattern rather than random straying. The following evidence appears to support his contention.

Many juvenile salmonids migrate in fairly precise patterns. For example, young fry of sockeye salmon, *Oncorhynchus nerka,* will migrate upstream against a current to reach appropriate rearing areas (Raleigh 1967). Experiments by Brannon (1972) showed that the genetic history of parental sockeye influenced the migratory behavior of the progeny. Juveniles of other species of salmonids also make extensive migrations (Hoar 1976). Many biologists believe that such migratory patterns developed so that juveniles could rear in areas where improved environmental conditions increase survival to maturity.

This theory makes the migration of half-pounders into freshwater a paradox because river conditions at the time of entry appear marginal for salmonids due to low flows and high water temperatures. Changes in body condition and growth rate indicate that development slows after entry into freshwater. Kesner and Barnhart (1972) found the body condition of half-pounders decreased proportionally in relation to the amount of time spent in freshwater. While residing in the river, half-pounders grow only about 1 cm in length. In comparison, cohorts remaining in the ocean grow about 15 cm during the same time interval (McPherson and Cramer 1982).

Although the potential for growth decreases, entry of half-pounders into freshwater may increase survival rates. At Cole M. Rivers Hatchery, less than 1% of the winter steelhead released as juveniles returned as adults. Conversely, adult returns from releases of juvenile summer steelhead averaged 2.8% (Evenson and Ewing 1984). This difference in survival rates may be attributable to a difference in life history strategies between the two races. While virtually all summer steelhead make half-pounder migrations, only 21% of scales taken from adult winter steelhead showed evidence of a half-pounder migration (McPherson and Cramer 1982).

Based on this evidence, I infer that the freshwater migration of half-pounders developed as a behavioral mechanism to reduce ocean mortality rates for summer steelhead produced in streams within northern California and southern Oregon. If this hypothesis is true, and the survival rate of half-pounders in freshwater is higher than the survival rate of cohorts remaining in the ocean, then there may be little or no adaptive advantage associated with the choice of which stream to enter.

During one summer, after a rare freshet breached sand bars blocking the mouths of two small streams on the southern coast of Oregon, survey crews collected half-pounders marked as smolts at hatcheries in the Klamath and Rogue river basins (Oregon Dept. of Fish and Wildl., Corvallis, unpubl. data). Such imprecise homing may reflect indiscriminate selection of streams to enter. Later, as maturation occurs, the precision of homing increases and acts as a behavioral mechanism which insures progeny rear in an environment for which they are adapted.

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