NOTES

HOMING AND FISHERIES CONTRIBUTION OF MARKED COHO SALMON, *ONCORHYNCHUS KISUTCH*, RELEASED AT TWO COLUMBIA RIVER LOCATIONS

In 1970 we conducted an experiment to determine if coho salmon, *Oncorhynchus kisutch*, released away from the rearing site would return to the release area and contribute to the fisheries there (Vreeland et al. 1975). We found the coho salmon returned almost exclusively to the release area and contributed to the fisheries near the release site. However, because the single fin marks applied were duplicated by other experimenters on the Pacific coast, we could not evaluate the contribution of the two groups to the ocean fisheries. We also surmised a possible detrimental effect of transportation on the survival of the group released downstream from the hatchery.

In 1972 we initiated a study with 1971-brood coho salmon to 1) confirm the homing results of the previous study, 2) eliminate possible differences in survival due to transportation, and 3) determine the contribution of the release groups to the Pacific coast fisheries.

Methods

We chose coho salmon originally from Klaskanine Hatchery in Oregon, the same fish stock used in the previous study. Hatchery personnel collected adults and took eggs at Little White Salmon National Fish Hatchery, located near Cook, Wash., on the Little White Salmon River about 1.5 km (1 mi) upstream from its confluence with the Columbia River and 242 km (150 mi) from the Pacific Ocean (Fig. 1). Coho salmon were reared at Willard National Fish Hatchery, 4.5 km (3 mi) up the Little White Salmon River from Little White Salmon Hatchery.

The two groups of fish were hatched and raised under uniform conditions in hatchery ponds. Fin clipping took place in September 1972 at Willard Hatchery. We applied two marks to the fish: adipose right ventral (Ad-RV) and adipose left ventral (Ad-LV).

Youngs Bay (Fig. 1) was selected as the release site, situated about 19 km (12 mi) upstream from the mouth of the Columbia River and fed by four small rivers: Lewis and Clark, Walluski, Youngs, and Klaskanine Rivers. We transported the Ad-RV marked coho salmon 253 km (157 mi) in about 4 h to Youngs Bay on 14 and 15 May 1973, where they were released at a public launch ramp. We transported the fish in two tank trucks, each 3,785 l (1,000-gal) capacity. Each truck was loaded with 462 kg (1,018 lb) of fish at 57.8 fish/kg (26.2 fish/lb) or about 26,700 fish. During the 2 d, we transported 106,852 Ad-RV marked coho salmon weighing 1,847 kg (4,072 lb) from Willard Hatchery to Youngs Bay (Table 1).

To maintain similar handling procedures and equalize any possible effects of transportation on survival, we transported the Willard Hatchery release for a time and distance similar to the Youngs Bay release. On 16 and 17 May 1973, we hauled 107,707 Ad-LV marked coho salmon weighing 1,835 kg (4,045 lb) in the same two tank trucks used for the Youngs Bay release. The fish were transported about 161 km (100 mi) for 3 h and 35 min on 16 May and 182 km (113 mi) for 3 h and 50 min on 17 May. Each truck contained about 458 kg (1,010 lb) of coho salmon. The hatchery crew released all the coho salmon from Willard Hatchery into the Little White Salmon River on 17 May.

We used catches of marked coho salmon in the fisheries and hatchery return data to determine the effect of release site on contribution and homing. Sampling for fin-marked coho salmon took place in 1973 and 1974 in the major Pacific coast salmon fisheries of Alaska, Washington, Oregon, and California, the Columbia River fisheries, and at potential hatchery return sites on the Columbia River. State fishery personnel sampled the Alaska troll fishery, the California, Oregon, and Washington ocean sport and troll fisheries, and the Columbia River gill net fishery. Personnel from National Marine Fisheries Service sampled catches from the Youngs Bay gill net fishery at two fish processing plants.

TABLE 1.—Numbers of marked coho salmon released in the Columbia River for the homing experiment. Ad-RV = adipose right ventral; Ad-LV = adipose left ventral.

Fin mark	Releases No.	Releases kg	Fish/kg	Release date	Release location
Ad-RV	106,852	1,847	57.9	14-15 May 1973	Youngs Bay
Ad-LV	107,707	1,835	58.7	17 May 1973	Willard Hatchery

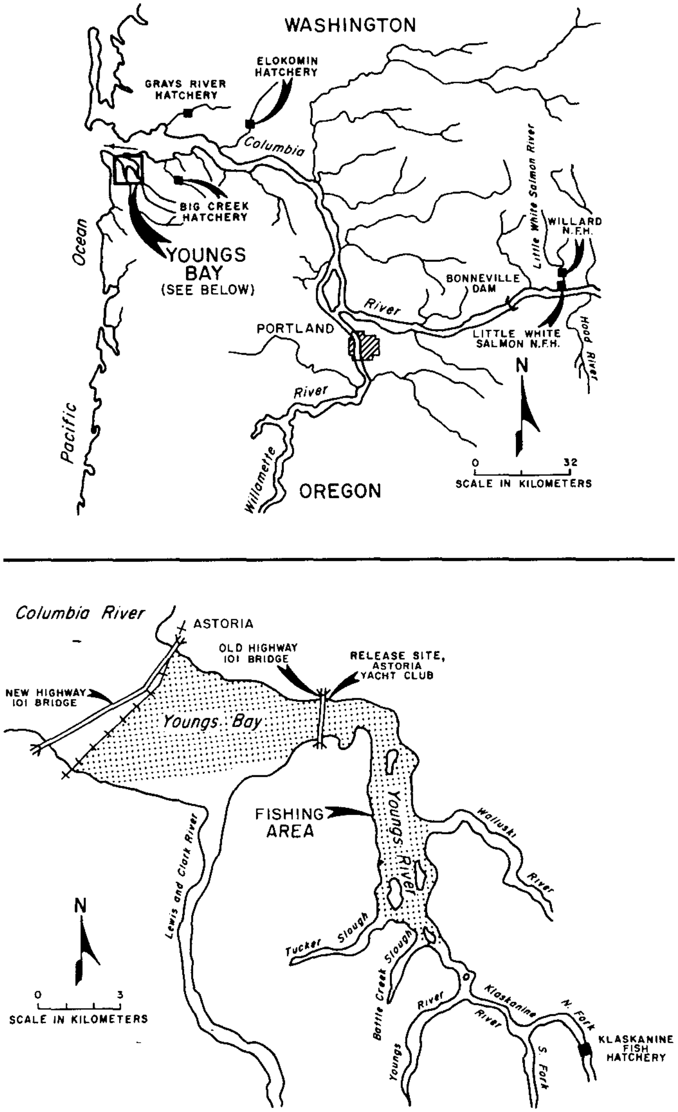

FIGURE 1.—Columbia River study area showing location of Willard and Little White Salmon National Fish Hatcheries and detailed features of the Youngs Bay region.

Returns of coho salmon to hatcheries near the two release sites were examined for marked fish to assess the effect of release site on homing. Hatchery personnel examined all returns to Little White Salmon National Fish Hatchery for marked coho salmon in the fall of 1973 and 1974. A series of waterfalls blocks access to Willard Hatchery; therefore, coho salmon released from Willard return to Little White Salmon Hatchery. In addition, State personnel examined all returns at the following hatcheries for marked coho salmon: Klaskanine Salmon Hatchery on the Klaskanine River (a tributary of Youngs Bay); Big Creek Salmon Hatchery on Big Creek near Knappa, Oreg.; the Elokomin Salmon Hatchery on the Elochoman River near Cathlamet, Wash.; and the Grays River Salmon Hatchery on the Grays River near Grays River, Wash. (Fig. 1).

Results

Homing

We compared 1) the location of catch within the Columbia River and 2) return sites of the two marked groups to determine the accuracy of homing to the release site.

The fish in this study returned almost exclusively to the area of release, similar to fish in previous studies (Rounsefell and Kelez 1938; Taft and Shapovalov 1938; Donaldson and Allen 1957; Ellis 1968[1]; Jensen and Duncan 1971; Mahnken and Joyner 1973; Vreeland et al. 1975; Scholz et al. 1976). No Willard Hatchery release fish were caught in the Youngs Bay fishery, but 199 Youngs Bay release fish were caught in the fishery. Only two Youngs Bay releases were seen in hatchery returns, one at Klaskanine Hatchery and the other at Little White Salmon Hatchery (Table 2). Hatchery personnel observed only 26 Willard releases at Little White Salmon Hatchery. Construction in 1974 of a new barrier dam and fish ladder at the hatchery may have prevented some coho salmon from entering the hatchery ponds. However, the hatchery biologist at Little White Salmon Hatchery believed most fish entered the adult holding ponds prior to the ladder closure.[2]

The specificity of the homing we observed is apparently linked to the physiological stage of parr-smolt transformation. Work by Hasler (1966) and Carlin (1968) indicated the imprinting process occurs rapidly at the time of parr-smolt transformation. With steelhead trout, *Salmo gairdneri*, Wagner (1969) hypothesized the homing imprint is acquired rapidly before and/or during downstream migration. Mighell (1975)[3] found fish exposed to a new water source for as little as 4 h will imprint on the new source. Coho salmon released in a Lake Michigan tributary strayed extensively (Peck 1970). Hasler et al. (1978) postulated that this was due to releasing the fish after smolting had taken place. Jensen and Duncan (1971) described accurate homing with coho salmon released at "smolt size." Cooper et al. (1976) found a 2-d exposure to morpholine at the onset of smolting imprinted fish to the chemical as well as did a 30-d exposure. W. S. Zaugg (1975),[4] who has attempted to define more closely the onset of the parr-smolt transformation, feels the imprinting will not occur until a certain stage of the transformation is reached. Unfortunately, none of the authors (nor do we) indicate a stage of the parr-smolt transformation at time of release. Time of smolting and imprinting has yet to be defined closely enough to predict the homing location of fish released in different areas. Until more is learned, we expect varying results could occur with homing studies depending on when the fish are released.

TABLE 2.—Number of 1971-brood Youngs Bay and Willard Hatchery release coho salmon recovered at five Columbia River hatcheries, 1973 and 1974. Ad-RV = adipose right ventral; Ad-LV = adipose left ventral.

	Youngs Bay release (Ad-RV)			Willard Hatchery release (Ad-LV)		
Hatchery	1973	1974	Total	1973	1974	Total
Klaskanine	0	1	1	0	0	0
Big Creek	0	0	0	0	0	0
Grays River	0	0	0	0	0	0
Elokomin	0	0	0	0	0	0
Little White Salmon	1	0	1	2	24	26
Total	1	1	2	2	24	26

Fishery Contribution

We examined ocean and Columbia River catches of coho salmon to determine the contribution of both release groups to the Pacific coast fisheries. Fishery samplers saw 350 Youngs Bay releases and 78 Willard releases in 1973 and 1974 (Table 3). No coho salmon from either release were observed in the catches of Alaska commercial fisheries. Fisheries samplers in Canada did not examine coho salmon for multiple fin marks; however, on the average, Canadian fishermen land only 6% of all Columbia River hatchery coho salmon (Wahle et al. 1974). Catches of the two marked groups occurred primarily in the Washington, Oregon, and California marine fisheries and the Columbia River gill net fishery.

Total estimated catches for 1973 and 1974 of Youngs Bay and Willard release groups are 2,455 and 598, respectively. Catches in the Oregon and California troll fisheries contained over 50% of both marked groups (55% Ad-RV, Youngs Bay and 61% Ad-LV, Willard releases). Washington marine recoveries occurred primarily near the Columbia River, except for catches of Willard release coho salmon at LaPush on the north Washington coast. Landings of Willard release fish at LaPush comprised nearly one-half of the release caught in the Washington troll fisheries.

[1]Ellis, C. H. 1968. A return of adult coho salmon demonstrating a high degree of selectivity in homing. *In* Proceedings of the Northwest Fish Culture Conference, December 4-6, 1968, Boise, Idaho, p. 40-42. Unpubl. manuscr. Wash. Dep. Fish., 115 Gen. Admin. Bldg., Olympia, WA 98504.

[2]S. L. Leek, U.S. Fish and Wildlife Service, Little White Salmon National Fish Hatchery, Willard, WA 98605, pers. commun., September 1978.

[3]Mighell, J. 1975. Some observations on imprinting of juvenile salmon in fresh and saltwater. *In* Summary notes from papers presented at homing workshop. Unpubl. manuscr., p. 11-12. Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

[4]W. S. Zaugg, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112, pers. commun., November 1975.

TABLE 3.—Observed (in parentheses) and estimated catches of marked 1971-brood coho salmon released from the two Columbia River sites and recovered in Pacific coast fisheries, by fishery type and year of capture.[1] Ad-RV = adipose right ventral; Ad-LV = adipose left ventral.

Location	Fishery type	Youngs Bay release (Ad-RV) 1973	1974	Total	Percent	Willard Hatchery release (Ad-LV) 1973	1974	Total	Percent
Alaska	Commercial	([2])	0	0	0	([2])	0	0	0
British Columbia	Commercial	([3])	([3])	([3])	—	([3])	([3])	([3])	—
	Sport	([3])	([3])	([3])	—	([3])	([3])	([3])	—
Washington									
Ocean	Troll	0	144(18)	144	6	0	47(9)	47	8
	Sport	0	219(32)	219	9	0	65(11)	65	11
Puget Sound	Commercial	0	0	0	0	0	0	0	0
	Sport	0	0	0	0	0	0	0	0
Oregon	Troll	0	668(84)	668	27	0	229(29)	229	38
	Sport	0	117(24)	117	5	12(1)	41(7)	53	9
California	Troll	0	694(65)	694	28	0	139(18)	139	23
	Sport	0	49(7)	49	2	0	5(1)	5	1
Columbia River	Gill net	0	365(14)	365	15	0	60(2)	60	10
	Indian[4]	0	0	0	0	0	0	0	0
	Sport	0	0	0	0	0	0	0	0
Youngs Bay	Gill net	6(2)	193(104)	199	8	0	0	0	0
Total		6(2)	2,449(348)	2,455	100	12(1)	586(77)	598	100

[1]Data obtained from: "1973 fin-mark sampling and recovery report for salmon and steelhead from various Pacific Coast fisheries" and "1974 Wire tag and fin-mark sampling and recovery report for salmon and steelhead from various Pacific Coast fisheries," Fish Commission of Oregon, Clackamas, Oreg.
[2]Not sampled.
[3]No sampling for multiple fin-marked coho.
[4]Setnet and dip net fisheries.

Overall fishery contribution rates for this study are lower than rates reported in studies conducted in the 1960's with coho salmon from Columbia River hatcheries. For all fisheries combined, the Youngs Bay release contributed 23.0 fish/1,000 released, and the Willard release contributed 5.6 fish/1,000 released. In a diet test at Washougal Hatchery (Senn and Noble 1968), the contribution of 1961-brood coho salmon, fed a diet similar to that fed the 1971-brood, was 51 fish/1,000 releases to the Pacific coast fisheries. Wahle et al. (1974) found the average contribution to the fisheries of 1965 and 1966 brood coho salmon was 55 fish/1,000 releases at Columbia River hatcheries. Fishery contributions of marked groups of 1967-, 1968-, and 1969-brood coho salmon at Cowlitz Hatchery ranged from 21 to 52 fish/1,000 releases.[5] In the earlier 1968-brood study, the Willard Hatchery release contributed 7.7 fish/1,000 releases to the Columbia River and Youngs Bay fisheries. We do not know the reasons for the poorer survival of the 1971-brood fish.

The release site significantly affected fishery contribution despite the low survival. We believe the Youngs Bay release survived at a higher rate than the Willard release fish because the Youngs Bay release contributed more heavily to all fisheries sampled than did the hatchery release. The contribution ratios of the Youngs Bay release to the Willard Hatchery release by fishery are 3.2:1 for Washington marine fisheries, 2.8:1 for Oregon ocean fisheries, 5.2:1 for California ocean fisheries, 9.4:1 for the Columbia River fisheries, and 4.1:1 overall. Differences between contribution rates when all fisheries are combined are significant ($\chi^2 = 137.36$).

We postulated two possible reasons for the higher fishery contribution of the Youngs Bay release. The Youngs Bay release possibly had a higher survival to the estuary than did the Willard hatchery release because the former group avoided downstream-migration mortalities from predation, gas bubble disease, and from passing over spillways or through turbines at the Bonneville Dam. A number of authors have reported the adverse effects of Columbia River dams on survival of juvenile salmonids (Schoeneman et al. 1961; Bell et al. 1967[6]; Long et al. 1968[7]; Bell and DeLacy 1971[8]; Ebel et al. 1973; Slatick et al.

[5]Hopley, C. W. 1975. Informal interim report on portions of 1967-, 1968-, and 1969-brood Cowlitz River coho stock timing evaluation. *In* Coho marking program on the lower Columbia River. Unpubl. manuscr., p. 9-43. Wash. Dep. Fish., 115 Gen. Admin. Bldg., Olympia, WA 98504.

[6]Bell, M. C., A. C. DeLacy, and G. J. Paulik. 1967. A compendium on the success of passage of small fish through turbines. Unpubl. manuscr., 268 p. U.S. Army Corps Eng., Portland Dist., Fish Eng. Res. Program, P.O. Box 2946, Portland, OR 97208.

[7]Long, C. W., R. F. Krcma, and F. J. Ossiander. 1968. Research on fingerling mortality in Kaplan turbines—1968. Unpubl. manuscr., 7 p. Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

[8]Bell, M. C., and A. C. DeLacy. 1971. A compendium on

1975; Collins et al. 1975[9]; Collins 1976; Ebel and Raymond 1976). Ebel (1970) found groups of fall chinook salmon, *Oncorhynchus tshawytscha*, released below Bonneville Dam, had over twice the survival rate to the Columbia River estuary compared with a group released above the dam. The low flow of the Columbia River in 1973 caused a particularly serious passage and survival problem for juvenile salmon because most of the river flowed through the turbines at the dams.[10]

A second possible reason for the higher contribution of the Youngs Bay release is that the bay may provide a better rearing area than the hatchery release site because food is more abundant. A large concentration of the amphipod *Corophium salmonis* occurs in Youngs Bay, particularly in May, and is a major food item for coho salmon in the bay.[11] Abundant food could have given the Youngs Bay release an initial survival advantage.

Summary

We conducted this study to confirm previous results on the feasibility of creating or enhancing a fishery in a specific area by releasing hatchery salmon into that area. We compared the location of return and contribution with the Pacific coast fisheries of coho salmon released at two locations on the Columbia River. Two groups each of about 100,000 1971-brood coho salmon at Willard National Fish Hatchery were fin clipped: In May 1973 one group was released at Youngs Bay near Astoria, Oreg., and the other at Willard Hatchery. Both groups were transported an equal time and distance prior to release to equalize any possible effects of transportation on survival.

Marine sport and commercial salmon fisheries of the Columbia River and Youngs Bay, as well as Columbia River hatchery returns, were sampled for marked coho salmon in 1973 and 1974. Over one-half of both groups of marked fish were caught by Oregon and California marine sport and commercial fishermen. Recoveries of the remaining marked fish occurred in Washington, Columbia River, and Youngs Bay fisheries. The Youngs Bay release contributed 23 fish/1,000 releases to the Pacific coast fisheries, and the Willard Hatchery release contributed 5.6 fish/1,000 releases. The fish homed to the release site with little straying. Only one Youngs Bay release returned to Little White Salmon National Fish Hatchery.

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[10]Columbia River Fisheries Council. 1978. Recommendations of Columbia River Fisheries Council for in-stream flows in the Columbia and Snake Rivers. Unpubl. manuscr., 24 p. Columbia River Fish. Counc., Suite 1240, Lloyd Bldg., 700 N.E. Multnomah St., Portland, OR 97232.

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MOVEMENT PATTERNS OF BONEFISH, *ALBULA VULPES*, IN BAHAMIAN WATERS

The regular daily movement patterns of fishes appear closely related to predictable changes in their environment. Factors such as tidal fluctuations (Dodson and Leggett 1973; Stasko et al. 1973), light levels (Yuen 1970; Collette and Talbot 1972; Standora et al. 1972; McFarland et al. 1979), and temperature (Coutant 1975; Kelso 1976; Haynes et al. 1978; Langford et al. 1979) have been found to influence the cyclic movement of fishes. Until recently, most information on such movement patterns has been obtained primarily through direct observation. However, there are many situations in which direct visual methods are not feasible. An alternate means of obtaining such information has been provided by recent advances in the use of ultrasonic telemetry as a research tool.

Ultrasonic telemetry has become a valuable technique both in freshwater and deep marine environments. However, the use of ultrasonics in coastal waters is still in the early developmental stages. Rapid signal attenuation occurs under such conditions because of combined effects of the high conductivity of the water, vegetative growth, turbulence, and bottom reflection (Stasko and Pincock 1977).

This research attempted to use ultrasonics to determine movements and daily activity patterns of the bonefish, *Albula vulpes*, in Bahamian waters. The only prior attempt at scientifically studying bonefish movements in the western Atlantic region was by Bruger,[1] who initiated a

[1]G. E. Bruger, Research Biologist, Florida Department of Natural Resources, Marine Research Laboratory, 100 Eighth Ave. SE., St. Petersburg, FL 33701, pers. commun. May 1980.