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MIGRATORY BEHAVIOR OF COHO SALMON SMOLTS (ONCORHYNCHUS KISUTCH) IN GRAYS HARBOR, WASHINGTON

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ABSTRACT

Using ultrasonic transmitters, we tracked fifteen coho salmon smolts in Grays Harbor, Washington, to document patterns of seaward migration. All fish were tracked continuously on the day of release and 12 fish were relocated on subsequent days, yielding 1032 h of intermittent observation. Fish moved in the direction of the current and also tended to hold position in areas of low current velocity near large structures such as pilings and docks, particularly in the area around Cow Point. Holding periods ranged from several hours to 12 d. To determine whether such migratory behavior is normal, or a consequence of human interference (i.e., industrial discharge, dredging, or shoreline development) similar tracking efforts are needed in more pristine locations.

INTRODUCTION

The Chehalis River drainage is the second largest watershed in Washington (Fig. 1). Coho salmon smolts from the Chehalis River have generally lower survival levels than those from the smaller, less industrialized Humptulips River, which also empties into Grays Harbor estuary. Evidence suggests that the difference in survival occurs during smolt migrations (S. Schroder, pers. comm.). The smolts from these two rivers may encounter unequal predation pressure, food availability, pathogen incidence or water quality. Information on the actual routes and timing of Chehalis River smolt migrations is needed before the relative importance of these factors can be assessed. With such information, laboratory and field experiments can be developed using realistic exposure times and dose levels for pollution bioassays. We therefore tracked coho salmon smolts from the lower Chehalis River into Grays Harbor estuary to document smolt migration routes and rates of travel in the spring of 1988, with additional tracking planned for 1989. The following is a preliminary report of our findings.
MATERIALS AND METHODS

Wild coho salmon smolts were collected from a weir in Scatter Creek, a tributary of the Chehalis River, and transported to a holding site at the mouth of the Wishkah River (Fig. 1). The fish were collected at least 24 h (but no more than 1 week) prior to use. Smolts were held in mesh pens (1.5 m², 4 mm mesh) which were suspended in a 2x3 m wooden box. Water flow in the box was regulated with movable mesh screens to protect the fish from rapid currents while allowing continuous exchange of water in the holding pens.

The smolts were tagged with ultrasonic transmitters (Vemco V2B-1L) 1-3 d before release. The transmitters were cylindrical, 33x9 mm, and weighed 4.6 g in air (2.5 g in water). Only smolts >160 mm fork length (FL) were tagged (mean=187 mm), in order to minimize the effects of transmitters on fish behavior and swimming performance (Moser et al. in press). We anaesthetized the fish with MS-222 (50 mg/l, 2-4 min) and gently pushed the transmitters down the esophagus with a smoothed wooden rod until they were no longer visible. The fish were then allowed to recover from the anaesthetic in a cooler (approximately 30 min) before being returned to the holding pen. Depth of water in the holding pen was reduced to 0.5 m for fish with transmitters so that they could easily reach the surface to fill the air bladder.

Two release sites in mid-channel of the Chehalis River were chosen: upper and lower (Fig. 1). The first 5 fish were released at the upper site and the remaining 10 at the lower one. Transmitter signals were detected using a directional hydrophone and tunable receiver (Vemco Ltd). Fish locations were estimated by determining the position of the tracking boat using a chart with grid marks. Location and water depth were recorded every 10 min for up to 16 h following release of each fish. Current velocity and direction at a depth of 1 m were measured every 30 min (Aqua Meter #660 Speed/Log) when possible.

Tagged fish were relocated on subsequent days by running mid-channel transects of the river. Tag signals were transmitted on four different frequencies to permit individual identification of relocated fish.

RESULTS

Fifteen coho smolts were tracked intermittently for a total of 1032 h. The movements of a representative fish are shown in Fig. 2. Twelve of the 15 fish spent more than 70% of the time holding in areas of low current velocities, usually around docks and pilings (Table 1). Periods of holding were defined as those times when a fish stayed in the same location over a tide change, 6.5 h. Seven of the ten fish which reached the area around Cow Point stayed in this location for over 24 h. Because the fish made local
movements during holding periods we were able to establish that they had not regurgitated their transmitters or died. When moving, the fish tended to move in the direction of tidal currents (Fig. 2). This tendency to reverse direction during tide changes was reflected in high ratios of gross:net distance travelled by the fish (Table 1). Six of the nine fish which passed Cow Point moved down the harbor via the North Channel and three followed the South Channel.

**DISCUSSION**

Chehalis coho smolt migration in Grays Harbor estuary was characterized by fish movement in the direction of the current and extensive periods of holding in areas of low current velocity. Ultrasonic tracking of Atlantic salmon smolts (Salmo salar) also revealed that smolts moved in the direction of tidal currents (Fried et al. 1978, Tytler et al. 1978) and in some cases exhibited extended periods of holding (Tytler et al. 1978). We found that fish holding behavior was most common in the region around Cow Point. Beach seine sampling in Grays Harbor has also indicated that coho salmon smolts are more abundant at this site than at other locations in the area (Simenstad and Eggers 1981). Cow Point is located at the confluence of the two major channels in Grays Harbor and there are large docks and numerous pilings in the area. Consequently, current flow in this area was complicated, with numerous back eddies and areas of slack water. Fish primarily oriented to current flow may accumulate at this site because of its hydrography. Similarly, prey organisms may accumulate at this location which could result in fish feeding aggregations. Finally, water quality at Cow Point may be affected by nearby pulp mill and sewage discharge points, resulting in altered fish behavior in this region (Fig. 1).

The extended periods of holding by smolts in Grays Harbor resulted in long estuarine residence times. In moving fish from Scatter Creek to our release sites in the Chehalis River we may have eliminated cues important to fish orientation during the transition from uni-directional river flow to reversing tidal currents. Future studies should evaluate whether transplanting fish in this way significantly alters smolt migratory behavior. Finally, tracking studies in less industrialized areas are needed to determine whether the migratory behavior we observed is typical of coho salmon smolts or a consequence of anthropogenic perturbations of the estuary.
LITERATURE CITED


Table 1. Distances travelled and patterns of holding for coho salmon smolts tracked in Grays Harbor, Washington.

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<th>Fish #</th>
<th>Fish size (mm FL)</th>
<th>Time tracked (h)</th>
<th>Gross distance (km)</th>
<th>Net distance (km)</th>
<th>% Time spent holding</th>
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Fig. 1. Locations of holding pens, release sites and pulp mill discharge points in the Chehalis River, Washington.
Fig. 2. Location of fish #15 at 30 min intervals during ebbing (circles) and flooding tides (squares). Lengths of time spent holding are shown at the holding site and sites where fish was relocated are represented by starred circles.