Tracking Seasonal Movements of Adult Pacific Herring in Prince William Sound

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Introduction

Along the eastern Pacific, adult Pacific herring (*Clupea pallasii*) often overwinter in habitats located in nearshore channels and close to spawning areas (Hay and McCarter 1997). This behavior pattern has been observed in the Prince William Sound (PWS) herring population, where historically large schools both overwintered and spawned around northern Montague and Green Islands. More recently, the major biomass of adult herring during winter has shifted to the northeast and southwest areas of PWS. Currently the largest concentration of adult herring overwinters and spawns around Port Gravina and Port Fidalgo (R. Thorne, PWS Science Center, pers. comm.). Some spring spawning aggregations are not located near known overwintering areas suggesting that: a) some adult herring populations are overwintering in areas outside of PWS; or, b) not all PWS overwintering populations are being detected; or, c) overwintering schools such as those at northeast PWS form smaller schools in spring with some schools moving away from their overwintering area to spawn.

Where PWS adult herring disperse to after spawning is poorly understood. In other parts of its range, it is common for large herring populations to migrate from nearshore spawning areas to coastal shelf areas for summer feeding habitat (Hay and McCarter 1997, Hay et al. 2008). To date, our only information on PWS adult herring movements comes from a study by Brown et al. (2002) that compiled local and traditional knowledge. In that study, fishers reported herring moving in fall up Montague Strait prior to the fall bait fishery while others reported herring moving into PWS in spring through Hinchinbrook Entrance, Montague Strait and the southwest passages of Erlington and LaTouche. These observations suggest that PWS herring are regularly migrating out of PWS and onto the shelf.

Acoustic transmitters make it possible to monitor fish movements both across large distances (Heupel et al. 2006) and in structurally complex habitats like those found in nearshore areas (Bishop et al. 2010). For herring, acoustic tags offer many advantages, including: 1) the potential for multiple data points over time and space for each individual fish; 2) minimal handling - fish are captured and handled only once; 3) transmitters can be implanted quickly, with low mortality and with low tag expulsion; 4) transmitters are programmed for individual identification; and 5) the capability to use portable receivers to monitor spawning schools or large wintering schools of herring regardless of the location (Bishop 2008).

In October 2008 the Pacific Ocean Shelf Tracking Project (POST), PWS Science Center (M.A. Bishop, Co-PI), University of South Alabama (S. Powers, Co-PI) and the PWS Oil Spill Recovery Institute installed across the mouth of Port Gravina the first long-term, large-scale hydroacoustic array in Prince William Sound (Fig. 1). At that same time, Bishop and Powers installed eight portable receivers at pinnacles near the POST array. In September 2010 we installed a new array at the mouth of Zaikof Bay near Hinchinbrook Entrance consisting of six portable receivers. At both Port Gravina and Zaikof Bay, acoustic-tagged lingcod (*Ophiodon elongatus*) are currently being monitored (Bishop et al. 2010).

In summer 2011, PWS Science Center and POST will collaborate with the Ocean Tracking Network (OTN) to install two, large-scale arrays including one across the mouth of Hinchinbrook Entrance and one across Montague Strait, and three, small arrays at the southwest PWS passages of Erlington, LaTouche, and Prince of Whales (Fig. 2). Equipment will be assembled and configured by PWS Science Center personnel in Cordova.

The Herring Marking Workshop sponsored by EVOS in December 2008, reviewed all potential marking methods for herring and stated with regards to acoustic tagging:

A specific recommendation is the conditional endorsement of acoustic tagging, with the caveat that the initial involvement should be limited. Arrays of acoustic receivers have been installed in PWS and there may be opportunities to leverage costs with other organization, so the present time is an excellent opportunity to pursue this approach…. It seems probable that useful information on herring ecology and migratory movements could be revealed by acoustic tagging (source: draft Integrated Herring Restoration Plan 2010, page 134).

Objectives

Here we propose to synergize with efforts of POST and OTN by marking adult Pacific herring with acoustic tags during fall 2011 and 2012. Fish will be tagged in collaboration with Alaska Department of Fish and Game and during their herring surveys. Specifically, the objectives of this project are:

(1) Field test the application of recent advances in acoustic telemetry on wild adult herring.

(2) Elucidate herring movement patterns between overwinter and spawning sites.

(3) Utilize the PWS acoustic arrays to monitor herring migration into and out of PWS.

Materials and Methods

Our tagging efforts will coincide with Alaska Department of Fish & Game (ADFG) surveys for adult herring (known as bait surveys) in November 2011 and November 2012. Following purse-seine capture of adult herring by the ADFG vessel, we will use a dipnet to collect herring then transfer healthy individuals to a 40 gallon aquarium containing aerated, ambient seawater aboard our research vessel. Surgical protocol will follow procedures used for implanting acoustic transmitters into age 2 and 3 Pacific herring (average size 180 mm) and similar sized Pacific salmon smolts (Welch et al. 2007; Seitz et al. 2010). Prior to surgery, individual herring will be transferred to a small, aerated bath containing ambient seawater and buffered tricaine methanesulfonate (MS-222; 60 mg/L), an anesthetic. Following sedation, the fish will be weighed, measured for standard and fork length, then placed on a V-shaped surgery board lined with a disposable surgical mat. During surgery the opercular cavity will be gently irrigated with ambient seawater.

For transmitter insertion, we will make a small incision (11-12 mm) along the ventral midline anterior to the pelvic fins. A Vemco series V9-1L acoustic transmitter (Vemco, Halifax, Nova Scotia) programmed to transmit an individually-encoded signal at 90-270 s random intervals will be inserted

into the abdominal cavity. Each transmitter measures 24 x 9 mm and weighs 3.6 g, and has an estimated battery life of 413 d. The incision will be closed with two sutures then swabbed with a broad spectrum antibiotic ointment. The surgical procedure will take less than 2 min per fish. Following surgery, fish will be held for recovery in an aquarium aerated with ambient seawater until equilibrium (upright swimming) and active swimming are observed. Post recovery we will release fish at the capture site.

The first winter we will tag up to 25 herring around Port Gravina and Port Fidalgo. The second winter we will expand our efforts to tag up to 75 herring across multiple overwintering areas seined by ADFG. For 1-2 d after tagging, we will monitor fish using a mobile, omnidirectional VH165 mobile hydrophone. In spring 2012 and 2013 we will use the mobile hydrophone to monitor for tagged fish around Port Gravina and Port Fidalgo spawning areas, as well as spawn areas identified during the expanded adult surveys (2013 only). Data from arrays will be uploaded every 6 to 9 months by the PWS Science Center and University of South Alabama and archived in the POST and OTN data bases, as per their guidelines.

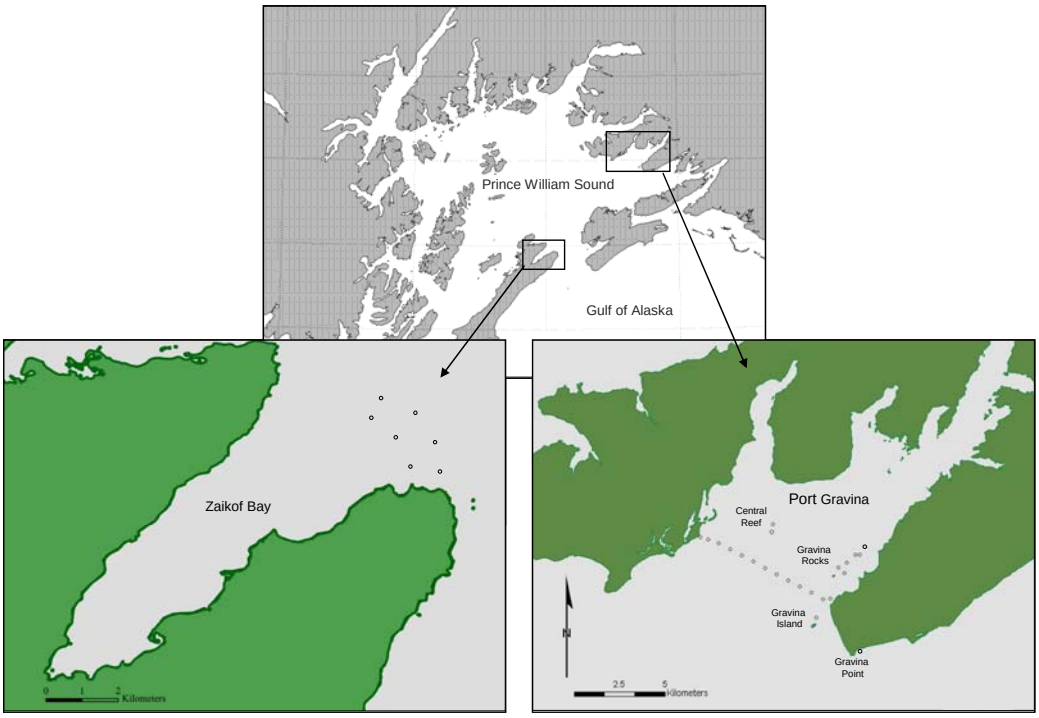

Figure 1. Map of Prince William Sound, Alaska, and acoustic array locations at Zaikof Bay and Port Gravina. Circles indicate the positions of hydro-acoustic receivers. Overwintering adult herring in this area will be captured and tagged during ADFG seine surveys in November 2011 (Port Gravina vicinity) and November 2012 (Port Gravina and additional areas).

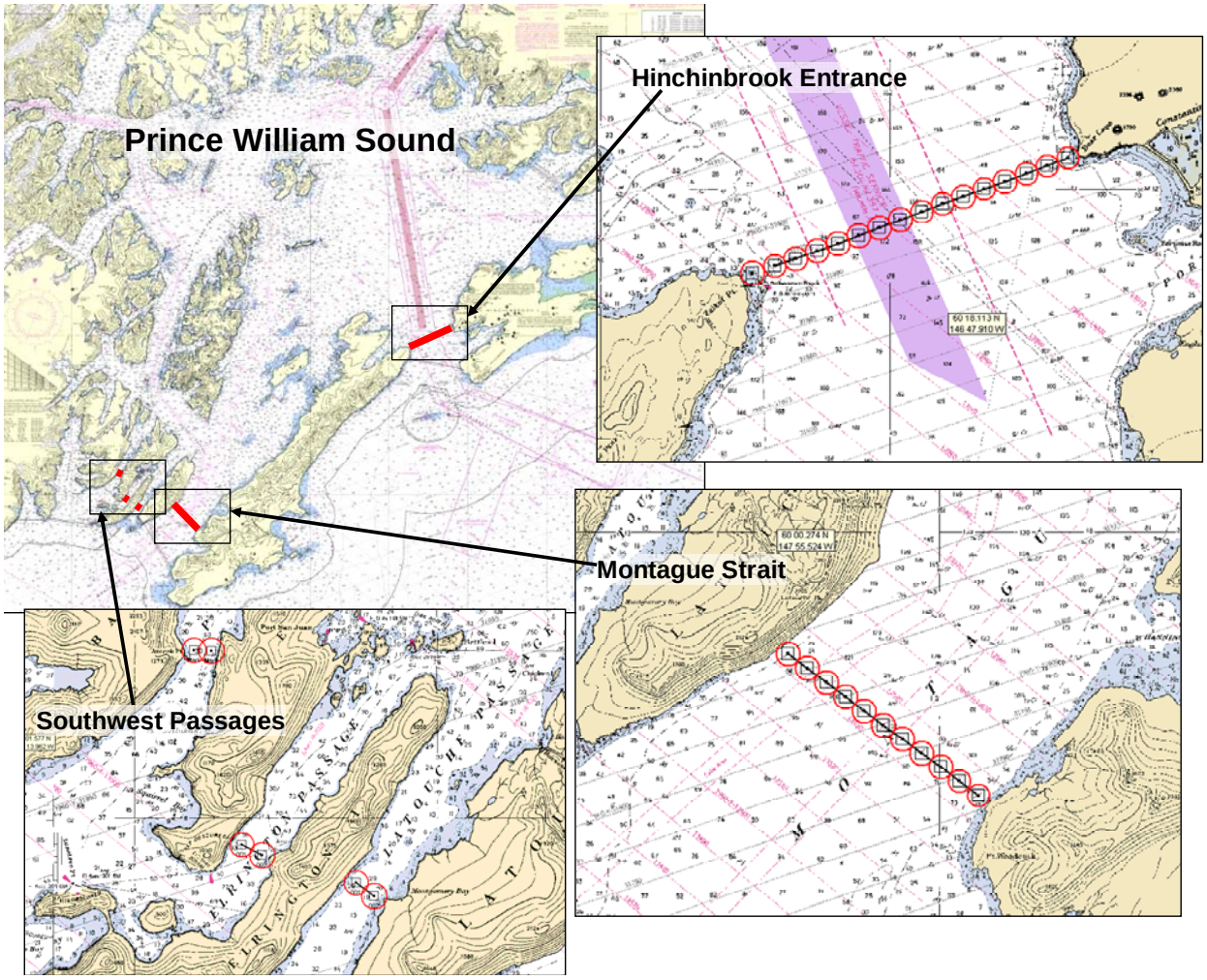

Figure 2. Proposed POST/OTN array locations, scheduled to be installed by PWS Science Center in summer 2011