PRELIMINARY RESEARCH PROPOSAL (COE)(FY07)

Title: Electronic recovery of ISO-PIT tags from piscivorous bird colonies in the Columbia River Basin

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PROJECT SUMMARY

Annually, piscivorous birds prey upon millions of juvenile salmonids *Oncorhynchus* spp., many of which have been PIT tagged, as they emigrate from the Columbia River Basin (Roby et al. 1998; Ryan et al. 2001). We propose to continue the sampling initiated in 1998 by using modified PIT-tag detection equipment (Ryan et al. 2001) to detect PIT-tag codes on piscivorous bird colonies in the Columbia River Estuary and characterize prey selectivity by avian predators on juvenile salmonids. PIT-tag detections in the estuary will be used to support decisions made in environmental impact statements that will be used to manage the impacts of Caspian tern

Caspia sterna and double-crested cormorant *Phalacrocorax auritas* predation on juvenile salmonids in the Columbia River estuary. In addition, PIT-tag detections in the McNary Dam reservoir will be used to evaluate the impacts of avian predation on survival in the Lower Monumental to McNary Dam reach. These detections will be used in conjunction with studies attempting to locate areas of salmonid mortality not directly attributed to Snake River dams and McNary Dam (Eppard et al. 2003).

In 2007, we will identify the boundary of Caspian tern and double-crested cormorant colonies that may impact juvenile salmonids. Once the birds complete their nesting season and abandon the site, we will deploy electronic PIT-tag detection equipment on each colony and detect all tag codes that can logistically be recovered. In addition, we will plant PIT tags with known codes on the surface of the colonies before nesting begins and throughout the nesting season and use these codes to evaluate sampling-gear detection efficiency for each site.

While salmonids migrating from above Bonneville Dam are relatively well-represented with PIT tags, other than tagging efforts from this study, there is virtually no representation of PIT tags from lower Columbia River stocks. This lack of tagging was apparent during the drafting of the Caspian tern Environmental Impact Statement (EIS) when attempts were made to evaluate the impacts of terns on the Lower Columbia River ESU's. The EIS process will now most likely be repeated for double-crested cormorants nesting in the estuary, and the lower Columbia River ESU will once again require representation. To provide these data, we will PIT tag fall Chinook salmon *O. tshawytcha* and steelhead *O. mykiss* from streams and rivers entering the estuary.

The goals of our study are to: 1) survey piscivorous bird colonies in the Columbia River basin for PIT tags, with an emphasis on lower Columbia River and estuarine sites, to provide

information for bird management activities and assess overall predation levels; 2) compare the vulnerabilities of fish of different species, rearing types, and migration and dam passage histories to avian predators; 3) compare the vulnerability of juvenile salmon released directly into the Columbia River estuary to those emigrating from upstream of Bonneville Dam; and 4) evaluate how the bird colonys' different physical environments affect tag sampling efficiency.

BACKGROUND

Rice Island, at river kilometer (RKm) 34, is a dredge-material-disposal island in the Columbia River estuary that has supported a colony of Caspian terns and double-crested cormorants since 1987. Approximately 8,000 breeding pairs of Caspian terns inhabited Rice Island annually and consumed millions of juvenile salmonids from the Columbia River (Roby et al. 1998) until 2001. The large number of PIT-tagged juvenile salmonids released into the Columbia River basin in recent years (over 1 million in 1999) led us to believe that a significant number of tags were being deposited on Rice Island bird colonies and were potentially detectable.

In 1998, National Oceanic and Atmospheric Administration (NOAA Fisheries) personnel modified PIT-tag equipment previously used in water (Ledgerwood et al. 1997) to detect PIT-tag codes on land from fish captured and consumed by piscivorous birds in the Columbia River Basin (Ryan et al. 2001). The modified PIT-tag detection electronics were used to detect PIT-tag codes from 14 bird colonies on 10 islands in the mainstem Columbia River. The colony locations ranged from East Sand Island near the mouth of the Columbia River to Island 18 (RKm 549) about 30 km upstream from the confluence of the Snake and Columbia Rivers. Tag codes were also detected on cormorant nests located on channel markers in the estuary and Caspian

tern colonies outside of the Columbia River basin in Potholes Reservoir. Tag-detection efforts resulted in the detection of over 360,000 unique tag codes dating back to 1987 (Ryan et al. 2000; Ryan et al. in press), the first year PIT tags were released into the Columbia River Basin (Prentice et al. 1990).

Concern over impacts from the Caspian tern colony on Rice Island prompted managers to initiate a tern relocation experiment (Anonymous 1998) designed to relocate a portion of the colony farther downstream in the Columbia River estuary to East Sand Island (RKm 8) near sources of alternative prey in brackish water. The relocation effort successfully attracted approximately 1,400 breeding pairs to East Sand Island in 1999 and 9,100 breeding pairs in 2000 (Collis et al. 2000), leaving approximately 600 breeding pairs on Rice Island. Since 2001, all tern nesting activities in the Columbia River estuary have been on East Sand Island (CBRW 2001). Through 1999, the Caspian tern colony located on Rice Island had been the major tag-detection location. Since 2000, the major tag detection location has been the East Sand Island tern colony (Ryan et al. 2003; Glabek et al. 2003).

While we successfully detected large numbers of PIT tags from piscivorous bird colonies and evaluated vulnerability (Collis et al. 2001; Ryan et al. 2001; Ryan et al. 2003), these vulnerabilities have only been available for juvenile salmonids emigrating upstream from Bonneville Dam because few juvenile salmonids have been PIT tagged from streams that discharge directly into the Columbia River estuary (PSMFC 1996). In 2001, we tagged 3,000 juvenile spring and fall Chinook salmon and steelhead each from estuary streams for comparison to those emigrating from areas upstream of Bonneville Dam. In 2002 and 2003, we repeated and expanded this effort by increasing the numbers of spring and fall Chinook salmon released during the tern and cormorant nesting season and by including wild coho salmon.

OBJECTIVES

Objective 1-- Detect juvenile salmonid PIT tags from Caspian tern and double-crested cormorant colonies in the Columbia River basin.

Previous tag-detection efforts from 1998 to 2006 indicated that the primary juvenile salmonid tag detection locations were from terns and cormorants (Ryan et al. 2001; Ryan et al. 2003). For this reason, in 2007, the primary tag-detection locations will be tern and cormorant colonies in the Columbia River estuary. We will also collaborate with researchers from Oregon State University (OSU) and Real Time Research (RTR) to detected tags on piscivorous bird colonies upstream of Bonneville Dam. However, our role upstream of Bonneville Dam will be more of a consultant and support role than actually physically collecting the tags.

The focus will be on East Sand Island to support the evaluation of Caspian tern relocation efforts to reduce impacts on juvenile salmonids (USACE 2001), along with the continued evaluation of the impacts from the growing number of double-crested cormorants nesting in the estuary. PIT tags detected by OSU and RTR in McNary Dam reservoir will be used to identify areas that directly affect reach survival. Tag detections in this area will also be used by other researchers (Eppard et al. 2003) to aid in survival estimates through Snake River dams and McNary Dam, thus isolating areas of mortality not attributable to dam passage. Additional locations will be sampled if they are identified as having the potential to produce PIT-tag detections as the result of avian predation. Each site will be surveyed for PIT tags using established techniques (Ryan et al. 2001).

Objective 2--Utilize PIT-tag detections on piscivorous bird colonies to evaluate the relative vulnerability of different salmonid ESUs and stocks to avian predation and support survival estimates for juvenile salmonids through various river reaches.

Using the PIT-tag detections collected under Objective 1, we will assess the relative vulnerability of juvenile salmonid ESUs along with species, rearing, migration, and dam-passage histories to avian predators. To date, these data have been used to evaluate the relative vulnerability of transported vs. river-run and hatchery vs. wild juvenile salmonids and the vulnerability of different species to piscivorous birds nesting in the Columbia River estuary (Ryan et al. 2003). These data have also been used to evaluate the impacts on specific ESUs when drafting the Caspian tern EIS (USFWS 2005). We will also use these data to provide similar comparisons for colonies upstream of the estuary, along with an analysis of vulnerability based on bypass history. In addition, PIT-tag detections on estuarine bird colonies comprise an important data set that will be used, in part, to estimate survival through the hydropower system to the tailrace of Bonneville Dam.

Objective 3--Compare the vulnerabilities of fall Chinook salmon released directly into the estuary and Snake River fall Chinook salmon barged around the Federal Columbia River Power System (FCRPS).

There is increased interest in barging Snake River fall Chinook salmon around the FCRPS and releasing them downstream from Bonneville Dam. It is unclear, however, how the behavior of these juvenile salmonids may be affected by this process after release. Possibly, barged fall Chinook salmon may tend to spend an increased period of time in the estuary, behaving more like earlier-migrating ocean-type Chinook than their in-river cohorts. If barged fall Chinook salmon do spend more time rearing in the estuary, their vulnerability would likely be similar to those released directly from lower Columbia River streams, which have been found to be considerably more susceptible to predation than those emigrating from above Bonneville Dam. PIT-tagging several stocks of lower river fall Chinook salmon that will be released into the

estuary will provide a comparison of vulnerability for both the barged and in-river migrating Snake River fall Chinook salmon. This information will assist managers in making decisions about the effectiveness of barging Snake River fall Chinook salmon and what role avian predation plays relative to this practice.

In addition, the vulnerability of lower Columbia River stocks is becoming increasingly important because of current efforts to relocate portions of the world's largest Caspian tern colony to other locations outside the Columbia River Basin. In addition, an EIS will most likely be required for cormorants nesting on East Sand Island before any management actions are taken relative to this avian predator. In this regard, PIT-tagged lower river salmonid groups will provide avian predation levels for ESUs from this area if managers are required to provide an EIS on cormorants.

Objective 4--Compare the proportions of PIT tags recovered on piscivorous bird colonies from microacoustically tagged hatchery yearling and subyearling Chinook to those from hatchery yearling and subyearling Chinook tagged exclusively with a PIT tag to determine relative avian predation rates on the two groups.

In 2007, a study will be conducted to evaluate the effectiveness of acoustic tags as a system-wide survival tool. This study is planning on releasing 3,500 acoustic-tagged yearling Chinook salmon over 10 releases paired with approximately 200,000 PIT-tagged yearling Chinook Pit tagged at Lower Granite Dam (from a study designed to evaluate latent mortality associated with passage of yearling chinook salmon through Snake River Dams). These fish will be treated essentially the same and should remain inriver until they reach the Pacific Ocean providing an opportunity to compare avian predation rates throughout the middle and lower Columbia River Basin.

In addition, the same system wide survival study is planning on releasing 7,000 acoustic-tagged subyearling Chinook over 20 releases paired with approximately 30,000 PIT-tagged only subyearling Chinook from Lower Granite Dam. These fish will provide the same type of data for subyearling Chinook as for earling Chinook from the same study.

Objective 5--Compare the proportions of yearling Chinook and steelhead transported in a barge and released at Skamania Landing that were subsequently detected on a piscivorous bird colony to the proportions of yearling Chinook and steelhead transported in a barge and released downstream of Astoria that were subsequently detected on a piscivorous bird colony.

In 2007, a study to evaluate alternate barging strategies to improve survival of transported salmonids will be releasing 53,000 PIT-tagged yearling Chinook and 53,000 PIT-tagged steelhead over six separate releases. Approximately 60% of the Chinook and steelhead will be released at Skamania Landing (the normal transportation release site) and the additional 40% will be released OR at night on out going tide at River Kilometer (Rkm) 10 downstream from Astoria. One of the purposes of the releases at Rkm 10 at night on an outgoing tide is to avoid avian predation by the world's largest Caspian tern and double-crested cormorant colonies. To evaluate the effectiveness of this release strategy, we will compare the proportions detected of the foregoing two groups based on release site.

Objective 6--Estimate the detection efficiencies for PIT tags planted on the surface of piscivorous bird colonies after being subjected to a single season of nesting activity.

Detection rates of known PIT tags planted on piscivorous bird colonies before, during, and after the nesting season will allow juvenile salmonid PIT-tag detections to be expanded to estimate the total number of PIT tags deposited on each colony. In addition, we will also use the detection efficiency data to assess how different physical environments affect sampling (detection) efficiency.

Objective 7--Develop a web-accessible, map-based database to facilitate access to PIT tag related avian predation information (including release data, in-river detections, bird colony detections and transport history).

This database will serve as a central repository for PIT-tag related avian predation information. The spatially explicit nature of the interface will allow users to query predation related information for a particular cohort by choosing a release or detection site from a map of the Columbia Basin and "clicking" on it. Data presented in this manner will offer the user practical insight into the nature of this information as it illustrates the relative location of detection efforts with respect to release sites. This project will be accomplished through collaboration between NOAA Fisheries researchers and database designers utilizing the extensive computer hardware and software resources at the Northwest Fisheries Science Center in Seattle, WA. In addition, GIS analysts at the Science Center will be enlisted to develop a suite of spatial analysis tools that will be intrinsically linked to the database. These tools will allow researchers to look more closely at the relative influences of release time, migration route, travel time, and various physical attributes of the system such as flow on predation rates.

Ultimately, we will produce two products: a web-based interface available to researchers

and managers that will provide an excellent spatial representation and insight with respect to predation and background-data-collection efforts, and a collection of advanced spatial analysis tools to be used within a personal GIS system for modeling relative vulnerability to predation including spatial attributes as descriptors.

These products will provide managers and decision makers with critical information as they continue to recommend and amend management actions to reduce salmonid mortality due to avian predation in the Columbia River Basin, while simultaneously protecting/conserving regional nesting colonies of piscivorous waterbirds protected under the Migratory Bird Treaty Act of 1918.

RELEVANCE

The NOAA Fisheries 2000 Biological Opinion (NMFS 2000) Actions 102 and 104 specify that avian predation on juvenile salmonids be evaluated using PIT-tag information, and Action 103 specifies that predation by white pelicans in the McNary Dam reservoir be quantified.

METHODS

Predatory bird colonies will be identified in collaboration with OSU, Willamette University (WU), and Columbia River Inter-Tribal Fish Commission (CRITFC) researchers by surveying islands in the Columbia River for PIT tags. These initial surveys will be based on previous research conducted by OSU, NOAA Fisheries, and CRITFC. After birds vacate the colonies (late-July), NOAA Fisheries will conduct ground surveys and determine the appropriate

method required for efficient recovery of ISO-tag information, either with a flat-plate antenna or with pole-mounted antennas (Ryan et al. 2001).

PIT-Tag Recovery

Target bird colonies will be surveyed, boundaries documented, and transect lines established within the colonies to ensure sampling coverage is complete. We anticipate tag recovery efforts will be concentrated on the tern and cormorant colonies of East Sand Island (Glabek et al. 2003). The flat-plate detector will be deployed on the East Sand Island tern colony and will be passed one time in one direction over the entire colony. In a similar manner, we will then pass the detector perpendicular to the initial direction to detect additional tags not previously detected due to orientation or other problems (in 1998 our second pass over the tern colony on Rice Island yielded about 20% additional tags). We will continue additional passes until numbers of new detections decline to <10%. For example, in 1998 the third pass on Rice Island yielded 6% new tags. The pole mounted antennas will be used on the remainder of the colonies due to the impracticality of using a flat-plate detector in these areas. Where the pole mounted antennas are used, the colony will be covered in two complete passes in opposite directions (Ryan et al. 2001; Ryan et al. 2003).

Estuarine Salmonid ESUs and Snake River Fall Chinook Salmon Vulnerabilities

As representation of Lower Columbia River fall Chinook salmon, 3,000 juveniles will be tagged at each of the following hatcheries: 1) Kalama Falls on the Kalama River, 2) Big Creek Hatchery, and 3) Bonneville Hatchery. The transport and in-river fall Chinook salmon groups will be PIT tagged during the ongoing Snake River fall Chinook salmon transportation

evaluation. Recovery rates from each release site will be compared after PIT-tag detection efforts are completed in the fall and winter of 2007. As representation of lower Columbia River steelhead, we will PIT tag 3,000 steelhead each at Elochoman River and Merwin Hatcheries. This effort will require a total of 15,000 PIT tags.

PIT-Tag Sampling Efficiency

To evaluate detection efficiencies of known PIT tags deposited on piscivorous bird colonies, we will deposit tags on the surface of each colony before, during, and after the nesting season. After tag recovery efforts have been completed, detection efficiencies will be calculated for each location and plant dates. On the East Sand Island tern and cormorant colonies, 140 PIT tags will be planted prior to the nesting season and at the chick stage, and 100 PIT tags will be planted at the fledgling stage and after the colony has been abandoned. The recovery rates of these tags will be used to help established when tags are being lost. The total number of tags needed to determine detection efficiencies is 960.

SCHEDULE

Once the birds vacate their nesting colonies in late July and after the pair-trawl work has been completed, the ISO-tag electronics from the pair-trawl operation will be transferred to this study. We will conduct initial site visits to assess logistical requirements for colonies we have not previously sampled. ISO-tag recoveries from bird colonies will begin as early as August 2007 and continue through January 2008.

DATA ANALYSIS AND STATISTICS

Using descriptive statistics, we will estimate the total number of PIT tags detected at each colony site by ESU, species, rear-type, and migration history and compare the totals detected to totals released for each individual group.

EXPECTED RESULTS AND APPLICABILITY

The results of recovery efforts obtained using the flat-plate and hand-held antennas from 1998 to 2005 yielded over 450,000 unique PIT-tag codes, including several fish species, runs, and rearing types dating back to 1987. The 2007 effort should provide 30,000 to 50,000 unique migration year 2007 ISO PIT tags from salmonids emigrating from the Columbia River basin. The continued collection of PIT-tag codes adds to a body of data that is and will be used to assess and inform several key issues related to the operation and configuration of the FCRPS and the effects of avian predation on smolt survival through the Columbia River basin and estuary. PIT-tag detections at upriver sites are particularly pertinent to understanding causation of the downward trend of steelhead in-river survival. For example, the Lower Granite Dam to Bonneville Dam survival in 2002 was only 26%. This is well below the 2000 Biological Opinion requirement for operation of the FCRPS, and the action agencies will need to address this issue. One cause of this reduced survival could be avian predation in the McNary Dam reservoir where 7.6% of in-river migrating steelhead detected at Lower Monumental Dam were subsequently detected on the Crescent Island tern colony in 2002 (Ryan et al. in prep).

PIT-tag detections will also allow us to look for potential effects from passing through the FCRPS and experiencing conditions in different passage routes. For example, we will continue to use these data to evaluate the differences between species, ESUs, transported and in-

river passage, potential effects of delayed mortality and passage through bypass systems. Moreover, these data are currently being used and will continue to be used to aid the USFWS and COE to decide what reduction in tern and cormorant predation will be needed to generate the necessary response in the lambdas of key salmonid ESUs. The 2007 detections will be used to estimate loss and vulnerability and may be used to estimate survival through the hydropower system to the tailrace of Bonneville Dam.

COLLABORATIVE ARRANGEMENTS

Collaboration with OSU, WDFW, and CRITFC researchers identifying piscivorous bird colonies will continue. Tag-deposition rates and detection rates will be evaluated with collaboration of Real Time Research. Tag-detection records will be uploaded to the PIT-Tag Information System (PTAGIS) regional database (PSMFC 1996), providing researchers in the region access to data on avian predation. Tagging of juvenile salmonids near the estuary will be completed with the cooperation of Kalama Falls and Elochoman Hatchery personnel, along with NOAA Fisheries researchers evaluating effects of ocean-entry timing.

TECHNOLOGY TRANSFER

Information acquired during the proposed work will be transferred in the form of written and oral research reports as required. Because we must rely on the accuracy of the data being loaded into PITAGIS, a draft report will be provided to the COE by 1 April 2008, and the final report will be completed after appropriate review.

KEY PERSONNEL

Brad Ryan - Research Fishery Biologist and Project Leader

Michelle Rub - Research Fishery Biologist

Gene Matthews – Research Program Manager

Steven Smith - Statistician

Benjamin Sandford - Statistician

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