

Table 1. Project metadata.

<b>Project Number</b>	2008-004-00
<b>Proposer</b>	Columbia River Inter-Tribal Fish Commission
<b>Short Description</b>	Sea lion hazing, abundance estimation, and local movements study at Bonneville Dam.
<b>Province(s)</b>	Mainstem
<b>Subbasin(s)</b>	n/a
<b>Contact Name</b>	Doug Hatch
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**Title:           Sea Lion Predation Rate Estimation and Non-lethal Hazing**

**a. Abstract**

California sea lion (*Zalophus californianus*) abundance and their impacts on listed salmonids (*Oncorhynchus* spp) have increased dramatically at Bonneville Dam over the last 5 years. So much so that in 2008 NOAA Fisheries granted the states of Oregon, Washington, and Idaho lethal removal authority under section 120 of the Marine Mammal Protection Act (NOAA 2008a). This authority is currently being litigated but the parties have agreed to a schedule that would complete proceedings prior to March 1, 2009, thus effectively prior to the next salmon run. Actions proposed in this narrative are independent of the lethal take litigation and are supported and deemed important by all parties. If the states retain lethal take authority from NOAA for removal of sea lions, implementation will require the states to transfer much of their efforts towards animal capture, which will reduce their effort available for nonlethal hazing and other activities. This project allows us to take up some of the slack in the nonlethal hazing component, provide some assistance to the states with capture efforts, plus implement a project to estimate sea lion predation in areas outside of the Corps observation area, and track movements (at various scales) of individual animals.

This project would be collaborative with the States of Oregon and Washington, ACOE, and USDA. The scope of the project includes a 3 person, boat-based, sea lion hazing crew operating 5 days a week for approximately 3 months near Bonneville Dam. This crew will conduct non lethal sea lion hazing, assist with trapping, and other field duties. A second objective will be implementing a project to estimate sea lion predation outside of the ACOE observation area. The ACOE observation project is limited to the Bonneville Dam tailrace area that is viewable from the deck of the Dam. The notion is to adapt video fish counting technology that we have developed to enumerate sea lions and salmon predation. A video system will be deployed to observe river surface activities in quantified areas of the river. Software will be used to scan recordings and select times when water surface disturbances are detected. Technicians will than review these time periods and note sea lion presence and predation activities. An additional video system will be deployed within the Corps observation area to evaluate effectiveness of the

fine scale near Bonneville Dam and at a courser scale throughout the lower Columbia River using acoustic telemetry. Observations regarding affinity to particular feeding stations, fine scale movement of animals in the area near Bonneville Dam, and course scale movement of animals downstream in the lower Columbia River will be made.

#### **b. Technical and/or scientific background**

Sea lion presence below Bonneville Dam was rare and their consumption of salmonids was not a major concern prior to the 2000 Biological Opinion for Operation of the Federal Columbia River Power System (FCRPS) (NMFS 2000). Since 2001, the ACOE have been documenting sea lion abundance and estimating predation rates using visual observations within a quarter mile of the dam. Estimated predation rates have ranged from 0.4 to 4.7 percent of the spring season salmonids migrating annually (Stansell 2004, Tackley et al 2008). This equates to 1,010 to 4,466 spring Chinook (*O. tshawytscha*) and steelhead (*O. mykiss*) being caught and consumed within the visual observation area adjacent to the dam (Tackley et al 2008). NOAA (NOAA 2008b) concluded that: *“collectively California sea lions at Bonneville Dam are having a significant negative impact on ESA listed salmon and steelhead species based on information in the record and in particular on the following factors:*

- *The predation is measurable, growing, and could continue to increase if not addressed;*
- *The level of adult salmonids mortality is sufficiently large to have a measurable effect on the numbers of listed adult salmonids contributing to the productivity of the affected ESUs,/DPSs; and,*
- *The mortality rate for listed salmonids is comparable to mortality rates from other sources that have led to corrective action under the ESA.”*

Deterrent activities using non-lethal hazing were initiated in 2005 by the state, federal and tribal agencies and have been ineffective at eliminating the fish predation problem (Norberg et al. 2005, Wright et al. 2007, Brown et al. 2007) but were shown to modify sea lion behavior (Tackley et al. 2008). This result prompted the states to seek lethal removal authority for sea lions under Section 120 of the Marine Mammal Protection Act (NOAA 2007a). NOAA Fisheries accepted the application, convened a Pinniped Fisheries Interaction Task Force which, concluded that predation at this rate was a significant negative impact on ESA listed salmonids and recommended that NOAA approve the states request to remove identifiable problem animals in November 2007 (NOAA 2007b). NOAA Fisheries reviewed the report along with pertinent information in their environmental assessment and granted the states authority to remove problem sea lions on March 18, 2008 (NOAA 2008a). This determination included a list of individually identifiable problem sea lions that could be removed and criteria to add sea lions to the list. Generally the criteria for problem animals includes being individually identifiable, has been observed consuming salmonids, and has been subjected to non-lethal hazing. Removal has currently been suspended while the decision is being litigated.

Currently, the only quantitative measure of sea lion predation in the Columbia River is the ACOE limited observation area below Bonneville Dam, however, the amount of

predation in the lower 150 miles is unknown and estimated through modeling at 13,000 in 2007 ([http://wdfw.wa.gov/wlm/sealions/sec\\_120\\_appl.pdf](http://wdfw.wa.gov/wlm/sealions/sec_120_appl.pdf)). Boat-based hazing activities in 2007, reported that approximately one-quarter of all hazing events involved a predation observation (Brown et al. 2007). Boat hazers reported a total of 1,494 hazing events and salmonid predation was observed in every site within the study area (Navigation Marker 85 to Bonneville Dam approximately 6 miles). This confirmed that substantial sea lion predation is occurring beyond of the observation limit (area viewable from the tailrace deck of the Dam) of the ACOE's enumeration program and necessitates the need for a technique to estimate sea lion predation. The Pinniped Fisheries Interaction Task Force expressed the desire for more data on sea lion abundance, distribution, and predation in the Columbia River (NOAA 2007b).

The Pinniped Fisheries Interaction Task Force and the NOAA Environmental Assessment call for the continuation of non-lethal deterrent activities, lethal removal, and to monitor and evaluate the sea lion activities near Bonneville dam. As a prerequisite for removal, California Sea lions need to be individually identifiable, be observed feeding on salmonids below Bonneville Dam and must be subjected to non-lethal hazing activities (NOAA 2008b). This proposed project will assist in these efforts by 1.) continuing boat based hazing to deter naïve individuals along with satisfying requirements for lethal removal. 2.) The proposed video project will assist in identifying and enumerating individuals near the dam, estimate the extent of the problem outside the ACOE observation area, and attempt to estimate salmonid predation rates. 3.) The final project will use acoustic telemetry to monitor fine scale movements of known individuals near the dam along with the greater migrations throughout the lower Columbia River. This telemetry project will also provide valuable information regarding feeding activity, diurnal habits, and help to ground truth visual and video enumeration of known individuals.

### **c. Rationale and significance to Regional Programs**

In NOAA Fisheries Pre-Decisional draft, the Proposed Reasonable and Prudent Alternatives for marine mammal control measures and monitoring are addressed in RPA 49 and 69. RPA 49 states that ...In addition the Corps will continue to support land and water based harassment efforts by NOAA Fisheries, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and the Tribes to keep sea lions away from the area immediately downstream of Bonneville Dam.

The Pinniped-Fishery Interaction Task Force by consensus recommended that non-lethal hazing efforts continue and despite the limited success in the past (NOAA 2007b). *“The Task Force felt strongly that preventing recruitment of California sea lions that have not yet learned of the density of salmon resources at Bonneville Dam is of utmost importance. This is especially true if the lethal taking of sea lions that have foraged at the Dam is likely to lead to reduction or elimination of sea lion predation at Bonneville Dam. Combining non-lethal hazing, especially further down river from the Dam, along with lethal taking at the Dam may provide the greatest potential for preventing the less experienced sea lions from reaching the dam and learning about the high density salmonids resources available there.”* The task force also agreed that there is a need to

enhance monitoring and evaluation of sea lions throughout the Columbia River to achieve a long term resolution to the pinniped-fisheries conflict. Enhanced understanding of this interaction is expected to provide more certainty for making future management decisions regarding the impacts and resolutions to the sea lion and salmonid conflict.

RPA 69 Monitoring Related to Marine Mammal Predation states that the Action Agencies will: Monitor the spatial and temporal distribution of sea lion predation attempts and estimate predation rates. And, monitor the effectiveness of deterrent actions and their timing of application on spring runs of anadromous fish passing Bonneville Dam. The Pinniped-Fishery Interaction Task Force: Columbia River agreed by consensus that enhanced monitoring and evaluation at Bonneville Dam and throughout the entire lower Columbia River is needed to achieve a long-term resolution to the pinniped-fishery conflict. These enhanced data are expected to provide more certainty for making future management decisions that could aid in the resolution of this conflict.

Addressing pinniped predation is also part of the Draft Columbia River Estuary Recovery Plan Module for Salmon and Steelhead (NMFS 2006), Final Upper Columbia Recovery Plan (Upper Columbia Salmon Recovery Board, adopted October 2007), and Interim Lower Columbia Salmon Recovery and Fish & Wildlife Plan (Lower Columbia Fish Recovery Board, approved February 2006).

#### **d. Relationships to other projects**

This project is complimentary to other sea lion interaction work that is currently being conducted or proposed. The ACOE non lethally hazes and observes sea lion activities from the deck of Bonneville Dam and from these data calculates predation rates, and enumerates sea lions. To evaluation the effectiveness of video systems used in this proposed study, an additional system will be deployed in an area where the ACOE is observing. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife have conducted non lethal sea lion hazing for the last three years and trapping in 2007. CRITFC hazing efforts will assist in deterring naïve sea lions near the dam and supports requirements of Section 120 implementation. The acoustic telemetry will also support Oregon and Washington's research efforts to track sea lions while they feed in the Columbia River along with documenting feeding behaviors while they hunt near the dam.

#### **e. Project history (for ongoing projects)**

In 2007, about \$20k was reallocated from CRITFC's coordination project (Implement Wy-Kan-Ush-Mi Wa-Kish-Witt Project number 1998-03-100) to conduct 8 days of sea lion hazing at Bonneville Dam. This was to assist the States' hazing effort by adding a second crew to cover the 6 river mile area between Bonneville Dam and navigation marker 85. The spring of 2008, \$75,000 was allocated through the Budget Oversight Group (BOG) process to CRITFC for non-lethal hazing activities (Project number 2008-004). The current proposal seeks to expand this project by increasing the CRITFC hazing effort to cover a reduced effort by the state agencies, develop video monitoring technology to enumerate sea lions and salmonid predation, and use acoustic telemetry to study feeding and migration behaviors.

**f. Proposal biological objectives, work elements, milestones, work element budget, spending plan**

Biological Objectives

Objective 1. Conduct boat-based non lethal sea lion hazing annually generally between March 1 and May 31.

Objective 2. Develop a video system to enumerate sea lions and estimate predation.

Objective 3. Track movements of individual sea lions at various spatial scales in the Columbia River using acoustic telemetry.

Objective 1. Non-lethal Hazing

We propose to conduct non-lethal boat based sea lion hazing in collaboration with Oregon, Washington, and the Corps. Granted non-lethal hazing has been ineffective at removing individuals from the concerned area, it has been shown to have an effect on sea lion behaviors. Hazing has had an affect on the presence of ESA listed Steller sea lions who appear to be more sensitive to boat based hazing methods. Generally Steller sea lions (*Eumetopias jubatus*) will leave areas where hazing activities occur but will return when boat based hazing ends. California sea lions are less detoured by hazing activities but do modify behaviors during hazing. There is an immediate affect during hazing events of occupying individuals that would otherwise be feeding. On days and hours that boat based hazing occurs, individuals are more wary and spend more time below the surface (Tackley et al. 2008)

Specific methods will include seal bombs, cracker shells, rubber bullets, and boat pursuit. Techniques will be consistent with those used in 2006 through 2008. Hazing would occur for approximately 6 hours per day, 5 days per week. A 3 person crew will be used and consist of a boat operator, a hazer, and a data recorder. Data on each sea lion encounter will be recorded including time / duration of the encounter, species, location, and predation. Hazing would commence about March 1, and conclude about May 31. Dates will ultimately depend on the presence of sea lions.

Objective 2. Estimating Sea Lion Predation

We propose to develop a system for estimating sea lion predation outside of the Corps observation area using video surveillance technology. This will be an extension of the video fish counting systems that we pioneered in early 1990's (Hatch et al. 1994, 1998) that is currently being used at numerous locations in New England (Haro and Fryer 2006), Michigan, Oregon, Alaska, and Europe. One video system would be deployed to observe river surface activities in known areas of the river. The camera system will scan the surface recording low and high resolution images that will be recorded on a computer. Fish counting software would be used to scan recordings and select only the times when water surface disturbances are detected. Technicians would than review these time periods and note sea lion presence and predation activities. An additional video system would be deployed within the Corps observation area to evaluate the video system. Figure (1) depicts potential locations for video observation stations. The advantage of this video technology is that it can scan for extended periods of time and enumerate sea lion presence and predation outside the ACOE observation area. Once this concept has been

proven similar systems could be deployed throughout the lower Columbia River to enumerate sea lions and predation.

The envisioned high resolution video systems are custom built for this application and will contain an array of cameras enabling detailed observations at long distances and continuous scanning of a larger known area. This is necessary so the system can scan a large area and still provide enough resolution to image sea lion predation events. Digital recordings will be multiplexed and stored on large capacity dockable hard drives.

It may be possible to conduct nighttime observations using infrared illumination and thus monitor for sea lion predation at night. The Task Force suggested that nighttime sea lion predation may increase after lethal removal is initiated. Therefore, we propose to install an infrared lighting array in association with the video system located at the deck of the dam. The video system is capable of imaging at night using infrared.

### Objective 3. Acoustic Telemetry

The acoustic telemetry project will work in concert with existing telemetry arrays already maintained by CRITFC (BPA project 2007-401) and the Oregon and Washington sea lion capture and branding efforts. This project will use similar methods to Wright et al (2007) which studied feeding behaviors of Harbor Seals on the Alsea River using acoustic telemetry. Vemco acoustic transmitters will be externally attached to newly captured individuals with the cooperation of the states' trapping effort. Based on past trapping efforts we expect to tag 12 to 15 animals in the initial year. Acoustic hydrophones will be set up in several arrays near each of the tailraces of Bonneville Dam and in several locations between the dam and marker 85 (Figure 2). Existing arrays are located on the Columbia River at Rkm 0, 53 and 140. Course scale movements of tagged individuals will be recorded as they migrate between the ocean and Bonneville Dam. Finer scale movements near the dam should provide diurnal feeding habits, duration and preferred location of feeding sites, number of feeding and resting cycles in a given day, and detection efficiencies of visual and video enumerations.

1. WE 165 Produce Environmental Compliance Documentation – MMPA & ESA Permits—Obtain necessary permits for hazing California and Steller sea lions.
  - a. Obtain section 109 permit
2. WE 119 Manage and Administer Projects -- Administration of Contract. – Perform administrative duties required to fulfill BPA programmatic and contractual requirements for implementation of the project including preparation (and modification as necessary) of SOW and budgets. Review of invoices and billings.
  - a. Hire technicians
  - b. Produce accrual estimates
  - c. Develop SOW and budgets
3. WE 174 Produce Plan – Develop Project Implementation Plan. – Develop a schedule and plan for implementation of non-lethal hazing. Includes safety training, BRZ training, boat handling training, sea lion identification and hazing training. Coordinate activities with the states. Develop a research plan for

- enumerating sea lions with video. Develop statistical approach to expand observation data to estimate sea lion abundance and calculate a variance on the estimate.
- a. Develop hazing schedule
  - b. Develop RM&E for video monitoring
4. WE 156 Develop RM&E Methods and Designs – Develop research methods. – Test different video system locations and settings to achieve optimum video image quality and surveillance of most advantageous locations for recording. Develop protocols for reviewing video and enumerating sea lion occurrences and predation events.
- a. Test various video observation techniques
  - b. Develop the best video observation protocols
5. WE 157 Collect/Generate/Validate Field and Lab Data – Collect Sea lion hazing data.— While hazing sea lions the following data will be collected: Abundance of sea lions below BON (location, date/time, individual identifications of all sea lions observed) Spatial and temporal distribution of sea lion predation attempts in order to estimate predation rates (location, date/time, individual identification of sea lion predation attempts). Observations on effectiveness of deterrent actions considering hazing method utilized, effects on identifiable individuals, proximity of effort to individual(s); and, immediate response to hazing.
- a. Record sea lion encounters during hazing
  - b. Generate sea lion observation video
  - c. Review video recordings
  - d. Generation observations from video
6. WE 166 Remove and/or Exclude Animals -- Sea lion Hazing. Conduct boat-based hazing using the following techniques: boat pursuit, above-water and below-water pyrotechnics. Above-water pyrotechnics (cracker shells) will be used throughout the study area. Below-water pyrotechnics (seal bombs) will be used outside of the BRZ (Boat Restricted Zone) and within the BRZ according criteria developed by the Fish Passage and Operation and Maintenance Committee.
- a. Conduct hazing activities
  - b. Collect data
  - c. Transmit data to ODFW
7. WE 156 Develop RM&E Methods and Designs – Field testing locations for acoustic array deployment.—Precise locations for acoustic hydrophones will be determined by conducting range tests from a variety of locations. The goal is to achieve maximum listening coverage of the area between river marker 85 and Bonneville Dam (Figure 1). Once the hydrophones are deployed they will be checked and data downloaded on a routine schedule.
- a. Using sentinel tags and receivers site locations for individual receivers.
  - b. Deploy acoustic receiver array.
  - c. Down load data from acoustic receivers.
8. WE 157 Collect/Generate/Validate Field and Lab Data – Tag sea lions and record movements -- Record data on captured, marked, tagged sea lions, collection and record data on sea lion movements and foraging behaviors,



download data from hydrophones. Data from hydrophones will be download and reviewed for false detections. Standard protocols for determining false detections will be used.

- a. Attach acoustic tags to individual sea lions
  - b. Down load data from acoustic receivers.
  - c. Evaluate data and scrub for false detections.
9. WE 160 Create/Manage/Maintain Database -- Develop and maintain database. After false detections have been removed a database of sea lion movements will be built and stored. These data will be available to all project collaborators.
10. WE 161 Disseminate Raw/Summary Data and Results. – Data summaries and results will be transmitted to audiences through presentations and reports.
11. WE 162 Analyze/Interpret Data.
12. WE 185 Produce Pisces Status Report -- Periodic Status Reports for BPA. WE 132 Produce Progress Report -- Produce Annual Report.
- a. Submit a draft progress report
  - b. Submit a final progress report

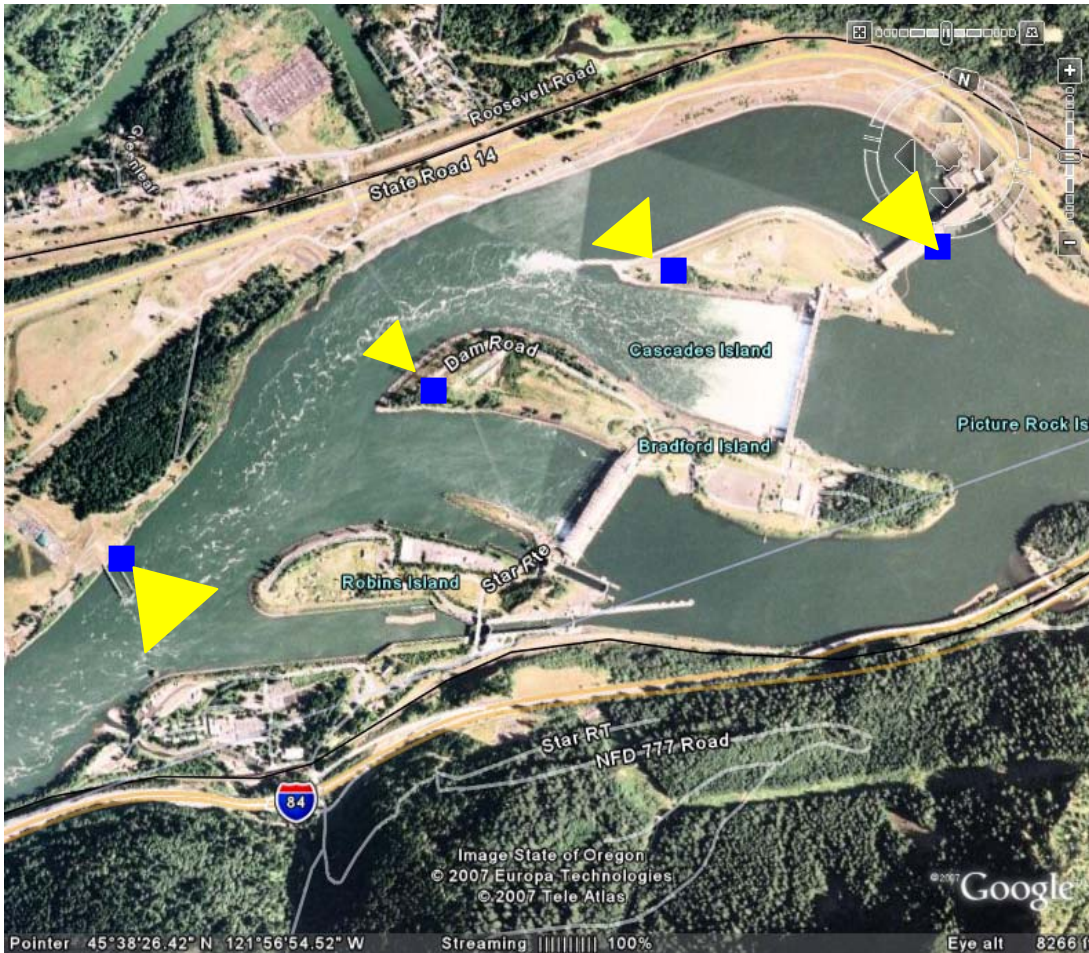




Figure 1. Aerial photo of the Bonneville Dam area with potential video observation sites marked in blue along with potential viewing areas marked in yellow.

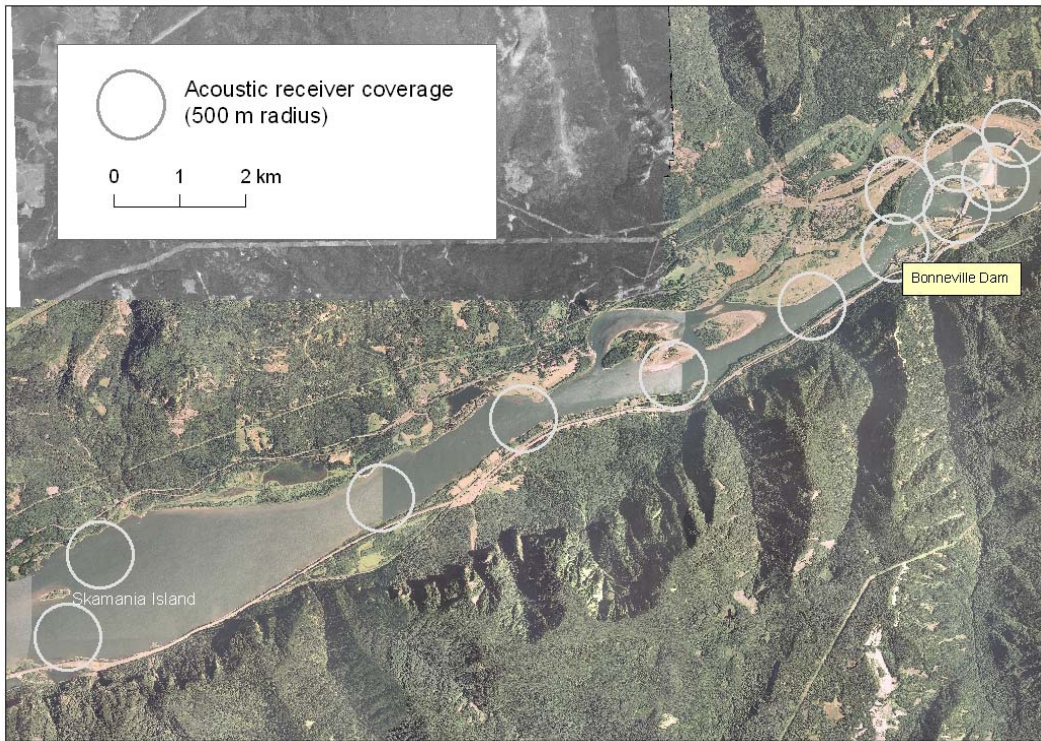


Figure 1. Aerial photo of the Bonneville Dam area with potential acoustic receiver locations shown. Additional detection arrays are located near Rkm 0, 53, and 140.

**g. Facilities and equipment**

This project will utilize a 22 foot Sea Dory for non lethal hazing activities. This boat has been used for this work in the past. GSA lease vehicles will be used to transport the boat. Video systems will be purchased with project funds. Acoustic telemetry equipment will be purchased with project funds, but detections are likely on receivers operated for other projects in the lower Columbia River.

**h. References**

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## Section 9i. Key personnel

Doug Hatch, Senior Fisheries Scientist, Columbia River Inter-Tribal Fish Commission Principal Investigator, background includes supervising non lethal sea lion hazing program in 2006 and 2007. Mr. Hatch was a key developer in CRITFC video fish counting projects.

1991 Master of Science in Fisheries Resources University of Idaho.

1986 Bachelor of Science in Fisheries Resources University of Idaho.

Robin Brown, Marine Mammal Program Leader, Oregon Dept of Fish and Wildlife. Mr. Brown has vast knowledge and experience with marine mammals and their interactions with fish. Mr. Brown leads the state's effort at Bonneville Dam.

B.S. Biology, San Diego State University, 1975

M.S. Oceanography, Oregon State University, 1980

Jeff Fryer, Fisheries Scientist

Dr. Fryer has vast experience in implementing video fish counting projects.

1995 PhD. University of Washington

1985 Master of Science in Computer Science University of New Brunswick

1979 Bachelor of Science in Computer Science University of New Brunswick

John Whiteaker, Fisheries Biologist

Mr. Whiteaker has been the field coordinator for CRITFC's sea lion hazing program for the last two years.

1995 Bachelor of Science in Zoology, Oregon State University