**Bottlenecks to Marine Survival Program: Lower River and Estuary Pinniped Monitoring Program**

**Activity 4:** Development of innovative monitoring programs to understand interactions between climate and predation on Chinook and coho salmon

**Sub-Activity:** Lower River/Estuary Pinniped Monitoring Program

**1.0 Purpose**

The broader Bottlenecks to Marine Survival Program is developing stage-specific survival estimates using Passive Integrated Transponder (PIT) tag technology for Chinook and Coho Salmon. Additional research is required to investigate the potential mediators of survival bottlenecks, such as environmental and anthropogenic influences on freshwater emigration, starvation in the first winter at sea, fishing-related incidental mortality (FRIM), and in-river/estuary pinniped predation. The latter will be addressed by Activity 4 of the Bottlenecks Program. Activity 4 consists of collaboratively developing a low cost standardized in-river/estuary pinniped assessment program to be implemented by communities along the east coast of Vancouver Island, including Snuneymuxw and K'ómoks Nations, Cowichan Tribes, and the A-Tlegay Fisheries Society. Collectively this work will greatly expand our understanding of pinniped utilization of these environments, which will help inform Chinook and Coho salmon survival estimates, catalyze strategies to increase productivity, and leave a legacy of long-term, effective assessment approaches.

**1.1 Monitoring Framework**

The intention is to develop a comprehensive strategy for monitoring the ecological interactions between pinnipeds and salmon. The core objectives include evaluating pinniped populations in terms of abundance, demographic composition (size, age, sex), and their spatial and temporal interactions with salmon. The monitoring program will be conducted annually, requiring two staff members from each community to dedicate approximately 40 days each year on their respective systems. Increased effort will be allocated during the critical salmon migration periods from April to July (concurrent with the juvenile outmigration) and September to December (concurrent with adult returns). The methodology and timeline for this research are detailed in Sections 2.1 and 3.2, respectively.

The research will deploy a variety of techniques for data collection. Regular drone surveys in estuarine and lower river areas will be utilized to establish a relative pinniped abundance index based on aerial data. This will be supplemented by in-river camera traps at major pinniped feeding sites, shore-based counts via visual observations, the deployment of Didsons/side scan sonars in rivers, and short-term deployment of acoustic sound traps in a subset of systems/months. The shore-based monitoring will occur at stratified random times, adjusted in frequency and effort according to the salmon migration patterns.

Essential to this study is the collection of salmon migration and movement data, which will be obtained from the Bottlenecks Program. This program utilizes PIT detections at strategically placed receivers in each river system, with a focus on the lower river areas near tidal water. Additionally, we will pilot surveys in the lower river to target adult Chinook and Coho salmon carcasses for head collection to see what additional information can be gained on causes of mortality (natural or predation event). This will add valuable data on lower river predation, aiding in the creation of a prey demographic metric.

Additional data, such as hatchery release numbers and dates, species, average fish size, as well as adult escapement estimates, can be incorporated to further enhance our understanding of the ecological interactions between pinnipeds and salmon. These data will be provided by the Department of Fisheries and Oceans (DFO) Stock Assessment and the Salmon Enhancement Program. These additional variables will be explored for use in refining our ecological interactions model.

Pinniped behaviour, habitat use, and predation on Chinook and Coho salmon are likely influenced by environmental factors. Therefore, regional environmental data will be collated from existing external datasets and can be incorporated in our analyses of pinniped-salmon interactions.

The comprehensive data collected from both estuarine and riverine ecosystems will be instrumental in developing standardized methods of monitoring pinniped utilization of these habitats and provide indices of abundance to be used by First Nations partners long-term. The above multi-faceted monitoring framework will be funded to the spring of 2026, after which time we will be able to identify the minimum data required to continue to derive habitat utilization and abundance indices. Therefore, the initial field program will be paired down into a more sustainable and cost-effective long-term monitoring program beyond 2026.

**1.2 Key Objectives and Deliverables (2023-2026):**

* Develop standardized methodology and standard operating procedures document(‘s)
* Develop electronic data applications for surveys with associated mapping products of study areas with key locations for monitoring (ArcGIS)
* Ensure that the First Nations communities on each system have the tools, training, and data to continue the monitoring and management of pinnipeds long-term
* Collect abundance, movement, and behavioural data on pinnipeds in the lower river and estuary for the creation of a novel lower river and estuarine pinniped database
  + Traditional knowledge will also be incorporated to provide context for current observations
* Develop a relative index of abundance for the lower river and estuary
  + Including analytical methods for deriving key indices
* Determine the optimal combination of survey methods (drones, side-scan sonar, wildlife cameras, visual surveys, sound traps) for continued use in the long-term monitoring program
* Explore spatiotemporal overlap between pinnipeds and salmon
  + Map/visual products
* Host a workshop with all project participants (2024)
* Create a video documentary
* Produce a final report on the ecology of pinniped and salmon interactions in lower rivers and estuaries of the east coast of Vancouver Island

**1.3 Project Description**

Target Systems:

* Campbell River
* Puntledge River
* Nanaimo River
* Cowichan River

**2.0 Key Components of the Framework**

**2.1 Lower River and Estuary Pinniped Monitoring**:

* Implement a year-round monitoring program led by First Nation partners that explores the following survey methods:
  + ARIS Didson / Garmin Sidescan Sonar and camera trapping for data collection
  + Frequent shore-based relative abundance counts and lower river monitoring (referred to as “visual surveys”)
  + Frequent drone imagery and counts for detailed data on pinniped populations
  + Camera trapping to cover periods between/during migration monitoring events
  + Sound traps deployed in the estuary during key periods of pinniped-salmon interactions
* Development of a QA/QC framework for monitoring data

**3.0 Detailed Action Plan**

**3.1 Staff Allocation and Training**:

* Partners allocate two staff members for ~40 days per year per study location for field surveys and monitoring.
* Bottlenecks program staff to provide training on shore-based observations, side-scan sonar operation, camera trapping.
* Third party to provide training on drone flights and aerial data collection

**3.2 Scheduling and Frequency**:

* Baseline monitoring is conducted monthly with increased monitoring during key migration windows: April-July and September-November
* Field activities include frequent shore-based visual surveys and aerial drone surveys

**Table 1.** Tentative Schedule for Lower River Pinniped Monitoring Program

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Month** | **Period** | **Field Activity Focus** | **Effort (Days)** | **Notes** |
| April | Juvenile Salmon Outmigration | Visual surveys  Installation of Didson/Sidescan Sonars; Soundtraps  Drone imagery collection | 4  1  2 | Beginning of fiscal year, setup of monitoring equipment, initiate drone contractor |
| May | Juvenile Salmon Outmigration | Visual surveys  Drone imagery collection | 3  3 | Continuation of spring monitoring during juvenile outmigration |
| June | Juvenile Salmon Outmigration | Visual surveys  Drone imagery collection | 4  3 | Continuation of spring monitoring during juvenile outmigration |
| July | Juvenile Salmon Outmigration | Visual surveys  Maintenance and checks  Drone imagery collection | 2  1  2 | Mid-season equipment checks (removal, download, clean, reinstall), continued monitoring during non-peak period |
| August | Adult Salmon Spawn Migration | Visual surveys  Pre-salmon return monitoring prep  Drone imagery collection | 2  1  2 | Setup for adult salmon return monitoring |
| September | Adult Salmon Spawn Migration | Visual surveys  (paired with Adult Salmon Return)  Drone imagery collection  Lower river prey demographic assessments | 5  3  2 | Start of intensive monitoring during adult salmon return |
| October | Adult Salmon Spawn Migration | Visual surveys  (paired with Adult Salmon Return)  Drone imagery collection  Lower river prey demographic assessments | 6  4  2 | Peak period for monitoring during adult salmon return |
| November | Adult Salmon Spawn Migration | Visual surveys  Removal of Didson/Sidescan Sonars;Soundtrap  Drone imagery collection | 4  1  4 | Removal of equipment due to flow/storm concerns (delay as long as possible), download data and begin QA/QC and compilation |
| December | Adult steelhead/Cutthroat Trout Spawn Migration | Visual surveys  Winter monitoring prep  Drone imagery collection | 2  1  2 | Preparing for winter monitoring activities, continued data QA/QC and compilation |
| January | Adult steelhead/Cutthroat Trout Spawn Migration | Visual surveys  Drone imagery collection | 2  2 | Monitoring activities during winter |
| February | Adult steelhead/Cutthroat Trout Spawn Migration | Visual surveys  Winter maintenance  Drone imagery collection | 2  1  2 | Continued monitoring and equipment maintenance |
| March | Adult steelhead/Cutthroat Trout Spawn Migration  Juvenile Salmon Outmigration | Visual surveys  Pre-salmon outmigration monitoring prep  Installation of Didson/Sidescan Sonars; Soundtraps  Drone imagery collection | 3  1  2 | Preparing for spring migration monitoring |

\*Purple = Shore-based visual surveys by project partners

\*Green = Equipment installation and monitoring

\*Orange = Contractor Drone and Satellite imagery

\*Blue = Lower River Predation Assessment

**Notes:**

* **Adult Salmon Return (September to November)**: This is the peak period for monitoring, with the highest effort allocated to track pinnipeds during adult salmon returns. Activities include intensified shore-based surveys and drone counts.
* **Spring Migration (April to June)**: Monitoring during this period focuses on the overlap with the juvenile salmon outmigration, with a moderate level of effort.
* **Off-Peak Periods (December-March, July-August)**: These months are utilized for data analysis, reporting, planning, and preparing for monitoring periods. They are also critical for understanding temporal variation in pinniped utilization of river and estuarine habitats.

**4.0 Data Collection Application Concept**

The electronic data application should be ArcGIS compatible for mapping purposes. Possible information to be collected during a shore-based migration monitoring survey are (final fields to be determined with partner groups):

* Date Time
* Location (GPS)
* Focal point of view image
* Start time of survey
* End time of survey
* Species observed
* Counts of each species observed
* Air temperature
* Water discharge
* Water temperature
* Cloud cover
* Drone flight conducted (Y/N)
* Comments

**5.0 Analysis and Reporting Framework**

* 1. **Data Analysis**
* Development of analytical framework by Post-doc in collaboration with Bottlenecks Management and partnered First Nations

**5.2 Collaboration and Workshops**:

* Host workshops to bring together participating Nations for information sharing and framework development
* Collaborate with First Nations for lower river pinniped monitoring

**5.3 Data Management and Sharing**:

* Develop data sharing agreements with project partners where necessary
* Regularly update the Strait of Georgia Data Centre Database with monitoring data
* Develop a pinniped monitoring database that partners can continue to run and update
* Obtain relevant environmental data from other sources
* Prepare for the creation of final reports and publications

**5.4 Outreach and Education**:

* Produce an outreach video documenting project goals, approaches, and results
* Prepare for presentations at domestic and transboundary conferences

**6.0 Conclusion**

The ecological interactions between pinnipeds and Pacific salmon are not well understood and are constantly changing. This monitoring framework aims to provide the first comprehensive dataset on pinniped utilization of estuary and lower river habitats from which we can improve our understanding of these interactions. In addition, the application of multiple data collection methods and novel technologies will allow us to establish optimized methods of data collection for future monitoring activities. The inclusion of environmental indices will also help us to understand and potentially forecast trends in pinniped-seal interactions in the face of a changing climate. The involvement and leadership of our First Nations partners is key to the success of the program and will enable them to monitor and steward the resources in their respective territories for the benefit of their communities.