

SPECIALISTS IN IDENTIFICATION SOLUTIONS



**Biomark**

# STATE-SPACE

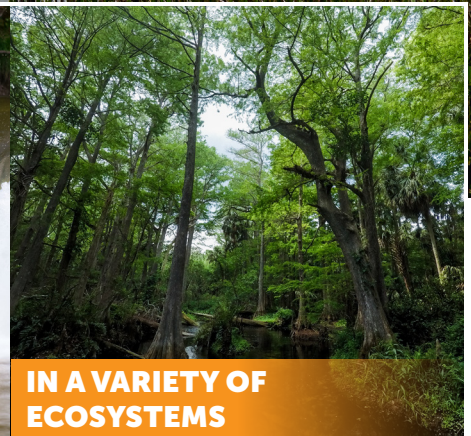
## ABUNDANCE ESTIMATION



**COMBINING VARIOUS  
DATA SOURCES**



**FOR POPULATION  
SCALE ABUNDANCE**



**IN A VARIETY OF  
ECOSYSTEMS**

Precise and unbiased estimates of abundance are often the foundation of management, supporting status and trend assessments, action-effectiveness evaluations, survival studies, and harvest management. Myriad methods are routinely employed to estimate abundance, each with accompanying statistical assumptions and logistical constraints. Problematically, assumptions are commonly violated, and methods for generating estimates often change across space and over time. State-Space Models (SSM) represent a powerful approach for reconciling bias by combining multiple imperfect estimators and through incorporation of novel covariates. Furthermore, SSM can be employed to reliably account for changes in survey types and effort that typify many long-term monitoring programs.

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# FEATURED PROJECT

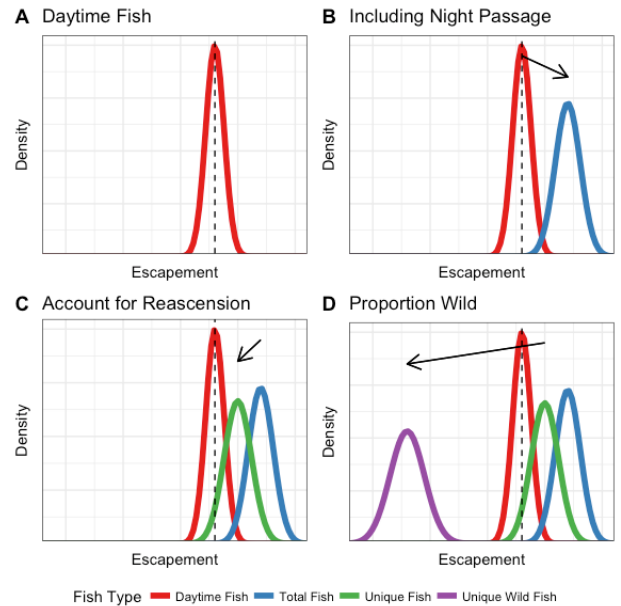
## STATE SPACE ADULT DAM ESCAPEMENT MODEL (STADEM)

Estimates of adult salmonid escapement, or upstream movement, is one of the most important metrics for evaluating the status of threatened species, the success of recovery programs, and the productivity of populations. In the Columbia River Basin, escapement past dams is an especially valuable tool for predicting abundance and productivity. Biomark researchers developed the STate-space Adult Dam Escapement Model (STADEM) R package to estimate the number of unique fish crossing the initial marking point (e.g., a dam) using multiple sources of data (fish window counts, fish trap data, PIT tag detections). This approach addresses a number of issues surrounding visual counts, such as salmon passing during night-time hours or ascending the ladder multiple times and provides an unbiased estimate of total escapement with appropriate uncertainty. In combination with other modelling tools developed by Biomark researchers (PITcleanr, DABOM), STADEM is used to estimate total abundance of adult Chinook salmon and steelhead returning from the ocean to spawn in tributaries throughout the Columbia River Basin. This type of modelling can be easily extrapolated to a variety of species, ecosystems, and data types including most types of visual counts (aerial surveys, counting towers) and tagging data.

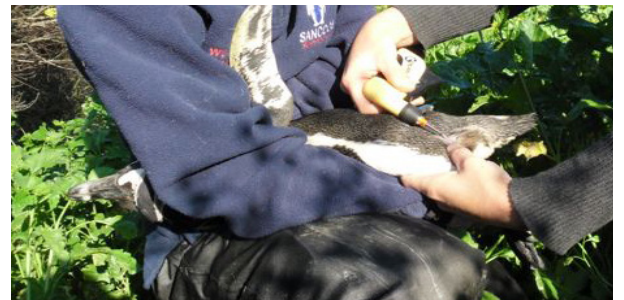
With funding from the Bonneville Power Administration, Biomark researchers have collaborated with the Nez Perce Tribe, Idaho Department of Fish and Game, and National Oceanic and Atmospheric Administration to develop tools that aid in Chinook salmon and steelhead recovery monitoring.

Biomark products, technology, and services used for this project:

- **Study Design**
- **Data Reduction, QA/QC**
- **State-space modeling**
- **Detection probability analysis**
- **Bayesian Statistics**
- **High Performance PIT Tags**
- **Instream PIT Tag Detection Systems**



STADEM pairs visual fish counts with PIT tag data to account for night passage and reascension (unmeasurable with a fish window alone) to estimate the density of unique wild fish crossing Lower Granite Dam, ID, USA.



Biomark Applied Biological Services collaborates with researchers studying a variety of species and ecosystems to adapt analytical techniques and extend statistical inference.

# OTHER PROJECT APPLICATIONS



**INSTREAM PIT TAG DETECTION**



**HIGH PERFORMANCE PIT TAGS**



**HPR LITE**