Influence of Incomplete Capture on Fish Monitoring and Management: Problems and Solutions

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Natural resource research and decision-making are influenced by the quality of sample data. One factor that influences the quality of fish sample data is incomplete detection. Not all fishes are captured during sampling and the ability to capture fishes varies with sampling method, fish species and size, and the characteristics of the habitats being sampled. Failing to account for differences in capture when comparing locations with different characteristics, species, and through time can introduce a systematic error or bias into the data. The problems are further exacerbated when existing sample designs and methods are changed in response to new program objectives. Several approaches have been developed to minimize the effects of gear bias including calibration, double sampling, and paired gear evaluations, and each differs with respect to relative costs and effectiveness. Another important and often overlooked, consideration when choosing an approach is how the data are integrated with management decision making. There is often profound uncertainty about the system's likely response to management, beyond environmental and other sources of uncontrolled variation. This uncertainty may be reduced through directed research, but management decisions usually cannot wait. Adaptive resource management can be used to reduce uncertainties and improve management through the integration of models and monitoring. Here, I discuss common sources of fish sampling biases and potential consequences of ignoring the biases. I then discuss approaches to minimizing the biases and integrating monitoring data and management decision-making in an adaptive framework using case studies from freshwater systems.

Keywords: capture probability, gear calibration, decision making
Session Title: Accounting for Gear Limitations in Fish Survey Data to Make Inferences about Population Abundances
Session Time: Thursday 10:20AM – 12:00PM Room 308-310

Incorporating Gear Evaluation Studies Data in a Delta Smelt Life Cycle Model (DSLCM)

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A life cycle model characterizing the population dynamics of delta smelt (DSLCM) was fit using catch data from several long-term fish survey monitoring programs in the Bay Delta. To connect the catch data to the underlying unknown population abundances, estimates of gear- and time-specific probabilities of capture were constructed using data from a series of side-by-side gear evaluation studies conducted by California Department of Fish and Wildlife and the US Fish and Wildlife Service. The methods for estimating these probabilities, along with the specific contact selectivity model structure and individual fish growth model, are explained and the resulting estimates are provided. How the estimates are incorporated in the DSLCM is shown along with subsequent DSLCM parameter estimates and output.

Keywords: Delta smelt, population dynamics, state space model, gear selectivity
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Constructing Juvenile Chinook Salmon Abundance Indices from Beach Seine Data Collected within the San Francisco Estuary, CA

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Resource managers rely on abundance and distribution metrics derived from long-term fish surveys to make vital decisions that affect fish population dynamics and assemblage structure within the San Francisco Estuary, California. However, population metrics such as abundance indices may be negatively biased by imperfect detection (i.e., false absences) of fishes, which can vary among gear types, species, and environmental conditions. Currently, there is considerable uncertainty about the capture efficiency of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) by beach seines and how efficiency varies with environmental conditions in the San Francisco Estuary. We evaluated the capture efficiency of beach seining conducted by the US Fish and Wildlife Service's Delta Juvenile Fish Monitoring Program within the Estuary and lower Sacramento and San Joaquin rivers. Beach seine capture efficiency was measured using a stratified random sampling design combined with fish enclosures and repeat sampling. A total of 148 samples were collected during the spring, summer, and fall of 2013 and spring and summer of 2014. To assess variability in capture probability and the absolute abundance of juvenile Chinook salmon, beach seine capture efficiency data were fitted using N-mixture models that represented *a priori* hypotheses about factors affecting capture and abundance processes. We observed that the capture efficiency of beach seines and the absolute abundance of juvenile Chinook salmon varied substantially among samples. The best approximating models indicated that capture probability varied among sites and physical habitat characteristics (e.g., water velocity). Our results suggest that beach seining has highly variable capture efficiencies within the San Francisco Estuary and failure to adjust for incomplete detection may bias population metrics. Therefore, capture efficiency sampling should continue to be incorporated into the Delta Juvenile Fish Monitoring Program and other monitoring programs to properly quantify and adjust catch data to develop more robust fish abundance and distribution metrics.

Keywords: beach seine, efficiency, sample design, bias, monitoring, fish, littoral, abundance
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Early Warning of Delta Smelt Movement During an Extreme Drought: Intensive Springtime Kodiak Trawling at Jersey Point

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The Spring Kodiak Trawl Survey (SKTS) is used to determine the relative abundance and spatial distribution of adult Delta Smelt (*Hypomesus transpacificus*). During January 2014 the SKTS had not captured any Delta Smelt in the south Delta, a region in relatively close proximity to the federal and state water pumping stations. The US Fish & Wildlife Service responded to the concern that the monthly sampling intervals of the regular SKTS would miss detection of migration by adult Delta smelt from rearing grounds around Suisun Bay towards the south Delta by conducting multiple tows at near daily intervals at Jersey Point (SKTS station 809) from Feb 6 through April 10, 2014. This talk will present the findings of this survey and discuss factors influencing density changes of Delta Smelt. Two findings will be highlighted: the importance of tow location within the channel for reliably detecting Delta Smelt, and the high probability of zero catch for typical volumes of water sampled per tow at the observed Delta Smelt densities.

Keywords: Delta Smelt, gear selectivity, hidden Markov model, Spring Kodiak Trawl
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Session Time: Thursday 10:20AM – 12:00PM Room 308-310

Compare and Contrast the Midwater and Otter Trawl of the Longfin Smelt San Francisco Bay Study

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Longfin smelt, *Spirinchus thaleichthys*, has been identified as one of the four species that suffered significant population decline since the year 2002 based on fish survey data from the Department of Fish and Wildlife. Fall Midwater Trawl data suggest a sharp decline in longfin smelt abundance during the last decade, though some of that decline might be attributable to a downstream movement in the longfin distribution into regions better covered by the Bay Study fish survey. The Bay Study uses two types of trawls, the Otter trawl and the Midwater Trawl. The Longfin smelt abundance index created from the Fall Midwater trawl is consistent with the trend in the Bay Midwater trawl but not the Bay Otter Trawl. In addition, there have been an increasing proportion of false zeros in the survey data where the Bay Midwater Trawl failed to detect any longfin smelt when they were detected in the Otter Trawl. An examination was initiated to determine what factor(s) were involved in the disparity. The analysis shows that a variety of factors may have affected the distribution and catchability of longfin smelt.

Keywords: Longfin smelt, San Francisco Bay Study, Survey, Bias
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