Science, Service, Stewardship

Assessment tools for evaluating effects of salmon fishery management on resident killer whales

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What tools are available and appropriate to evaluate impacts of fishery management measures on resident killer whales?

- Tools used to assess, evaluate, and shape fishery management measures include FRAM, the PSC Chinook (CTC) model, the CTC exploitation rate analysis (ERA), and to some extent, genetic stock identification (GSI).
- Analyses of effects of Chinook abundance on the vital rates of RKW have focused on the “Parken-Kope” indices of Chinook abundance.
- How do we reconcile these?

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Fishery assessment tools - FRAM

- Single season model
- Multiple time steps (Oct-Apr, May-Jun, July-Sep, Oct-Apr)
- 73 fisheries from Southeast Alaska through California
- 38 stocks from Lower Georgia Strait through Sacramento River
  - Each stock partitioned into marked and unmarked components
- Has detailed documentation

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Fishery assessment tools – CTC model

- Multi-year model
- One time step per year
- 25 fisheries from SEAK through Central Oregon
- 30 stocks from SEAK through Central Oregon

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Fishery assessment tools – FRAM vs CTC model

- Both use the same basic algorithms.
- Neither includes natural mortality within time steps
  - Multiple time steps of FRAM more closely approximate the "competing risks" model the panel requested.
- FRAM omits SEAK, NBC, Grays Harbor and upper GS stocks; Fraser River fisheries
- CTC model omits Sacramento fall and lower Columbia spring stocks, and fisheries south of central Oregon
- Neither includes coastal Chinook south of central Oregon, or upper Columbia spring stocks
- FRAM includes much more detail for Puget Sound stocks, and Puget Sound and lower US coastal fisheries.

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Fishery assessment tools – ERA

- Simple cohort analysis of CWT recoveries by brood year.
- Routinely performed for 38 indicator stocks.
- Maps recovery location codes to 61 “fisheries” – typically aggregates these to 32 fisheries (including escapement).
- Provides age- and year-specific estimates of exploitation rates and maturation rates, brood survival.
- It is typically a year out before data are complete (2012 ERA included CWT recoveries through 2010)
- Another 3 years until brood recoveries are nearly complete (2012 ERA includes complete broods through 2004 or 2005 brood year)

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Fishery assessment tools – GSI

- Still an emerging technology
- Not yet used for stock assessment
- Provides estimates of stock composition of samples
- Provides probable stock identity of individual fish
- Is used to shape fisheries to target or avoid specific stocks
- Is used to identify fish in RKW diet studies

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Parken-Kope Indices - Canadian stocks

- Actual terminal run data were used.
- Stocks were disaggregated to a finer scale than CTC model stocks.
- Pre-terminal fishery impacts were estimated from CWT recoveries of exploitation rate indicator stocks.
- Missing values in CWT fishery impact rates were filled in with CWT average rates, or relationships with other CWT or CTC model stocks.
- Expansions were made by calendar year.
- Incidental fishing mortality is included.

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Parken-Kope Indices - US stocks

- For most US stocks, terminal runs and fishery impacts were calculated by the CTC model.
- Terminal run estimates are input as age-structured data, but are smoothed by summing over brood years, applying an average maturity schedule to the broods, and then summing by calendar year.
- Incidental pre-terminal fishing mortality is included.
- Model stocks were further aggregated in some cases (Puget Sound, Columbia River tule fall, bright fall, and lower river spring).

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Comparisons

- ERA, GSI, and Parken-Kope indices are retrospective.
- CTC model and FRAM are both retrospective and predictive.
- Only the CTC model and FRAM can be used to evaluate impacts of proposed fisheries.
- Both rely on similar assumptions.
- Both are limited by the accuracy and precision of catch and escapement estimates, and abundance forecasts

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Accuracy and precision of catch estimates

- Commercial catch is enumerated from sales records
- Recreational catch is well sampled (>20%)
- Stock composition is not known
  - GSI can shed light on this
  - There is not a 1:1 correspondence between GSI reporting groups and fishery management units
- Stock composition is currently inferred by the CTC model and FRAM

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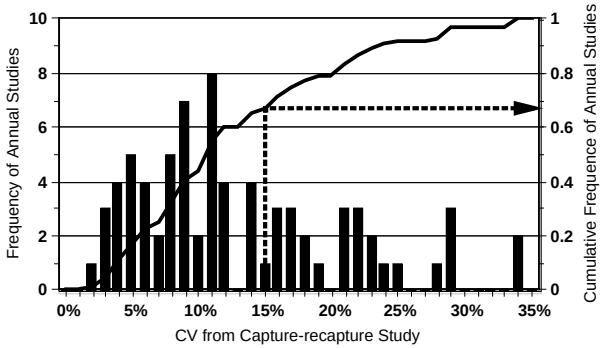
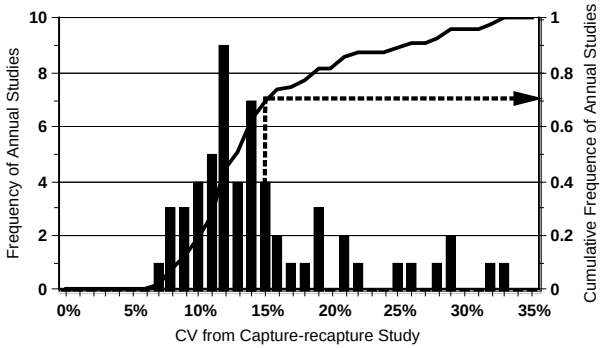
Accuracy and precision of escapement estimates

- "Gold standard" for escapement data is mark-recapture estimates
  - The only estimates for which we have estimates of precision.
  - Accuracy depends on meeting the assumptions of the estimator and probably varies widely
- Redd counts, carcass surveys, spawner counts
  - Some have been checked against mark-recapture estimates
  - Accuracy and precision are largely unknown

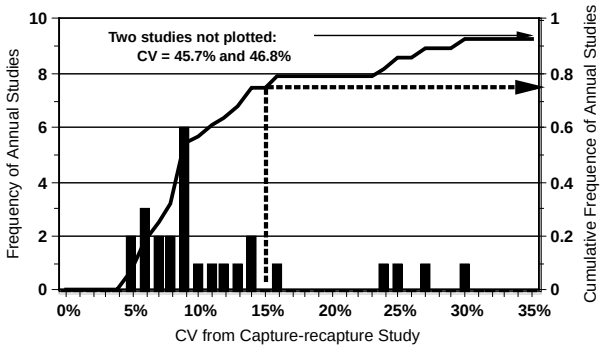
Canadian Stocks (14) from 1984-2007



SEAK Stocks (7) from 1989-2007



Oregon Stocks (7) from 1998-2007



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Precision of forecasts

Stocks	n	Average CV
Escapement indicators with accepted goals	8	30%
Stock components used by the CTC	32	47%
Agency forecasts for CTC Model stocks	23	31%
Model-generated forecasts for CTC Model stocks	28	41%

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Parting Thoughts

- All estimates of salmon abundance have large uncertainties.
- When you examine many correlations using noisy time series, you will find spurious correlations.
  - The highest correlation does not necessarily denote the best predictor.
- FRAM and CTC models share most data, and algorithms.
- Because of greater stock, fishery, and time resolution, FRAM is probably the best tool to evaluate fishery impacts.
  - If you want to evaluate the impacts of closing the non-treaty troll fishery in Neah Bay (area 4) during the month of August, you are better off using a model that has July-Sept, Area 3&4 non-treaty troll as a fishery than one that has Oregon-Washington troll for the entire year.