Calibrating MRFSS by Modeling Bias

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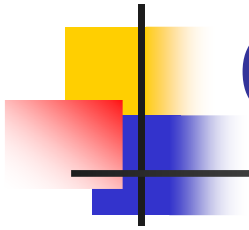
MRFSS Estimation

- New design and estimation methods for MRFSS have been implemented
  - Data collection follows explicit sampling design and statistical protocols
  - Estimates are fully weighted to reflect design and protocols
- Issue: estimates for previous years did not follow same approach, so weighting method does not apply directly

Estimates for recent past

- For 2004-2011, design information available to create "retroactive" weighting procedure
  - Selection of primary site-days and anglers at selected sites have known design, can be weighted
  - Selection of alternate sites did not follow statistical design, but incorporated through simplified weighting procedure
  - Model developed to relate interviewer "time on site" to 24-hour day of angling activity



Going further back?

- Two possible approaches:
  - Extend retroactive weighting
  - Time series calibration

Retroactive weighting

- Requires good quality information on selection methods *and* confidence that protocols were followed
  - Problematic when looking further into past
- Involves significant effort to…
  - Find/process/create old design information
  - Ensure design assumptions are reasonable
  - Ensure weight stability
- When completed, can be applied to all survey variables

Time series calibration

- Requires two time series, one following old method and one new method
  - The longer the overlap, the better
- No need to find/process/create old design information
- Involves significant effort to develop valid calibration model
- Needs to be done for each survey variable separately

Two available types of estimates

- Consider overlap period of both old and new estimates
  - old estimates have potential bias due to design-estimation mismatch
  - new re-weighted estimates should be nearly unbiased

The idea of calibration

- “Calibrate” to get consistent time series of estimates over time
  - Model relationship between old and new
  - Extrapolate new results back in time, prior to the overlap period, using available old estimates and the modeled relationship

A basic model for calibration

- Consider a particular species in a specific mode
- Let **s**=state and **t**=time point
- Suppose that true catch is given by
- **mu(t)+M(s)+m(s,t)**

where

- **mu(t)** is the temporal trend common across states
- **M(s)** is the state-specific effect that does not change over time
- **m(s,t)** is the temporal trend that is unique to a state

Estimation by the new method under the basic model

- The new method matches design to estimation and yields unbiased estimates for a given species:
- **New(s,t)=mu(t)+M(s)+m(s,t)+e(s,t)**
  = truth + sampling error

  where
- **e(s,t)** is zero-mean sampling error
- This can be thought of as the main effect of time, the main effect of state, and the interaction of state and time, plus sampling error

Estimation by the old method under the basic model

- The old method did not match design to estimation, and so it led to potential bias in estimates
- Model the bias in pieces:
- **Old(s,t)=truth + biased sampling error =mu(t)+M(s)+m(s,t)+beta(t)+B(s)+b(s,t)**

where

- **beta(t)** is the temporal bias that is common across states
- **B(s)** is the state-specific bias that does not change over time
- **b(s,t)** is the temporal bias and other error that is unique to a state

Estimating the bias components

- For states and time periods with both new and old estimates, compute
- **Old(s,t)-New(s,t)**

  =beta(t)+B(s)+b(s,t)-e(s,t)
- Roughly speaking:
- **beta(t)** is estimated by averaging over states **s** for each fixed time **t**: call this estimate **Est.beta(t)**
- **B(s)** is estimated by averaging over times **t** for each state **s**: call this **Est.B(s)**
- Since **e(s,t)** has mean zero, estimate **b(s,t)** by **Est.b(s,t)=Old(s,t)-New(s,t)-Est.beta(t)-Est.B(s)**

Calibrating the old estimates

- Suppose the overlap period with both **New(s,t)** and **Old(s,t)** runs from **t=h+1,…,T**
- Consider **Old(s,t)** for **t=1,…,h**, corresponding to estimates using the old method before the overlap period:
  - Extrapolate **Est.beta(h+1)** down to **Est.beta(t)** using time series and/or regression methods
  - Extrapolate **Est.b(s,h+1**) down to **Est.b(s,t)** using time series and/or regression methods
- Compute the calibrated estimate **Est.New(s,t)=Old(s,t)-Est.beta(t)-Est.B(s)-Est.b(s,t)**

Concerns with calibration

- **Old(s,t)** is then approximately calibrated
- This ***requires extensive modeling***: building time series/regression models for every species in every mode
- Also ***requires extensive assumptions***: sensible extrapolation back in time assumes that design and measurement methods did not change
- Also ***requires extensive testing***: assess models and assumptions (both statistically and scientifically), wherever possible

Possible extensions

- Easy to incorporate other effects, like wave and its interactions, in the same kind of analysis
  - wave*state interaction, for example: bias effect of wave 6 in New Hampshire might be different from bias effect of wave 6 in North Carolina
- Known design changes might be reflected with indicators in the time series/regression models

Assessing the calibration

- Alternative to calibration is to re-weight the data, as was done for the overlap period.
- Could calibrate for 1998-2003, then later check these calibrations against re-weighted estimates when they become available
- Earliest time period will probably never have re-weighted estimates
  - Not enough design information, and limited QA/QC

Science, Service, Stewardship

Related Alternatives to Approach for Catch Series

John Foster

MRIP Calibration Workshop

March 27-29, 2012

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Simplified Time Series

- Single ARIMAX model for each catch series
  - ARIMA models of MRFSS catch bias or MRIP catch estimates
  - External “tuning” series
    - MRFSS estimates
    - Fishery independent indices
  - Hindcast MRFSS bias or MRIP catch estimates
- Tradeoff between speed of implementation and robustness

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"Effort" Calibration

- Apply approach proposed for catch series to series of sums of the sample weights ("effort")
- Models would incorporate terms for sample design (pressure categories, strata) allowing for variable adjustments within standard estimation cells
- Back out individual trip sample weights from calibrated "effort" and use to calculate revised catch estimates for all species