Sample Designs and Bycatch Estimates

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Fisheries covered by the Pacific Islands Regional observer program.

- Hawaii shallow-set longline fishery (SSLL)
  - 100% observer coverage

- Hawaii deep-set longline fishery (DSLL)
  - 20% observer coverage on an annual basis

- American Samoa longline fishery (ASLL)
  - ≈20% observer coverage on an annual basis

The challenges of creating a probability sampling design for the DSLL fishery.

- Impractical to maintain a constant proportion of observers to fishing activity,

$$\frac{\#obervers}{\#\ trips\ departing}.$$

- Observer placement on SSLL trip has priority.

- Observers are not paid while waiting to be deployed.

Systematic-Plus Design (SYSPLUS)

- Sampling frame is the list of notifications.
- SYSPLUS design is a two-stage design.
- The first stage sample is a systematic sample with coverage 5% lower than the targeted coverage.
  - Each systematic sample (cluster sample) is a simple random sample without replacement (SRSWOR) of 5 systematic clusters.
- The plus sample (second stage sample) is a series of simple random samples drawn when have extra observers that are ready for deployment.
- The SYSPLUS design is a hierarchical unequal probability design.
- A year's sample may be stratified with SYSPLUS sample within strata.

Estimation of total incidental take.

Use the generalized ratio estimator (GRE) to estimate total incidental take (T). For inclusion probababilities π_i, the GRE is

$$\hat{T} = T_x(\hat{T}_y/\hat{T}_x)$$

where T_x it the population total of the auxiliary variable x, $\hat{T}_y = \sum y_i/\pi_i$ and $\hat{T}_x = \sum x_i/\pi_i$.

Auxiliary variable (x) is typically

$$ntrip = \begin{cases} 1, & trip\ landed\ during\ year \\ 0, & otherwise. \end{cases}$$

Interval estimation of total incidental take.

- Normal-based confidence intervals are inappropriate.
- Use model-based interval estimators based on the Poisson distribution.
- Shifting from a frequentist approach to a Bayesian approach.

Examples of Hawaii DSLL estimated turtle takes.

Species	Year	#Observed	Est. Take	95% CI
Leatherback	2011	3	14	[3,36]
	2012	1	6	[1,24]
	2013	3	15	[3,36]
Olive Ridley	2011	7	36	[13,69]
	2012	6	34	[12,65]
	2013	9	42	[19,77]
Loggerhead	2011	0	0	[0,15]
	2012	0	0	[0,16]
	2013	2	11	[2,31]

Estimation of incidental takes resulting in a classification of death or serious injury (DSI) within subgeographical areas.

- Since 2013, the GRE is used to estimate total DSI within areas where

$$adj.trip = \begin{cases} 1, & trip\ fished\ in\ area\ and\ landed\ during\ year \\ 0, & otherwise \end{cases}$$

and

$$adj.y = \begin{cases} y, & DSI\ takes\ \ that\ occurred\ in\ area\ and\ trip\ landed\ during\ year \\ 0, & otherwise. \end{cases}$$

- Before 2013, the GRE was used to estimate T within area where

$$adj.ntrip = \begin{cases} 1, & trip\ fished\ in\ area\ and\ landed\ during\ year \\ 0, & otherwise, \end{cases}$$

and

$$adj.y = \begin{cases} y, & takes\ that\ occurred\ in\ area\ and\ trip\ landed\ during\ year \\ 0, & otherwise. \end{cases}$$

- Then, estimate the probability a take results in a DSI classification (p_{DSI}) based on the proportion of observed takes in comparable years of similar species that were classified as DSI.

- Estimator of DSI within area (a) is

$$\#observed\ DSI\ in\ area + (\hat{T}_a - \#observed\ takes\ in\ area)\hat{p}_{DSI.}$$

Interval Estimators of DSI

- Since 2013, I've been shifting from a frequentist model-based interval estimator to using a Bayesian interval estimator based on the Poisson distribution.

- Before 2013, the interval estimates were computed using a parametric bootstrap algorithm. For several species coverage of the approximate confidence interval was likely lower than the nominal coverage.
  - If used similar estimator of DSI in future will likely use a Bayesian interval estimator.

Examples of marine mammals 2009-2013 5-year average DSI estimates.

		DSLL Estimates		Hawaii EEZ Estimates	
Species	**#Observed**	**Est. DSI**	**95% CI**	**Est. DSI**	**95% CI**
False Killer Whale	4.6	20.4	[10.4,28.4]	11.6	[6.6,17.0]
Short-finned pilot whale	0.6	0.4	[0.6,2.0]	0	[0.0,0.8]
Blackfish	1.4	4	[1.4,7.0]	2.4	[1.0,4.4]
Risso's dolphin	0.4	0.9	[0.4,2.8]	0.6	[0.2,1.8]
Sperm Whale	0.2	0.7	[0.2,1.4]	0.7	[0.2,1.2]
Pantropical spotted dolphin	0.2	0.5	[0.2,1.2]	0	[0.0,0.4]
Striped Dolphin	0.2	0.6	[0.2,1.2]	0	[0.0,0.4]
Bottle dolphin	0.4	1.9	[0.4,3.8]	0	[0.0,1.2]

The challenges of sampling the ASLL fishery.

- ❖ Fishery has been unstable.
- ❖ Length of ASLL trips is highly variable.
- ❖ Port stops (vessels arrives back at a port and does not offload catch) can be longer than a week.
- ❖ Have a small number (≈3) of observers.

ASLL sampling protocol.

- When an observer is ready for deployment, randomly select a vessel from vessels preparing to depart on a new trip.

- An ASLL trip ends when a vessel comes into port and offloads their catch or a port stop exceeds 96 hours (4 days).

Estimation of Total Incidental Takes.

- ❖ Use classification trees and records of observer deployment to identify periods where trips are selected at about the same frequency.

- ❖ Define these intervals as strata and assume the sample within a stratum behaves like a simple random sample without replacement.

- ❖ Estimate T and DSI using the same GRE as used for the Hawaii DSLL fishery .

Examples of ASLL incidental sea turtle take estimates and marine mammal DSI estimates.

Species	Year	#Observed	Est. Take/DSI	95% CI
Green	2011	11	32	[16,48]
	2012	0	0	[0,43]
	2013	2	19	[3,5]
Leatherback	2011	2	4	[2,26]
	2012	1	6	[2,45]
	2013	2	13	[2,36]
False Kiler Whale	2011	3	6	[4,28]
	2012	0	0	[0,43]
	2013	1	9	[1,36]