

SEDAR 77 HMS Hammerhead Sharks Review Workshop

Developing total bycatch estimates for live and dead discard rates

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Bycatch estimates developed based on observer data from the shark bottom longline and coastal gillnet fisheries

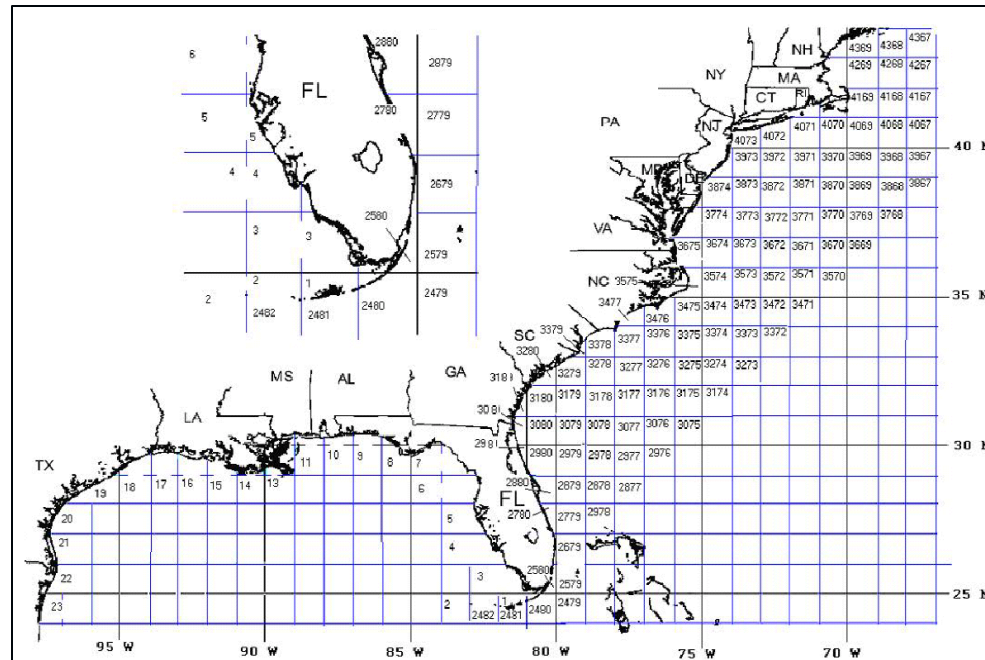
- Vessels are selected based on a random sample of vessels within a strata (quarter) based on previous years logbook reported effort
- Observer coverage levels based on available funding range from 100%-~5%
- Observer coverage began in 1993, depending on the fishery



Derivation of estimates

Ratio estimator from observer data utilized to extrapolate to total discards by multiply by total effort from logbook data

- Catch per hook or set
- Error calculated using bootstrapping



Initial estimates

- The ratio method used for SEDAR77-DW-20 and SEDAR20-DW-21 that provided discard estimates was a reasonable approach, but the estimated standard deviations (or CVs) are extremely high from bootstrap resampling.
- It was recommended to use the delta-lognormal method (Pennington, 1983) as an alternative method to estimate dead discards and live discards with the same data sets.

Delta-lognormal method (Pennington 1983)

When number of sets in which a non-zero bycatch was observed (positive sets) is greater than 1, the mean discard rate, C , is calculated as:

$$C = \frac{m}{n} e^L G_m \left(\frac{s^2}{2} \right) \quad (1)$$

m is number of sets in which a non-zero bycatch was observed (positive sets),

n is total number of sets observed,

L is the mean of the log-transformed number of animals taken per 1000 hooks for the positive sets,

s^2 is the variance of the log-transformed number of animals taken per 1000 hooks for the positive sets, and

$G_m \left(\frac{1}{2} s^2 \right)$ is the cumulative probability function from the Poisson distribution given as:

$$G_m \left(\frac{1}{2} s^2 \right) = 1 + \frac{m-1}{m} \left(\frac{1}{2} s^2 \right) + \sum_{j=2}^{\infty} \frac{(m-1)^{2j-1}}{m^j (m+1)(m+3)\dots(m+2j-3)} \times \frac{\left(\frac{1}{2} s^2 \right)^j}{j!} \quad (2)$$

The series was computed numerically over j terms until meeting a convergence criterion of a change in the function value of < 0.001 with additional terms (j). The variance of the delta estimator is:

$$\text{var}(C) = \frac{m}{n} (e^{2L}) \left[\frac{m}{n} G_m^2 \left(\frac{s^2}{2} \right) - \frac{m-1}{n-1} G_m \left(\frac{m-2}{m-1} s^2 \right) \right] \quad (3)$$



Delta-lognormal method (Pennington 1983)

When number of sets in which a non-zero bycatch was observed (positive sets) is equal to 1, the mean discard rate reduces to the simple mean rate where:

$$C = \frac{e^L}{n} \quad (4)$$

and the variance of the delta estimator is:

$$\text{var}(C) = \left(\frac{e^L}{n}\right)^2 \quad (5)$$

When number of sets in which a non-zero bycatch was observed (positive sets) is equal to 0, the mean discard is:

$$C = 0 \quad (6)$$

and the variance of the delta estimator is:

$$\text{var}(C) = 0 \quad (7)$$

When number of sets in which a non-zero bycatch was observed (positive sets) is greater than or equal to 1, the coefficient of variation for the mean discard rate is taken as:

$$CV = \frac{\sqrt{\text{var}(C)}}{C} \quad (8)$$

Delta-lognormal method (Pennington 1983)

The C calculated above gives either the annual mean or the grand mean number of animals caught per 1000 hooks for the observed sets. To estimate annual discards, N , these rates are multiplied by the annual total number of logbook hooks (in thousands). With an assumption of effort (*number of logbook hooks*) being a known constant, the coefficient of variation for the annual (or grand) mean discard rate is the same as the coefficient of variation for the annual discards. Approximate 95% confidence intervals (95% CI) were calculated assuming a log-normal distribution of annual discards as Nk and N/k for the upper and lower confidence bounds respectively where:

$$k = e^{\left[1.96\sqrt{\ln(1+CV^2)}\right]} \quad (9)$$

Recommendations for Bycatch

- ✓ For consistency with the landings, which started in 1981, the longline and gillnet discards were back-calculated to 1981 using an approach similar to that used for landings
- ✓ Use the delta-lognormal method to replace the ratio method
- ✓ Base run: estimated dead discards and post release mortality (PRM) estimates for estimated live discards are included
- ✓ Low catch: estimated LCI dead discards and post release mortality (PRM) estimates for estimated LCI live discards are included
- ✓ High catch: estimated UCI dead discards and post release mortality (PRM) estimates for estimated UCI live discards are included
- ✓ Annual discard estimates using the grand mean CPUE and annual effort
- ✓ There are no uncertainty estimates or OBSERVED dead discards associated with published pelagic longline dead discards. CVs are calculated by area/quarter but not overall, and are not included in data reporting to ICCAT. Data workshop panel recommended using ICCAT pelagic longline dead discards in base run (and low catch and high catch scenarios)

