

WP#13: Envelope Method

WP#13-Envelope Method Application: Summary

- Using survey and catch data, the Envelope method assumes a range of plausible values for catchability and fishing mortality to develop a constrained range of stock sizes consistent with both sets of assumptions.
- Only under the most extreme assumptions, i.e., the lowest possible swept area estimates (100% efficiency, 100% of stock is in the survey area, natural mortality is one sixth the standard rate of 0.06/wk) does the estimated **F** approach any of the F50%MSP thresholds in Table 3 of Hendrickson and Hart

WP#13-Data & Methods(1)

- Is observed catch the result of high fishing mortality on small stock or low mortality on a small stock?
- Key data sources:
 - **Post fishery** fall bottom trawl survey
 - Total landings
- Assume range of
 - catchability (q) = {q_lo, q_hi}
 - availability (v) = {v_lo, v_hi}
- Assume range of
 - F = {F_lo, F_hi},
 - M = {M_lo, M_hi}

$$B_t = \frac{I_t}{q} \frac{A}{a} \frac{1}{v} = \frac{AI_t}{qav}$$

$$B_0 = B_t e^{Mt} + C_t e^{\frac{M}{2}t}$$

$$B_0 = \frac{C_t}{\frac{F}{F+M} (1 - e^{-(F+M)})}$$

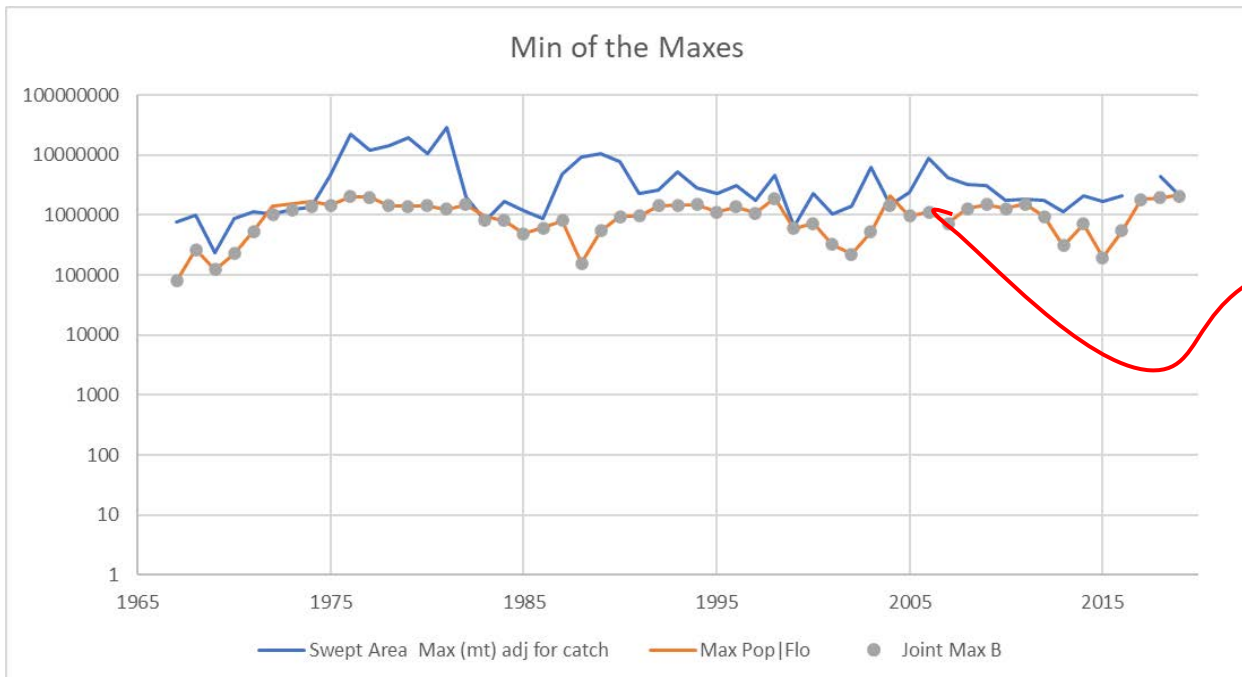
WP#13-Data & Methods(2)

- Find constrained min of maximums, and max of Minimums

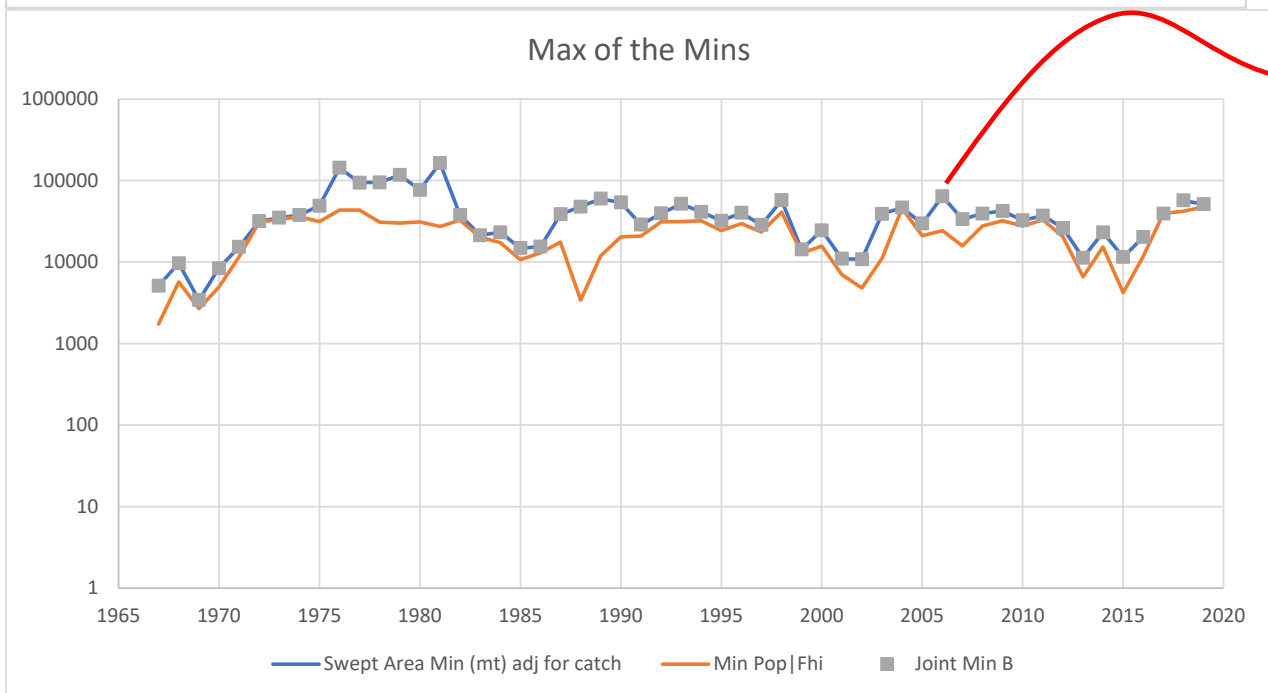
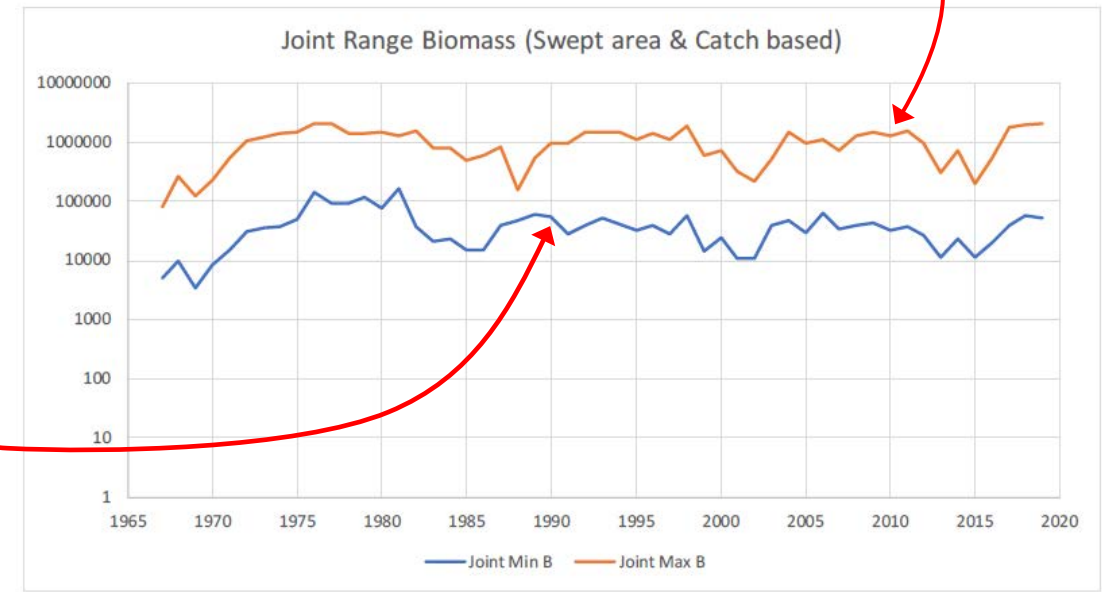
$$\begin{array}{l} \hat{B}_{1,t} = B(I_t, q_{Low}, v_{Low}, M_{High}) \\ \hat{B}_{2,t} = B(I_t, q_{High}, v_{High}, M_{Low}) \\ \hat{B}_{3,t} = B'(C_t, F_{Low}, M_{High}) \\ \hat{B}_{4,t} = B'(C_t, F_{High}, M_{Low}) \end{array} \begin{array}{l} \longrightarrow \\ \longrightarrow \\ \longrightarrow \\ \longrightarrow \end{array} \begin{array}{l} \hat{B}_{upper,t} = \min(B_{1,t}, B_{3,t}) \\ \hat{B}_{lower,t} = \max(B_{2,t}, B_{4,t}) \end{array}$$

- Find $F_{hat(t)}$ by substituting $B_{upper(t)}$ or $B_{lower(t)}$ for B_0 , and $C(t)$ and $M_{assumed}$ into catch equation.

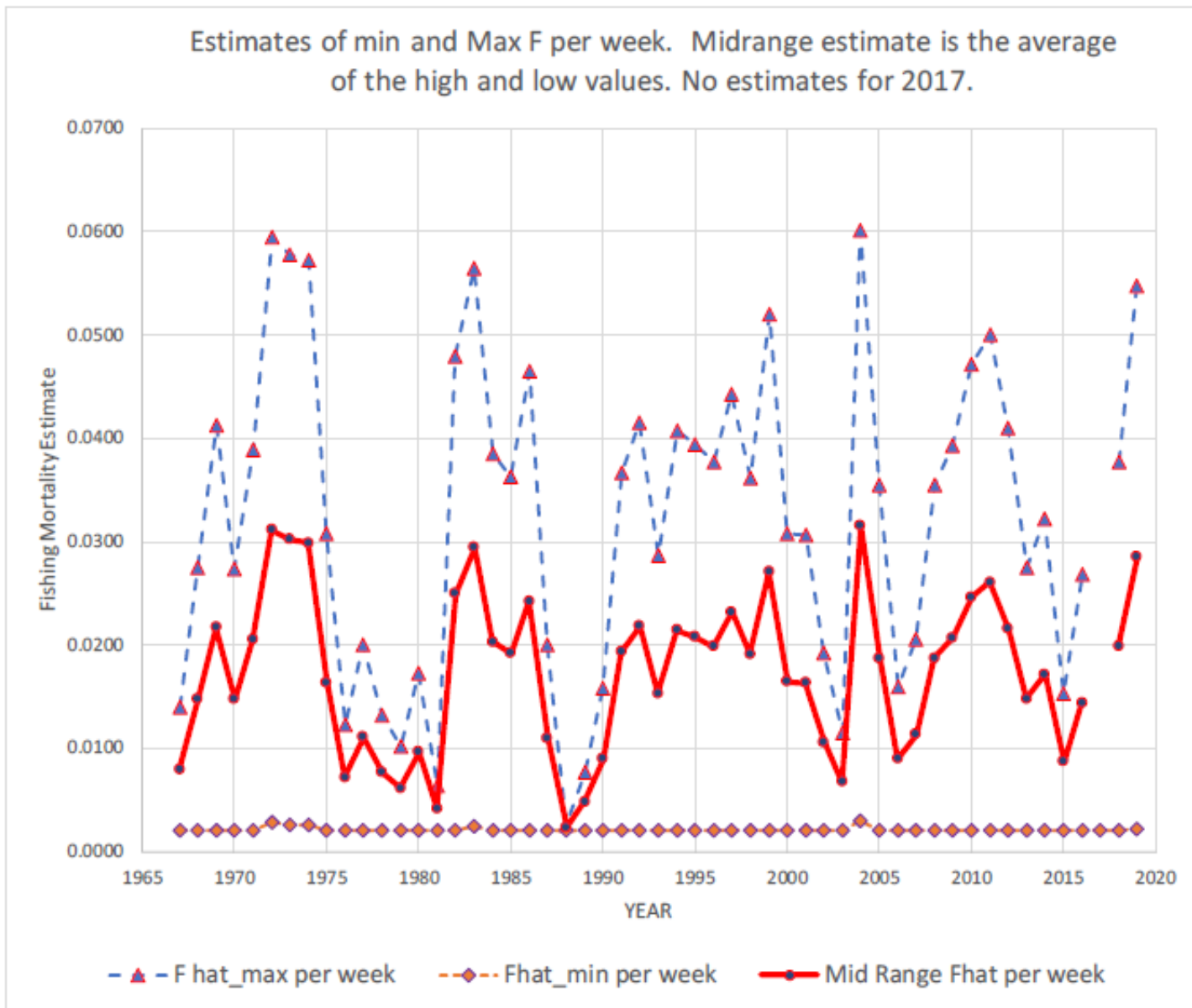
$$B_0 = \frac{C_t}{\frac{F}{F+M} (1 - e^{-(F+M)})}$$



Upper bound determined primarily by assumed lower bound on F



Lower Bound determined primarily by assumed upper bound on swept area catchability



WP#12-Key Results(2)

- Mid range is average of upper and lower estimates of F.
- Reference Points for Illex are typically greater than 0.12 in Hendrickson and Hart 2006.

Figure 2. Range of fishing mortality rates derived from constrained bounds on population biomass using the envelope method.

WP#13-Sources of Uncertainty

- Assumed ranges of F and M are consistent with literature.
- Need to consider fall survey as a post fishery survey.
- However, for F to be higher, M would have to be near zero.
- Poor man's Bayesian analysis—refinement might improve bounding