Adjusting station-level catchability using side-by-side trawl studies and environmental information

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Estimating NMFS station-level trawl efficiency using side-by-side trawl studies and environmental information (1)

- Somerton et al. (2013) estimated NMFS survey haul efficiency for snow crab using side-by-side BSFRF survey tows

$$C = D \cdot r \cdot A \cdot S$$

- C = catch in length bin z at station h
- D = crab density in length bin z at station h
- r = trawl efficiency in length bin z at station h
- A = area swept at station h
- S = catch sampling proportion at station h

$$\Phi \equiv \frac{C_a}{C_a + C_b}$$

- C_a = catch in length bin z at station h for AFSC survey
- C_b = catch in length bin z at station h for BSFRF survey

- and with a little math

$$\Phi = \frac{r_a}{r_a + R_A \cdot R_S}$$

- $D_a \equiv D_b$
- $r_b \equiv 1$
- $R_A = A_b/A_a$ = ratio of swept areas
- $R_S = S_b/S_a$ = ratio of sampling fractions

- and a little more

$$\text{logit}(\Phi) = \ln(r_a) + \ln(R_A \cdot R_S)$$

Estimating NMFS station-level trawl efficiency using side-by-side trawl studies and environmental information (2)

- Somerton et al. (2013) fit the following model for using generalized additive models (GAMs)

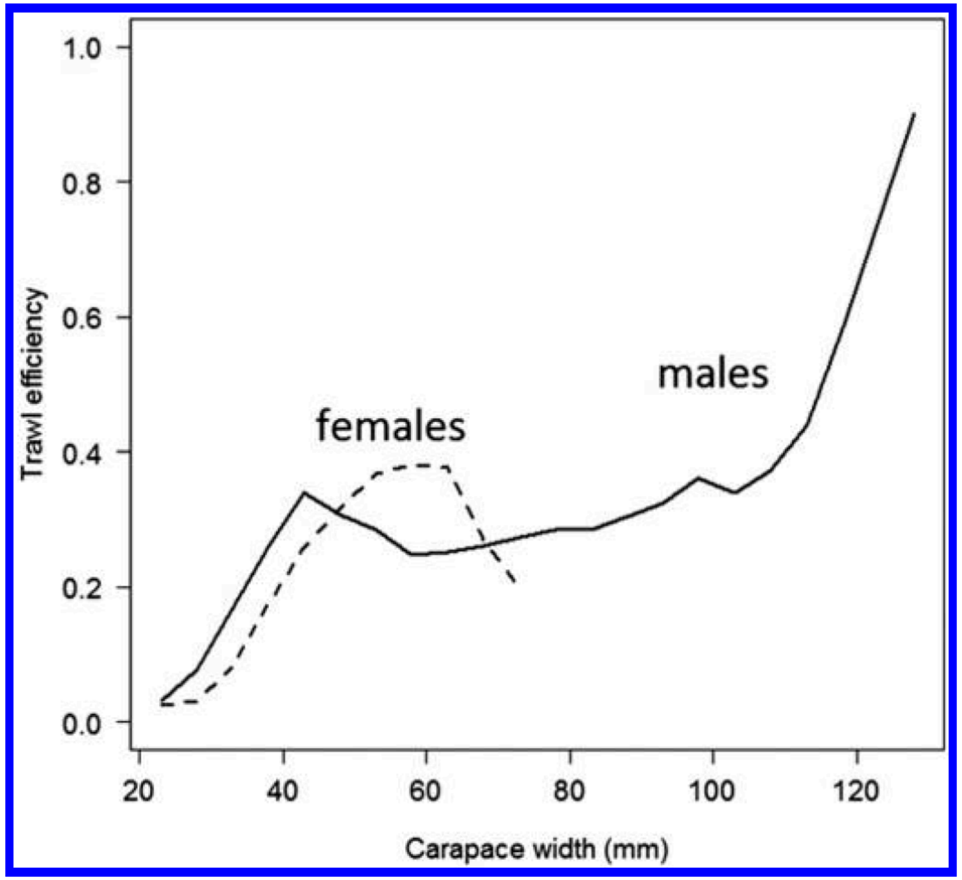
$$\mathrm{logit}(\Phi) = \ln(r_a) + \ln(R_A \cdot R_S) = \Omega_1(W) + \Omega_2(X)$$

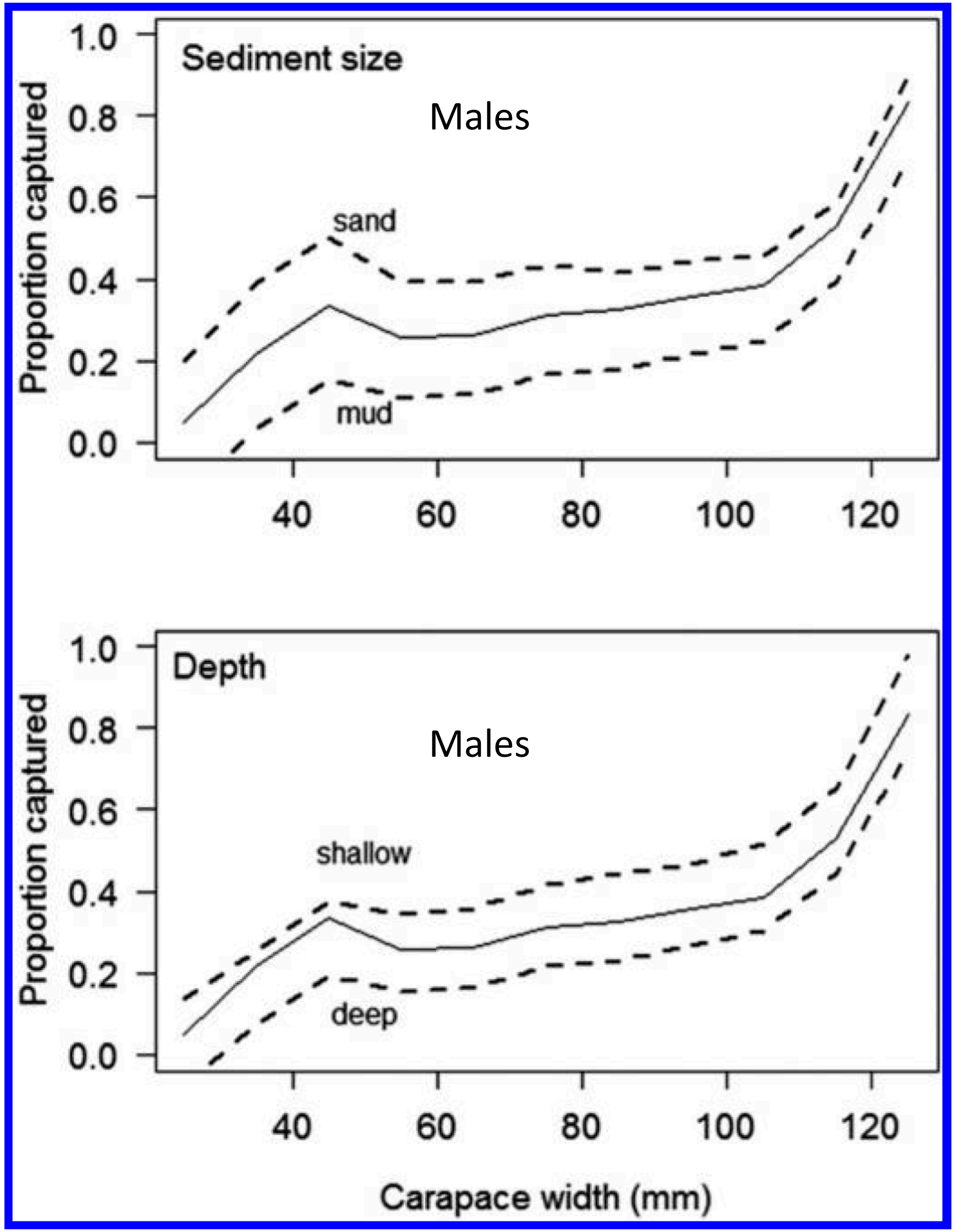
- Ω = smooth, nonparameteric functions
- W = carapace width
- X = set of environment variables

$$r_a = \exp[\mathrm{logit}(\Phi) - \ln(R_A \cdot R_S)] = \exp[\Omega_1(W) + \Omega_2(X) - \ln(R_A \cdot R_S)]$$

Somerton et al. (2013) Results

Mean Trawl Efficiency





Adjusting station-level catchability using side-by-side trawl studies and environmental information (3)

- Somerton et al. (2013) fit the following model for using generalized additive models (GAMs)

$$\text{logit}(\Phi) = \Omega_1(W) + \Omega_2(X)$$

- Ω = smooth, nonparametric functions
- W = carapace width
- X = set of environment variables

- Somerton et al. (2013), using kriging to interpolate grain size

Sex	X	R^2	Deviance explained
male	depth, grain size	49%	45%
female	depth, grain size	55%	54%

- Somerton et al. (2017), using acoustically-determined sediment characterization variables Q_1, Q_2, Q_3

Sex	X	R^2	Deviance explained
male	depth, Q_1, Q_2, Q_3	--	52%
female	depth, Q_1, Q_2, Q_3	--	73%

Adjusting station-level catchability using side-by-side trawl studies and environmental information (4)

- So can estimate AFSC trawl efficiency **on a haul basis** as

$$r_a = \exp[\Omega_1(W) + \Omega_2(X) - \ln(R_A \cdot R_S)]$$

- Could inflate AFSC survey catches by station to account for local environmental effects (by $\exp[\Omega_2(X)]$)
  - would estimate size selectivity (and availability) in assessment model
- Could inflate AFSC survey catches by station to account for all efficiency effects (by $\exp[\Omega_1(W) + \Omega_2(X)]$)
  - would treat inflated survey catches as estimates of population abundance
- Would not include BSFRF surveys in assessment model fits(?)
- One wrinkle: how to treat $\ln(R_A \cdot R_S)$ at stations without side-by-side information?