

Estimating Rates of Crab Mortality from Trawl Encounters

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Conservation Engineering

- Changing fishing gear or methods to reduce incidental problems
 - (e.g., Bycatch or effects on habitat)
- Need ways to measure effects (e.g., crab mortality rates), but relative measures are usually sufficient
- May not perfectly match considerations needed for stock assessment analyses

Outline

- Study of crab injuries after they escaped trawl groundgear
- Methods to measure **unobserved** crab mortality rates
- Measurements of unobserved crab mortality rates
- Reduction of unobserved crab mortality rates
- Other studies of unobserved crab mortalities
- Measurements of **discard** crab mortality rates

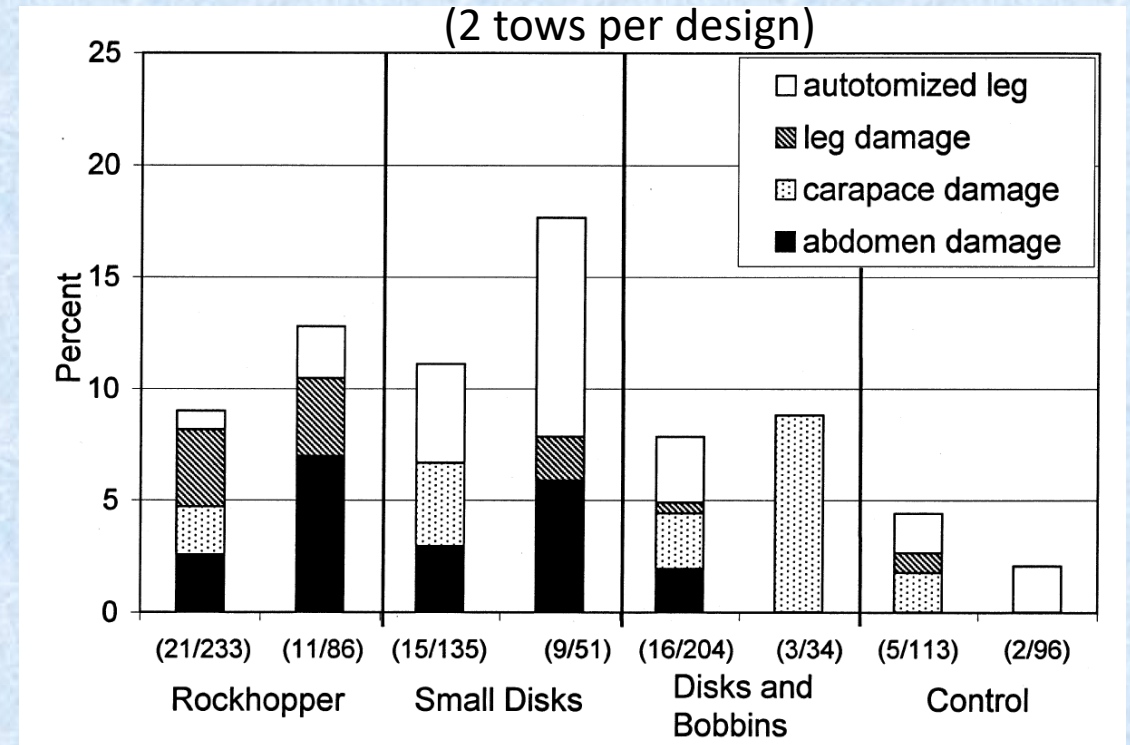
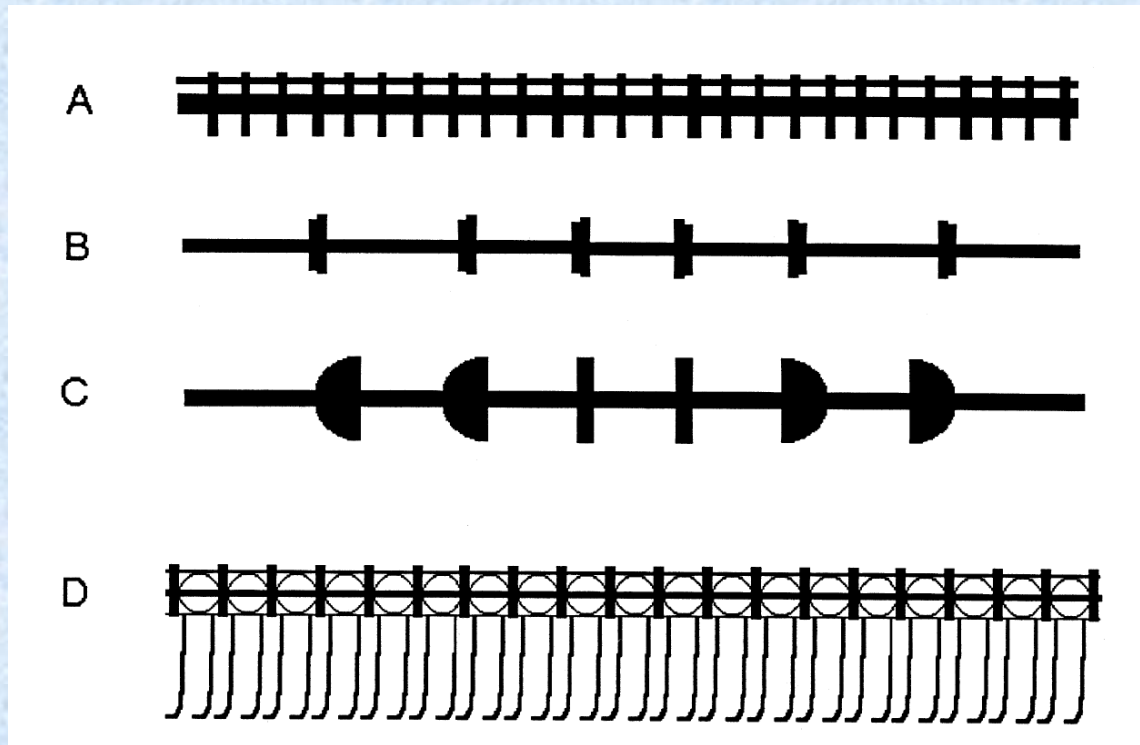
Unobserved crab mortality rates

- How many of the crabs that encounter trawls, but are not caught, die as a result?
 - What part of the trawl? Groundgear design?
 - Crab behavior and shape (Rose 1995*)
 - Generally much better chances than if caught (Discard mortality)
 - Shorter and generally less damaging encounters
 - Released immediately into preferred environment

* *Solving Bycatch Workshop: Considerations for Today and Tomorrow*, Seattle, Washington, Alaska Sea Grant College Program

Injury rates for RKC passing under trawl footropes

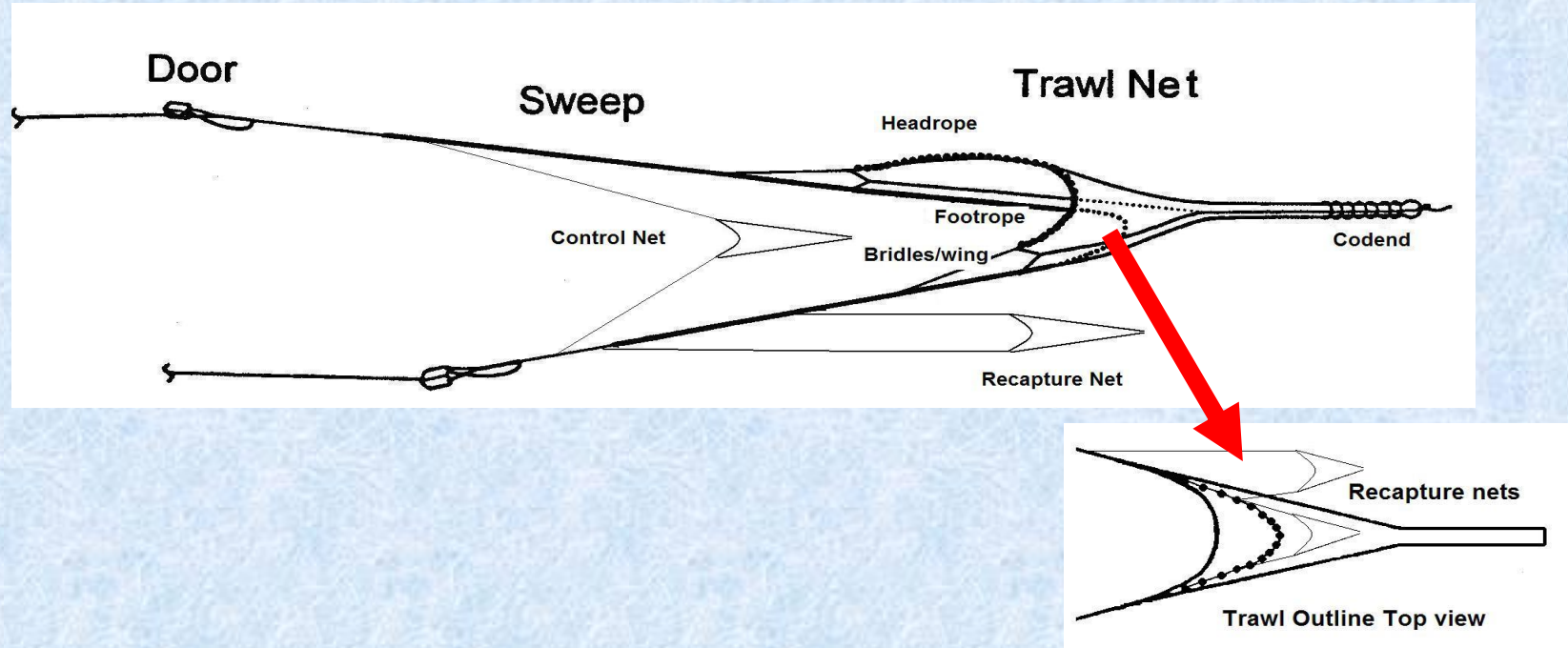
1996 study



Rose, C.S., 1999. Injury rates of red king crab, *Paralithodes camtschaticus*, passing under bottom trawl footropes. *Mar. Fish. Rev.* 61(2) 72-76.

Estimating unobserved mortality of crabs encountering trawls

Recapture after passing trawl groundgear (plus handling control)



- Affected crabs captured in auxiliary nets after contact
- Short tows to minimize recapture stress
 - Better simulates the experience of escaping crabs
- Control net to adjust for capture and handling damage

Estimating unobserved mortality of crabs encountering trawls

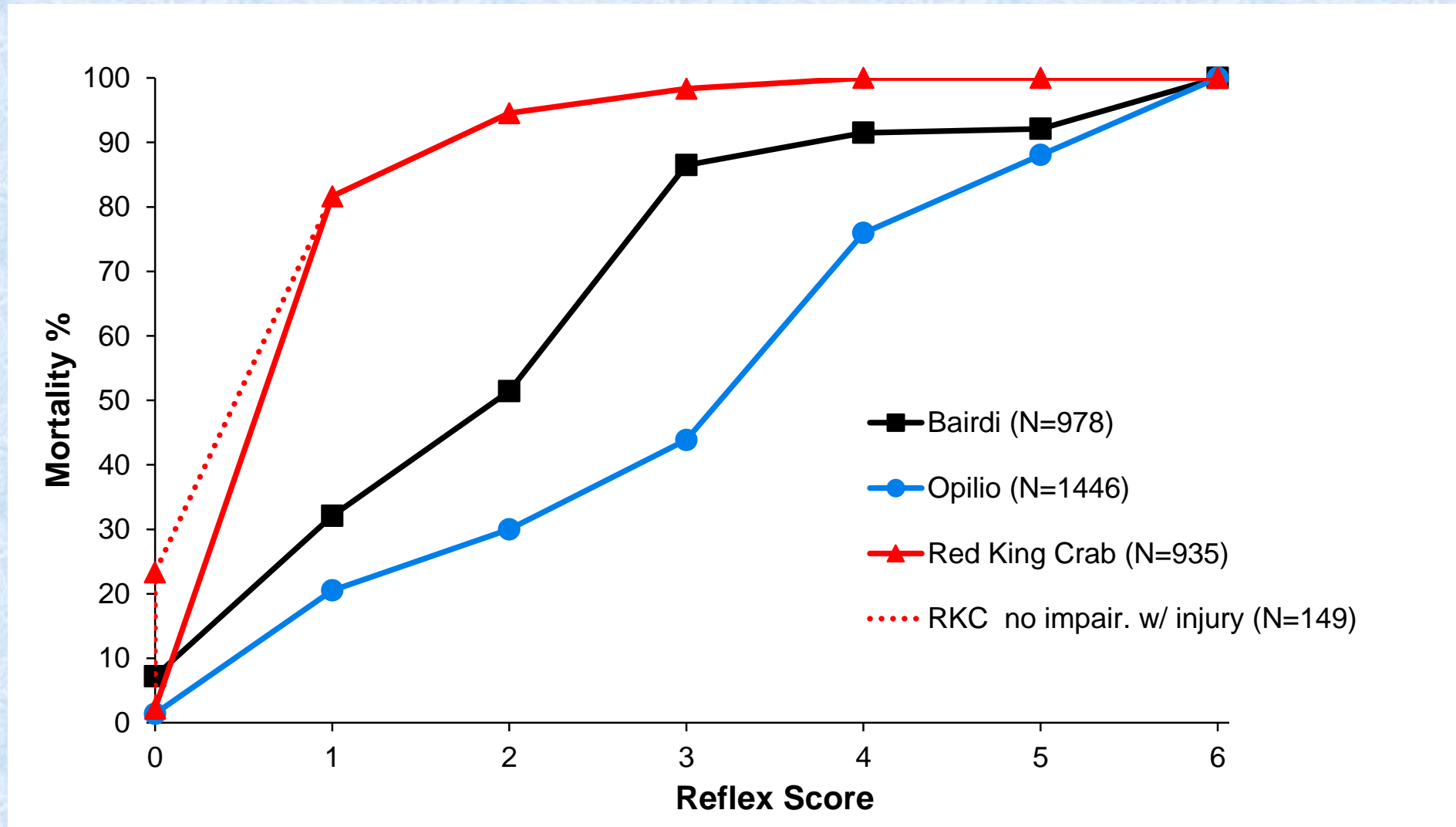
Reflex Action Mortality Predictors (RAMP)



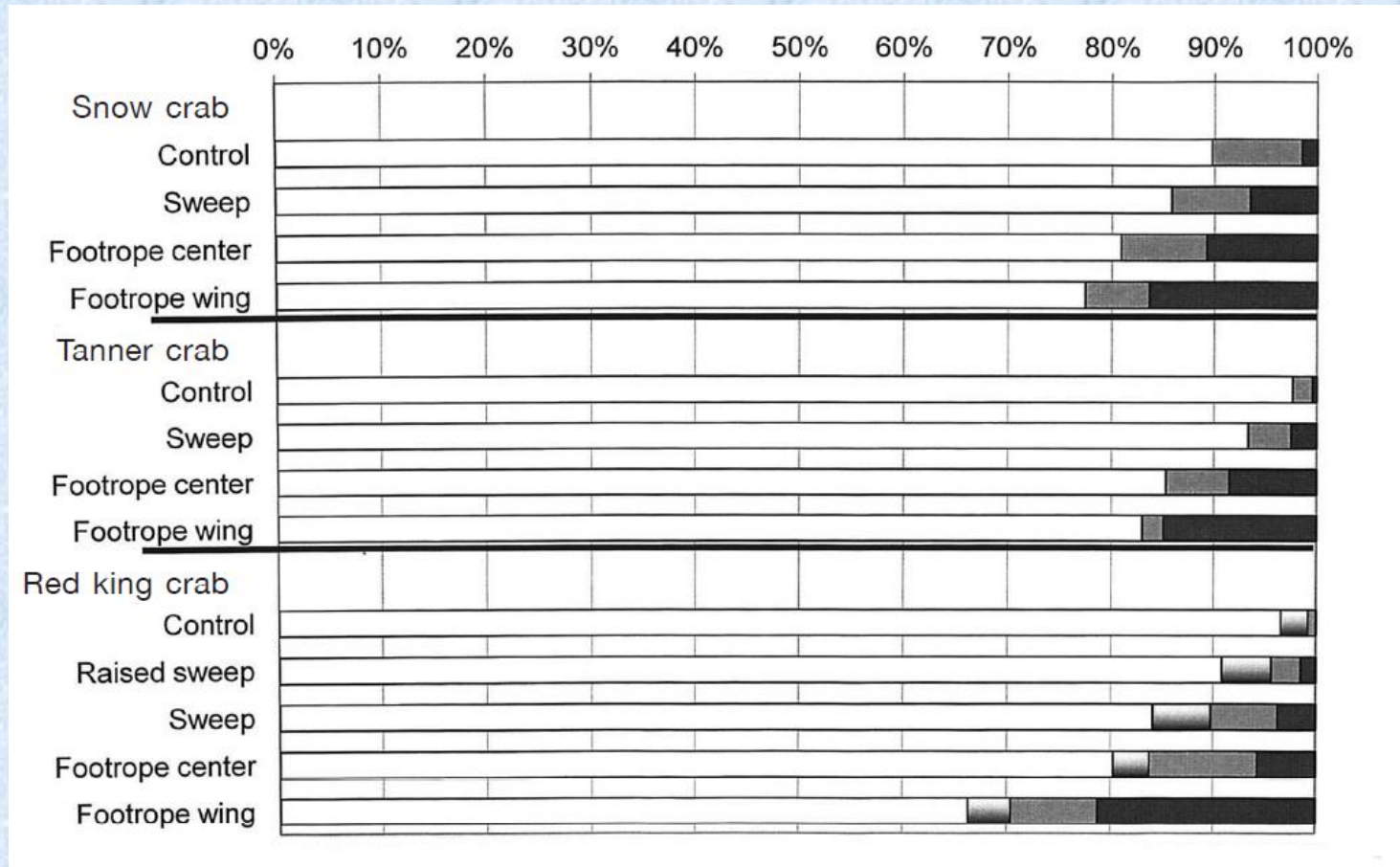
- Assessed presence or absence of six reflexes from all crabs
- Held marked crabs in on-board tanks to observe delayed mortality
- Number of reflexes missing indicates survival probability (2007 study)

Stoner, A.W., C.S. Rose, J.E.Munk, C.F. Hammond, & M.W. Davis 2008. Fishery Bulletin 106: 337-347

Reflex Action Mortality Predictors (RAMPs)



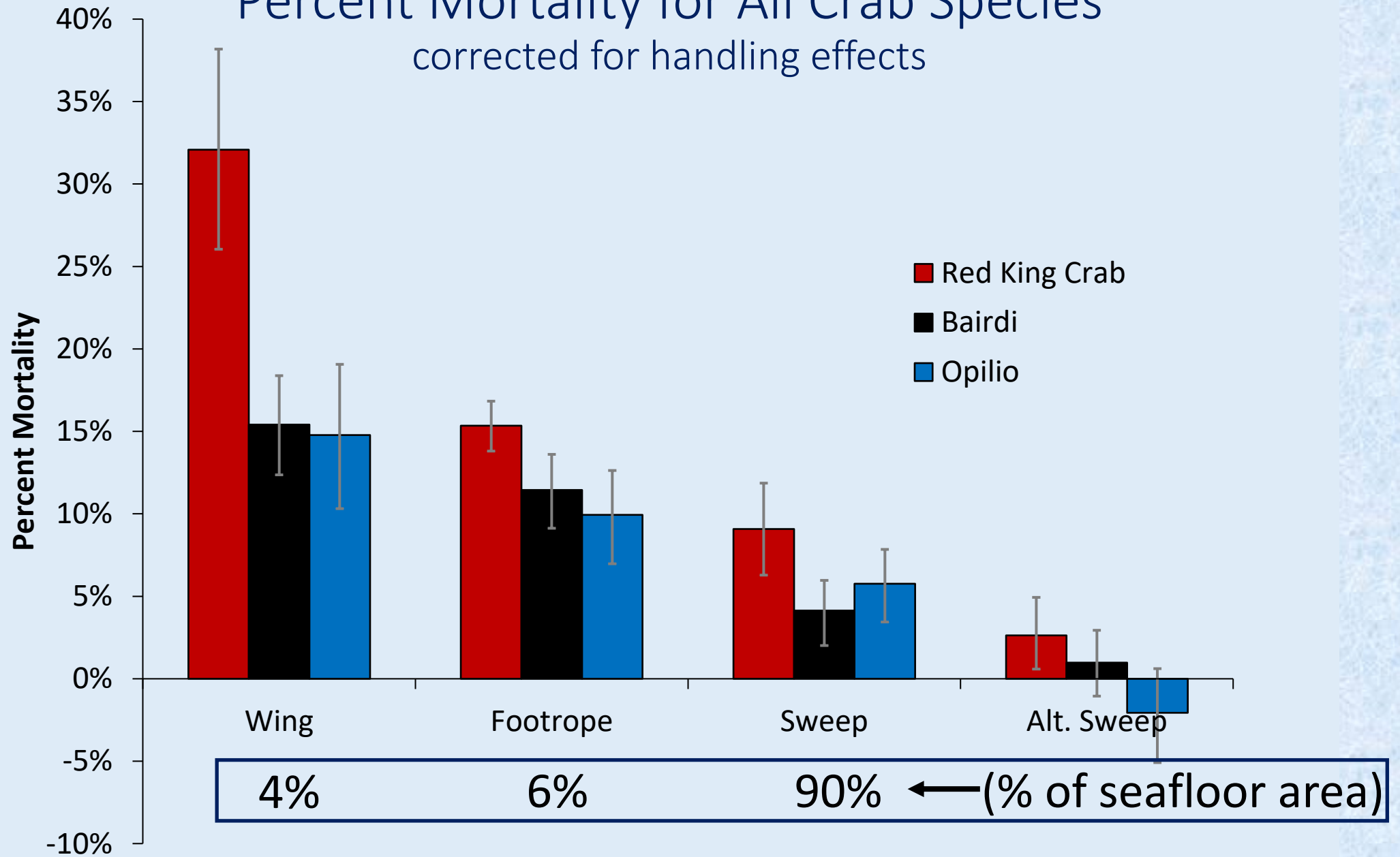
Proportion of crabs with each reflex score



- Most crabs have either all or no reflexes (likely to survive or dead)
- RAMP completes the picture with delayed mortalities

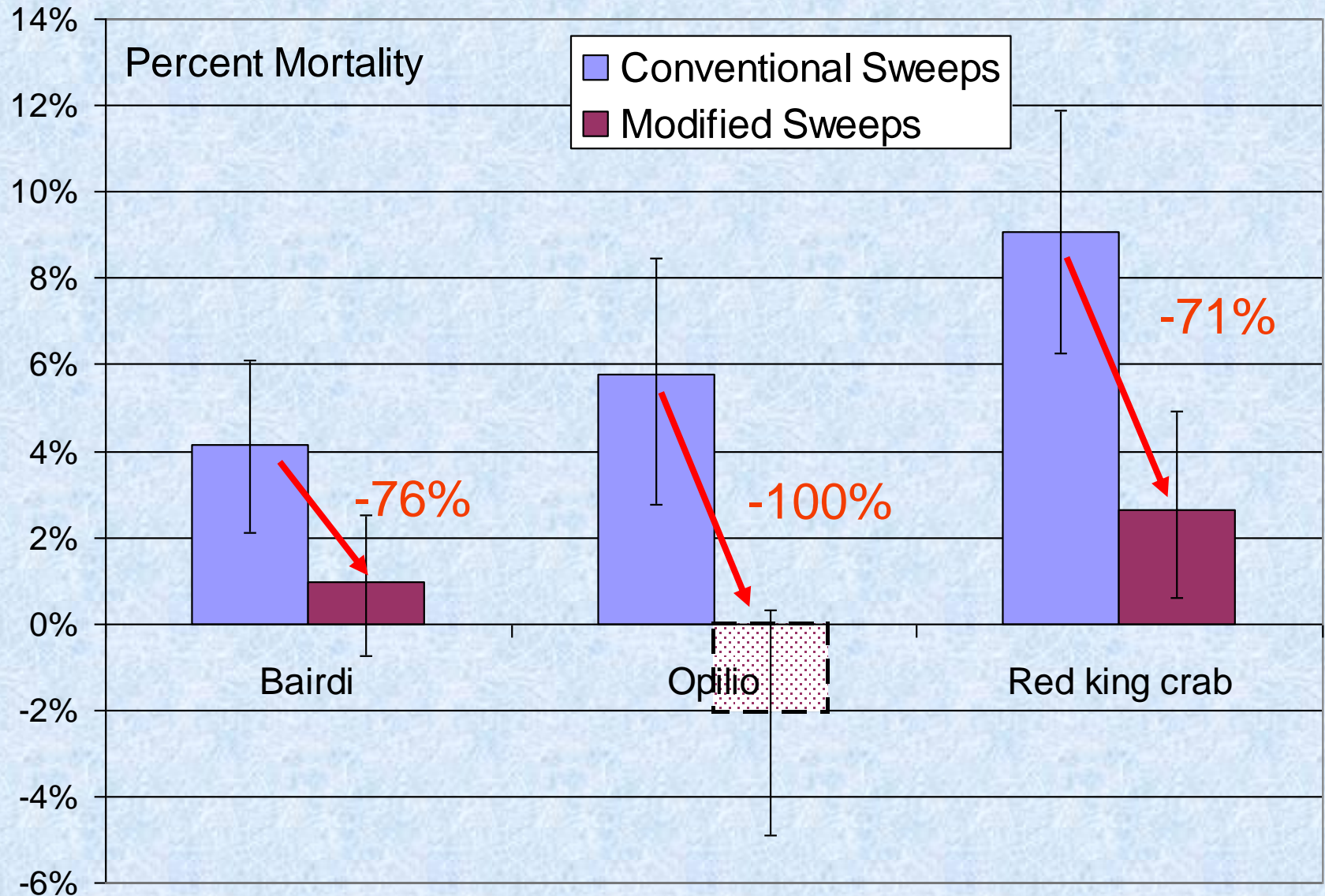
Percent Mortality for All Crab Species

corrected for handling effects

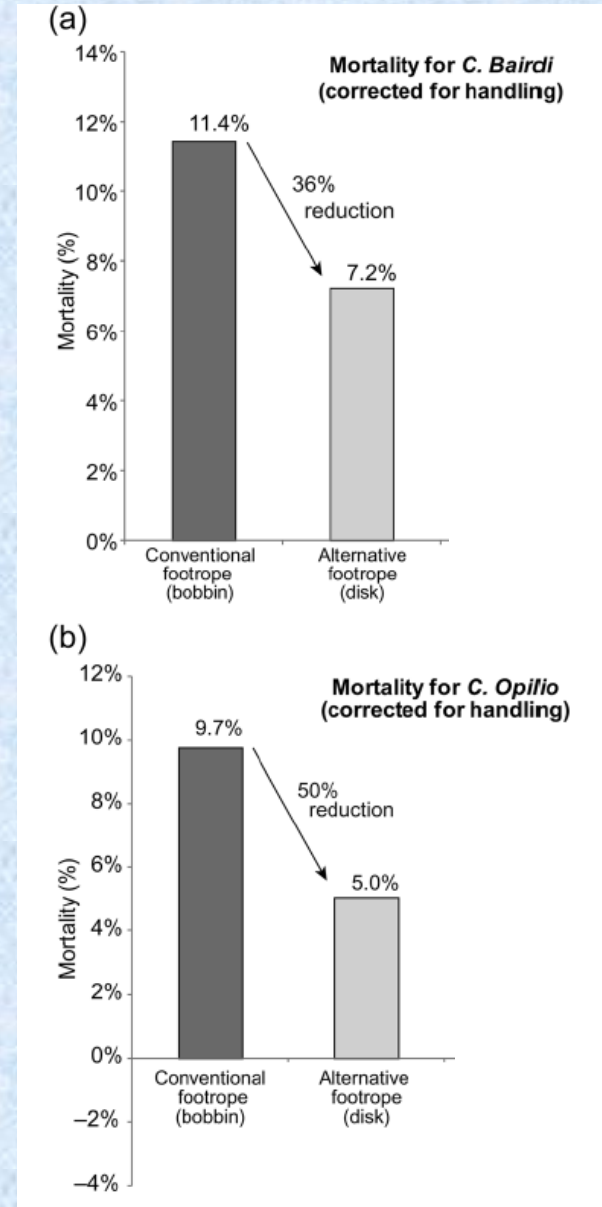
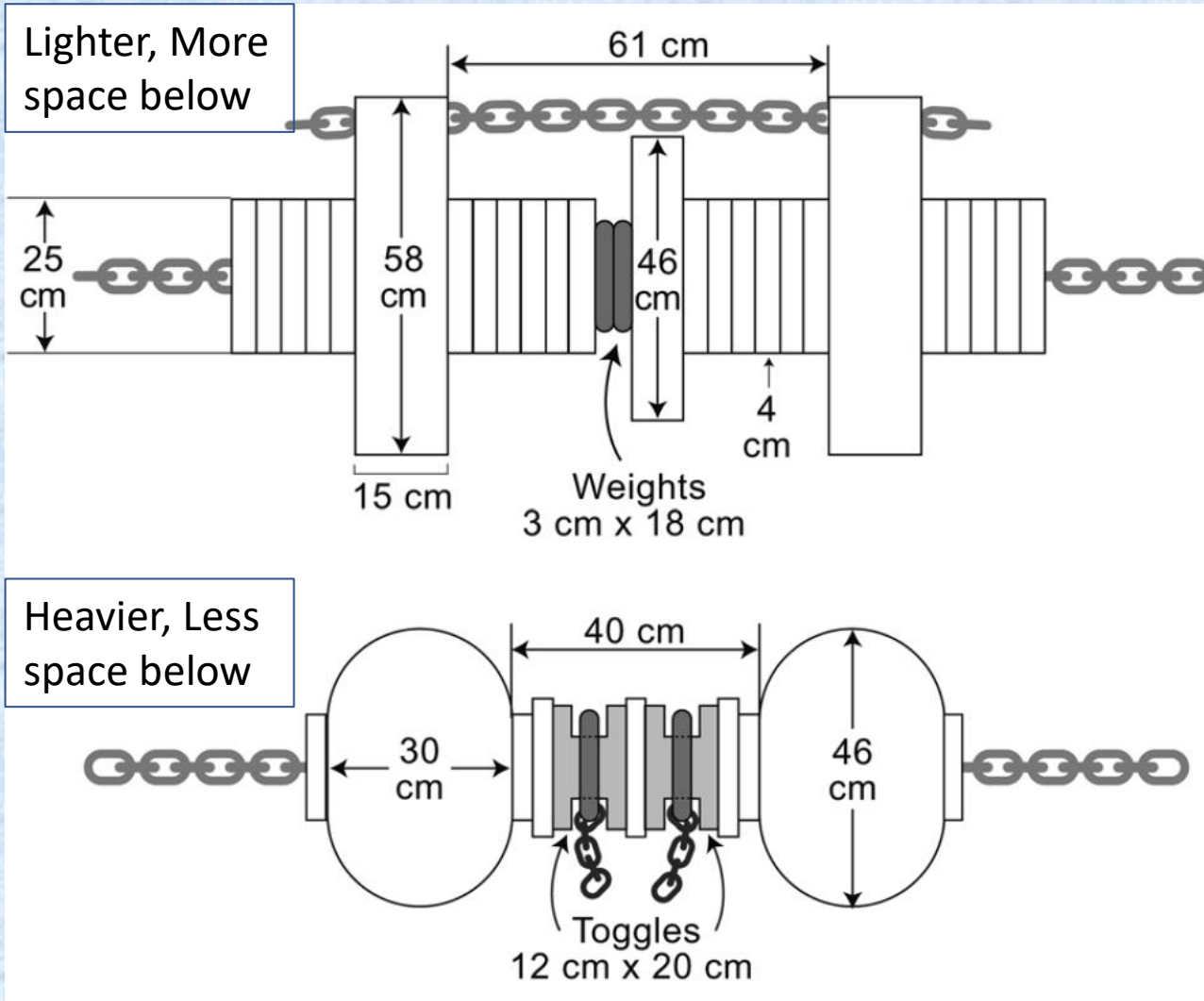


Reduced Mortality with Modified Sweeps

corrected for handling effects

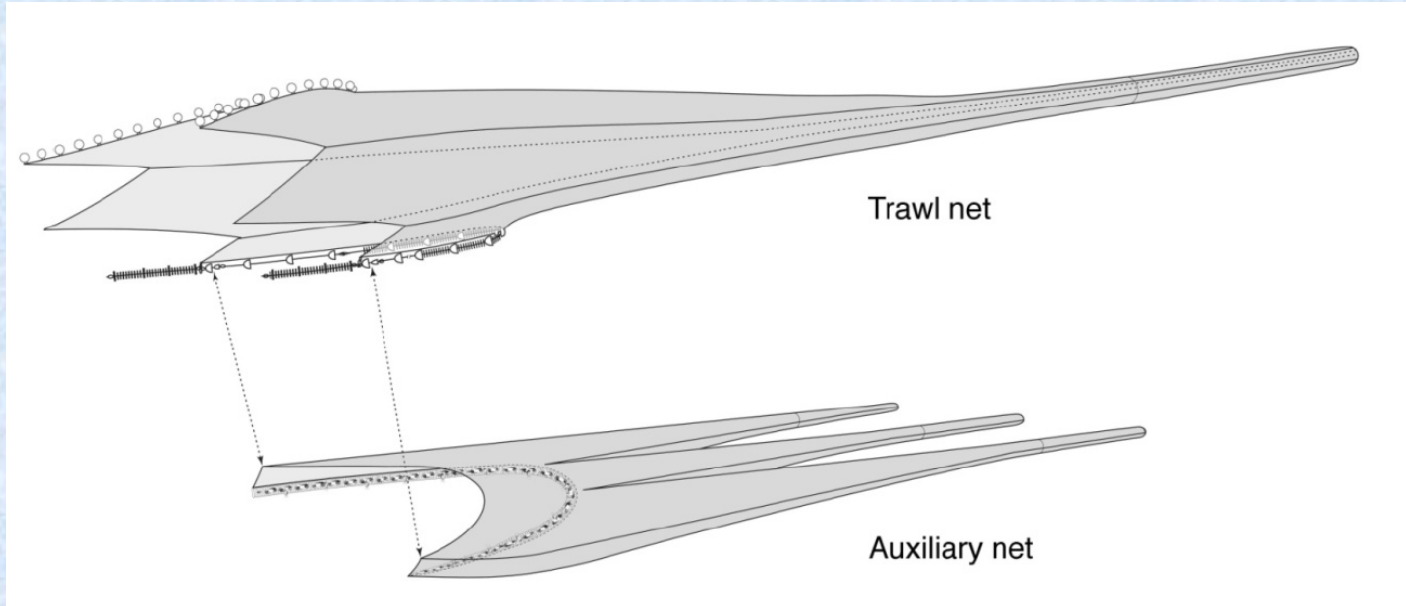


Unobserved mortality rates with alternative footrope designs



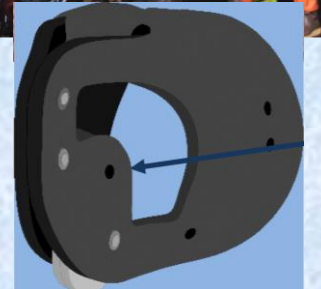
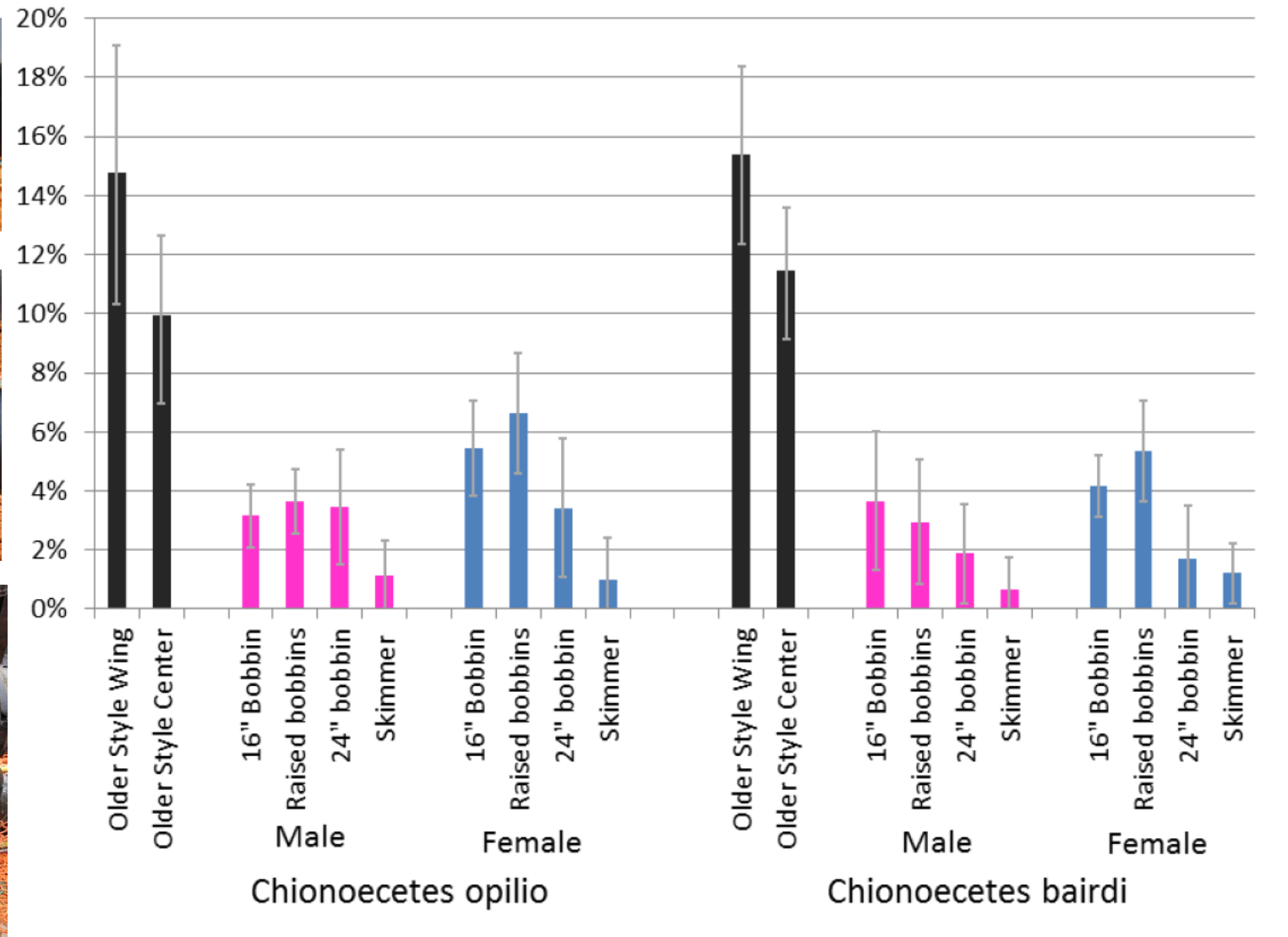
Unobserved mortality rates with alternative footrope designs

NPRB project 1117

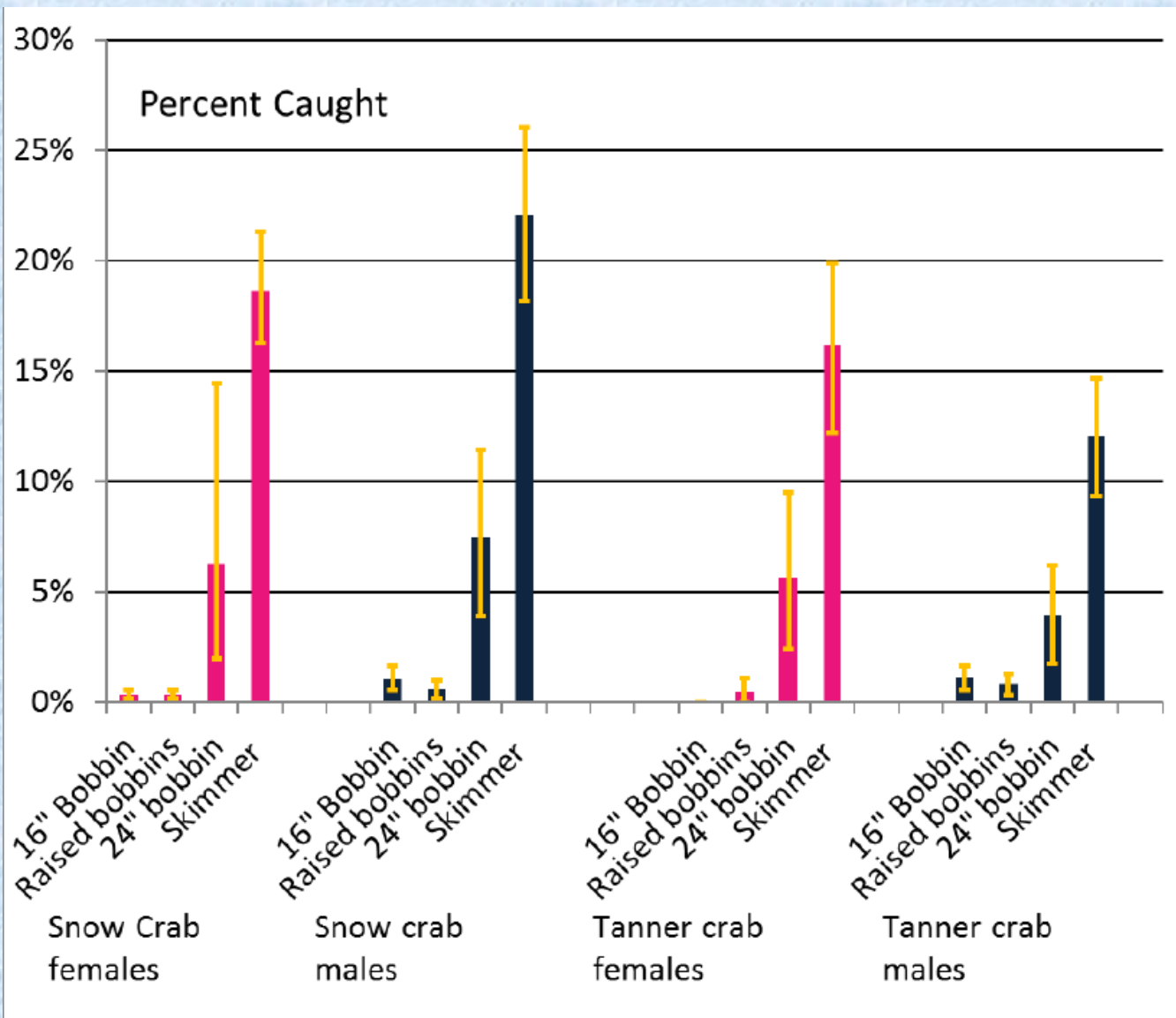


- Several alternative footrope designs tested for:
 - Crab unobserved mortality and catch rates
- Recapture net covered the full footrope of full-scale trawls
- Better represented current designs

Unobserved mortality rates with alternative footrope designs



Using percent caught to estimate number of unobserved crab encounters



- Proportion captured is low
 - <1% in 2012
 - 4-7%, 24" footrope in 2013
 - rigging difference
- Multiplier to estimate encounters from bycatch can be quite large and variable (15-100+ times)
- Proportions can change substantially with minor footrope differences

Other options/considerations in estimating number of crabs encountering trawls

- Overlap crabs and trawling distributions
 - Crab distribution only available for summer
 - Supplementary surveys? Alternative methods?
- On-trawl cameras
 - Cameras require difficult deploy and removal processes
 - Video reviews are slow and labor-intensive
- Need to better define vulnerability effects of molting
 - Timing and overlap with fisheries
 - Progression of hardening and durability
 - Stevens (2009)* measured hardening for RKC
 - Vulnerability progression?

* JOURNAL OF CRUSTACEAN BIOLOGY, 29(2): 157–160

Other studies of non-capture crab/trawl interactions

- Dawe et al 2007 – Eastern Canada Agency Research Report
 - 48 and 58% footrope coverage in two trawl corridors
 - Sampled corridors before and after trawling with ROV video and traps
 - Smaller, tighter packed shrimp trawl footropes (14” high, 7” spacing)
 - Recapture nets behind trawl footropes – injury assessments
 - No significant mortalities or carapace damage detected,
 - Leg loss was detected – more with smaller crabs
- Nguyen et al 2014 – Publication in Fisheries Research
 - Observed crab behavior ahead of footropes – crabs attempt to avoid
 - 54% contact trawl components (unable to observe outcomes)
- Luettel (2015) and Brinkhoff (2015) – MSc Theses, U. of Tromsø, Norway
 - Assessed injuries of escaping crabs using retention nets (mostly Luettel)
 - Large rockhopper and experimental footropes, with close spacing
 - Very long tows, no control for capture/handling
 - Only 187 crabs – n.s.d., but fresh injuries were observed

Other studies of non-capture crab/trawl interactions

- **Differences from Alaska studies**
 - Assessed injuries, not mortalities (no holding or reflex assessments)
 - Long tows – handling injuries more likely
 - No control for handling damage
 - Much smaller sample sizes generally
 - Mostly only middle of footrope, not wings or sweeps
 - Different footrope designs than Alaska – all with less space beneath
- **Still, in general:**

Results were consistent with Alaska results

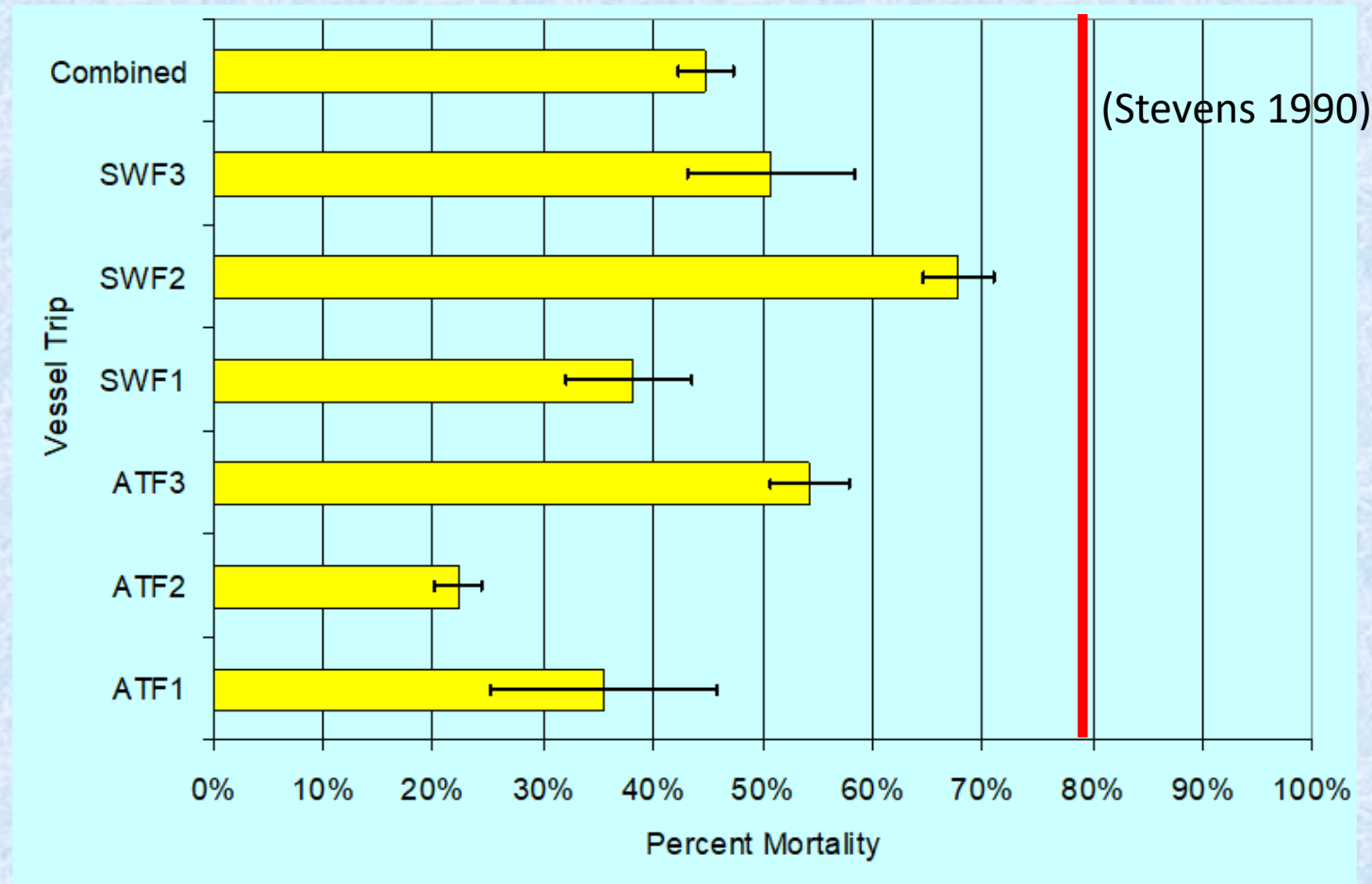
Discard mortality

Mortality rates for GOA trawl bycatch 2010 study – Six bottom trawl trips

Trip targets

SWF – shallow water flatfish

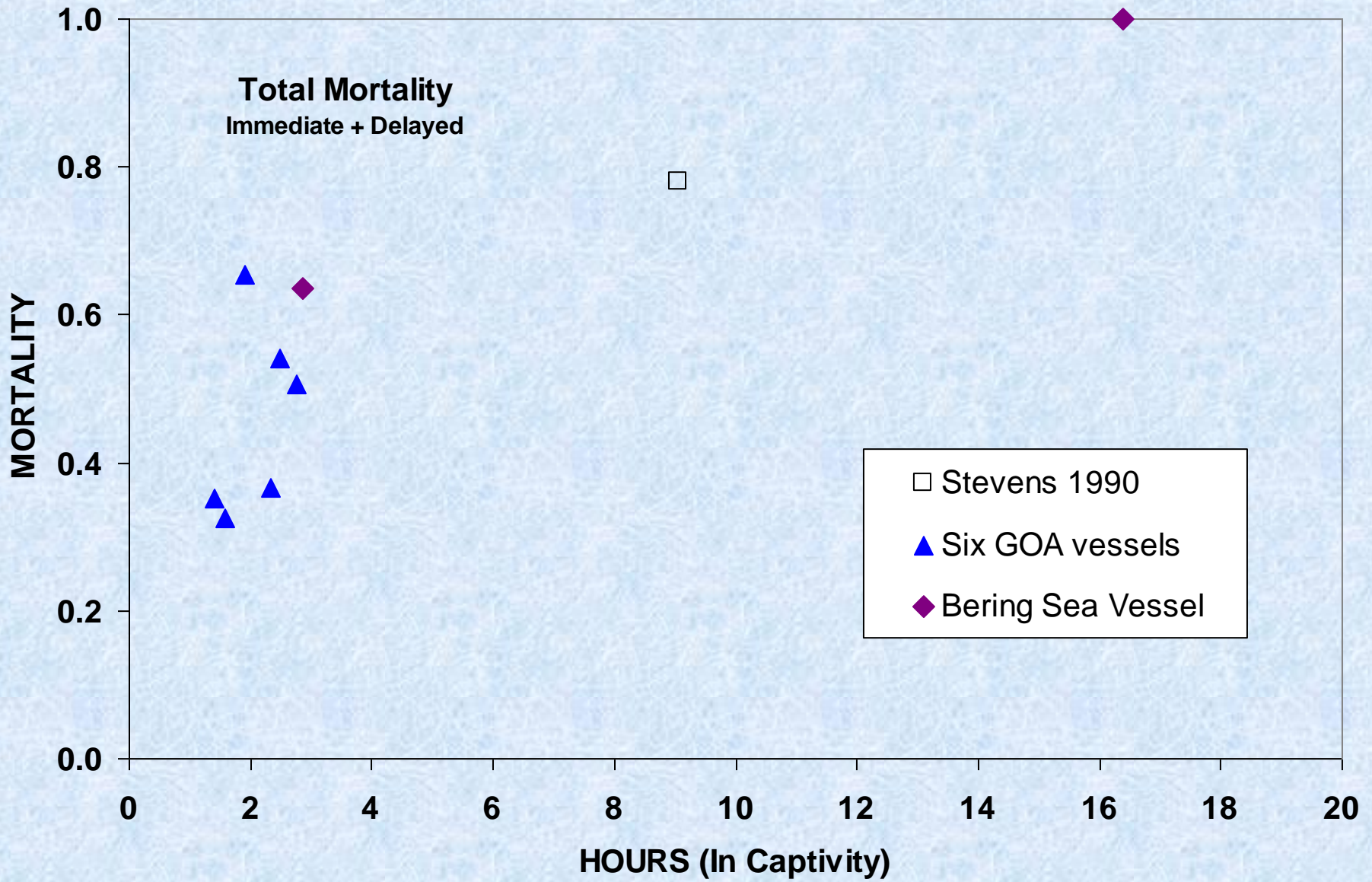
ATF – arrowtooth flounder



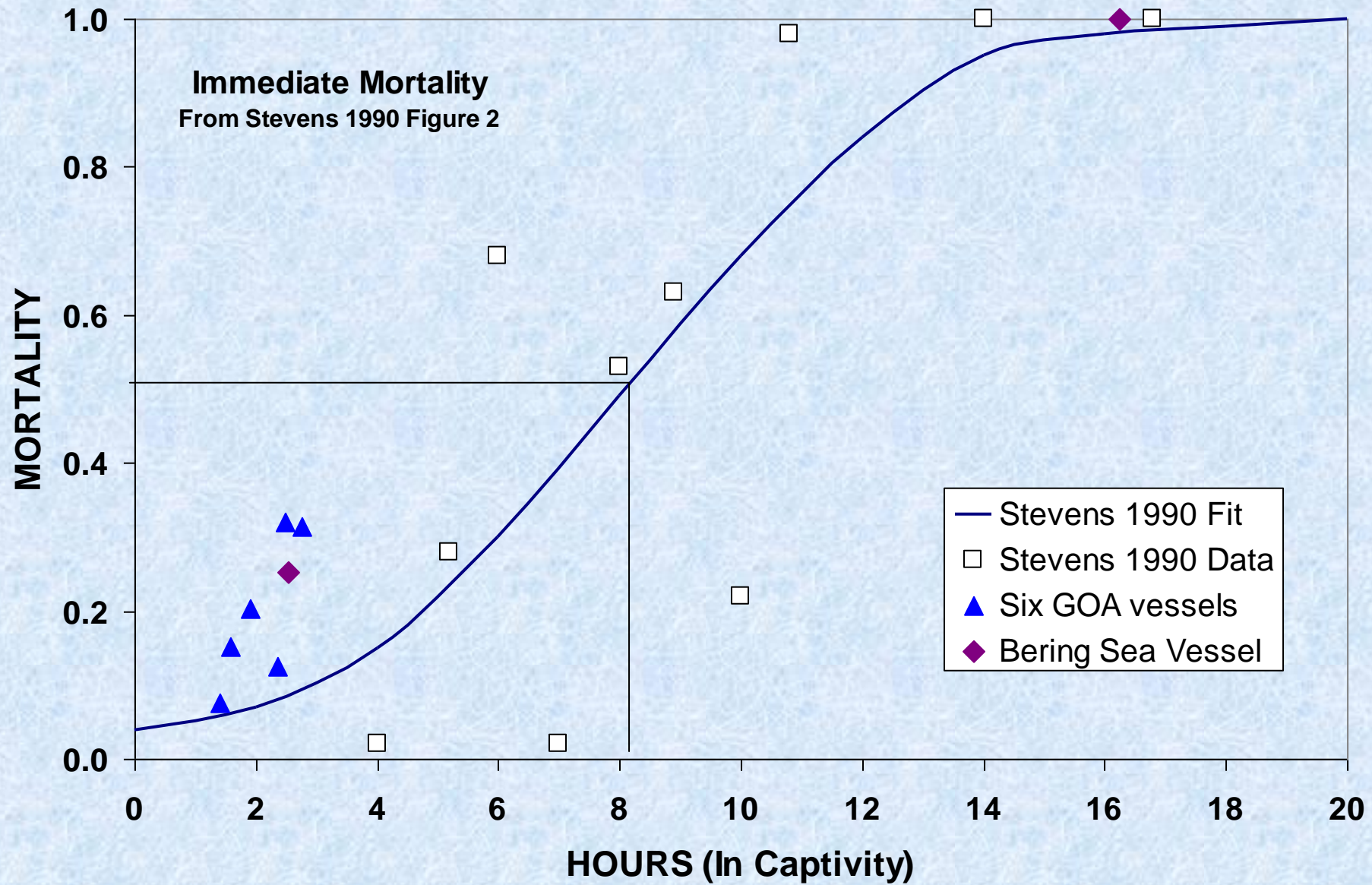
(Stevens 1990)

Stevens 1990
Trials aboard a Soviet processor receiving codends from American catcher vessels (“Joint Venture”).
Included very long exposures both On-deck and In-net
(Fishery Bulletin 88: 731-744)

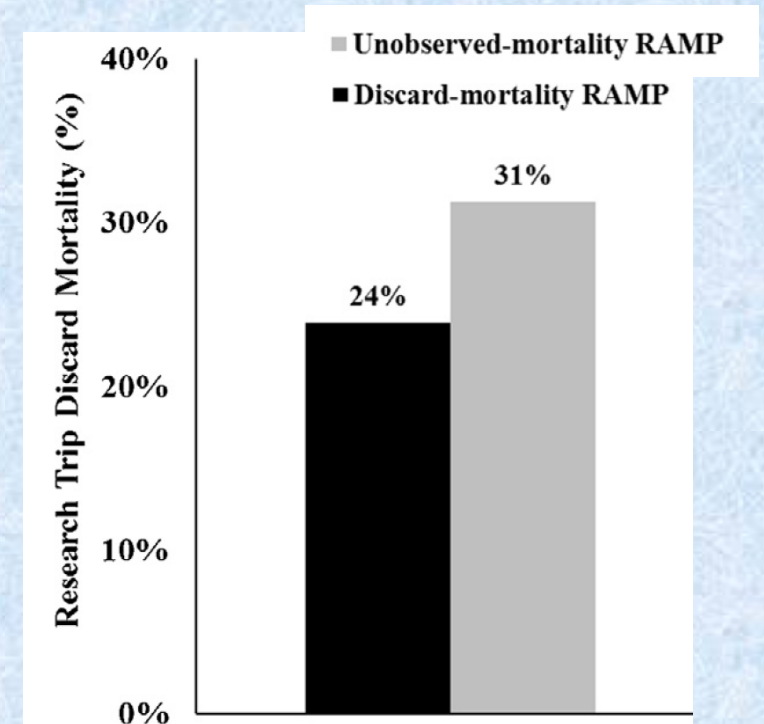
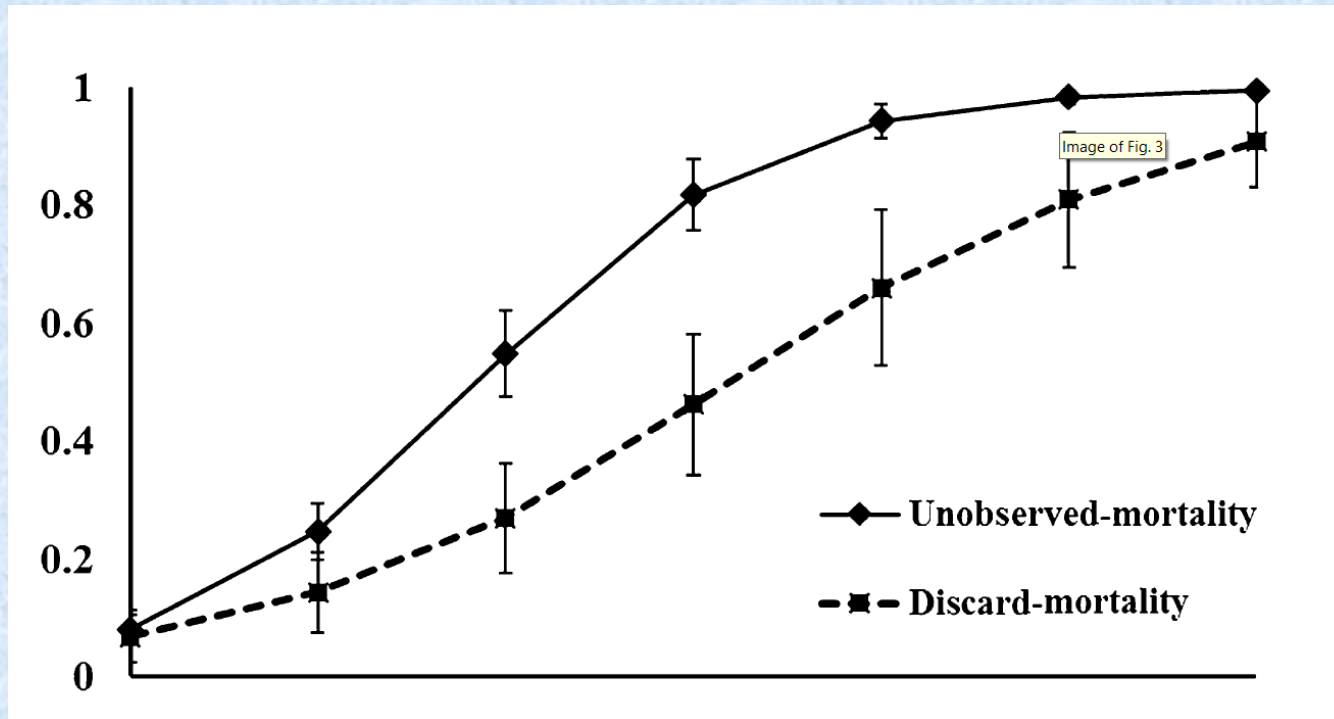
- Overall, the combined 47% mortality is much lower than current 78%
- But, used unobserved mortality reflex relationship



Stevens, B.G. 1990. Fishery Bulletin 88:731-744



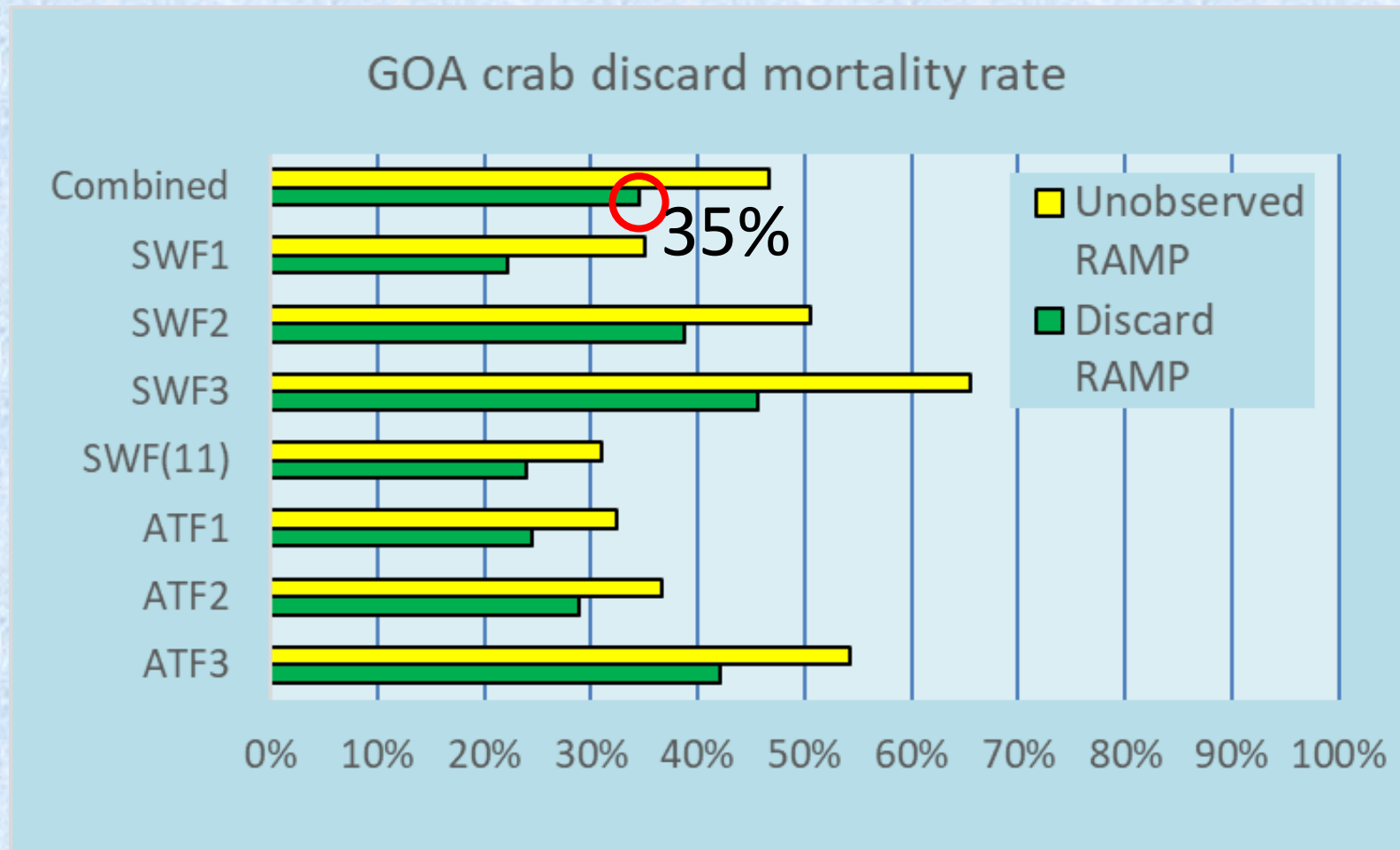
Yochum et al 2015 compared reflex estimation of deaths for discard vs unobserved mortalities



- Reflexes predict less mortality from discards than unobserved mortality for the same reflex deficits
- Air exposure is a major factor for discards, but not unobserved mortalities
 - Does on-deck time impair reflexes, but with less fatal outcomes?
- Initial mortality estimates from 2010 GOA were overestimated

Yochum, N., C.S.Rose, C.F. Hammond. 2015. Fisheries Research 161: 226–234.

Recalculated with RAMP calibrated from crab discard handling



- Appropriate reflex relationship (RAMP) reduced mortality rate estimate
 - Combined estimate dropped from 47% to 35%
- (SWF- shallow-water flatfish, ATF – arrowtooth flounder)

Questions?