

**Evaluating the flexibility of a reflex
action mortality predictor to
determine bycatch mortality rates:**

**A case study of Tanner crab
(*Chionoecetes bairdi*) bycaught in
Alaska bottom trawls**

Noëlle Yochum, Oregon State University

Craig Rose and Carwyn Hammond, NOAA Alaska Fisheries Science Center

Bycatch mortality

- A component of fisheries mortality
- **Discard-mortality:** captured, brought on-deck, released
 - Capture process
 - Air and sunlight exposure
 - Handling/ injury on deck
- **Unobserved-mortality:** encounters gear, without capture
 - Injury from gear or from captured animals

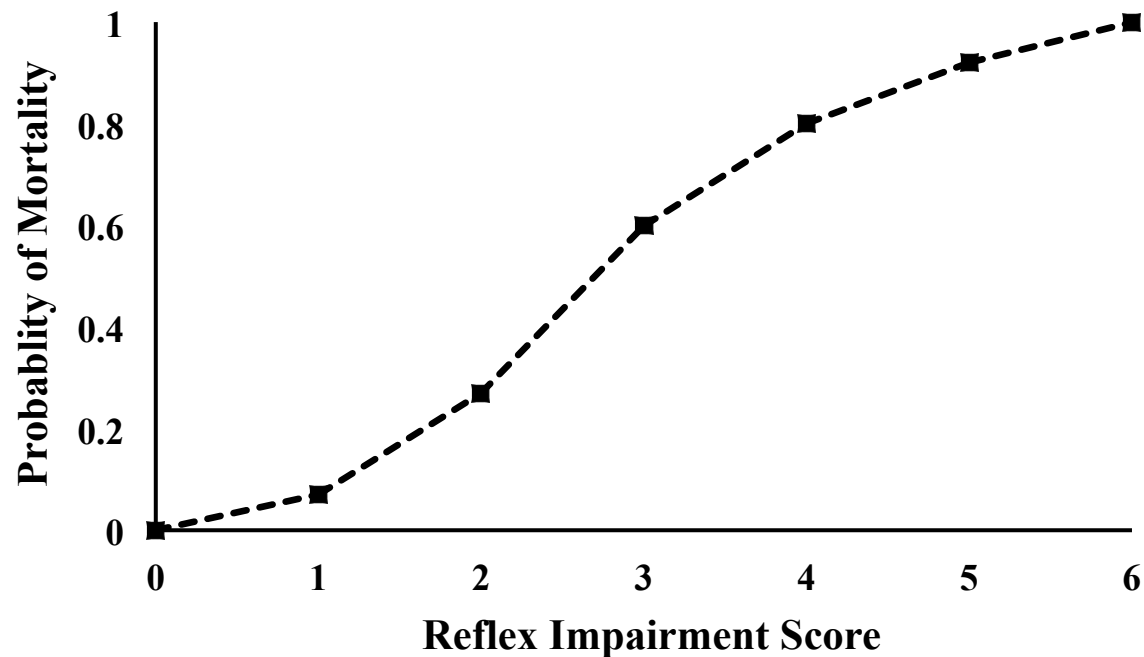
Bycatch mortality

- Direct observation
 - Mark-recapture
 - Acoustic telemetry
 - Captive holding
- Physiological assessment (stress)
 - Metabolic
 - Biochemical
 - Immune response



RAMP

- Reflex Action Mortality Predictor
 - (Davis and Ottmar, 2006; Davis, 2007)
- Relates reflex impairment to probability of mortality



RAMP

- Quantify bycatch mortality
- Evaluate influences on mortality
- Conservation engineering

- Fishes and invertebrates
- Pot and trawl gear

Case Study: Bycaught Tanner Crab

- Alaska bottom trawl fishery
 - Bering Sea
 - Gulf of Alaska
- Tanner and snow crab bycatch
 - *Chionoecetes bairdi* and *C. opilio*
- Zero retention
- Prohibited fishing grounds
- Bycatch limits





Bycatch Mortality: Tanner crab

- **Unobserved Tanner and snow crab bycatch**

- Stoner et al., 2008, Rose et al., 2013; Hammond et al., 2013
 - Bottom trawl fishery in the Bering Sea
 - RAMP
 - Gear modifications

- **Discarded Tanner crab**

- Blackburn and Schmidt (1988)
 - 17%: bottom trawl fishery in the Gulf of Alaska
 - Viability assessments
- Stevens (1990)
 - 78%: bottom trawl fishery in the Bering Sea
 - At-sea holding

RAMP Reflexes for Tanner and Snow Crab

Stoner et al., 2008



- Leg flare
- Leg retraction
- Chela closure
- Eye retraction
- Mouth closure
- “Kick”

Bycatch Mortality: Tanner crab

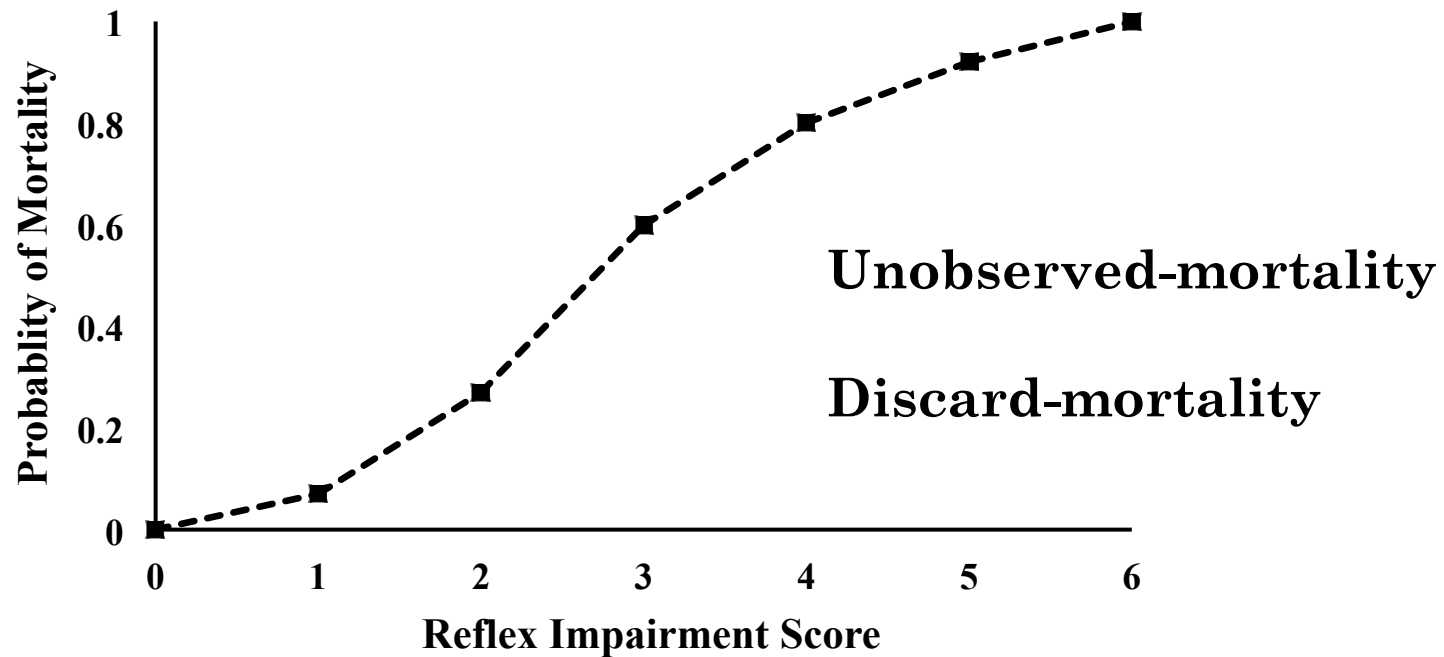
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- Discarded Tanner crab

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Evaluation of RAMP: “Flexibility”



Evaluation of RAMP: “Flexibility”

“Unobserved-mortality”

- Hammond et al., 2013
- Bottom trawl fishery
- Research trip
- Bering Sea
- RAMP
- Auxiliary net
- Short tows
- Air exposure < 15 minutes
- Some recovery in water before assessment

“Discard-mortality”

- This study
- Bottom trawl fishery
- Commercial trip
- Gulf of Alaska
- RAMP
- Commercial fishing
- Commercial tow duration
- Average air exposure 90 minutes (9-230 minutes)
- No recovery in water

Discard-mortality Study: Data Collection

- May 2011
- F/V *Sea Mac*
- 3-day shallow-water flatfish bottom trawl fishery
- Tow information:
 - Water depth
 - Temperature at depth
 - Tow duration
 - Catch size



Discard-mortality Study: Data Collection

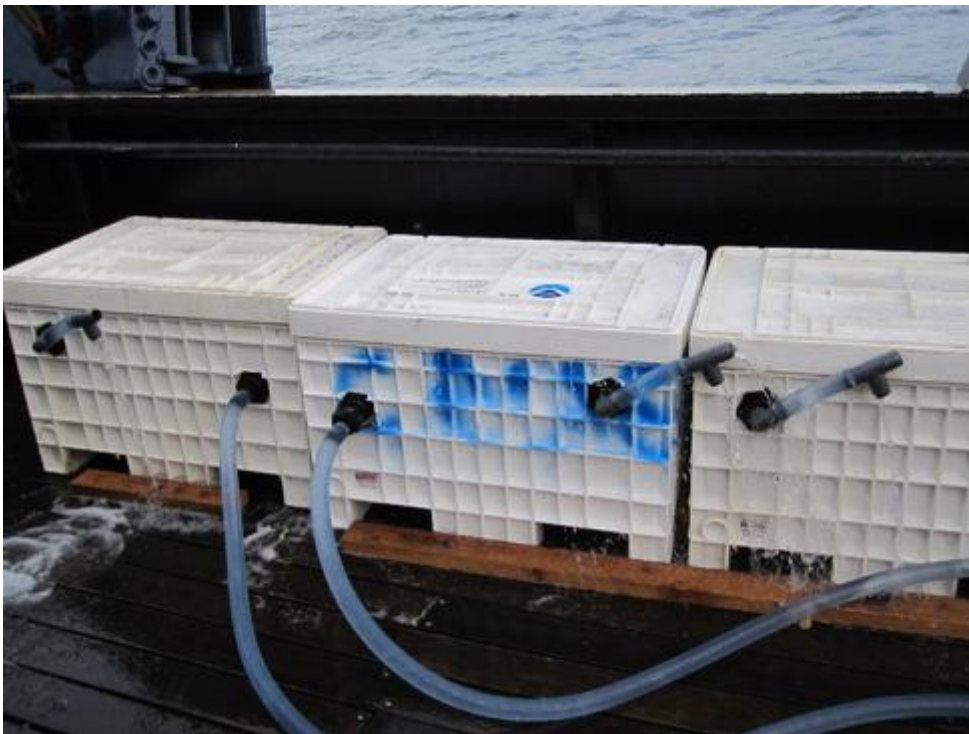
- Crab information:
 - Carapace width (mm)
 - Sex
 - Chela loss
 - Shell condition (0-5)
 - RAMP “Score” (0-6)
 - Time out of water prior to assessment



Discard-mortality Study: Holding

On-board Tanks

- Plumbed on-board tanks (1-3 days)
- Cable tie with RFID chip (Hallprint)



Discard-mortality Study: Holding

At-sea Cages

- 92 crab
- Mixed Score, size, and sex
- 11 days of holding

Laboratory Tank

- 28 crab
- Mixed Score, size, and sex
- 12 days of holding
- Fed
- Temperature controlled



Discard-mortality Study: Data Analysis

- **Logistic RAMP:** Binary logistic regression
 - Response: Mortality
 - Predictors: Fishing and biological variables
 - Score
 - Sex
 - Shell condition
 - Haul duration
 - Carapace width
 - Continuous
 - Binned: Small and large (\leq 90 mm)
 - Backward stepwise model selection
- **Discrete RAMP**
 - Actual proportion died

Study Comparison: Data Analysis

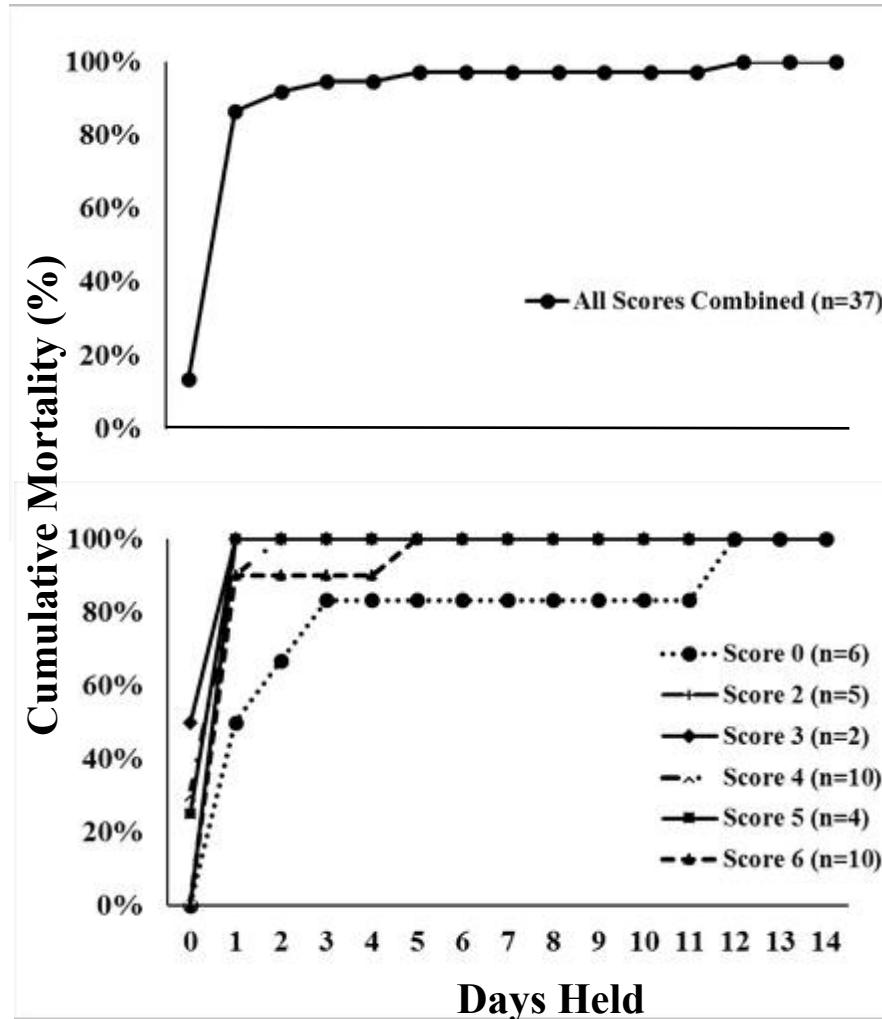
- **Compare RAMPS**
 - Visual
 - Fisher's exact test
 - Mantel-Haenszel test
 - Logistic RAMP: Combined data
 - "Study" as a predictor
 - Interaction between "Study" and "Score"
 - Backward stepwise model selection
 - Mortality rate estimation

Discard-mortality Study: Results

- 261 discard crab
- Immediate mortality: 12 crab
- 68% held crab survived

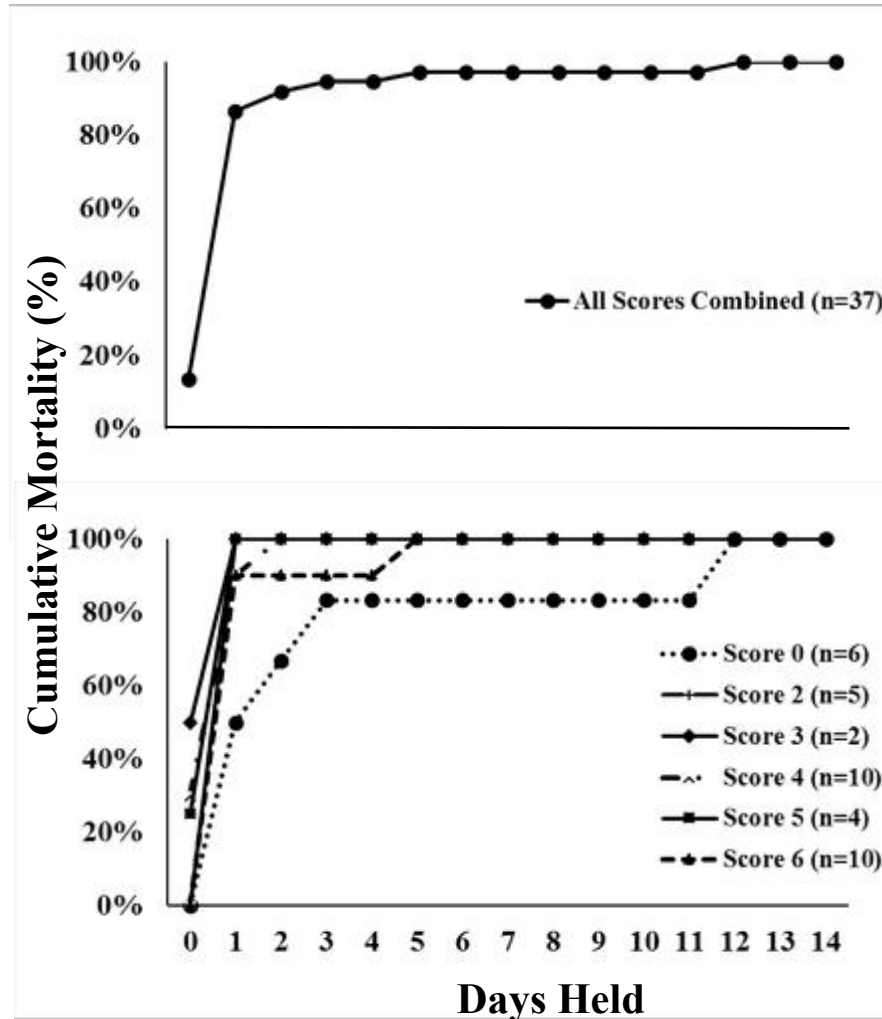
Discard-mortality Study: Results

- 86% within 1 day
- 92% within 2 days



Discard-mortality Study: Results

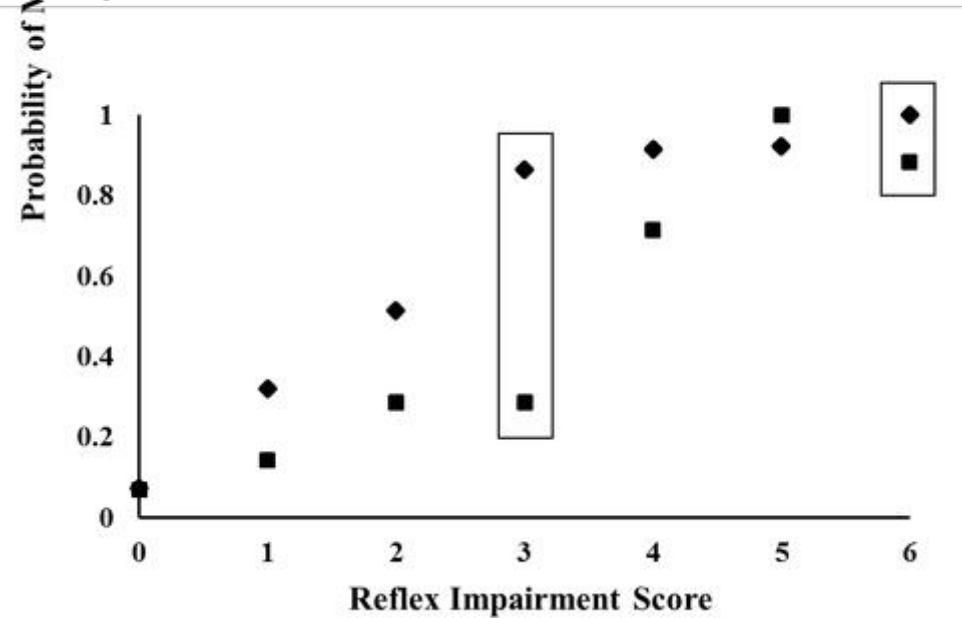
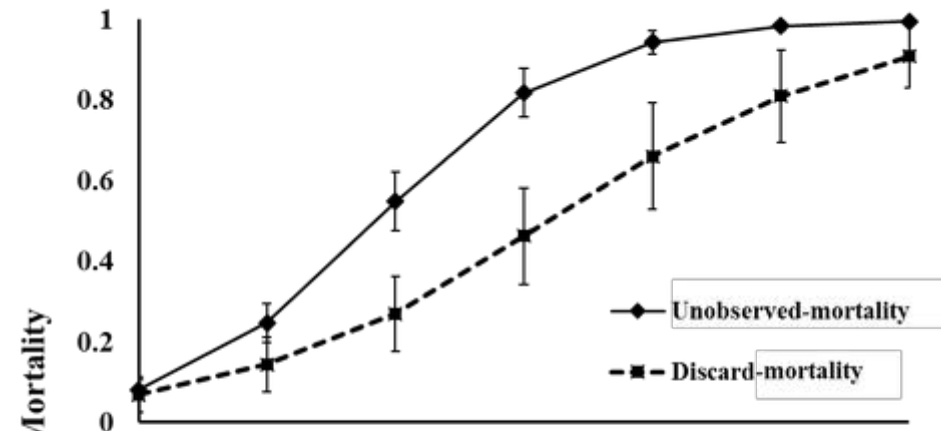
- **Laboratory holding**
 - Mortality at 12 days
 - 3 Score-zero crab died
- **At-Sea Cage holding**
 - 3 crab died
 - Scores 1, 2, and 6



Study Comparison: Results

Selected predictors:

- Discard-mortality
 - Score
- Combined data
 - Score
 - Binned-width
 - Study
 - Study * Score

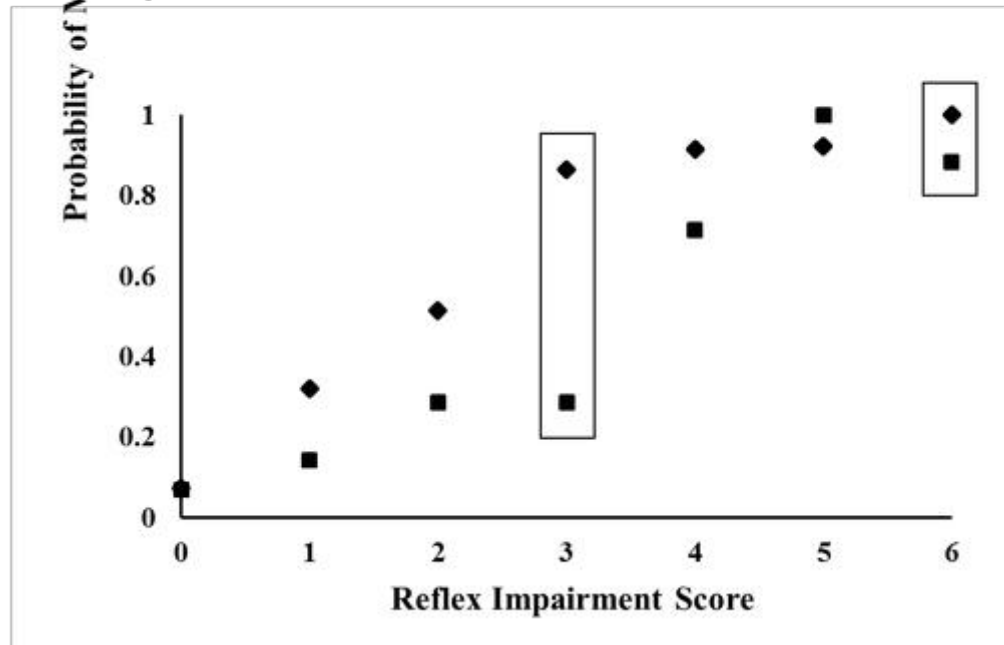
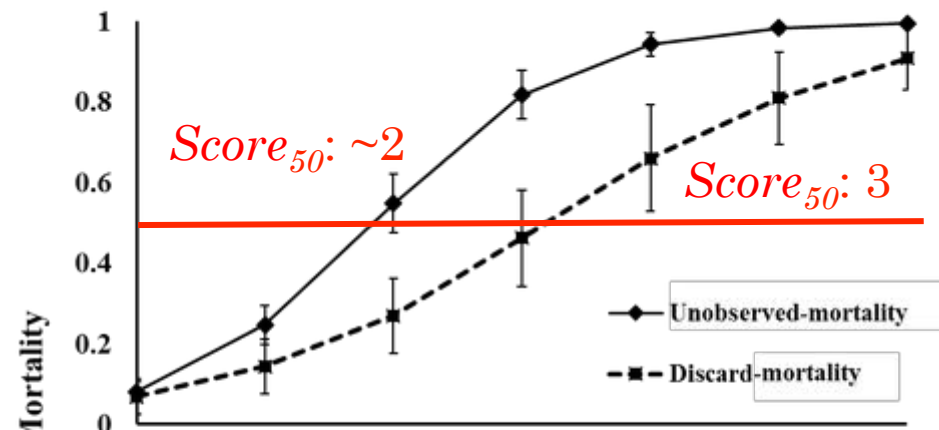


Study Comparison: Results

Selected predictors:

- Discard-mortality
 - Score

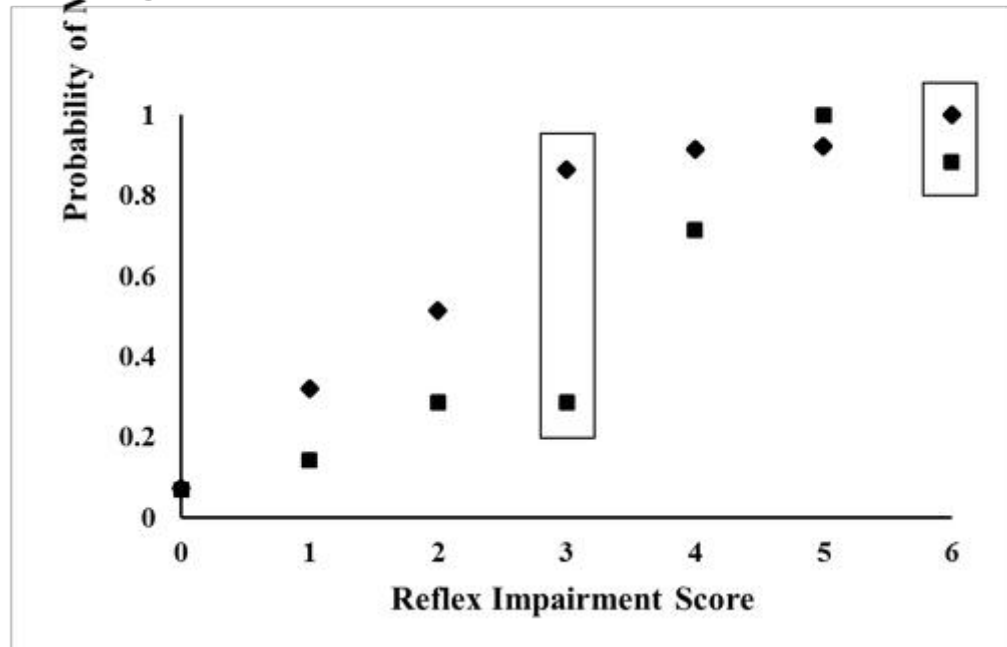
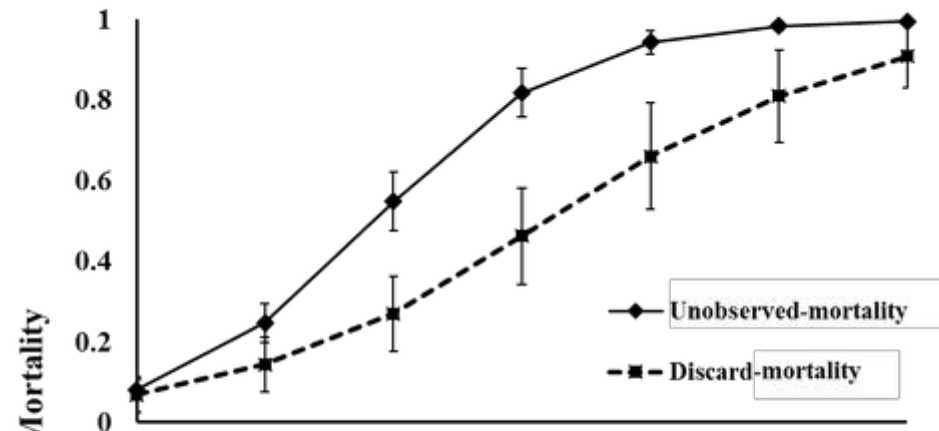
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 - Score
 - Binned-width
 - Study
 - Study * Score



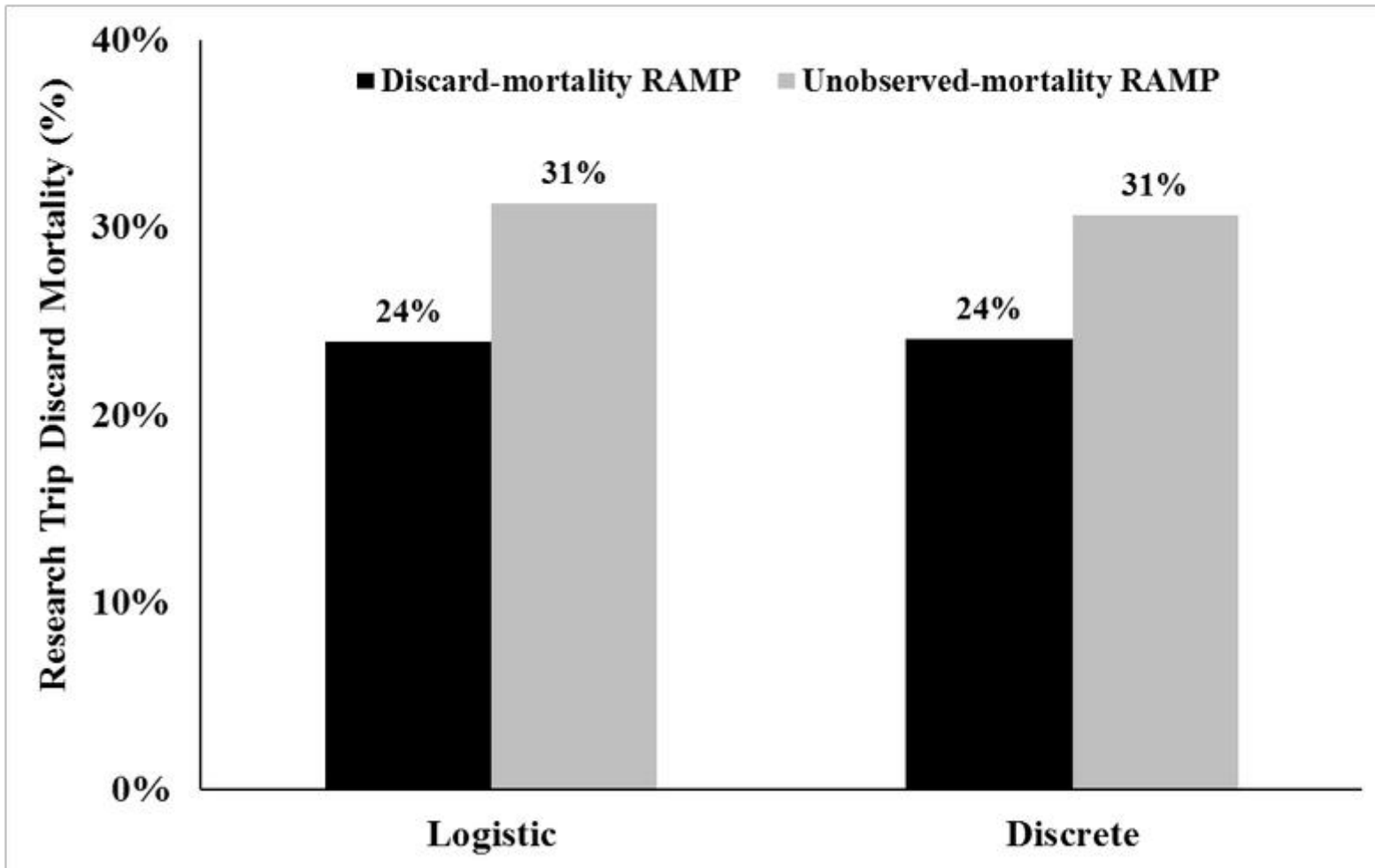
Study Comparison: Results

Selected predictors:

- Discard-mortality
 - Score
- Combined data
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 - Binned-width
 - Study
 - Study * Score



Study Comparison: Results



Study Comparison: Conclusion

- Main difference:
 - Treatment of crab before assessment
 - Recovery period in water
 - Discard: No
 - Unobserved: Sometimes
 - Air exposure:
 - Discard: 90 minute average (9-230 minutes) of air exposure
 - Unobserved: <15 minutes

Study Comparison: Recommendations

- RAMP may produce more accurate mortality estimates when applied to animals experience similar stressors as those evaluated to create the RAMP, through similar methodology
- Especially important with large number of animals with intermediate Scores

Study Comparison: Recommendations

- Creating a RAMP:
 - Create well documented, repeatable methods
 - Collect data on all possible stressors and evaluate them for their contribution to mortality
 - In methods, make it clear what is meant by “absent” and how immediate mortalities are treated
- Reflexes:
 - Assess RAMP reflexes in a standardized order
 - If reflexes influence other reflexes, do last or not at all
 - If reflex is difficult to determine presence/absence do not use

Conclusions

- RAMP is an effective tool for quantifying and evaluating bycatch mortality
- RAMP from this study can be used to determine discard mortality rates for Tanner crab in the Alaska bottom trawl fishery
- Additional study needs to be done on the role of a recovery period in water and air exposure on determining a RAMP “Score” (in process)

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Questions?

