

# D1 Unobserved Fishing Mortality Working group

SARAH RHEINSMITH-GARDINER

JUNE 2024



# Working Group Members

Andrew Olson (NMFS)

Brad Harris (APU)

Chris Siddon (ADF&G)

Franz Mueter (UAF)

Katie Palof (ADF&G)

Krista Milani (AKRO)

Mason Smith (NOAA HCD)

Mike Litzow (AFSC)

Sam Cunningham (NPFMC)

Sarah Rheinsmith (NPFMC)

Sherri Dressel (ADF&G)

William Stockhausen (AFSC)

# UFMWG Background

- Crab Conservation Workplan (December 2022)
- SSC report (October 2022) and Council motion (December 2022)
- SSC report, AP motion, Council motion (June 2023)
- Working group met for four two-hour meetings (Nov / Dec 2023)
  - Composed of CPT / SSC members and NMFS employees

# Council motion (June 2023)

The Council approves the objectives of working group as follows:

- Identify data sources, major data gaps, and assumptions to estimate unobserved mortality for stock assessments and to better understand temporal/spatial extent across fisheries and gear types.
- Provide research priority recommendations and/or needed research projects.

The anticipated products include:

- Framework for estimating unobserved fishing mortality and explicitly incorporating into stock assessments.
- Report on specific research priorities and data needs.
- Recommendations for approaches to investigate spatial/temporal extent of unobserved mortality over fisheries and gear types to the extent practicable.

The Council will consider a public workshop on the working group progress and/or products in the future.

# Objectives for Review

1. Provide feedback on if the UFMWG report is comprehensive and responsive to Council requested objectives
2. Identify potential next steps for the Working Group
  - Included but not limited to:
    - Pause the WG until there is more research to inform UFM estimates
    - Continue UFMWG meetings with current membership, but provide additional objectives or revisit those that were not comprehensively addressed
    - Following completion of ongoing research, expand WG membership and re-define objectives
    - Expand to a public facing workshop, but would need Council-defined workshop objectives

# Working Group Terms of Reference

- Only considered “big three” stocks: BBRKC, EBS Tanner and snow
- Did not consider any uncertainty around data on *observed* mortality
- Did not consider any habitat effects from gear (direct mortality only)
- Gear considered: pots, ghost pots, hook and line, non-pelagic trawl, pelagic trawl
- WG cautions that conclusions and perspectives in this report reflect the perspective and expertise of the membership



# Outline

---

01

Assumptions and uncertainties for estimating unobserved mortality

02

Tools for estimating unobserved mortality

03

Framework for incorporating unobserved mortality in stock assessment models

04

Framework for comparing potential magnitude among gears and research priorities (Tables 1 & 2)

05

Working group recommendations

# 1. Assumptions and Uncertainties

## **Information required for assessing UFM**

1. Estimated gear bottom contact in space and time
2. Distribution of crab in space and time
3. Probability of gear-crab encounter based on (1) and (2)
4. Mortality rate if encounter occurs

## *Other considerations*

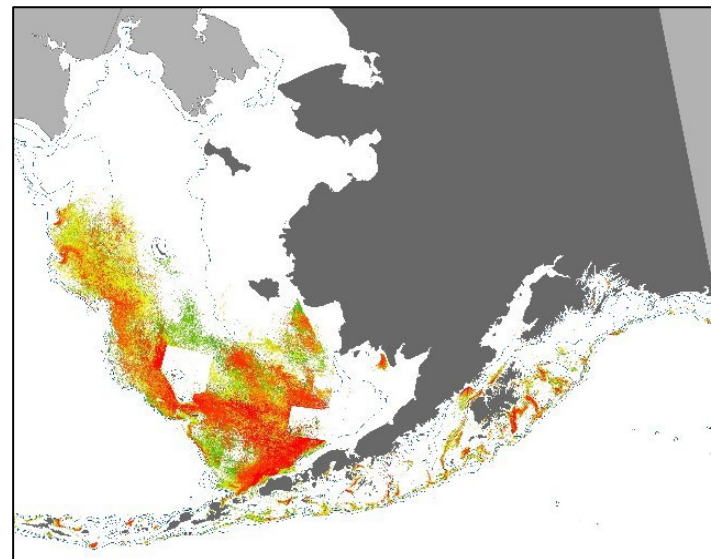
- Variability in gear materials & design likely critical to unobserved mortality



## 2. Tools for Estimating UFM

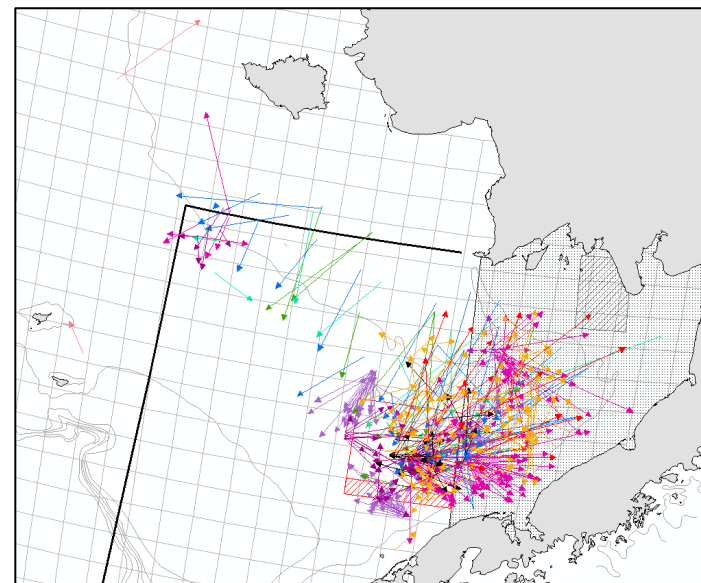
### 1. Fishing Effects (FE) model (FAST Lab, APU)

- Bottom contact estimates for 50 gear configurations
- Currently available
- Doesn't estimate contact with crab or "lethality" of gear



## 2. Tools for Estimating UFM

1. Fishing Effects (FE) model (FAST Lab, APU)
  - Bottom contact estimates for 50 gear configurations
  - Currently available
  - Doesn't estimate contact with crab or "lethality" of gear
2. BBRKC satellite tagging
  - (ADF&G / BSFRF / NMFS)
  - Extensive data collection
  - Analysis under way



# 3. Incorporating UFM in assessments

## Approach #1

- Parameterized for each gear as:

$$U_{g,x,m,s,z}(t) = \alpha_g \cdot \tau_g(t) \cdot S_{g,x,m,s,z}(t)$$

estimated gear-specific scaling parameter

gear-specific life stage-specific vulnerability scaling

gear-specific bottom contact index

- Incorporated as additional mortality term ( $U$ ; specified or estimated) or additional “fleet” (fit to data)
- Required data do not exist
- Most valuable as a research model framework

# 3. Incorporating UFM in assessments

## Approach #2

- Incorporate independent estimates of UFM in models
- Similar to approach for incorporating observed bycatch mortality
  - Could be similar to previous approach of inflating observed bycatch mortality to evaluate sensitivity of snow crab population to UFM
  - Could be informed by additional field experiments estimating unobserved:observed mortality ratios for different gear types

# 3. Incorporating UFM in assessments

## Caveats:

- Most necessary data do not exist
- Model structure varies for different stocks, requiring specific approaches for each
- Any approach for incorporating unobserved mortality would undergo normal CPT / SSC / AP / Council review process before implementation for management purposes

# 4. Framework for estimating the magnitude of UFM and research prioritization

**Table 1: Information for estimating magnitude, data availability and gaps, and research priorities**

- Individual fishing event level
  - Area contacted
  - Time on bottom
  - “Lethality” of gear
- Population level
  - Total # of events
  - Overlap with crab
- Information types for each level
  - Magnitude
  - Data available
  - Research priority
  - Research timeline

# 4. Framework for estimating the magnitude of UFM and research prioritization

**Table 1: Information for estimating magnitude, data availability and gaps, and research priorities**

***Fixed gear-***

Note shading for medium / high priority research items

Gear Type (# of configs)	Information Type	Individual Event (e.g., pot/trawl) Level			Population Level	
		Bottom Contact Area	Time on Bottom	"Lethality" of gear	Total # of Events (pot lifts/trawls)	Overlap with Crab
<b>Pots (2)</b>	<i>Magnitude</i>	10 <sup>1</sup> m <sup>2</sup>	Hours to Days	High	10 <sup>5</sup>	High
	<i>Data Available</i>	Yes	Yes	No	Yes	Yes
	<i>Research Needed</i>	Data mining	Data mining	Field exp'ts	Data mining	Data mining
	<i>Priority</i>	Low	Low	Low	Low	Low
	<i>Timeline (years)</i>	0.5-1	0.5-1	3-5	0.5-1	0.5-1
<b>Lost Pots (2)</b>	<i>Magnitude</i>	10 <sup>1</sup> m <sup>2</sup>	Months to Years	Medium	Unknown	High
	<i>Data Available</i>	Yes	Some	Some	Some	Some
	<i>Research Needed</i>	Data mining	Field exp'ts	Field exp'ts	Data mining/Field exp'ts	Data mining
	<i>Priority</i>	Low	Medium	Medium	Medium	Low
	<i>Timeline (years)</i>	1-2	3-5+	1-3	3-5	0.5-1
<b>Hook-and-Line (3)</b>	<i>Magnitude</i>	10 <sup>4</sup> m <sup>2</sup>	Hours to Days	Low	10 <sup>4</sup>	Medium
	<i>Data Available</i>	Yes	Yes	No	Yes	Some
	<i>Research Needed</i>	Data mining	Data mining	Field exp'ts	Data mining	Crab Dist.
	<i>Priority</i>	Low	Low	Low	Low	Low
	<i>Timeline (years)</i>	0.5-1	0.5-1	3-5	0.5-1	0.5-1

# 4. Framework for estimating the magnitude of UFM and research prioritization

**Table 1: Information for estimating magnitude, data availability and gaps, and research priorities**

## ***Trawl gear-***

Note shading for medium / high priority research items

Gear Type (# of configs)	Information Type	Individual Event (e.g., pot/rawl) Level			Population Level	
		Bottom Contact Area	Time on Bottom	"Lethality" of gear	Total # of Events (pot lifts/trawls)	Overlap with Crab
<b>Non-Pelagic Trawl (13)</b>	<i>Magnitude</i>	10 <sup>6</sup> m <sup>2</sup>	Minutes	High	10 <sup>4</sup>	Medium
	<i>Data Available</i>	Yes	Yes	Some	Yes	Some
	<i>Research Needed</i>	Data mining	Data mining	Field Exp'ts	Data mining	Crab Dist.
	<i>Priority</i>	Medium	Medium	Medium	Low	Medium
	<i>Timeline (years)</i>	0.5-1	0.5-1	3-5	0.5-1	1-5
<b>Pelagic Trawl (30)</b>	<i>Magnitude</i>	10 <sup>5</sup> m <sup>2</sup>	Minutes	High	10 <sup>4</sup>	Medium
	<i>Data Available</i>	Yes	Yes	No	Yes	Some
	<i>Research Needed</i>	Data mining	Data mining	Field Exp'ts	Data mining	Crab Dist.
	<i>Priority</i>	Medium	Medium	High	Low	Medium
	<i>Timeline (years)</i>	0.5-1	0.5-1	3-5	0.5-1	1-5



# 4. Framework for estimating the magnitude of UFM and research prioritization

## **Table 2: Information required for estimating UFM: approaches, availability, limitations, and research needs**

- Information required
  - Gear bottom contact
  - Crab spatial distribution
  - Crab movement
  - Size / life stage vulnerabilities
  - Encounter rate
  - Mortality rate if encountered
- Each needed piece of information evaluated based on:
  - Possible approaches for providing information
  - Available data
  - Key limitations to available data or models
  - Research needs

# 4. Framework for estimating the magnitude of UFM and research prioritization

**Table 2: Information required for estimating UFM: approaches, availability, limitations, and research needs (1/3)**

Note shading for medium / high priority research items (darker grey is higher priority).

Information Need	Approach	Available data/inputs	Key limitations (data & models)	Research needs
Bottom contact (footprint of fishing gears)	Fishing Effects model (all fisheries/gear types)	Catch-In-Areas database, based on VMS & observer data	uncertain estimates of 'effective' bottom contact, switch to EM may affect accuracy	Improved contact ratio estimates; sensitivity to model assumptions
	SDM approach to model distribution of ghost pots	Some empirical data for ghost pots (log book data)	'Effective area' unknown & dependent on crab movement	Direct observations (video)
Crab spatial distribution by size or life stage and season	Species Distribution Models (SDMs) such as GAMs, VAST, etc.	Summer bottom trawl surveys (EFH analyses & maps)	Summer distribution only	Surveys in other seasons
		BSFRF small mesh trawl surveys	Few years of data, summer only	Integrate with SDMs of summer distribution
		Winter Cooperative Pot Survey (CPS) for Red King Crab	Spatially restricted	SDMs of winter distribution; additional winter surveys
		Fishery-dependent CPUE (incl. bycatch 'CPUE' in groundfish fisheries)	Sampling effort not independent of crab distribution, limited footprint of fishery	Models appropriate to fishery-dependent CPUE & combining data from multiple fisheries

# 4. Framework for estimating the magnitude of UFM and research prioritization

**Table 2: Information required for estimating UFM: approaches, availability, limitations, and research needs (2/3)**

Note shading for medium / high priority research items (darker grey is higher priority).

Information Need	Approach	Available data/inputs	Key limitations (data & models)	Research needs
Movement (relative to stationary gear, ghost pots)	Movement models	Tagging data (e.g. RKC)	Sparse data, large crab only	Integrating movement into SDMs when possible
	Infer movement from SDMs	combine fishery-dependent & independent data	limited seasonal & spatial coverage to infer movement	Improved models for combining multiple, disparate data sources
Size / life stage dependent vulnerabilities	Vulnerability assessment	Literature review, assumed high during molting	limited information on relative vulnerability at different life stages	Timing and location of molting
	Use size as proxy for vulnerability	Spatial distribution by size class over the observed size range	Distribution & habitat requirements for recently settled juveniles	Vulnerability of small crab to fishing impacts
Encounter rate	Mechanistic: FE impacts model	Fishery footprint + SDM results on distribution of crab	Uncertainty associated with inputs	Distribution of crab during fishing seasons
	Empirical: Ratio of unobserved / observed encounters	Rose et al under-bag experiments	few experiments, likely high variability across gear configurations	Experiments / direct observations (all gear types & configurations)

# 4. Framework for estimating the magnitude of UFM and research prioritization

**Table 2: Information required for estimating UFM: approaches, availability, limitations, and research needs (2/3)**

Note shading for medium / high priority research items (darker grey is higher priority).

Information Need	Approach	Available data/inputs	Key limitations (data & models)	Research needs
Mortality rate (when encountered)	Under-bag experiments	Rose et al (some NPT gear)	Mortality difficult to assess	Experiments / direct observations (all gear types & configurations)
	High volume tagging experiments	None	Study design - feasibility of estimating M and disentangling mortality sources	Simulations to assess effectiveness and sampling effort needed
	Video observations	Limited observations from experimental fishing	Visibility, assessing injury & long-term mortality risk visually	Forward-looking cameras on trawls + independent video observations in trawl pass
	Assess escape mechanism effectiveness	<a href="#">ADF&amp;G reports (AI GKC)</a> <a href="#">Literature</a>	Variety of pot types & escape mechanisms	lab experiments on degradation rates & force needed to escape
	Pop Dy model with M linked to modeled encounters	Modeled encounter rates by stock (FE model)	Model complexity is expensive; model does not account for small crab	Develop research models for Tanner and snow crab; begin exploring modeling approaches and information needs
	Pop Dy model with R linked to modeled encounters	Modeled encounter rates by stock (FE model)	Unlikely to provide estimates of mortality of small crab	Research models to explore potential impacts on recruitment

# 5. Working Group Recommendations

- Report is the first step to achieving Council's requested products
- Substantial data deficiencies preclude estimation of UFM
- Additional WG meetings would likely not be fruitful until further data have been collected
- If additional meetings are held, input from a broader group of experts would be helpful

# UFMWG Report Review

- CPT review ([CPT report](#))
- SSC Subgroup review- filtered through research priorities
  - Research ID: SSCSub006, [April 2024 Plan Team Summary Report](#)). Through the research priorities process, the SSC had the opportunity to review and incorporate research suggestions made by the UFMWG into their decision-making process for elevating the top 10 research priorities.

Questions?

