Gag Discard Mortality

Beverly Sauls
Fish and Wildlife Research Institute
Florida Fish and Wildlife Conservation Commission
Saint Petersburg, FL

Presented to:
Gulf of Mexico SSC
September 2023

Reef Fish Surveys in Florida

- State Reef Fish Survey
  - Private boat effort and catch
  - Implemented in Gulf in 2015
  - Also collects information on:
    - Artificial reef use
    - Areas fished
    - Release methods (new in 2022)
- For-Hire At-Sea Observer Program
  - Fishery observers ride along on headboat and charter trips
  - Implemented in Gulf in 2009
  - Provides:
    - Species and size composition of discards
    - Capture, handling and release methods
    - Release condition
    - Fate of discards

SRFS
STATE REEF FISH SURVEY

Oscar "Butch" Ayala, FWC

Management, Outreach, Education, Monitoring, Assessment

- Venting tool and/or fish descender device
  - Required in Gulf EEZ in 2022
  - Required in FL in 2023
- Return ‘Em Right, ongoing since 2022
  - Training and free gear distributed to 11,349 offshore anglers in first year
  - 41% of private boat anglers have a descender device on board (2022)
    - From state reef fish surveys in FL, AL, MS
  - Expanded for-hire observer coverage
    - Methods adopted in AL and MS
    - Supplemented on Gulf coast of FL
  - Continue monitoring impacts over time
- Data inputs for SEDARs
  - Magnitude, size composition of discards
  - Where, when and how fish are caught and released
  - Fate of discarded fish

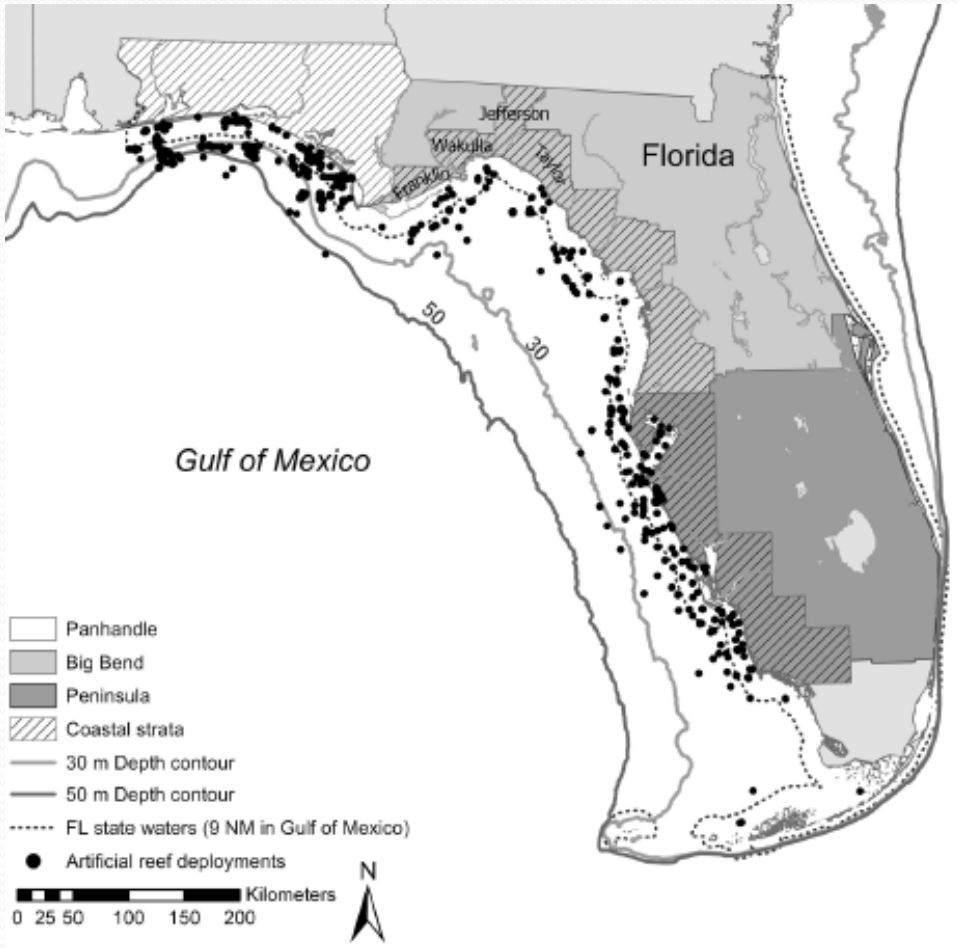
SOUTHEAST DATA, ASSESSMENT & REVIEW

RETURN ‘EM RIGHT

https://returnemright.org/program-impact/

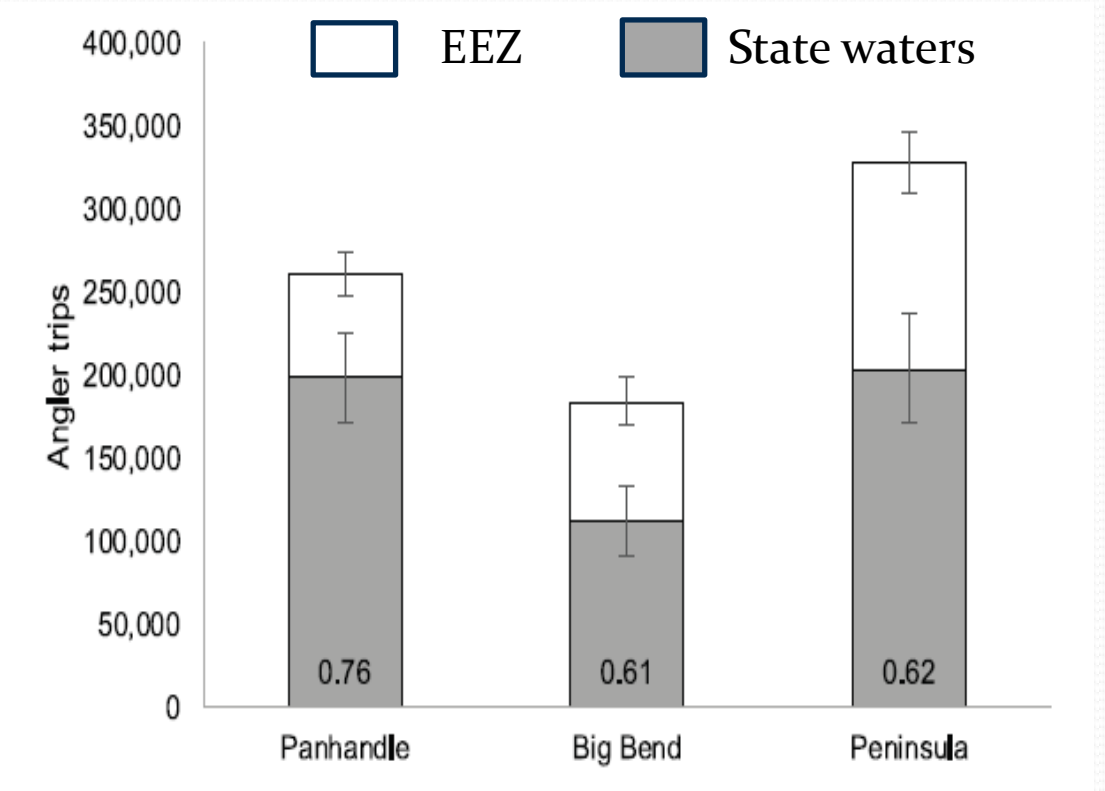
Reef Fish Fishery on Gulf Coast of Florida

- Anglers target reef fishes on natural hard-bottom and artificial reefs
  - Black dots show artificial reefs deployed by FWC as of 2018
- Distance to deep water varies regionally
  - 30 and 50m depth contours
- FL state territorial seas boundary 10 statute miles from shore
  - Dotted line



Private Boat Reef Fish Effort
Gulf coast of Florida (May 2016-Dec. 2017)

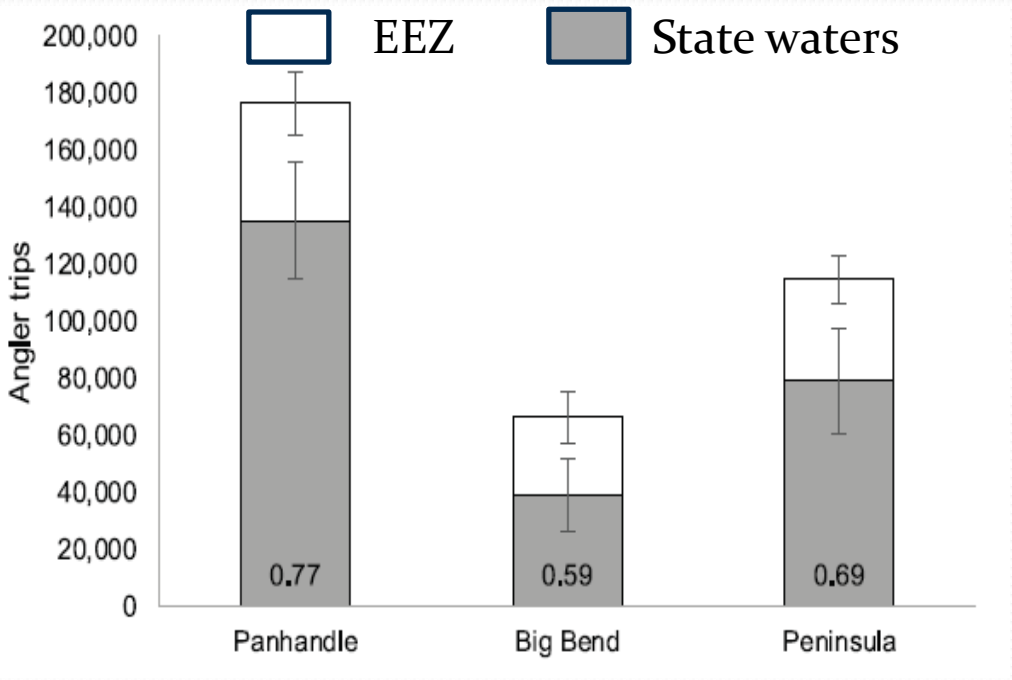
- Highest effort off the western Peninsula.
  - Large population
  - Less seasonal
- Majority of trips fish in state waters
  - Panhandle 76%
  - Big Bend 61%
  - Peninsula 62%



Cross, T., B. Sauls, R. Germeroth and K. Mille. 2018. Amer. Fish. Soc. Symposium 86: 265-277.

Reef Fish Effort on Artificial Reefs Gulf Coast of Florida (May 2016-Dec. 2017)

- 46% of reef fish trips utilized artificial reefs.
- 50% of all artificial reef trips were in the Panhandle.
- Majority of artificial reef trips took place in State waters
  - Panhandle 77%
  - Big Bend 59%
  - Peninsula 69%



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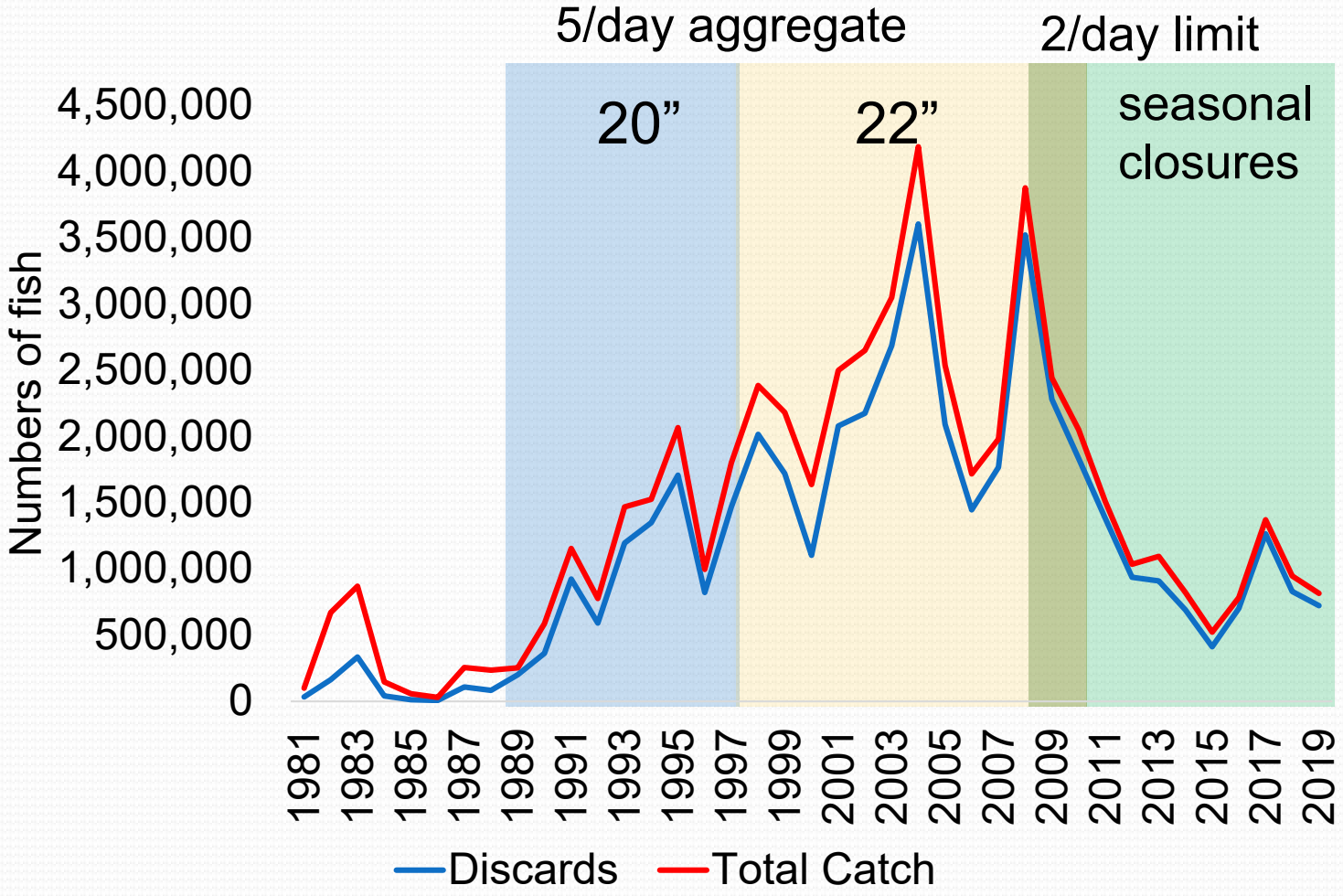
Discards are majority of recreational catch

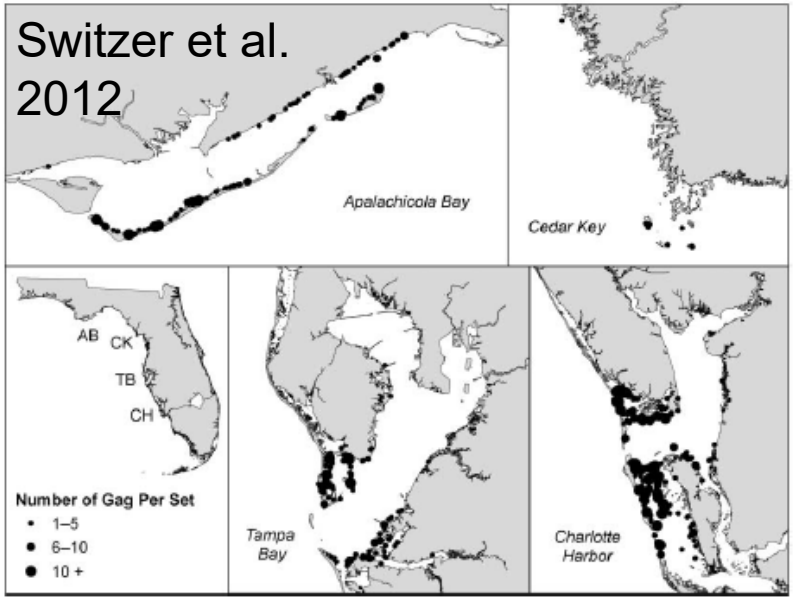


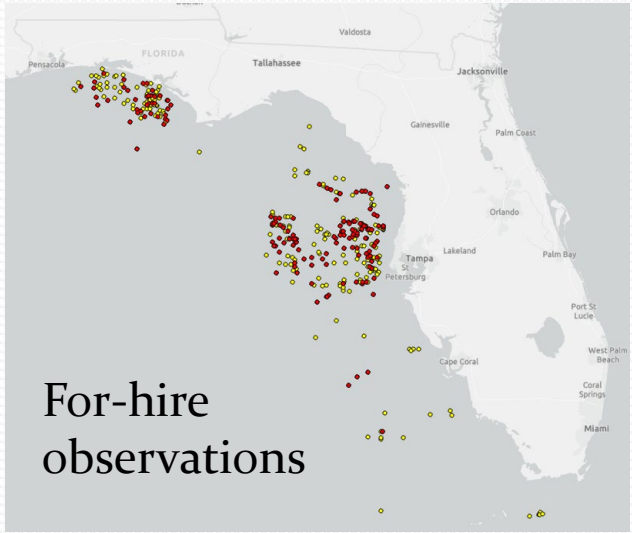
Source: SRFS calibrated time-series, SEDAR 72

Gag Life History and Fishing Effort Intersect

Gag are vulnerable to fishing pressure throughout their life history.

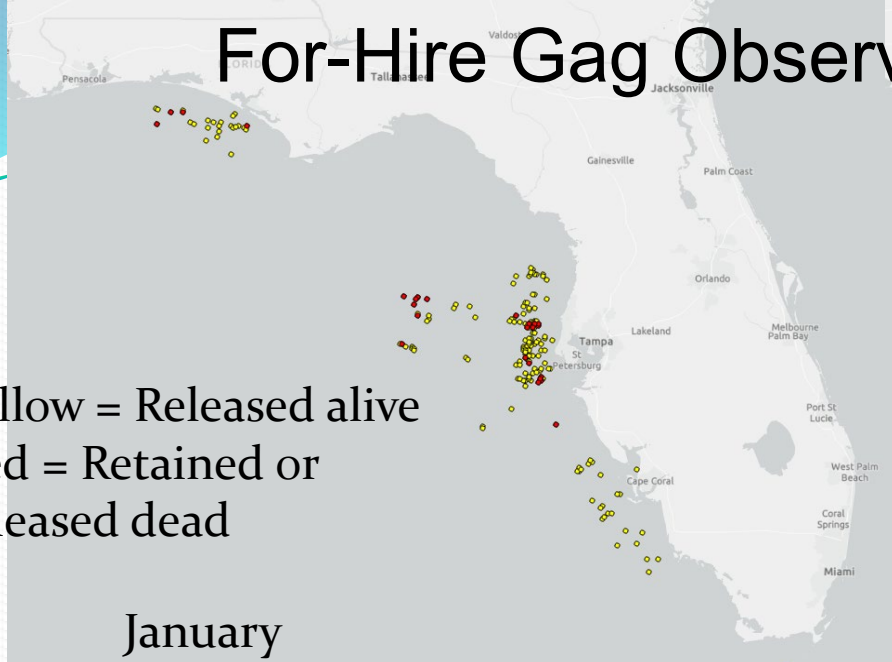
- Juveniles recruit to high salinity seagrass habitat in eastern Gulf
  - Recreational catch-and-release
- Sub-adults and females associate with nearshore natural hard-bottom habitat
  - Recreationally targeted
- Males and spawning females found farther offshore
  - Commercially and recreationally targeted



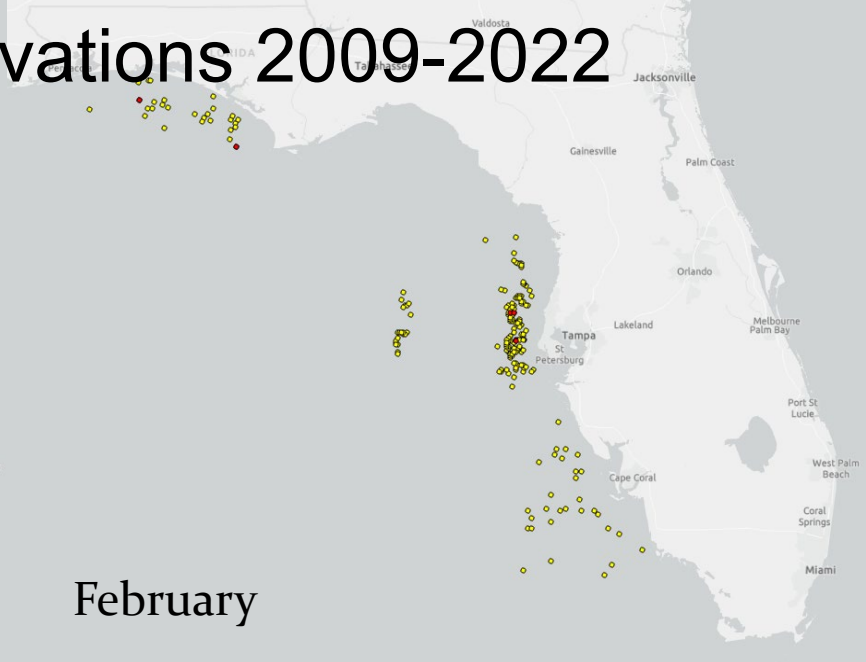


For-Hire Gag Observations 2009-2022

Yellow = Released alive
Red = Retained or released dead



January



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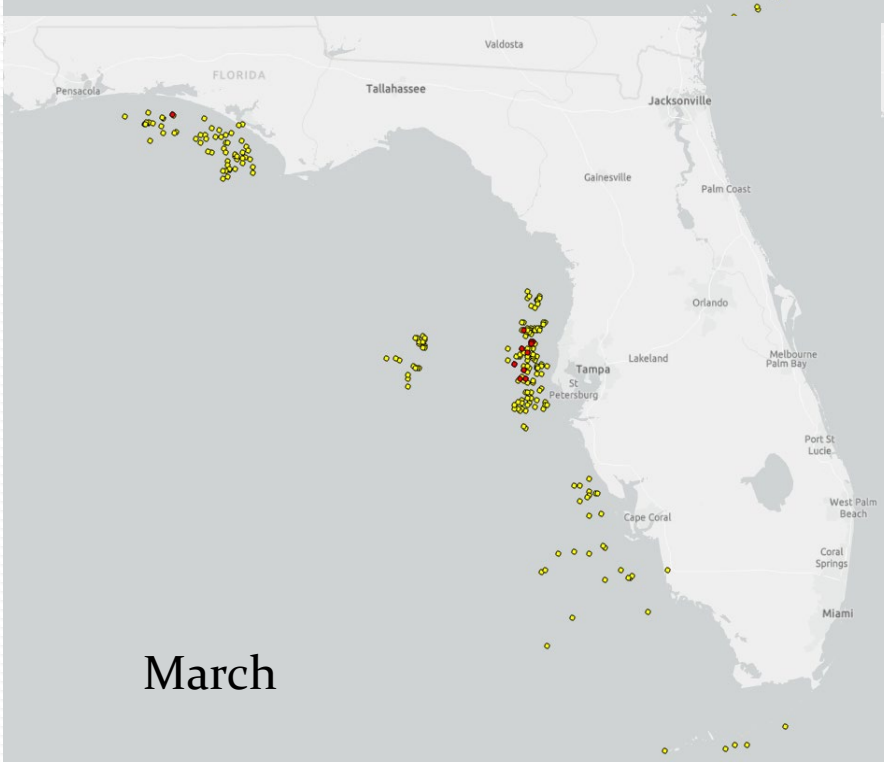
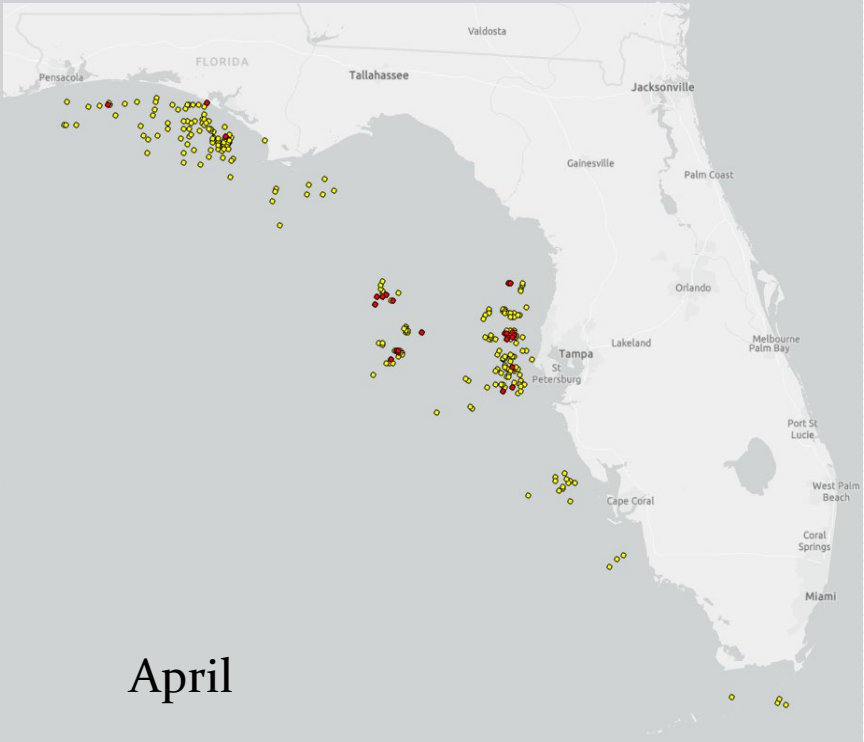


March



April

For-Hire Gag Observations 2009-2022

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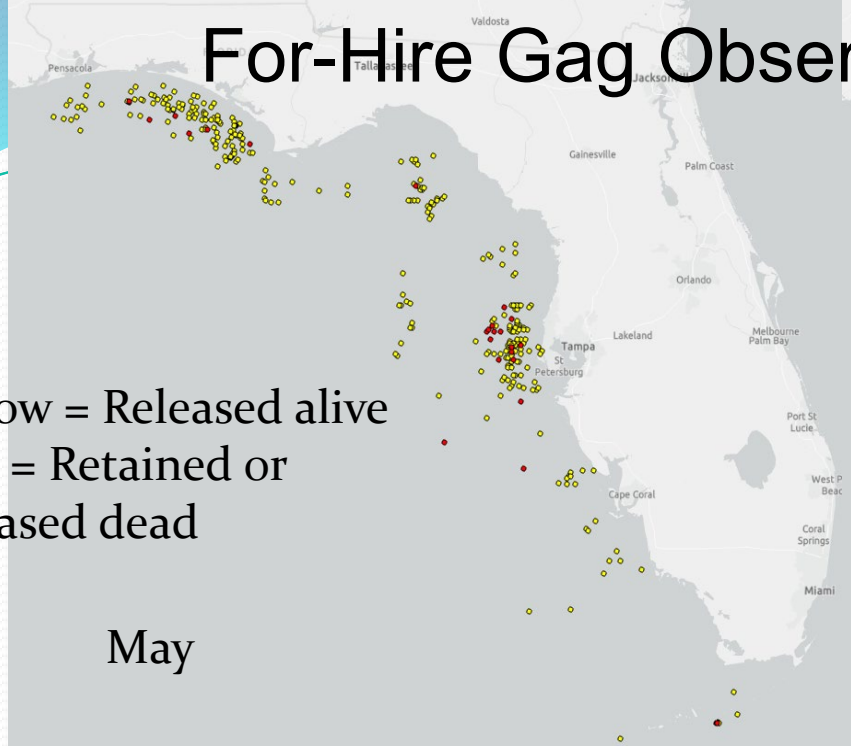
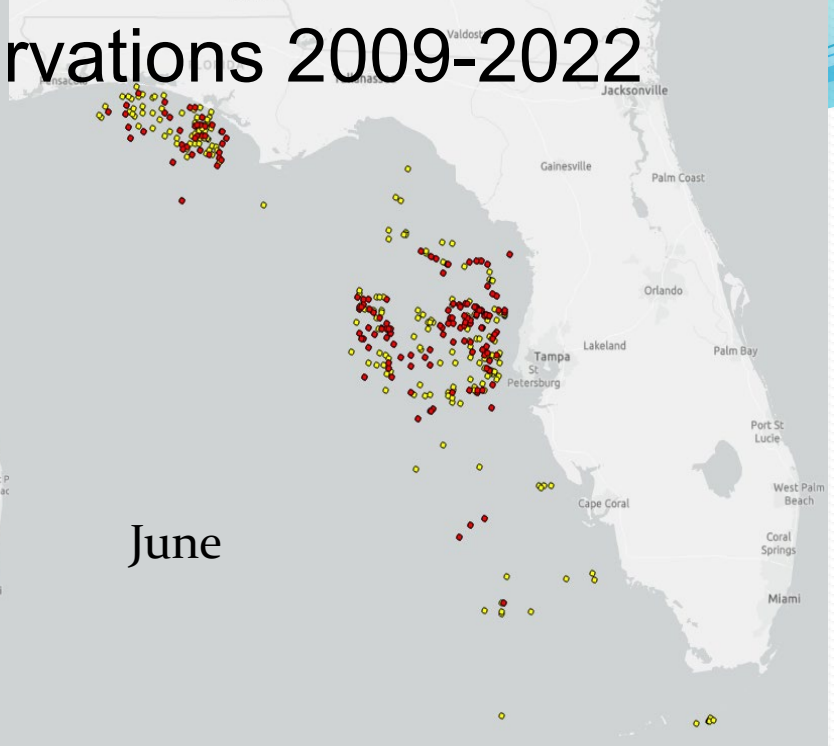
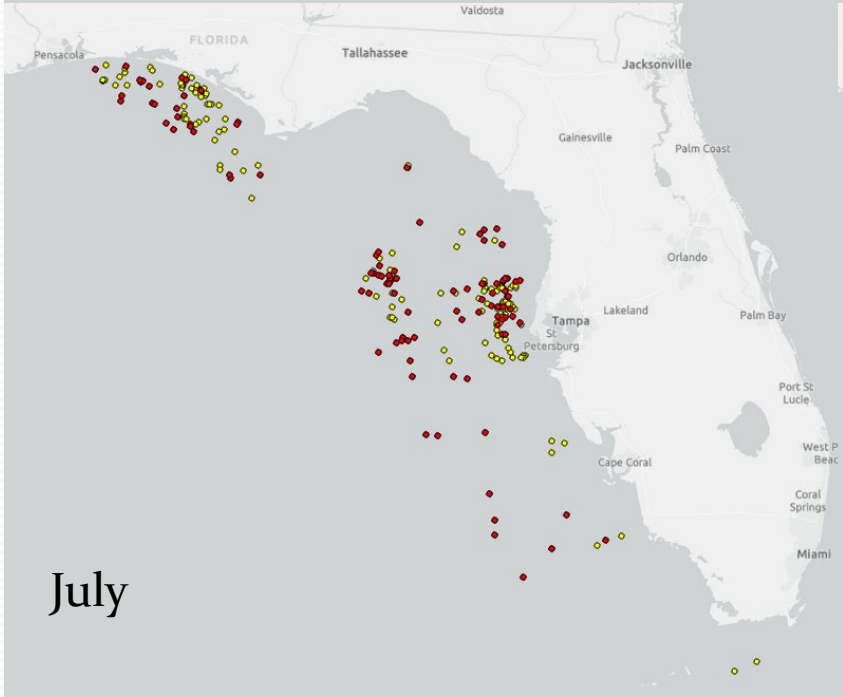


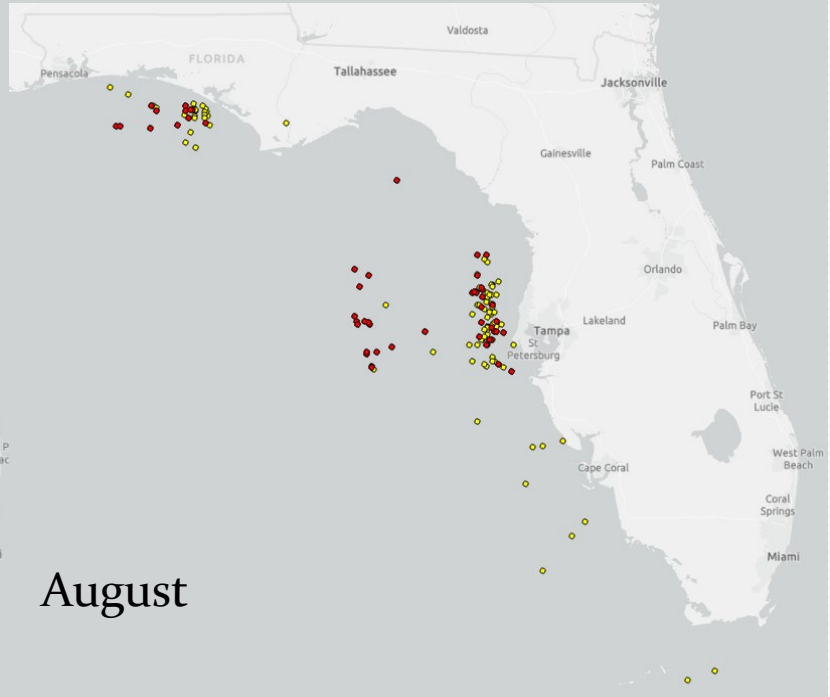
May



June



July

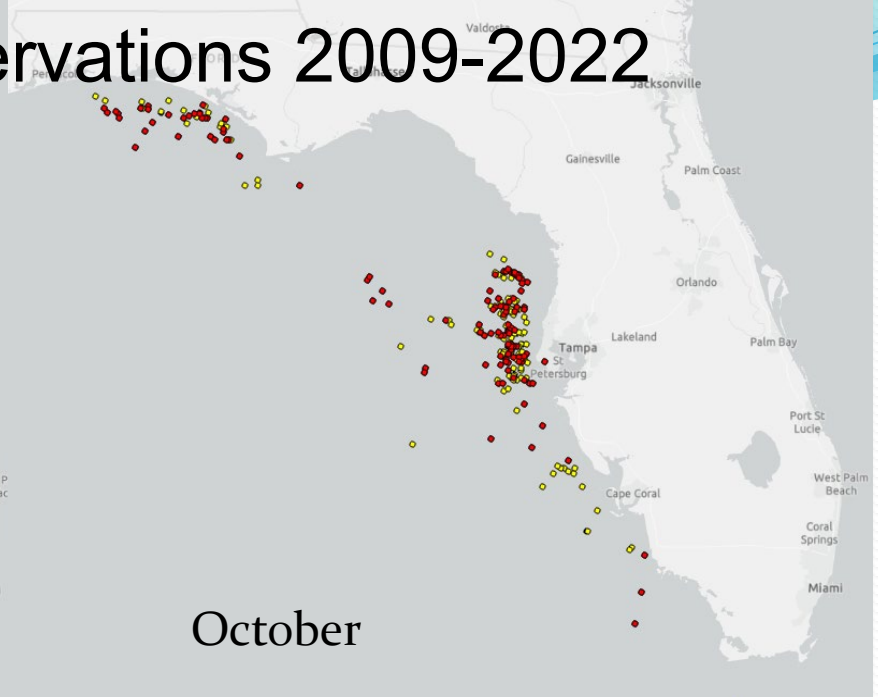


August

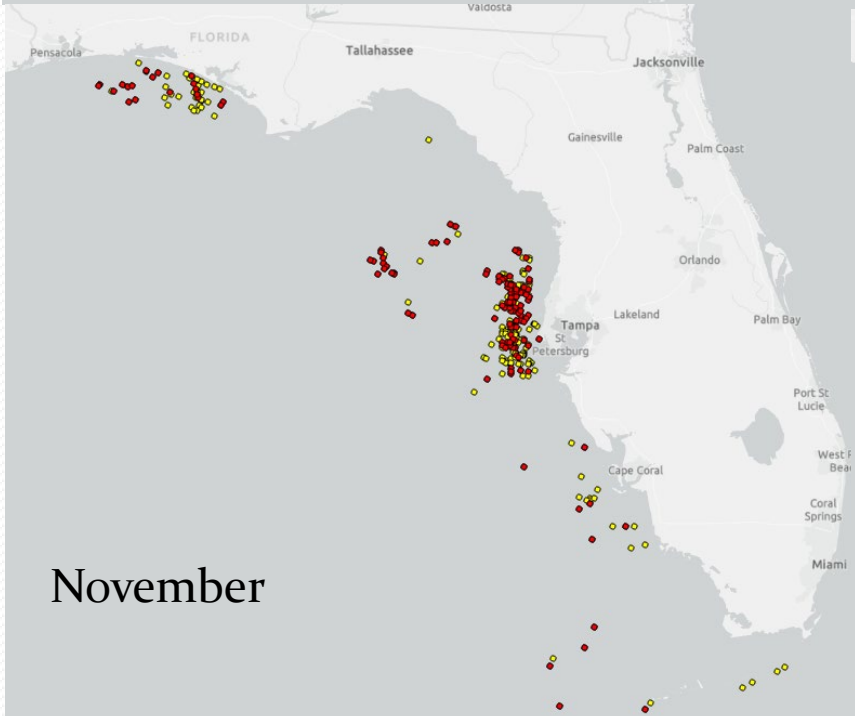
For-Hire Gag Observations 2009-2022

Yellow = Released alive
Red = Retained or released dead

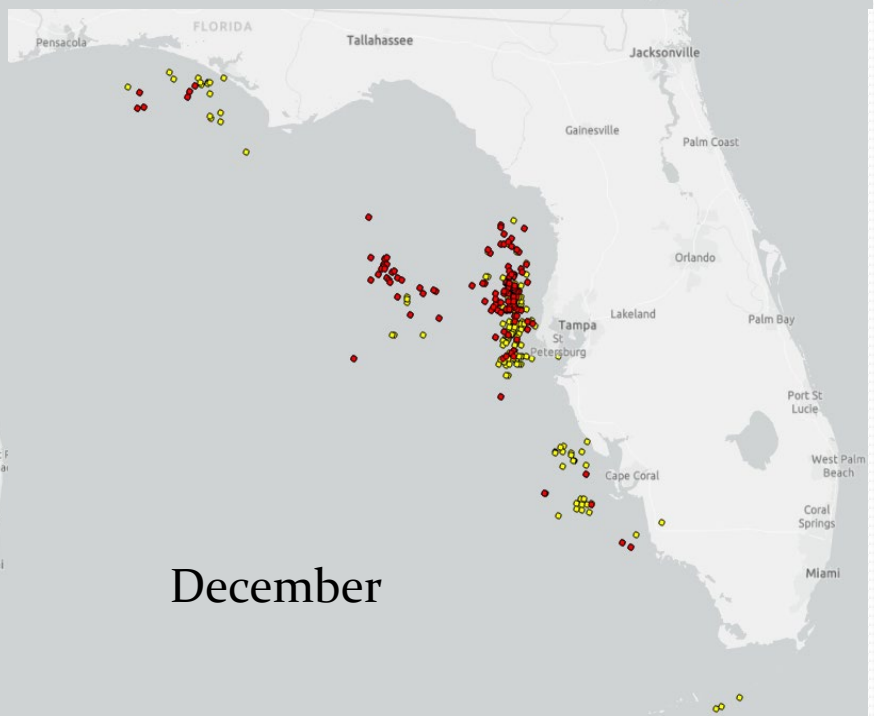
September



October

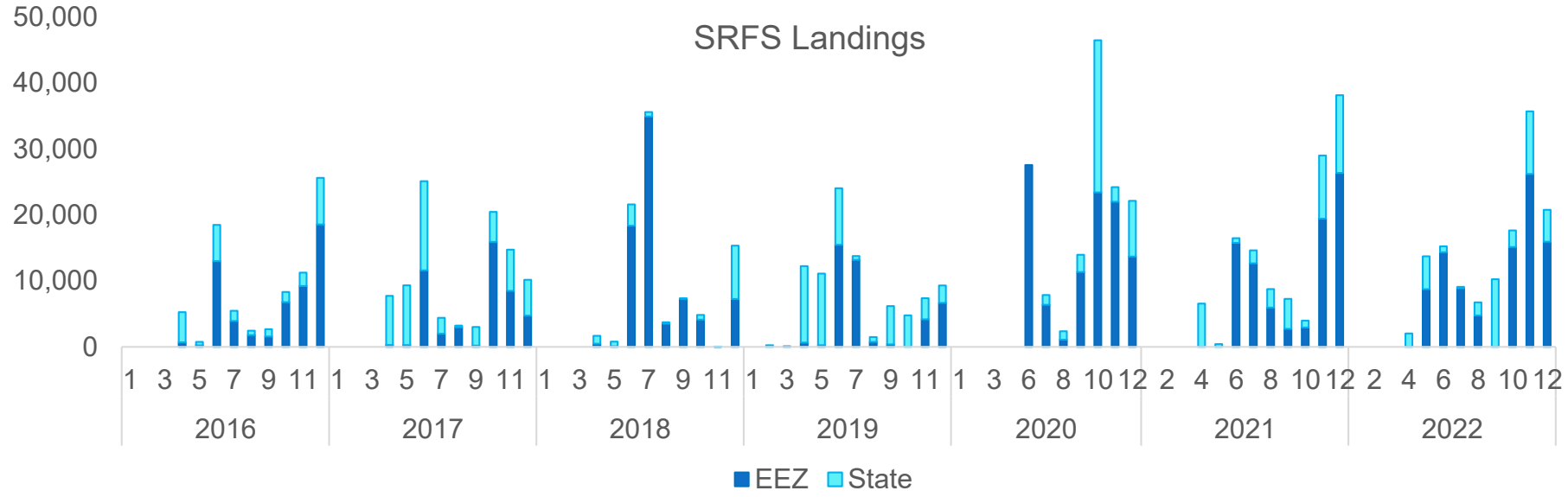


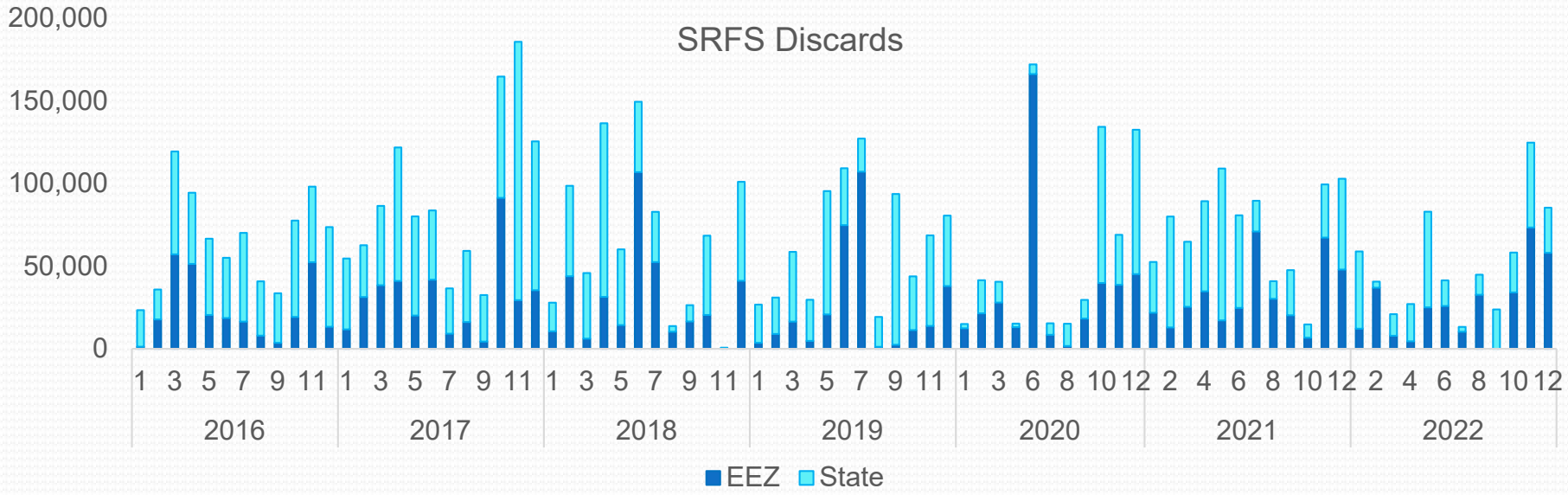
November



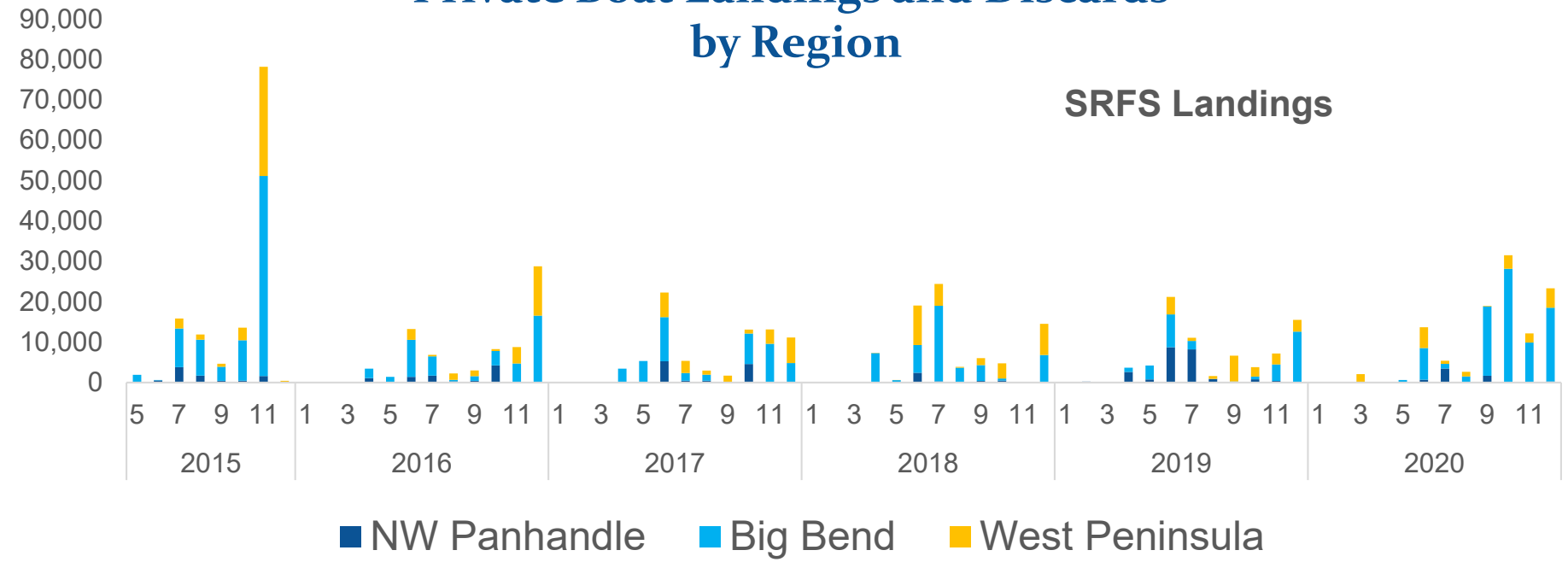
December

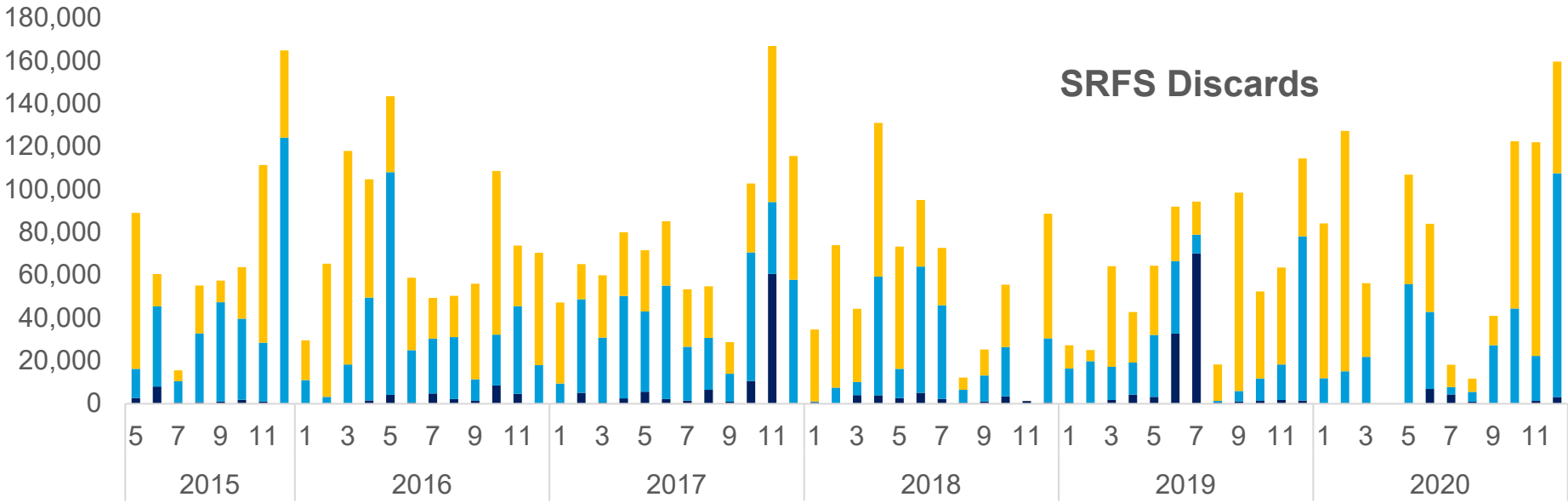
Private Boat Landings and Discards by Area Fished





Private Boat Landings and Discards by Region





Fishery-Dependent Discard Mortality Study

Relative survival of gags *Mycteroperca microlepis* released within a recreational hook-and-line fishery: Application of the Cox Regression Model to control for heterogeneity in a large-scale mark-recapture study

Beverly Sauls[a,b,*]

[a] *Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 Eighth Avenue SE, Saint Petersburg, FL 33701, USA*
[b] *University of South Florida, College of Marine Science, 140 7th Avenue S, MSL 119, Saint Petersburg, FL 33701, USA*

Fisheries Research 150 (2014) 18– 27

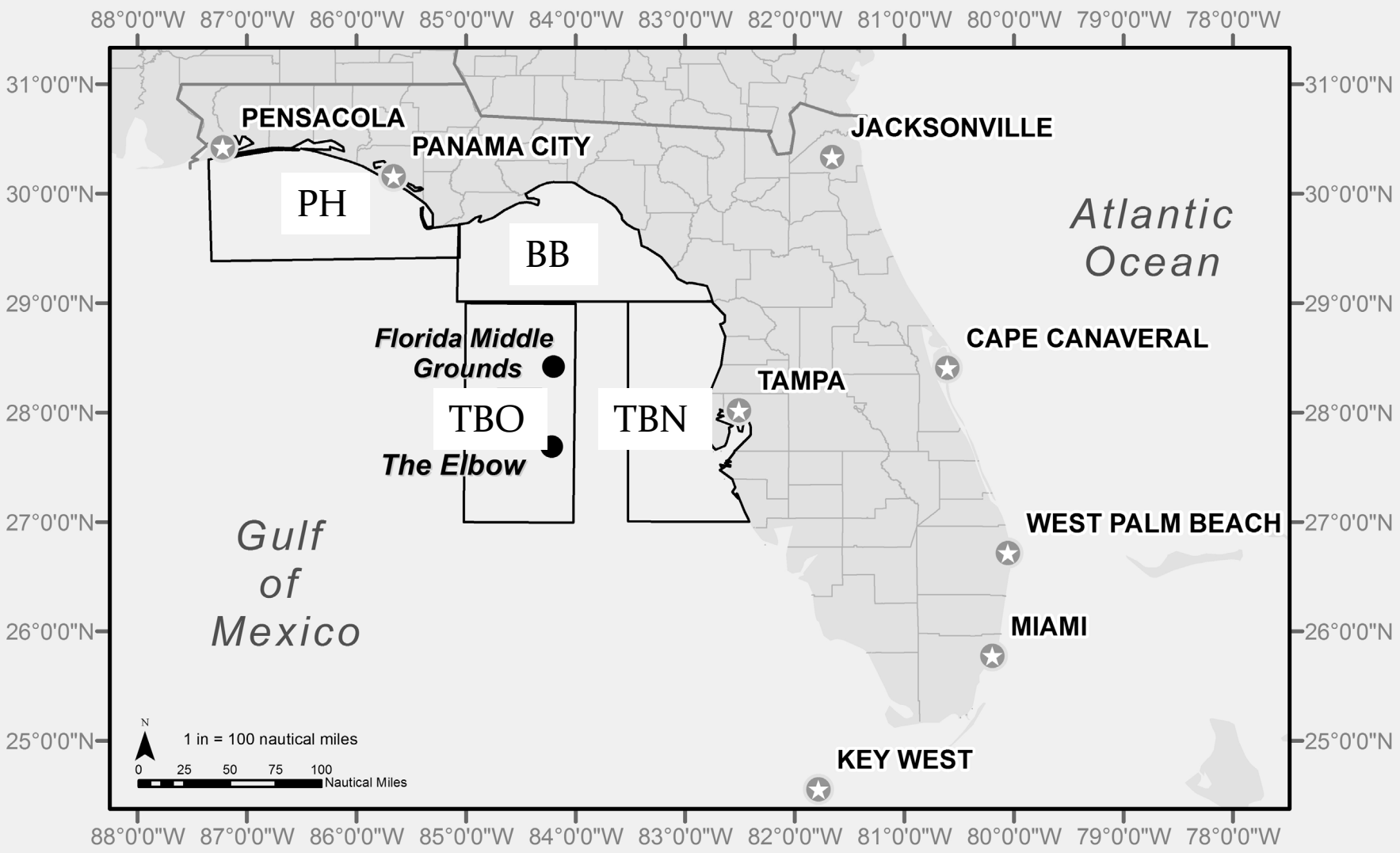
Objectives

1. Develop methods to rapidly assess condition of discards directly observed in a large-scale recreational fishery.
2. Develop a survival effects model to estimate relative survival of gags released in different conditions.
3. Estimate the portion of gag discards that die under conditions experienced within the fishery.

Cooperative Research

- June 2009-December 2012
- West coast of Florida
- Recruited >160 for-hire vessels
- Vessels selected year round to carry an FWC observer

Study Area


88°0'0"W 87°0'0"W 86°0'0"W 85°0'0"W 84°0'0"W 83°0'0"W 82°0'0"W 81°0'0"W 80°0'0"W 79°0'0"W 78°0'0"W
31°0'0"N
30°0'0"N
29°0'0"N
28°0'0"N
27°0'0"N
26°0'0"N
25°0'0"N
PENSACOLA
PANAMA CITY
JACKSONVILLE
PH
BB
Atlantic Ocean
Florida Middle Grounds
CAPE CANAVERAL
TAMPA
TBO
TBN
The Elbow
Gulf of Mexico
WEST PALM BEACH
MIAMI
KEY WEST
N
1 in = 100 nautical miles
0 25 50 75 100
Nautical Miles

Observed Discards

- Directly observe fish as they are being caught
- Discards marked with Hallprint plastic dart tags
- FWC Tag Return Hotline
- REWARD

Observed Discards

- Depth
- Size
- Hook location
  - Mouth, throat, gut, gill, foul
- Gill injury
- Barotrauma symptoms
  - Swollen bladder
  - Everted stomach or intestines
  - Exopthalmia
- Vented or unvented
- Surface swimming behavior
  - Immediately submerged
  - Disoriented, then submerged
  - Floating


Bleeding from gill


Barotrauma

Release Condition

- GOOD
  - Immediately submerged without venting
  - No internal hook injuries or visible gill injuries
- FAIR
  - Did not immediately submerge, OR
  - Submerged with venting
  - No internal hook injuries or visible gill injuries
- POOR (one or more impairments)
  - Remained floating at surface
  - Suffered internal hook injuries
  - Suffered visible gill injuries

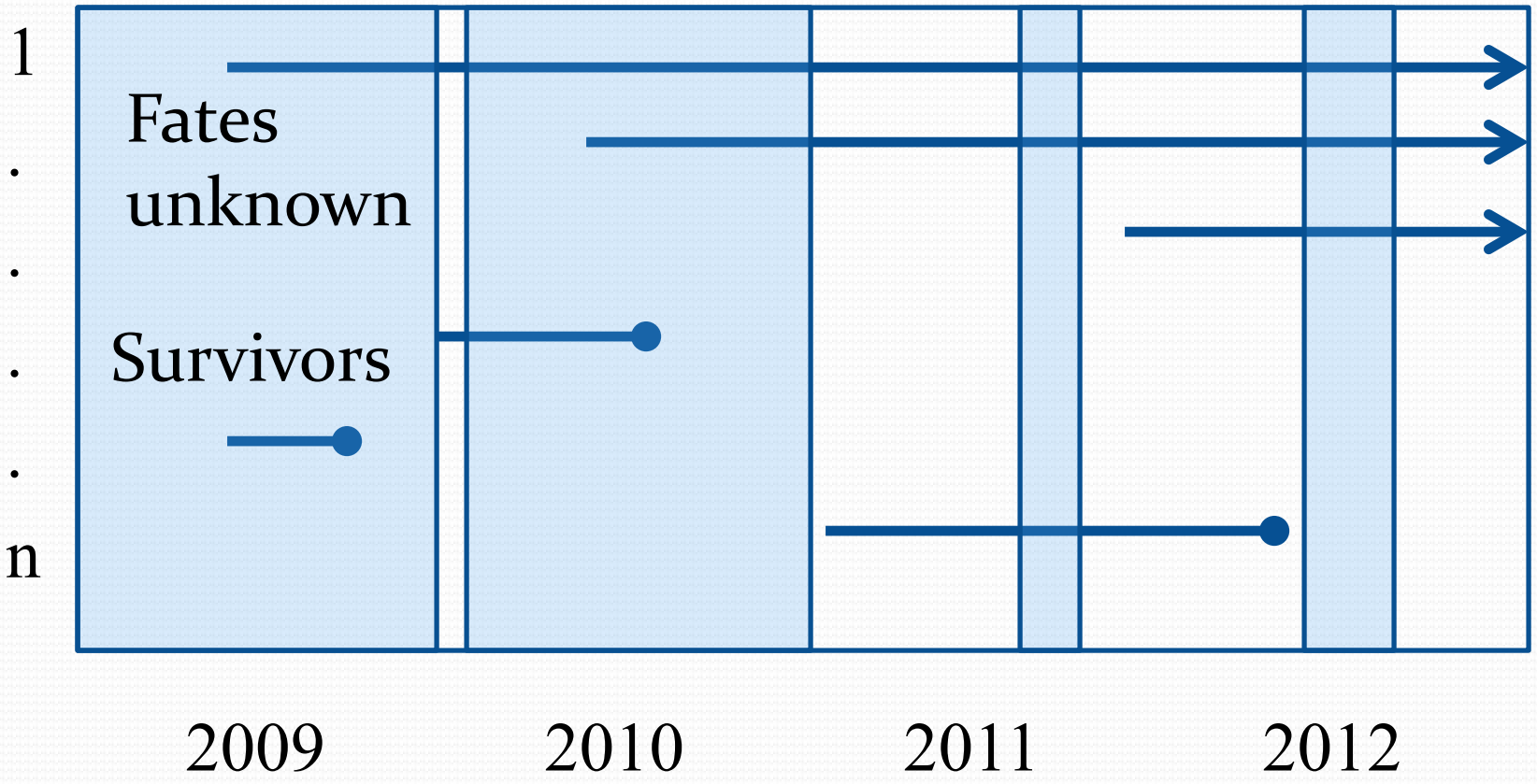
Note: descending device use was rare and not observed during this study

Mark-Recapture Model

- Fish were tagged year-round, over multiple years, and over a large geographic area.
- Fishing effort varied:
  - Regionally
  - Annually
  - Seasonally
- Discards of all sizes tagged
- Robust model needed to
  - control for potential confounding factors
  - detect significant differences under highly variable conditions in the fishery

Small tagged red grouper.

Survival Effects Model



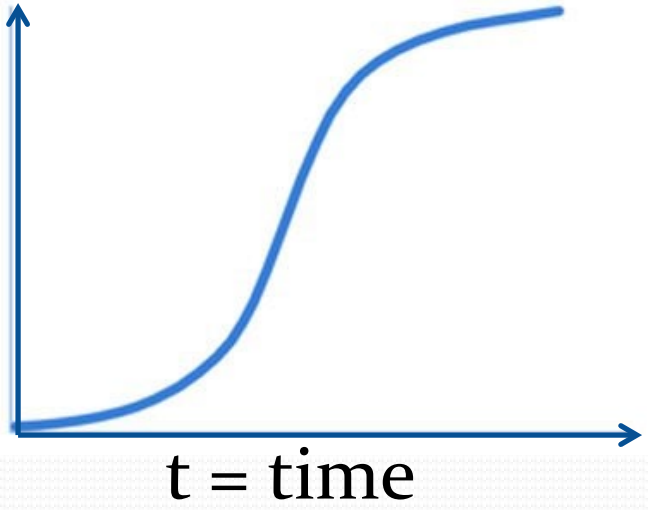
Survival Effects Model

- For the overall population of tagged fish, we know the cumulative distribution of reported recapture events
  - Let T = time until an individual fish was reported as recaptured

$$F(t) = pr\,(T<t)$$

- Unreported fish:
  - Tag loss
  - Non-reporting
  - Movement
  - Mortality

Assumed same for all groups



Survival Effects Model

- Probability of being reported as a recapture can be expressed as a time-specific rate by the hazard function:

$$h(t) = \lim_{\Delta t \to 0} \frac{pr\ (t <= T < t+\Delta t \mid T>=t\ )}{\Delta t}$$

- Explains variability in recapture reporting rate with high precision
- Controls for more variability than a simple percentage

Proportional Hazards Regression Model

- A simple example:
  - x=0 if released in good condition
  - x=1 if released in poor condition

$$h(t|x) = h_0(t) * \exp(\beta x)$$

- When x=0, $h(t) = h_0(t)$
  - Risk of a recapture event for individuals in reference group
- When x=1, $h(t) = h_0(t) * \exp(\beta)$
  - Proportionate increase/decrease in risk for individuals with characteristic x

Proportional Hazards Regression Model

- When each individual tagged fish has one or more covariates (x_1 …. X_k):

$$h(t|x_1 \ldots x_k) = h_0(t) * \exp(\beta_1 x_1 + \ldots \beta_k x_k)$$

$$\log h(t|x_1 \ldots x_k) = \log h_0(t) + \beta_1 x_1 + \ldots \beta_k x_k$$

Proportional Hazards Regression Model

- The ratio of hazards for two groups:

$$h_i(t)/h_j(t) = \exp(\beta x_i) / \exp(\beta x_j) = \exp(\beta(x_i - x_j))$$

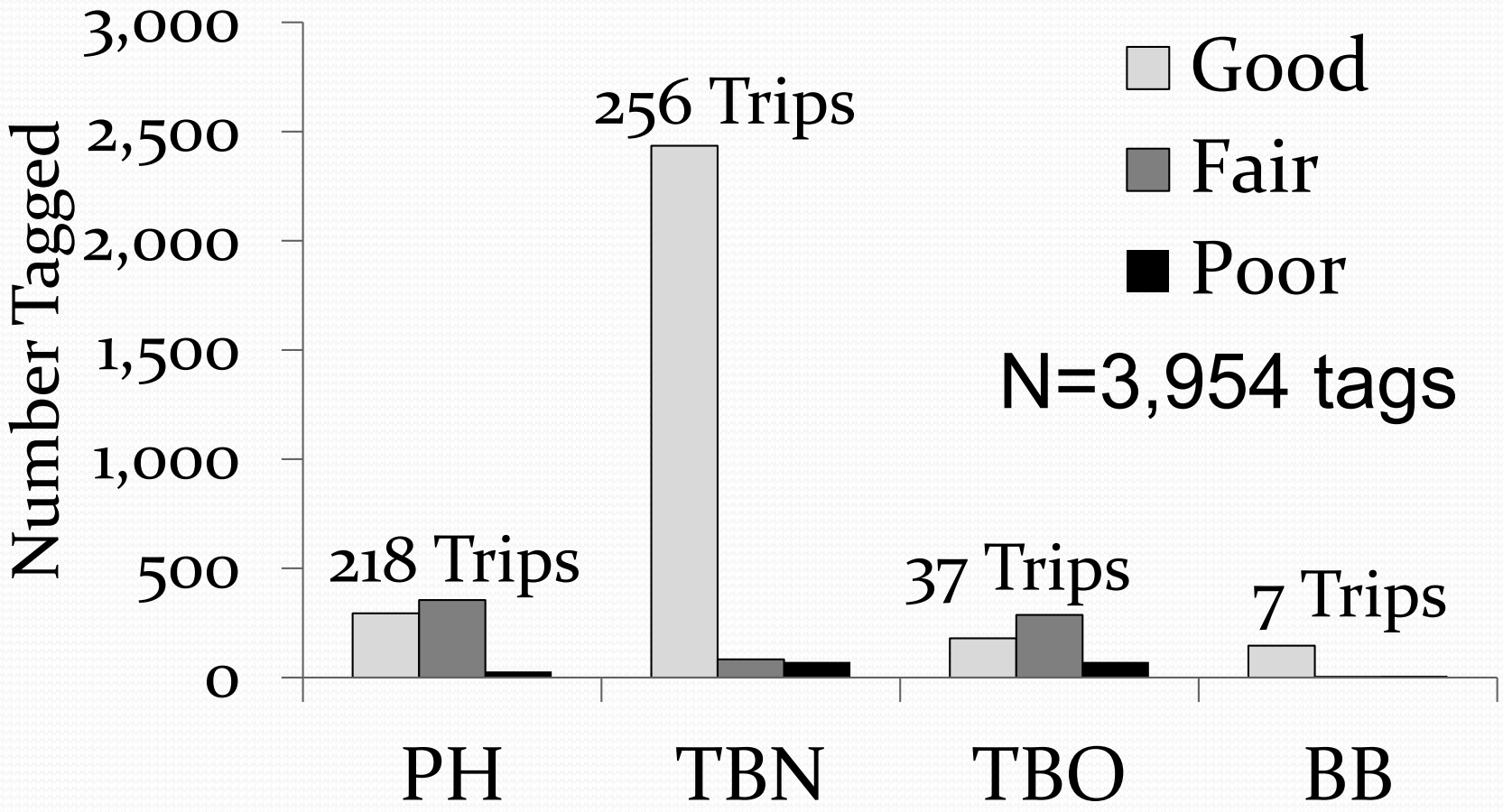
- Note $h_0(t)$ cancels out
- Ratio is constant over time (proportional)
- Measures relative survival

Model Inputs

- Event: 1 if recaptured, 0 if not recaptured
- Time: number of days from date tagged to date recaptured or censored
- Explanatory variable of interest
  - Release condition (good, fair, poor)
- Control variables
  - Month of entry into study (class)
  - Region fish was released (class)
  - Fish length at time of release (continuous)
  - Depth of capture at time of release (continuous)
  - Interaction terms
- Stratification
  - Year tagged

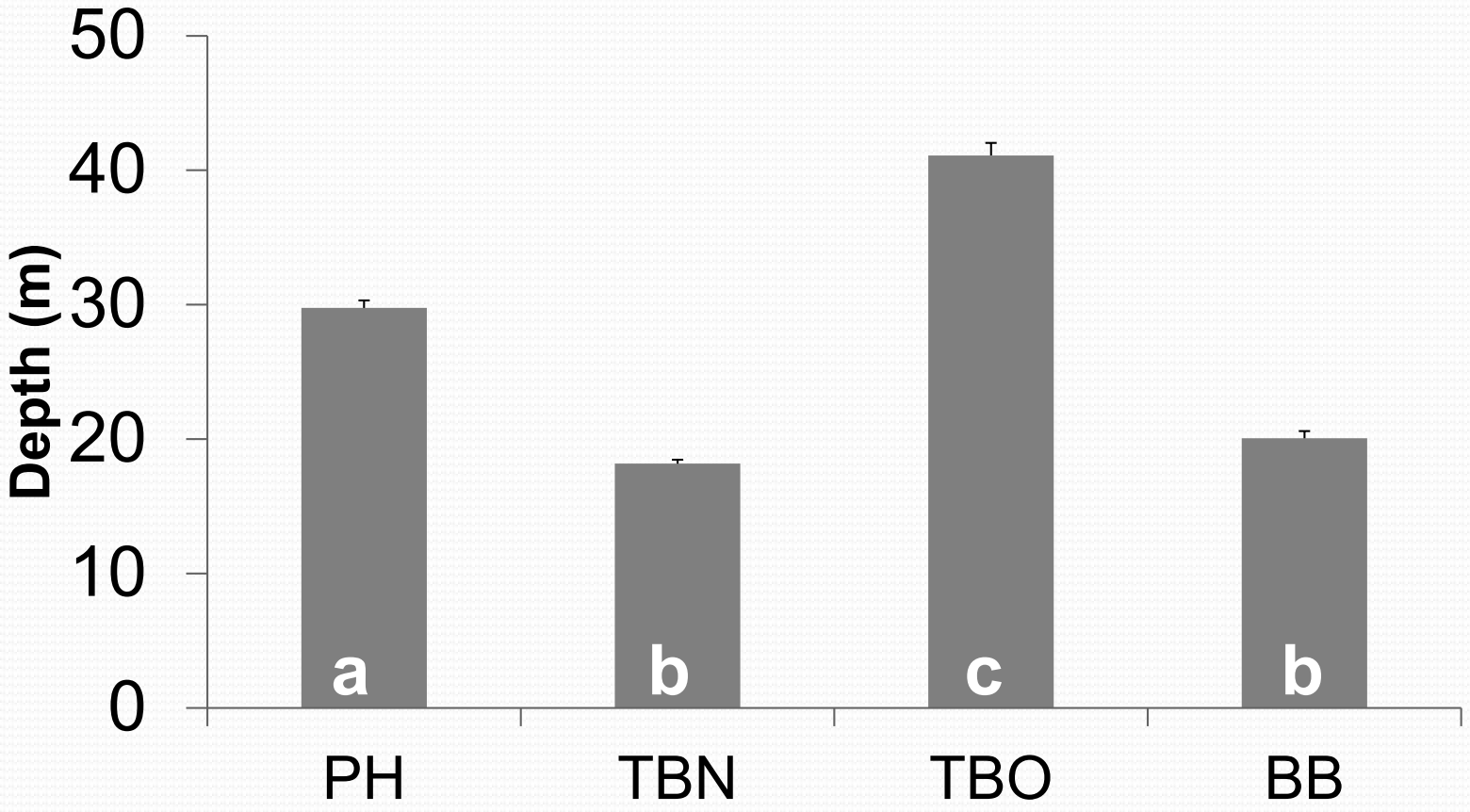
Results

Observed Gag Discards

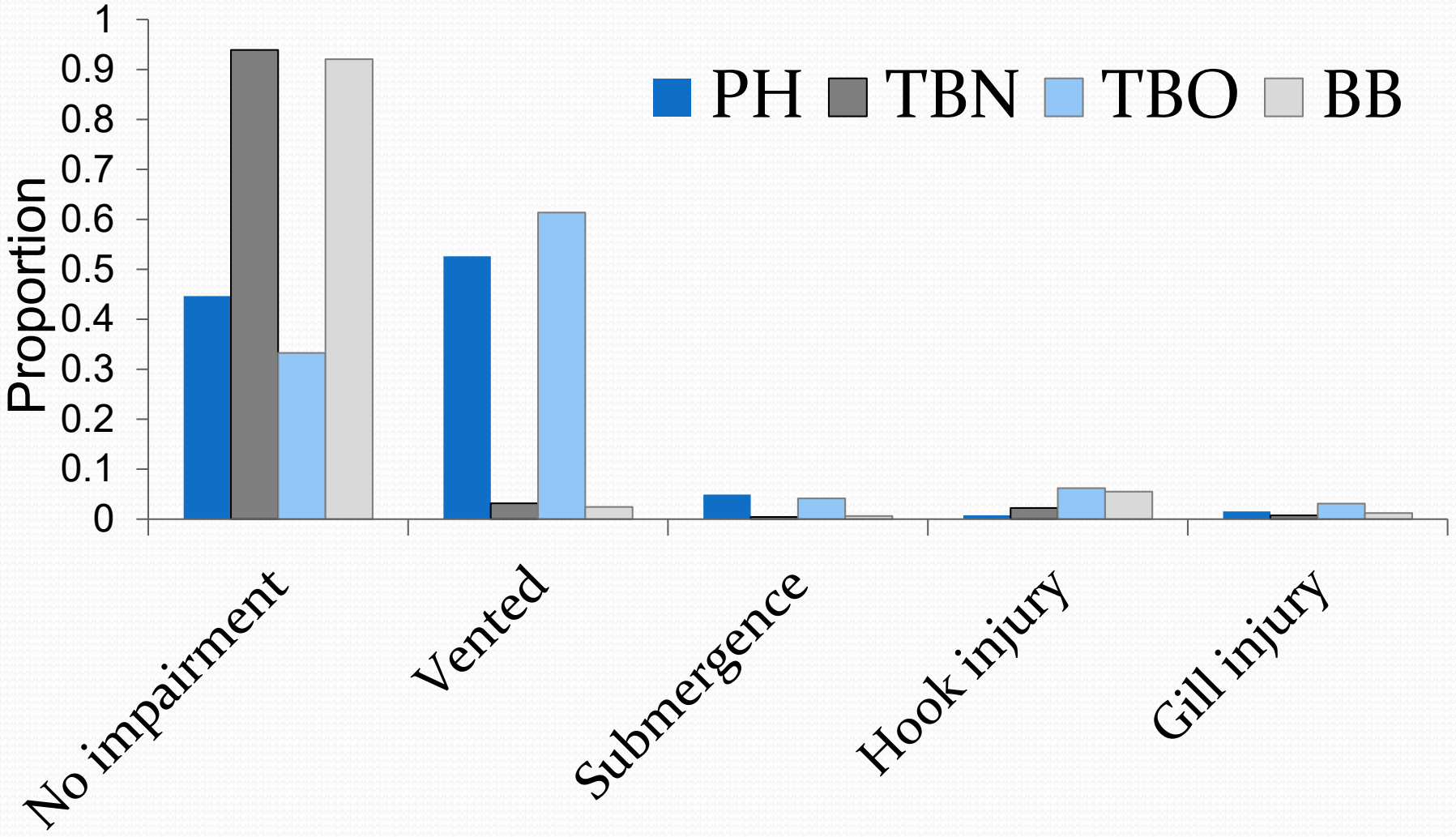


PH=panhandle, TBN=Tampa Bay nearshore, TBO=Tampa Bay offshore (multi-day trips), BB= Big Bend

Mean Capture Depth for Discards

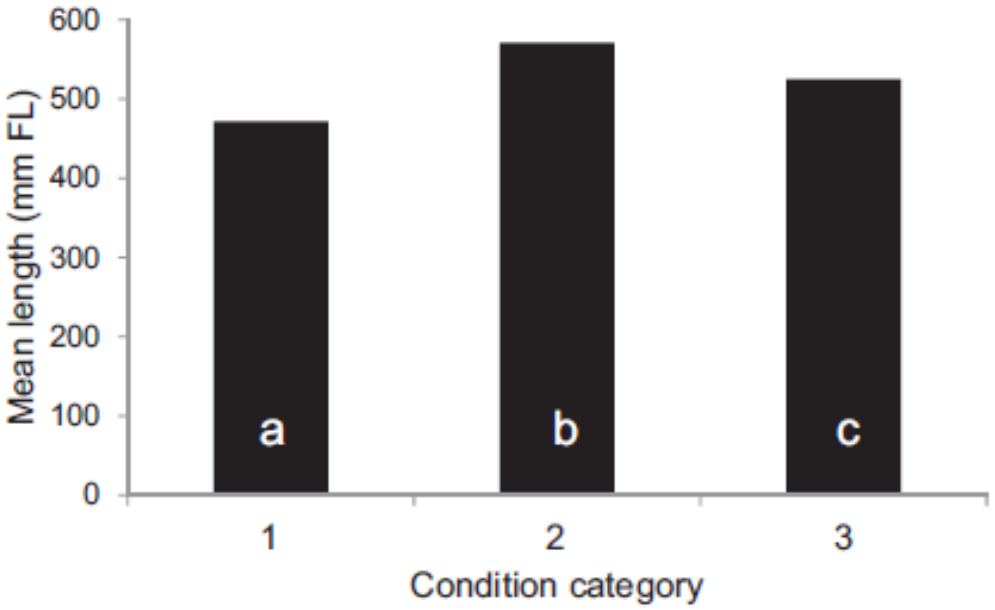


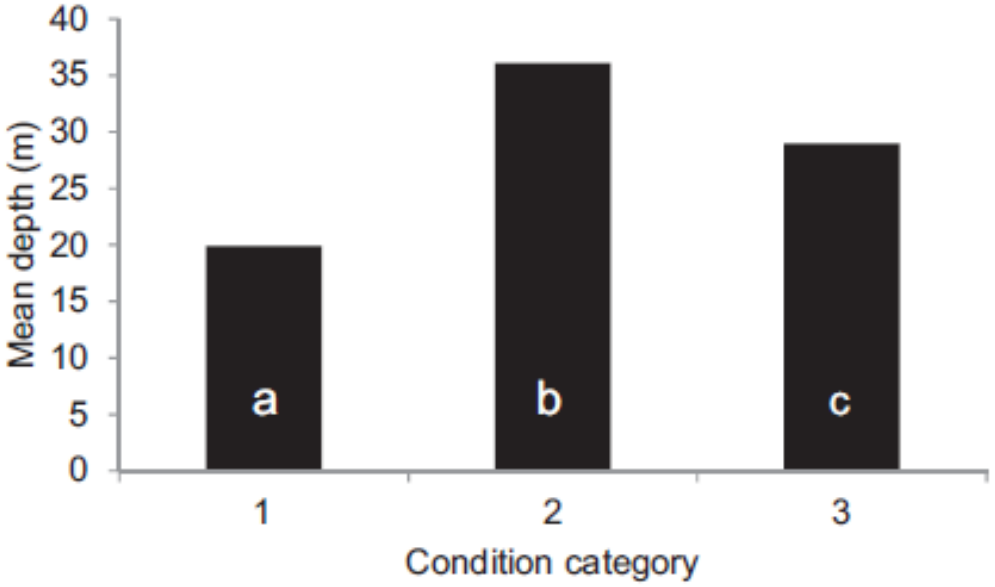
Gag Discard Impairments



Effects of Size, Depth

- Gags released in good condition (category 1) were:
  - Smaller (top graph)
  - Caught shallower (bottom graph)





Proportional Hazards Model

Forward selection	d.f.	Chi-square	*p*
Region	2	20.995	<0.0001
Month	11	20.895	0.035
Length	1	4.098	0.043
Length*month	11	24.301	0.012
Release condition	2	7.896	0.019

Relative Survival

Comparison	Hazard Ratio	95% CI	Chi-square	*p*
Fair (2) vs. Good (1)	0.664	0.47, 0.94	5.32	0.021
Poor (3) vs. Good (1)	0.506	0.26, 0.98	4.11	0.043
Fair (2) vs. Poor (3)	1.314	0.67, 2.59	0.62	0.430

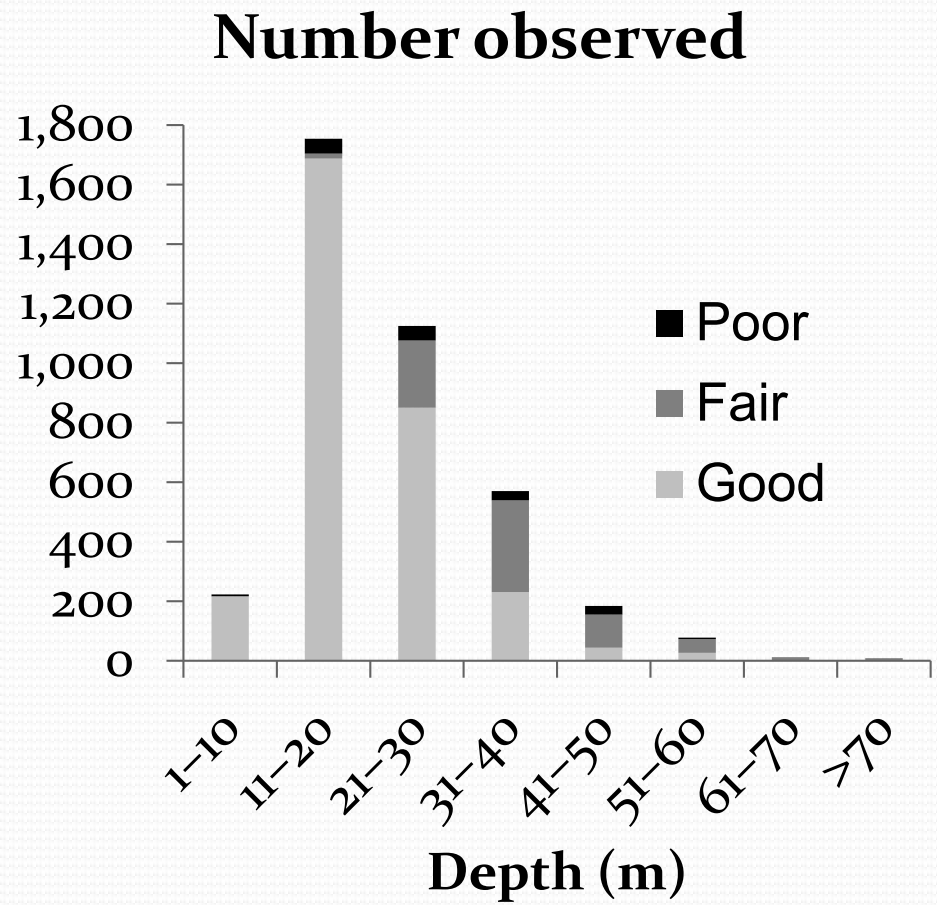
Depth-Dependent Discard Mortality

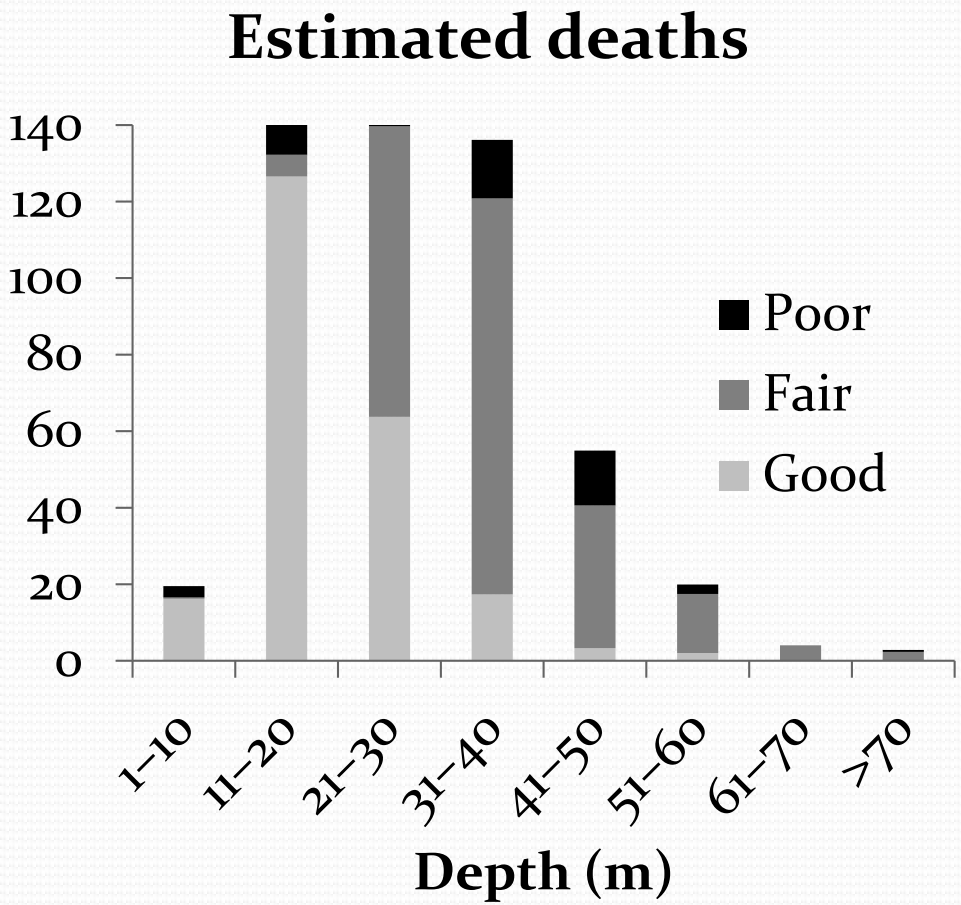
Depth (m)	Number Observed			Portion That Die (1-survival)			Total Deaths
	G	F	P	G	F	P	G+F+P
1-10	N1	N2	N3	M1= ?	M2= 1-0.66	M3= 1-0.51	(N1*M1)+(N2* M2)+(N3*M3)
11-20							
21-30							
31-40							
41-50							
51-60							
61-70							

Good Condition Group (M1)

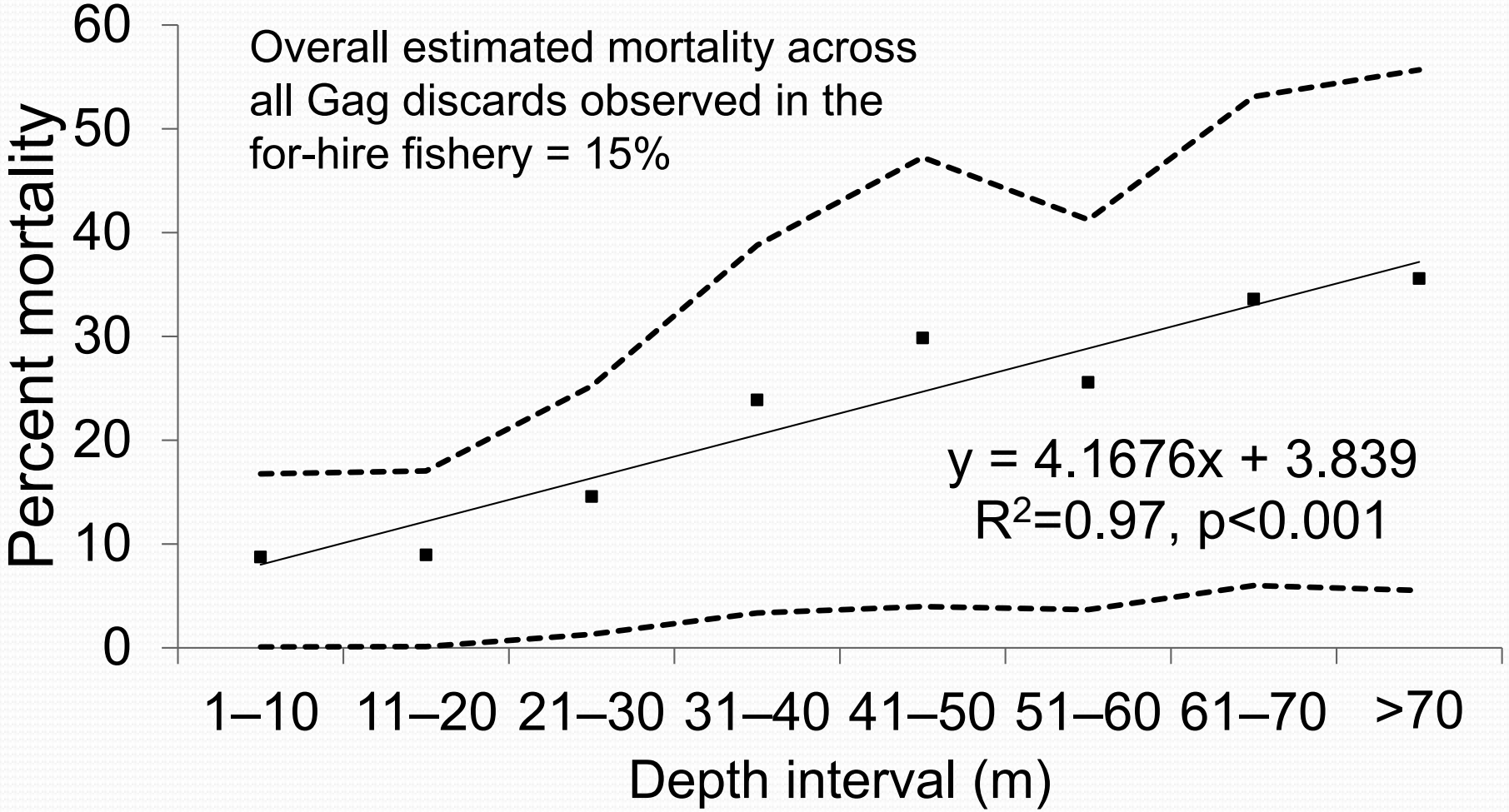
- No true control to use as reference for good condition category
- Assume mortality >0, expected to be low
  - Impaired fish excluded from good condition group
  - 79% released in depths ≤30 meters
- Assigned based on literature review
  - Point estimate = 7.5%
  - Upper and lower range of 0-15%

Depth-Dependent Discard Mortality





Depth-Dependent Discard Mortality



Conclusions

- Majority of gags:
  - Caught in <30m
  - Submerged without venting
  - Released in good condition
- For gags not released in good condition:
  - Caught in deeper depths
  - More frequently vented
- Discard mortality increased significantly with depth
  - Overall discard mortality lower than previous estimate from SEDAR 10

Future Work

- SRFS and for-hire at-sea observer programs granted recurring state funding in 2020
- Continued long-term monitoring allows us to:
  - Evaluate impacts of changes in fishing regulations
    - Increased harvest restrictions on gag
    - Longer red snapper seasons in state and federal waters
    - Increased use of descender devices
  - Provide additional data and analyses for assessments
    - Potentially update mark-recapture model to evaluate conservation benefits of increased descender device use
  - Continue researching differences between SRFS and MRIP and understand sources of bias

Thank you!

- For-Hire Industry
- Recreational Anglers
- FWRI Fisheries Dependent Monitoring

Funding and support:

USF UNIVERSITY OF SOUTH FLORIDA

NATIONAL FISH AND WILDLIFE FOUNDATION NFWF

GULF STATES MARINE FISHERIES COMMISSION

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

SPORT FISH RESTORATION

	A) Panhandle	B) Tampa Bay nearshore	C) Tampa Bay offshore	D) Big Bend
Numbers of fish tagged:				
Condition 1 (%)	294 (43.43)	2,435 (94.02)	180 (33.96)	146 (93.00)
Condition 2 (%)	355 (52.44)	83 (3.20)	287 (54.15)	3 (1.91)
Condition 3 (%)	28 (4.14)	72 (2.78)	63 (11.89)	8 (5.10)
Numbers of fish recaptured:				
Condition 1 (% tagged)	46 (15.65)	217 (8.91)	19 (10.56)	10 (6.85)
Condition 2 (% tagged)	42 (11.83)	4 (4.82)	26 (9.06)	0
Condition 3 (% tagged)	4 (14.29)	3 (4.17)	3 (4.76)	0
Mean length (mm midline)	522.65 ± 117.14 (a)	462.77 ± 87.49 (b)	584.98 ± 105.20 (c)	532.24 ± 82.99 (a)
Mean capture depth (m)	29.76 ± 7.44 (a)	18.18 ± 7.45 (b)	41.10 ± 10.97 (c)	20.60 ± 3.44 (b)
Number of trips:				
Single-day charter	99	127	-	-
Directed red snapper charter	72	-	-	7
Single-day headboat	47	129	-	-
Multi-day headboat	-	-	37	-

Private Boat Discards by Region and Area Fished