Estimating Discard Survival of Gray Triggerfish Using Surface and Bottom Tagging

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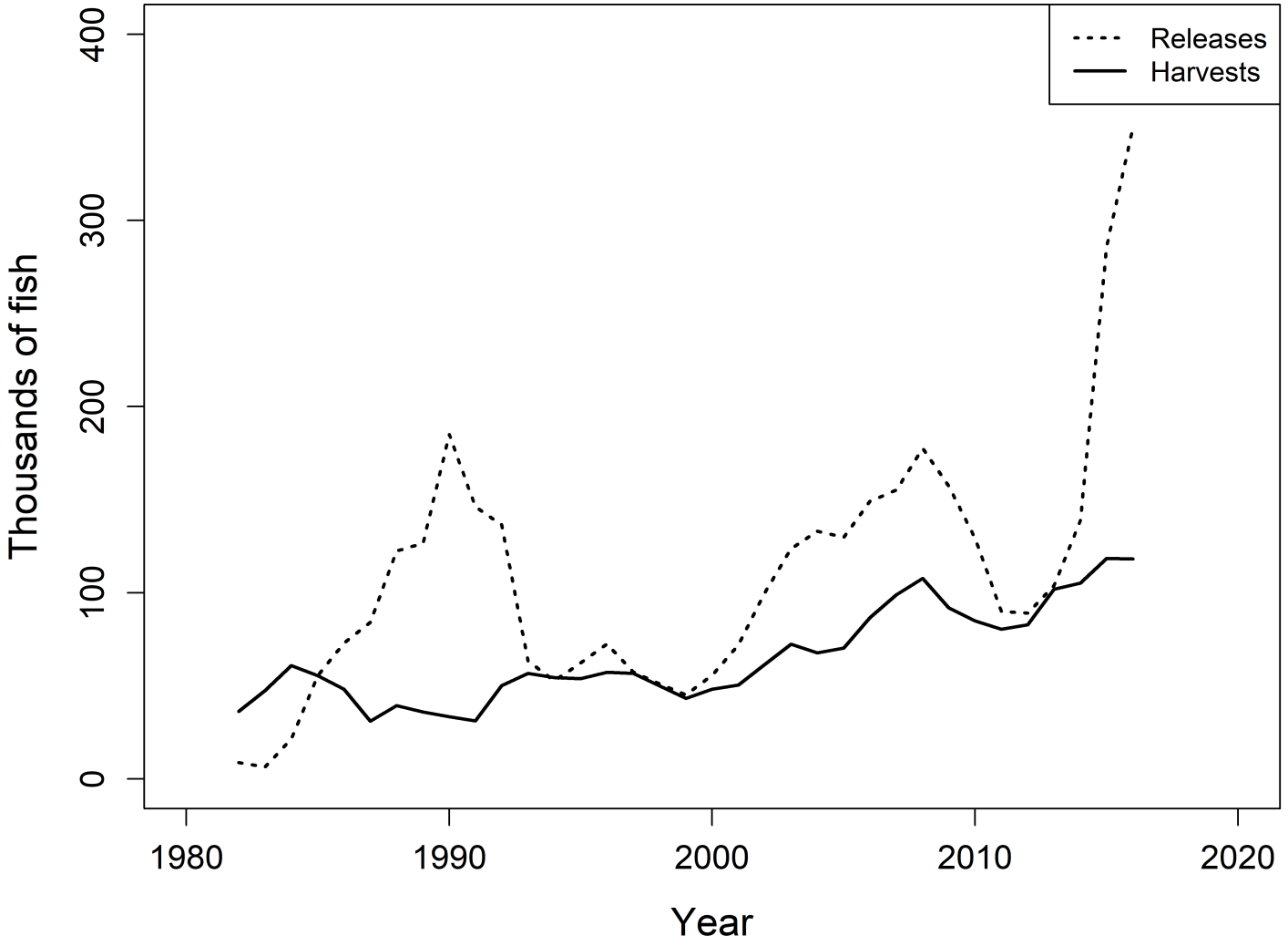
Gray triggerfish harvests and releases, US South Atlantic



Harmful effects of discarding – Gray triggerfish

Potential causes of injury → mortality

- Exhaustion or fatigue
- Hooking injury
- Exposure to air / thermal shock
- Water column predators

- **Barotrauma**

Immediate mortality is easier to estimate – severe injuries / floating

Delayed is difficult – sublethal injuries leading to a decrease in survival probability

- Better estimates needed for many species

Gray triggerfish discard survival

- High levels of discards mean discard survival is important for stock assessment
- 2016 stock assessment: discard mortality = 0.125 or **survival = 0.875**
  - No delayed mortality component

Source	Depths	Methods	n fish	Gear	Control?	Est. survival
Sauls et al. (2013)†	Broad; mean = 29 m	Observer data, condition proxy	797	HL	No	0.88
McCarthy (2013)†	Unreported	Logbooks, condition proxy	N/A	HL, trap	No	0.88
Rudershausen et al. (2010)†	29-37 m	Tagging, condition proxy	332	HL, trap	No	0.85
Collins (1996)†	21 m, 46-54 m	Condition proxy	6	HL	No	0.83
Stephen and Harris (2010)‡	20-80 m	Condition proxy	25	HL	No	0.07
Patterson et al. (2002)‡	21-32 m	Tagging, condition proxy	842	HL	No	1.00

†Gray literature; ‡Peer reviewed literature

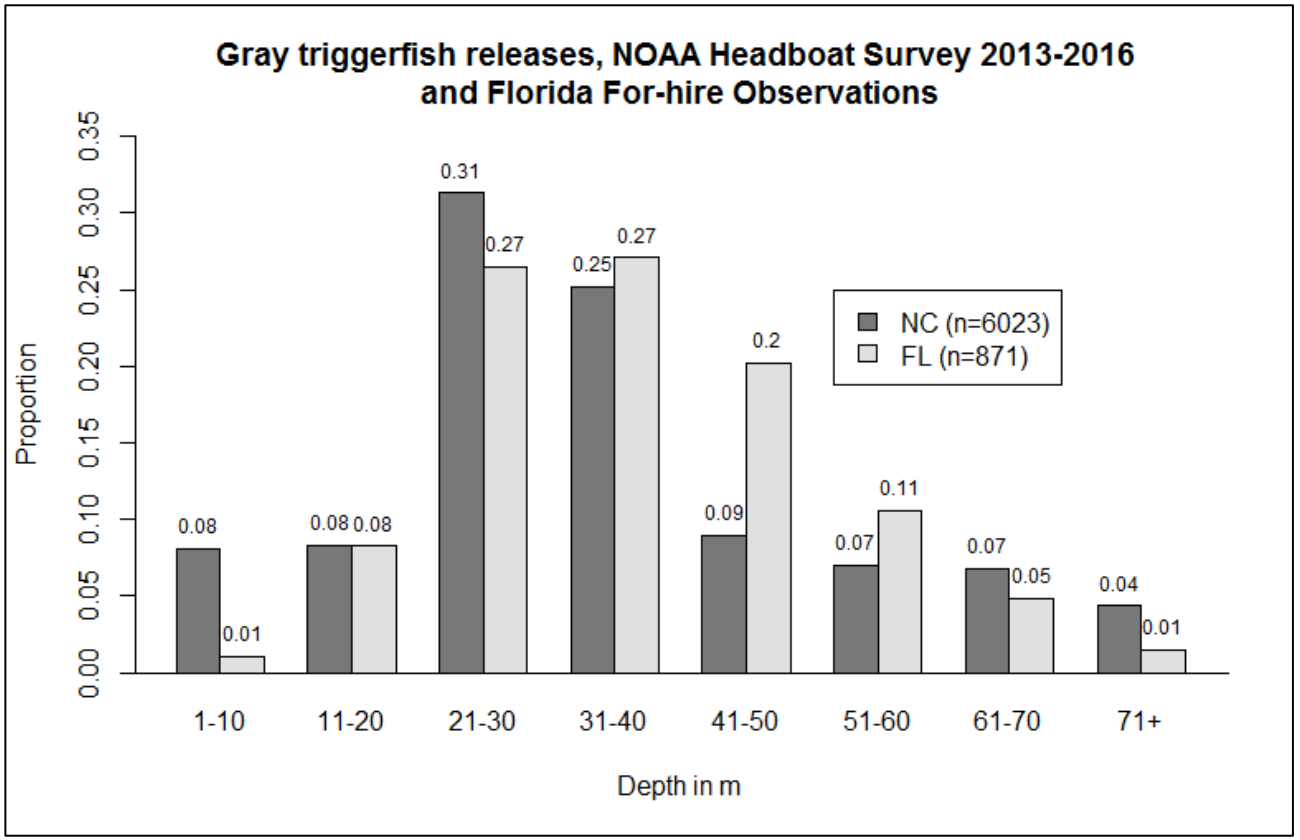
Study objectives

1: Determine condition-specific discard mortality (including delayed) of gray triggerfish using conventional tagging

2: Estimate fishery-dependent discard mortality by applying tagging results to observer data of untagged fish

Objective 1: Tagging study

- Gray triggerfish captured with hook-and-line and fish traps in 30m and 36-40m



NC data courtesy J. Hackney, NMFS

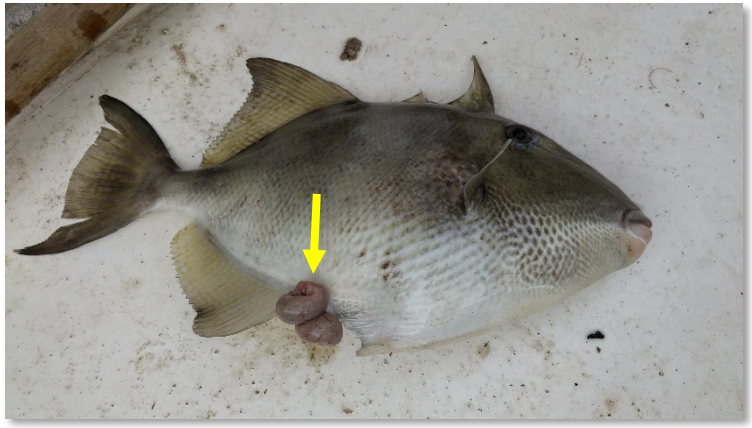
Tagging study: Methodology

- Tagged with Floy FM-95W internal anchor tags
- Categorized fish by condition at release

  Condition 1 - No visible trauma, swam down

  Condition 2 - Visible barotrauma, but swam down

  Condition 3 - Floated



Relative tag return rates inform mortality estimates

Most previous studies have assumed Condition 1 survival = 100%

Not a robust assumption – subclinical injuries

Need a robust control group!

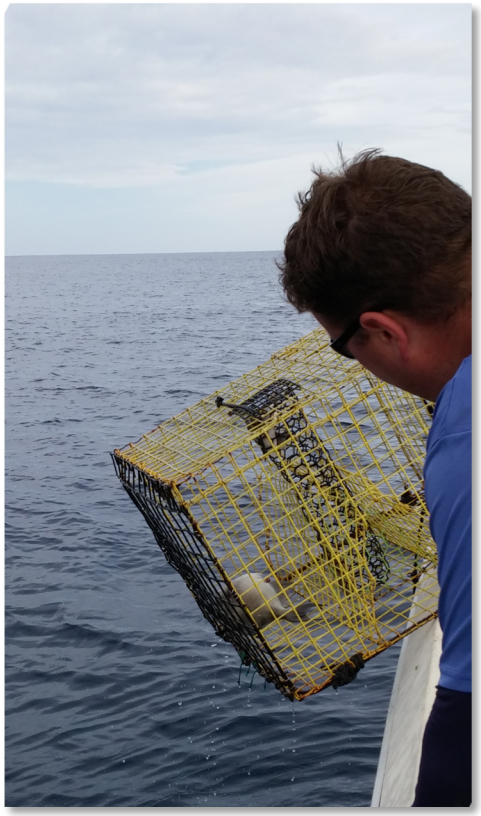
Establishing a robust control: seafloor tagging

Seafloor release

Control

Hislop and Hemmings 1971
Rudershausen et al. 2013

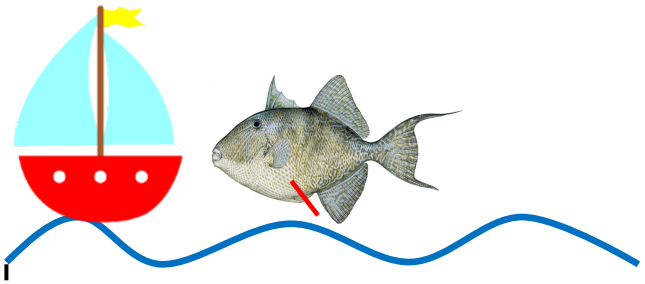
Surface release



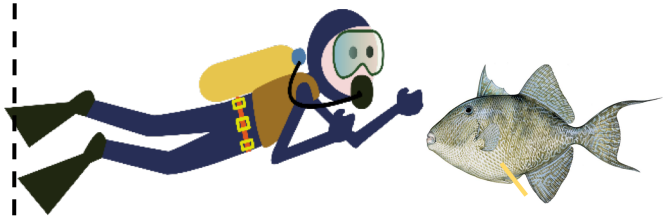
Photos: Personal, Steve Lombardo

Basic tagging example:

- 20 fish surface tagged (condition 1)



- 20 fish bottom tagged (SCUBA control)



- Location and time are equal – only difference is exposure to injury via capture
- Relatively few tag returns → low survival
- More tag returns → increased survival

Tag returns:

Condition 1

SCUBA control

Approximation:

$$Survival = \frac{{}^{6}/_{20}}{{}^{10}/_{20}} = \frac{0.3}{0.5} = 0.6 \; or \; 60\%$$

Photos: Wiki Commons, Illustration adapted from J. Hightower

Statistical methods

- Cox proportional hazards regression model
- Survival of an individual = hazard ratio at a given time
- Takes into account liberty period ($time_{recapture} - time_{tagged}$)
- Allows for estimation of the effect of covariates
  - Size
  - Gear
- Based on assumption that seafloor-tagged fish have 100% survival

Statistical methods: two model phases

Phase 1:
- Condition 1 vs. SCUBA Control = absolute

Phase 2:
- Condition 2 vs. Condition 1 = relative
- Condition 3 vs. Condition 1 = relative

(most tagging studies)

After scaling:
- Condition 1 vs. SCUBA Control = absolute
- Condition 2 vs. SCUBA Control = absolute
- Condition 3 vs. SCUBA Control = absolute

Tagging study results

30 m depth

Condition	2.5%	Est. Survival	97.5%
0. SCUBA control	------	***1.00***	------
1. No trauma at surface	0.26	**0.43**	0.73

36-40 m depth

Condition	2.5%	Est. Survival	97.5%
0. SCUBA control	------	***1.00***	------
1. No trauma at surface	0.10	**0.24**	0.61
2. Trauma, swam down	0.03	**0.18**	1.02
3. Floated	-	**-**	-

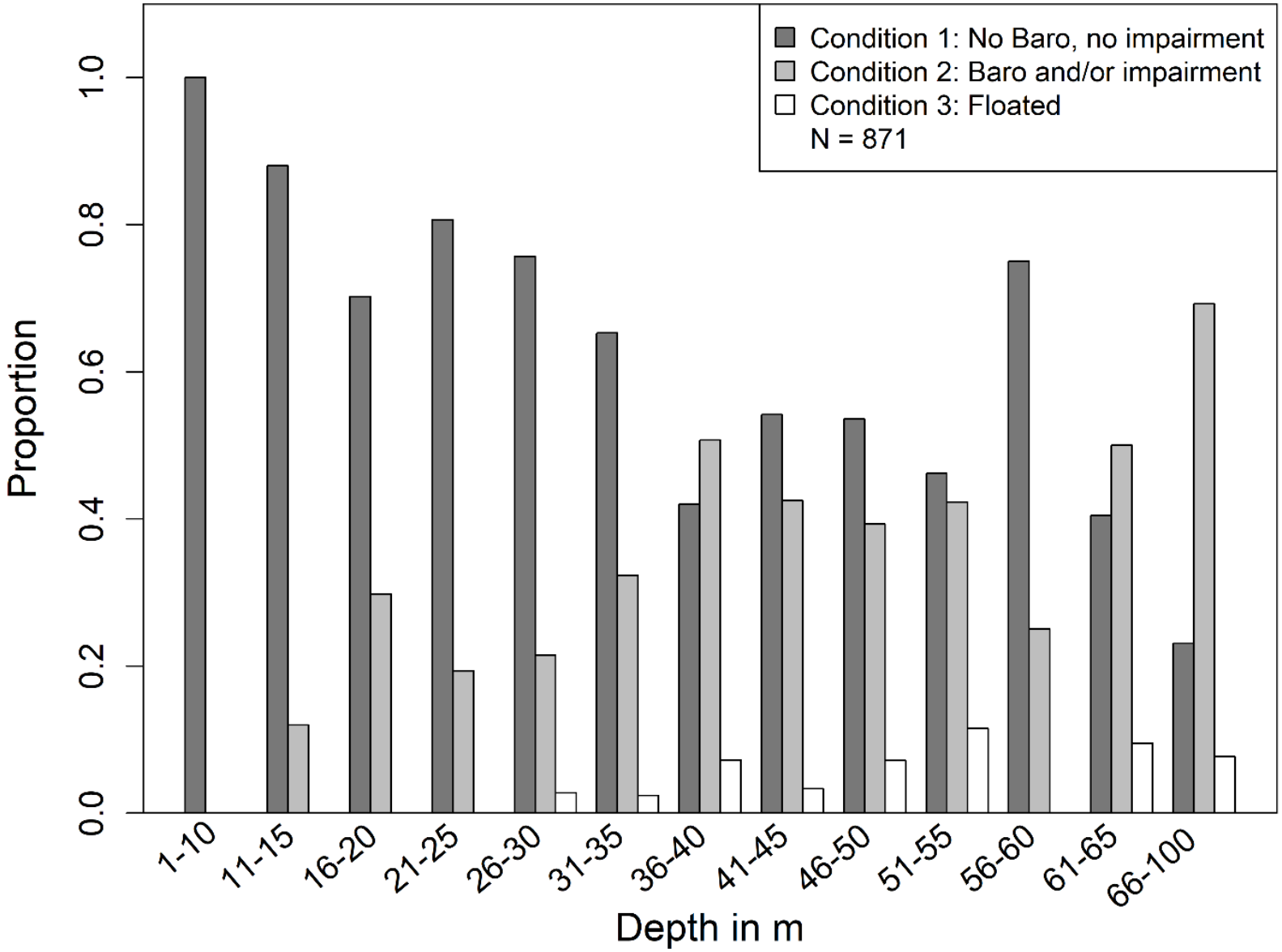
Floating fish: zero recaptures

Objective 2: Fishery dependent estimate

- Question: what proportion of released triggerfish are in each condition?

- Could use our own data, but tagging may alter the condition of fish
  - Incision ≈ venting

- Observer study from Atlantic Coast of Florida
  - Headboats and charter vessels
  - Detailed conditions of released triggerfish



Reference: Sauls, B., A. Gray, C. Wilson, and K. Fitzpatrick. 2015. SEDAR41-DW34. SEDAR, North Charleston, SC. 13 pp.

Extrapolated discard survival

30 m

Condition	Est. Surv 30 m	Proportion released in 30 m	Product
1. No trauma at surface	0.43	0.76	0.33
2. Trauma, swam down	0.32	0.22	0.07
3. Floated	0.00	0.02	0.00
Total survival in 30 m			**0.40**

36-40 m

Condition	Est. Surv 36-40 m	Proportion released in 36-40 m	Product
1. No trauma at surface	0.24	0.42	0.10
2. Trauma, swam down	0.18	0.51	0.09
3. Floated	0.00	0.07	0.00
Total survival in 36-40 m			**0.20**

Survival estimates across depths

Depth	0-25 m	26-30 m	31-35 m	36-40 m	41+ m
Estimated Survival	0.40-1.00[1]	0.40*	0.30[2]	0.20*	0.20[3]

- *Estimated empirically from tagging data; [1]Theoretical survival in 0-25 m ranges from 0.40-100; [2]interpolated based on empirical estimates in neighboring depth bins; [3]conservative estimate based on empirical estimate in 36-40 m.

In what depths are fish released?

- Observer data: overall number of releases by depth zone

Depth	0-25 m	26-30 m	31-35 m	36-40 m	41+ m
Estimated Survival	0.40-1.00[1]	0.40*	0.30[2]	0.20*	0.20[3]
North Carolina	0.01	0.19	0.25	0.15	0.40
Florida	0.24	0.12	0.19	0.08	0.37

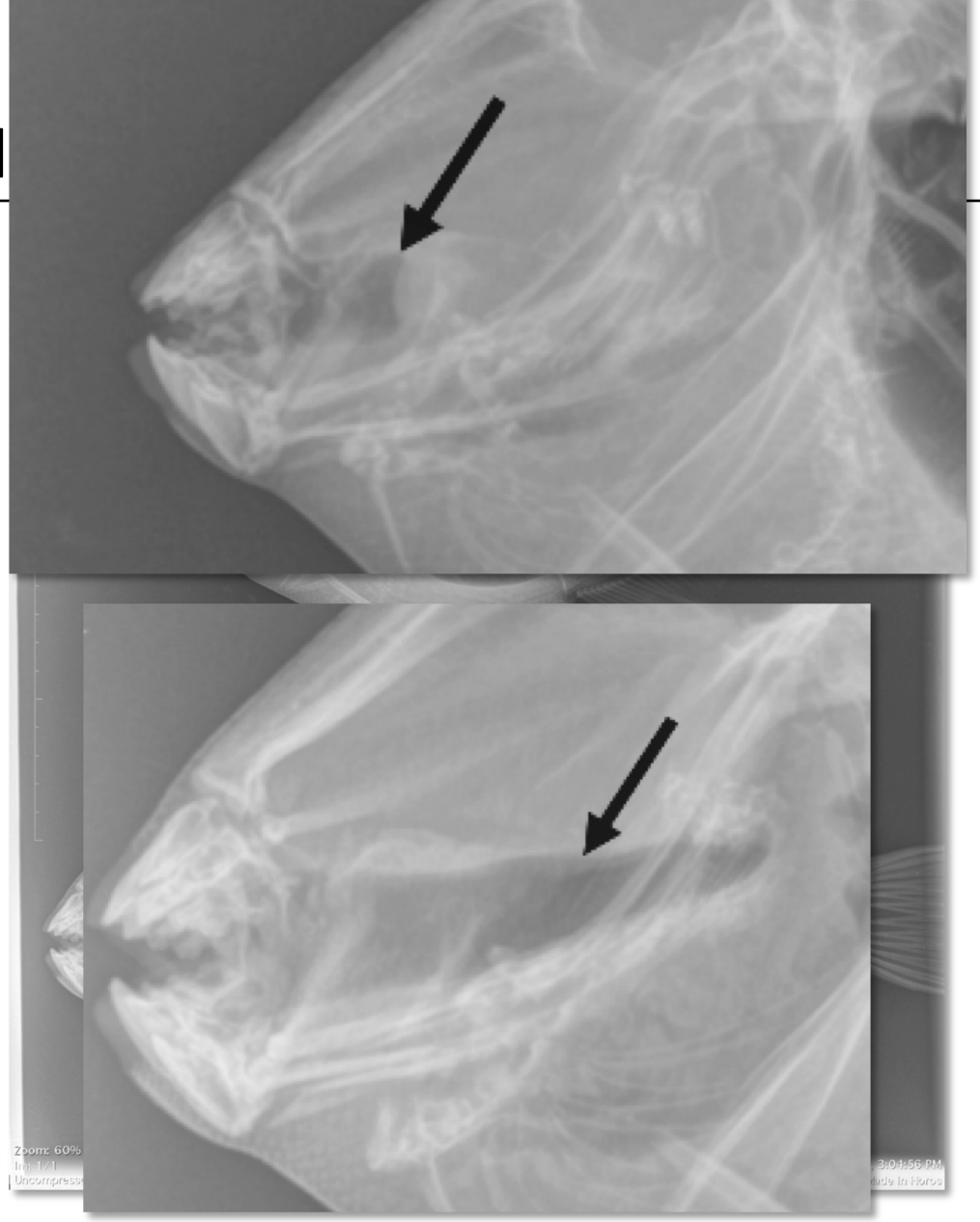
Overall survival estimates across depths and conditions

- North Carolina: 0.26-0.27
- Florida: 0.29-0.43

Conclusions

- SEDAR 41 used 0.875 survival for gray triggerfish
- We estimate survivals as:
  - North Carolina: 0.26-0.27
  - Florida: 0.29-0.43
- Similar work with black sea bass (Rudershausen et al. 2014) found much higher survival
- Low survival of gray triggerfish may merit revisiting of 12” size requirement

Potential



Radiograph: C. Harms


INCHES
1
2
LIVING
CULTURES
METRIC 1
2
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