Reducing Sturgeon Bycatch While Preserving Commercial Harvest: Two Approaches, Two Locations, One Species

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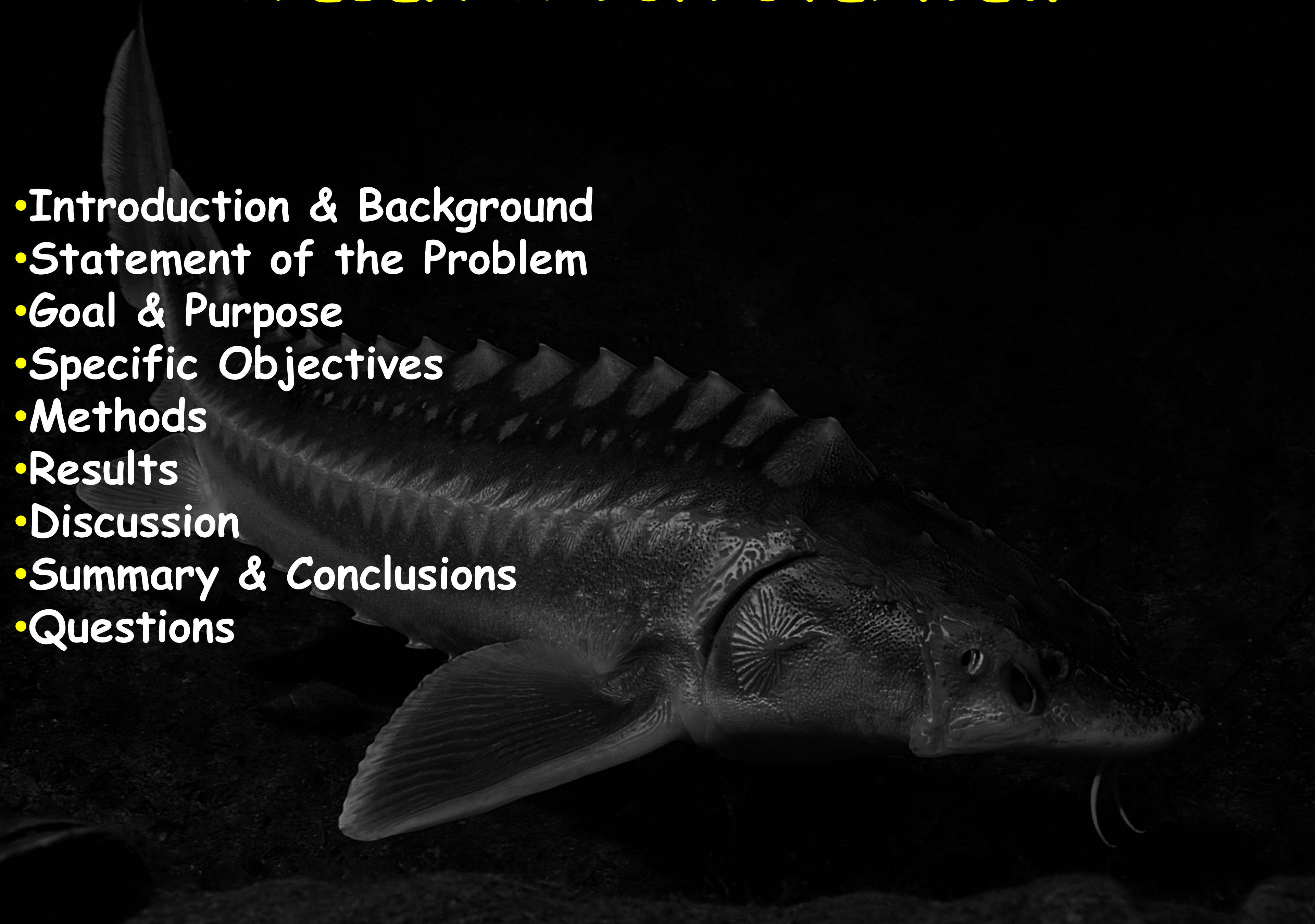
PRESENTATION OVERVIEW



- Introduction & Background
- Statement of the Problem
- Goal & Purpose
- Specific Objectives
- Methods
- Results
- Discussion
- Summary & Conclusions
- Questions

INTRODUCTION & BACKGROUND

- Bycatch is one of the greatest challenges for commercial fisheries and the fishery managers who are required to address bycatch issues (Magnuson-Stevens Act, ESA, and MMPA).

- Bycatch threatens the conservation, protection, and recovery of many protected species. Addressing the problem often causes drastic and harmful alterations to commercial fisheries and associated economics.

OVERVIEW OF BYCATCH PROBLEM

1) Many protected species are sensitive to small levels of mortality (Secor *et al.*, 2002).

2) Most protected species seasonal migrate in conjunction with commercial species (Lewison *et al.*, 2004). Overlapping <u>spatial</u> and <u>temporal</u> distributions increases the risk and often leads to elevated fishery interaction rates.

3) Often gear engineering is only effective in limited cases.

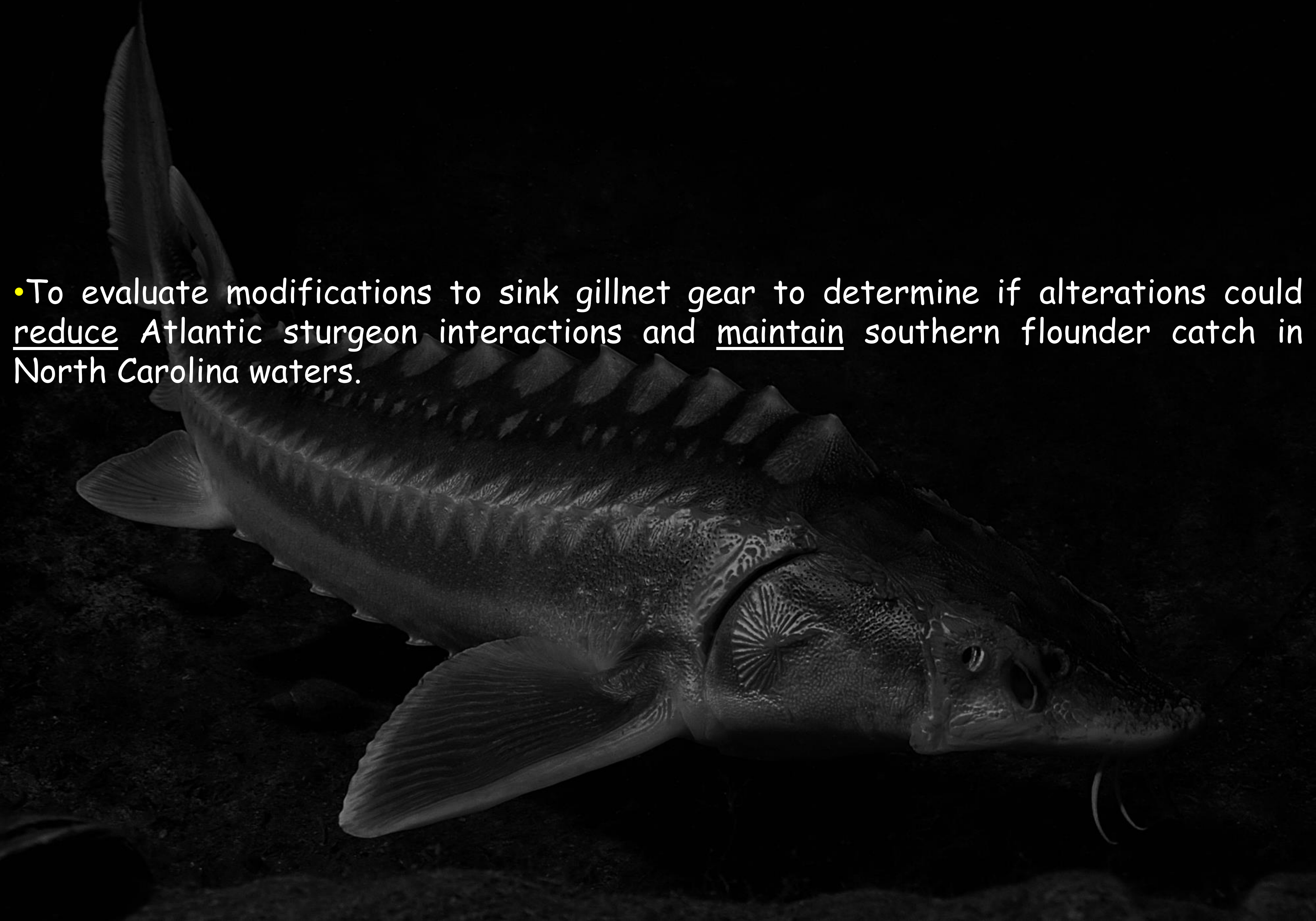
4) Despite management measures (time/area fishing closures, reductions in target quota, size-limits, fishing effort, and prohibition of specific fishing gear or fishing techniques [Harrington *et al.*, 2005]), fishery-interactions with protected species continue.

ATLANTIC STURGEON

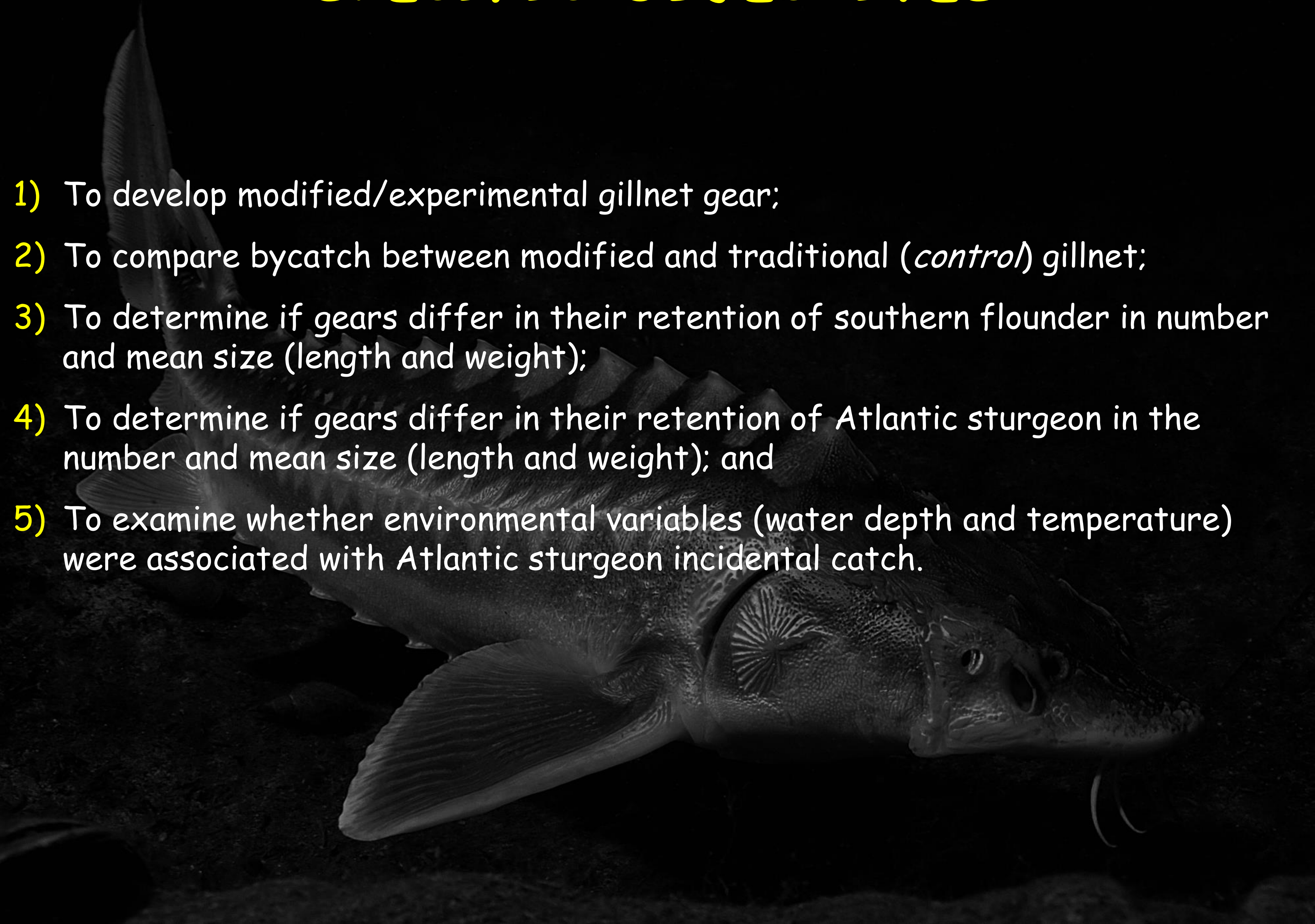
- Atlantic sturgeon populations were primarily impacted by commercial fisheries (1890s-1920s).
- Protected under the ESA in 2012, but Atlantic sturgeon bycatch continues.
- Atlantic sturgeon are particularly vulnerable to sink gillnet fisheries.
- In North Carolina, Atlantic sturgeon are incidentally captured in the southern flounder (*Paralichthys lethostigma*) fishery.

GOAL & PURPOSE

- To evaluate modifications to sink gillnet gear to determine if alterations could <u>reduce</u> Atlantic sturgeon interactions and <u>maintain</u> southern flounder catch in North Carolina waters.



SPECIFIC OBJECTIVES



1) To develop modified/experimental gillnet gear;
2) To compare bycatch between modified and traditional (*control*) gillnet;
3) To determine if gears differ in their retention of southern flounder in number and mean size (length and weight);
4) To determine if gears differ in their retention of Atlantic sturgeon in the number and mean size (length and weight); and
5) To examine whether environmental variables (water depth and temperature) were associated with Atlantic sturgeon incidental catch.

METHODS

Overview

1) Reviewed the literature
2) Selected the study area
3) Discussed and solicited ideas with commercial fishermen and researchers
4) Built a modified gillnet using a local experienced commercial fishermen
5) Designed our experiment
   i. Field and Statistical Approaches/Analyses
   ii. Data Collection

METHODS

Literature

Limited Literature and Data

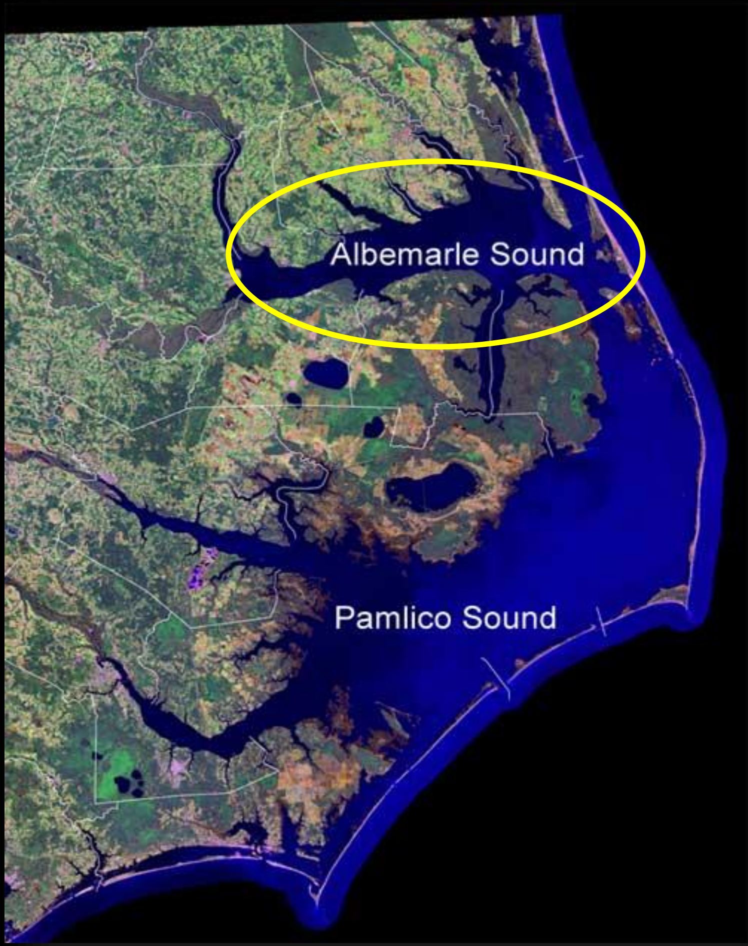
- Armstrong, 1999; White & Armstrong, 2000; Federal Register, 2012 (NCDMF data) reported Atlantic sturgeon interactions in the North Carolina southern flounder fishery.
    - Suggest 0-19% mortality in the Albemarle and Pamlico Sounds fisheries.
    - Encounter rates are variable, but could be high. White & Armstrong (2000) reported 131 Atlantic sturgeon were taken by <u>one</u> fisherman (1998-2000) targeting southern flounder in Albemarle Sound, NC.
    - NCDMF data (2001-2009) suggests a catch rate of 0.03 sturgeon/914 m of net/24 hour soak.

METHODS

Study Area

Albemarle Sound, North Carolina (USA)

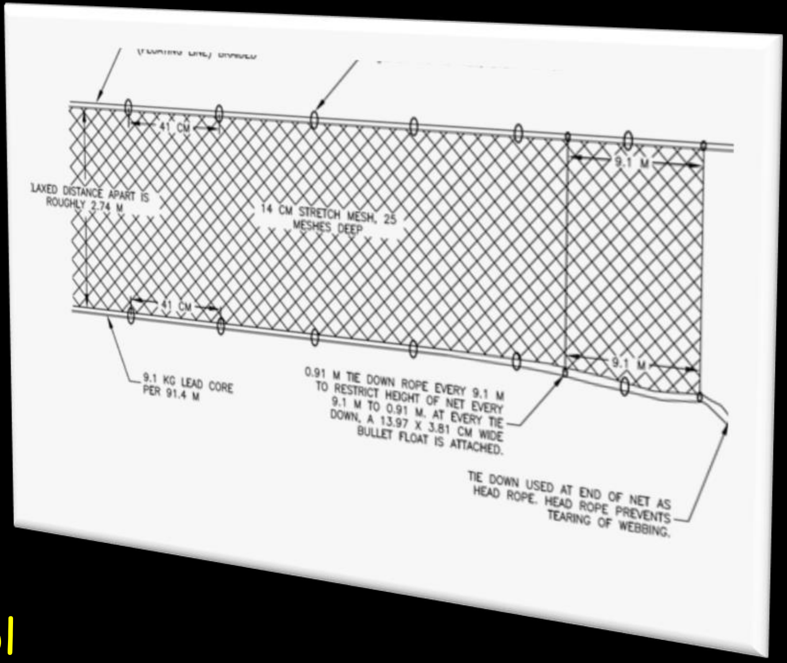
- To optimize the probability of encountering Atlantic sturgeon.
- The current fishery-interactions in the southern flounder fishery (Armstrong, 1999; White & Armstrong, 2000; FR, 2012a; FR, 2012b).
- At one time, the area (Roanoke River) supported the largest commercial fishery for Atlantic sturgeon (Kahnle *et al.*, 1998).



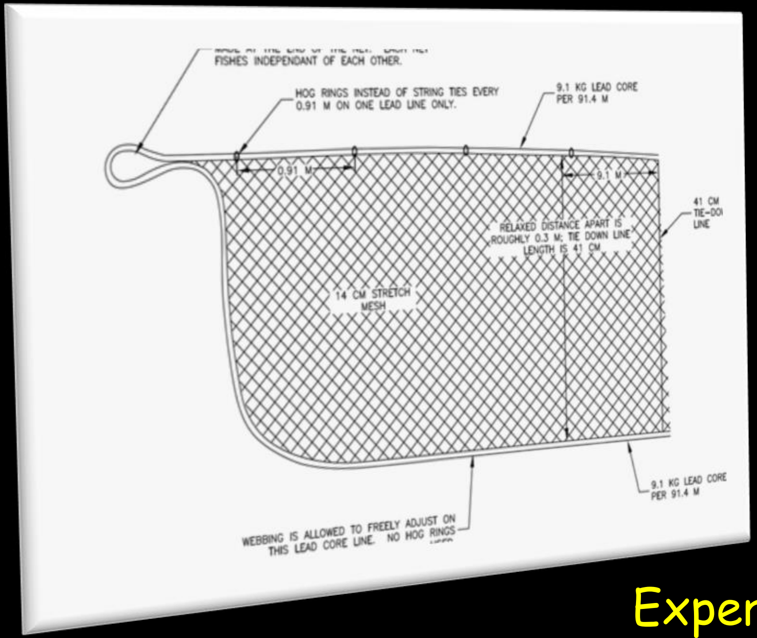
METHODS

Monofilament Gillnet

The monofilament gillnet was constructed with 30 equal length (91.4 m (100 yd)) panels or sections in a standard (legal) <u>length</u> of 2,743 m (3,000 yd) and <u>stretch-mesh</u> (14 cm). The net design configuration used an alternating pattern approach (15 control and 15 experimental sections); Match-pair Approach.



Control



Experimental

METHODS

Experimental Sections

- Webbing in the experimental section was hung between two leadlines (no floatline), which reduced the profile to 1-3 ft instead of 10 ft.
- The number of meshes was also reduced (10 less meshes; 75% less mono).
- Normal tie down strings that connect the float and lead lines on traditional nets were replaced with hog rings that connected both leadlines.

Control

Experimental

METHODS

Experimental Study Design

- Fishing effort mimicked the fishery; Season (Sept/Oct; April). Time (night); Soak Duration (24-hr).
- Using the McNemar Test (Power Curve) and incidental catch rates (NCDMF 2001-2009), we calculated that 70 sets could detect an 80% reduction in Atlantic sturgeon encounters.
- Matched pair design; randomly set gear near historical Atlantic sturgeon encounters and southern flounder catch.
- Alternated which section (control/experimental) was set first.
- Gear set by co-author (experienced fishery technician (ECU) and active NC commercial fishermen).
- Adaptive approach- The fishing location was based on daily catch rates (A. sturgeon and S. flounder) and discussions with other fishermen; this ensured statistical integrity (sample size).
- Standard data collected on catch (bycatch, target, and Atlantic sturgeon).
- Applied basic statistical tests (Paired t-test, ANOVA, KS and Chi-square tests, and non-parametric tests).

RESULTS

Sampling Effort & Environmental Conditions

•192.02 km (210,000 yds) of net; 1,615.87 hours.

•70 sets (1,050 matched pairs) were conducted during April-October (2014).

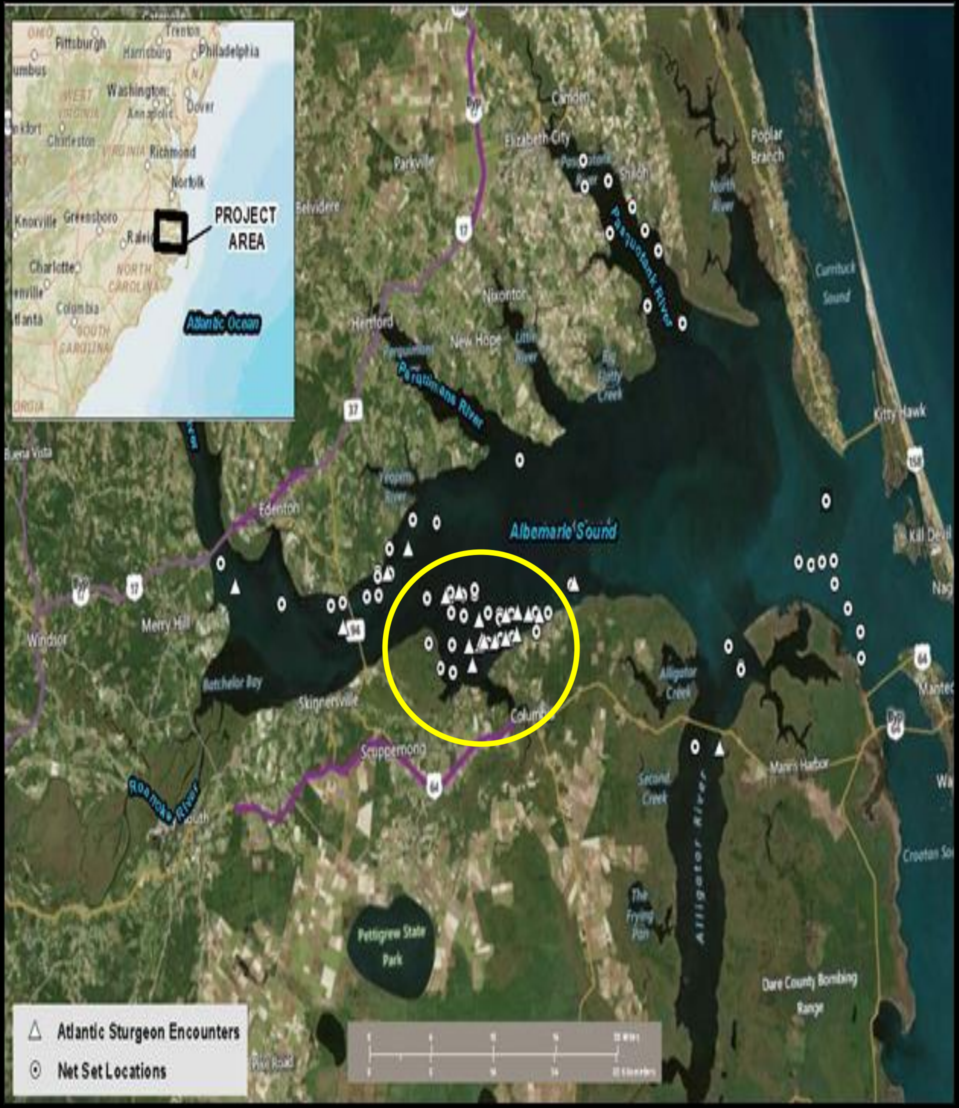
•Most sets (65.7%) conducted in October.

•Sets primarily associated with major river mouths.

•Average soak time was 23.1 hours.

•Water Temperature was 18.5-28.9°C; Water Depth was 0.7-7 m.

•Fishing conditions (wind & seas; average) mimicked the rest of the fishery.



RESULTS

Total Catch

8,234 individuals representing 28 species in Albemarle Sound from April to October, 2014. The total catch consisted of 3,891 bony fish (23 species), 4,303 Atlantic blue crab, 37 rays, 3 double-crested cormorants, and 2 Kemp's Ridley sea turtles.

Bycatch

- Control retained 7 more ($n = 27$) species than Experimental sections.
- Control retained more bycatch ($n = 4{,}316$, 62%) than Experimental ($n = 2{,}608$, 38%) sections ($t(922) = 6.06$; $p < 0.05$).
- Control retained more blue crab ($n = 2{,}653$, 62% vs $n = 1{,}650$, 54%), Atlantic menhaden ($n = 1{,}307$, 64% *vs* $n = 739$, 24%) than Experimental sections.
- Control retained more (9.9%) bony fish than Experimental sections ($t(922) = 6.06$; $p < 0.05$).

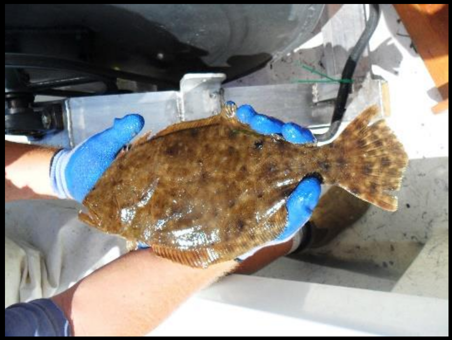



RESULTS

Target Catch (Southern Flounder)

- 1,310 (845.5 kg) southern flounder.
- Experimental (*n* = 427, 33%) sections retained 51.6% (*n* = 456) less southern flounder than Control (*n* = 883, 67%) sections ($t(924) = 11.25$; $p < 0.01$).
- By weight, catch in Experimental (285.9 kg, 32%) sections was also significantly ($t(924) = 12.35$; $p < 0.01$) lower than Control sections (559.6 kg, 66%).
- CPUE in Control (044.9 southern flounder per hour, x = 0.64 southern flounder per hour) exceeded Experimental (0-21.8 southern flounder per hour with a mean of 0.31 southern flounder per hour) sections ($t(923) = 11.18$; $p < 0.01$).
- Both designs retained individuals with a similar mean weight ($t(819) = 0.72$; $p = 0.47$), but Control entangled longer individuals ($t(69) = -2.13$; $p = 0.03$).
- Length and weight distribution comparisons, indicated distributions in Experimental were slightly skewed toward heavier (KS test, $D = 3.09$; $p < 0.05$) and longer (KS test, $D = 1.88$; $p = 0.002$) southern flounder.

The corresponding economics indicated the southern flounder landings with the experimental sections were $1,341 lower than the control sections.

RESULTS

Protected Species

Thirty-seven individuals representing three protected species (Atlantic sturgeon (n = 32), double-crested cormorant (n = 3), and Kemp's ridley sea turtle (n = 2)) were incidentally encountered during the study; all protected species were released alive. No mortalities.

Atlantic Sturgeon

- Seventy-two percent (n = 23) of Atlantic sturgeon were entangled in the Control sections, while 28% (n = 9) were entangled in the Experimental.

- Experimental sections entangled 60.9% (n = 14) fewer Atlantic sturgeon than the Control (Wilcoxon signed-rank test, Z = 2.06; p = 0.04; 2 [1, 32] = 45.8; $p < 0.001$). Difference between net designs was significant ($p < 0.05$; power > 80%).

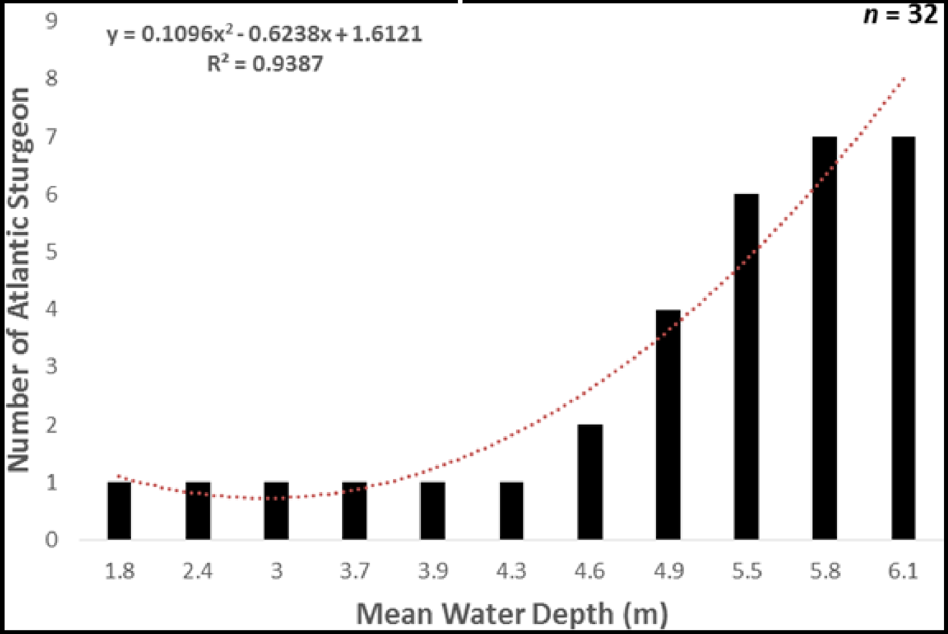
- Mean encounter CPUE (0-0.1988 Atlantic sturgeon per hour, x = 0.0151 Atlantic sturgeon per hour) in the Control sections was greater than the Experimental section (t (68) = 2.19; p = 0.03).




RESULTS

Atlantic Sturgeon

- Experimental sections entangled Atlantic sturgeon with a similar length (Wilcoxon signed-rank test, Z = 82:0; p = 0.67) and weight (Wilcoxon signed-rank test, Z = 59.0; p = 0.38) as the Control sections;
- Length (χ^2 = 0:58; $p > 0.05$) and weight (χ^2 = 0.39; $p > 0.05$) distributions were similar between the net sections.
- No significant difference was found in the number of Atlantic sturgeon encountered among net sections; entanglement location (H = 24.9; p = 0.68).
- More Atlantic sturgeon were incidentally encountered in deeper than shallower waters (χ^2 [3,32] = 25.2; $p < 0.01$). Twenty-four (62.5%) Atlantic sturgeon were incidentally encountered at a water depth between 5.1 and 6.3 m.



DISCUSSION

Protected Species (Atlantic Sturgeon)

Literature is limited, especially bycatch reduction studies, which makes comparison difficult given diverse target species and fishing gears; however, important points are the following:

- ✓ Sample Size (Effort and Encounters); Statistical Power; Balance (sturgeon/target species) is essential
- ✓ Experimental Bias (He & Jones, 2013 found difference between vessels)
- ✓ Morphometric Differences (e.g. we encountered larger individuals than White & Armstrong (2000), which is potentially better-higher post-release survival rates)
- ✓ Fishing Encounters can change (e.g. we did not encounter any individuals after 30 Sept unlike White & Armstrong, 2000); movement/behavior important considerations (Musick & Hager 2007; Hager, 2011)

Target Catch (Southern Flounder)

- ✓ Catch (weight and size); 51.6% fewer (48.9% loss in total weight); reduction in target catch similar to others (Fox *et al.*, 2011; He & Jones, 2013)
- ✓ Bycatch (other species)
- ✓ Economic Considerations (What are the limits?) Must find a balance between conservation and economics

Fishing Gear

- ✓ Considerably more time/effort (spin-ups); Durability (additional costs)

CONCLUSIONS & SUMMARY

- Engineering solutions are possible for reducing Atlantic sturgeon fishery interactions, but modifications need to be fishery and location specific (Hager, 2011). *Statistical power is essential when testing new gear/ideas.*

- We believe additional gear refining is necessary before commercial fishermen will support changing their traditional gear and tactics, especially if the transition to modified gear requires more maintenance.

- We mainly conducted the study in September to coincide with peak southern flounder fishing effort, but based on our limited fishing effort and associated catch (Atlantic sturgeon and southern flounder) in April, we recommend additional sets be conducted in the spring to further validate our results.

- The results showed that more Atlantic sturgeon were incidentally encountered in deeper waters while more southern flounder were taken in slightly shallower waters. Therefore, we recommend additional research to investigate catch associated with depth.

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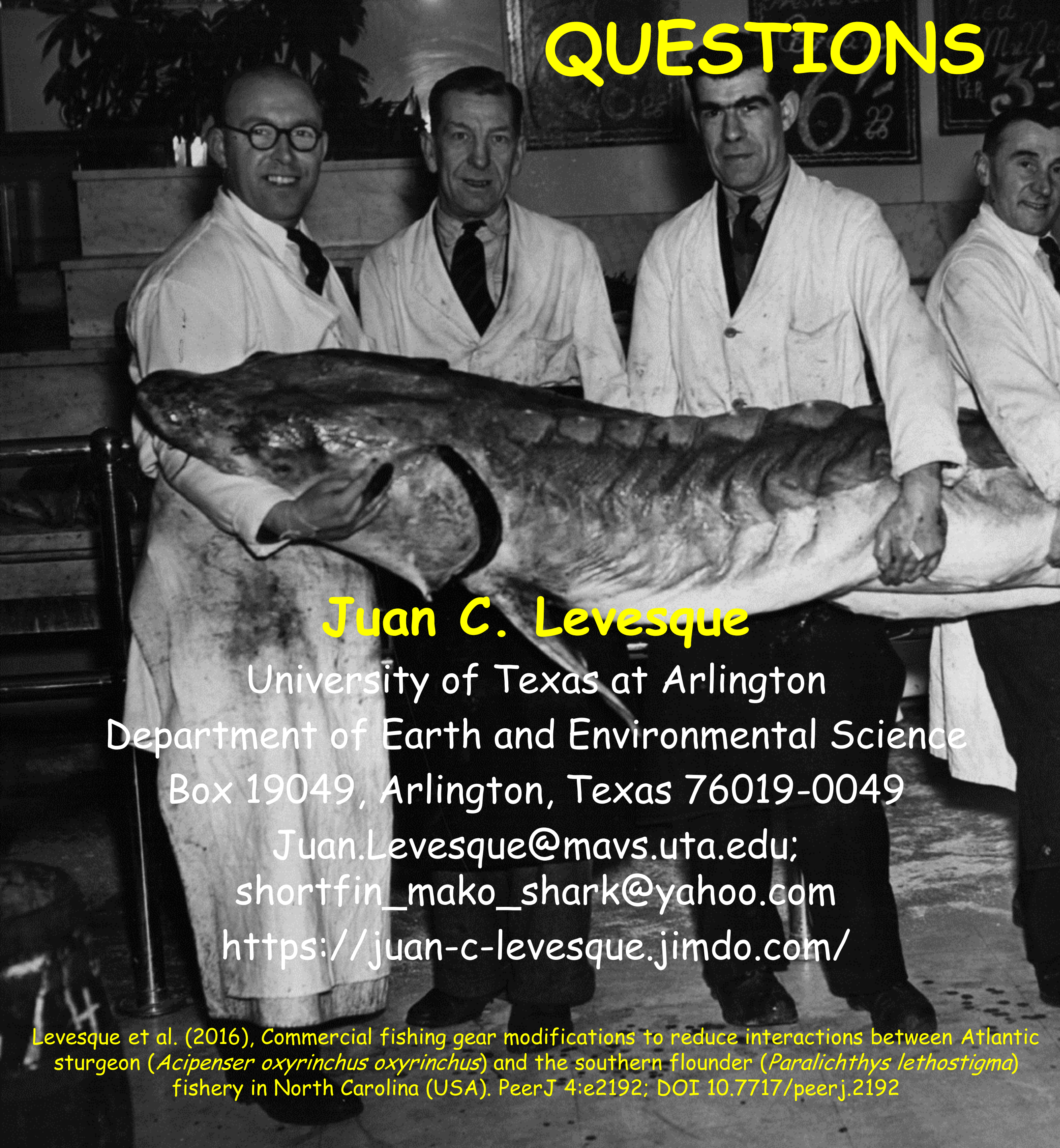
QUESTIONS



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PeerJ

Commercial fishing gear modifications to reduce interactions between Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and the southern flounder (*Paralichthys lethostigma*) fishery in North Carolina (USA)

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ABSTRACT

Bycatch of protected species in commercial fishing operations is a primary concern to fishery managers because it threatens the conservation, protection, and recovery of fragile species, such as the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). One potential solution to reduce the risk associated with commercial fishing operations is to design commercial fishing gear that is more selective in terms of interactions between Atlantic sturgeon and commercial fisheries. Given this conservation and management need, the overarching goal was to reduce Atlantic sturgeon fishery interactions and maintain southern flounder (*Paralichthys lethostigma*) catch in North Carolina. The specific objectives of this study were to design and evaluate the effectiveness of a modified gillnet. Overall, the results proved that lowering the profile and amount of webbing had a beneficial impact at reducing Atlantic sturgeon incidental encounters and bycatch. The modified gillnet reduced bycatch and Atlantic sturgeon encounters by 39.6% and 60.9%, respectively. Our design entangled 51.6% fewer southern flounder, which corresponded to a 48.9% reduction in total weight; the modified gear entangled slightly larger southern flounder than the control gear. Our findings showed the number of Atlantic sturgeon encounters was positively associated with mean water depth, with more Atlantic sturgeon encountered in deeper (5.1–6.3 m) than shallower waters; 75% were encountered at depths between 4.6 and 6.1 m. Most southern flounder ($n = 518$, 39.7%) were taken at a water depth between 3.76 and 5.0 m. This observation suggests that southern flounder prefer slightly shallower waters than Atlantic sturgeon.

Subjects Aquaculture, Fisheries and Fish Science, Conservation Biology, Marine Biology

Keywords Bycatch, Commercial fisheries, Fishery interactions, Protected species

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