"Weak hook" Research: Results and Next Steps

David W. Kerstetter, Ph.D.

Nova Southeastern University Oceanographic Center

Consortium for Wildlife Bycatch Reduction,
New England Aquarium

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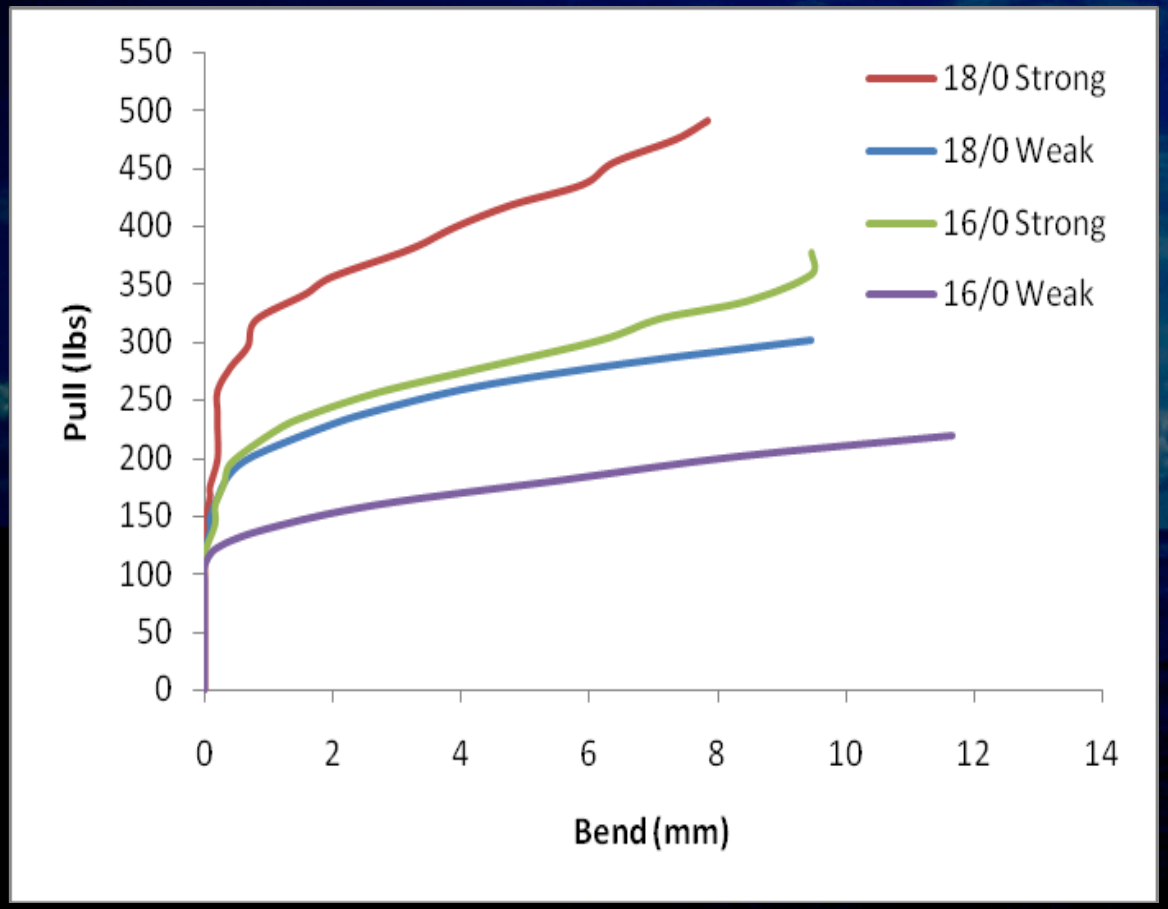
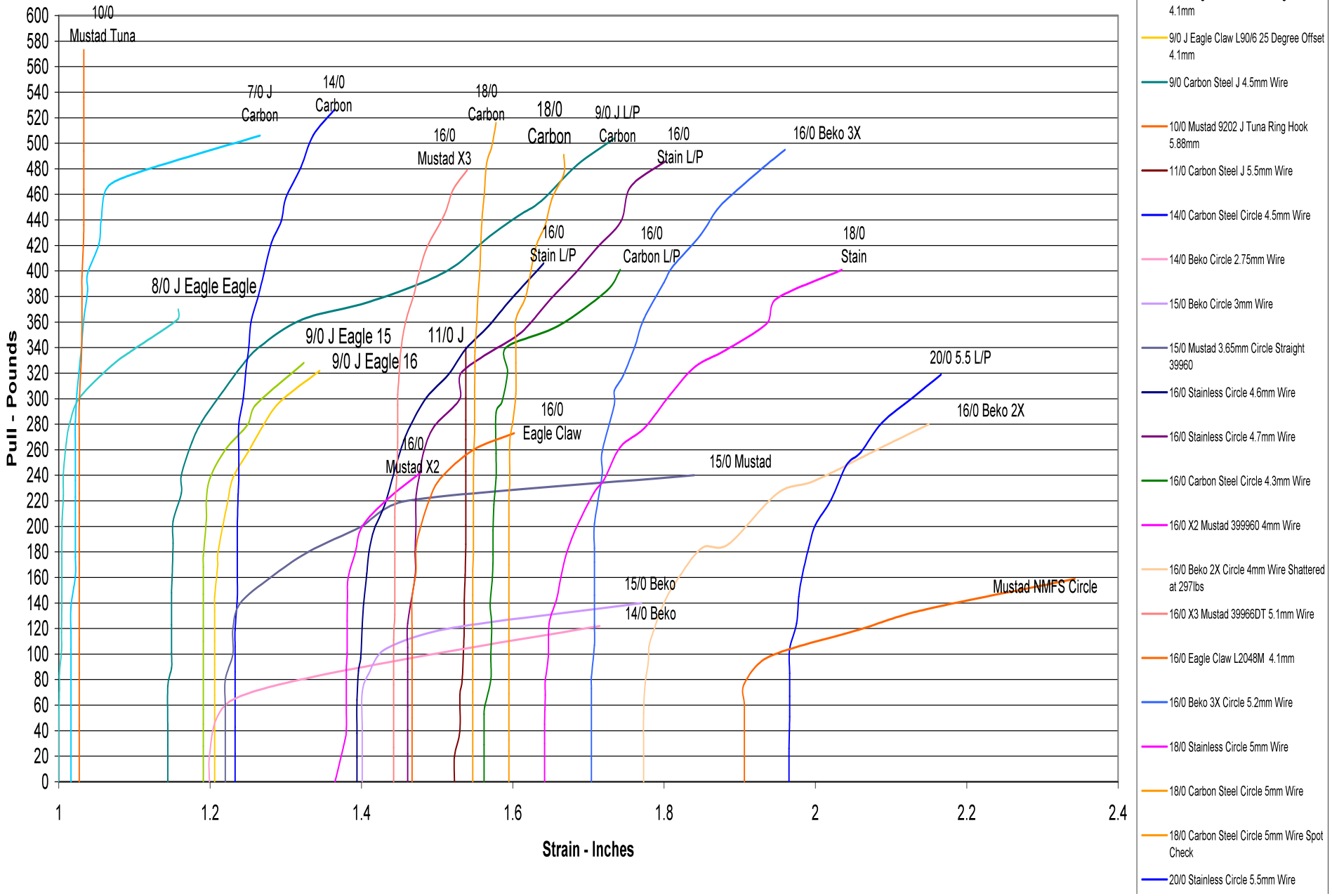
Hook strength… ?



Hook Pull vs Strain

Note The X axis represents the measurment of the hook between the tip and shank after being pulled to the listed pounds on the Y axis



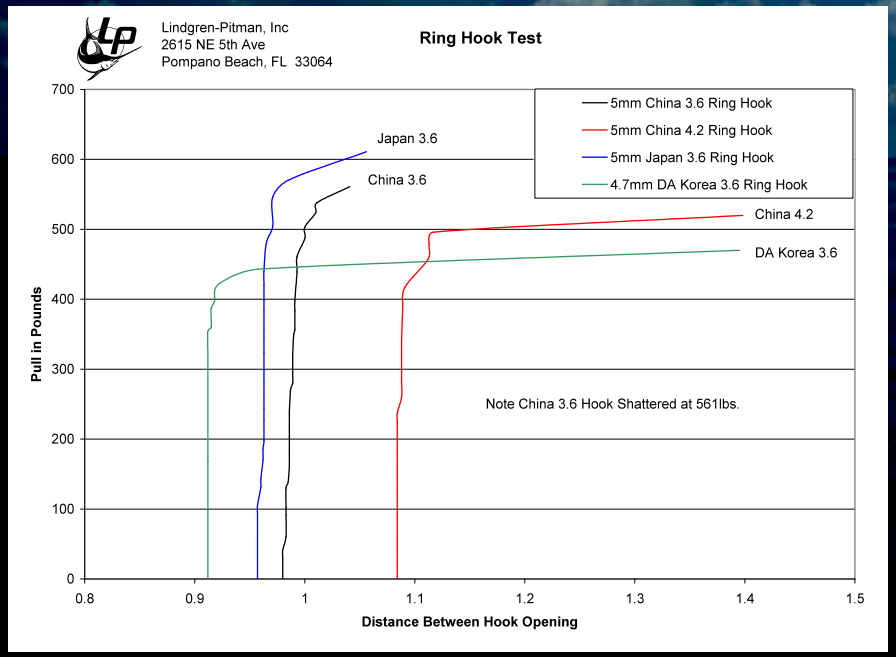
- 7.0 Carbon Steel J 4.5mm Wire
- 8/0 J Eagle Claw L90/5 25 Degree Offset 4.1mm
- 9/0 J Eagle Claw L90/5 25 Degree Offset 4.1mm
- 9/0 J Eagle Claw L90/6 25 Degree Offset 4.1mm
- 9/0 Carbon Steel J 4.5mm Wire
- 10/0 Mustad 9202 J Tuna Ring Hook 5.88mm
- 11/0 Carbon Steel J 5.5mm Wire
- 14/0 Carbon Steel Circle 4.5mm Wire
- 14/0 Beko Circle 2.75mm Wire
- 15/0 Beko Circle 3mm Wire
- 15/0 Mustad 3.65mm Circle Straight 39960
- 16/0 Stainless Circle 4.6mm Wire
- 16/0 Stainless Circle 4.7mm Wire
- 16/0 Carbon Steel Circle 4.3mm Wire
- 16/0 X2 Mustad 399960 4mm Wire
- 16/0 Beko 2X Circle 4mm Wire Shattered at 297lbs
- 16/0 X3 Mustad 39966DT 5.1mm Wire
- 16/0 Eagle Claw L2048M 4.1mm
- 16/0 Beko 3X Circle 5.2mm Wire
- 18/0 Stainless Circle 5mm Wire
- 18/0 Carbon Steel Circle 5mm Wire
- 18/0 Carbon Steel Circle 5mm Wire Spot Check
- 20/0 Stainless Circle 5.5mm Wire

Hook strength… ?

Percent of average "fail" strength

Total pull strength range

	Initial Conditions			Avg.			
	Wire dimensions	Hook gape	No. tested	"Fail" Strength	"Fail" Range		
3.6 Japanese ringed tuna hook by Japanese manufacturer	5.0mm dia.	23.0mm	3	564 lbs	512-600	88	0.16
3.6 Japanese ringed tuna hook by Korean manufacturer	4.8mm dia.	23.4mm	3	457	450-462	12	0.03
18/0 Korean SS circle hook with a welded SS ring (swordfish)	5.3mm dia.	23.3mm	6	383	364-400	36	0.09
15/0 Korean SS circle hook with an eye	3.7x 4.5mm	22.0mm	3	311	290-324	34	0.11
15/0 Korean SS circle hook with a welded SS ring; Hi-Fishing brand	4.5mm dia.	25.0mm	3	303	300-310	10	0.03
15/0 Korean forged SS circle hook with a welded SS ring; OPI brand	3.7 x 4.7mm	24.0mm	3	315	306-324	18	0.06
15/0 Mustad galvanized steel hook with an eye	3.6mm dia.	18.0mm	3	188	176-196	20	0.11



1) experimental size 16/0 Mustad 39988D at ~100 lb/45 kg (C. Bergman, NOAA Fisheries);
2) stock size 18/0 Mustad 39960, at ~225 lb/102 kg (Bayse and Kerstetter, 2010); and
3) experimental size 18/0 Mustad 39960 model made with the 5.0 mm (size 16/0) wire rather than the standard 5.2 mm wire, which should straighten out at between ~150-200 lb/68-91 kg (J. Pierce, O. Mustad & Son A.S.)

"Please note that all the 15/0 SS circle hooks tested had similar 'fail' ranges while the Mustad 15/0 would not be acceptable in our fishery because it is so weak…"

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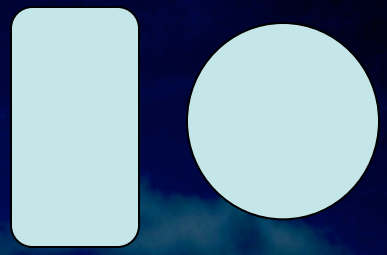
Hook strength… ?



- Actually very few “good” metrics for comparisons of hook model strength:
  - Different definitions of “open”; different pull methods
  - Hook cross-section shape likely more important than wire gauge (shearing vs. bending with force)
  - J-style vs. “circle” vs. tuna hook models all different, also when ring/directional snelling is added
  - Hook model numbers (if available!) rarely reported

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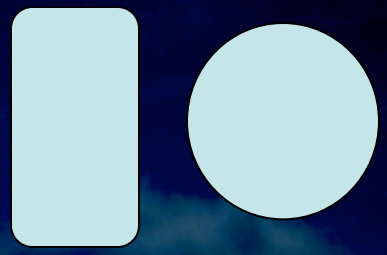

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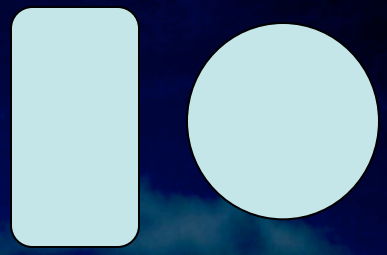

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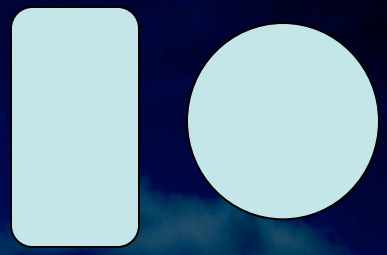

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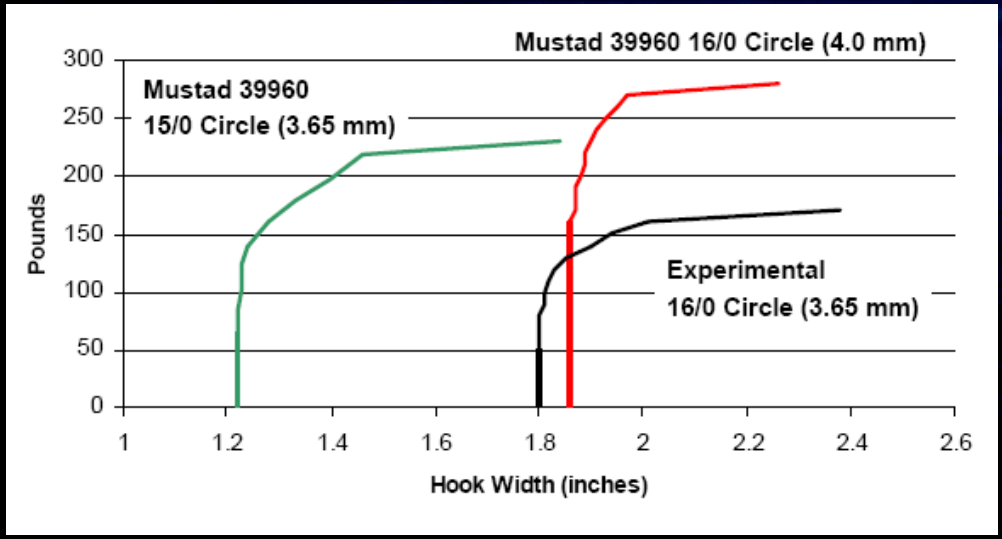
- Largest problem is that we have little idea (theoretically, and NO idea experimentally) what force is required from within the water to cause hooks to "open" – pull strength =/≠ animal size?
- Most important aspect to "opening" is likely direction of pull, affected by hook attachment and hooking location on the animal

Main “weak hook” studies:

- Only two studies completed to date, and only one has been published:
  - Gulf of Mexico YFT – JUST ENDED
  - North Carolina YFT and South Carolina SWO
  - North Carolina YFT (Part II) – IN PROGRESS
  - Hawai’I DSLL – IN PROGRESS
- However, all studies have used the same alternating-hook methodology (see Falterman and Graves 2002; Watson et al. 2005; Kerstetter and Graves 2006; Kim et al. 2006)

Gulf of Mexico YFT Research

- Run by NOAA Fisheries SEFSC Pascagoula Lab (Foster and Bergman)
- Designed to test reduction in BFT bycatch from northern GOM YFT fishery
- Used two different gauges of same 16/0 circle hook model:



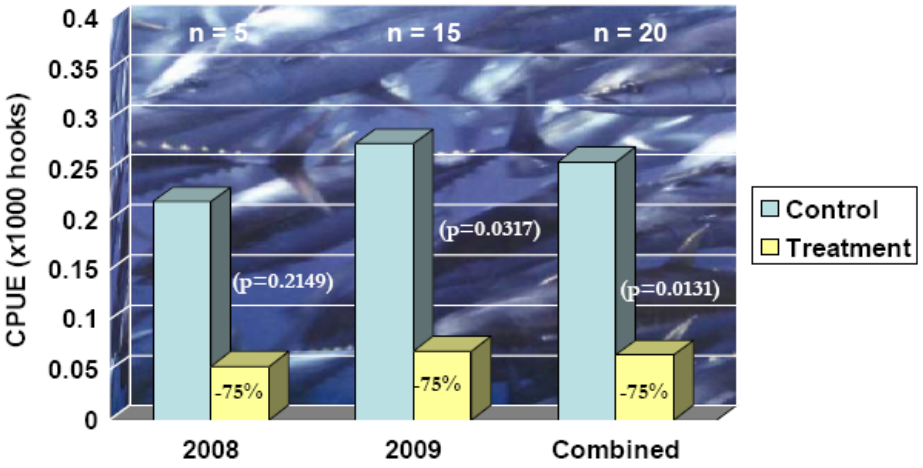
daniel.g.foster@noaa.gov
charles.bergmann@noaa.gov

Gulf of Mexico YFT Research

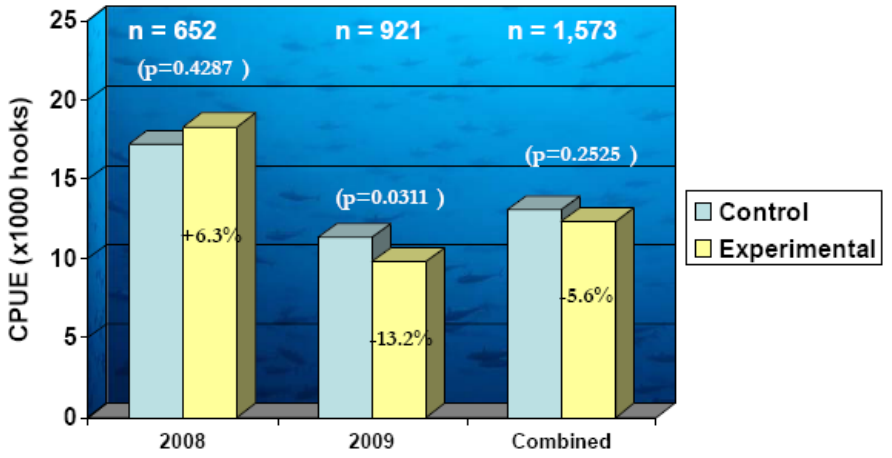
- Preliminary results (2008-2009):
  - 5 vessels and 123,872 hooks
  - New 16/0 hook design bends with less force
  - Observed 75% (significant) BFT reduction and 5.6% (non-significant) YFT reduction

Gulf of Mexico YFT Research

Bluefin CPUE



Total Yellowfin CPUE

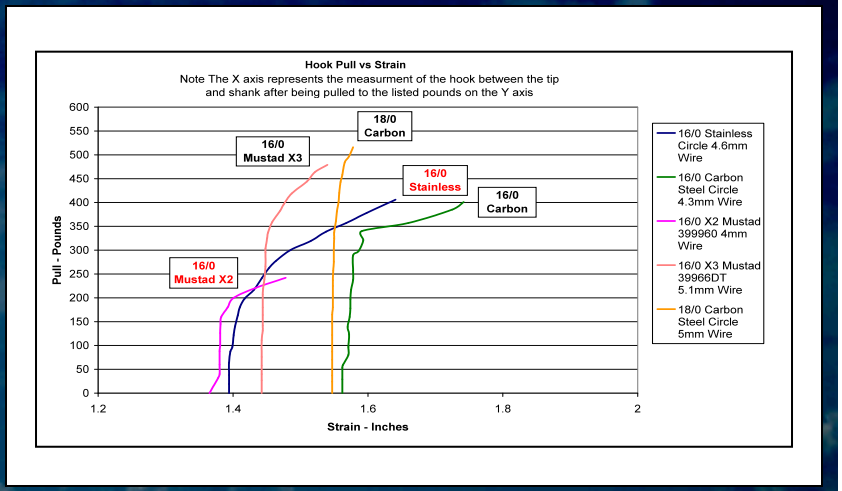


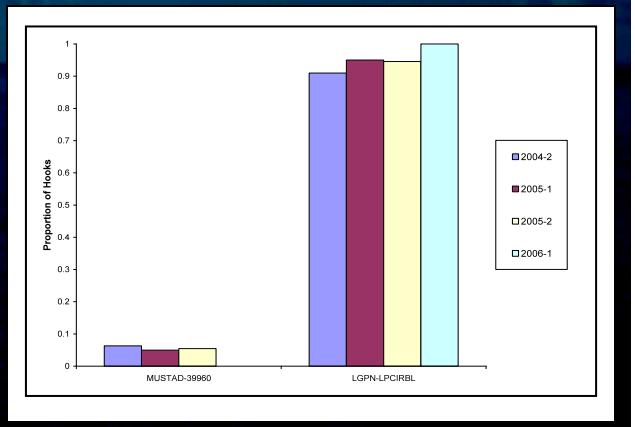
Gulf of Mexico YFT Research

- Results:
  - 2008-2009, 5 vessels and 123,872 hooks
  - New 16/0 hook design bends with less force
  - Observed 75% (significant) BFT reduction and 5.6% (non-significant) YFT reduction
- Conclusions?
  - Appears to work for reducing BFT bycatch
  - Strong vessel/captain effects – still being teased out of analyses

NC/SC YFT and SWO

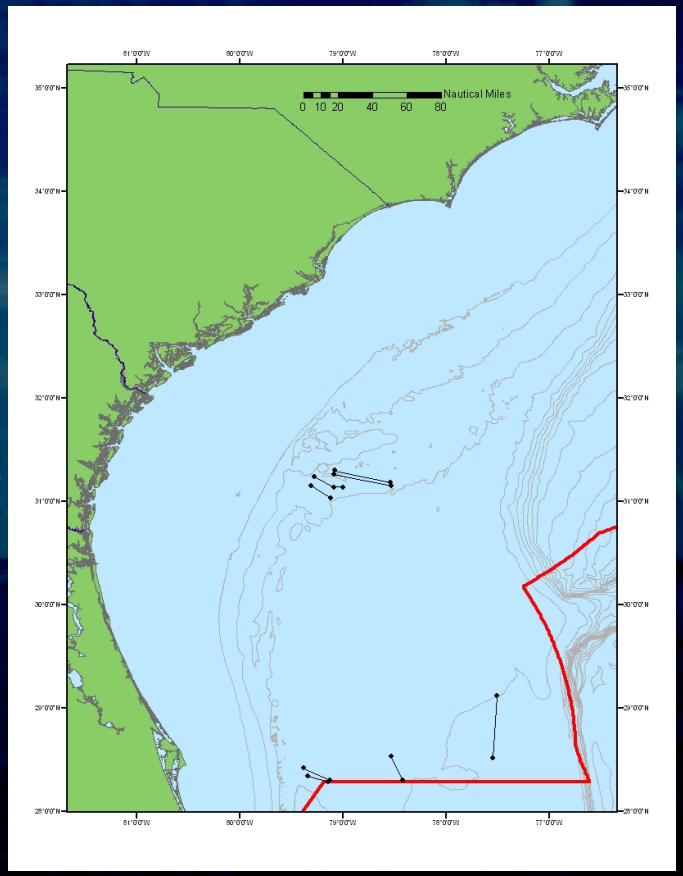
- Run by NSU OC (Kerstetter and Bayse)
- Designed to test reduction in PW bycatch from MAB/ SAB YFT and SWO PLL fishery
- Used two models of 16/0 and two models of 18/0 circle hooks





Results: 18/0 Sets

- 9 sets, targeting swordfish
- From 27 Feb - 4 Mar 2008
- 4,655 hooks deployed

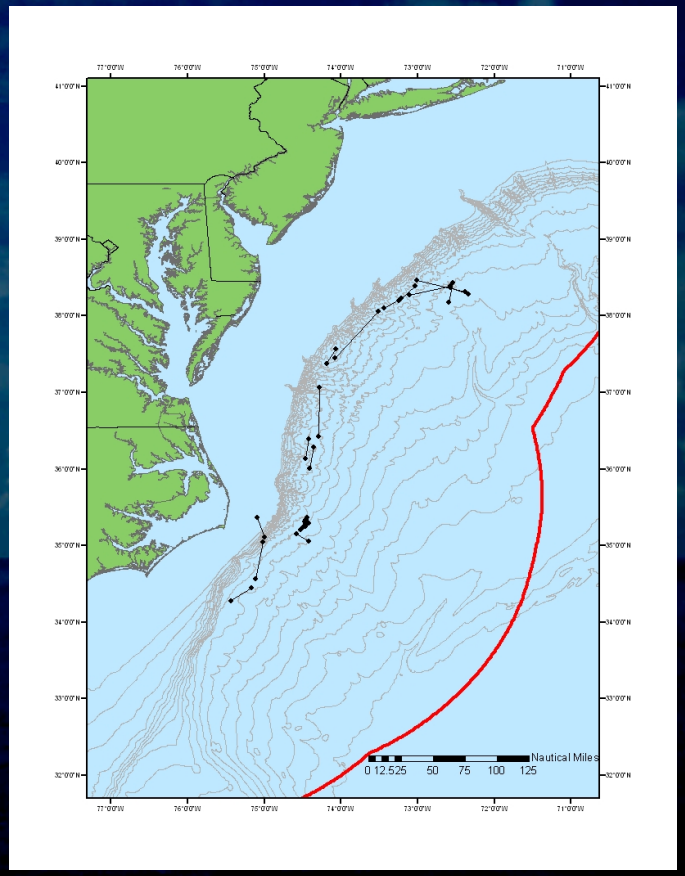


Results: 18/0 Sets

- Significantly higher numbers of swordfish were caught with the strong hook at $\chi^2 = 4.59$, $p = 0.032$ ($CPUE_{strong} = 29.78$ vs. $CPUE_{weak} = 22.58$)
- Swordfish caught with the weak hook trended longer, and were significantly heavier ($p = 0.037$)
- Within set comparisons showed no significant catch between hook types for swordfish
- No bycatch species showed differences in total catches or within a set

Results: 16/0 Sets

- 21 sets, targeting YFT
- 1 Aug - 2 Oct 2008
- 15,568 hooks deployed



Results: 16/0 Sets

- No significant differences in CPUE of target species
- Catch rates trended higher for YFT and BET with “weak” hook
- YFT and BET caught with “strong” hooks trended heavier and longer, length for YFT being significantly larger

Species	Strong Hook	Weak Hook	χ^2	p-value	Ratio (S:W)
Yellowfin Tuna	87	91	0.089	0.764	1.00 : 1.01
Bigeye Tuna	36	43	0.620	0.431	1.00 : 1.16

CPUE	Strong Hook	Weak Hook
Yellowfin Tuna	5.985	6.604
Bigeye Tuna	2.777	3.478

Results: 16/0 Sets

- Only one species with a significant catch rate difference: pelagic stingray
- Hook ratio of 1.85 strong to 1.00 weak
- $\chi^2 = 11.94$, $p < 0.001$

http://www.fpir.noaa.gov/Graphics/OBS/obs_rays/obs_pelagic_stingrays/obs_pelagic_stingray1.jpg

Within set results

- Compared catches within sets if 10 or more of the same species were caught
- 19 comparisons with 16/0 work (none within 18/0 sets), five significantly different:
  - YFT 13 to 3, in favor of the strong hook
  - BSH 11-3, weak hook
  - PEL*3 (16-6, 12-4, 14-5), strong hook

Marine Mammal Interactions

- MM were observed throughout sets within the MAB, generally following gear and/or boat
- 10 direct interactions between marine mammals and PLL were observed: 8 undetermined MM, 1 pilot whale, and 1 false killer whale
  - 8 undetermined MM depredations from fish returned with bite marks indicating MM (6 YFT and 2 PEL)
  - 1 undetermined pilot whale, caught, subsequently released after hook straightened in a few minutes
  - 1 FKW had a YFT removed from its mouth by Captain at boatside

- Animal straightened “weak” size 16/0 Mustad hook ~15 m from vessel and swam away

Ongoing NEAq-CWBR research: North Carolina

- Funding for 45,000 deployed hooks, testing three circle hook models:
  - 16/0 CS LP vs 16/0 experimental Mustad 39988D*
  - 18/0 CS LP vs 18/0 stock Mustad 39960D
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* Same hook model used in GOM work; concerns about bait availability in summer 2010

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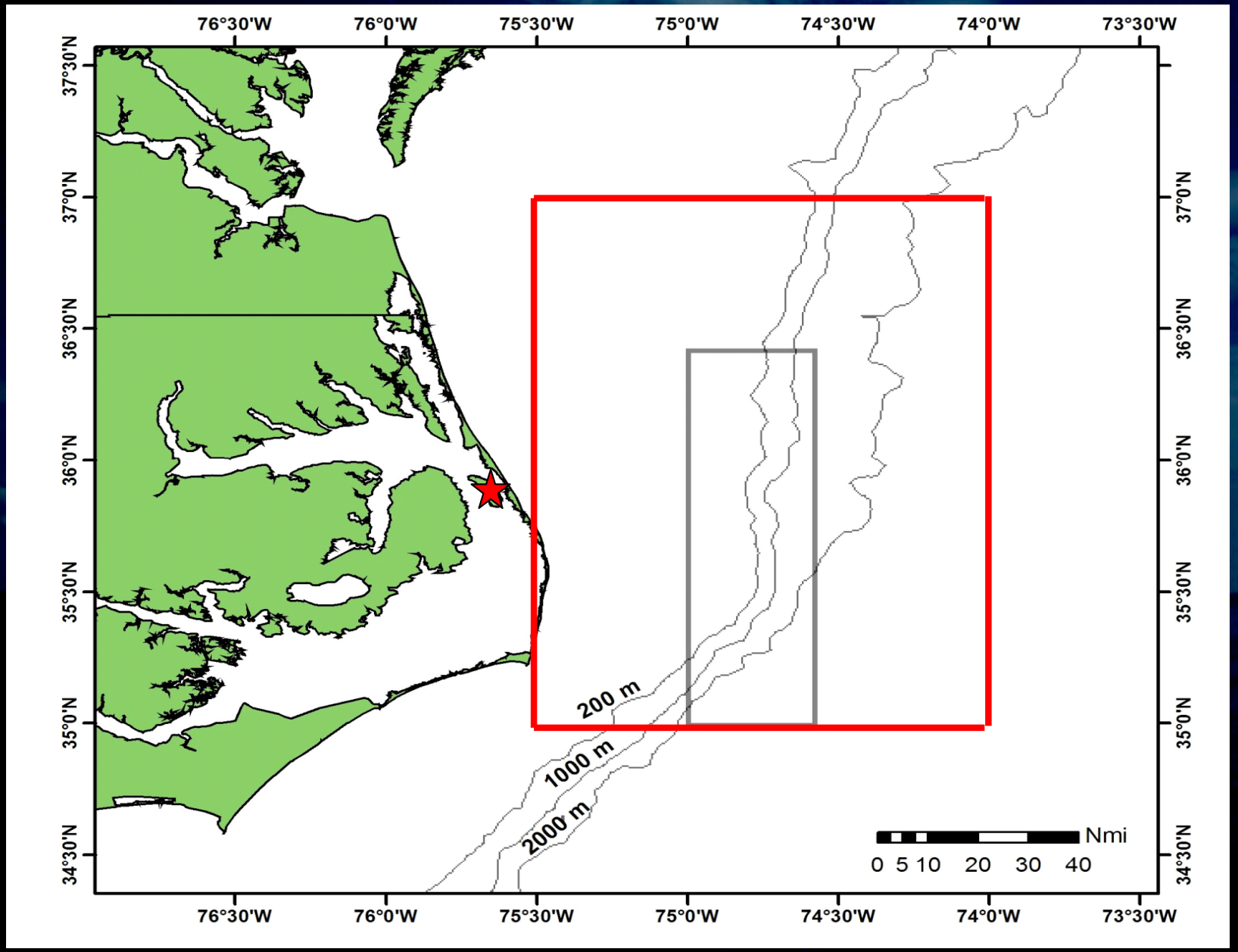
- Same experimental protocols as MAB work:
  - POP-trained fisheries observers (NSU grad students)
  - Alternating hooks, odd-number baskets

* Same hook model used in GOM work; concerns about bait availability in summer 2010

Ongoing NEAq-CWBR research: North Carolina

- Sets started in September and are on-going for the size 16/0 experimental hooks:
  - 9 sets completed, 5916 hooks total
  - No significant differences in catch by numbers or lengths for BET or YFT, main target species
  - Bycatch (all released alive) has been minimal: 4 BIL, 1 LB turtle, 1 pilot whale (on “strong” hook)
- Planned (season) end in mid-November 2010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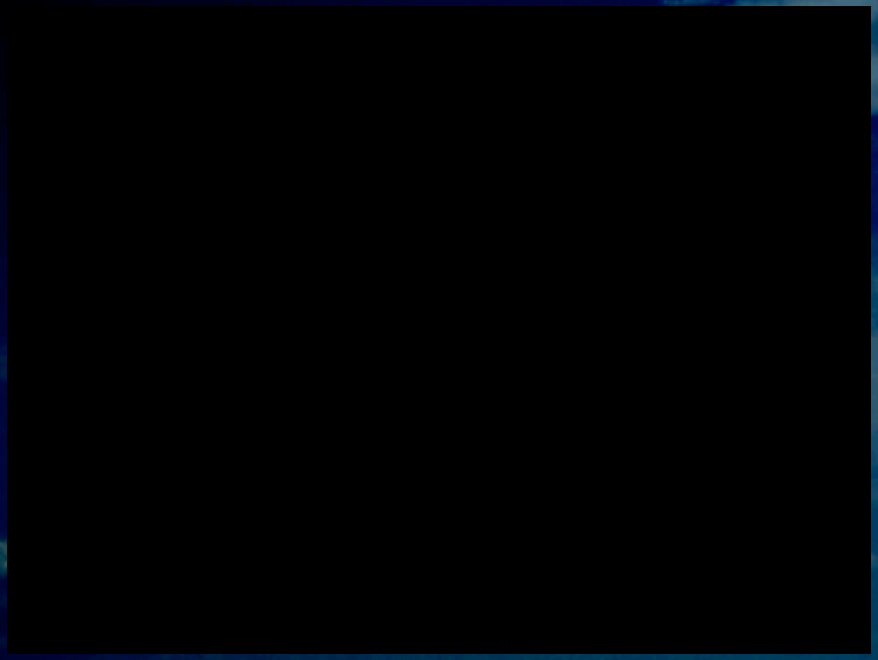
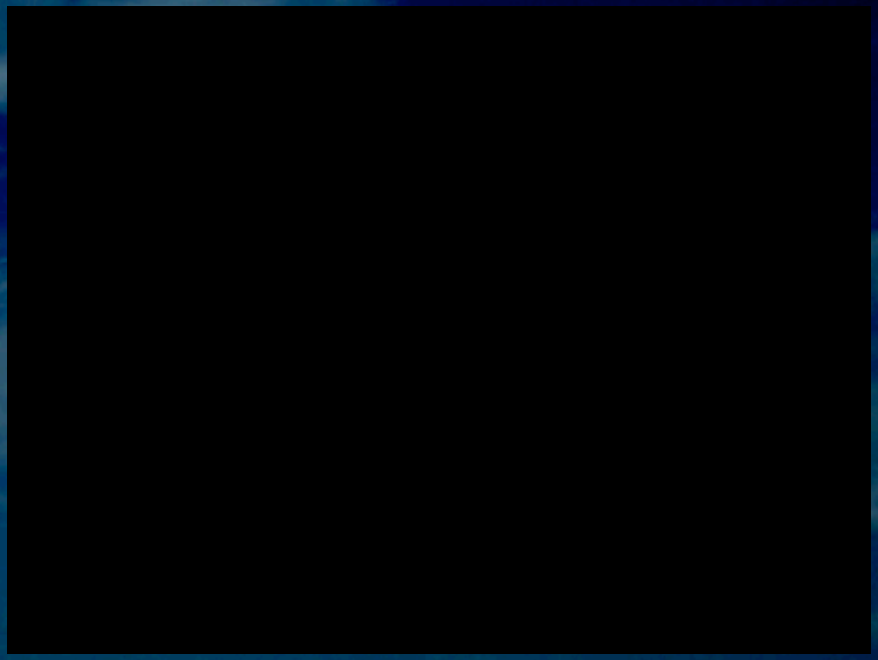
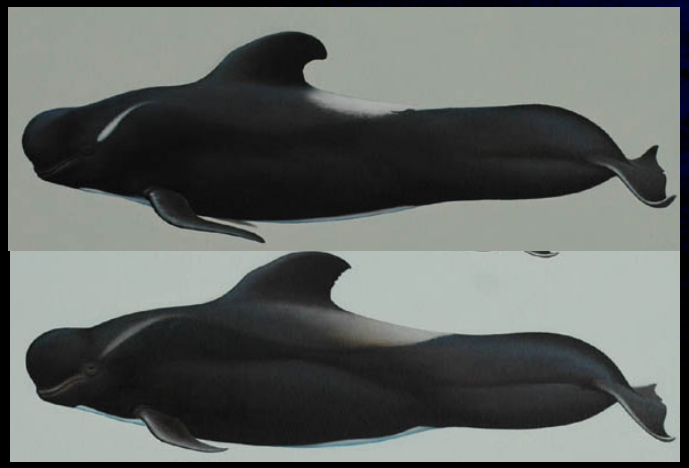




Videos from S. Khamesi, NSUOC in September 2010

Ongoing NEAq-CWBR research: Hawaii (with PIFSC and HLA)

- Similar rationale *might* work for FKW interactions in WCP region… multiple assumptions, though: fishery buy-in for research (likely), appropriate experimental hook determination, etc.



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Ongoing NEAq-CWBR research: Hawaii (with PIFSC and HLA)

- Combined effort of CWBR, Hawaii Longline Association (HLA), and NOAA Fisheries Service Pacific Islands Fisheries Science Center (PIFSC)
- Different rationale for power analyses (sets vs. hooks), conclusion for significance at 120 sets
- 4.0 mm vs. 4.5 mm ringed 15/0 circle hook
- Training provided free by Pacific Islands Regional Office Observer Program

Ongoing NEAq-CWBR research: Hawaii (with PIFSC and HLA)

- One trip completed:
  - 6 sets, 15,457 hooks total
  - For BET, 33 control to 42 'weak'.
  - Total catch - 105 control to 100 ‘weak’
- Four vessels now out at sea; returning to port in about three weeks
- Planned presentation of results at May 2011 Circle Hook Symposium in Miami, FL

Conclusions

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- Only one observed hooking interaction with MM, despite 20,223 deployed hooks – very, *very* large numbers of hooks likely needed to achieve any MM significance
- Terminal gear (hook) changes likely the least intrusive means for bycatch reduction, but fishery buy-in essential

“Big Picture” Comments:

- While L-P and Mustad appear willing to help, custom hooks take time – might it be best to use off-the-shelf models?
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  - Upfront cost
  - Time delay
- Two prior studies designed for reduction in VERY different species (BFT vs PW)
- If numbers aren’t available for bycatch species’ significance, will fishery accept no difference in target species’ CPUE and adopt hooks in a precautionary sense?

Synergistic Activities:

- On-going use of TDRs to characterize effective fishing depths of NC-style shallow-set tuna pelagic longline gear
- In-review proposal to NC Sea Grant to examine interaction potentials between pilot whales and gear (with A. Read at Duke and E. Jordan at Mt. Olive College)

Thanks to:

- Current NSU OC students: Matt Dancho and Sohail Khamesi
- Pelagic Observer Program, NOAA Fisheries Service
- Atlantic Pelagic Longline and False Killer Whale TRTs

"We're gonna need a bigger boat…"

Consortium for Wildlife Bycatch Reduction

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Sea Grant North Carolina

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