“Weak hook” Research in the Atlantic: Results and Next Steps

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False Killer Whale Take Reduction Team Meeting

Turtle Bay Resort, Hawai’i

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Sea Grant North Carolina

New England Aquarium

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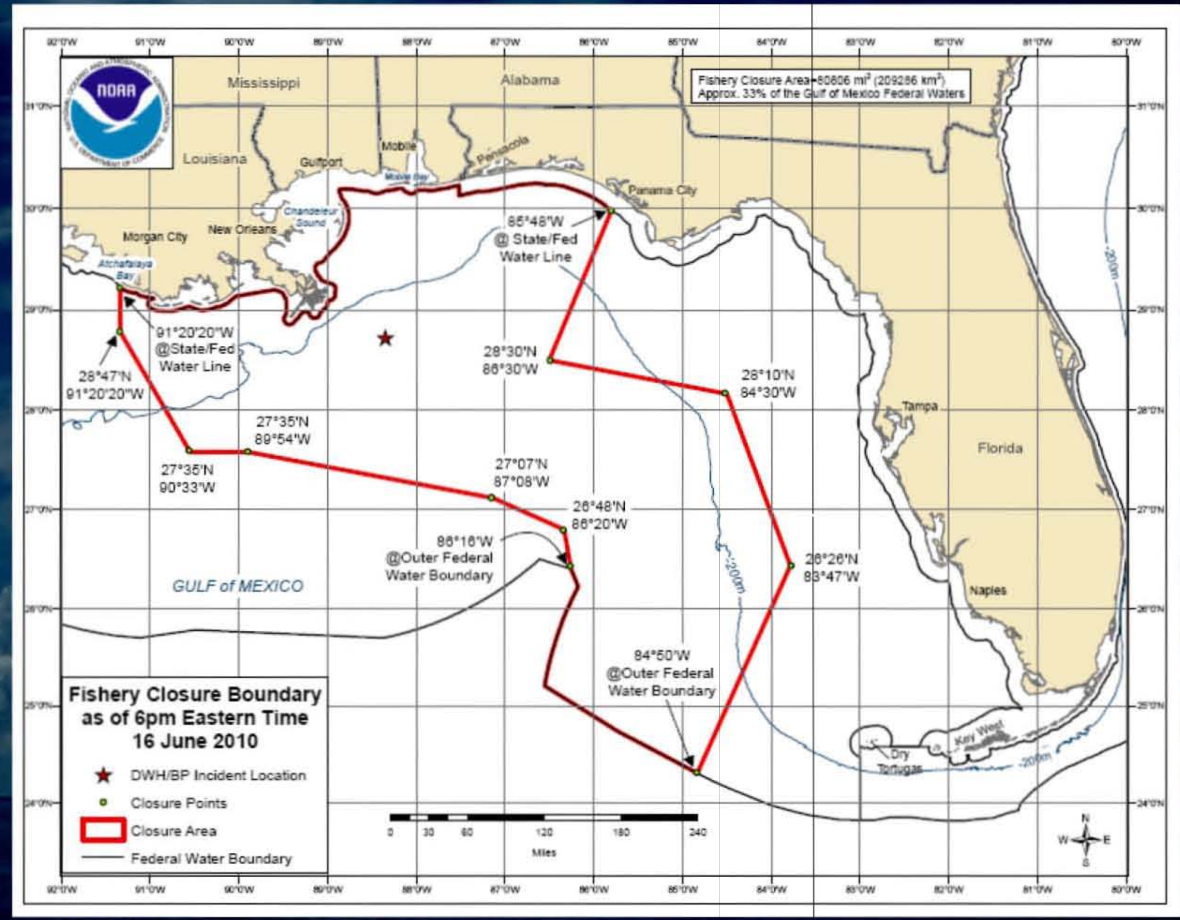


Florida's been a bit distracted lately…

Standard bycatch approach:

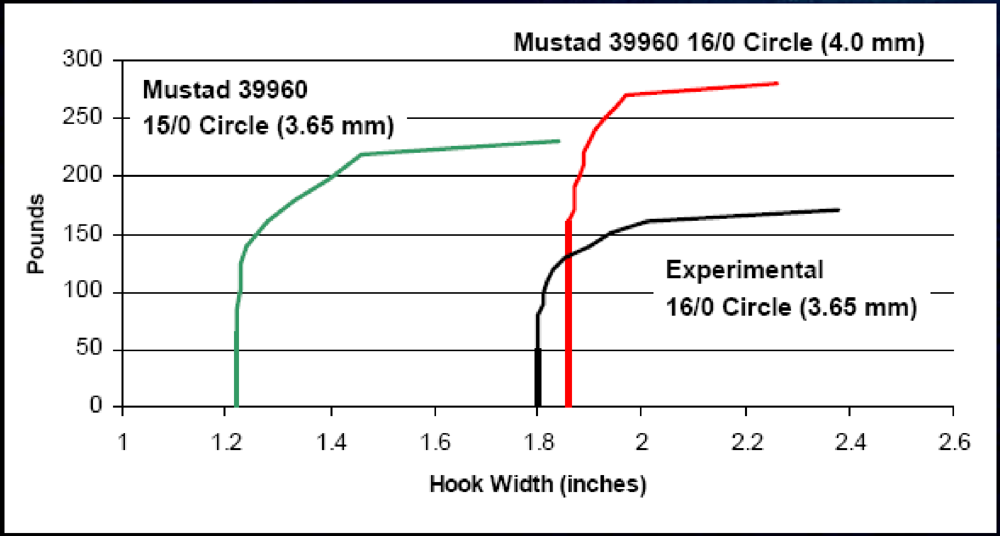
- Avoid bycatch species altogether (vertically and/or horizontally)
- Minimize bycatch mortality
  (or “serious injury”)

Main “weak hook” studies:

- Only two studies to date, and only one published:
  - Gulf of Mexico YFT – in progress, kind of…
  - North Carolina YFT and South Carolina SWO
  - North Carolina YFT (Part II) – coming soon
  - Hawai’I DSLL – also coming soon?
- However, both:
  - Exploited size disparity between target and bycatch
  - Used 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 (75# vs 450+# dressed weights)
- Originally tried break-away leaders, then used two different gauges of same 16/0 circle hook model:



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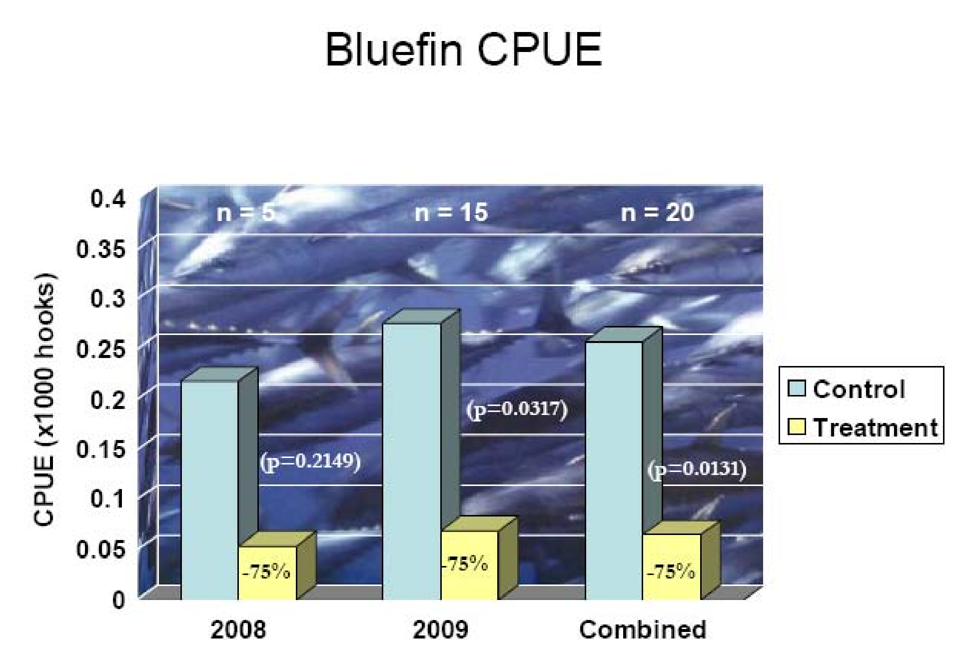
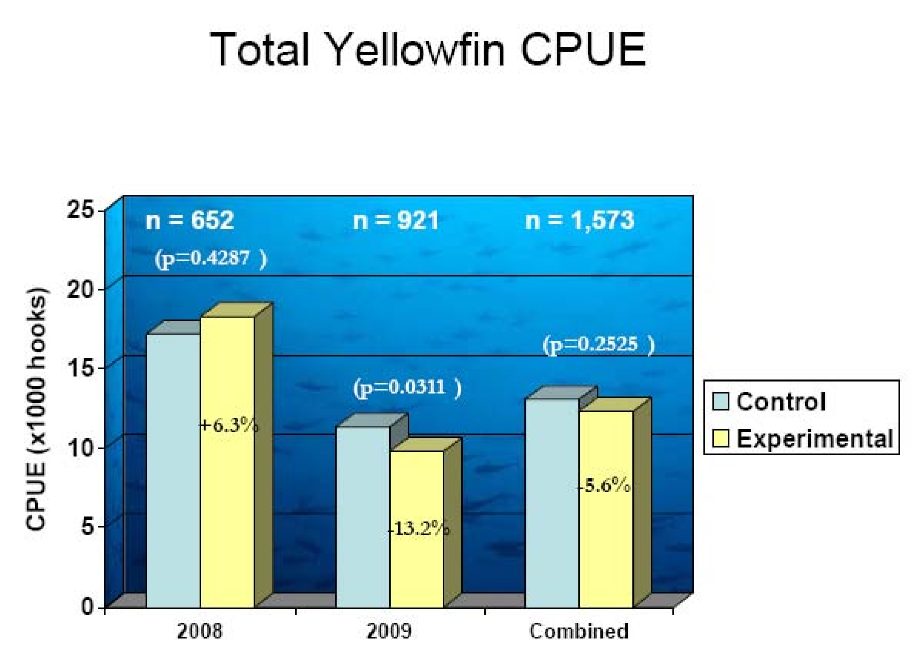
Gulf of Mexico YFT Research

- 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

Gulf of Mexico YFT Research



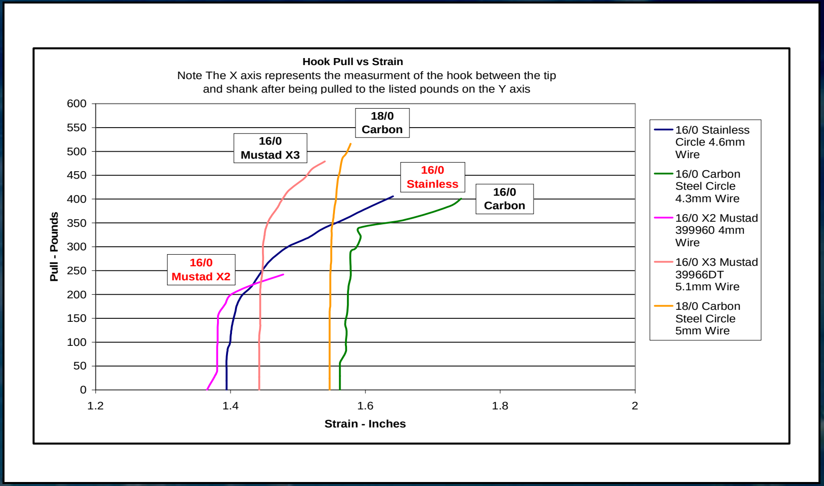


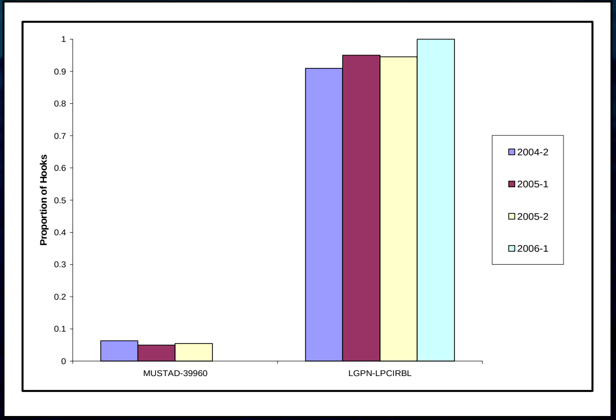
Gulf of Mexico YFT Research

- 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

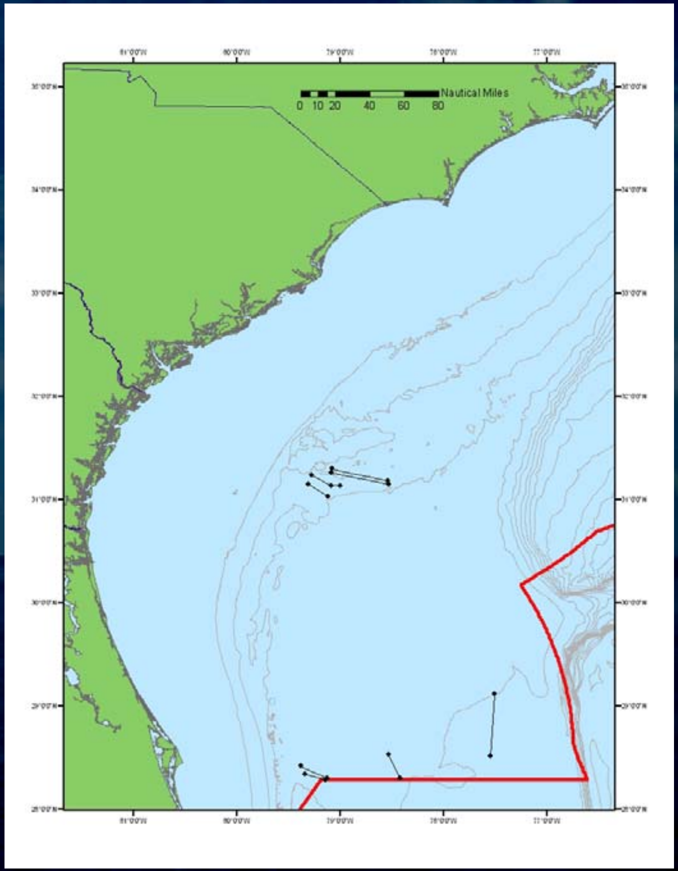
- Run by NSU OC (Kerstetter and Bayse)
- Designed to test reduction in PW bycatch from MAB/SAB YFT and SWO PLL fishery
- Used two models of 16/0 and two models of 18/0 circle hooks





Results: 18/0 Sets

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

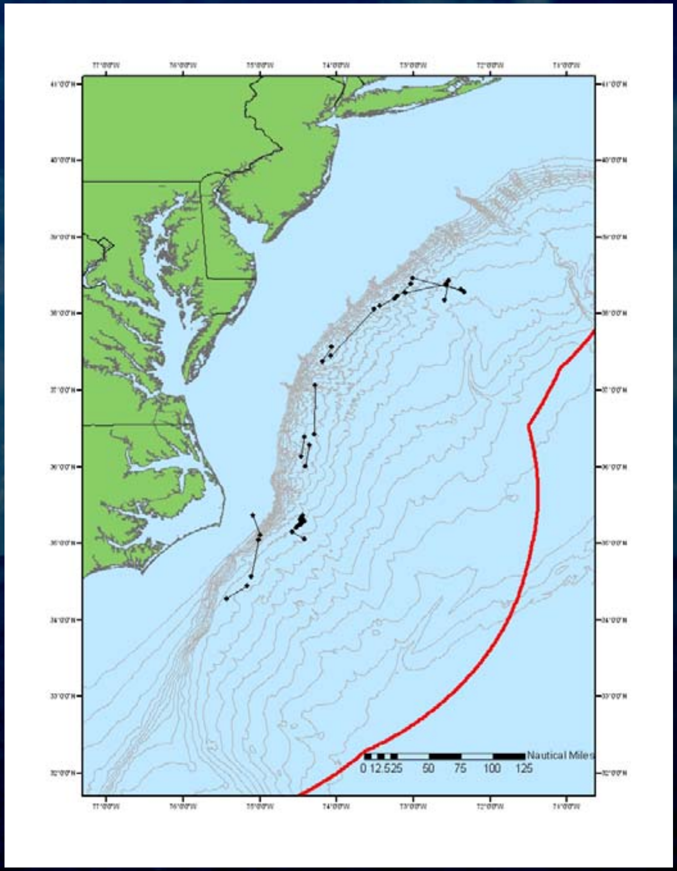


Results: 18/0 Sets

- 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

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

- Catch rates trended higher for YFT and BET with “weak” hook

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

- YFT and BET caught with “strong” hooks trended heavier and longer, length for YFT being significantly larger

Results: 16/0 Sets

- Only one species with a significant difference: PEL
- Ratio of 1.85 strong hooks to 1.00 weak hook
- $\chi^2 = 11.94$, $p < 0.001$

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

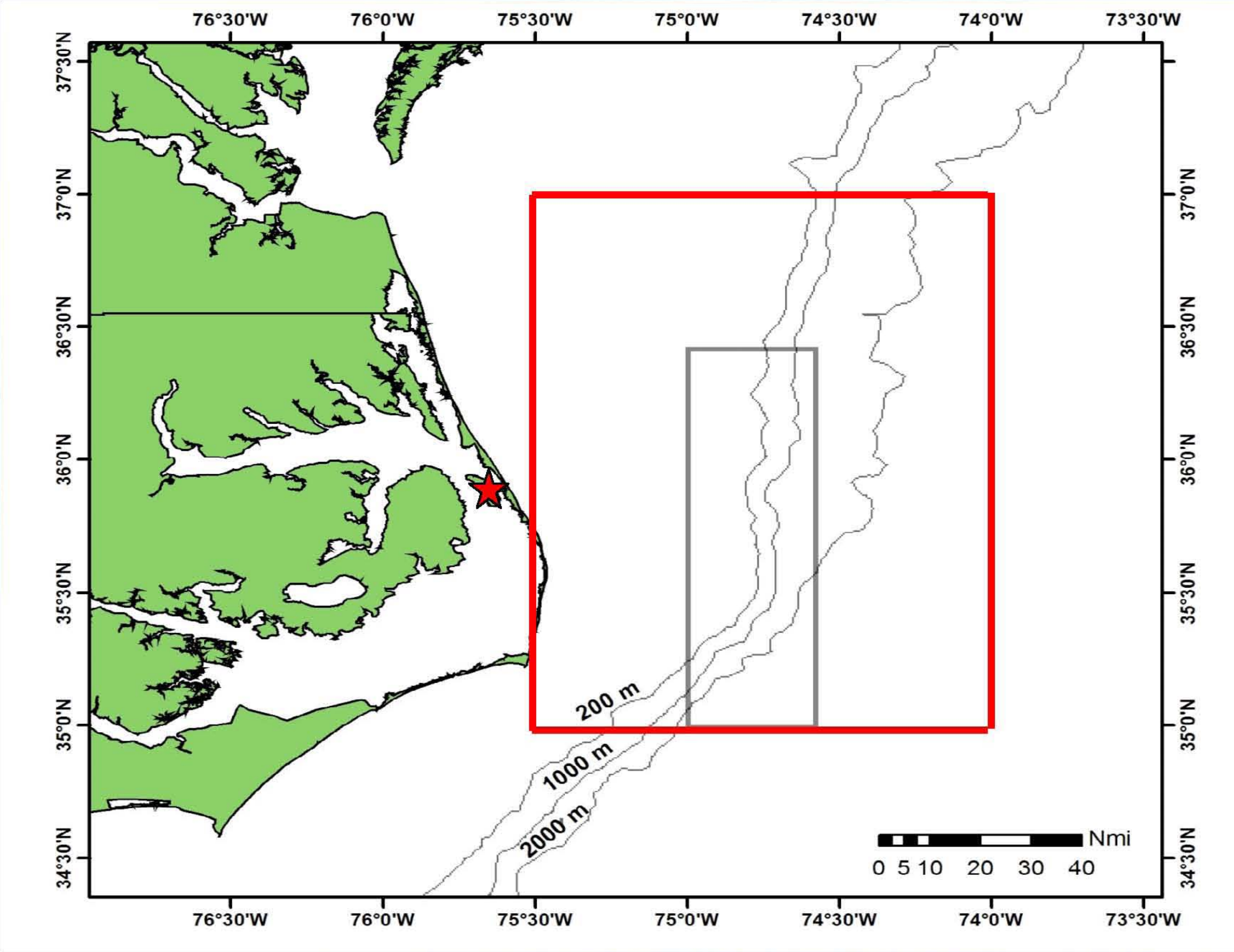
- MM were observed throughout sets within the MAB, generally following gear and/or boat
- 10 direct interactions between marine mammals and PLL were observed: 8 undetermined MM, 1 pilot whale, and 1 false killer whale
  - 8 undetermined MM depredations from fish returned with bite marks indicating MM (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

Future research: North Carolina

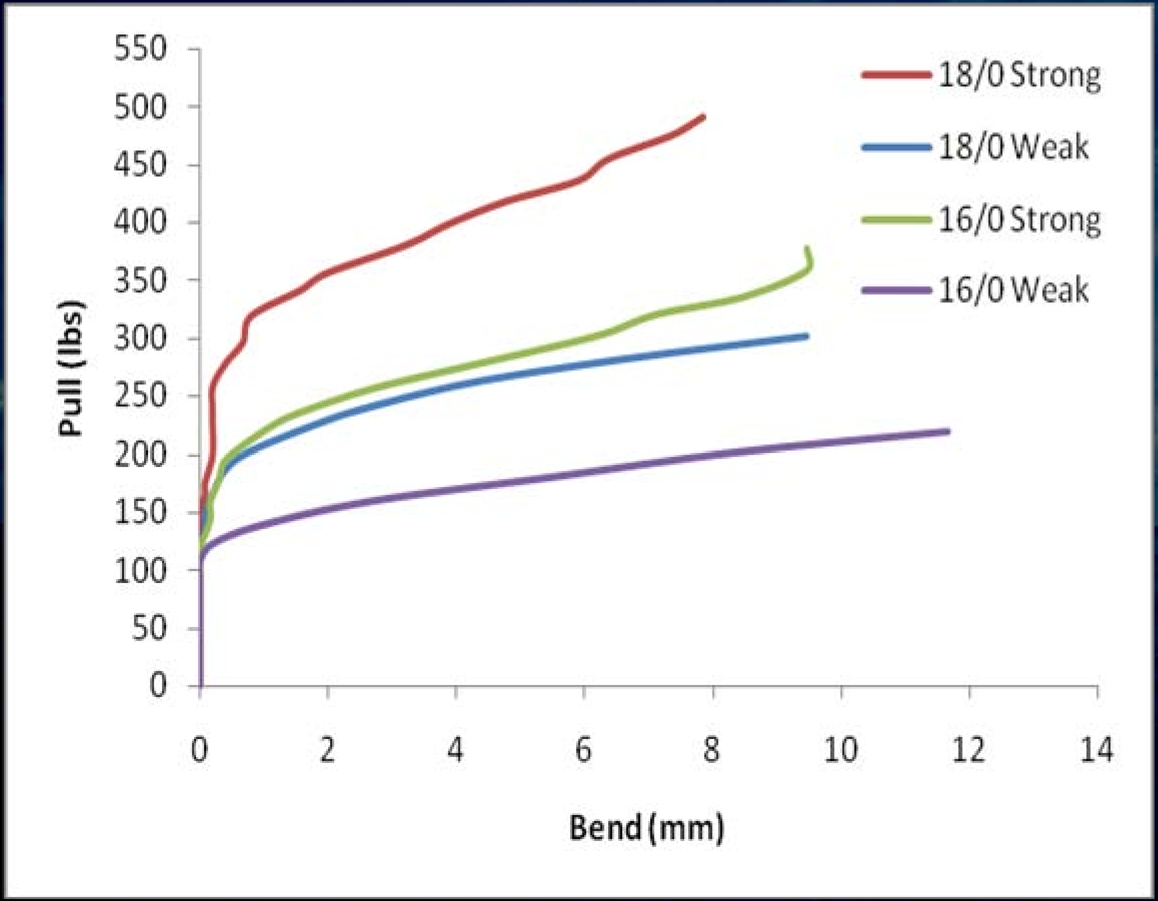
- Funding through NEAq for 45,000 deployed hooks, three circle hook models:
  - 16/0 CS LP vs 16/0 experimental Mustad 39988D*
  - 18/0 CS LP vs 18/0 stock Mustad 39960D
  - 18/0 CS LP vs 18/0 experimental Mustad 39960D
- Same experimental protocols as MAB work:
  - POP-trained fisheries observers (NSU grad students)
  - Alternating hooks, odd-number baskets
- Sets to start by end of June and then be completed by October 2010

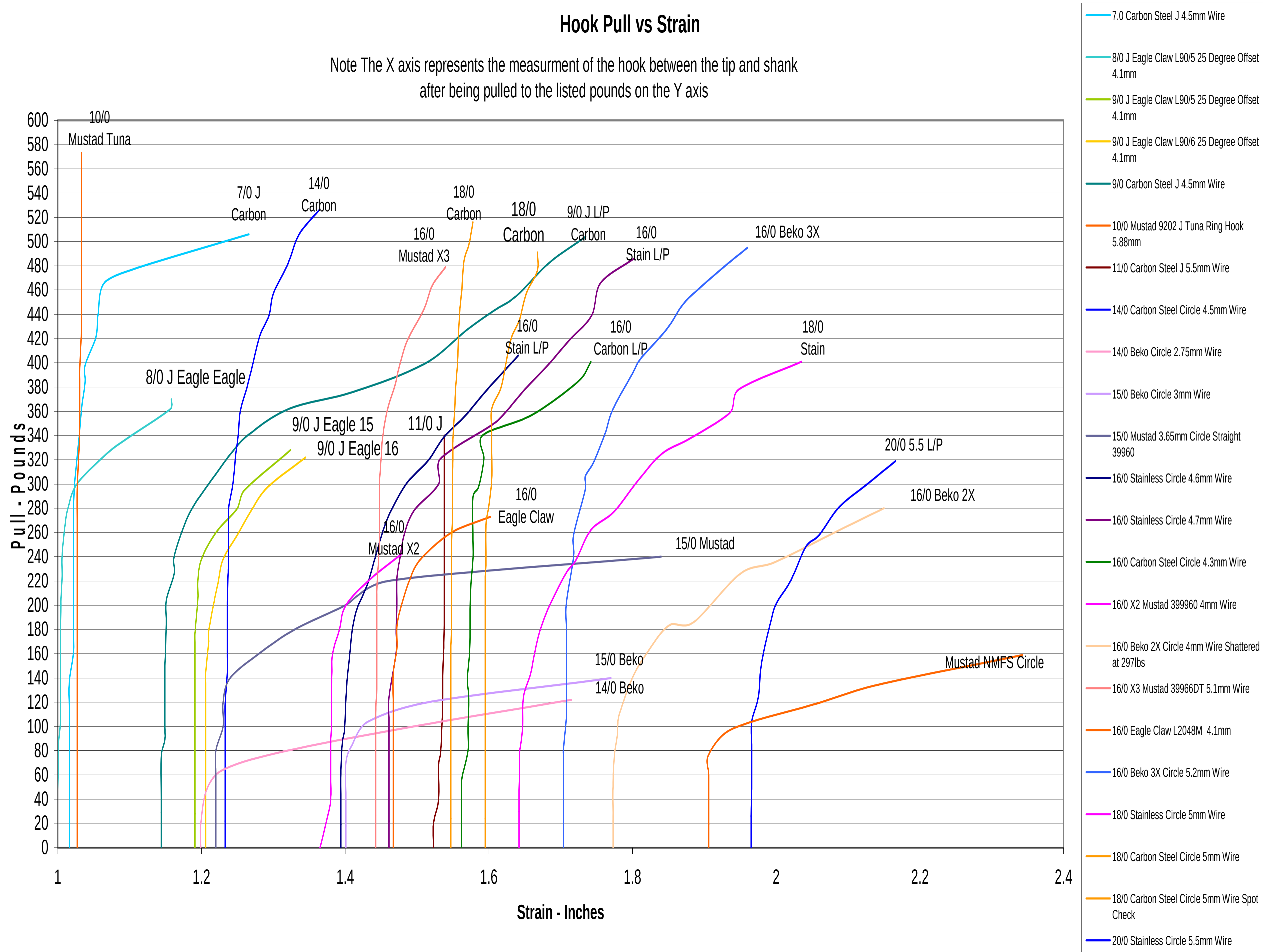
* Same hook model used in GOM work; concerns about bait availability in summer 2010



76°30'W
76°0'W
75°30'W
75°0'W
74°30'W
74°0'W
73°30'W
37°30'N
37°0'N
36°30'N
36°0'N
35°30'N
35°0'N
34°30'N
200 m
1000 m
2000 m
Nmi
0 5 10 20 30 40

Hook strength… ?





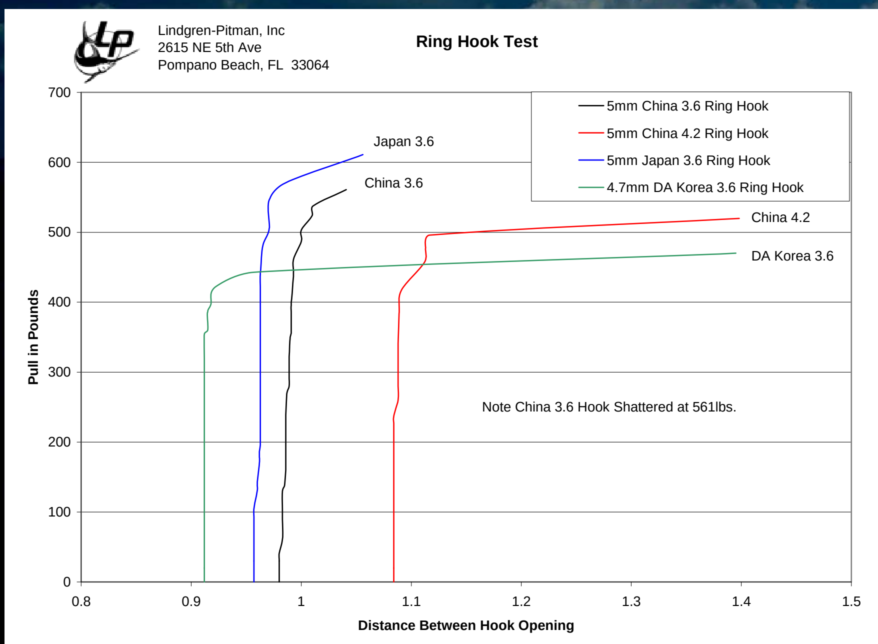
Hook Pull vs Strain
Note The X axis represents the measurment of the hook between the tip and shank
after being pulled to the listed pounds on the Y axis
10/0
Mustad Tuna
7/0 J
Carbon
14/0
Carbon
18/0
Carbon
18/0
Carbon
9/0 J L/P
Carbon
16/0
Mustad X3
16/0
Stain L/P
16/0 Beko 3X
8/0 J Eagle Eagle
16/0
Stain L/P
16/0
Carbon L/P
18/0
Stain
9/0 J Eagle 15
11/0 J
9/0 J Eagle 16
20/0 5.5 L/P
16/0
Eagle Claw
16/0 Beko 2X
16/0
Mustad X2
15/0 Mustad
15/0 Beko
14/0 Beko
Mustad NMFS Circle
P u l l - P o u n d s
Strain - Inches
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
1
1.2
1.4
1.6
1.8
2
2.2
2.4
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…"

Hook strength… ?

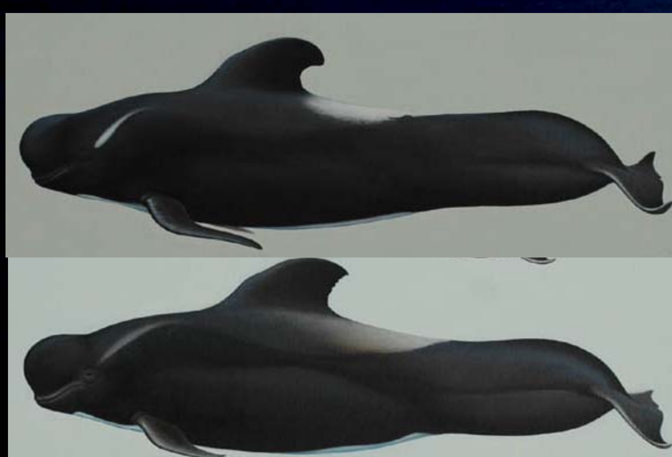
- Actually very few "good" metrics for comparisons of hook model strength:
  - Different definitions of "open"; different pull methods
  - Hook cross-section shape likely more important than wire gauge (shearing vs. bending with force)
  - J-style vs. "circle" vs. tuna hook models all different, also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

Hook strength… ?

- Problem is also compounded by inter-batch strength variation (for some manufacturers, at least) based on the factory’s source metal
- 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

Future research: Hawai'i

- Similar rationale *might* work for FKW interactions in WCP region… multiple assumptions, though: fishery buy-in for research (likely), appropriate experimental hook determination, etc.
- Limited funding likely to be available via NEAq for fall 2010 through summer 2011



? =

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Conclusions

- No (statistically significant) reduction in target catch species or fish bycatch
- 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

So, can this work here?

- Is there a size difference to exploit?
- Can we find (or design) an appropriate hook?
- Can we get funding?
- Can we get fishery buy-in for experiments?

If these are all “yes”, then it’s probably worth a try.

"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?
  - 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?

Thanks to:

- Shannon Bayse (Florida FWC)
- False Killer Whale TRT and NOAA Fisheries Service
- Atlantic Pelagic Longline TRT

"We're gonna need a bigger boat…"

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