Testing Hook-Tissue Interactions in pilot whale mouths

Part 2

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Longline hook testing in the mouths of pelagic odontocetes

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Several species of odontocete cetaceans depredate bait and catch and, as a result, become hooked and entangled in pelagic longline fisheries. The present study measured how selected commercial longline hooks, including "weak hooks", behaved within odontocete mouths. Five hooks (Mustad-16/0, Mustad-18/0, Mustad J-9/0, Korean 16, and Korean 18) were tested on three species of odontocetes known to interact with longline fisheries—short-finned pilot whales (*Globicephala macrorhynchus*), Risso's dolphins (*Grampus griseus*), and false killer whales (*Pseudorca crassidens*). Specimens were secured to a stanchion, hooks were placed in the mouth at multiple positions along the dorsal lip, and the force required to pull each hook free was measured. The soft tissue lips of these odontocetes were capable of resisting forces up to 250 kg before failing. The polished steel M-16, M-18, and J-9 hooks straightened at forces between 50 and 225 kg, depending on hook gauge. When straightened, these hooks exposed the sharpened barb, which sliced through the lip tissue, usually releasing the hook intact. The K-16 and K-18 hooks behaved very differently, breaking at higher forces (110–250 kg) and consistently just at the barb; usually, there was measurable soft-tissue loss and often shards of the hook were retained within those soft tissues. The different behaviours of these two hook types—the M and J type polished steel vs. the K type carbon steel—were consistent across all species tested. Mechanical tests were also conducted to determine if hooks could fracture the mandible of these same odontocetes. Only the M-18 and K-18 hooks had sufficiently large gapes to hook around the mandible, and both hook types fractured bone in short-finned pilot whales and Risso's dolphins. These results support other lines of evidence indicating that longline hooks can cause serious injury to these species, and suggest possible steps to mitigate these impacts.

Keywords: conservation, longline hooks, odontocete, serious injury, tissue testing, weak hooks.

Introduction

Several species of odontocete cetaceans depredate fishery bait and catch and, as a result, become seriously injured within, pelagic longline fisheries (reviewed by Hamer *et al.*, 2012). For example, from 1992 to 2008, 83 short-finned pilot whales (*Globicephala macrorhynchus*) were determined to be seriously injured (likely fatally), and five individuals died, as a result of interactions with the Atlantic US pelagic longline fishery (Waring *et al.*, 2012). Eighteen false killer whales (*Pseudorca crassidens*) were determined to be seriously injured, and one individual died, through interactions with the Hawaiian pelagic longline fishery from 2006 to 2010 (Waring *et al.*, 2012). The present study focused on measures that would reduce the serious injury of large odontocetes after they become hooked by pelagic longline gear, by testing how various hooks, including "weak hooks", behave within the soft and hard tissues of the odontocete mouth.

Weak hooks are formed from bent wire that is circular in cross section, while traditional forged strong hooks are oval in cross section (Kerstetter, 2012). Weak hooks are designed to exploit differences in size (and, thus, hypothesized strength) of target (e.g. tuna, swordfish) and non-target (e.g. large odontocetes) species in pelagic longline fisheries (e.g. Bayse and Kerstetter, 2010). Recent studies suggest that the use of weak hooks has little effect on the catch of target fish species but does result in the retrieval of more straightened hooks from the fishery (Bayse and Kerstetter, 2010; Bigelow *et al.*, 2012; Kerstetter, 2012). These are promising results,

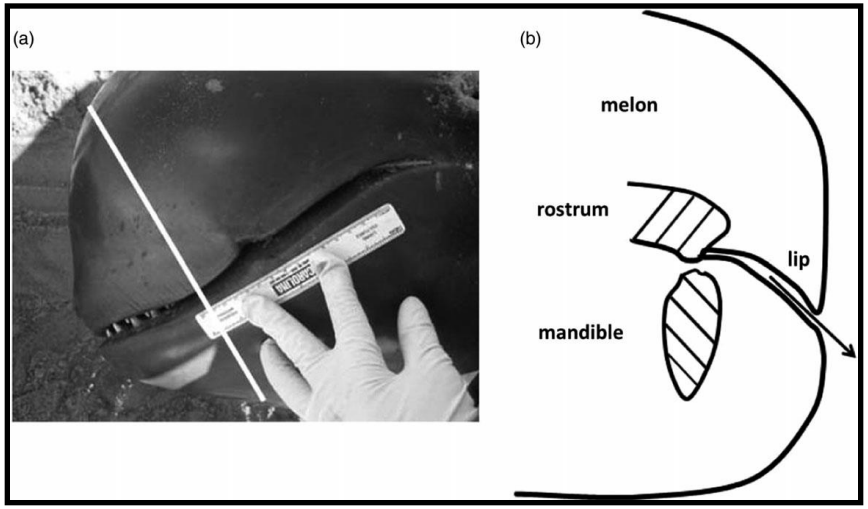
Take Homes from 1st Study

- Korean Carbon hooks were highly variable in breaking strength and "exploded" leaving hook shards

- Mustad hooks were highly predictable and bent open exposing the barb that cut the hook free

- ALL hooks, if able to wrap around the lower jaw, could break the jaw

- Better identification of hook types is required to better predict behavior



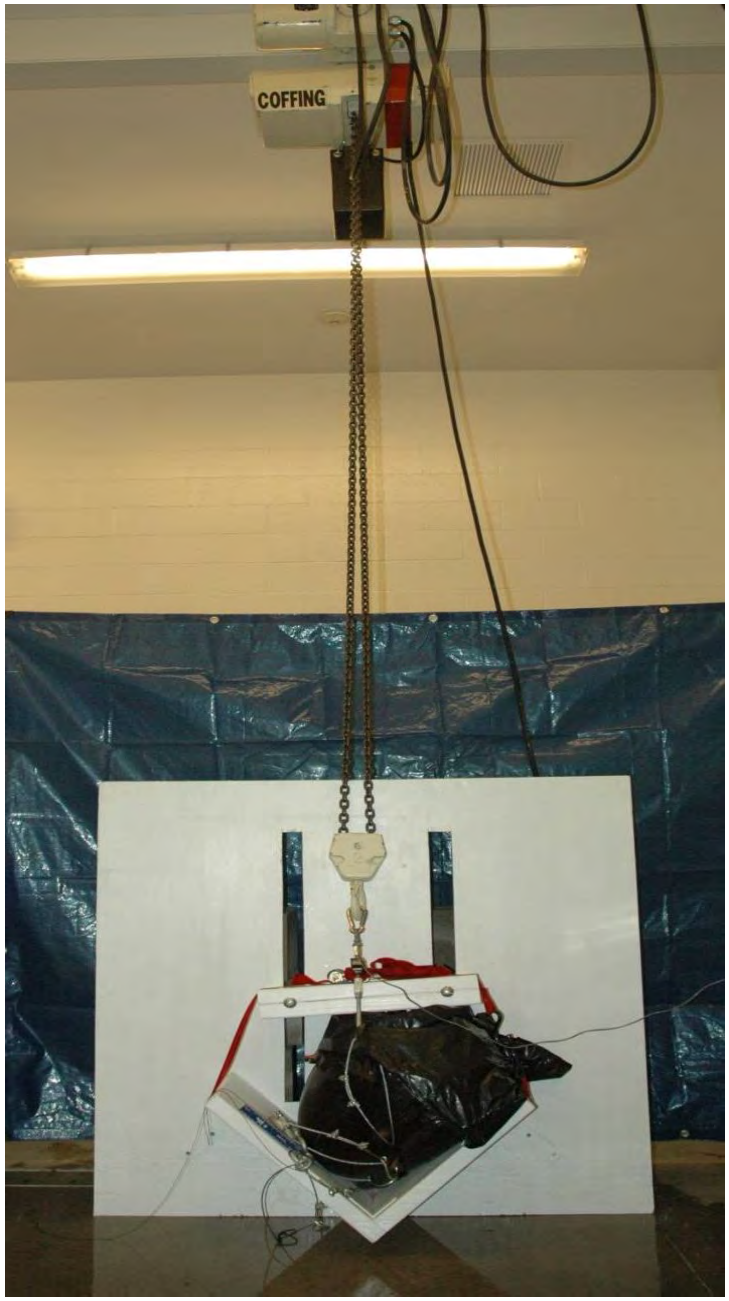
OUTLINE FOR TODAY

Review Methodology

Hook Tests- Isolated

Hook Tests- in Tissue

Conclusions



Set Up:

Overhead crane to 3 tons of force

Stanchion to strap down head loaded with 1,000 lbs of weight

Head is strapped onto stanchion

Hooks inserted and pulled with force gauge recording

In-line Load Cell

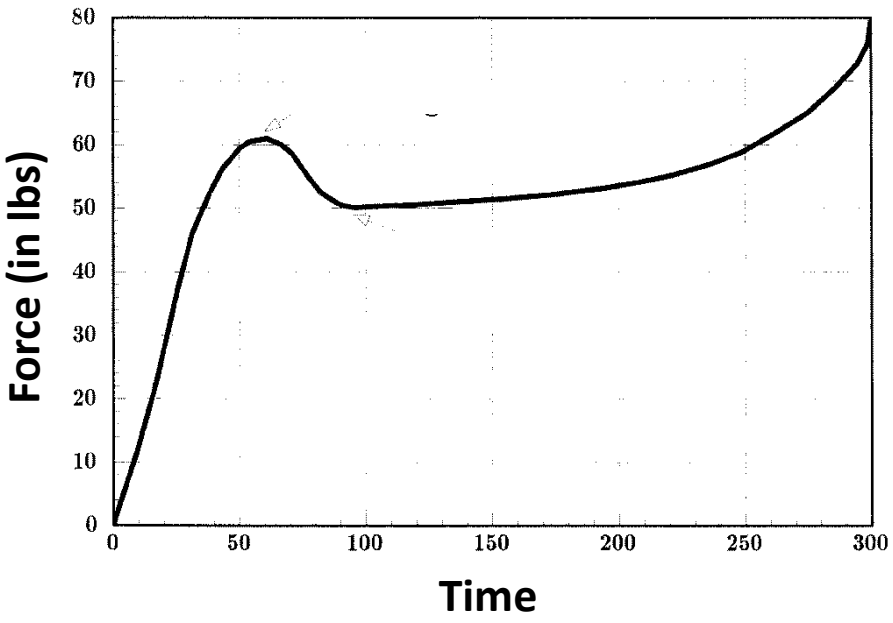
Measures forces up to 1,000 lbs

Samples at 20 samples/second

In-line Load Cell

Measures forces up to 1,000 lbs

Samples at 20 samples/second

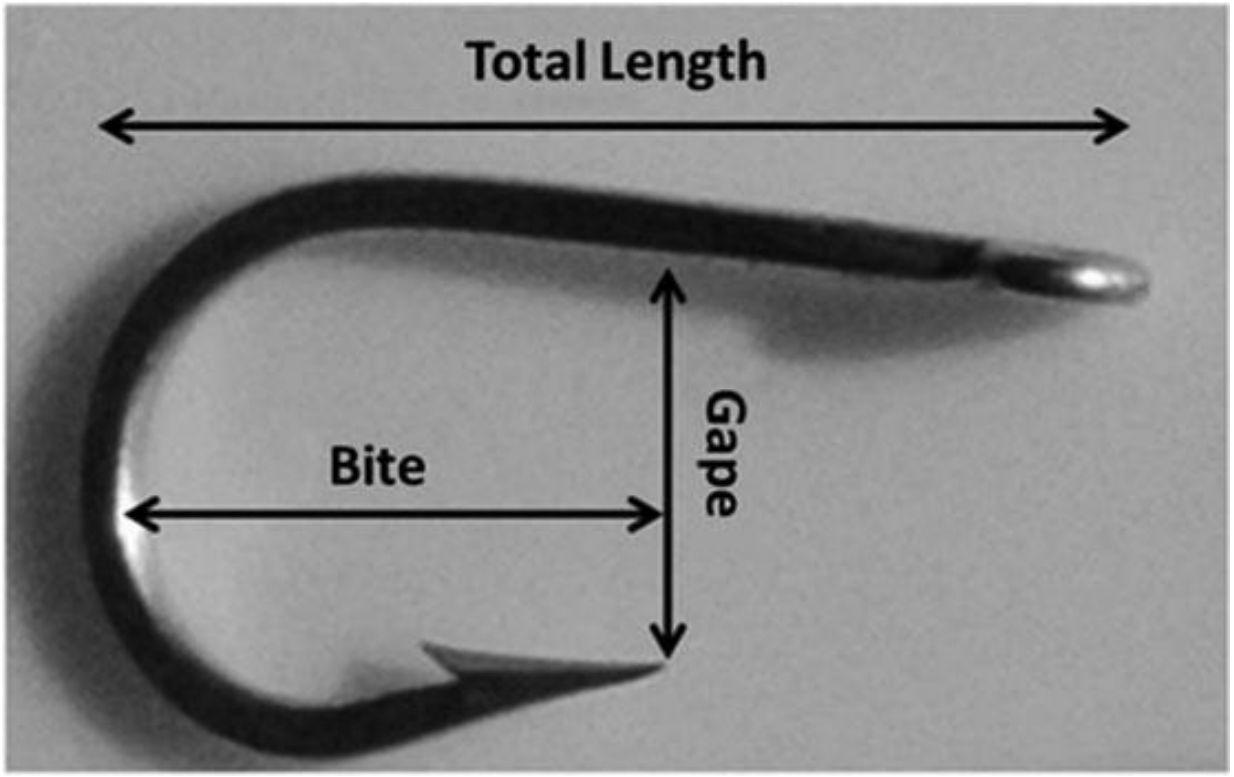


4 HW Hooks Tested

Flattened Hooks

Round Hooks

Hook Measurements

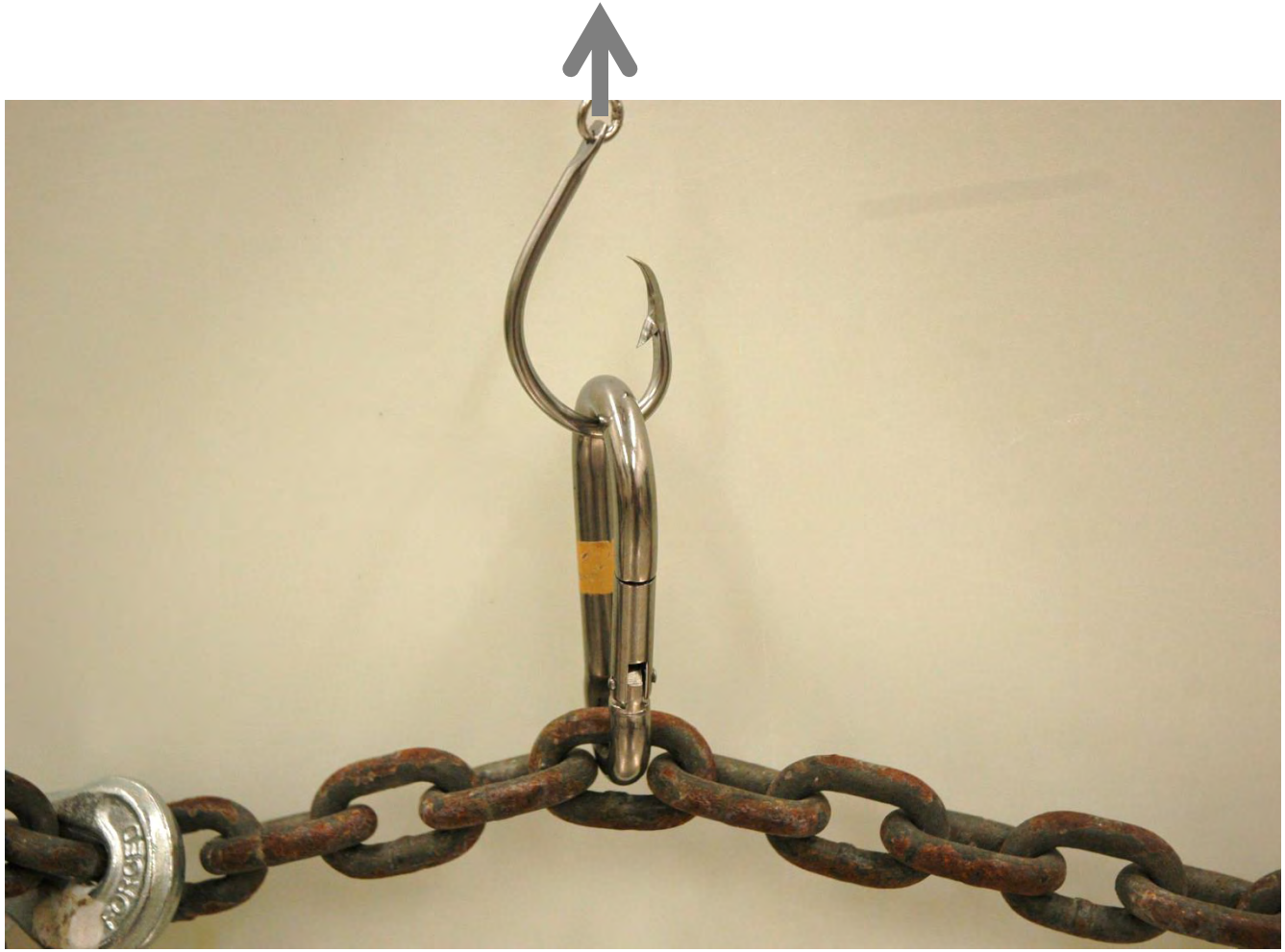


Hook Measurements

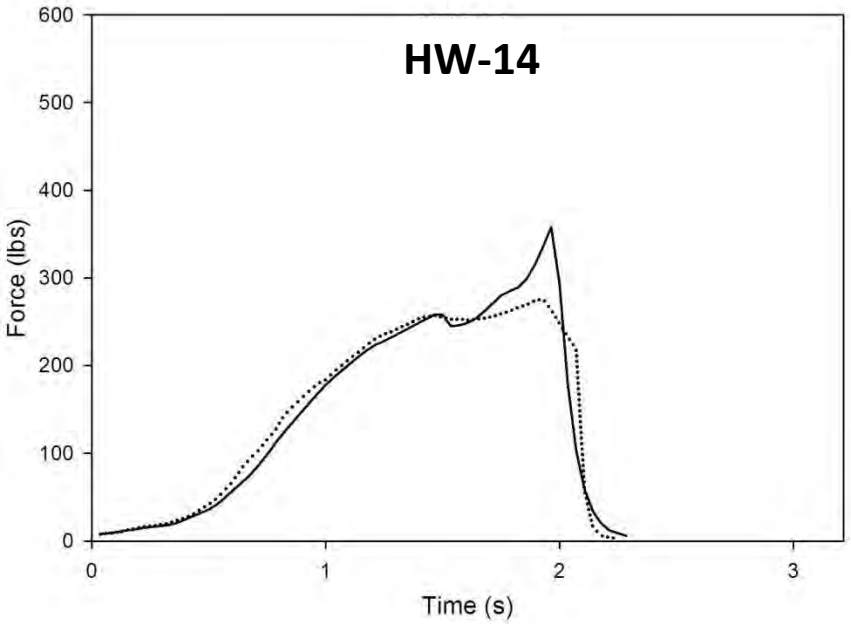
Hook Type	Total Length (mm)	Gape (mm)	Bite (mm)	Gauge (mm)	Weight (g)
HAWAII					
HW-14	53	25	30	3.6/4.5*	13
HW-15F	57	22	28	3.5/4.0*	15
HW-15	61	21	36	4.4	15
HW-15R	62	21	36	4.4	15

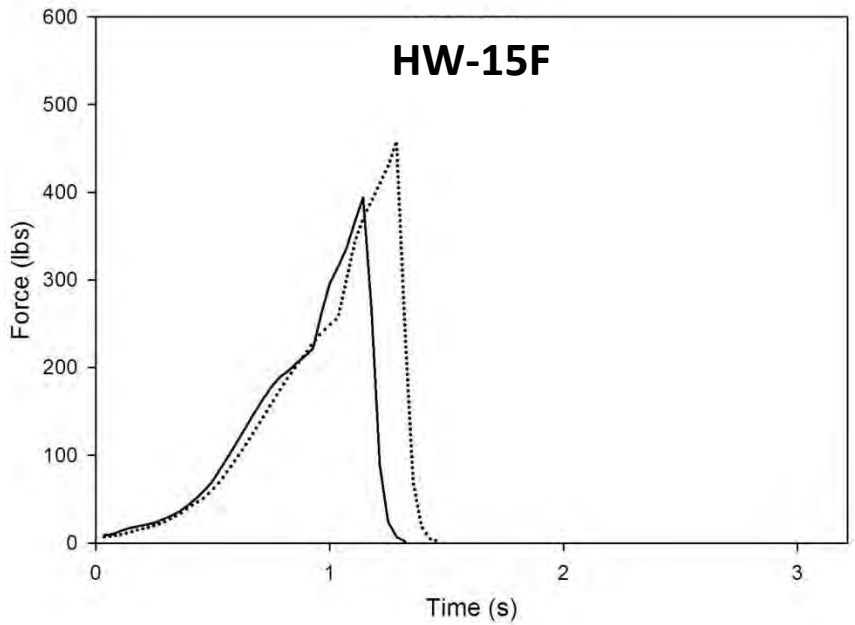
* Flattened width / rounded wire width

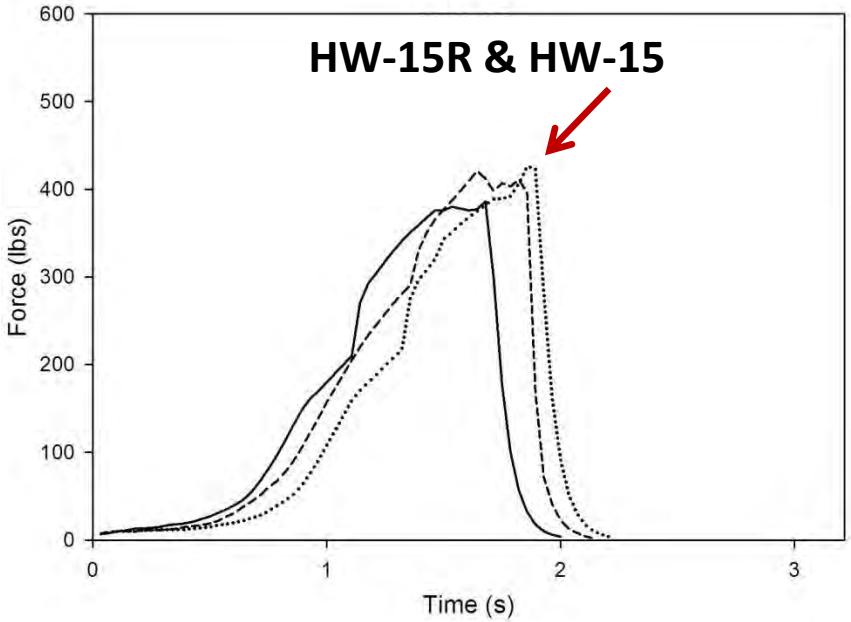
HOOK TEST- ISOLATED



Hook Tests- Isolated







HOOK MEASUREMENTS AND MEAN STRAIGHTENING TESTS

Hook Type	Total Length (mm)	Gape (mm)	Bite (mm)	Gauge (mm)	Weight (g)	Mean straightening force (lbs)
HAWAII						
HW-14	53	25	30	3.6/4.5*	13	317
HW-15F	57	22	28	3.5/4.0*	15	426
HW-15	61	21	36	4.4	15	411
HW-15R	62	21	36	4.4	15	415

* Flattened width / rounded wire width

HOOK MEASUREMENTS AND MEAN STRAIGHTENING TESTS

Hook Type	Total Length (mm)	Gape (mm)	Bite (mm)	Gauge (mm)	Weight (g)	Mean straightening force (lbs)
HAWAII						
HW-14	53	25	30	3.6/4.5*	13	317
HW-15F	57	22	28	3.5/4.0*	15	426
HW-15	61	24	32	4.0	15	401
HW-15R	62	21	36	4.4	15	415

* Flattened width / rounded wire width

Develop a Systematic Approach to Hook Identification/Numbering Scheme

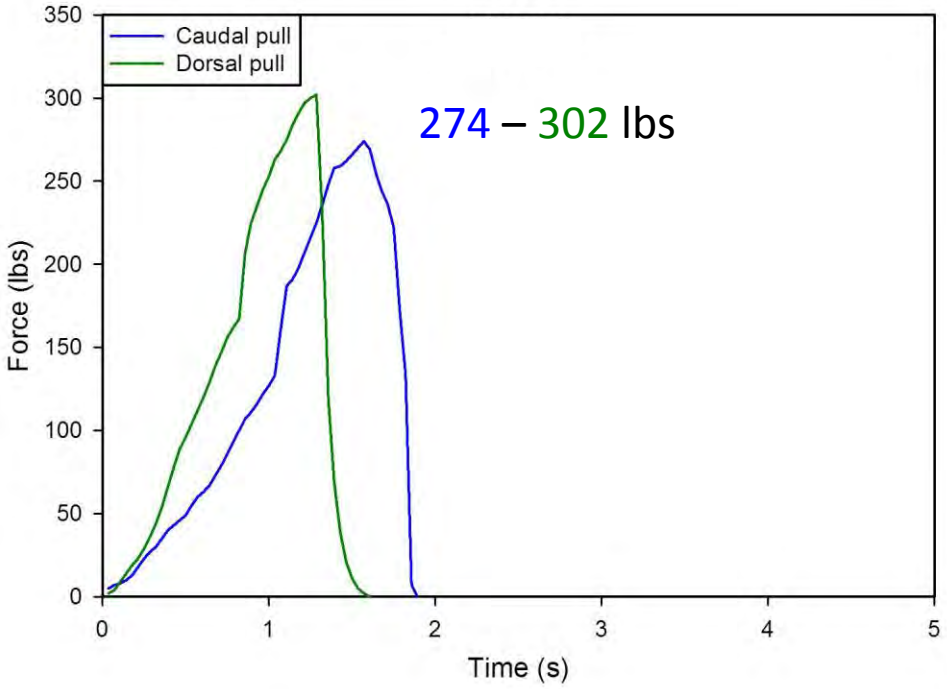
Species Tested To Date:

short-finned pilot whales (*Globicephala macrorhynchus*)


DORSAL
CAUDAL

Flattened Wire Hooks

HW-14

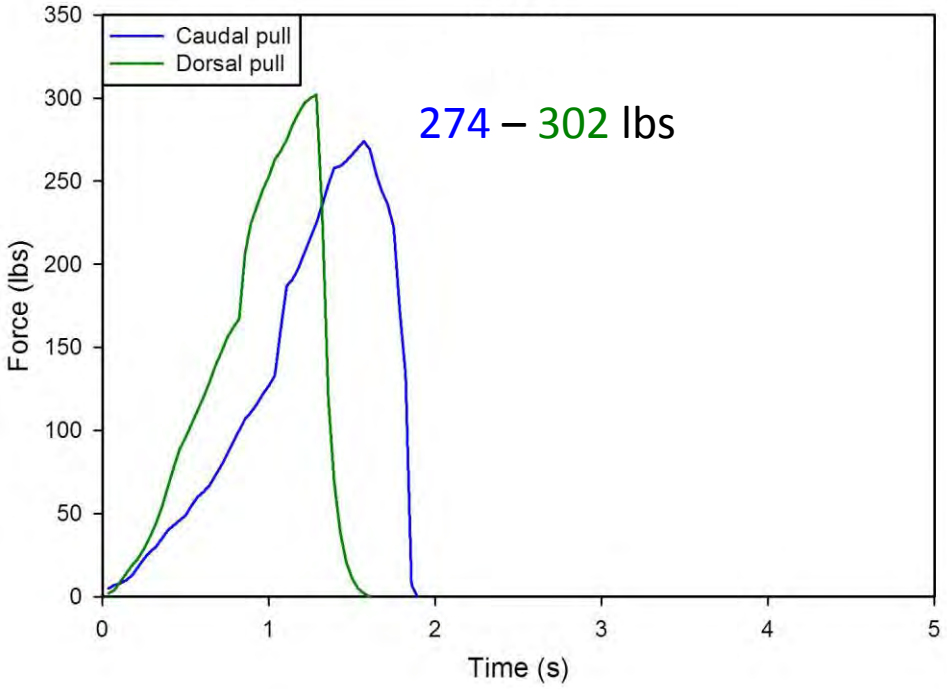


Dorsal Pull

Short-finned pilot whale tests

Flattened Wire Hooks

HW-14



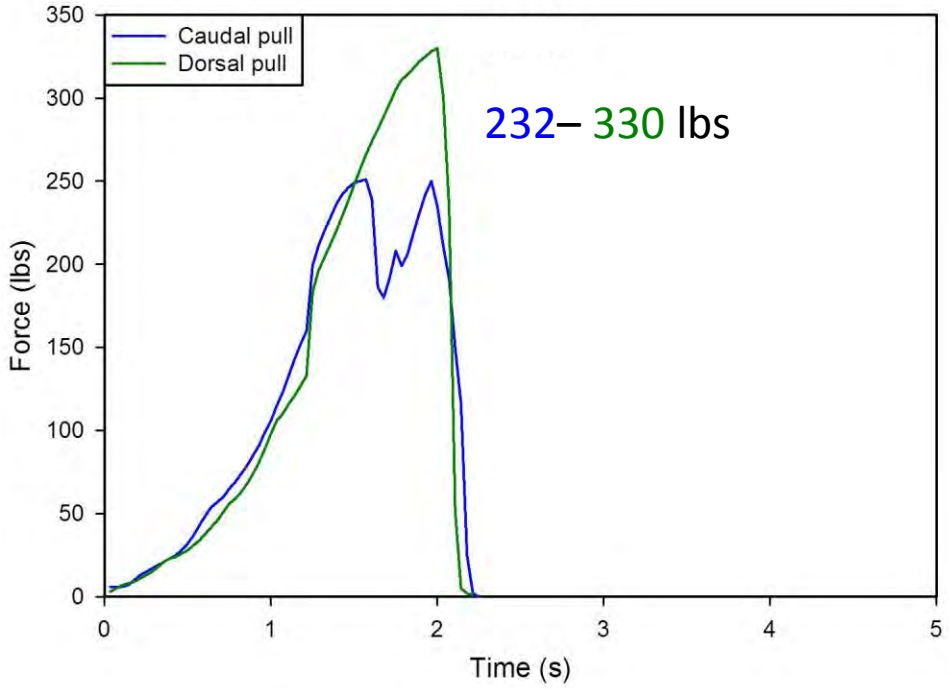
Caudal Pull

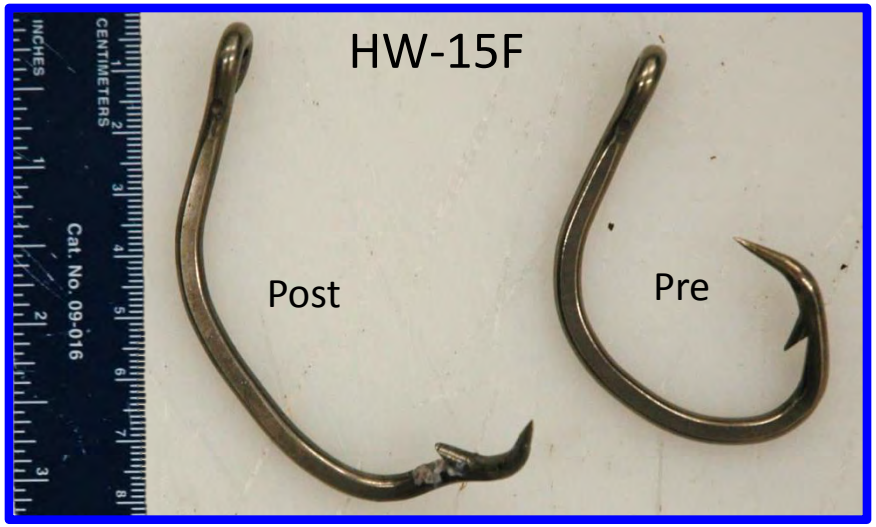
Short-finned pilot whale tests


DORSAL
CAUDAL

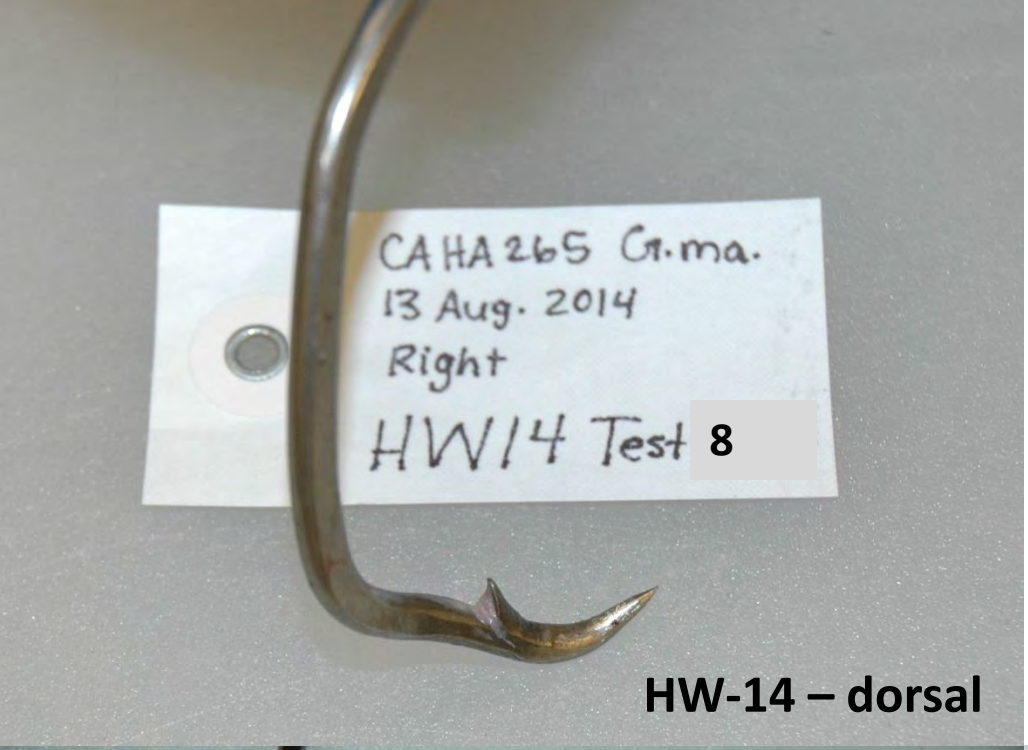
Flattened Wire Hooks

HW-15F





Short-finned pilot whale tests



HW-14 – dorsal

HW 14 & 15 Flattened Hooks

- Bend along hook straightens, exposes barb and point (one HW 14 broke)
- Large barb collects whale tissue (for sampling?)

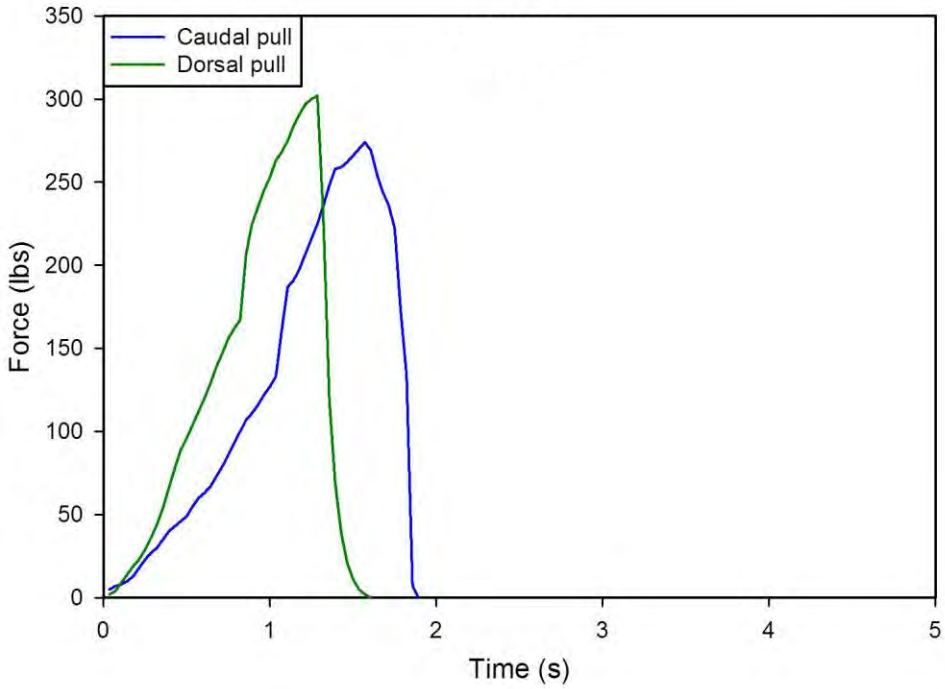
HW-15 – caudal

HW-15 – dorsal

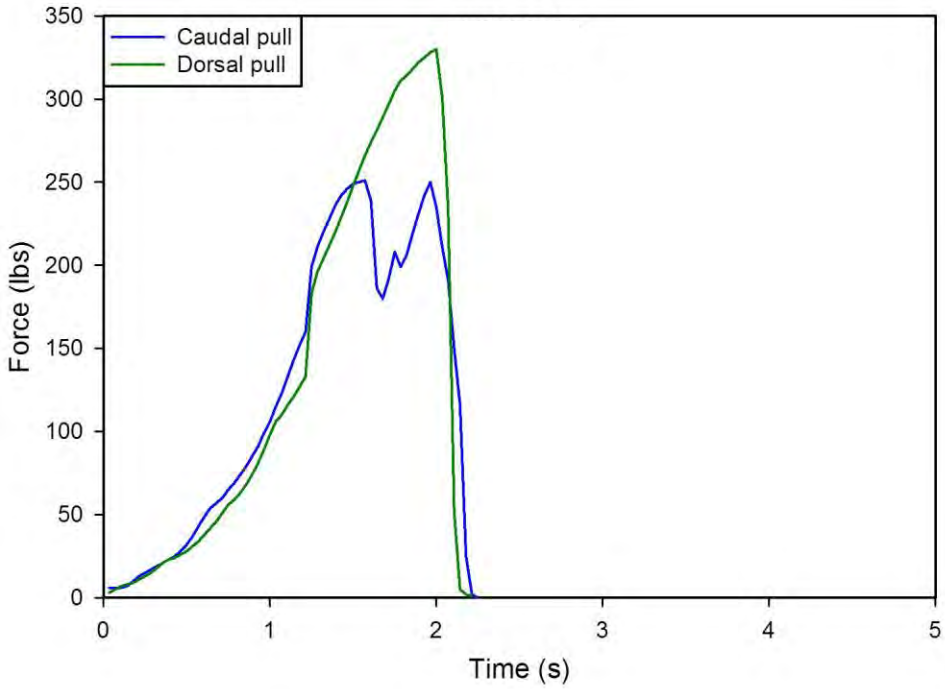
Flattened Wire Hooks

<u>Take home</u>: Flattened hooks deform to expose barb, cuts to release from tissue; HW 14 can break at barb

HW-14



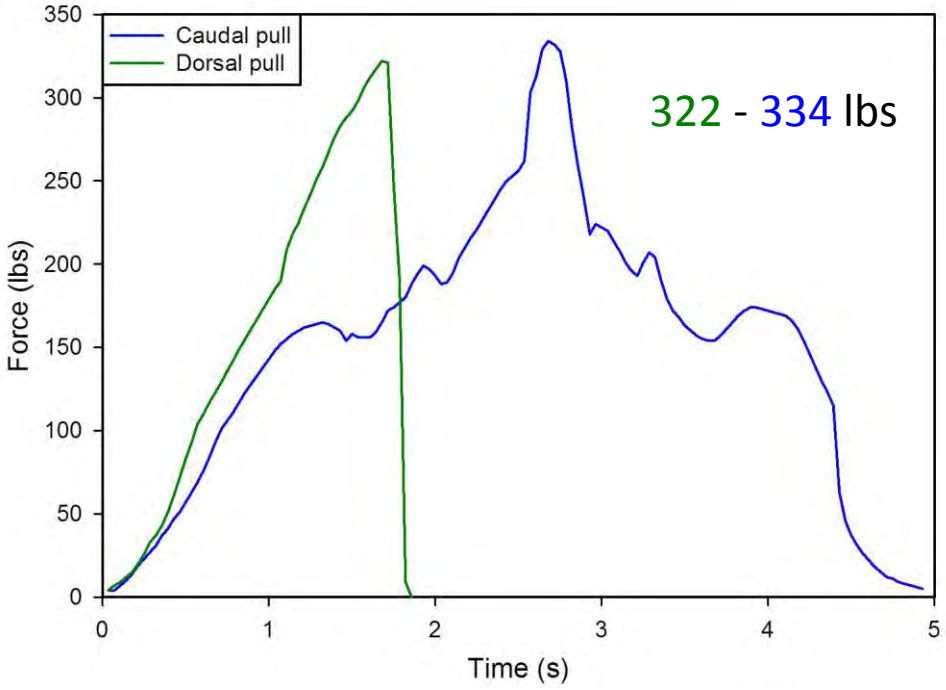
HW-15F

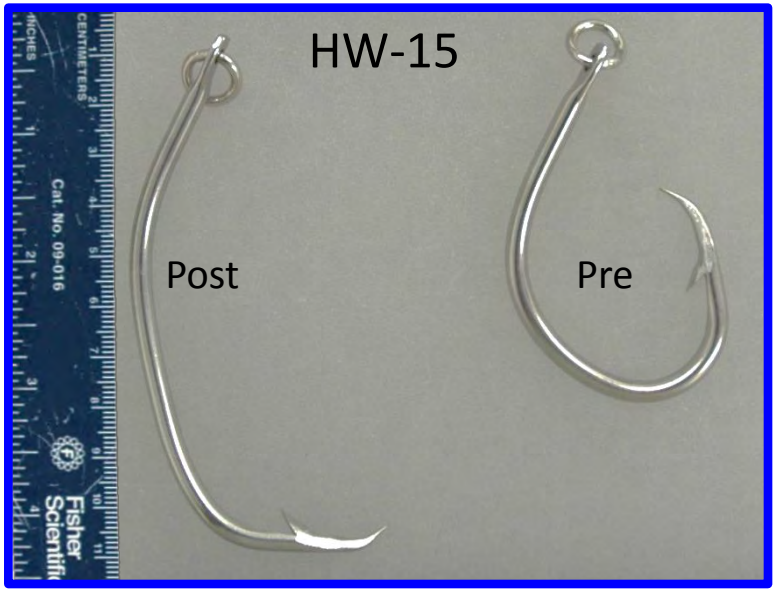


Short-finned pilot whale

Rounded Wire Hooks

HW-15

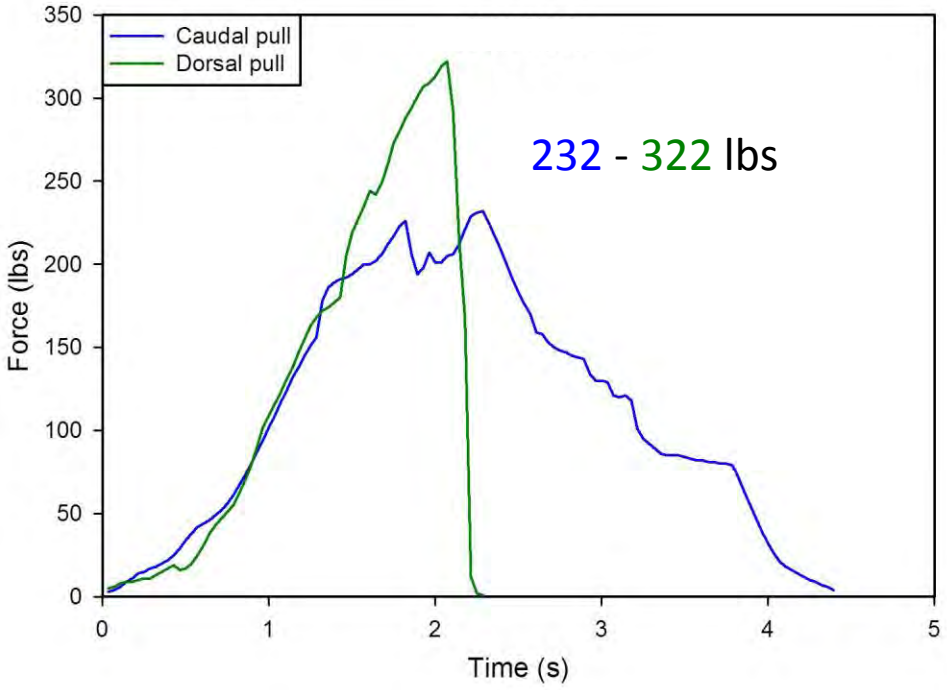


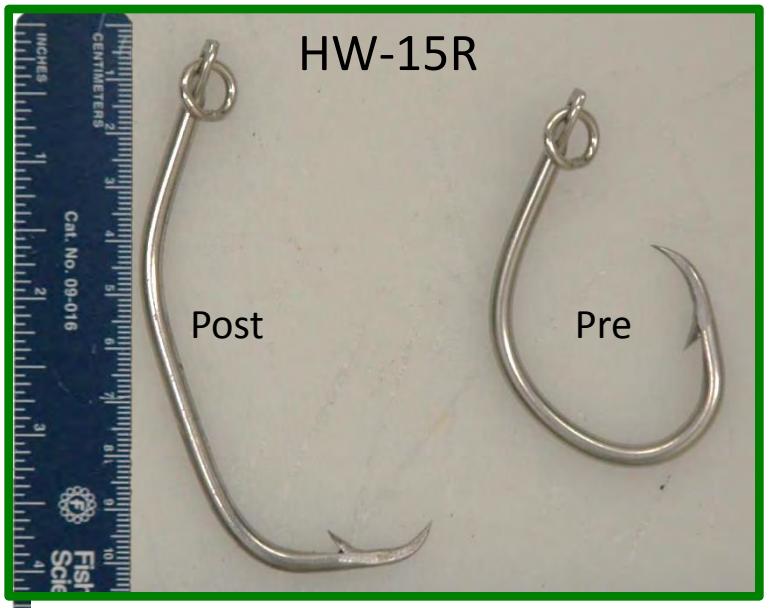


Short-finned pilot whale tests

Rounded Wire Hooks

HW-15R



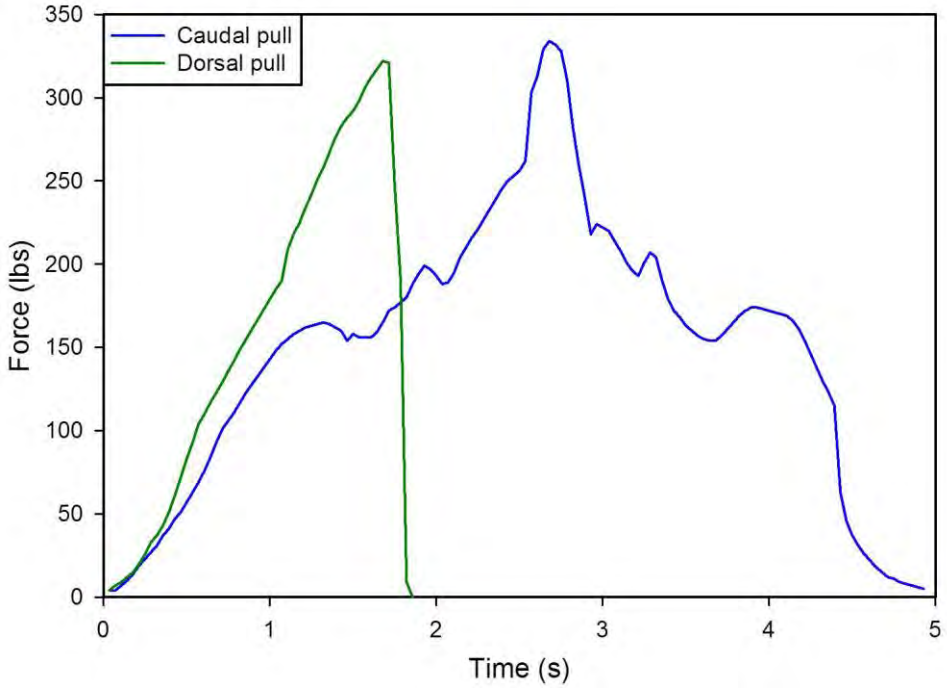


Short-finned pilot whale tests

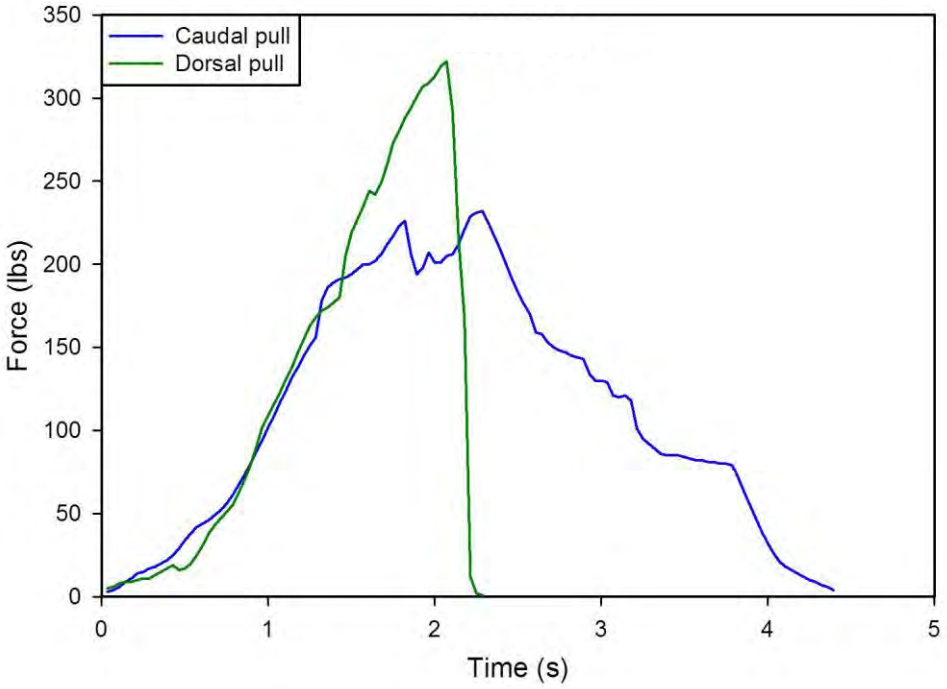
Rounded Wire Hooks

<u>Take home</u>: Rounded wire hooks straightened more along length to expose barb and release from tissue

HW-15



HW-15R



Short-finned pilot whale

Conclusions

- **Systematic naming of hook type would be valuable.**
- **No hooks tested had a large enough gape and/or bite to hook around the jaw in the two adult pilot whales tested.**
- **All Hawaiian hooks tested deformed sufficiently to expose barb and point, which cut through tissue and released hook. Pilot whale lip tissues resisted up to 330 lbs of force.**
- **Flattened wire hooks straightened, but distal portion leaves more of a "hook" remaining.**
- **One HW 14 flattened hook broke at barb (in caudal pull) at lower force than was required to break isolated hook.**
- **Round wire straightened more smoothly along entire length and generally* sliced through tissues more cleanly than flattened hooks.**

Acknowledgments:

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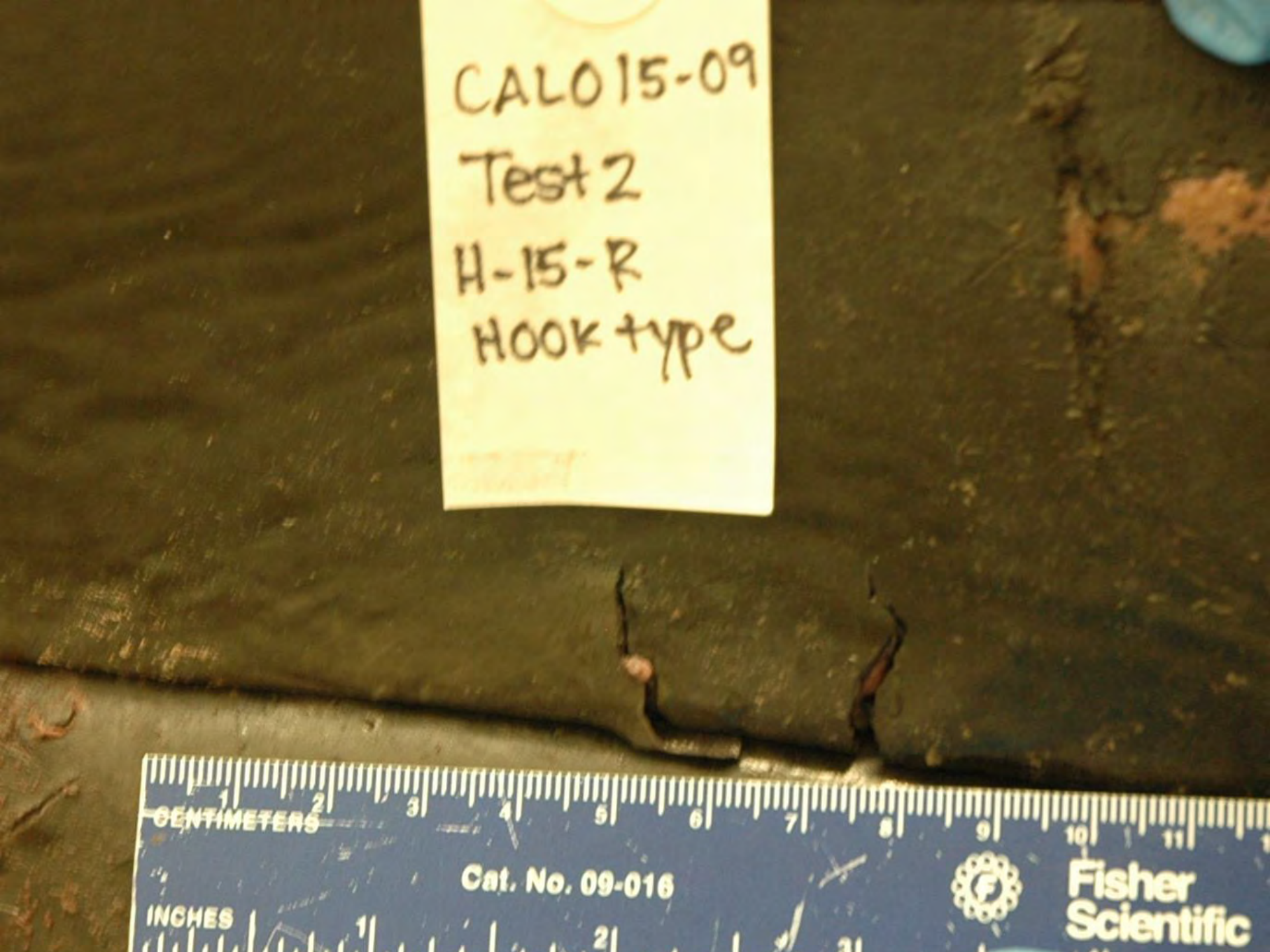
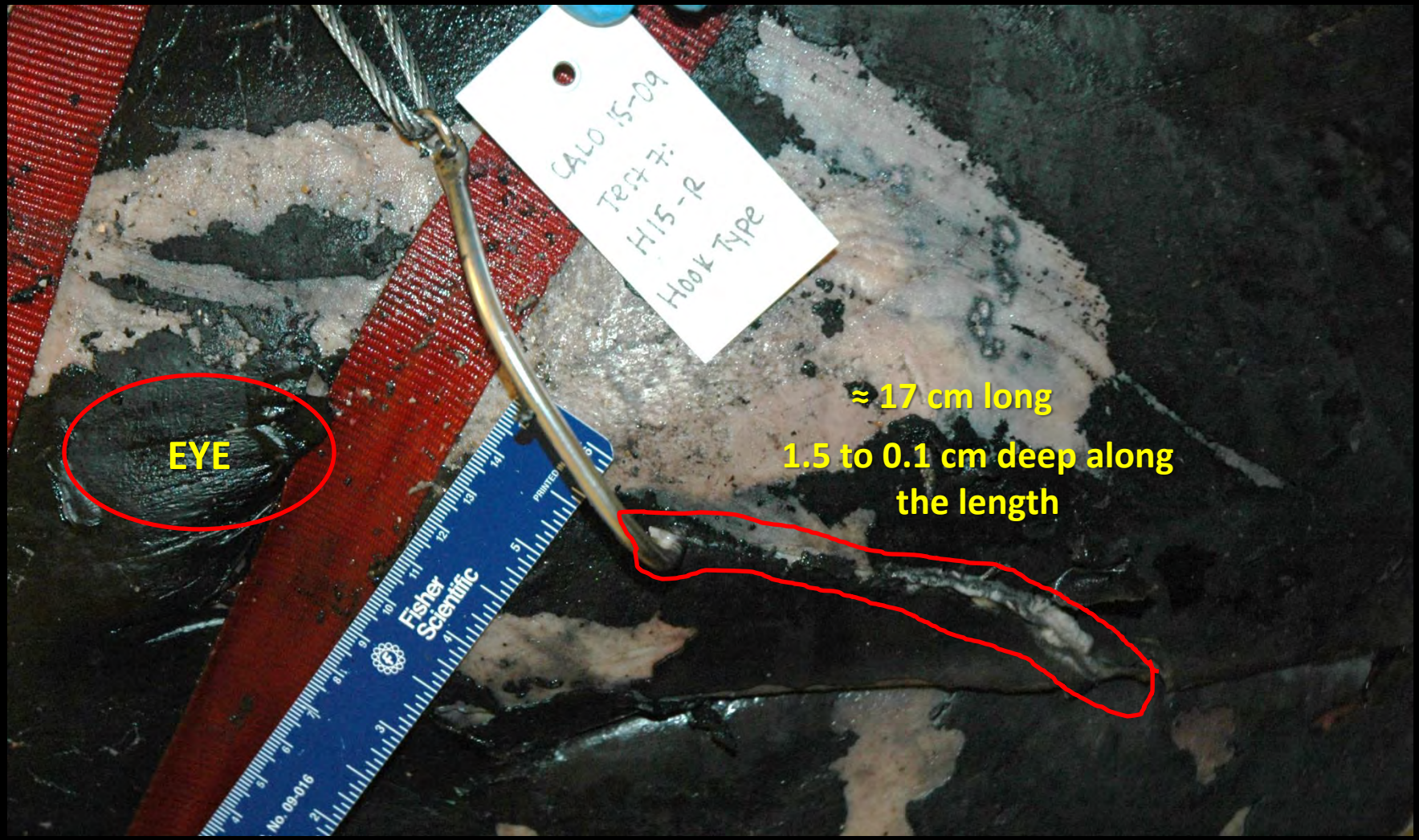
NOAA Prescott Grants
Consortium for Wildlife Bycatch Reduction


CALO 15-09
Test 2
H-15-R
Hook type
CENTIMETERS
Cat. No. 09-016
INCHES
Fisher Scientific


CALO 15-09
Test 7:
H15-R
Hook Type
EYE
≈ 17 cm long
1.5 to 0.1 cm deep along
the length
Fisher Scientific