



# Catch rates with variable strength circle hooks and the potential to reduce false killer whale injury in the Hawaii-based tuna longline fleet

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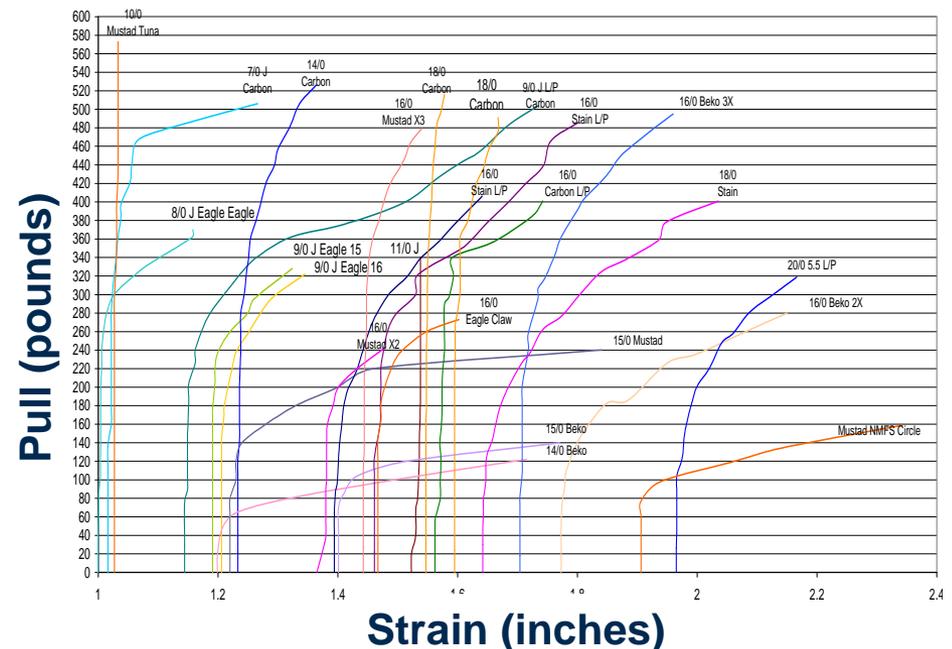
## Introduction: MMPA, the TRT, and the TRP

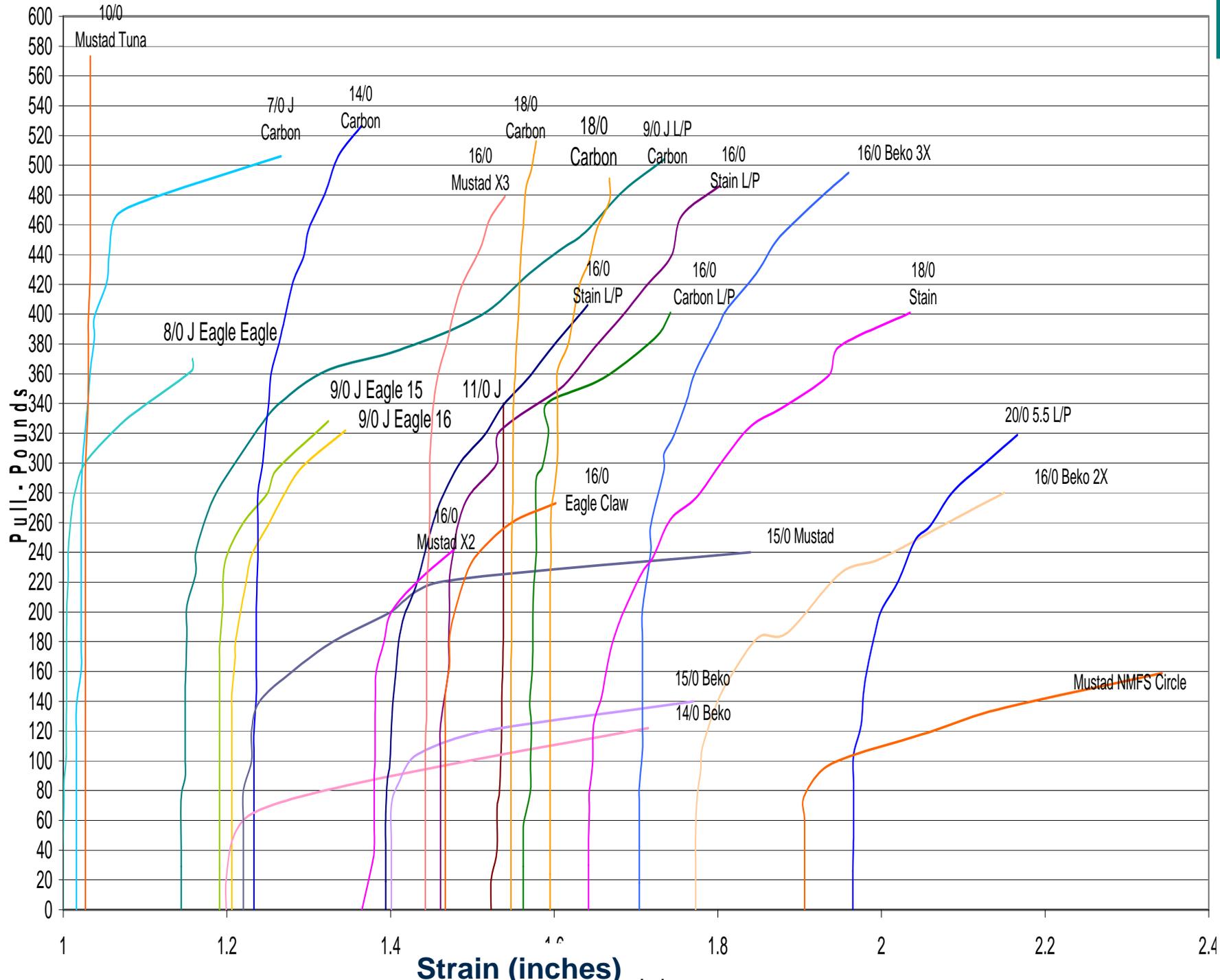
- Under MMPA, a take reduction plan (TRP) required for the Hawaii-based deep- and shallow-set fisheries for the “strategic” Hawaii Pelagic stock of false killer whales.
- A false killer whale Take Reduction Team (TRT) established in January 2010; TRT submitted a Draft TRP in July 2010.
- TRP included such measures as increased training on best practices to reduce marine mammal bycatch.
- The main longline research recommendation was to evaluate so-called “weak” circle hooks regarding the catch of bigeye tuna and bycatch of false killer whales.



# Introduction: Weak Hooks

- Current regulations only address size and material
- Strength differences between hooks could be used to exploit weight differences between catch and bycatch species

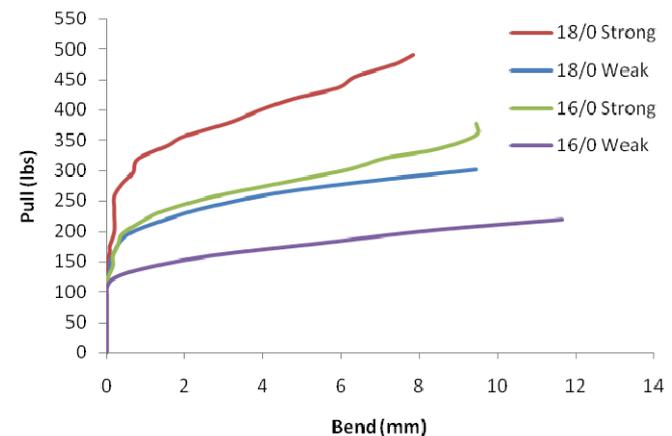
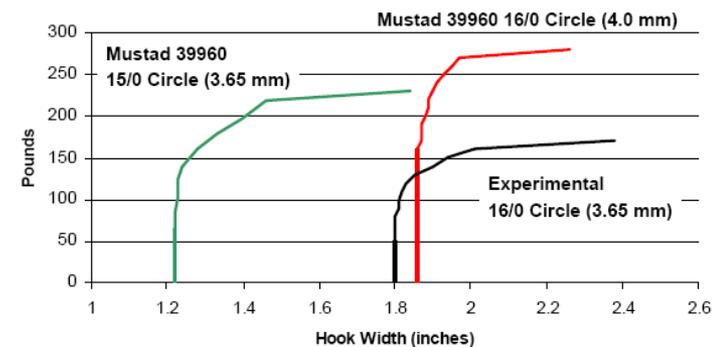






# Introduction: Weak Hook Studies

- Few studies to date:
  - Gulf of Mexico yellowfin tuna (bluefin tuna)
  - Atlantic yellowfin tuna and swordfish (pilot whales)
  - This study: Hawaii bigeye tuna (false killer whales)
- Commonalities:
  - Alternating hooks
  - Sizable weight differences between targets and bycatch





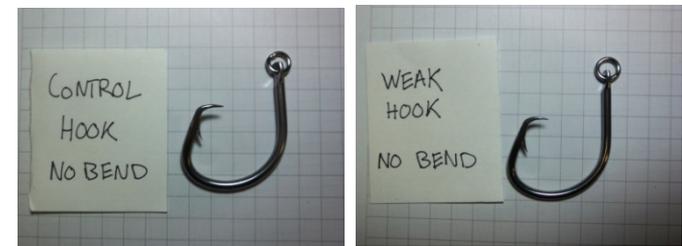
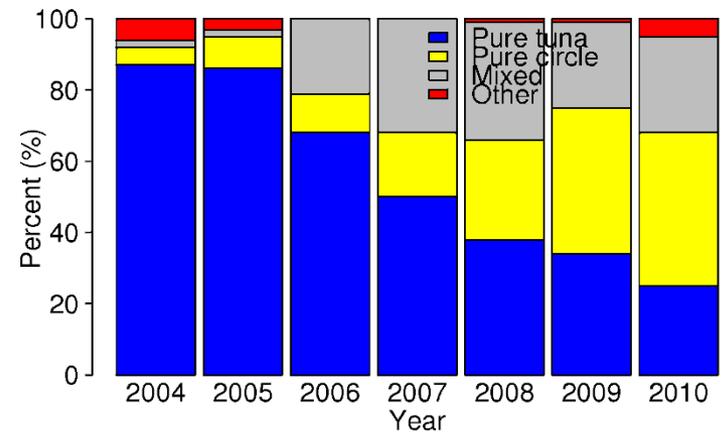
## Introduction: Study Parameters

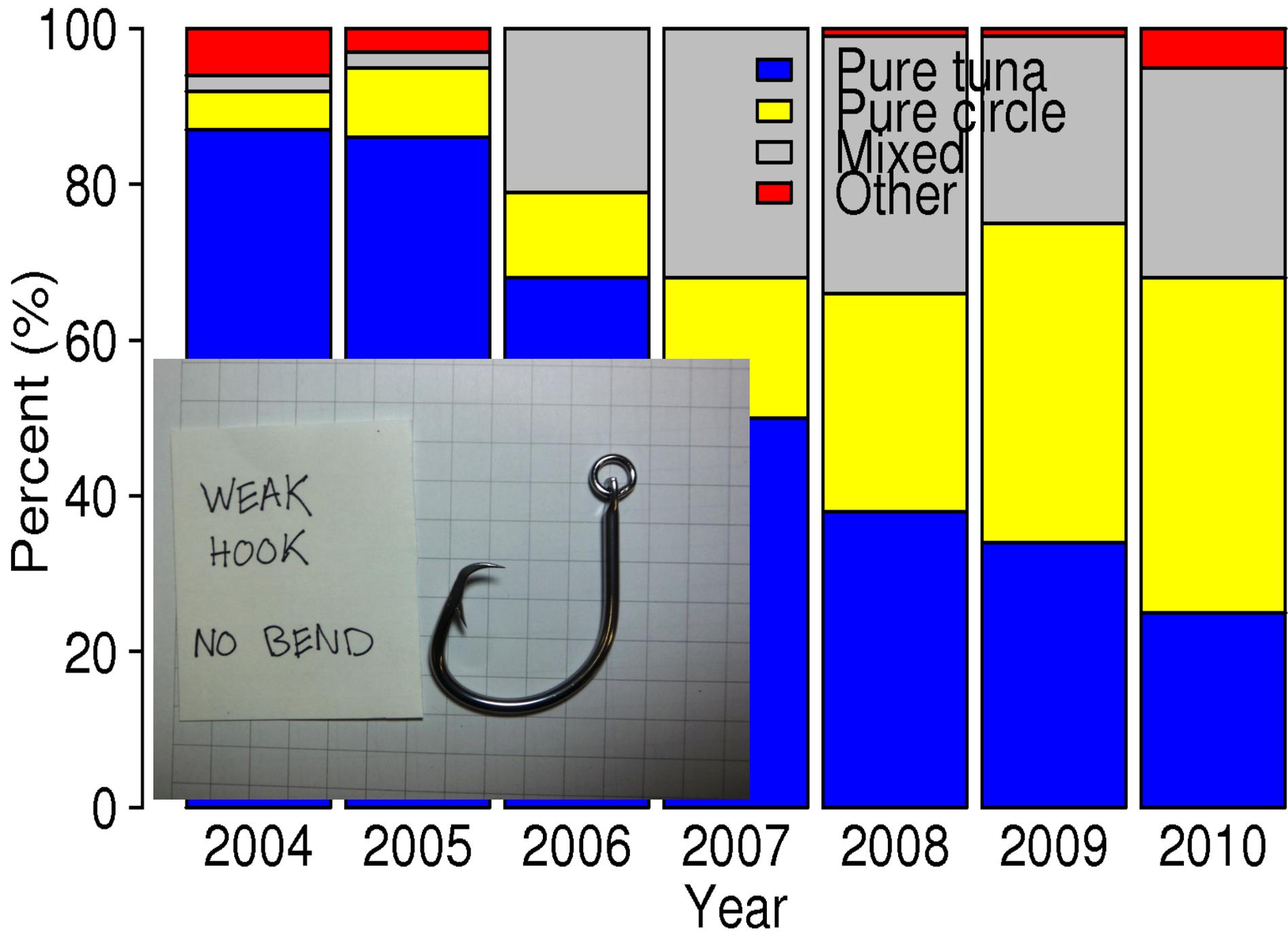
- As with prior studies, low bycatch rates for marine mammals makes statistical testing on them impractical; study focused on target species catches
- This study examined the following:
  - Catch rates of target, incidental (retained non-target), and bycatch (discarded or released) species;
  - Size selectivity; and
  - Frequency of straightened hooks



- Ringed and eyed circle hooks: size 15/0, stainless, offset 10°
- Strength tests:
  - Control hook (4.5 mm) straightened at ~303 lbs (137.7 kg, n=3, range: 300-310 lbs)
  - Weaker hook (4.0 mm) straightened at ~205 lbs (93.2 kg, n=6, range: 196-214 lbs)

## Methods: Hooks

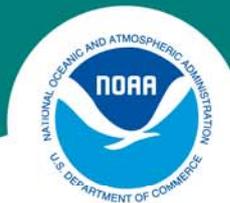






## Methods: Deployments

- In all longline deployments, vessels sequentially alternated control and experimental hooks (1:1 ratio)
- Branchline snaps marked with cable ties to allow easy identification of the terminal hook type and fish catch
- Vessel captains chose where they fished and were allowed to retain and sell their catch
- All sets observed by PIRO-trained fisheries observers, who recorded and measured all catch; all bent hooks were also retained and numbered by observers to match with individual animal



## Methods: Bigeye Lengths/Weights

- Additional analyses were considered for target bigeye tuna as fishermen preferred analyses structured upon catch weight compared to catch numbers.
- A randomization test was used to assess differences in the bigeye tuna catches in weight between hook types for each longline set..



## Methods: Statistical Analyses

- A randomization test was used to assess catch differences between hook types. The test statistic ( $S$ ) was the average difference in catch between paired control circle hooks and weak circle hooks by set.
- Data were randomized, resampled 10,000 times, and scored for whether or not the resampled  $S$  value was equal to or greater than the observed  $S$  value.
- Fish lengths were transformed to natural logarithms and tested for hook type effects using one-way ANOVA.

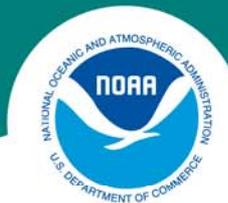
**Note: sharks not landed, so lengths not assessed.**



## Results: Deployments

- Four fishing vessels conducted 10 trips in the vicinity of the Hawaiian Archipelago from October-December 2010
- 127 experimental sets, with a total of 302,739 hooks (two sets excluded for not reaching 2000 hook minimum)

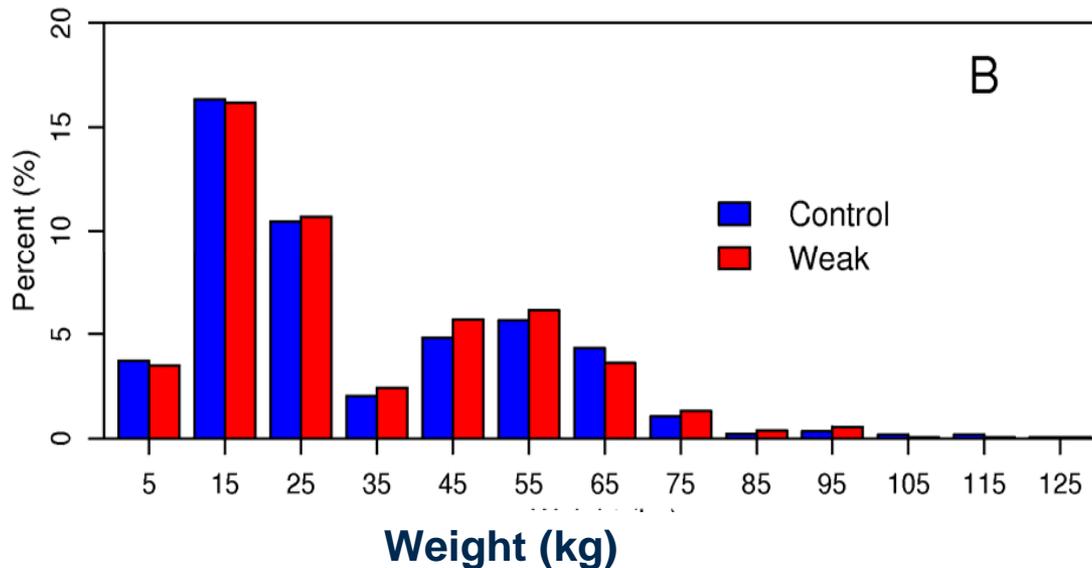
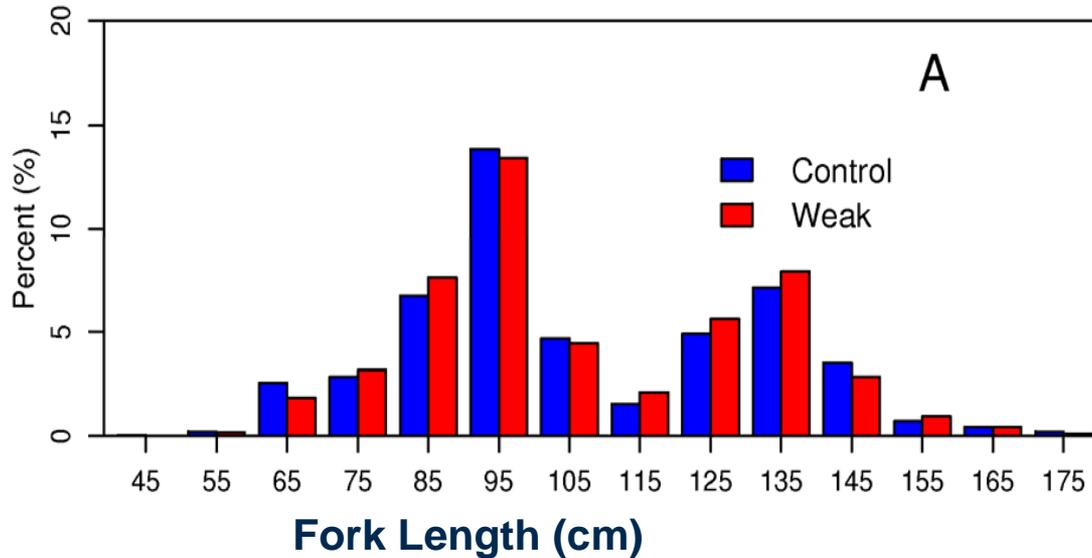




## Results: Catches – Overall

- 8,024 individual animals representing 48 species or species groups
- 22 species had greater than 14 individuals captured; these represented 97.9% of the total catch by number.
- By number, bigeye tuna (1,888 individuals) were the most predominant catch, followed by lancetfish (1,302), blue shark (1,163), and dolphinfish (939)
- Nominal CPUE of all 48 species captured was 26.29 for control and 26.11 for weaker circle hooks and nominal CPUE of retained species was 13.75 for control and 13.81 for weaker hooks

# Results: Bigeye Summary

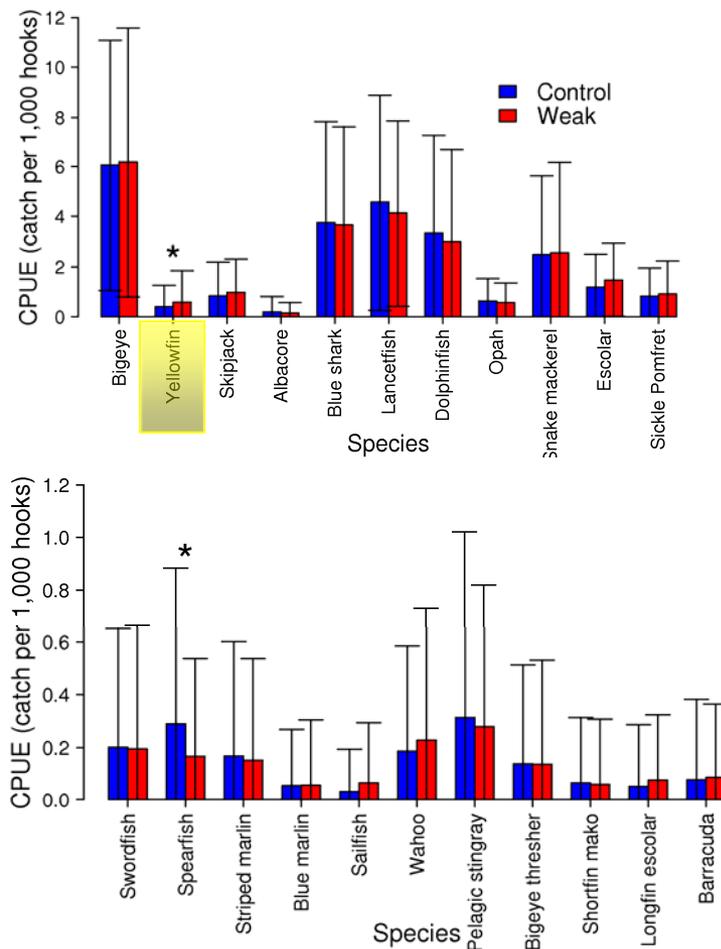


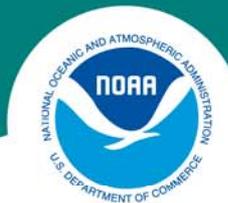
**There were no significant differences in bigeye tuna catch per set expressed in number of individuals or weight estimated from fork lengths.**



# Results: Catch Rates - Fishes

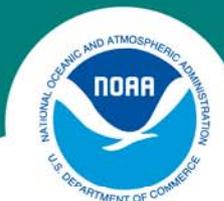
- Randomization tests detected no significant differences in CPUE between hook types for 20 species
- Significant differences for yellowfin tuna and spearfish, but results were inconsistent; yellowfin catches were higher on weaker hooks and spearfish catches were higher on control hooks





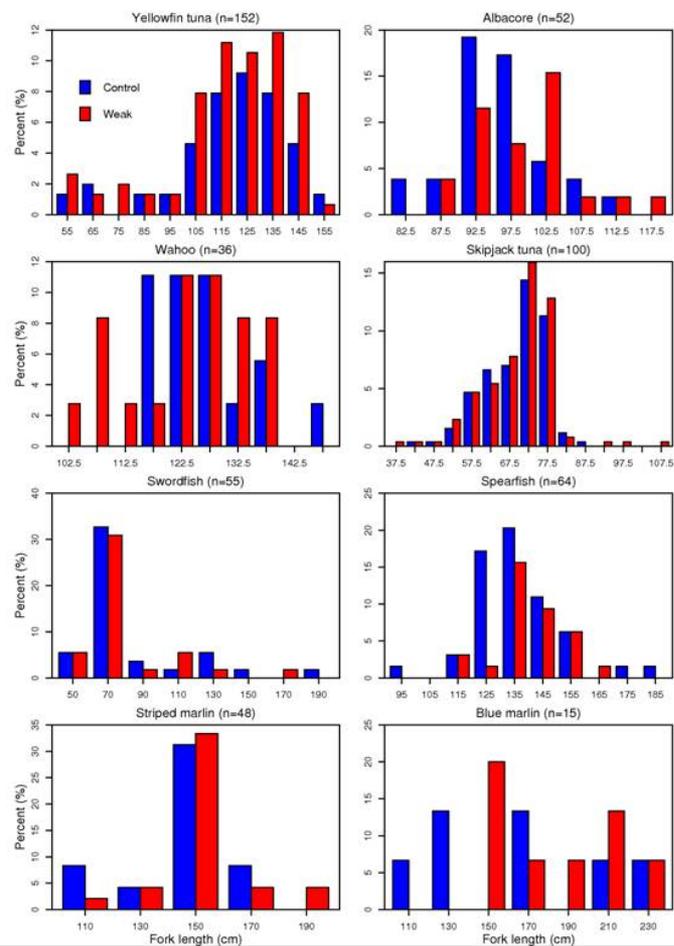
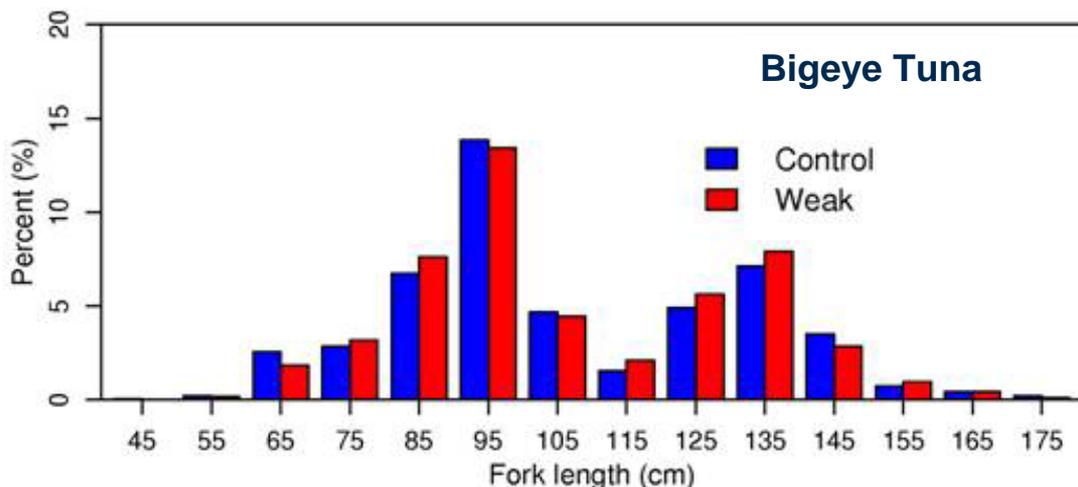
## Results: Catches – Protected Species

- One olive ridley turtle (65 cm carapace length).
  - Hooked with a control hook in the front flipper on the 7th hook from the floatline
  - The turtle had little response when brought aboard and was pronounced dead after a 22 hr period of attempted resuscitation and monitoring
- One false killer whale (~4.3 m/~14 ft estimated)
  - Caught on control hook; leader was on “lazy line”
  - Animal straightened hook and released; swam away with no apparent injuries, no hook, and no trailing gear



# Results: Length-Frequencies

- F-tests indicated no significant differences ( $P > 0.05$ ) between hook types in mean fish length for 15 non-shark species.

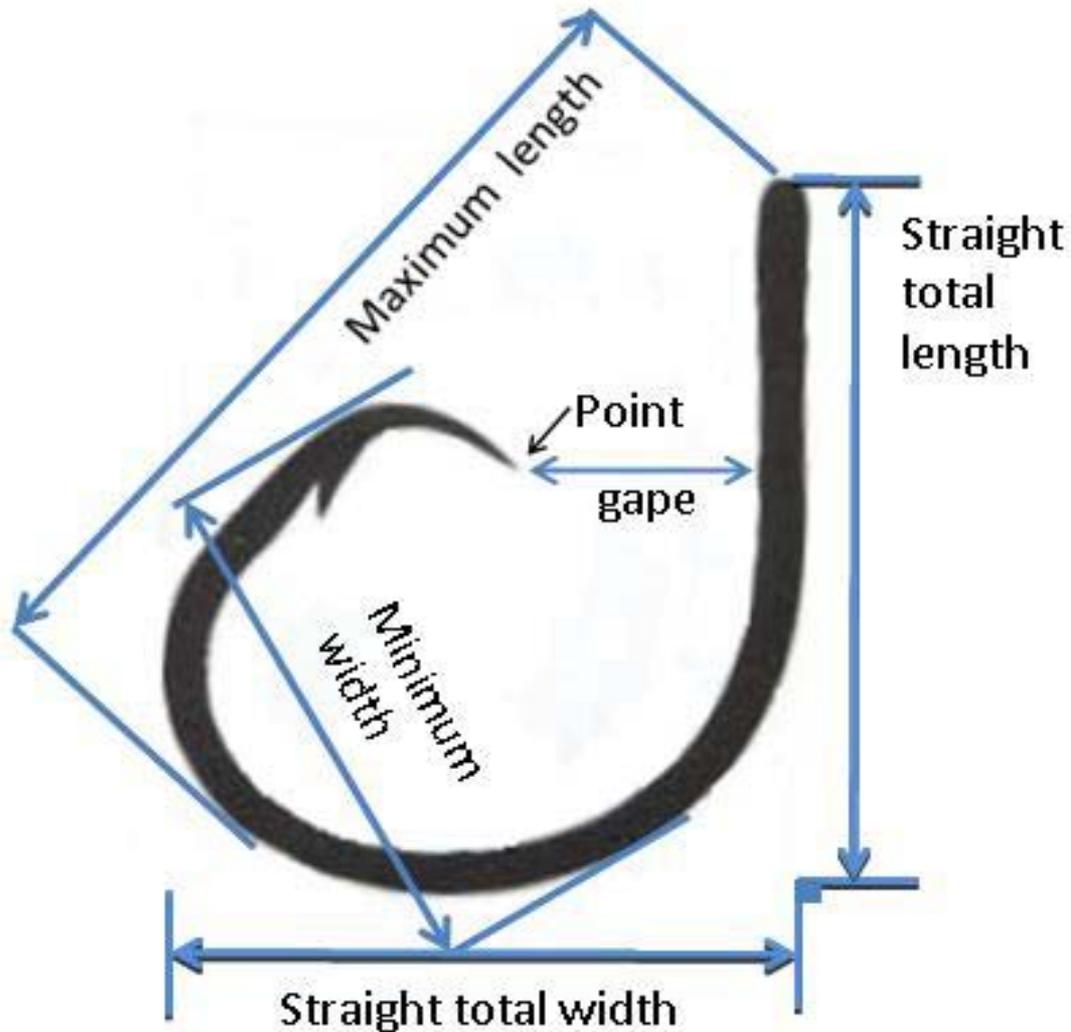




## Results: Straightened Hooks

- 76 straightened hooks: 6 control and 70 weak; weak hooks had a higher rate of straightening ( $\chi^2=53.895$ ,  $P<0.0001$ ).
- There was no catch associated with 49 straightened (5 control and 44 weak) hooks
- Catch on remaining 27 hooks:
  - Straightened weak hooks retained 20 bigeye tuna (average=146.7 cm FL), four blue marlin (average=188.0 cm FL), one yellowfin tuna (140 cm FL), and one bigeye thresher shark (~ 7 ft)
  - One bigeye tuna (173 cm FL) was retained on a straightened control hook

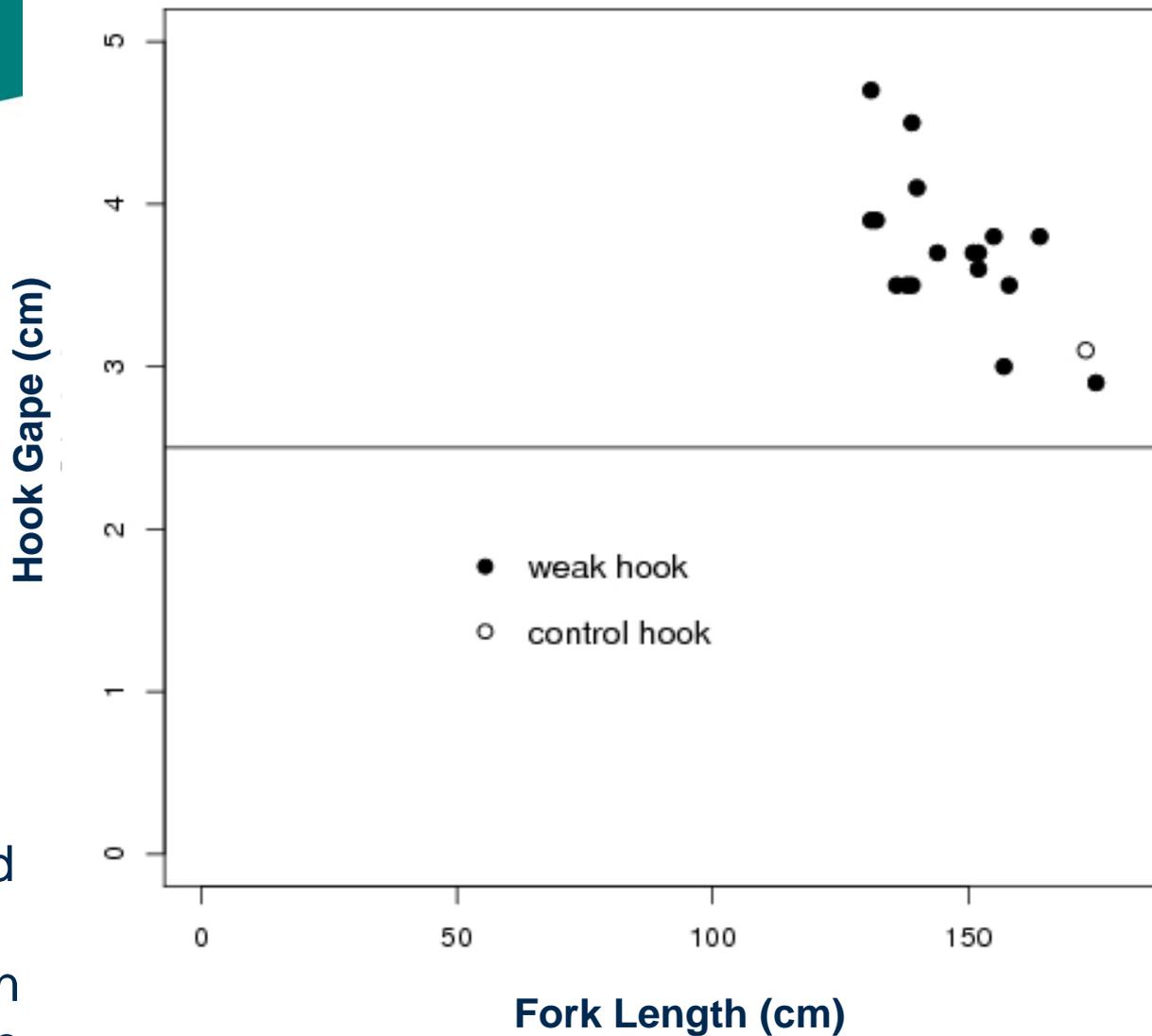
# Hook measurements



- The magnitude of deformation was estimated from the gape size in relation to a 2.5 cm gape of a non-deformed hook:



- For 18 bigeye retained on straightened hooks (with known FLs), a 131 cm (~50 kg) fish had the largest hook deformation (4.7 cm gape width)
- The negative relationship between hook deformation and bigeye size suggests that bigeye escape on weaker hooks at large (>50 kg) sizes

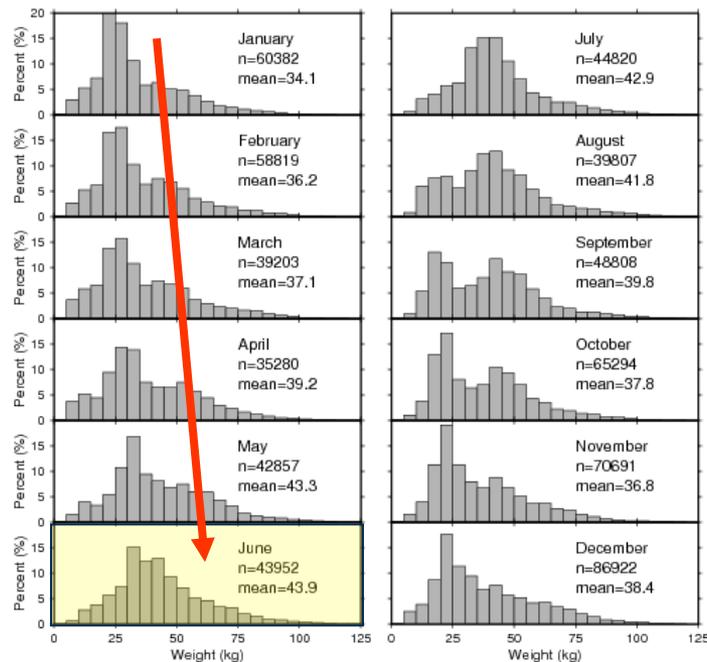


Horizontal line at 2.5 cm is the gape width of an unfished hook.



# Results: Bigeye Temporal Variability

- Monthly average weight of bigeye tuna landed from 2005 to 2009 ranged from a low of 34.1 kg (75.0 lb) in January to a high of 43.9 kg (96.6 lb) in June.
- Bigeye tuna landed during October-December ranged from 36.8 to 38.4 kg or averaged ~6 kg less than in June.





## Conclusions

- No difference in target catch rates for bigeye tuna and most other fishes
- Only one observed hooking interaction with a marine mammal, despite 302,739 deployed hooks in Hawaii research – very, very large numbers of hooks likely needed to achieve any statistical significance in marine mammal catches
- Large individuals of many fish species (e.g., manta rays) still retained by “weak” hooks in all such studies





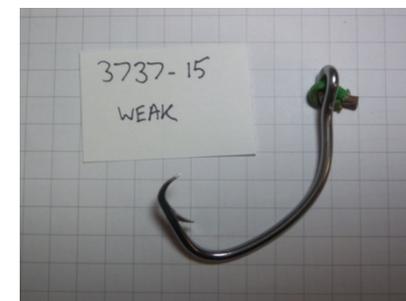
## Conclusions

- Terminal gear (hook) changes can be the least intrusive means for bycatch reduction, but fishery buy-in essential
- Weak hooks are not the solution for all bycatch problems – just the biggest species – but may still be another potentially useful “tool” in the fisheries management toolbox

**Control hook straightened by a false killer whale (A), weak hook with a 131 cm FL retained bigeye tuna (B), and a weak hook from an unknown animal (C).**



A



B



C



# Acknowledgements

- Captains/crews of F/Vs *Kimmy 1*, *Knowledge*, *Lihau*, and *Miss Lisa*
- Hawaii Longline Association for overall vessel logistics
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