Assessment of Patterns in the Observer Data

Karin A. Forney (SWFSC), Donald R. Kobayashi (PIFSC),
David W. Johnston (PIFSC/ Duke University)

Photo: NOAA-PIRO Observer Program

False Killer Whale Take Reduction Team Meeting

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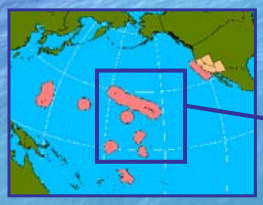
Many thanks to:

- PIRO Observer Program
- The Hawaii longline fishing community

Hawaii-based longline fisheries

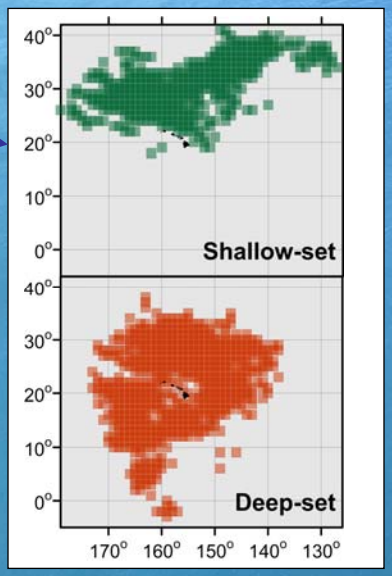


Shallow-set (swordfish)
2004 regulations for turtles and seabirds, including:

- Limit of 2,120 sets/yr
- 100% observer coverage
- 18/0 offset circle hooks
- Turtle mortality cap

Deep-set (tuna)

- ~12,000 sets/yr
- ~25% observer coverage



Objectives

Emphasis on false killer whales or 'blackfish'

1. Examine cetacean **depredation** rates relative to gear and habitat variables to see if interactions can be avoided/reduced
2. Examine cetacean **bycatch** rates relative to gear and habitat variables *when cetaceans were documented in contact with catch or gear* to see if takes can be avoided/reduced.
3. Examine catch rates of **target species** relative to potential mitigating factors.

VARIABLES EXAMINED:

- Geographic location
- Month, year
- Gear configuration (e.g., hook type, hooks per float, mainline length, number of hooks,…)
- Set characteristics (e.g., deep vs. shallow, day vs. night,…)
- Environmental variables (water temperature, surface chlorophyll, currents, bathymetry, etc.)
- Vessel characteristics

Methods: Data Sets

OBSERVER PROGRAM DATA INCLUDED

- Deep-set (DSLL) and shallow-set (SSLL) fisheries
- August 2003 – June 2009
- Marine mammal depredation systematically recorded
- Excluded 19 vessels during and after gear experiments
- Excluded 2 trips in 2009 not yet fully processed

	DSLL	SSLL
# Trips	1,499	348
# Sets	18,875	6,097
# Sets with mammal damage	1093	182
# cetacean takes	48	18
# 'blackfish' takes	34	2
# false killer whale takes	23	1

→ **CONSIDER DSLL AND SSLL FISHERIES SEPARATELY**

Methods: Statistical Tests

STATISTICAL TESTS:

1. **Descriptive analyses and plots:** Compare variables for sets with and without depredation; examine rates of take/depredation by variable
2. **Randomization tests:** Examine significance with randomization tests.
3. **Regression models (GLM, GAM) and Classification and Regression Trees (CART, RandomForest):** Examine whether a suite of variables can help predict depredation or bycatch (presence/absence)

DATA USED

1. **Depredation rates: All sets (18,875 DSLL, 6,097 SSLL)**
2. **Bycatch rates: All sets where cetaceans interacted with catch or gear (mammal damage or cetacean take: 1,117 DSLL, 200 SSLL)**

CAVEATS:

- **Sets not independent, samples sizes small**

→ **Exploratory analysis only**

Objective 1

Emphasis on false killer whales or 'blackfish'

1. Examine cetacean **depredation** rates relative to gear and habitat variables to see if interactions can be avoided.

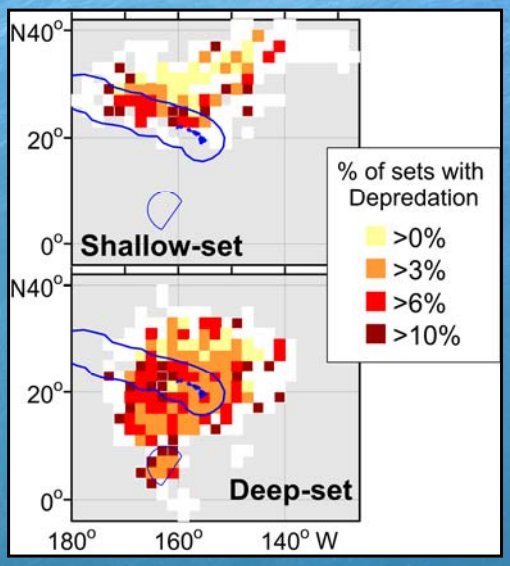
   → Emphasis on DSLL fishery

2. Examine cetacean **bycatch** rates relative to gear and habitat variables when cetaceans were documented in contact with catch or gear.

Frequency of depredation and marine mammal takes, 2003-2008
(excluding vessels during and after experimental trips)

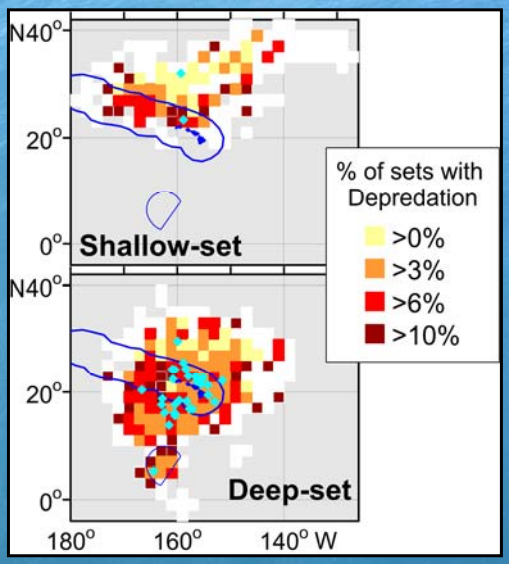
DEEP-SET	# Sets	%	Sets with MM Takes	
Sets with MM depredation	1000	6%	20	2.0%
Sets without MM depredation	16729	94%	22	0.1%
TOTAL	17729		42	0.2%
SHALLOW-SET	# Sets	%	Sets with MM Takes	
Sets with MM depredation	130	3%	0	0.0%
Sets without MM depredation	4588	97%	14	0.3%
TOTAL	4718		14	0.3%

Results: Depredation Spatial Patterns, SSLL and DSLL

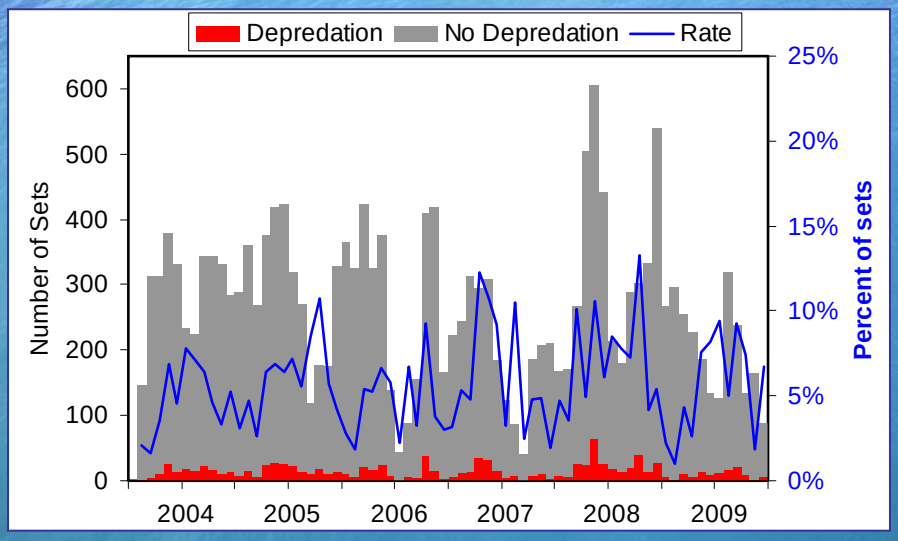


Results: Depredation
Spatial Patterns, SSLL and DSLL

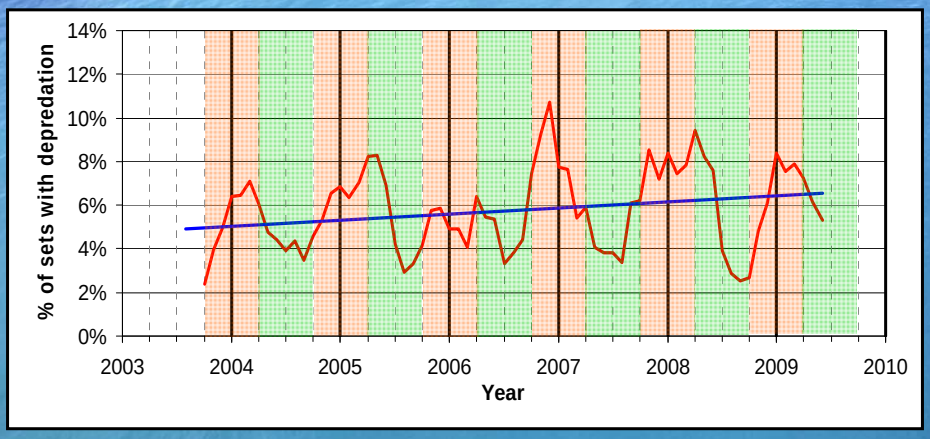
With false killer whale, pilot whale and 'blackfish' takes



Results: Depredation
Temporal Patterns (DSLL)



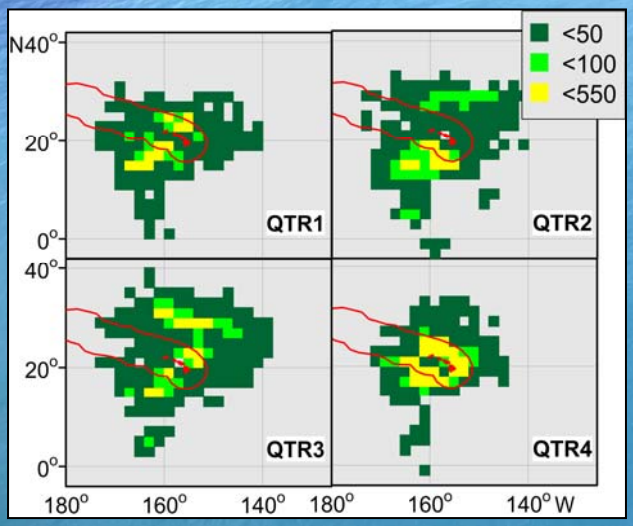
Results: Depredation (DSLL)
Temporal Patterns: 3-month running average



- Apparent trend, but not statistically significant (p=0.15)
- Potential seasonality: ~ Quarters 1 and 4 > Quarter 2 and 3

→ Changes in fishing behavior (e.g. location) or animal behavior?

Results: Generalized Additive Model - Depredation in DSLL
Interpretation of Month effect?



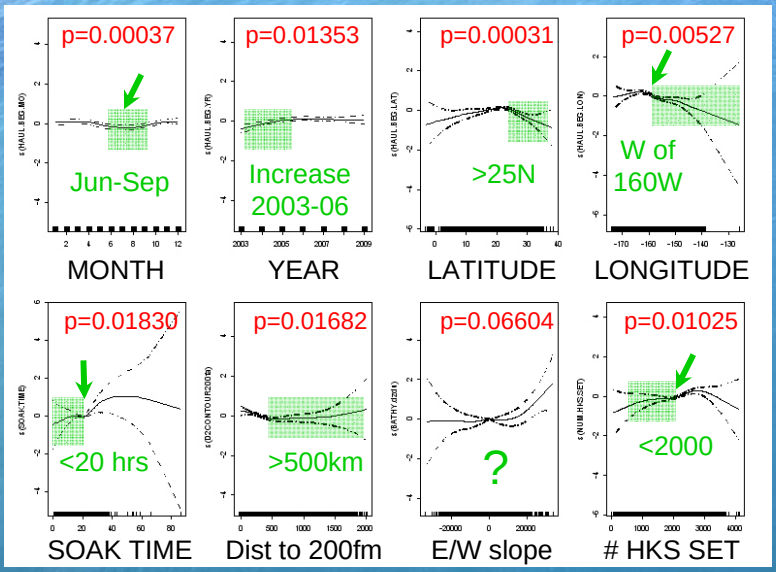
Fishing behavior:

- Distance to islands
- Latitude (SST)
- Longitude

What else?

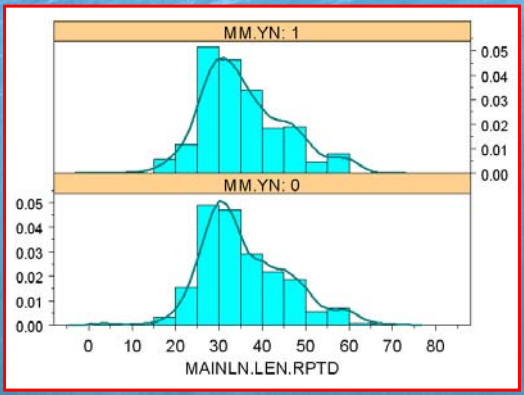
- FKW distribution?
- Prey distribution?

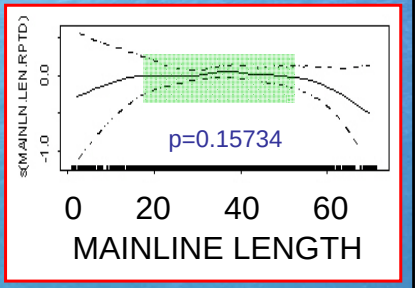
GAM Results: Depredation in DSLL



Results: Generalized Additive Model Depredation in DSLL

What about mainline length?



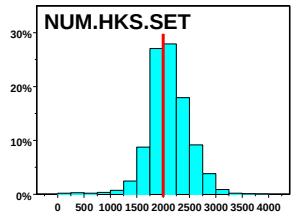


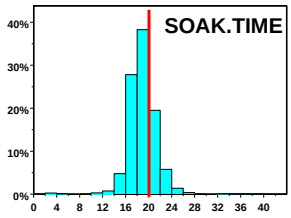
- Fishery and animals are more dispersed than in the Atlantic, so shorter lines may not reduce encounters in the same way.

Depredation Summary - DSLL

*Examine cetacean **depredation** rates relative to gear, set, and habitat variables.*

- Latitude, month, and longitude were strongest predictors
- Increasing trend 2003-2006, then stable
- Gear/Set variables of potential interest:





- Depredation higher closer to land/shelf areas and where E/W slope greatest

Objective 2

Emphasis on false killer whales or 'blackfish'

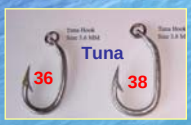
1. Examine cetacean **depredation** rates relative to gear and habitat variables to see if interactions can be avoided.

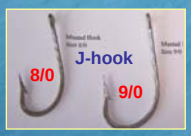
2. Examine cetacean **bycatch** rates relative to gear and habitat variables when cetaceans were documented in contact with catch or gear.

Results: Blackfish Bycatch Patterns
Hook Type & Size (SSLL)

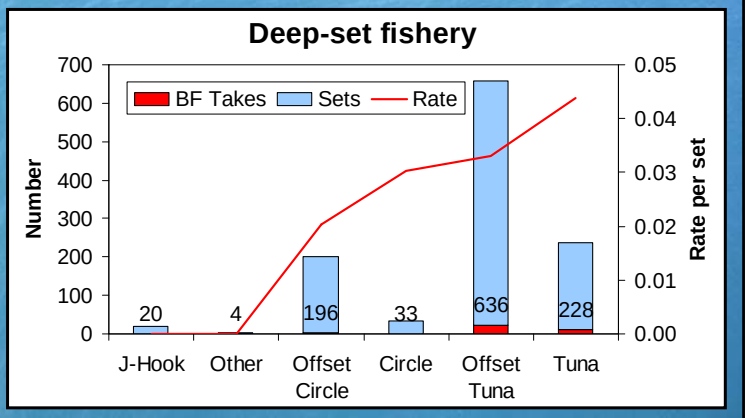
186 sets	16 cetaceans	0.086/set
	2 blackfish	0.011/set
	1 FKW	0.005/set

Results: Blackfish Bycatch Patterns
Hook Type & Size (DSLL)

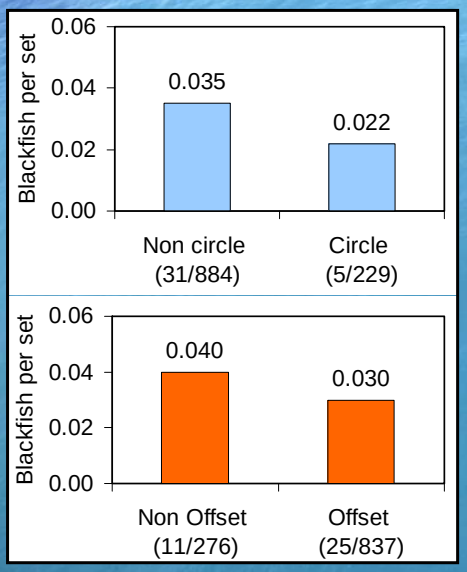




<u>Deep-set:</u> 1117 sets; variety of hooks
- **Tuna (36mm, 38mm)**
- **Circle (12/0, 13/0, 14/0, 15/0, 16/0, 18/0)**
- **J hooks (8/0 – 9/0)**

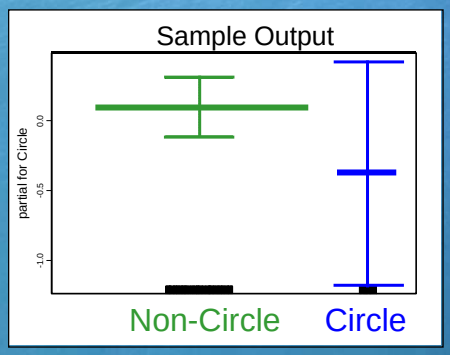


Results: Blackfish Bycatch Patterns
Hook Type - DSLL



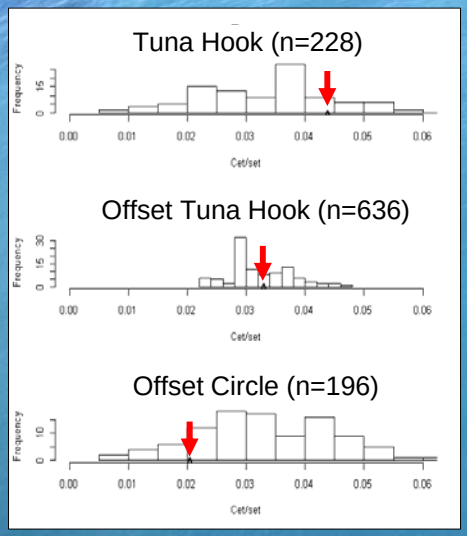
- GAM, Logistic regression:

Hook types difference not statistically significant



Results: Blackfish Bycatch Patterns
Hook Type – DSLL

Permutation test for three most common hook types



- Weak patterns
  Tuna hooks caught slightly more blackfish than one would expect by chance.

- Offset tuna hooks caught about what's expected; lower rate of blackfish catch than non-offset tuna hooks.

- Circle hooks caught slightly fewer blackfish than one would expect by chance; lowest bycatch rate. Sizes:

12-14/0	15/0	16-18/0
10%	62%	27%

Bycatch Summary and Caveats

*Examine cetacean **bycatch** rates relative to gear and habitat variables when cetaceans were documented in contact with catch or gear (DSLL).*

- When cetaceans were known to have interacted with catch or gear, they were slightly less likely to become hooked or entangled when **circle** or **offset tuna hooks** were used compared to standard **tuna hooks**.
- In Atlantic longline fishery, cetacean catch rates **increased** following mandatory use of 16/0 or 18/0 **circle hooks** *(Garrison et al. 2007).*
- Most commonly used circle hook in the DSLL fishery is 15/0

→ 'Hook type' is recorded based on the majority hook type used, but mixed-hook sets exist and may confound results. Need to examine this in more detail.

Summary

- Provided a sample of types of things we can test with the observer data set
- Some potential patterns:
  - Depredation changes with latitude, distance to islands
  - Soak time <20 hrs and setting with <2000 hooks may reduce depredation
  - Bycatch rates appear slightly lower for circle hooks
- Additional statistical tools available, but not shown today (Classification & Regression Trees; Mantel tests, etc)

Take Reduction Team Feedback:

- Interpretation of results
- Additional analyses
- Further questions to ask