A BOOTSTRAP ANALYSIS OF FISHERY OPERATION UNDER PROTECTED SPECIES HARD CAPS

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IIFET 2018
July 16-20, 2018
Seattle, WA

Motivation

- Hard cap = common pool quota for protected species interactions
- HI shallow-set longline swordfish fishery endangered sea turtle hard caps:
  - 26 leatherback turtles
  - 34 loggerhead turtles

- In 2015, hard caps were proposed by the Pacific Fishery Management Council to manage the drift gillnet (DGN) swordfish fishery off California
- Research questions:
  - How would hard caps affect the profitability of fishing?
  - Would reducing protected species bycatch create an opportunity cost?
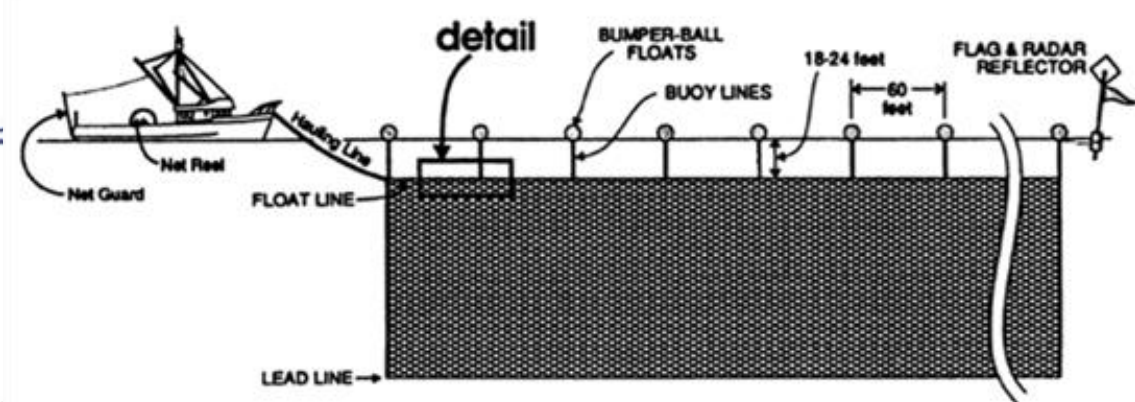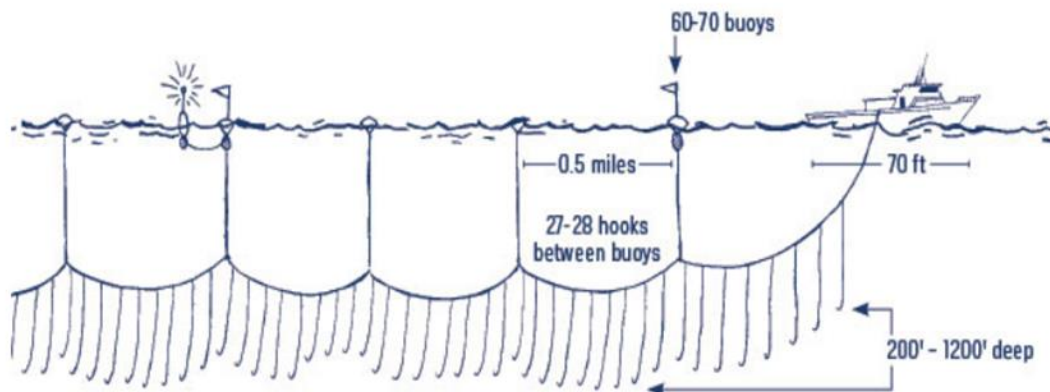 - How would an increased bycatch rate affect performance?
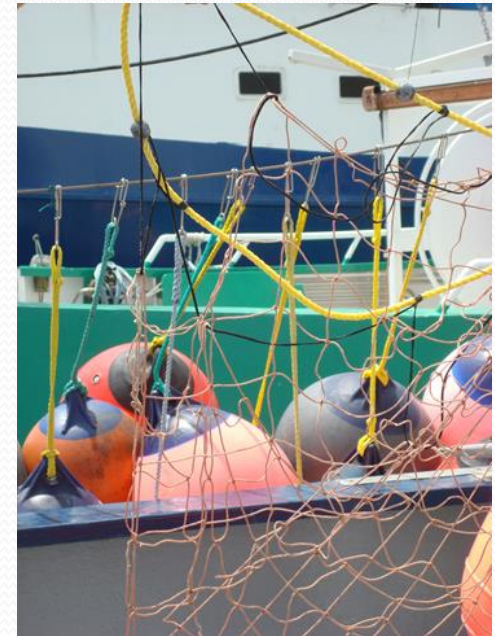
Swordfish Fisheries

Longline   Drift gillnet

Proposed Hard Caps Species

Fin Whale

Humpback Whale

Sperm Whale

Short-Finned Pilot Whale

Bottlenose Dolphin

Leatherback Turtle

Green Turtle

Loggerhead Turtle

Olive Ridley Turtle

Proposed Hard Caps Alternatives

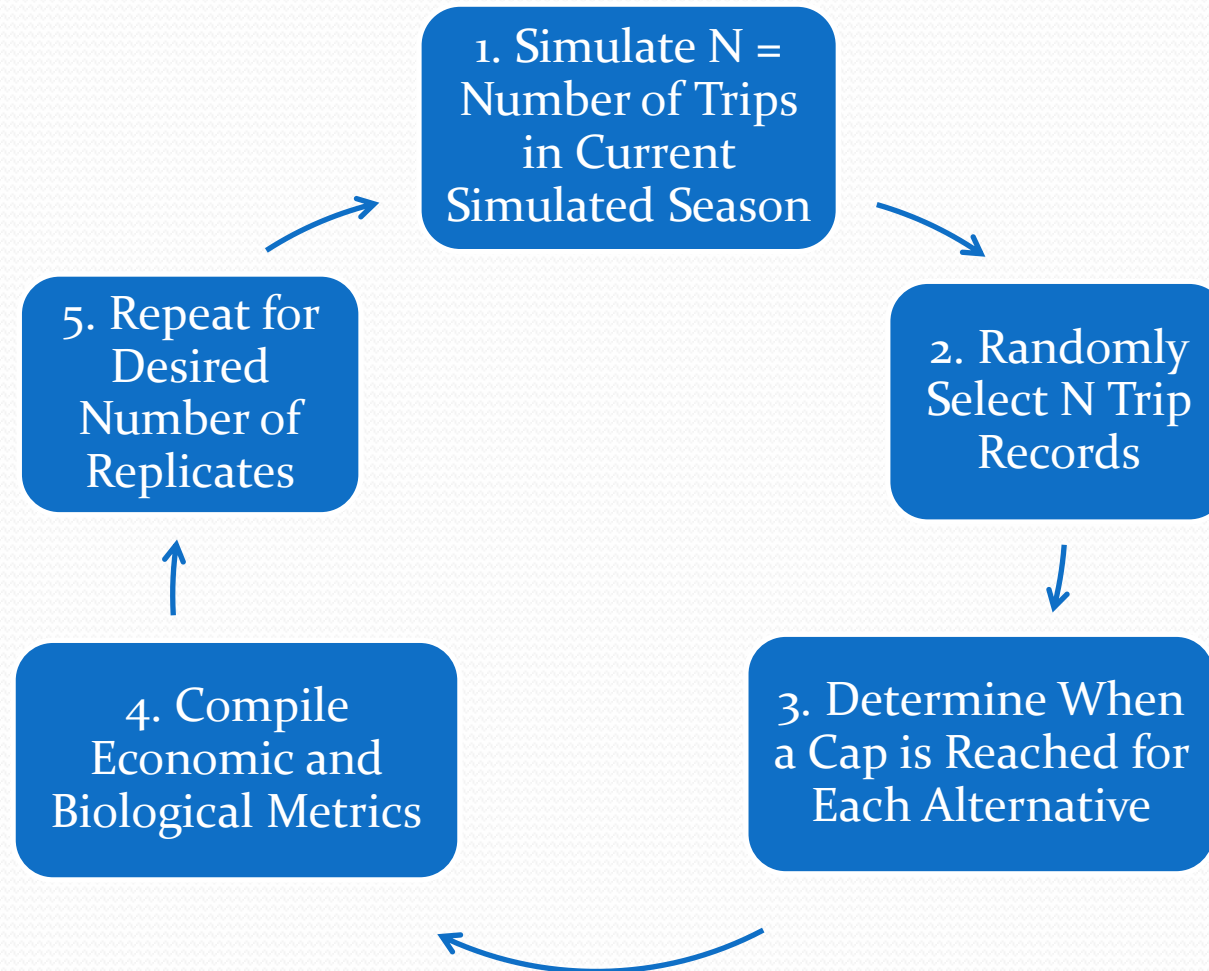| Number of Years	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
	1	5	1	5	1	5	1	2-Year Average	1	2-Year Average
Fin Whale	1	2					2	2	1	1
Humpack Whale	2	4	11	55	5	25	2	2	1	1
Sperm Whale	2	8	2	8	3	15	2	2	1	1
Leatherback Turtle	3	10	3	10	4	13	3	3	1	1
Loggerhead Turtle	3	7	3	7	4	9	3	3	1	1
Olive Ridley Turtle	1	2					2	2	1	1
Green Turtle	1	2					2	2	1	1
Short-fin Pilot Whale CA/OR/WA stock			5	23			5	5	2	2
Bottlenose Dolphin CA/OR/WA stock							6	6	2	2
Pinniped Group			4,316	21,580						
Dolphin Group			13,582	67,910						

Methods

- Bootstrap simulation

- **Objectives:**

- Use recent DGN effort, observed marine mammal and turtle bycatch, retained finfish catch, prices and cost data to simulate the operation of the DGN fishery under hard caps

- Gauge conservation and economic effects of hard caps alternatives

Bootstrap Algorithm
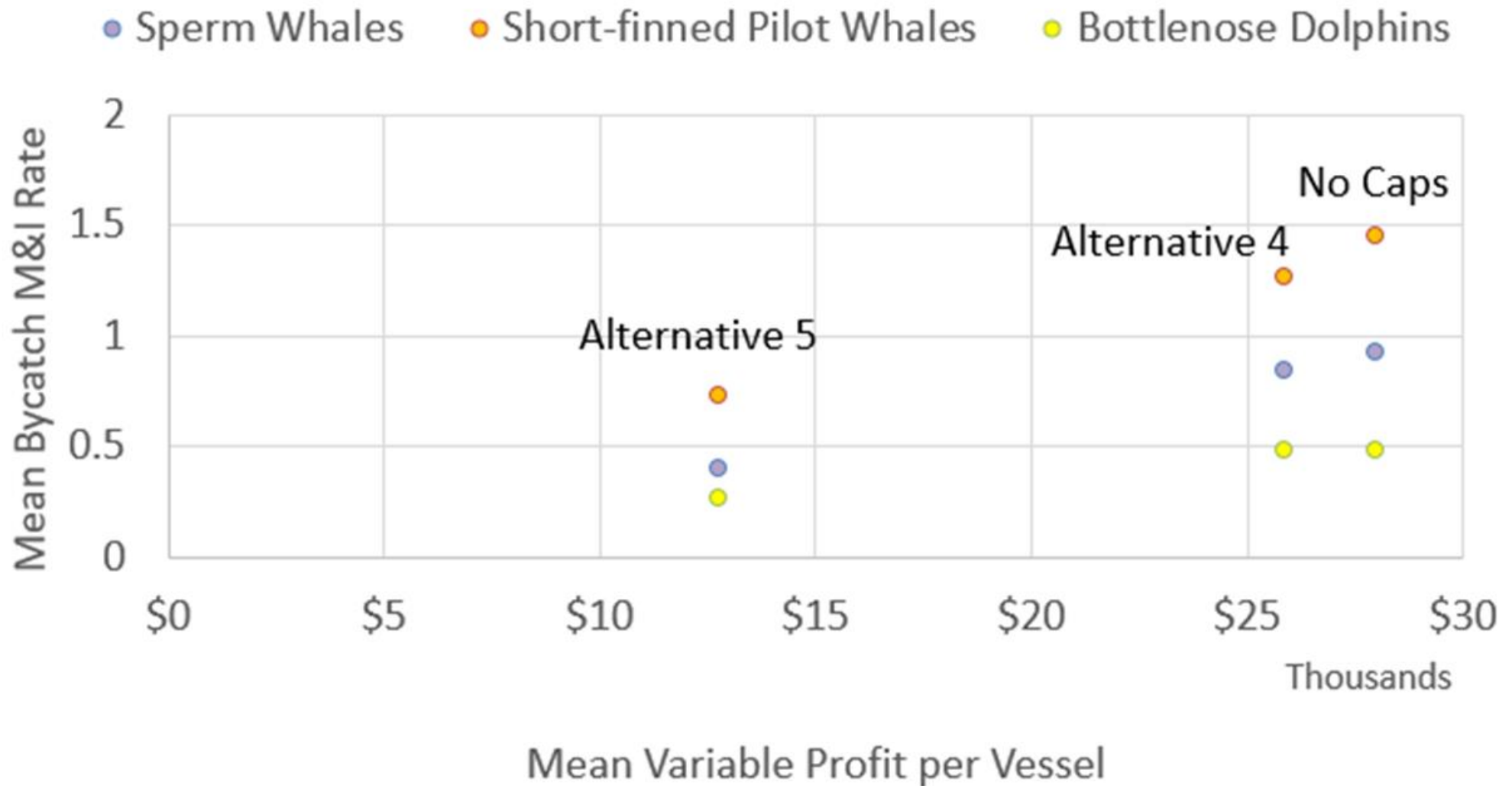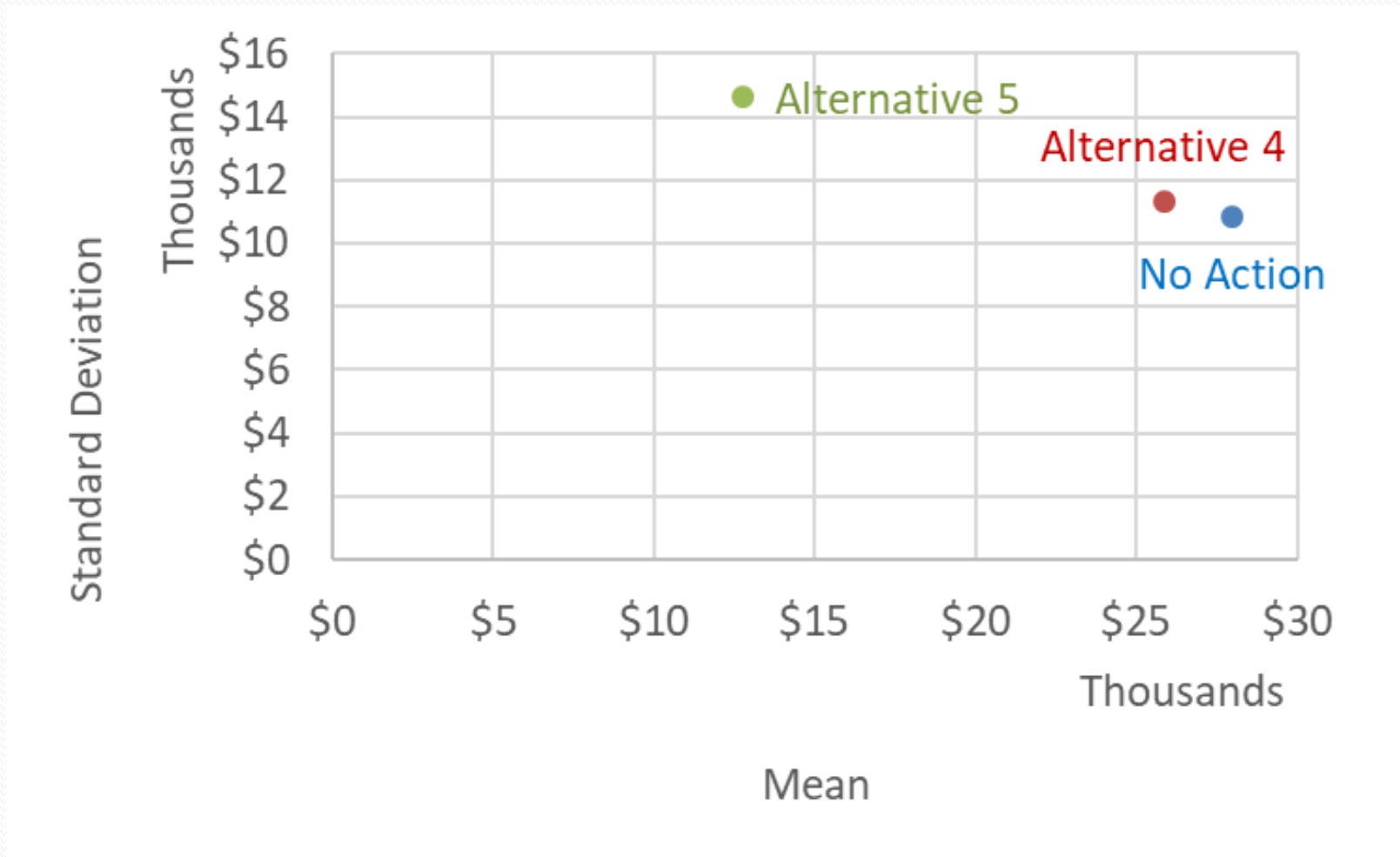
1. Simulate N = Number of Trips in Current Simulated Season

2. Randomly Select N Trip Records

3. Determine When a Cap is Reached for Each Alternative

4. Compile Economic and Biological Metrics

5. Repeat for Desired Number of Replicates

Results

	No Action: No Caps						
	Q5	Q25	Q50	Q75	Q95	Mean	StdDev
Sets	772	1,001	1,184	1,389	1,735	1,210	292
Total Revenues	$1,082,470	$1,453,599	$1,737,650	$2,057,539	$2,608,209	$1,779,241	$463,295
Total Variable Profits	$239,456	$403,257	$536,816	$691,882	$951,293	$559,033	$217,375
Average Variable Profits	$11,973	$20,163	$26,841	$34,594	$47,565	$27,952	$10,869
Landings	176.3	233.4	280.0	330.9	417.5	286.1	73.7
Leatherback Turtles	0	0	0	0	0	0.00	0.00
Loggerhead Turtles	0	0	0	0	0	0.00	0.00
Olive Ridley Turtles	0	0	0	0	0	0.00	0.00
Green Turtles	0	0	0	0	0	0.00	0.00
Fin Whales	0	0	0	0	0	0.00	0.00
Humpback Whales	0	0	0	0	0	0.00	0.00
Sperm Whales	0	0	0	2	4	0.93	1.39
Short-finned Pilot Whales	0	1	1	2	4	1.45	1.23
Bottlenose Dolphins	0	0	0	1	2	0.48	0.71

Mean Variable Profits versus Bycatch

● Sperm Whales　　　● Short-finned Pilot Whales　　　● Bottlenose Dolphins

No Caps

Alternative 4

Alternative 5

Mean Bycatch M&I Rate

Mean Variable Profit per Vessel

Thousands

9

Mean and Standard Deviation of Variable Profit per Vessel

Key Findings

1. Hard caps would slightly reduce protected species bycatch

2. Estimated rare event mortality or injury rates are typically much lower than nominal cap levels, due to frequent 0s

3. The most restrictive alternatives would create negative economic impacts, through lower mean and higher SD of variable profits

4. Further information is needed to gauge the importance of bycatch reductions (e.g. population status information)

Summary

1. A bootstrap analysis simulates the operation of the DGN fishery under hard cap alternatives

2. Methodology addresses several Magnuson-Stevens Act National Standards: NS1 (Optimize Yield), NS6 (Consider variations and contingencies in fisheries), and NS9 (Minimize bycatch and bycatch mortality)

3. Results indicate minimal differences in bycatch rates across caps alternatives, with significant negative economic impacts of the most stringent hard caps alternative

4. A policy intended to safeguard protected species populations may impose negative economic impacts on the fishery