Fisheries Policy Design in response to Climate Change

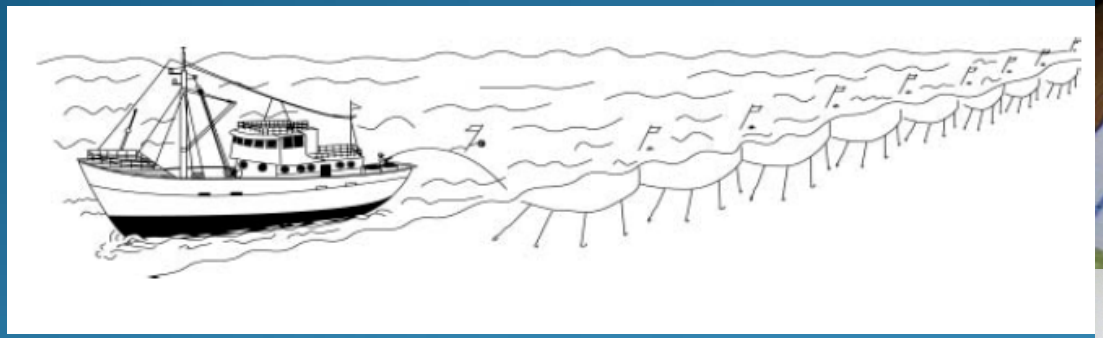
A case study for the Hawaii swordfish fisheries management

Dr. Minling Pan

PICES 17th Annual Meeting, October 23 – November 2, 2008, Dalian, China

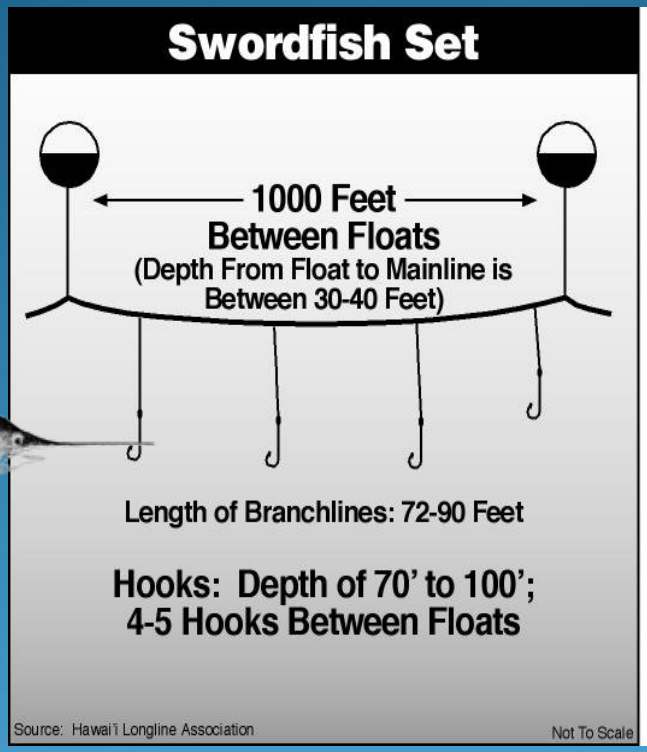
Pacific Islands Fisheries Science Center
NOAA National Marine Fisheries Service

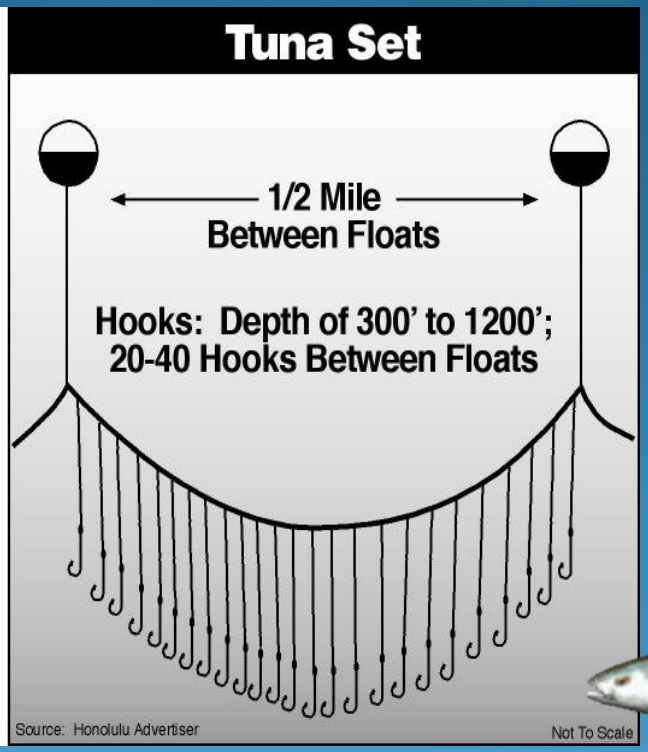
The Hawaii Longline Fisheries



- Two components
  - Tuna (deep-set 300-400m)
  - Swordfish (shallow set < 100m)
- Mostly in the Western and Central Pacific ocean
  - Sharing resources with Taiwan, Japan, China, Korea, Australia etc…
- Incidental catch with endangered species
  - Sea turtles (fishing for swordfish with shallow sets)

Swordfish vs. Tuna Set





Main Sea Turtle Species in Pacific

- **Leatherback**
- **Loggerhead**
- Hawksbill
- Green
- Olive Ridley

Leatherback

Loggerhead

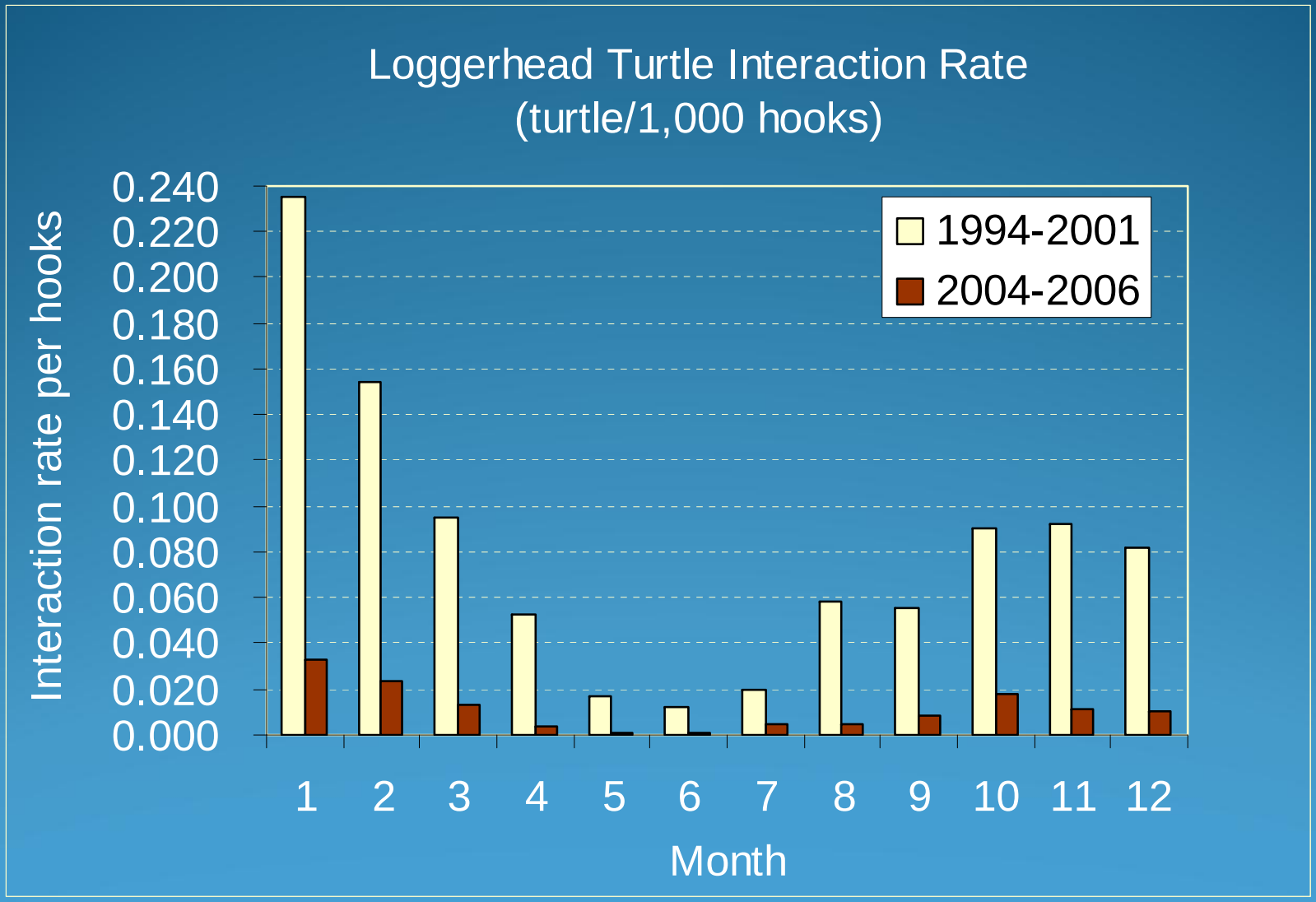
Current Policy Dealing with Protected Species

- Law suite in 1999
  - Complete closure of the swordfish in April 2001
- Re-open with new regulations in 2004
  - Circle hooks (not J hooks)

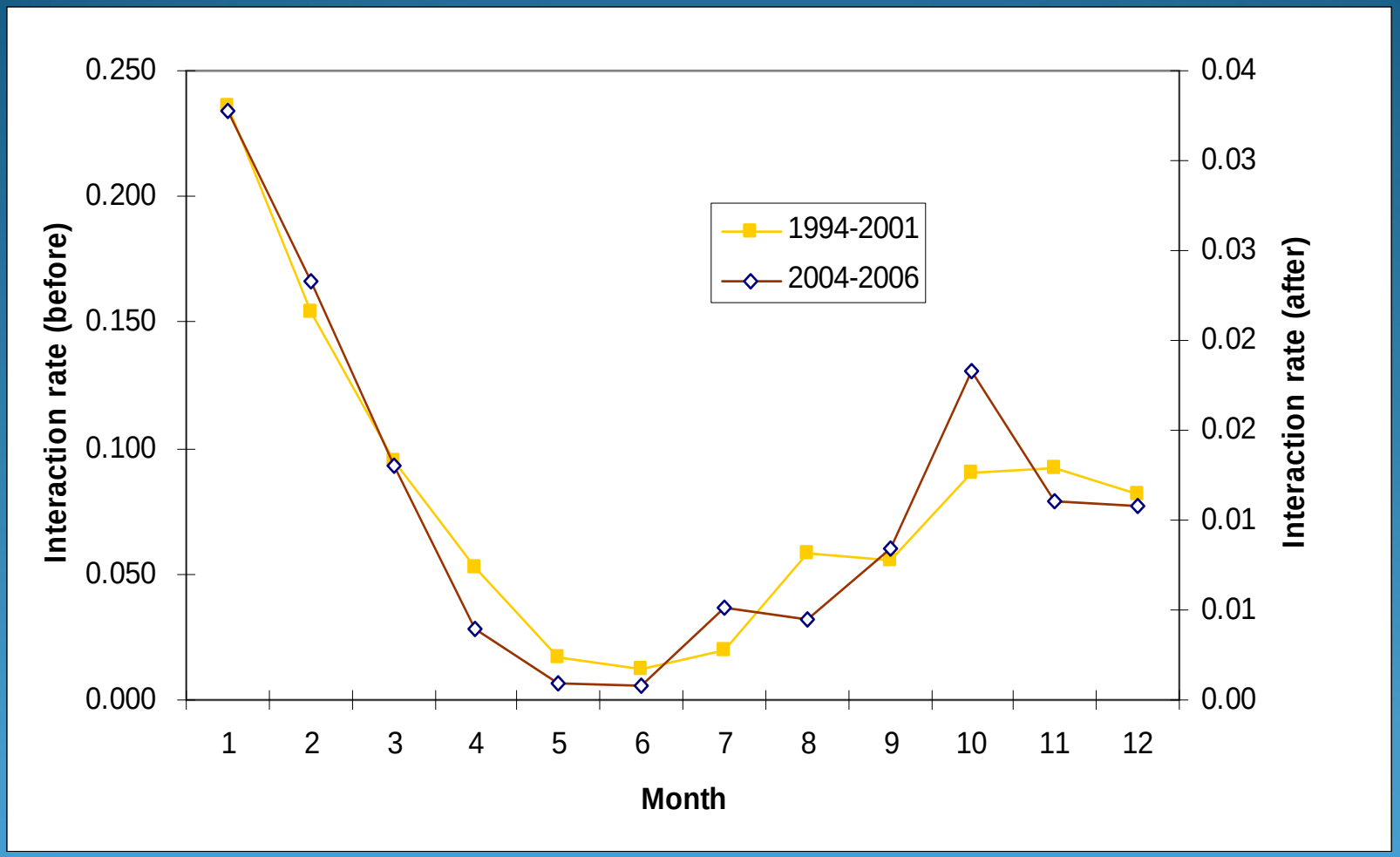
Current Policy Dealing with Protected Species

- Law suite in 1999
  - Complete closure of the swordfish in April 2001
- Re-open with new regulations in 2004
  - Cycle hooks (not J hooks)
  - Fish bait (not squid)
  - Effort cap (2120 sets effort, < 50% historical level)
  - Turtle cap (17 loggerhead or 16 leatherback)
-

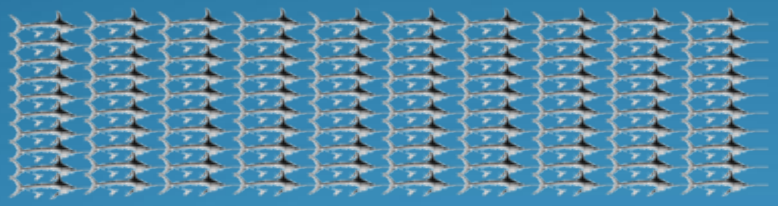
Turtle Catch Rate **Before** the Policy



Turtle Catch Rate **Before** the Policy



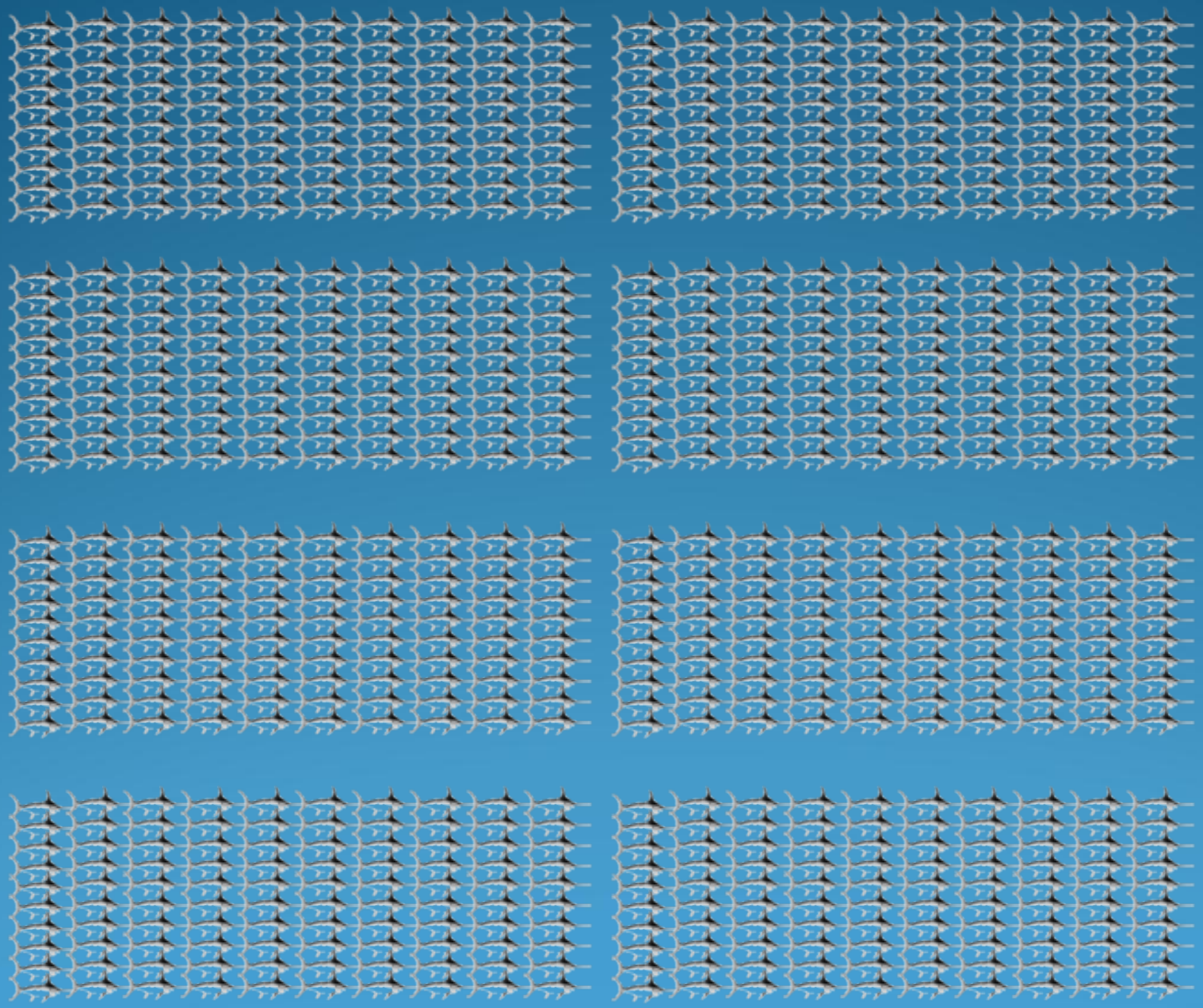
Turtle Catch Rate **Before** the Policy



100 fish

1 turtle

Turtle Catch Rate **After** the Policy



1 turtle

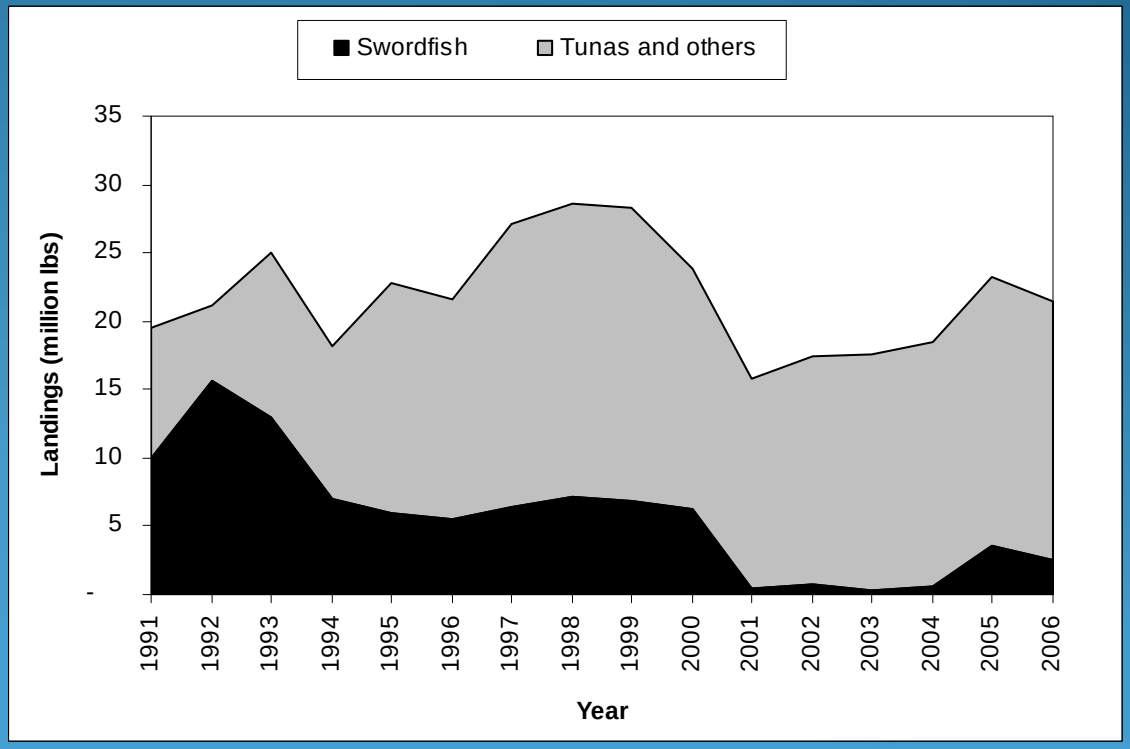
800 fish

Impacts to the Fisheries under Current Policy

- Unstable fisheries and sea turtle catches
  - 2004 used 7% effort quota (2 turtles)
  - 2005 used 78% effort quota (12 loggerheads and 8 leatherbacks)
  - 2006 used 48% effort quota (17 loggerheads in March 17, 2006)

- Economic loss - Foregone fishing opportunity

- Market transfer effect – Increasing imports from less restricted fisheries



Searching for Potential Policy Options

- Goals
  - Sustainable swordfish harvests
  - Minimizing sea turtle interactions
- Challenges
  - Climate changes
    - Short term – seasonal, monthly
    - Long term – annually, El Niño, La Nina, Global warming
  - Fishermen behavior changes
    - Fishing locations – following climate changes?
    - Fishing seasons – following the market or climate changes

The Spatial & Temporal Economic Model

- Understand the trade-offs (time and spatial)
  - Sea turtle interactions
  - Economic returns
- Sea turtle interactions - predict sea turtle interactions
  - Used Generalized Additive Models (GAMs) model (Kobayashi and Polovina)
  - Included climate change variable (SST) and moon phase
  - Associated with season and location
- Economic returns
  - Incorporated a cost function
  - Associated with vessel size, travel distant (locations)
- Assume changes in fishermen's fishing behavior

Turtle Interaction Rate Prediction Functions

Loggerhead ~ *year + s(month) + s(set type) + s(SST)*
+ s(moon phase) + s(latitude) + s(longitude)

Leatherback ~ *year + s(month) + s(set type) + s(SST)*
+ s(moon phase) + s(latitude)

Cost Function Estimation

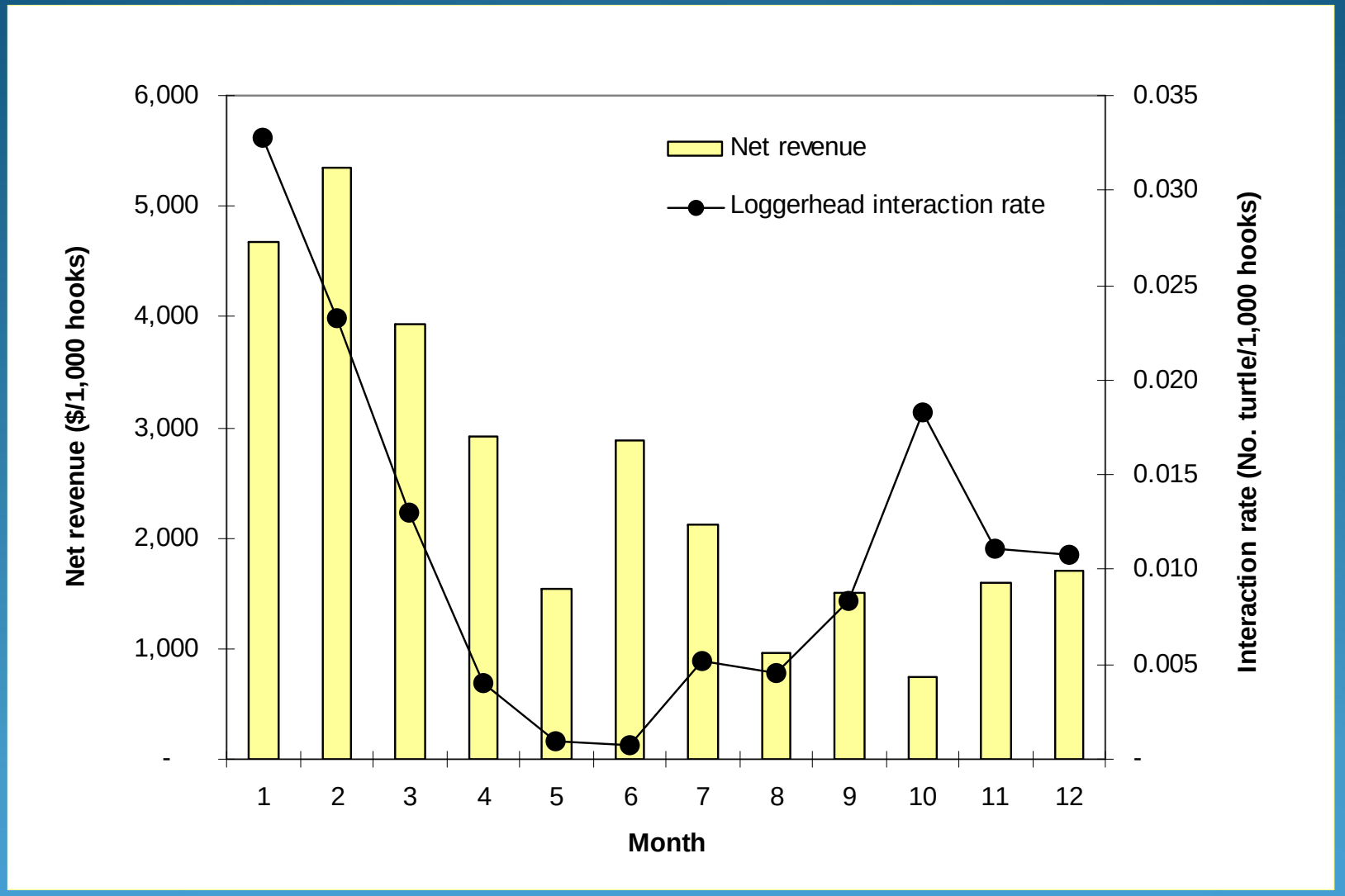
Variables	Adjusted R^2	Sig F	T-test	*P*-value	Coefficients
Intercept	0.803	0.000	69.5	0.000	3.50558
# Fishing days			10.0	0.000	0.02126
Distance			3.4	0.001	0.00012
Vessel size			7.0	0.000	0.00529
Tuna or swordfish			10.2	0.000	0.19984

Dummy variable: Deep set = 0; Shallow set =1

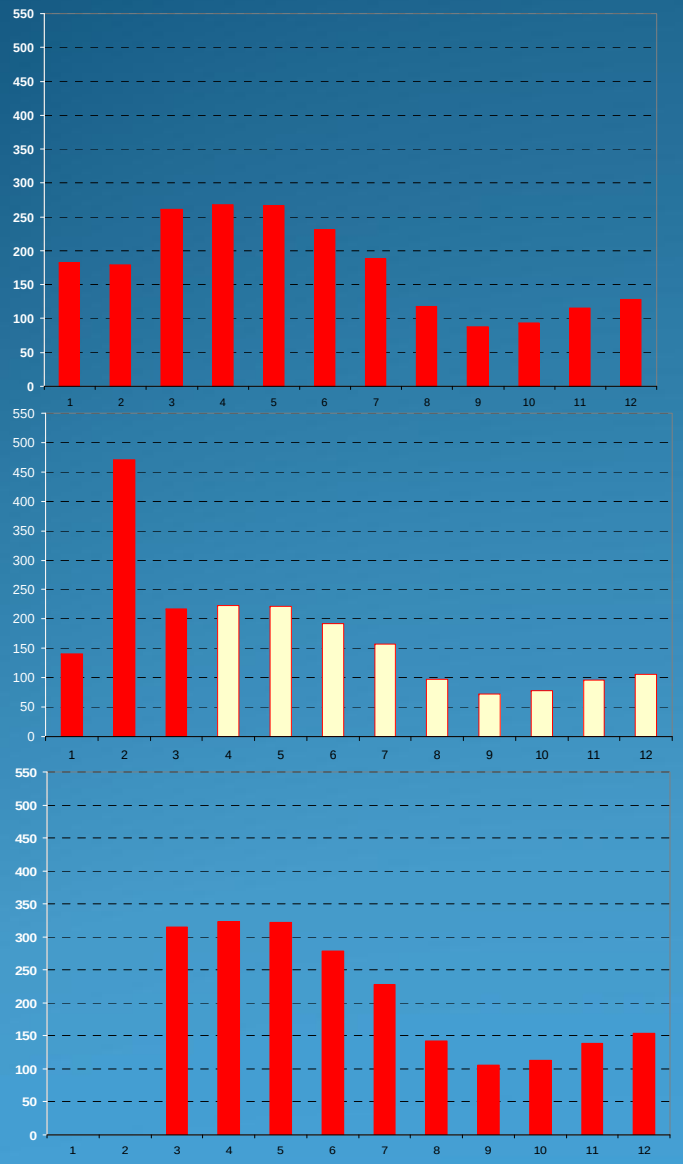
Number of observations = 181

Data sources: 1) 2005 observer economic add-on data
2) 2005 Hawaii longline logbook data

Trade-offs by Season (2004-2006)



Policy Analysis – Seasonal distributions



Scenario I (historical pattern)

Turtle interaction: 17
Net revenue: $4.5 millions

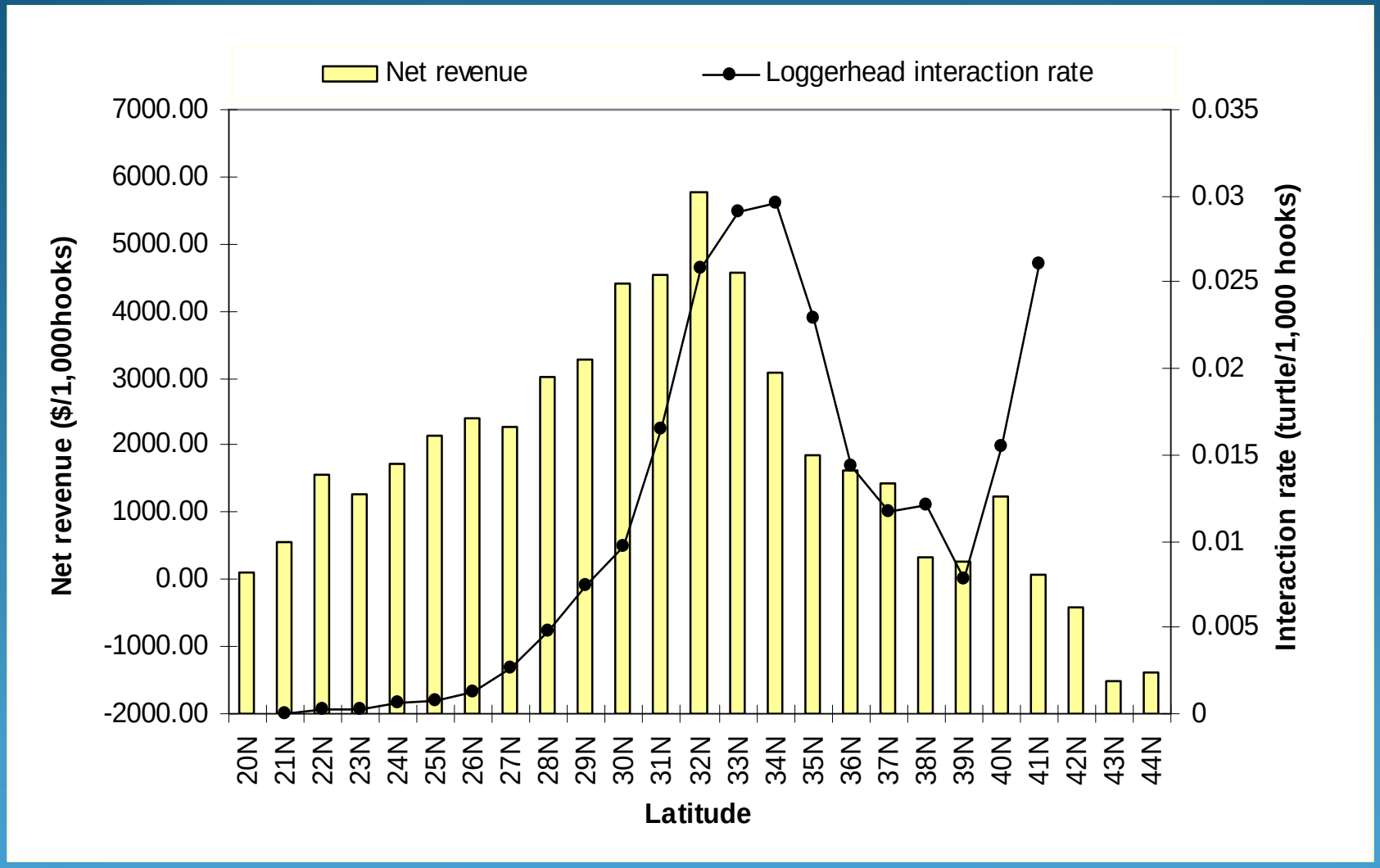
Scenario II (2006's pattern)

Turtle interaction: 17 in March
Net revenue: $3.5 millions

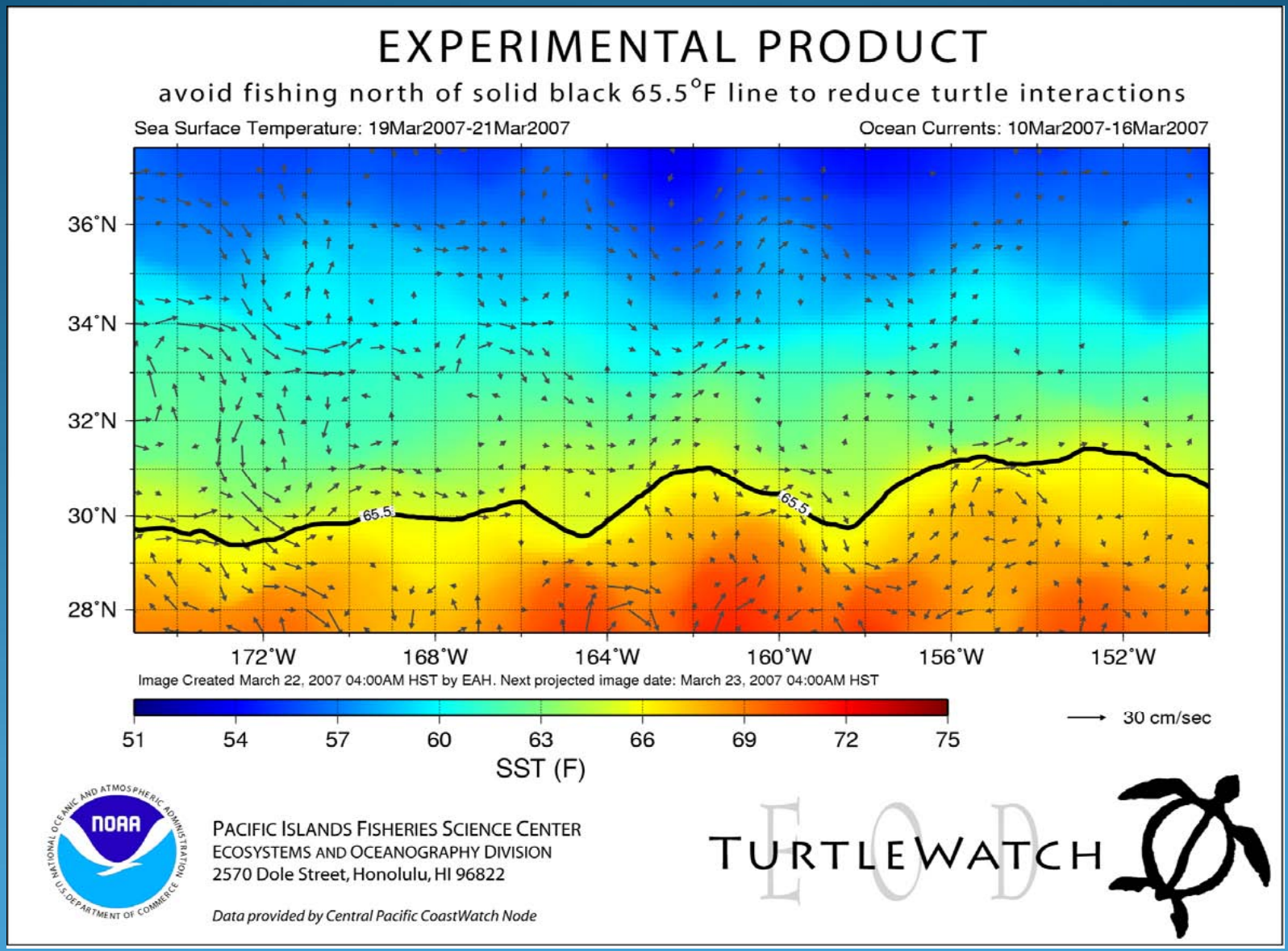
Scenario III (Closure in Jan & Feb)

Turtle interaction: 12
Net revenue: $3.8 millions

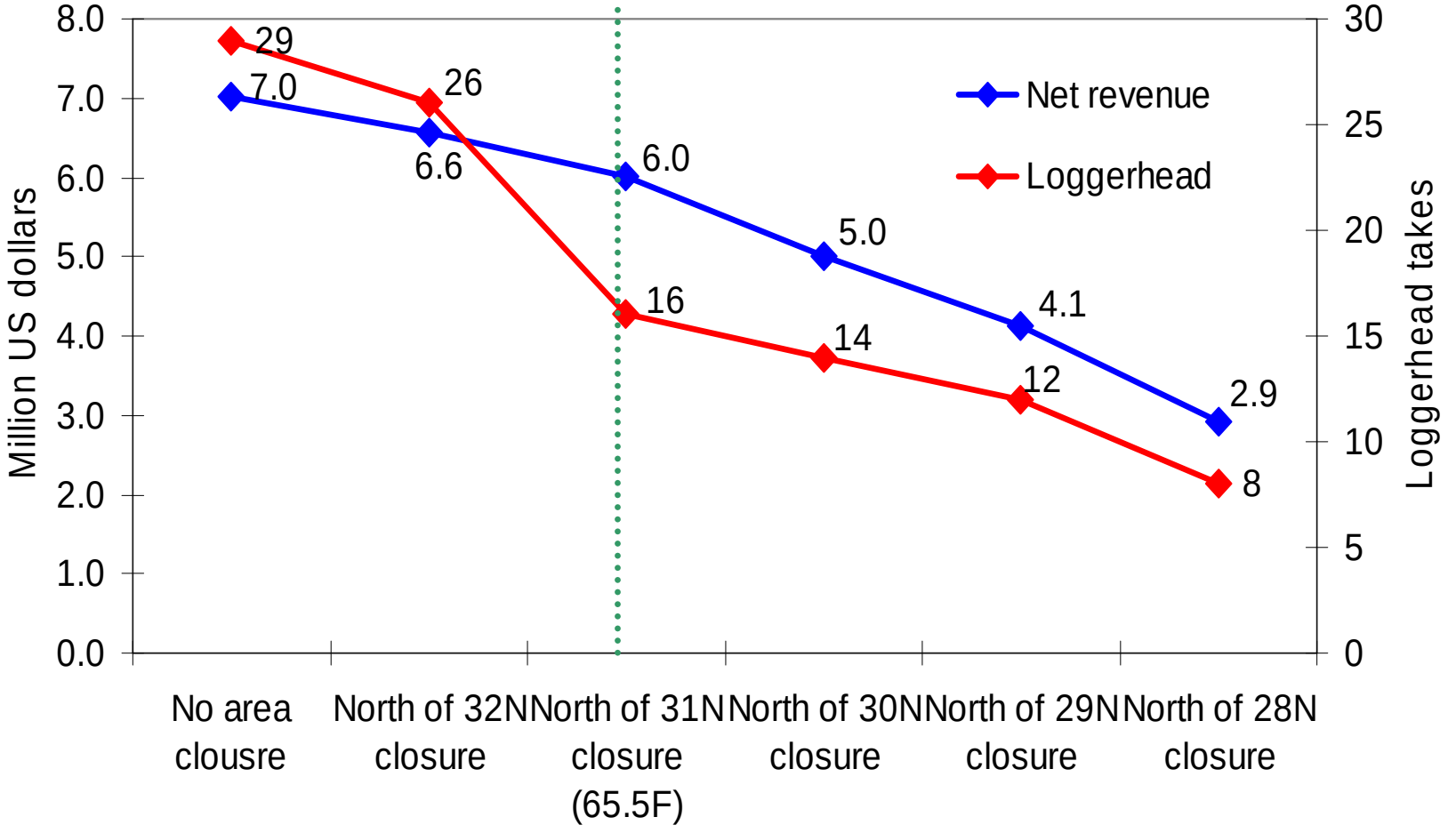
Trade-offs by Latitude (2004-2006)



Turtle Watch Analysis - SST 65.5 °F



Policy Analysis – Area Closure



(Assuming 2120 sets fishing the first 4 months)

Conclusions and Implications

- Fishermen's behaviors (seasonal and spatial distribution of fishing effort) significantly affect sea turtle interactions
- Closure of sea turtle 'hot spot' (area near SST 18.5°C) could be an optimal policy to reduce sea turtle interactions
- The bioeconomic model is a useful tool in decision making process for the fishery management in respect to climate changes
- Implementation of the time-area closure can be a challenge
  - SST shifting line
  - More than one nation efforts


Any questions?
06/29/2005