Spillover Effects of Marine Environmental Regulation for Sea Turtle Protection

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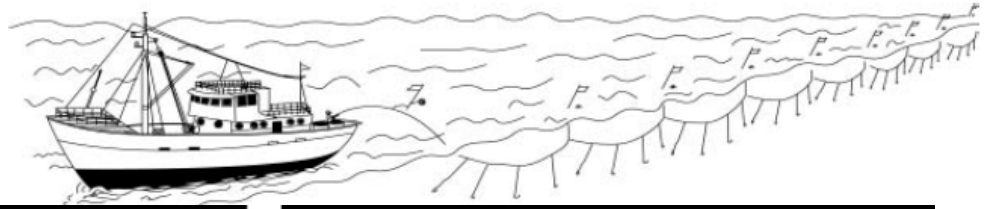
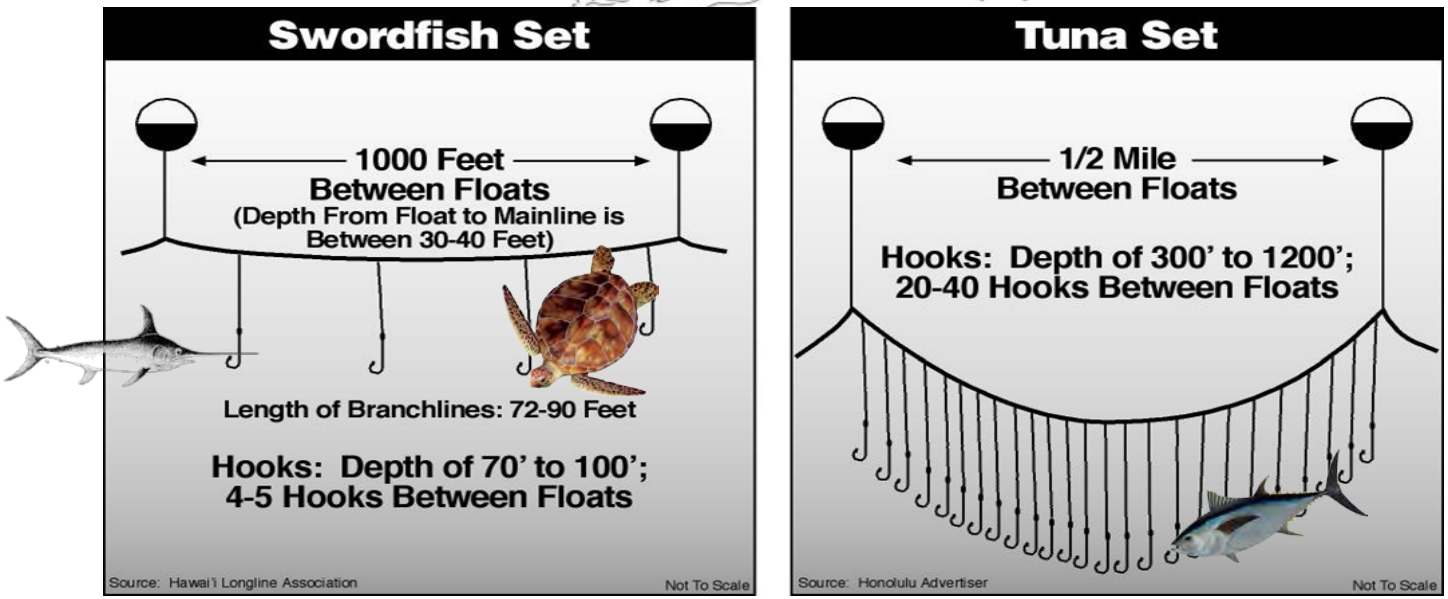
Study Background

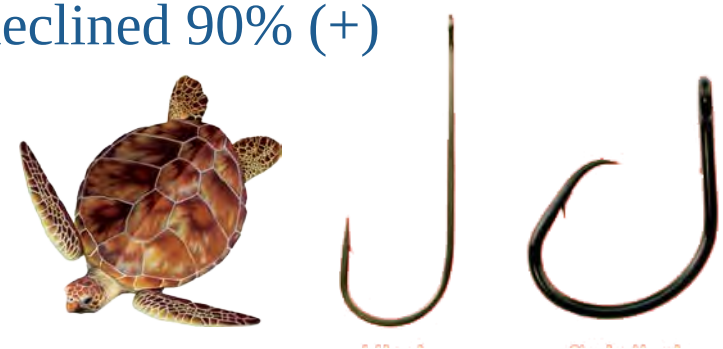
- Hawaii swordfish longline fishery was the major domestic producer for the U.S. swordfish market
- Incidental catch with endangered species - Sea turtles bycatch



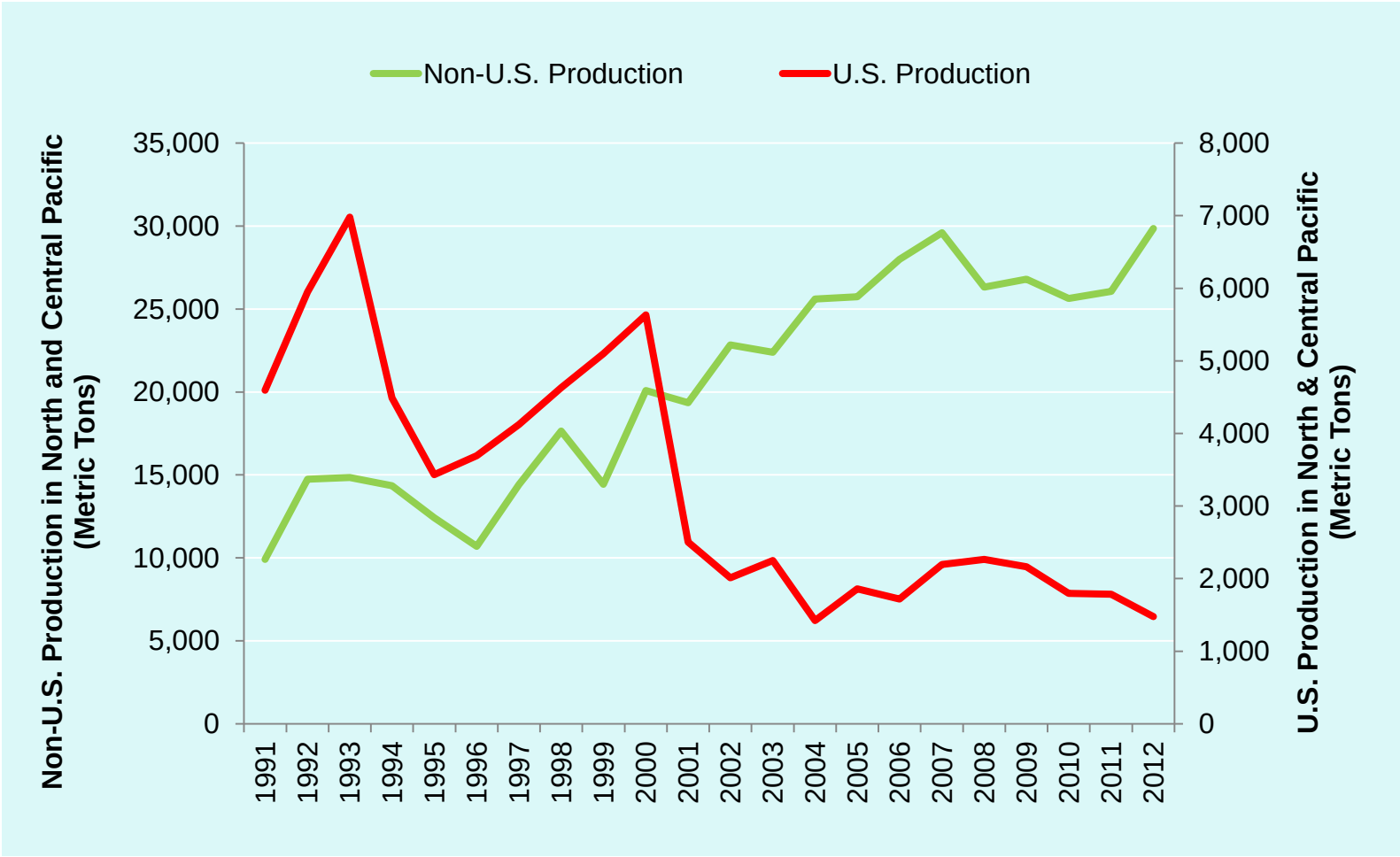


Study Background

- The fishery was closed between 2001-2004, due to a lawsuit
- Re-open in 2004 with a series of new regulations
  - Circle hooks (not J hooks)
  - Fish as bait (not squid)
  - Annual effort limits (< 50% historical level)
  - Annual turtle limits (17 loggerhead or 16 leatherback turtles)
- Impacts of the new regulations
  - Interaction rate with sea turtle declined 90% (+)
  - Fishing landings declined (-)



U.S. vs. Foreign Swordfish Production in North Pacific Ocean



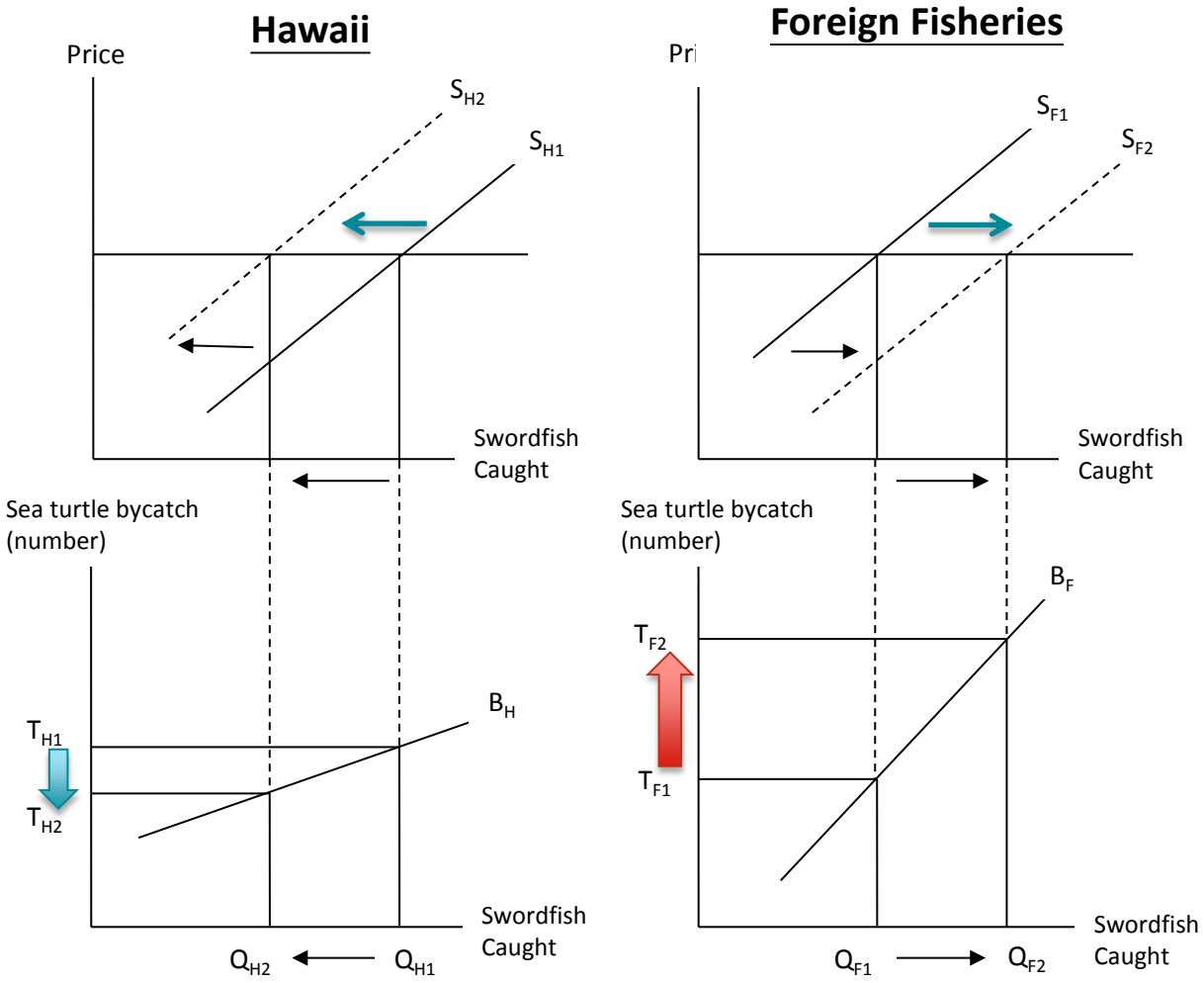
Study Objective

- While these regulations reduced sea turtle interactions by the Hawaii fleet, what happen to the sea turtle stocks ocean-wide?
- While Hawaii fish production declined but other countries' fish production increased, did the sea turtle conservation goal achieve?
- This study examines whether, and to what extent, U.S. fishing regulations could cause "**spillover effects**" and changed foreign fleet activity that ultimately had adverse effects on the very species intended for protection.

Spillover Effects Between Fisheries

Story on the fish side

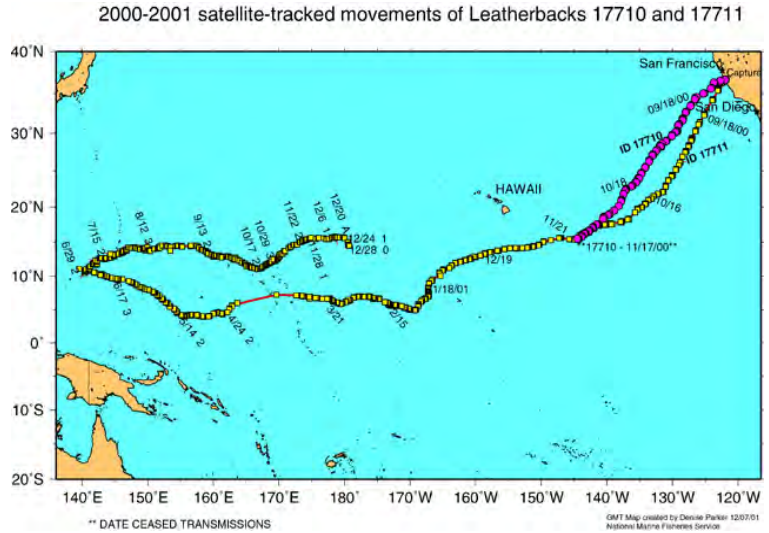
Story on the turtle side



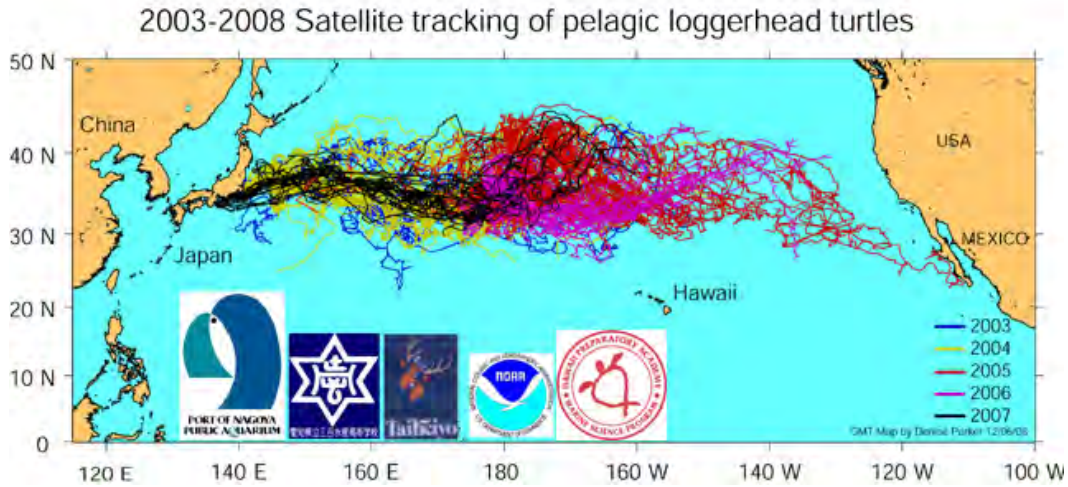
Conditions for Spillover Effects

- ***Shared resources in high seas***: both turtles and swordfish are globalized resources on the high seas and caught by Hawaii and foreign fisheries;
- ***Production displacement***: the fishing activities of foreign fleets respond to the changes of Hawaii swordfish production (production displacement); and
- ***Lower sea turtle bycatch rate of Hawaii longline swordfish fleet,*** *compared to* most of foreign fleets

Shared Resources in High Seas: Turtle



Leatherback turtle



Loggerhead turtle

Shared Resources in High Seas: Swordfish

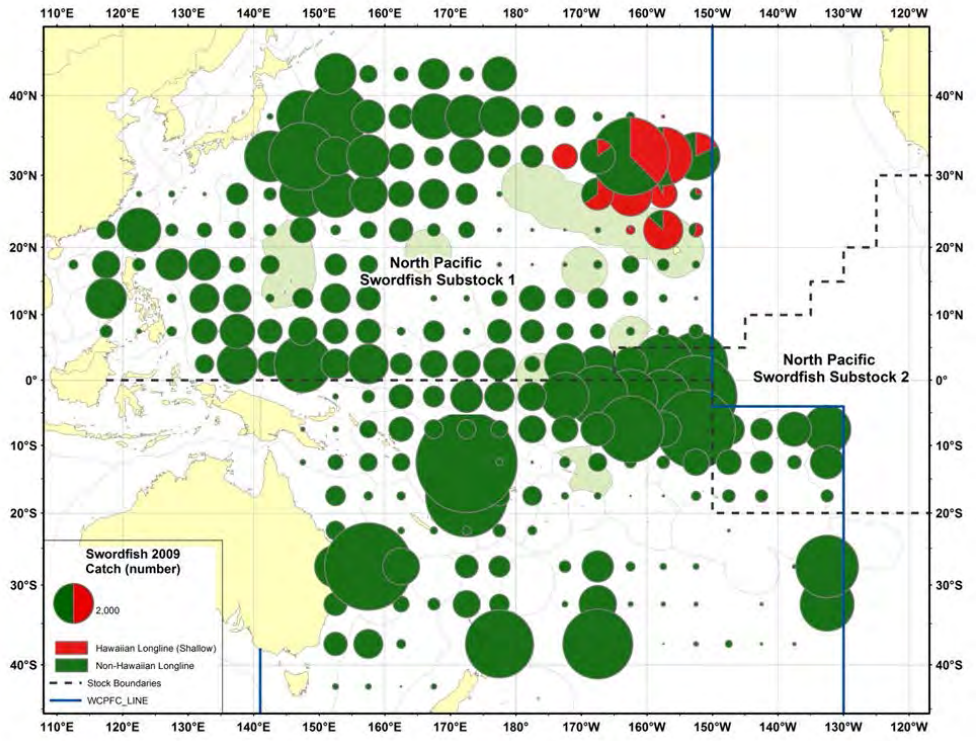
- Hawaii swordfish production represented 6% of total swordfish in North Pacific in 2009 and 81% of U.S. production

Red:

Hawaii

Green:

Other countries



Sea Turtle Bycatch Rate Across Countries

Top Producers in North and Central Pacific	Production Weight in North and central Pacific 2012	Turtle Bycatch per Unit of Effort (# turtle/mt)	Annual Turtle Bycatch
Taiwan	24%	0.073	550
Japan	18%	0.025	140
Indonesia	16%	0.100	500
Philippines	14%	0.100	440
China	8%	0.100	270
Republic of Korea	4%	0.100	130
Hawaii/U.S.	4%	0.013	19
Australia	3%	0.006	6
Mexico	1%	0.174	80
Total	100%		2270

Spillover Estimation

Step 1: To test the correlation between non-U.S. and U.S. production from 1991 to 2012 (22 years)

- 1991-2000 before policy (the fishery was closed or restricted)
- 2001-2012 after the policy

Pearson Correlation (r)		U.S. production (X_t)	Non-U.S. production (Y_t)
U.S. Production (X_t)	Before Policy (1991-2000)	1	0.455
	After Policy (2001-2012)	1	-0.527*

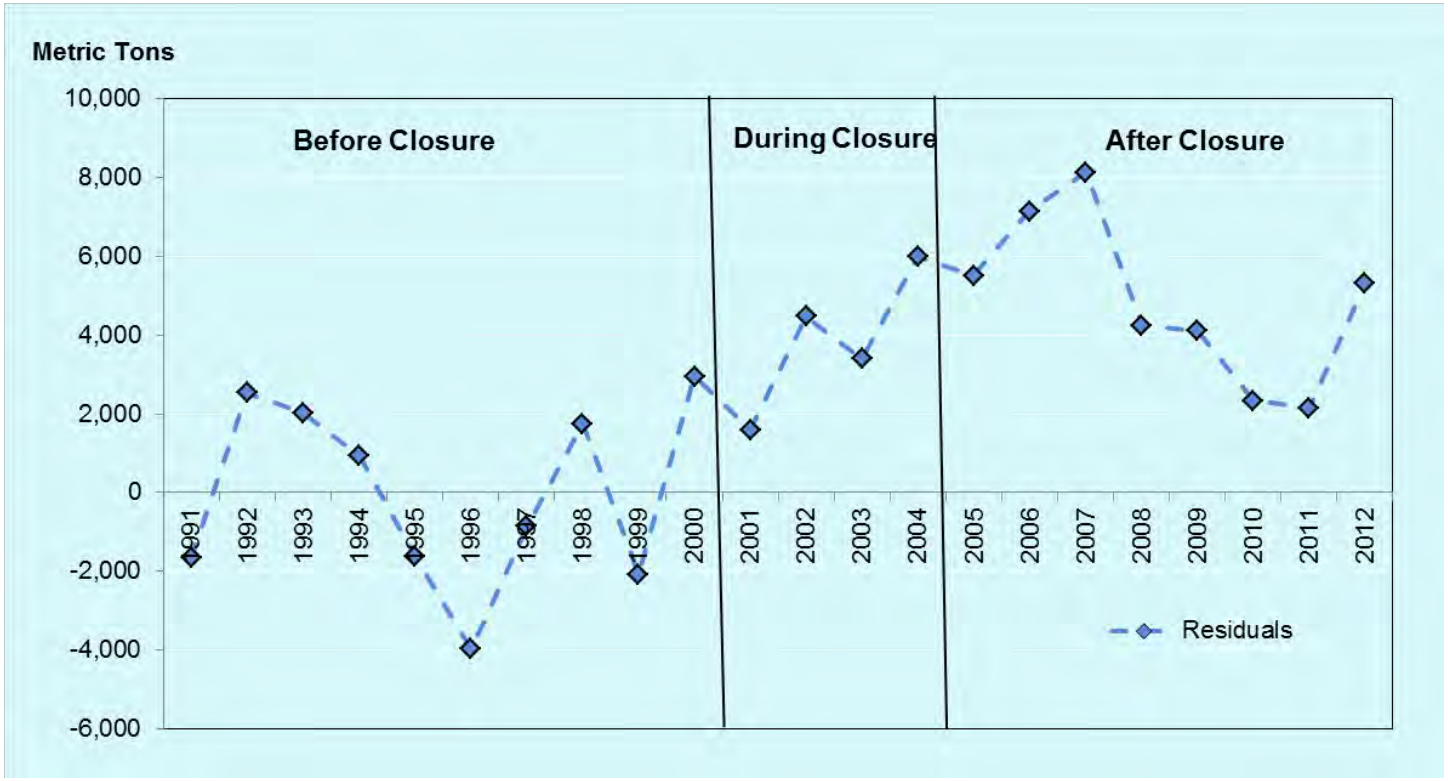
*significant at the 10% level.

Spillover Estimation

Step 2. To estimate the "normal" trend (before policy 1991-2000) for non-U.S. production (Y)

$$Y_t = a + bt + \varepsilon_t \quad \Longrightarrow \quad \varepsilon_t = Y_t - \hat{Y}_t \text{ (for 22 years)}$$

t = 1991-2000 $\qquad$ t = 1991-2012



Spillover Estimation (to quantify)

Step 3. To estimate how did non-U.S. swordfish production respond to the changes of U.S. production from 2001 to 2012

$$Y_t - \hat{Y}_t = c + d\,X_t + u_t$$

Independent Variable	Coefficient	T-value
c	5,770.09***	(4.42)
d	-1.01***	(-2.82)
R^2	0.28	

***significant at the 1% level.

Results

- The coefficient d = -1.01 is significant at the 95% level. This implies that, a decrease of one unit of U.S. production is associated with an increase of 1.01 units of non-U.S. production, and vice versa.

- Production displacement exists between U.S. and non-U.S. swordfish production.

How Production Displacement related to Sea Turtle Catch/Interactions?

	Hawaii Swordfish Production (mt)	Total Swordfish Production in N&C. Pacific (mt)	# Total Turtle Catch	Reduction in Turtle Catch (#)	% Reduction in turtle catch
Status quo (2012)	1,080	31,330	2,270	-	-

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Scenario 1: Hawaii product at Historical level peak	4,985	31,330	2,010	260	11%

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Scenario 2: Everyone fishes like Hawaii	31,330	31,330	392	1,878	83%

Conclusions

- Strong spillover (market transfer effects) from regulation of the Hawaii shallow-set longline fishery for swordfish.
- Reduced swordfish production by Hawaii longline fishery did not contribute stock-wide conservation of sea turtles.
- Conversation acts for marine resource can not be isolated at the local level.


Thank you and Question?