NOAA
FISHERIES

Economic and Social Science Research

A Quasi-experimental Approach to Evaluating the Efficacy of the "Rights to Fish": The Effects of Catch Shares on Fishermen's Days At Sea

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Catch Shares

- "Catch shares": A general term that refers to a variety of market-based management systems akin to "rights to fish"
- <u>Cooperatives</u> are one type of catch shares
  - Each member holds a *negotiated* share of the sector's allocation of total allowable catch (TAC)
  - Self-governed with government oversight
- Individual Fishing Quotas (IFQs) refers to individual fishing rights; trading is often permitted

Research Question

How do catch shares–cooperatives–impact fishermen's decisions regarding the number of days a vessel spends at-sea fishing?

Hypothesis

- After catch shares are adopted, fishermen's days at sea will lengthen (where biological feasible), as fishermen learn to fish more slowly, with more precision, and with fewer input (Wilen 2006).

Gap in Literature

- Much has been published on the effectiveness of catch shares (Casey et al. 1995; Homans & Wilen (1997, 2005); Wilen & Casey (1997); Felthoven (2002); Costello et al. 2008; Abbott et al. 2010; Grimm et al. 2012)
- Yet, prior research consists primarily of studies limited by correlational evidence (except for Costello et al. 2008)
- Challenge: capture the *actual* effects of catch shares as opposed to changes in market or fishery conditions unrelated to catch shares

Paper's Contributions

1. Identification strategy for "effects" of catch shares → Quasi-experimental design
2. Modeling of two closely linked fisheries
3. A first step toward more detailed structural analysis on product quality, labor use, capital investments

Alaska Pollock

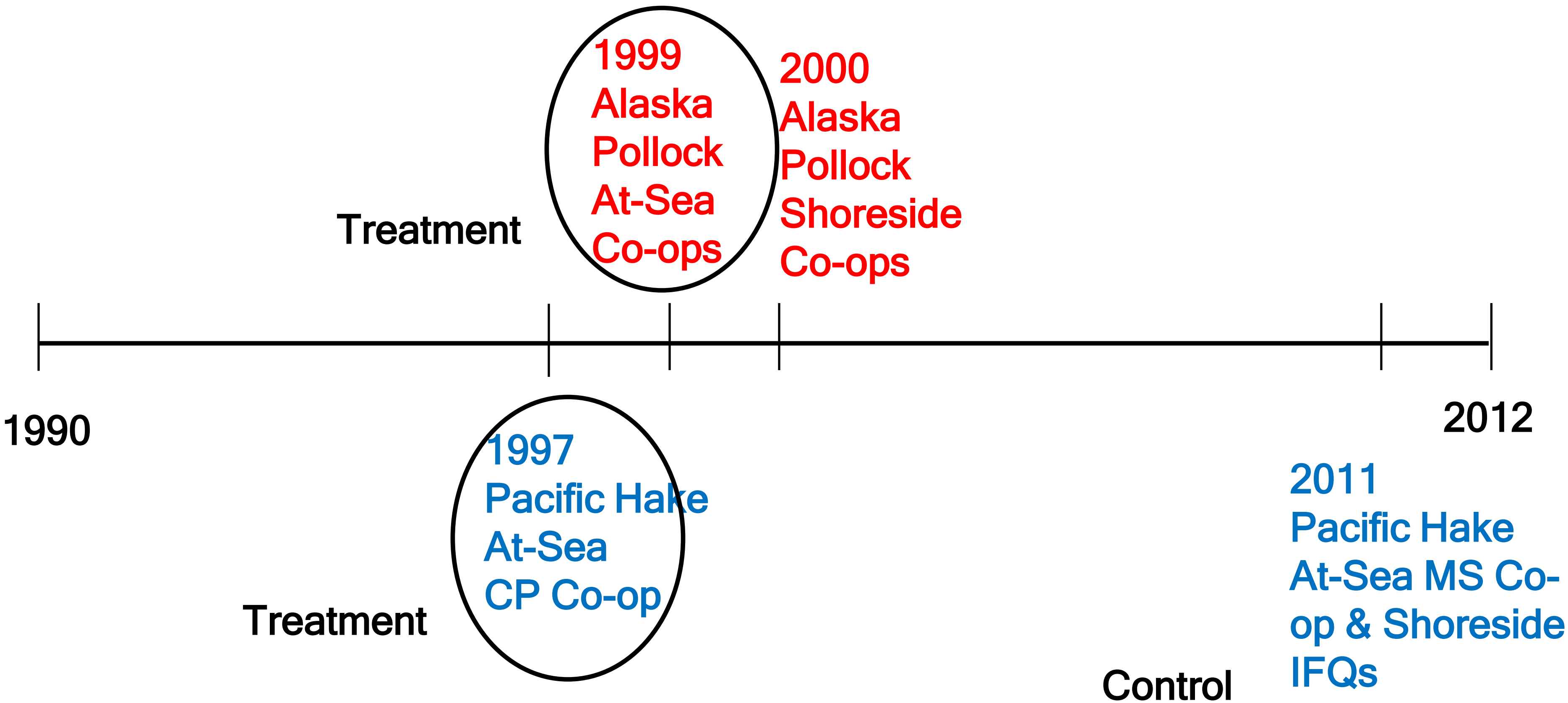
Pacific Hake

Alaska Pollock

	PACIFIC HAKE	ALASKA POLLOCK
Order/Family	Gadiformes/Merlucciidae	Gadiformes/Gadidae
Length (maturity/max)	34-40 cm/91 cm (60 cm common)	37 cm/100 cm
Fishing "age" range	4-5 years onwards	3 years onwards
Life span	Up to 15-16 years	Up to 12 years
Reproduction	Reproduce by 3-4 years	Reproduce by 3-4 years
Fish abundance	Not overfished; MSC certified (2009)	Not overfished; MSC certified (2005)
Fishing gear	Pelagic trawl	Pelagic trawl
Bycatch	Low % bycatch	Low % bycatch
Ocean bottom habitat impact	Very little since mid-water trawl	Very little since mid-water trawl
Commercial products	Surimi (primary), fillets and roe (emerging)	Surimi, fillets, and roe
Export markets	Japan, US., and Europe	Japan, US., and Europe
Management	Pacific Fishery Management Council, National Marine Fisheries Service	North Pacific Fishery Management Council, National Marine Fisheries

Pacific Hake

Staggered Introductions of Catch Shares



2 Quasi-experiments

Data Sources

- At-sea Pollock Observer Program (1997-2012)
  - Haul dates, catch weight
  - Annual ex-vessel/wholesale prices
- At-sea Hake Observer Program (1991-2012)
  - Haul dates, catch weight
  - Ex-vessel/wholesale prices by deliveries from shoreside sector
- Alaska State's Commercial Operator's Annual Report (1997-2012)
  - Annual prices by product type
- Pollock, Hake Stock Assessments (1991-2012)
  - Fishing biomass estimates

Dependent Variable

- **Days at Sea**
  - Vessel Level: Count the #days with at least one haul for a given year

    ➔ Similar to season length index created by Alaska Fisheries Science Center

Control Variables

- What affects fishermen's decision to fish?
  - *Economics:* Vessel-specific total catch, ex-vessel/wholesale prices, fish product prices
  - *Biology*: Fishing biomass
  - *Regulation*: Bycatch avoidance rules
  - Participation in the other fishery
  - Vessel fixed effects, year fixed effects

Difference-in-Differences

- Consider two groups. Neither group receives the treatment in the period 1 and only one group receives it in period 2.

- Calculate the change in the outcomes among the treated group between the two periods and then subtract the change in outcomes among the untreated group.

$$T^{DD} = \{E[Y_{1i}|D_i = 1, t = 2] - E[Y_{1i}|D_i = 1, t = 1]\}$$
$$- \{E[Y_{0i}|D_i = 0, t = 2] - E[Y_{0i}|D_i = 0, t = 1]\}$$

- This change is expected to be the "impact" that can be attributable to the policy intervention.

Fishery Participation

 # Vessels that Fish in AK, WC, AK + WC

	AK Only	WC Only	AK + WC
1996	143	33	43
2012	121	13	31

% Vessels that Fish in Both AK and WC as a Share of AK or WC

	AK[2]	WC[3]
1996	23%	57%
2012	20%	70%

[1] (AK + WC)/AK + (AK + WC); For example, for 1996, % Vessels that fish in both AK and WC as a Share of AK = 43/186 = 23%

[1] (AK + WC)/WC + (AK + WC)

Difference-in-Differences-in-Differences

- To robustify the model, I exploit variation that may exist between control and treatment fisheries
- Changes in fishery participation may be systematically different across treatment and control fisheries that is unrelated to catch shares

$$T^{DDD} = \{E[Y_{1i}|D_i = 1, t = 2] - E[Y_{1i}|D_i = 1, t = 1]\}$$
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Pollock Estimation Equations

Policy Treatment: **1999** Catch Processor Cooperative

D-D-D Estimation

$$daysatsea_{itj} = \beta_0 + \beta_1 pollock_{ij} + \beta_2 postcoop_t + \beta_3 p\_other\_fishery_{ij}$$
$$+ \beta_4 \left(pollock_{ij} \times postcoop_t \times p\_other\_fishery_{ij} \right) +$$
$$\beta_5 X_i + year\_fe + vessel\_fe + \varepsilon_{itj}$$

Pacific Hake Estimation Equations

Policy Treatment: **1997** Catch Processor Cooperative

D-D-D Estimation

$$daysatsea_{itj} = \beta_0 + \beta_1 hake_{ij} + \beta_2 postcoop_t + \beta_3 p\_other\_fishery_{ij}$$
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$$\beta_5 X_i + year\_fe + vessel\_fe + \varepsilon_{itj}$$

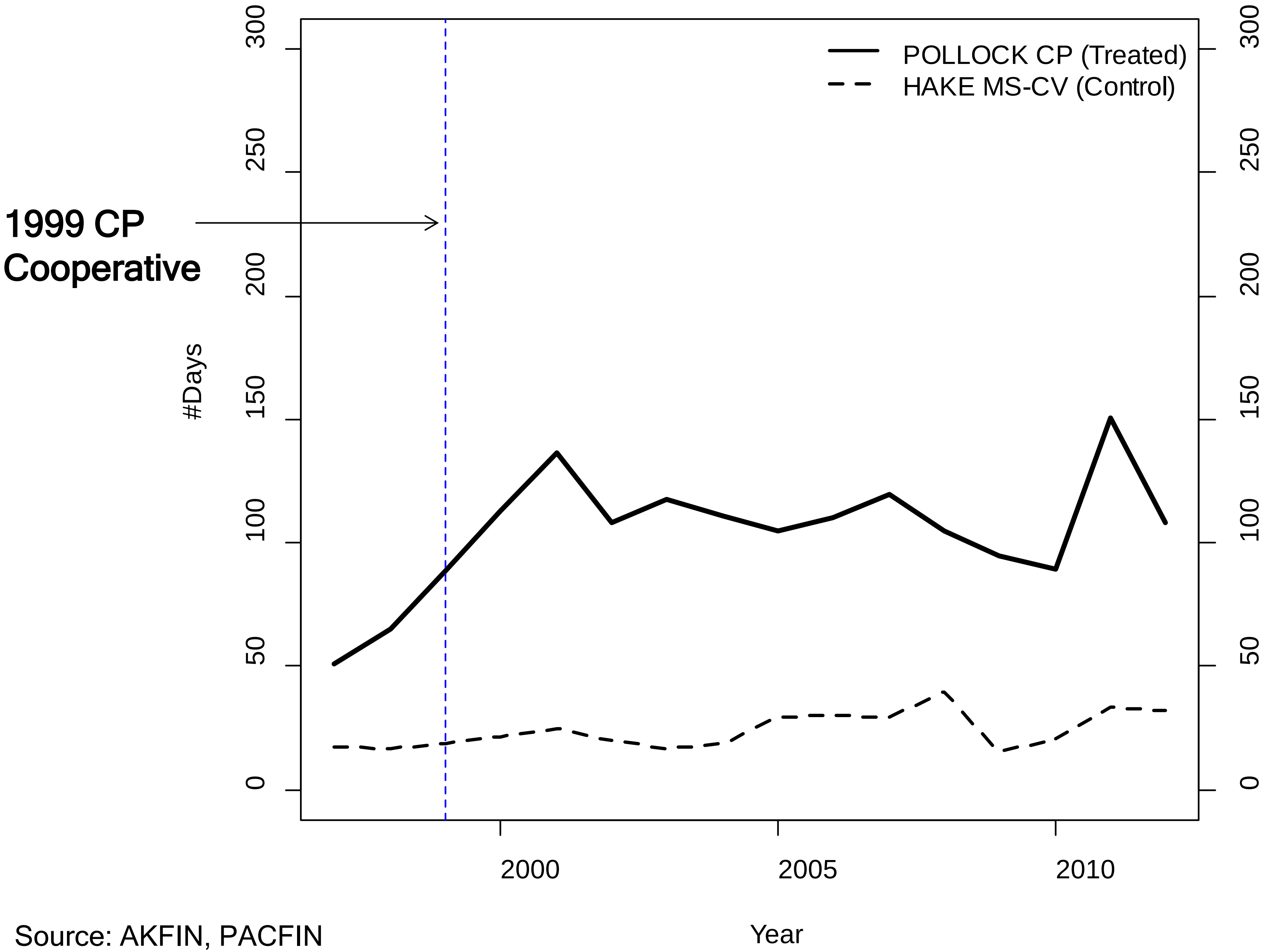
Treatment Fishery:

Alaska Pollock Catcher Processors

Control Fishery:

Pacific Hake Mothership Catchers

At-Sea Pollock vs At-Sea Hake Fis
Average Vessel Days at Sea by Se (1997-2012)



Source: AKFIN, PACFIN

Pollock Fishermen's Days at Sea

	Model 1 Days At Sea D-D-D	Model 2 Days At Sea D-D-D	Model 3 Days At Sea D-D-D
Pollock Fishery	-6.58* (3.769)	6.20 (5.378)	6.03 (5.564)
Post Cooperative	8.51*** (2.707)	4.13*** (1.368)	0.46 (1.656)
Participation in Other Fishery	-0.63 (2.895)	0.36 (3.038)	0.83 (2.920)
Effects of Cooperative	8.11** (3.153)	9.81*** (3.761)	9.20** (3.853)
Total Catch (vessel-specific, thous. tons)	2.87*** (0.161)	2.81*** (0.186)	2.81*** (0.203)
Fishing Biomass (mil. tons)		-1.27** (0.447)	-1.84*** (0.486)
Ratio of Hake to Pollock Prices			-3.98*** (0.853)
Ratio of Fillet to Surimi Prices			7.27*** (2.621)
Year Effects	YES	NO	NO
Vessel Effects	YES	YES	YES
R-square	0.95	0.93	0.94
N	593	593	570

Model 1: Basic D-D-D model; Model 2: Model 2 + Biology; Model 3: Model 2+ Biology + Economics
***Stat. sign. at p = 0.001; **Stat. sign. at p=0.05; *Stat. sign. at p=0.1. Robust standard errors are in parentheses.

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<u>Treatment Fishery:</u>

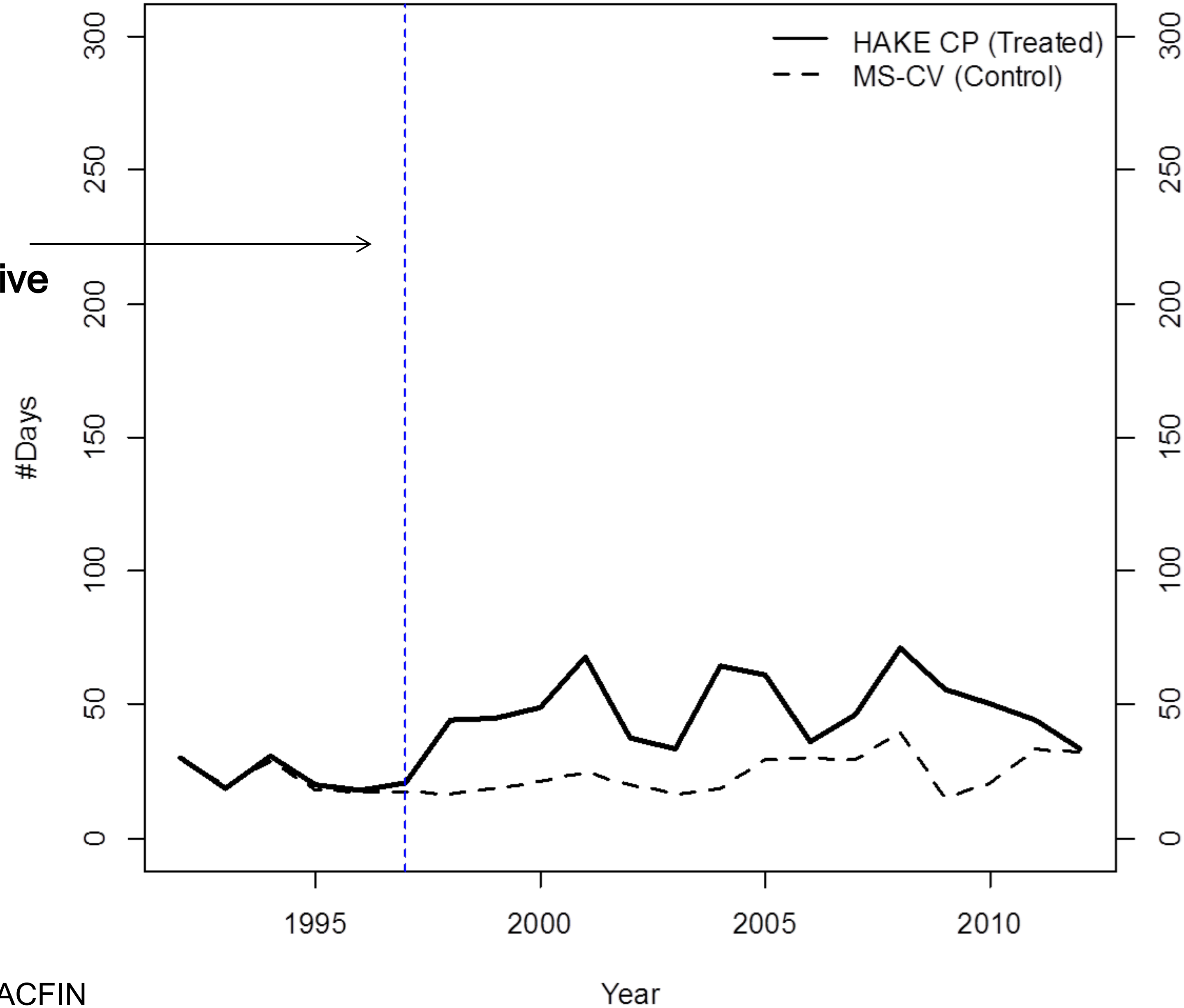
Pacific Hake Catcher Processors

<u>Control Fishery:</u>

Pacific Hake Mothership Catchers

At-Sea Hake Fishery
Average Vessel Days at Sea (1991-2012)

1997 CP Cooperative



Source: PACFIN

Hake Fishermen's Days at Sea

	Model 1 Days At Sea D-D-D	Model 2 Days At Sea D-D-D	Model 3 Days At Sea D-D-D
Hake Fishery	-3.02 (5.493)	-9.88* (5.950)	-9.99** (4.132)
Post Cooperative	-19.51** (5.033)	-3.58** (1.040)	-4.75*** (0.757)
Participation in Other Fishery	-1.47 (2.184)	-3.41* (1.999)	-6.43** (1.883)
Effects of Cooperative	7.26*** (1.978)	6.60*** (1.897)	9.41*** (1.712)
Total Catch (vessel-specific, thous. tons)	3.96*** (0.295)	4.04*** (0.359)	3.54*** (0.205)
Bycatch Caps for Overfished Rockfish	9.36*** (1.918)	5.48*** (0.811)	1.73*** (0.670)
Fishing Biomass (mil. tons)		3.78* (2.131)	-7.30** (1.213)
Ratio of Pollock to Hake Prices			-3.27*** (0.490)
Year Effects	YES	NO	NO
Vessel Effects	YES	YES	YES
R-square	0.82	0.77	0.87
N	681	681	554

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Preliminary Findings

- Further evidence of catch shares' effectiveness in ending the "race to fish"
- Catch shares are associated with increases in days at sea for pollock and hake catcher processors
- A vessel's total catch and fish product prices are positive predicators
- Participation in the other fishery matters
- Bycatch avoidance leads to an increase in days at sea, implying more careful fishing

Work Ahead

- Why do fishermen's days at sea increase?
- Shares for catch <u>and</u> bycatch avoidance
- Model relationship between the pollock & hake fisheries and impact on effort allocation in a multi-stage behavior model
- <u>More data</u>:
  - Data on shoreside catcher vessels
  - Cost earnings data for hake fisheries

Thank You!

- Economists and biologists at Northwest Fisheries Science Center, NOAA
- Economists and biologists at Alaska Fisheries Science Center, NOAA
- Pacific Fishery Management Council
- National Research Council

Reference Slides

BSAI Pollock Fishery

- Largest fishery in North America
- At-sea: Catcher processors & motherships
  - 5-year avg. total allowable catch: 455K mt
  - Revenue: $157 million
  - Price: $350/mt
- Late 1980s: Fishery was americanized.
- Early 1990s: Overcapacity resulted in inefficient, unsafe, unprofitable fishery

Pacific Hake Fishery

- Most abundant West Coast commercial fish species
- At-sea: Catcher processors and motherships
  - 5-year avg. total allowable catch: ~108K mt
  - Revenues: ~$26 million
  - Prices: ~$203/ton
- Harvesting was done by foreign vessels and joint ventures. By 1989, hake are harvested by U.S. vessels.
- There is joint U.S. – Canada harvest assessment and management (U.S.: 74%; Canada: 26%).

Major U.S. Domestic Species Landed in 2011

Ranked by Volume and Value

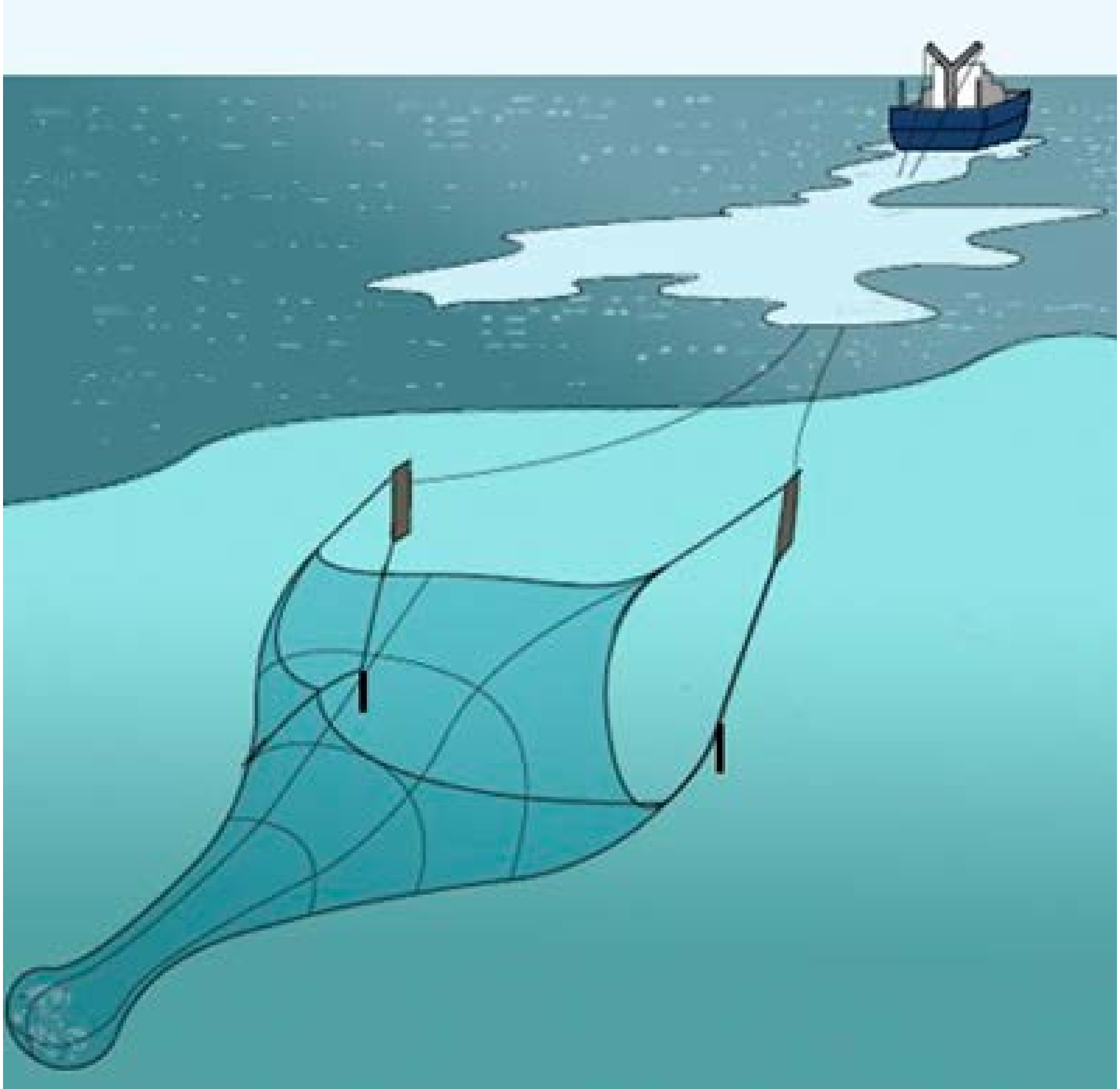
Volume of Landings

Rank	Species	Thousand Pounds
1	Pollock	2,826,692
2	Menhaden	1,875,035
3	Salmon	780,088
4	Flatfish	707,360
5	Cod	681,895
6	Hakes	521,246
7	Crabs	369,152
8	Squid	331,343
9	Shrimp	312,658
10	Herring (sea)	276,341

Value of Landings

Rank	Species	Thousand Dollars
1	Crabs	$650,237
2	Salmon	$618,316
3	Scallops	$587,042
4	Shrimp	$517,697
5	Lobster	$473,528
6	Pollock	$374,913
7	Cod	$236,186
8	Halibut	$213,007
9	Clams	$186,644
10	Sablefish	$183,883

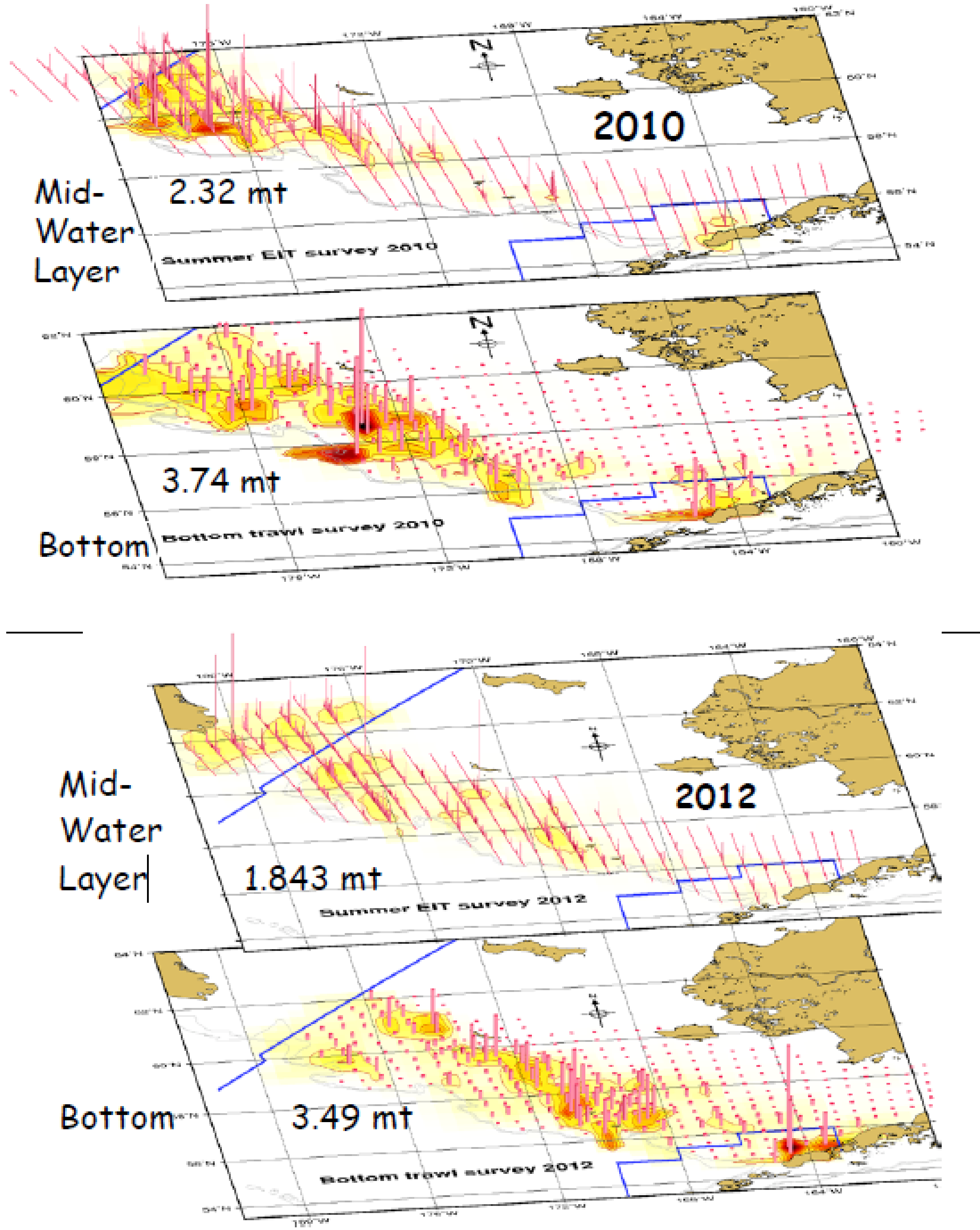
Source: Fisheries of the United States 2011 (2012)



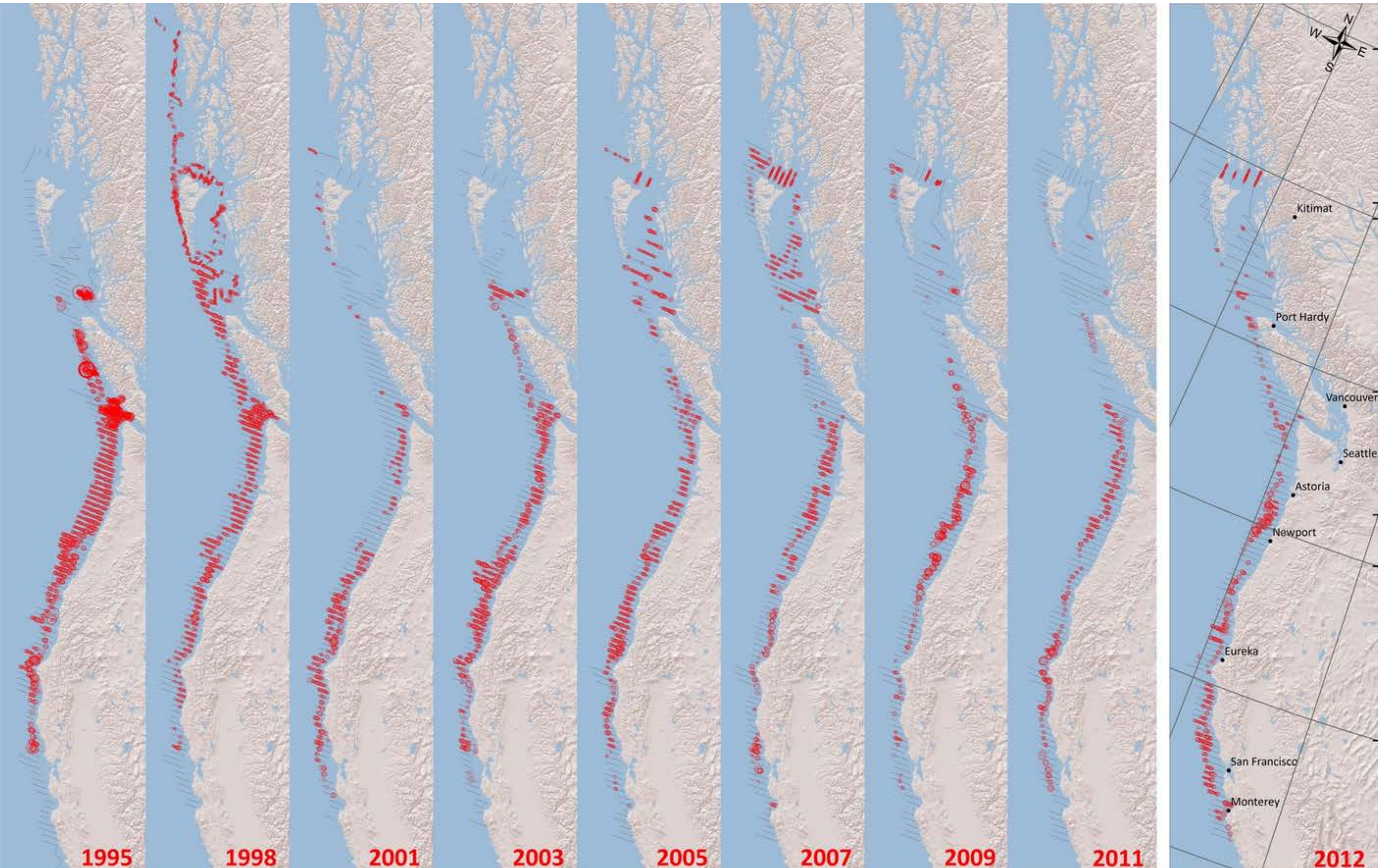
Pollock Catch
(70 metric tons)

Hake Catch

Pollock Biomass Distribution, 2010-2012



Biomass Distribution of Hake,1995-2012



Pollock and Hake Seasons

- Pollock A Season
  - January 20 to March
- Whiting Season (Some PLCK B Season)
  - June to July-August
- Pollock B Season (After Whiting Season)
  - July-August to October

Implementation

1. Create daysatsea and daysatsea per thous. Tons measures

2. Create indicators for treatment
   - pollock = 1 if region = treated fishery

3. Create post-policy treatment indicators
   - $postcoop_t = 1$ if $1998 < year < 2013$ (pollock) or $postcoop_t = 1$ if $1997 < year < 2013$ (hake)

4. Create indicators for participation in the other fishery
   - p_other_fishery = 1 if participation in the other fishery (.e.g., pollock or hake)

5. Create interaction effects
   - pollock*postcoop → DD estimator
   - pollock*postcoop*p_other_fishery → DDD estimator

6. Include control variables, robust standard errors