Science, Service, Stewardship

Modeling Changes in Fishery Participation and Economic Impacts in Response to Climate Variation and Climate Change

Dan Holland, NWFSC
Jerry Leonard, NWFSC
Kate Richerson, University of Washington, NWFSC

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Outline of Webinar

- **Focus: How will climate driven changes in the California Current Ecosystem affect fishers and fishing communities?**
- **Three Presentations:**
  - *Dan Holland: The Dynamics of Adaptation to Climate-Driven Variability in California Current Fisheries And Fishing Communities*
  - *Jerry Leonard: Atlantis and Input Output Model for Pacific Coast Fisheries (IO-PAC) Collaborations*
  - *Kate Richerson: Quantifying and Predicting Impacts of Salmon Ocean Fishery Closures*
- **Discussion**

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The Dynamics of Adaptation to Climate-Driven Variability in California Current Fisheries And Fishing Communities

Josh Abbott, Dan Holland, Nate Mantua, Karma Norman, Malin Pinsky, Melissa Poe, Andre Punt, Kate Richerson

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Funding and Organization

- NSF CNH Award 1616821 $1.5 million 2016-2020 with Josh Abbott Arizona State University as lead PI
  - Josh Abbott (ASU)
  - Andre Punt (UW SAFS)
  - Melissa Poe (UW Sea Grant)
  - Malin Pinsky (Rutgers)
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  - Dan Holland (NFWFC)
  - Karma Norman (NWFSC)
  - Nate Mantua (SWFSC)
  - Kate Richerson (ECS, JISAO)

National Science Foundation WHERE DISCOVERIES BEGIN
ASU JULIE ANN WRIGLEY GLOBAL INSTITUTE of SUSTAINABILITY ARIZONA STATE UNIVERSITY
W COLLEGE of the ENVIRONMENT
Sea Grant Washington
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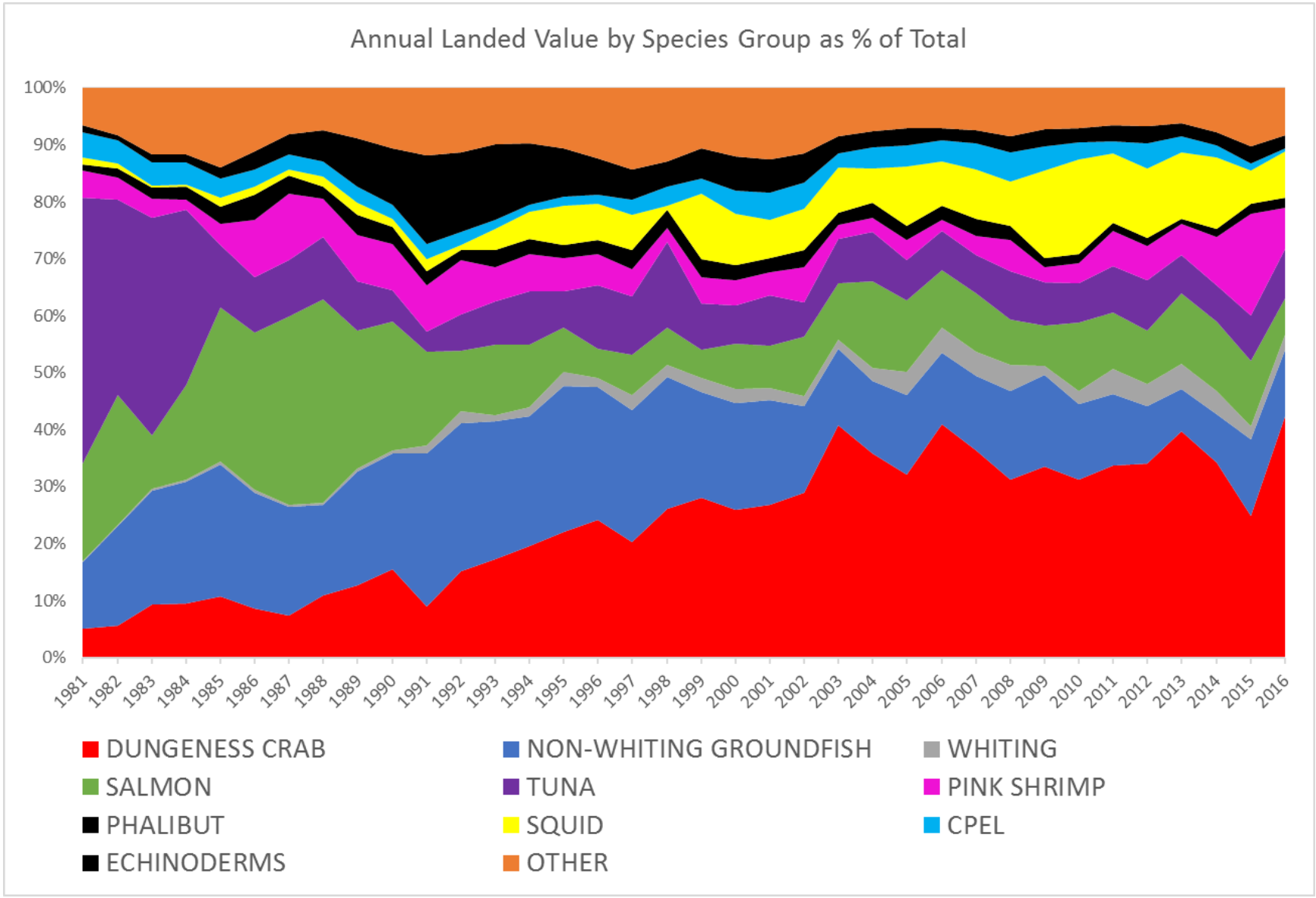

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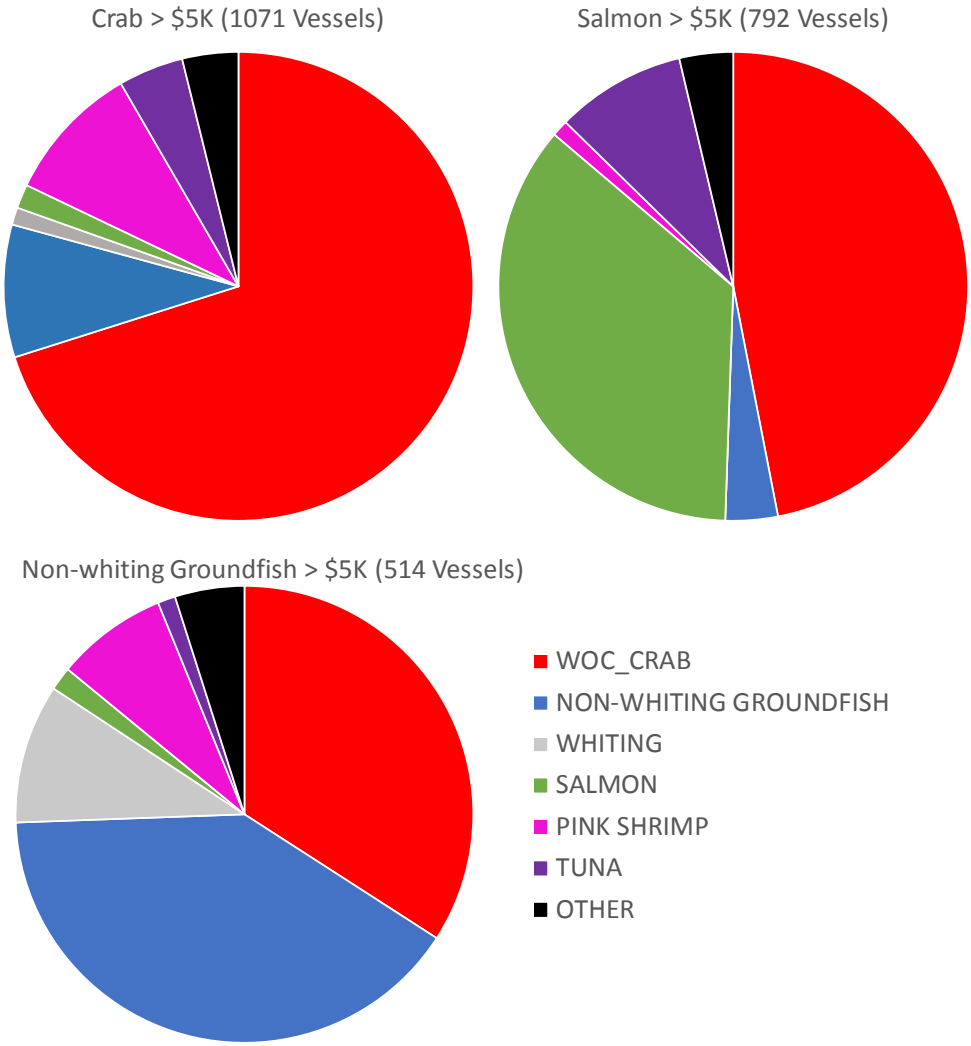
2016 Total Revenue for Fleets of Vessels Defined by Having Revenue of Dungeness Crab, Salmon, or Non-whiting Groundfish Over $5000



Percent of Fishers with >$5K in two or more fisheries in 2016

- 43% of all fishers with rev >$5k
- 36% of Salmon Fishers
- 52% of Dungeness Crab Fishers
- 63% of Groundfish Fishers

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Project Objectives

- To understand how environmental variability travels through, and is dampened or amplified by, linked social and ecological processes in fisheries systems on the U.S. West Coast.
- To explore how more integrated management of fisheries can be used to increase resilience and human benefits derived from West Coast commercial fisheries.
- To engage disparate parts of the fishery management community (for state and federally managed fisheries) in development and application of the research and modeling tools needed to implement ecosystem-based fishery management.

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Some “Big Picture” Questions

- Do differential effects of environmental conditions on productivity across species make it possible for fishers to form robust portfolios of fisheries?
- How do biological fluctuations interact with management, economic and social/psychological factors to influence the adaptive flow of effort across fisheries in these portfolios?
- How do these adaptations feed back to the variability and robustness of the system?
  - Do fisher’s adaptations moderate or exacerbate ecosystem variability induced by climate variation?
  - How do management and access regimes affect this relationship?
- Can an understanding of the dynamics of this system of fisheries enable managers to anticipate and mitigate affects of climate variation.

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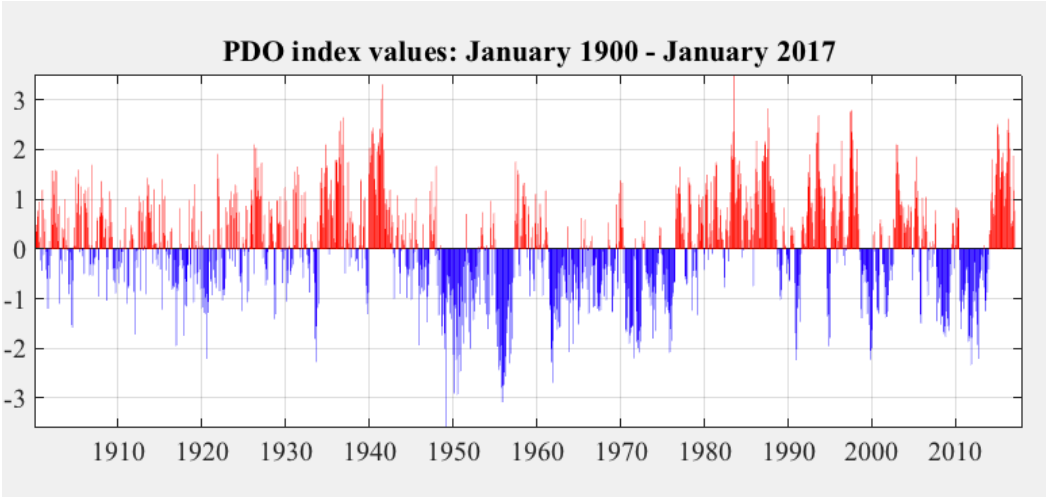
Theme 1: Linking Environmental Variability to Marine Species' Recruitment and Distribution

- How does climate variability affect recruitment, growth, and distribution of key target species
- To what extent are California Current species' population dynamics synchronized?
- Is synchrony driven by climate variability?
- Do populations within synchronous groups share similar characteristics?



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Theme 2: Psychological and Social Benefits and Drivers of Fishery Participation

- How do personal tastes for fishing vs. socially influenced identity serve as a motivation for participation in fisheries?
- What role do non-fishery sources of income play in fishing households and how does that affect participation?
- What role does social capital play in participation and in fishing community resilience.
- What role does seafood retained for personal use play in fishing households and communities and how does it affect participation in particular fisheries?

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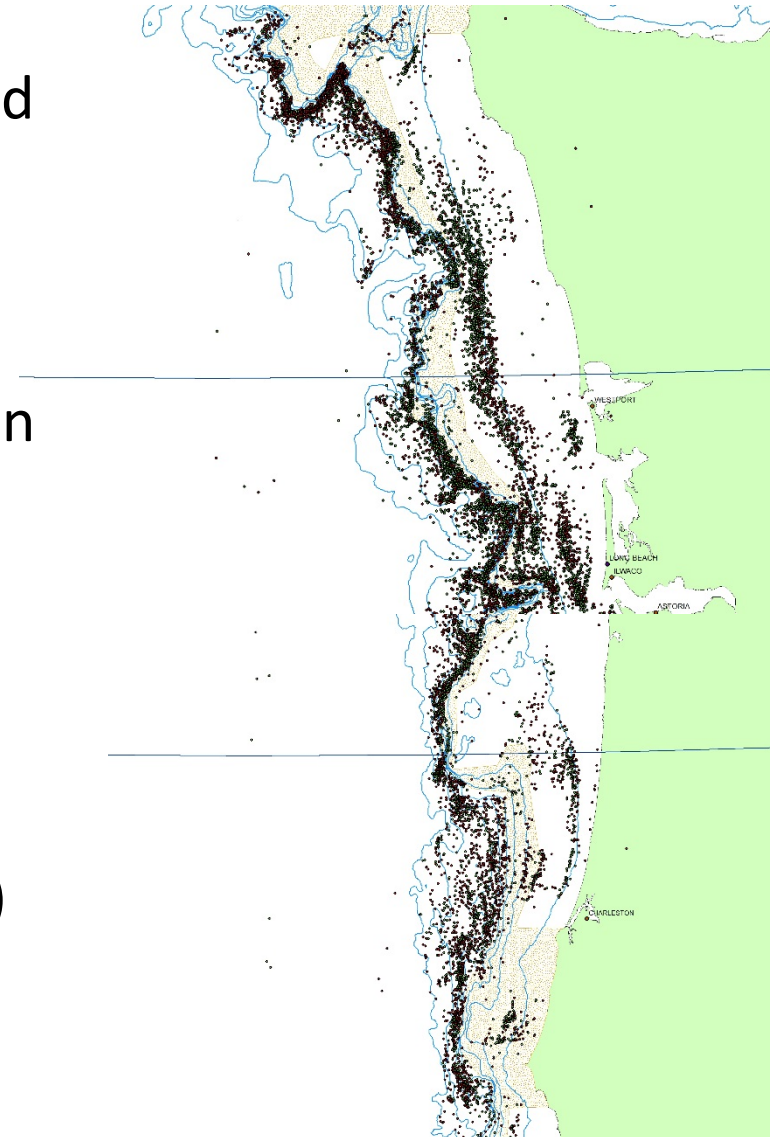
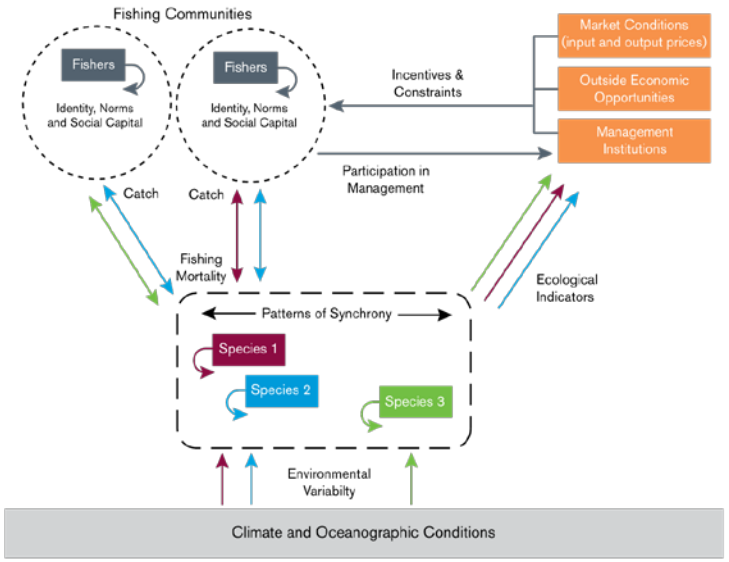
Theme 3: Linking Stock Status, Regulation and Social Motivations to Fisher Behavior

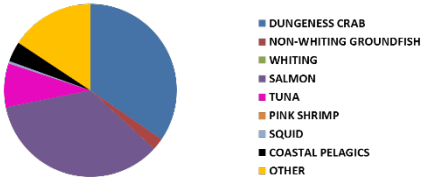
- Statistical models of fishery choice and entry/exit that improve on standard single-fishery participation models
  - Capture substitutability and complementarity of participation in various fisheries
  - Explore how individual-specific characteristics influence choices (e.g., non-monetary motivations, alternative income sources, and group or community membership)



Theme 4: Model Integration

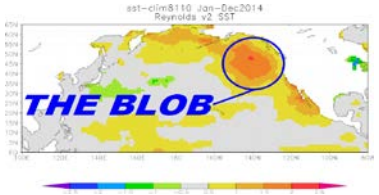
- Linked bioeconomic models for major fisheries (groundfish, Dungeness crab, salmon, pink shrimp, albacore)
- Explore how exogenous shocks (climate variation, price changes) propagate through the system.
- Can management systems and fishing strategies (e.g., diversification with specific portfolios) reduce variability of income for individuals and communities?





Identify fishing portfolios for individuals or communities that reduce variation in income

Hold workshop with fishery managers and industry to consider the results of model simulation scenarios



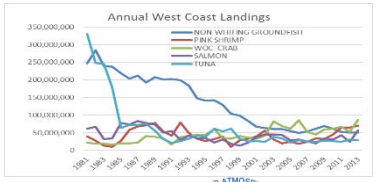
Understand how climate or economic shocks affect fisheries directly and indirectly as a result of fishing participation decisions

Construct models of salmon, Dungeness crab, groundfish, albacore and pink shrimp fisheries linked by participation model

Survey fishermen to determine motivations for participation

Seek input from fishery managers and industry stakeholders on research design

Acquire or estimate historical biomass and recruitment for salmon, Dungeness crab, albacore, groundfish, and pink shrimp stocks



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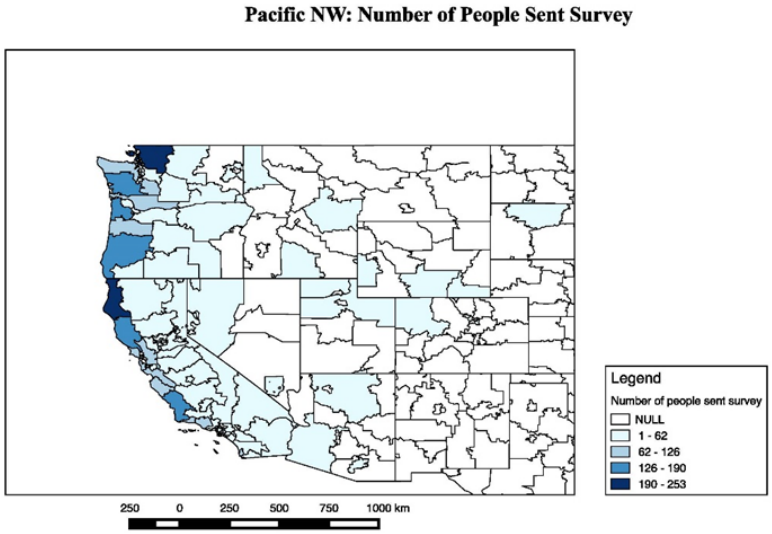
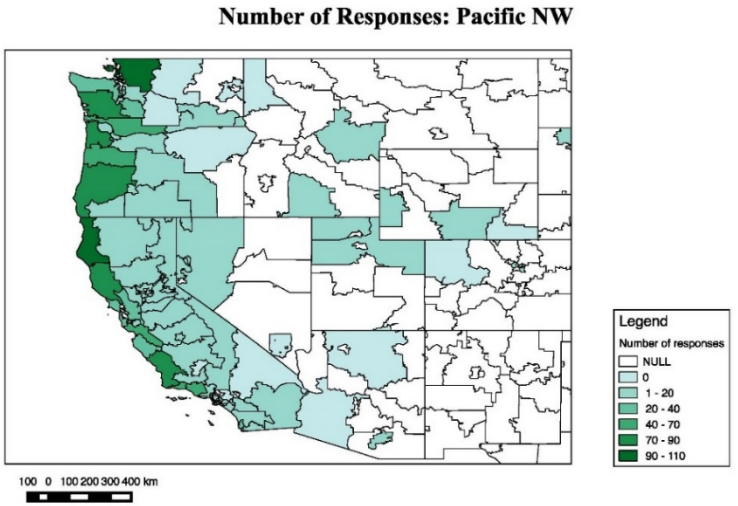
Theme 2: Participation Survey

- Mail survey of 2800 vessel owners active in West Coast commercial fisheries in 2015/16
- Full Dillman Survey Method plus $5 cash incentive
- Achieved 50% response rate (>1400 surveys) with no indication of response bias
- Key Focus: non-monetary and indirect motivations for fishery participation
- Non-fishery income diversification
- Information on catch for personal use





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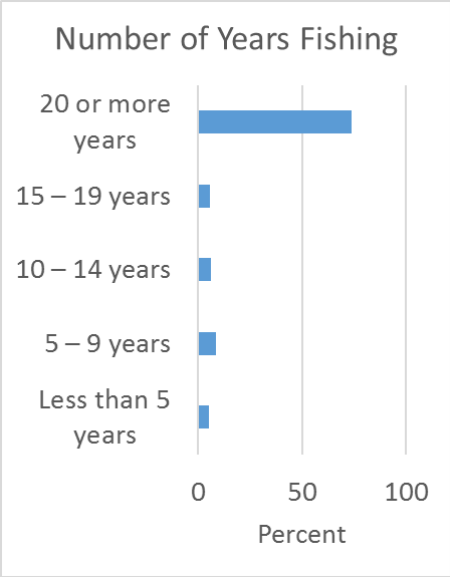
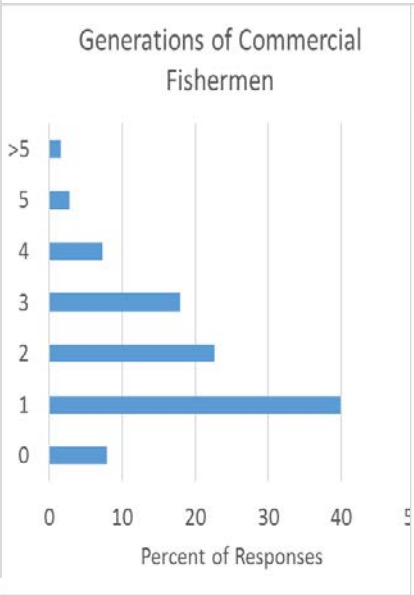
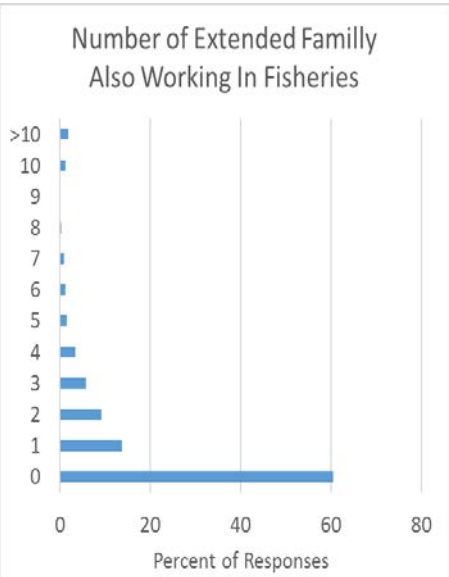
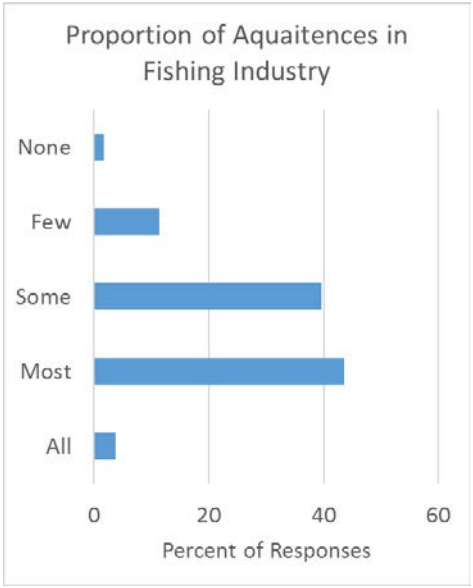
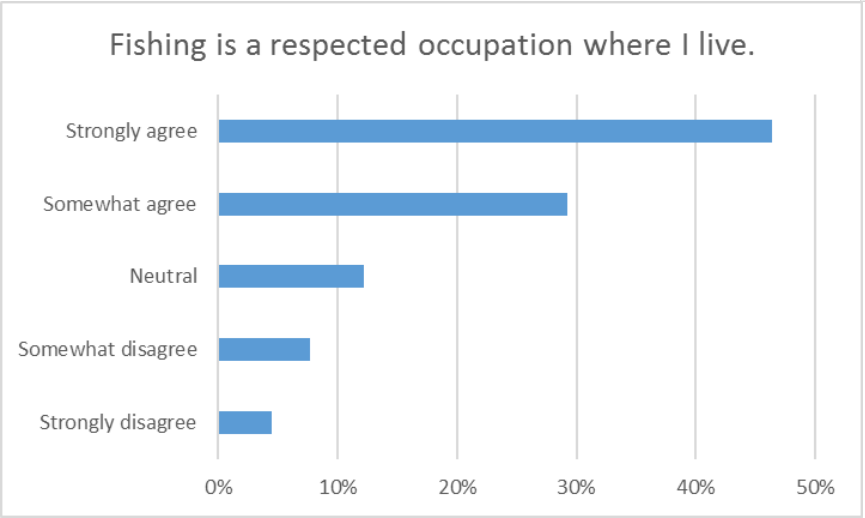
Social Capital

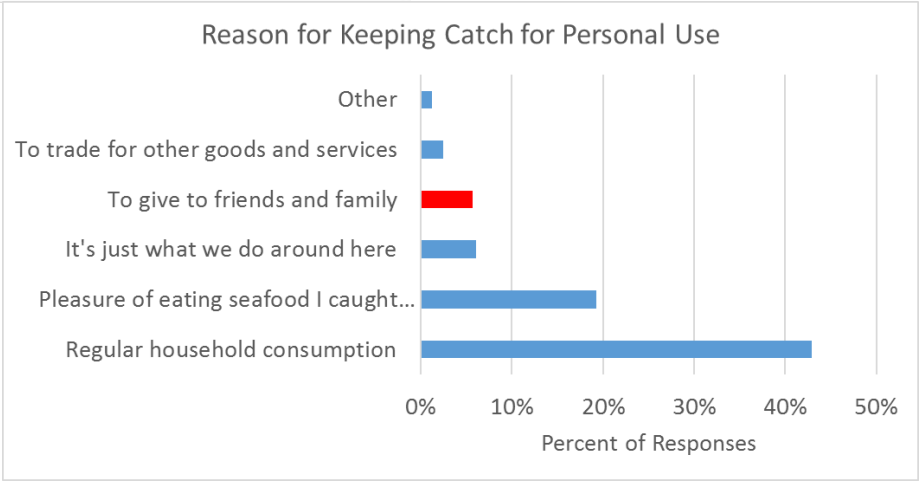












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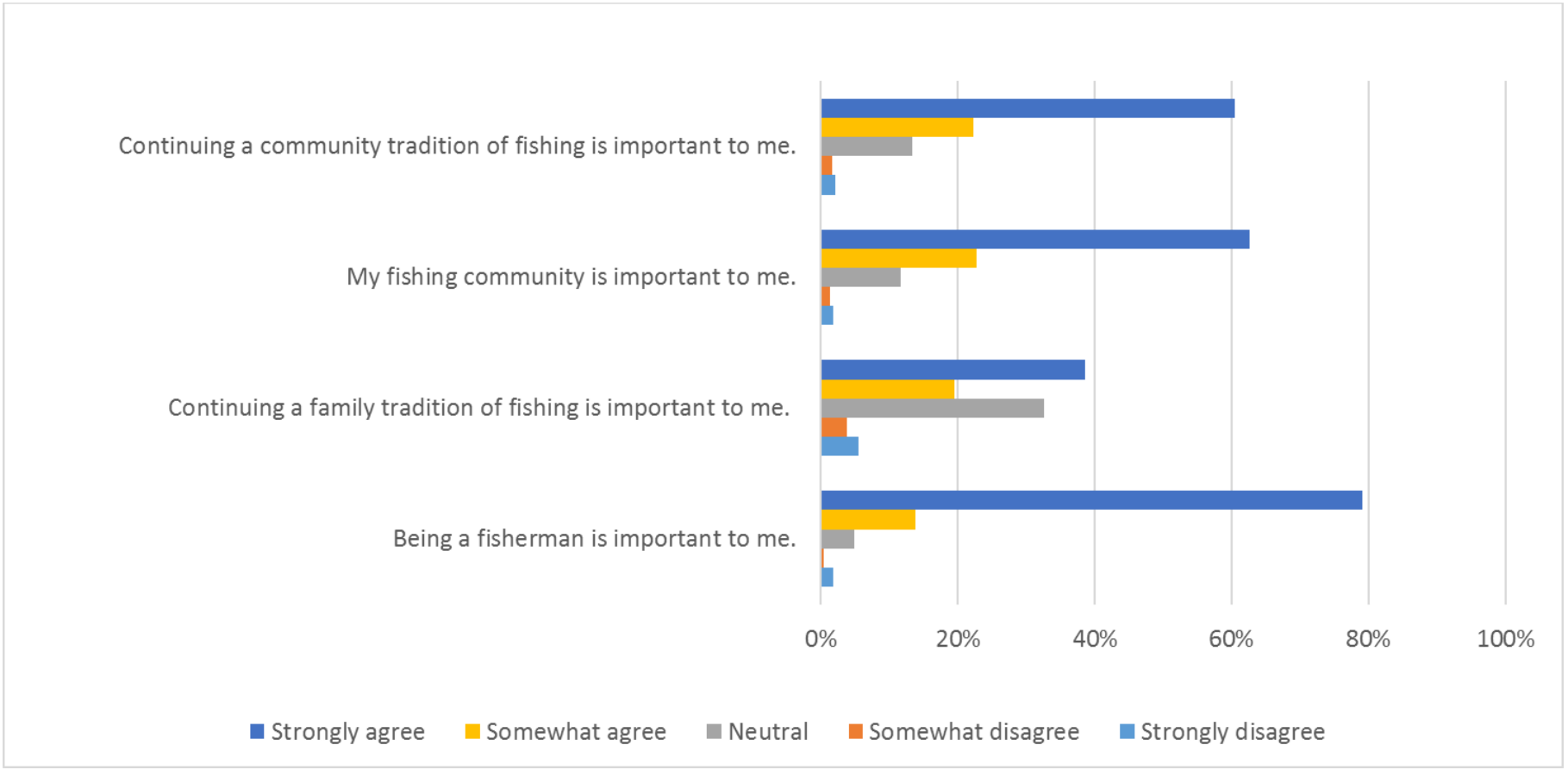
Identity



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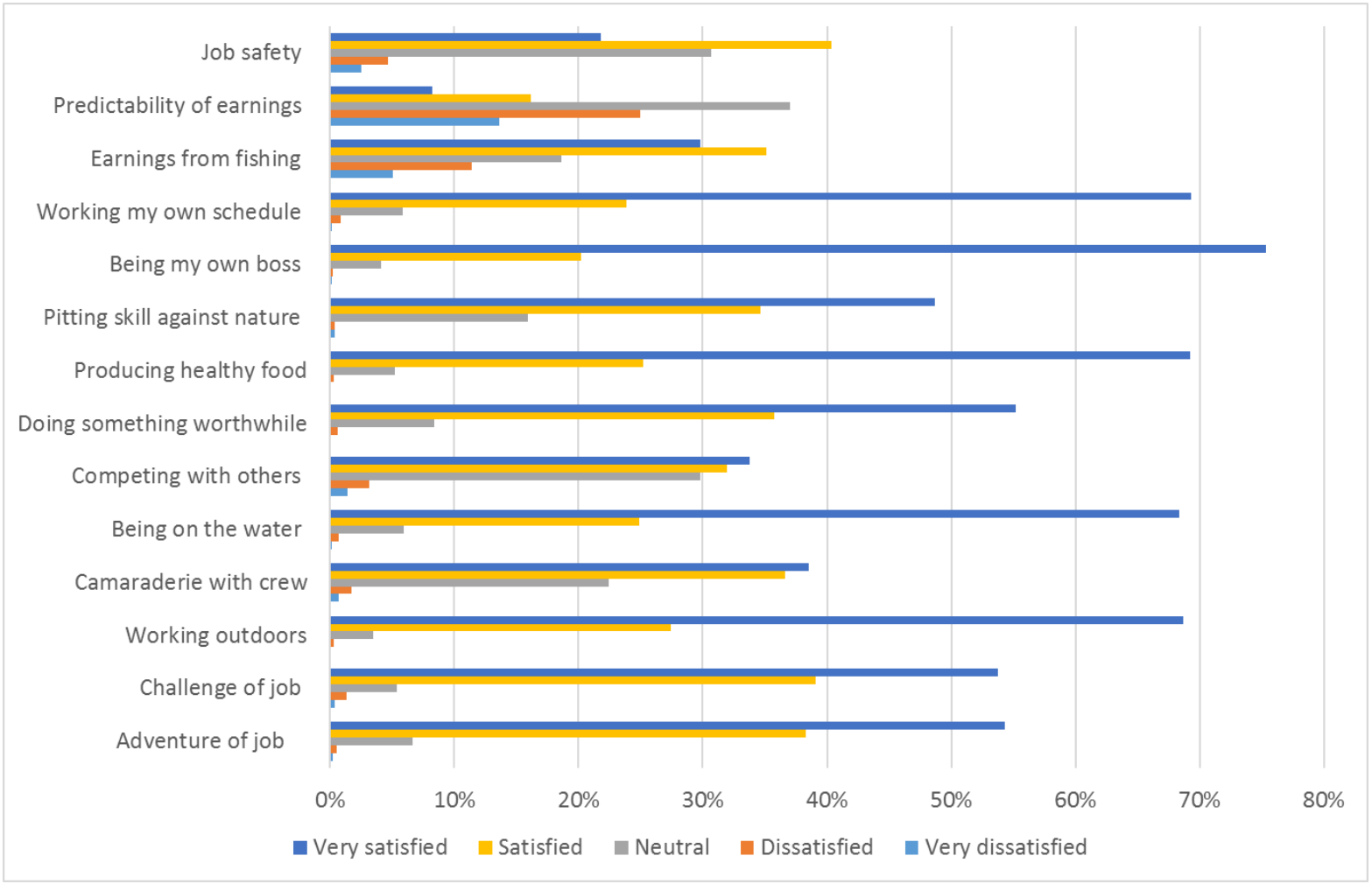
Job Satisfaction



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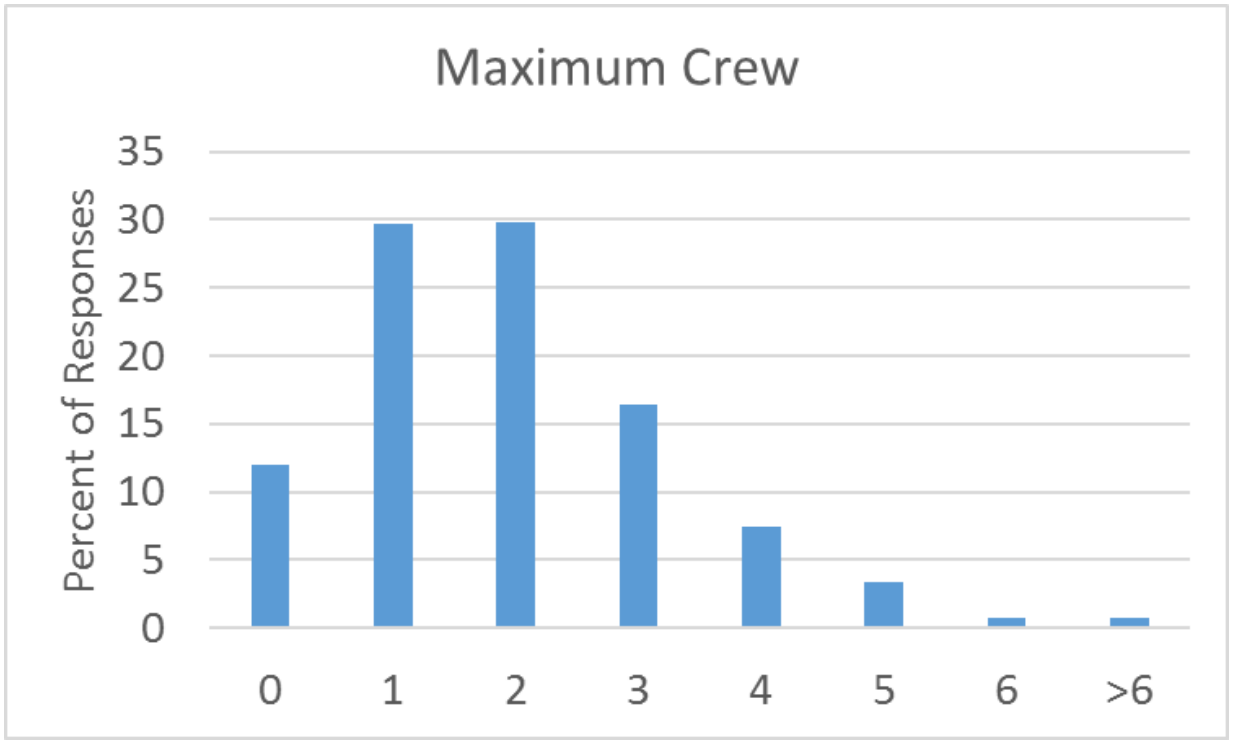
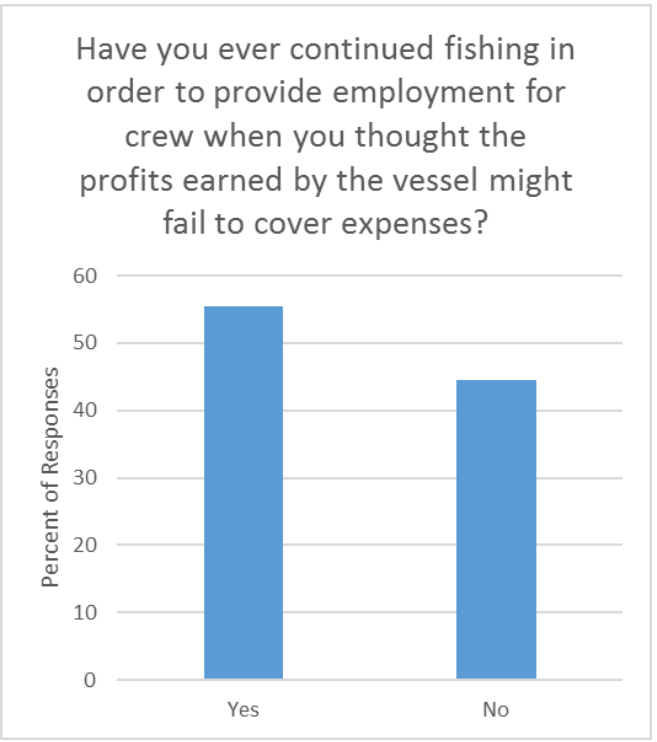
Crew





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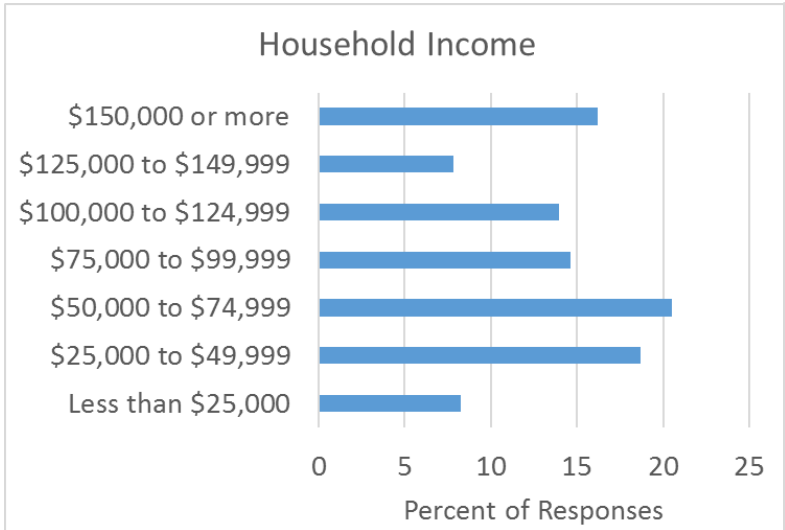
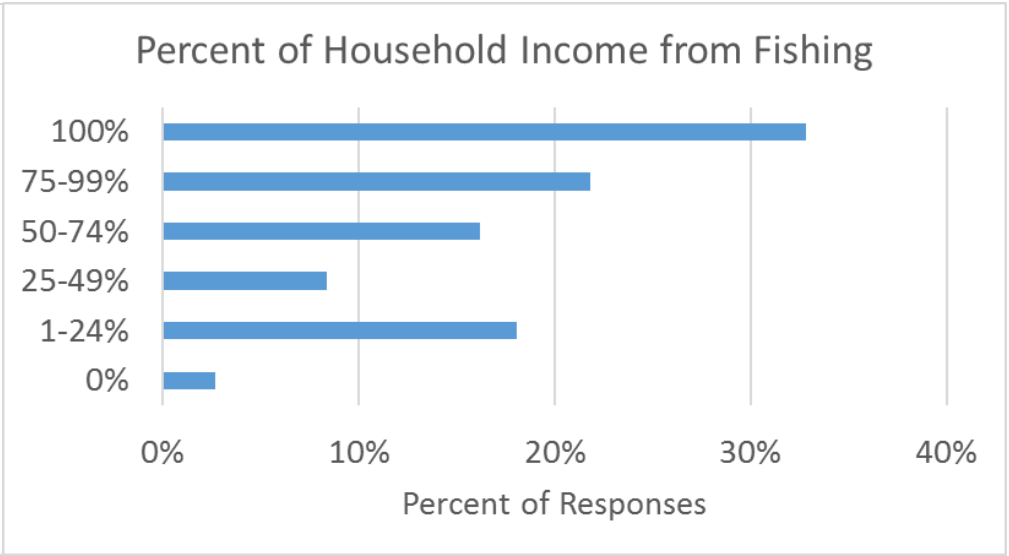
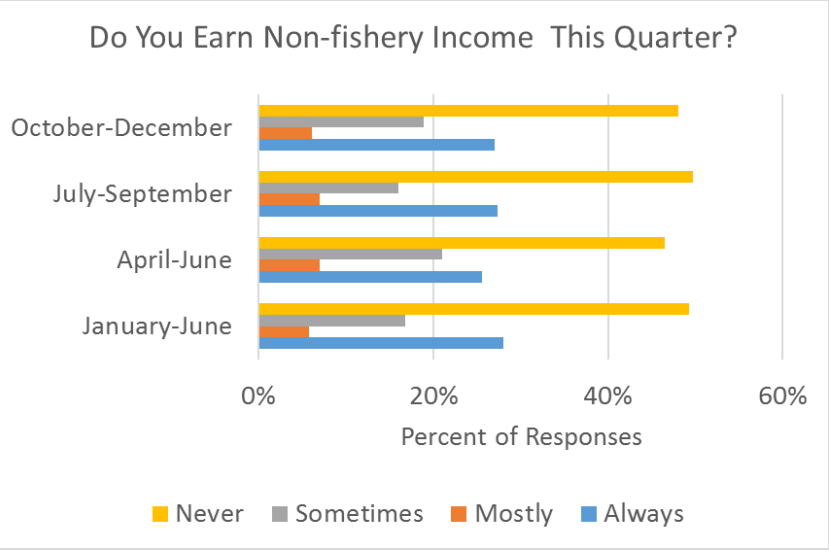
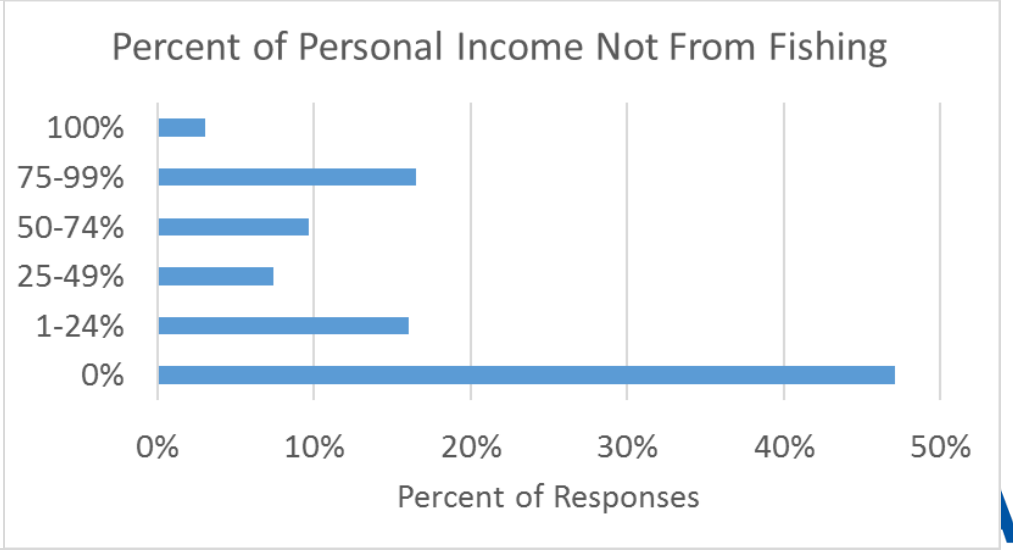
Household Income









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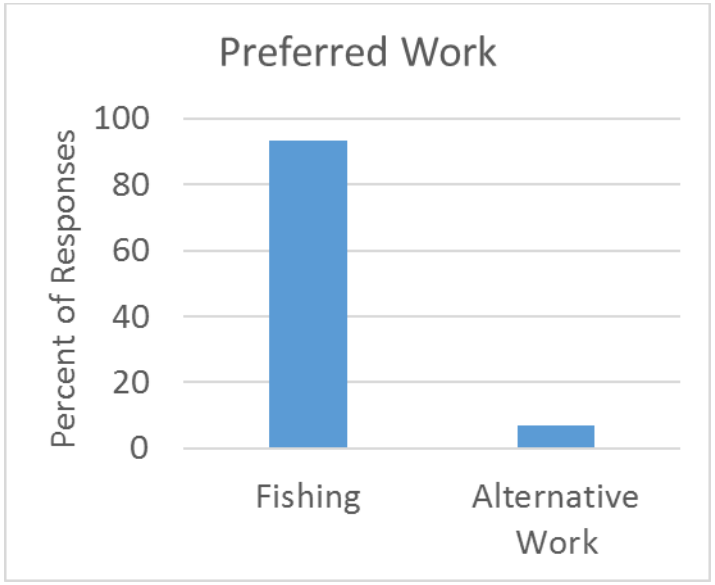
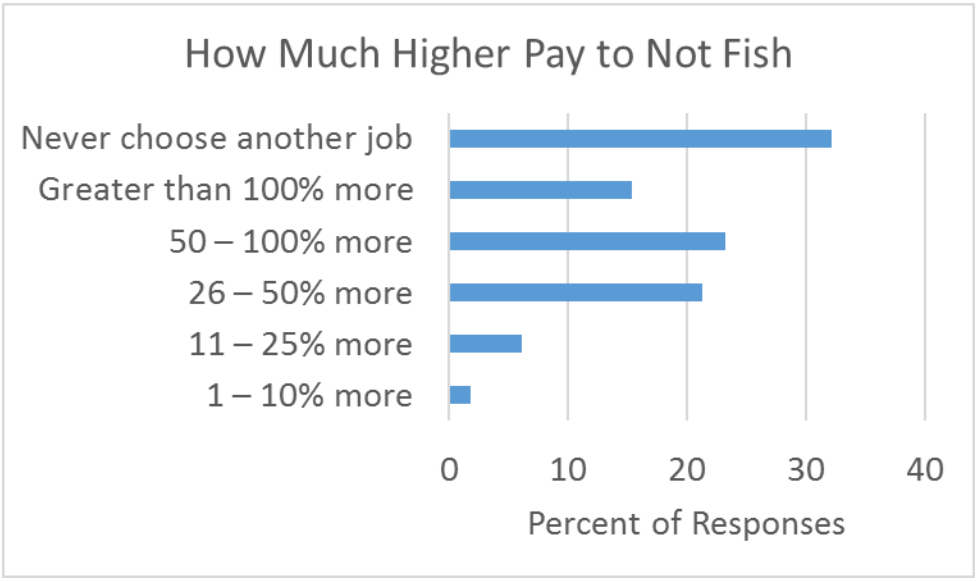
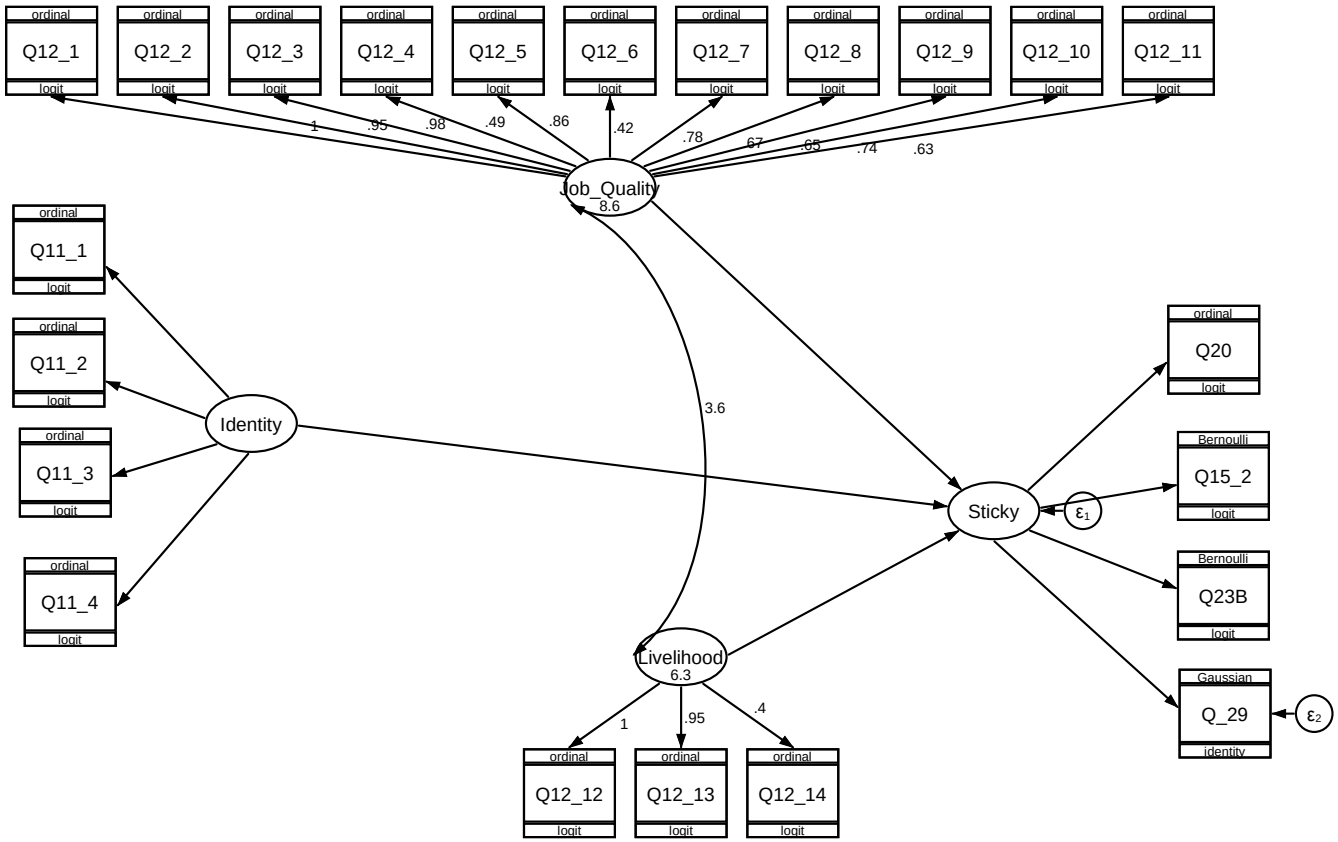
Work Preferences

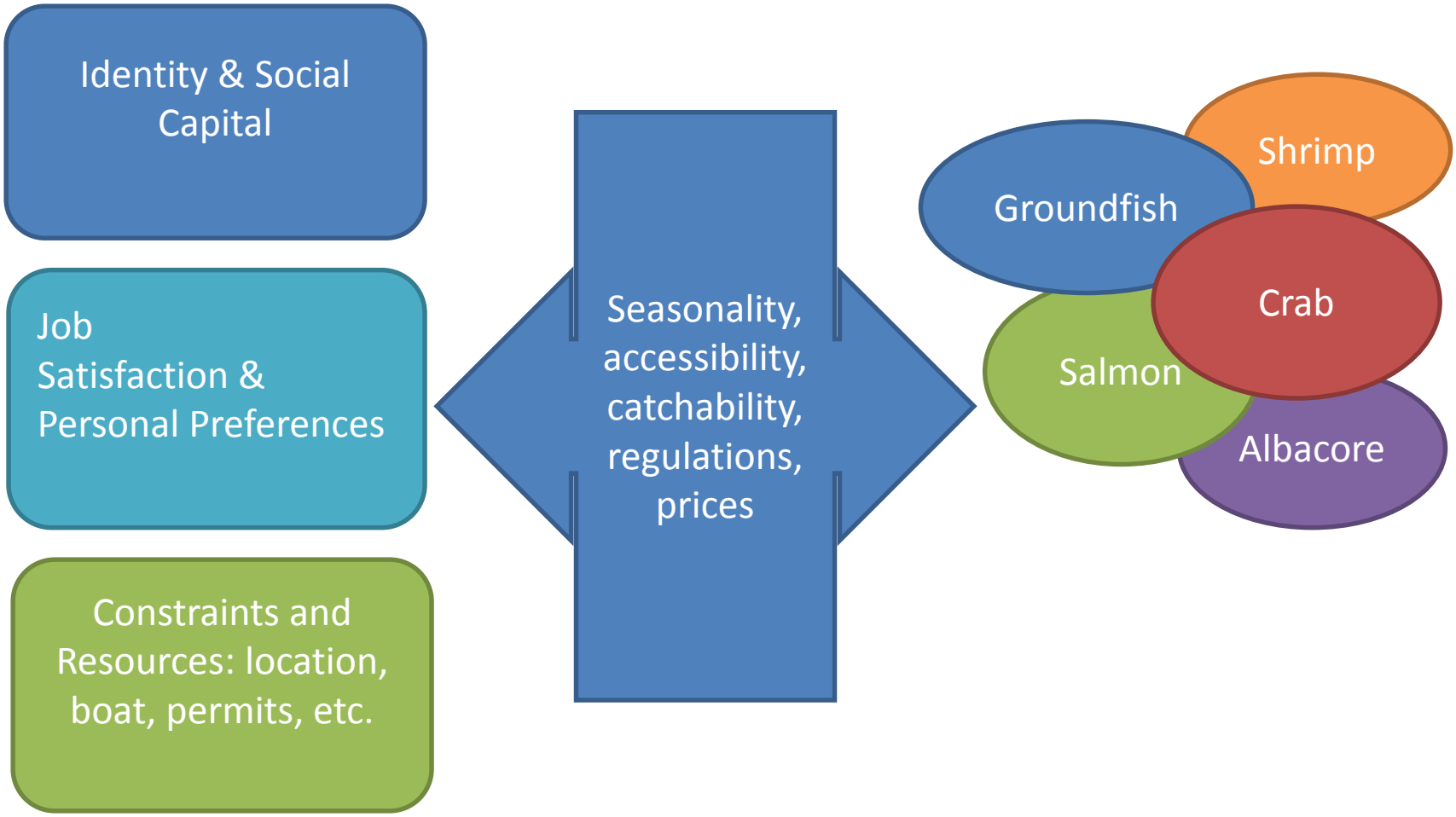






Structural Equation Modeling

Fishery Participation Choice



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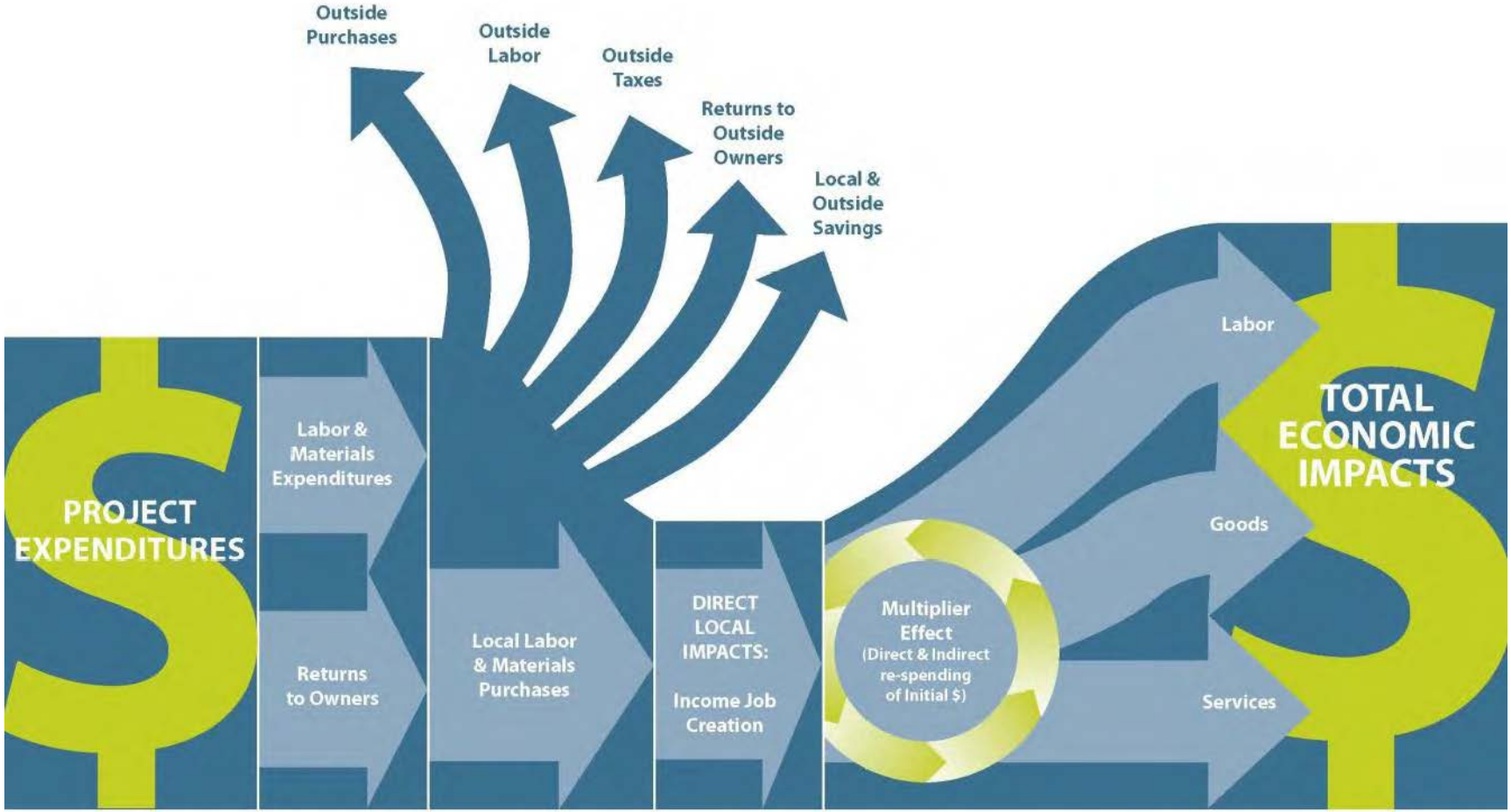
Atlantis and Input Output Model for Pacific Coast Fisheries (IO-PAC) Collaborations

Jerry Leonard
Economics Team
Fishery Resource Analysis and Monitoring Division

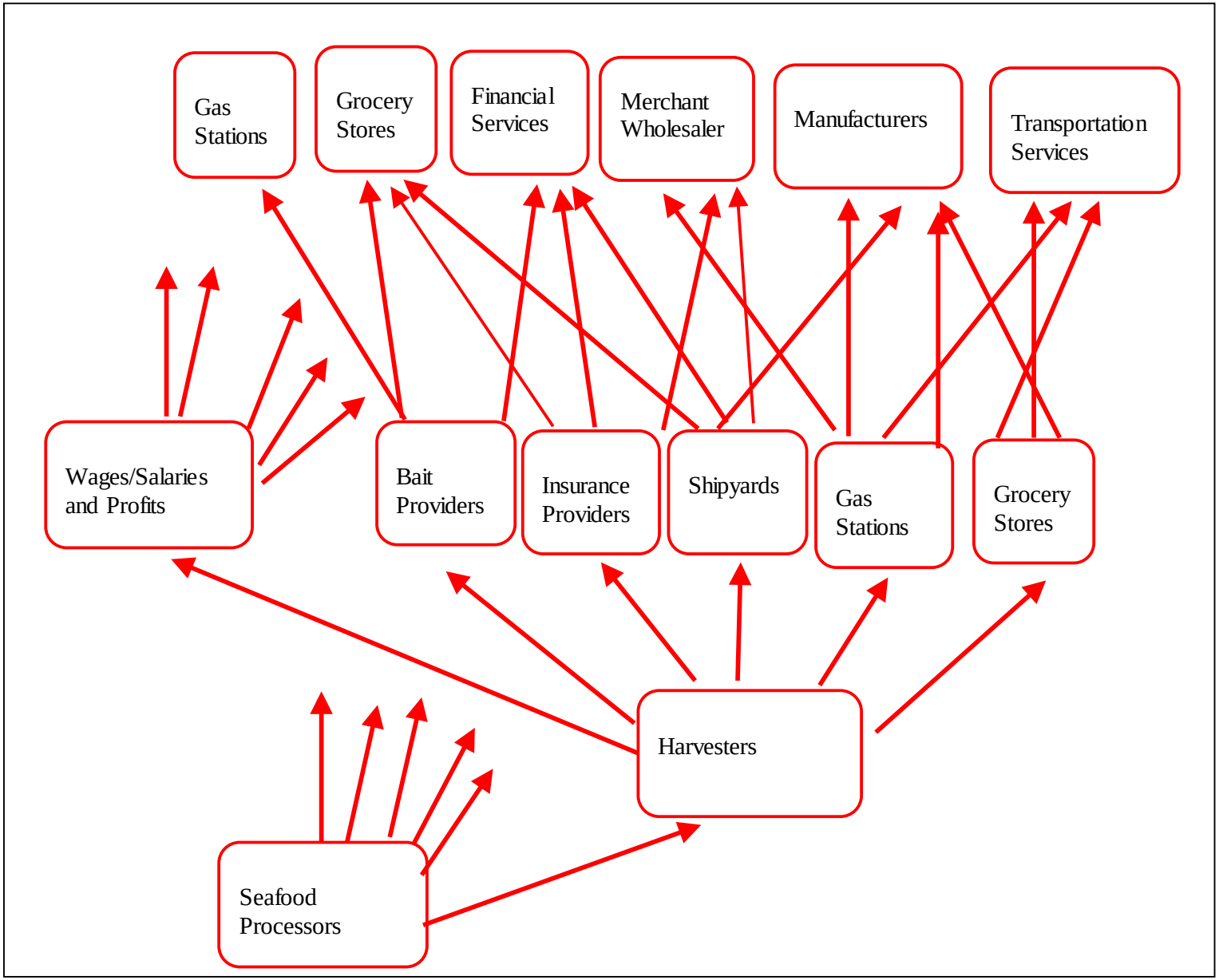
Input Output Modeling

- Regional economies are interconnected system of entities
- Uses accounting framework to create a picture of the flow of goods between industries and consumers
- Outputs from one industry become inputs to another
  - Industries purchase inputs from other sectors
  - Industries sell outputs to other sectors
- Can be used to predict changes in overall economic activity as a result of some change in the regional economy

Regional Economic Impacts



Source: Northern Economics, Inc. *The Economic Impact of Shellfish Aquaculture in Washington, Oregon and California*
http://www.pacshell.org/pdf/Economic_Impact_of_Shellfish_Aquaculture_2013.pdf


Gas Stations
Grocery Stores
Financial Services
Merchant Wholesaler
Manufacturers
Transportation Services
Wages/Salaries and Profits
Bait Providers
Insurance Providers
Shipyards
Gas Stations
Grocery Stores
Harvesters
Seafood Processors

Key Assumptions

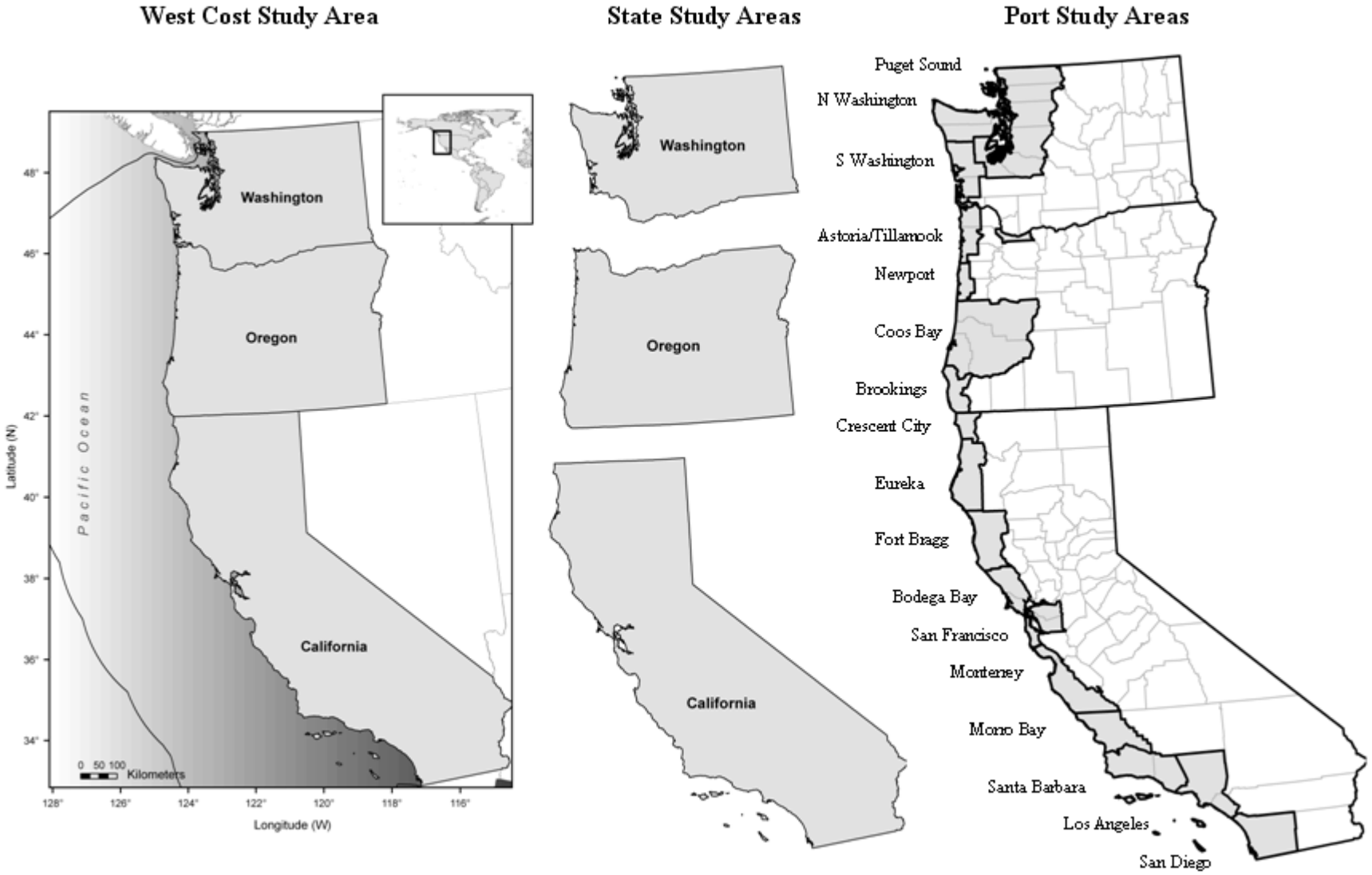
- Supply of outputs is unlimited. An increase in demand is always met by an increase in supply
- Prices are fixed
- IO models assume zero substitution elasticities in production and consumption.
  - For producers, proportion of inputs to production are fixed.
  - For consumers, proportions of total expenditures made on different commodities are fixed

IO-PAC Model

Objective: Develop a regional economic model to describe the impacts associated with marine resources

- Measure economic contributions and impacts
- Commercial and recreational fishing, aquaculture, other commercial and recreational uses
- Geographic resolution
  - Pacific Coast
  - States
  - Port areas
- Use for regulatory or environmental changes that affect harvest
- Create a model that can be updated to include new or better data

Study Areas


West Cost Study Area
Washington
Oregon
California
Pacific Ocean
Latitude (N)
Longitude (W)
0 50 100
Kilometers
State Study Areas
Washington
Oregon
California
Port Study Areas
Puget Sound
N Washington
S Washington
Astoria/Tillamook
Newport
Coos Bay
Brookings
Crescent City
Eureka
Fort Bragg
Bodega Bay
San Francisco
Monterey
Morro Bay
Santa Barbara
Los Angeles
San Diego

Overview

Mothership			
Catcher Processor		Whiting, At Sea	HMS, Fixed Gear
Alaska Fisheries Vessel		Whiting, Trawl	HMS, Net
Pacific Whiting Trawler		Whiting, Fixed Gear	CPS, Trawl
Large Groundfish Trawler		Sablefish, Trawl	CPS, Fixed Gear
Small Groundfish Trawler		Sablefish, Fixed Gear	CPS, Net
Sablefish Fixed Gear		Dover/Thornyhead, Trawl	CPS, Other Gear
Other Groundfish Fixed G.	PacFin Data	Dover/Thornyhead, Fixed G.	Halibut, Trawl
Pelagic Netter	(Make Matrix)	Other Groundfish, Trawl	Halibut, Fixed Gear
Migratory Netter		Other Groundfish, Fixed G.	Halibut, Net
Migratory Liner		Other Groundfish, Net	Other Species, Trawl
Shrimper		Crab, Trawl	Other Species, Fixed G.
Crabber		Crab, Fixed Gear	Other Species, Net
Salmon Troller		Crab, Net	Other Species, Other G.
Salmon Netter		Crab, Other Gear	
Other Netter		Shrimp, Trawl	
Lobster Vessel		Shrimp, Fixed Gear	
Diver Vessel		Salmon, Trawl	
Other > $15,000		Salmon, Fixed Gear	
Other <= $15,000		Salmon, Net	

IO-PAC Data Sources

	Open Access Survey	Limited Entry Fixed Gear Survey	Marine Rec. Exp. Survey	WA and OR Charter Vessel Survey	CA Charter Vessel Survey	EDC DATA	IMPLAN	PacFIN Fish Ticket
Data Year	**2012**	**2012**	**2011**	**2012**	**2012**	**2016**	**2014**	**2017**
Application								
Commercial Vessels								
Production Functions	X	X				X		X
Vessel Industry Output				X	X	X	X	X
Vessel Employment	X	X				X		X
Processors								
Production Functions						X	X	
Processor Industry Output						X	X	X
Processor Employment						X	X	X
Recreational Fishing								
Expenditures			X					
Charter Prod. Functions				X	X			
Charter Industry Output			X	X	X			
Charter Employment			X	X	X			
Non-Fishing Data							X	

Cost and Earnings Data

- Open Access Groundfish Salmon Troll, Salmon Net, Crab, Shrimp
  - 1,700 vessels in population
- LE Fixed Gear
  - Approx. 250 vessels
- The EDC program collects from the following types of businesses.
  - Limited Entry Trawl Catcher Vessels
  - Motherships
  - Catcher/Processors
  - First Receivers/Shorebased Processors

Economic Data Collection Program (EDC)

- The EDC program collects vessel/plant characteristics, capitalized investments, annual expenses, annual earnings, crew/labor payments, and quota and permit expenses from the following types of businesses.
  - Limited Entry Trawl Catcher Vessels
  - Motherships
  - Catcher/Processors
  - First Receivers/Shorebased Processors

Commercial Vessel Production Functions
(shaded sectors are covered)

Expenditure categories (table continued horizontally below)	**Catcher processor**	**Mother-ship**	**Alaska**	**Pacific whiting trawler**	**Large groundfish trawler**	**Small groundfish trawler**	**Sablefish fixed gear**	**Other groundfish fixed gear**	**Migratory liner**	**Pelagic netter**
Captain	—	—	13.4	12.3	17.5	17.5	21.6	18.3	16.6	16.6
Crew	—	—	19.6	17.8	21.6	21.6	23.7	21.5	18.1	18.1
Fuel, lubricants	—	—	13.2	12.8	16.8	16.8	7.4	7.5	8.3	8.3
Food, crew provisions	—	—	1.4	1.6	1.5	1.5	2.0	1.9	1.2	1.2
Ice	—	—	0.1	0.8	1.4	1.4	1.2	1.1	0.7	0.7
Bait	—	—	0.8	1.0	0.8	0.8	4.4	4.3	2.8	2.8
Repair and maintenance: vessel, gear, equipment	—	—	8.7	11.3	14.3	14.3	10.7	12.4	10.4	10.4
Insurance	—	—	3.2	5.4	4.6	4.6	2.8	5.9	3.6	3.6
Interest and financial services	—	—	0.4	1.7	1.1	1.1	2.1	1.8	1.1	1.1
Purchases of permits	—	—	1.7	0.1	0.5	0.5	0.5	2.6	0.9	0.9
Leasing of permits	—	—	0.6	0.0	0.5	0.5	2.1	0.2	0.5	0.5
Moorage	—	—	0.8	0.7	0.7	0.7	2.4	1.6	1.2	1.2
Landings taxes	—	—	0.7	4.3	4.4	4.4	0.1	0.0	1.1	1.1
Enforcement	—	—	0.5	1.1	0.4	0.4	1.1	0.7	0.4	0.4
Dues	—	—	0.1	0.3	0.9	0.9	0.3	0.0	0.3	0.3
Freight Supplies	—	—	0.0	0.0	0.0	0.0	0.0	0.6	0.1	0.1
Offloading	—	—	0.0	0.0	0.0	0.0	0.0	1.0	0.2	0.2
Trucking	—	—	0.0	0.0	0.0	0.0	0.0	1.1	0.2	0.2
Other miscellaneous	—	—	1.1	1.1	2.8	2.8	2.4	6.7	4.7	4.7
Proprietary income	—	—	33.6	27.7	10.2	10.2	15.0	10.8	27.5	27.5
Total (%)			**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Commercial Vessel Production Functions
(shaded sectors are covered)

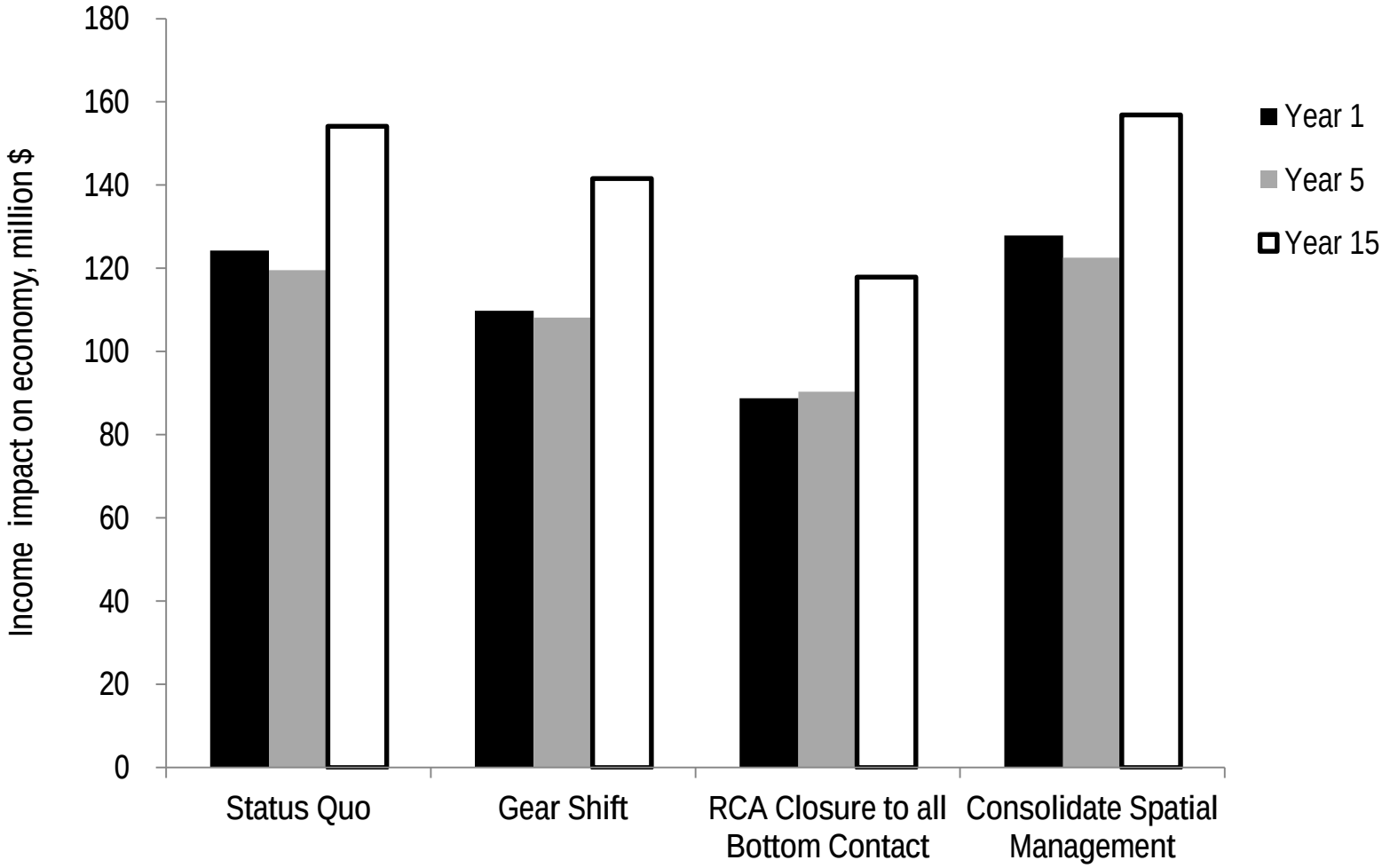
Expenditure categories (column list repeated from above)	**Migratory netter**	**Shrimper**	**Crabber**	**Salmon troller**	**Salmon netter**	**Other netter**	**Lobster**	**Diver**	**Other >15,000**	**Other <15,000**
Captain	16.6	20.8	21.4	7.5	19.0	16.6	16.6	16.6	16.6	17.9
Crew	18.1	17.7	21.6	17.2	8.2	18.1	18.1	18.1	18.1	13.3
Fuel, lubricants	8.3	2.3	6.9	9.9	1.4	8.3	8.3	8.3	8.3	17.6
Food, crew provisions	1.2	13.4	1.1	3.0	4.3	1.2	1.2	1.2	1.2	3.6
Ice	0.7	1.2	0.4	0.3	0.0	0.7	0.7	0.7	0.7	1.0
Bait	2.8	2.2	4.4	0.2	0.0	2.8	2.8	2.8	2.8	2.7
Repair and maintenance: vessel, gear, and equipment	10.4	7.5	11.3	15.6	17.7	10.4	10.4	10.4	10.4	27.0
Insurance	3.6	4.4	4.2	5.0	2.2	3.6	3.6	3.6	3.6	4.7
Interest and financial services	1.1	0.0	1.0	3.1	0.0	1.1	1.1	1.1	1.1	0.6
Purchases of permits	0.9	0.0	1.2	3.2	0.2	0.9	0.9	0.9	0.9	5.9
Leasing of permits	0.5	0.0	0.4	0.3	0.3	0.5	0.5	0.5	0.5	0.3
Moorage	1.2	3.0	1.2	3.2	0.8	1.2	1.2	1.2	1.2	8.4
Landings taxes	1.1	1.2	0.1	0.0	1.0	1.1	1.1	1.1	1.1	0.0
Enforcement	0.4	0.3	0.1	0.3	0.0	0.4	0.4	0.4	0.4	0.7
Dues	0.3	0.2	0.2	0.8	0.5	0.3	0.3	0.3	0.3	0.8
Freight Supplies	0.1	0.4	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0
Offloading	0.2	0.5	0.4	0.0	0.5	0.2	0.2	0.2	0.2	0.1
Trucking	0.2	0.0	0.2	0.6	1.7	0.2	0.2	0.2	0.2	1.1
Other miscellaneous	4.7	0.4	8.2	10.7	3.3	4.7	4.7	4.7	4.7	6.5
Proprietary income	27.5	24.4	15.6	19.1	38.9	27.5	27.5	27.5	27.5	-12.1
Total (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**.100.0**	**100.0**	**100.0**	**100.0**

Linking Ecosystem Models to Economic Input-Output Models

Kaplan, I.C. and Leonard, J. (2012). From krill to convenience stores: Forecasting the economic and ecological effects of fisheries management on the US West Coast. Marine Policy.

Atlantis Fleet	**IOPAC Fleet or Sector**	**Multiplier for Income Impact on Economy**
Limited entry bottom trawl	Large groundfish trawler	0.97
California halibut (trawl)	-	-
Pink shrimp (trawl)	-	-
Nonnearshore fixed gear (pot and demersal longline)	Sablefish fixed gear	1.25
Nonnearshore fixed gear (pot and demersal longline)	Other groundfish fixed gear	1.03
Nearshore fixed gear (hook and line, jigging)	-	-
At sea hake midwater trawl	-	-
Shoreside hake midwater trawl	Shoreside hake midwater trawl	0.96
-	Processor	0.66
-	Wholesaler	1.14

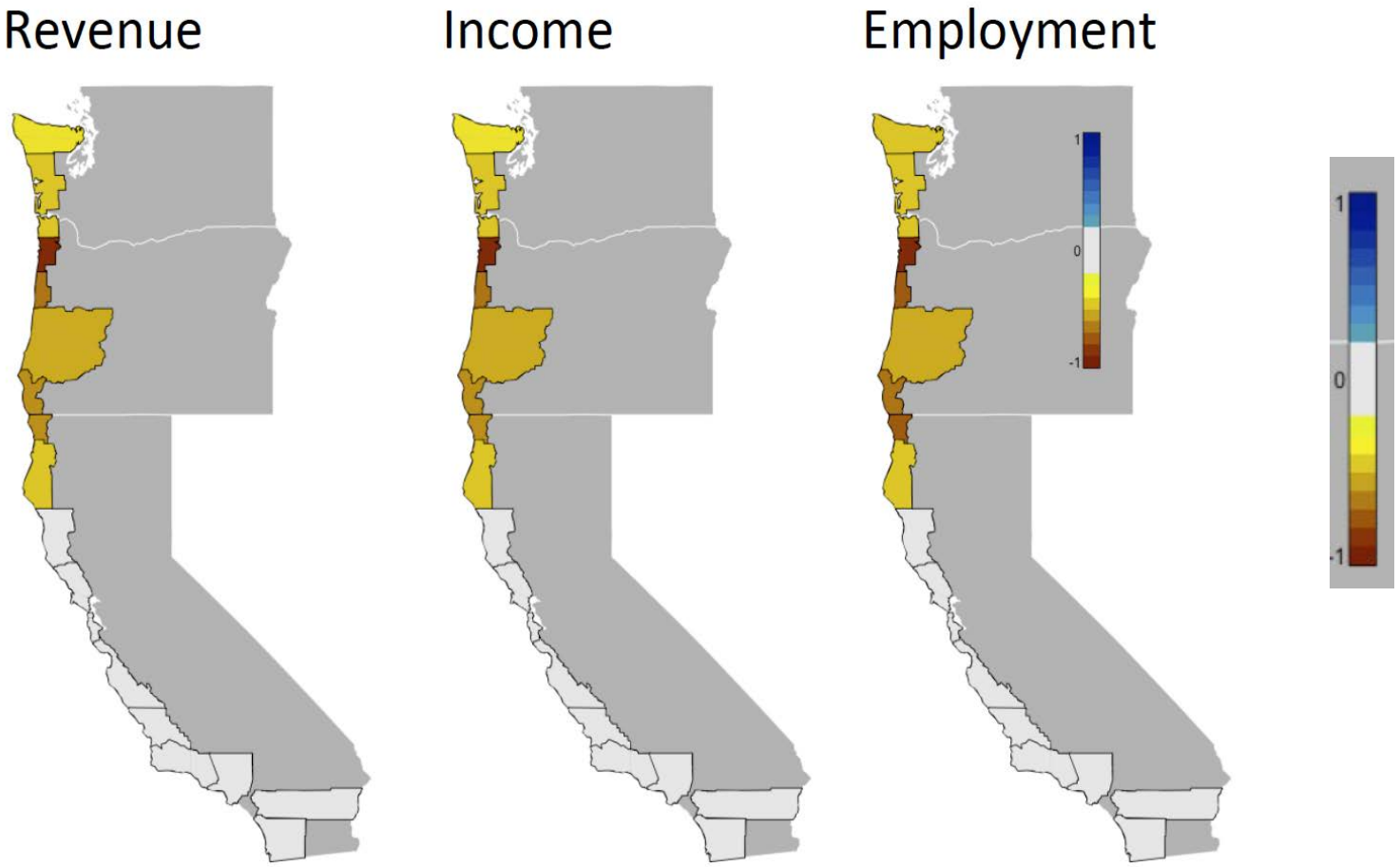
Impact on Economy Over Time (Wages and Other Income)



Consequences of spatially variable ocean acidification in the California Current: lower pH drives strongest declines in benthic species in southern regions while greatest economic impacts occur in northern regions. Hodgson et al. (in review)

IO-PAC Fleet	Atlantis Designation
Pacific whiting trawler	Spatial
Large groundfish trawler	Spatial
Small goundfish trawler	Spatial
Sablefish fixed gear	Spatial
Other groundfish fixed gear	Spatial
Pelagic netter	Generic
Migratory netter	Generic
Migratory liner	Generic
Shrimper	Spatial
Crabber	Spatial
Salmon troller	Generic
Salmon netter	Generic
Other netter	Generic
Lobster vessel	Generic
Diver vessel	Spatial
Other, more than 15K	Generic
Other, less than 15K	Generic

Economic responses to pH sensitivity



Strongest economic impacts in US northern ports (reliance on Dungeness crab), though biological impacts stronger in south.

E.E. Hodgson et al. (in review)

Strengths

- Builds on existing modeling efforts: Atlantis, IO-PAC
- Both models have been reviewed by Fishery Council and applied elsewhere for policy
- Straightforward one-way coupling
- Complements social vulnerability indices and potentially studies of human wellbeing

Challenges

- Input-output models assume no substitution of inputs
- No change in prices
- For long term projection, computable general equilibrium models may be more appropriate

Computable General Equilibrium Models

- Substitution between various factors of production is permitted

- Prices are not fixed and are endogenously determined in CGE models. This enables analysts to calculate the welfare change of various policies

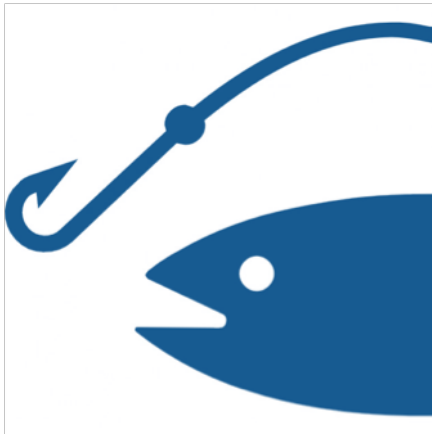
Computable General Equilibrium Models

- More complicated with much higher data requirements.

CGE Elasticities and Parameters
Elasticity of Substitution in Production
Elasticity of Substitution in Consumption
Elasticity of Substitution between Imports and Local Goods
All fish harvesting, agriculture
All fish processing
All the other commodities
Elasticity of Export Demand for seafood
Dynamic Parameters
Labor force participation rate
Population growth rate
Capital growth rate
Factor migration elasticity

- Greater industry sector aggregation.
- Greater spatial aggregation.

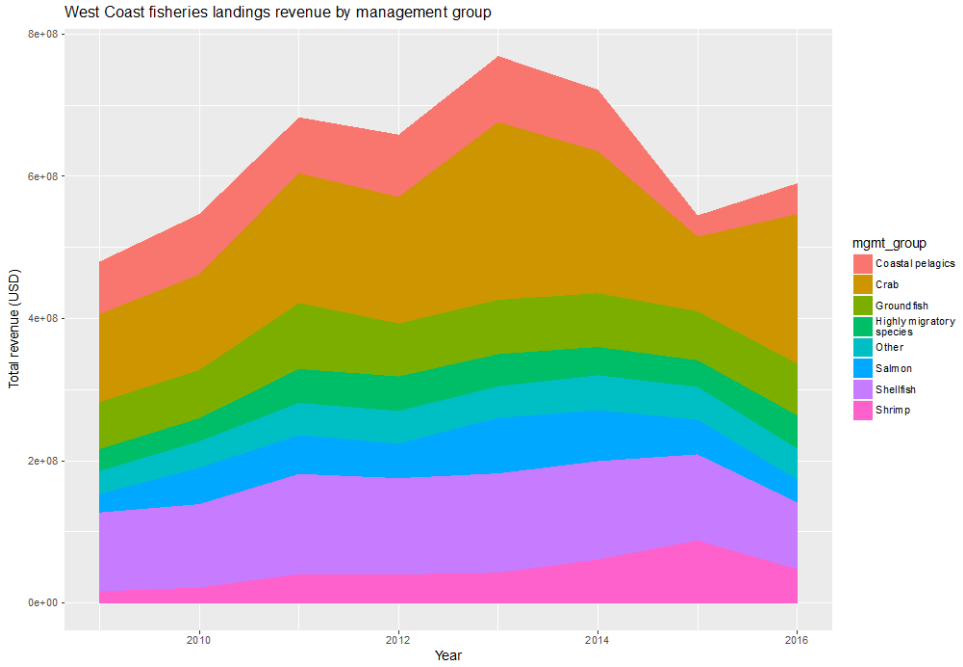
Quantifying and predicting impacts of salmon ocean fishery closures



Kate Richerson
Dan Holland
Jerry Leonard

West Coast ocean salmon fishery

- Targets mainly Chinook salmon (*Oncorhynchus tshawytscha*) using troll gear
- Landings valued at $12.4 - $35.8 million
- Mixed-stock fishery is managed to minimize impacts on weak stocks



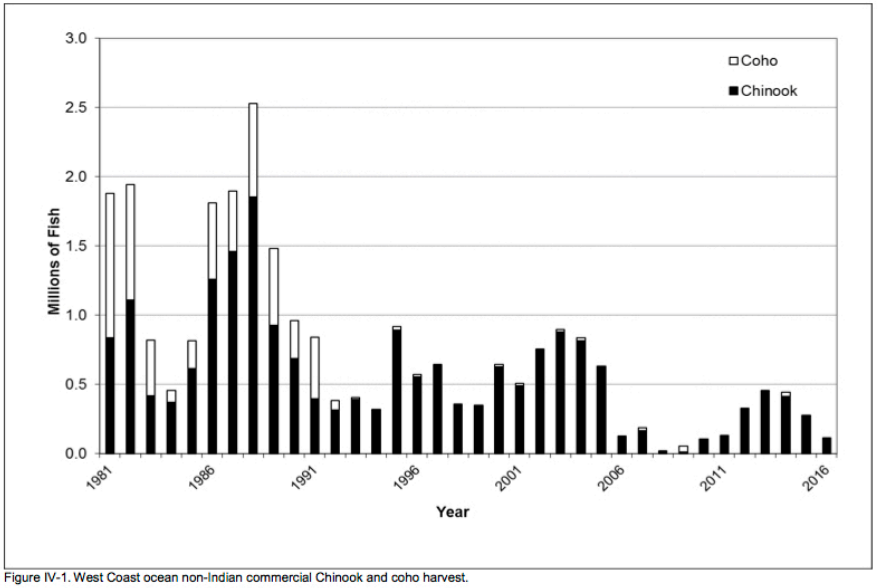
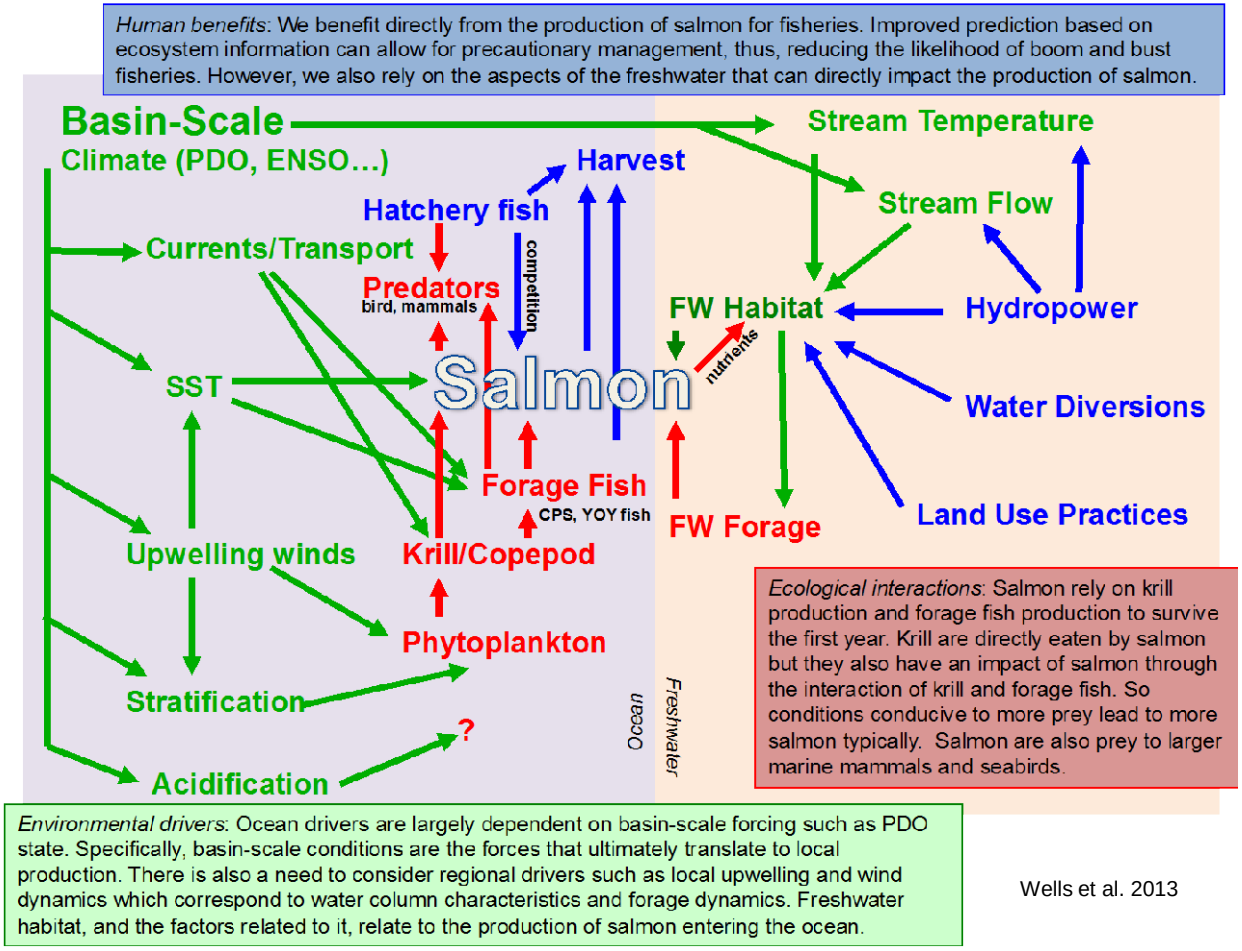


Figure IV-1. West Coast ocean non-Indian commercial Chinook and coho harvest.

West Coast ocean salmon fishery

- Stocks fluctuate depending on hatchery production, freshwater and ocean conditions

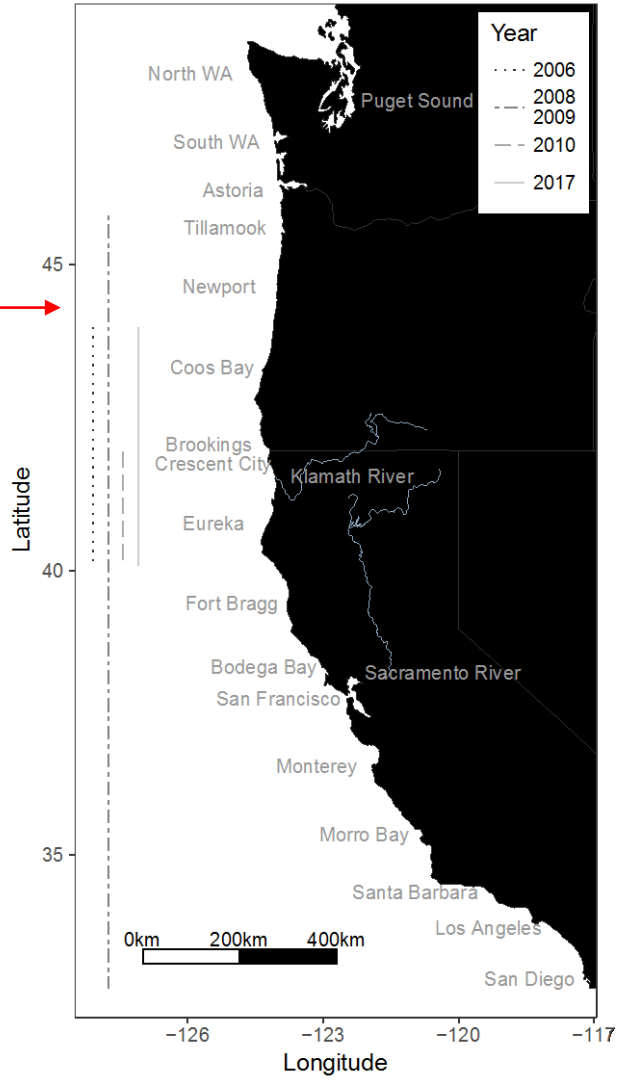


Wells et al. 2013

West Coast ocean salmon fishery

- Parts of the fishery may be closed entirely to protect stocks with low forecasted returns

Closures



All salmon fishing banned on West Coast

CALIFORNIA

By Peter Fimrite Published 4:00 am, Friday, May 2, 2008

Dead in the water: Salmon season canceled in California, Oregon

By LARRY PARSONS , Herald Staff Writer

Fishermen hit hard by closure of West Coast salmon fishing

Drastic federal action to try to save chinook salmon is latest move in ongoing battle.

By Brad Knickerbocker, Staff writer of The Christian Science Monitor | APRIL 23, 2008

WATER & DROUGHT MARCH 2, 2017 3:53 PM

California faces another bleak salmon-fishing season, a holdover from the drought

West Coast ocean salmon fishery

- Closures have lead to declarations of federal disasters

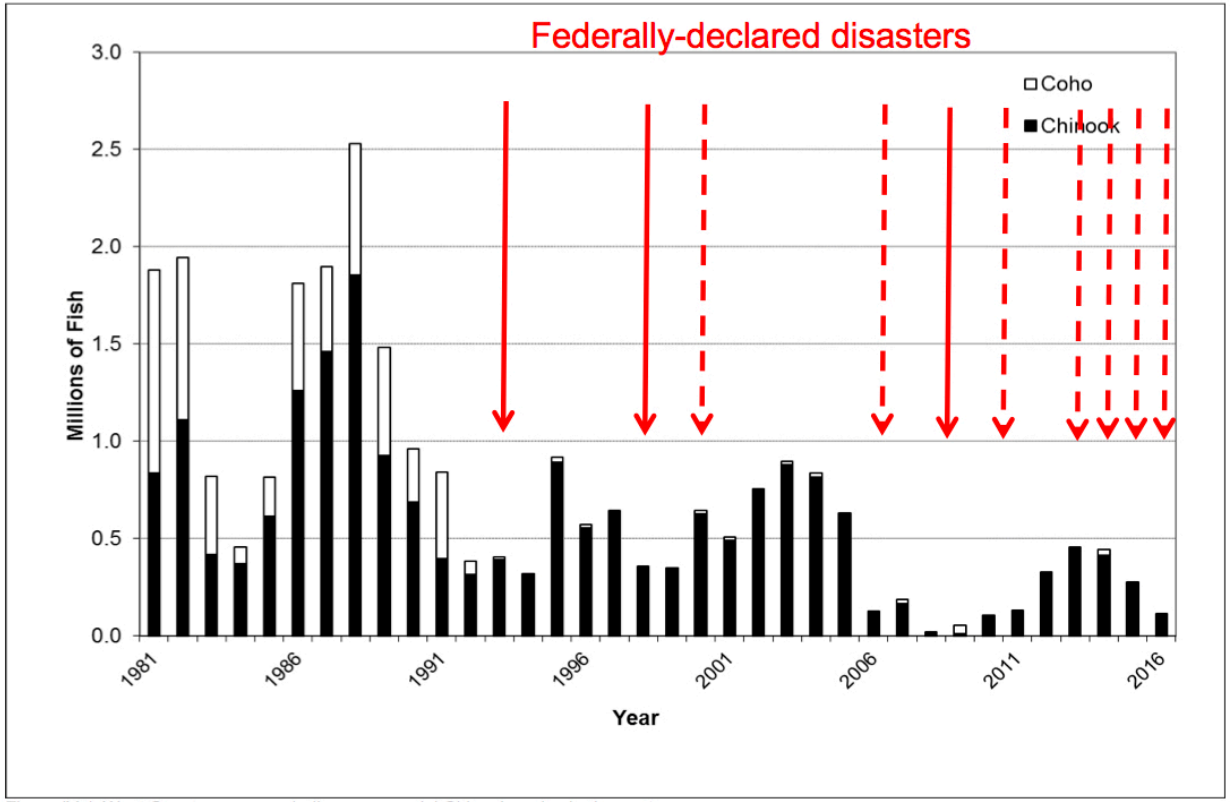


Figure IV-1. West Coast ocean non-Indian commercial Chinook and coho harvest.

1992-1995: $29 million in disaster aid

1998: $11 million

2008-9: $170 million

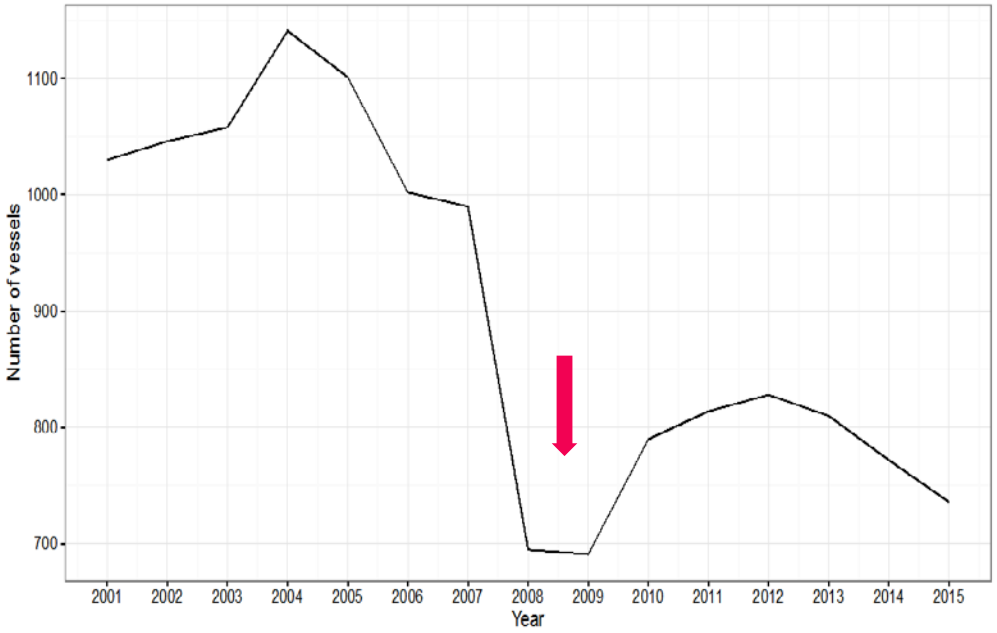
2016-17: Pending for California and Oregon (Klamath)

What happened to salmon fishers in 2008-2009?

- Use vessels as proxy for fishermen
- Note vessels are very diverse and most participate in multiple fisheries
- Look at whether they fish, how much money they make, participation in other fisheries in closure and non-closure years
- Correlate response to vessel characteristics

What happened to salmon fishers in 2008-2009?

- Vessels less likely to fish at all during closure, particularly if they were:
  - More dependent on salmon
  - Less diversified
  - Further south
  - Higher revenue



Richerson and Holland 2017 ICES JMS

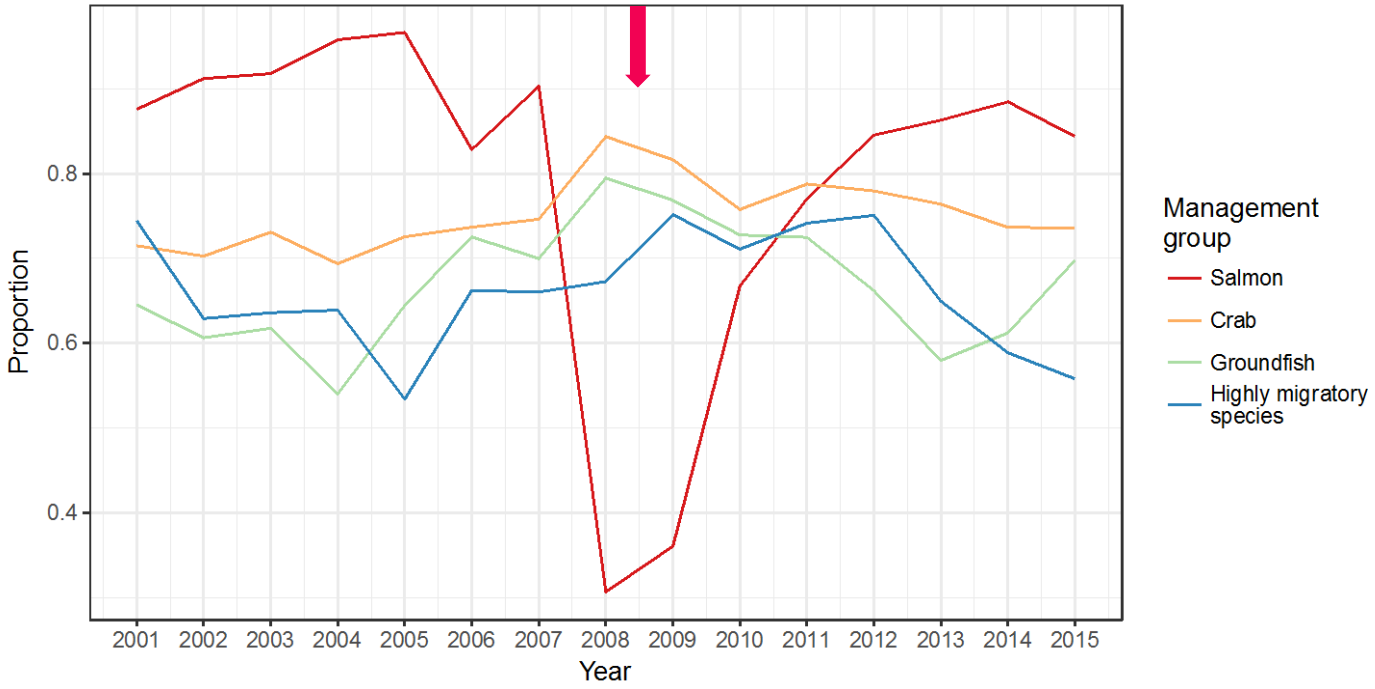
What happened to salmon fishers in 2008-2009?

- Vessels made less money relative to their long-term mean, particularly if they were:
  - More dependent on salmon
  - Higher revenue
  - Fished fewer years

Richerson and Holland 2017 ICES JMS

What happened to salmon fishers in 2008-2009?

- Little evidence that vessels were more likely to participate in non-salmon fisheries in 2008-9.



Richerson and Holland 2017 ICES JMS

What happened to salmon fishers in 2008-2009?

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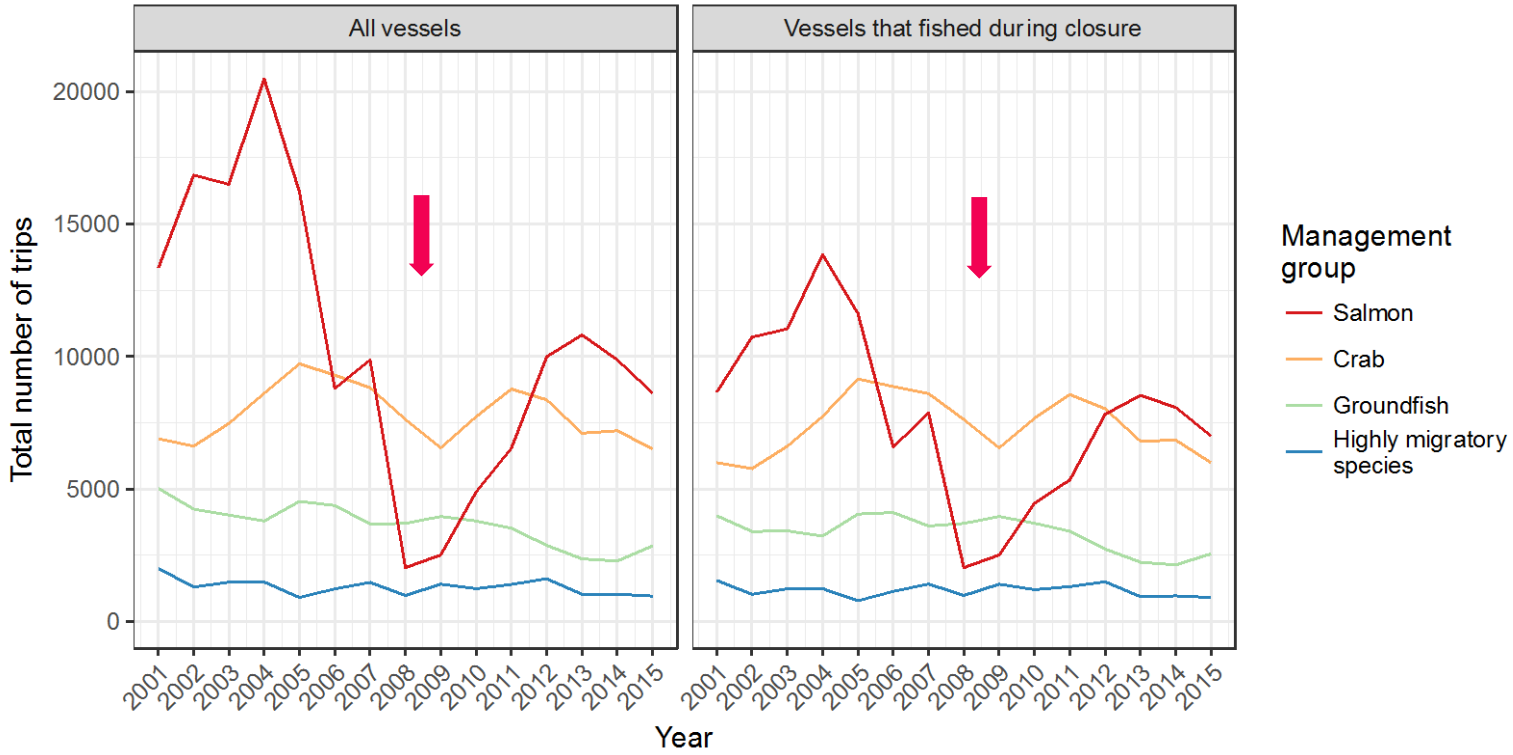


Richerson and Holland 2017 ICES JMS

What happened to salmon fishers in 2008-2009?

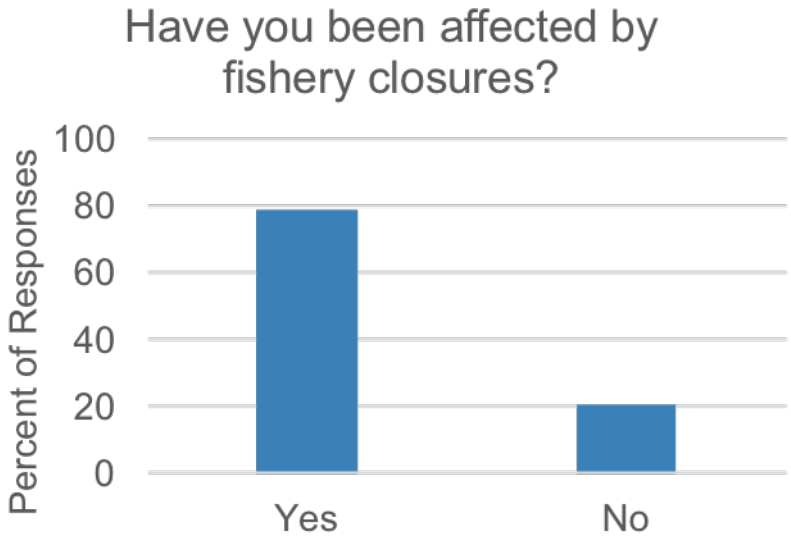
- Fishermen may not be able to easily use other fisheries as a buffer against reduced salmon availability.

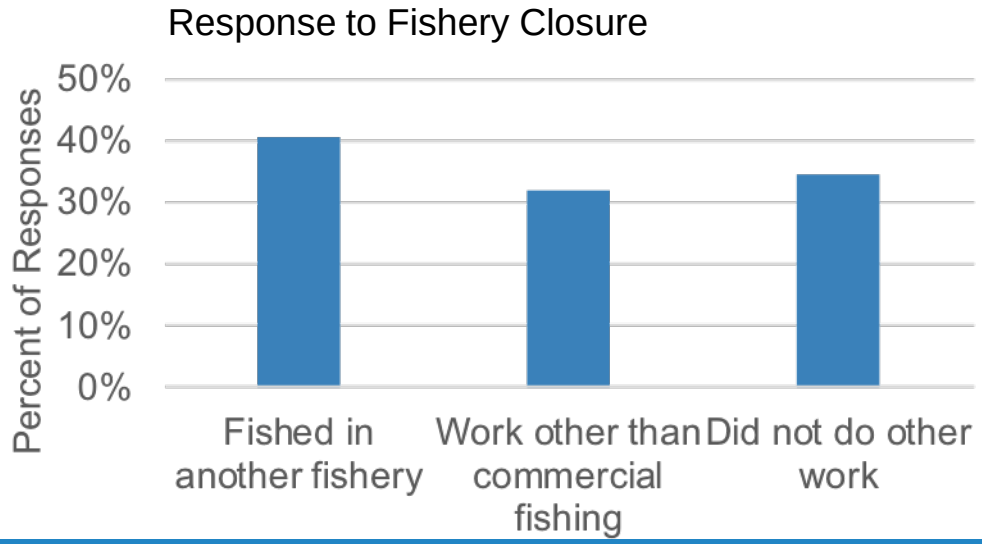
One fisherman's perspective:

"The impact [of the salmon fishery closures] was tremendous, in that you have communities, for example Garibaldi, where the fisherman, who depend on salmon fishing as part of their fisheries income could not go fishing. **If you take away one of those income streams then it's not like you can create more by increasing your catch with albacore or crab.**"

Ackerman et al. 2016

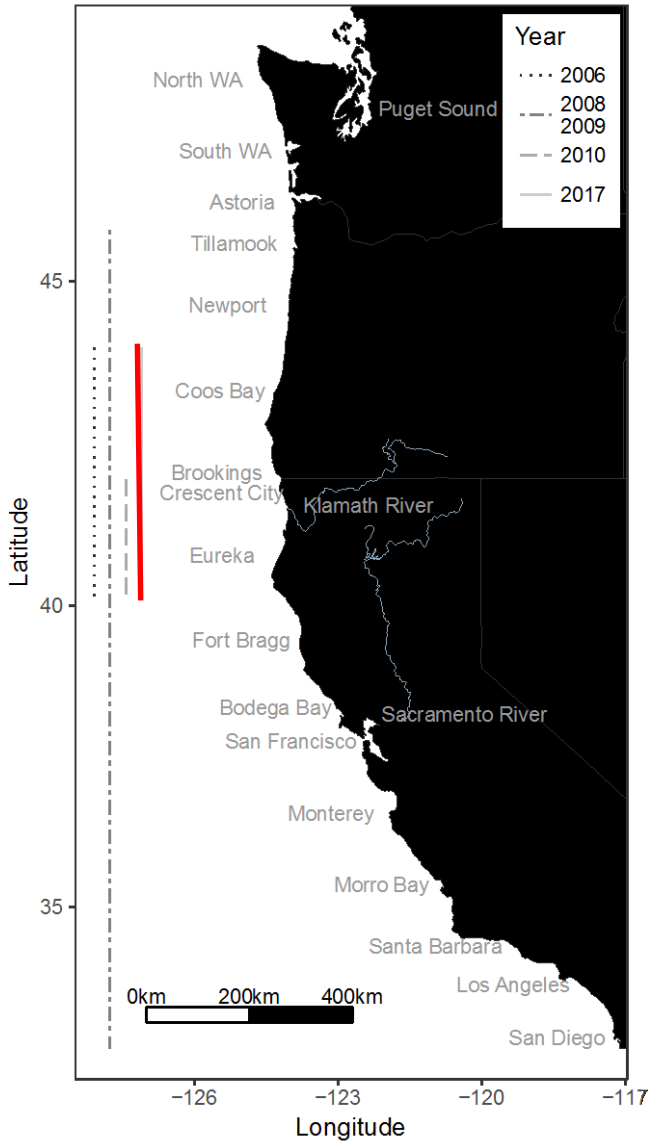
Survey responses from West Coast fishermen





What are the predicted impacts of the 2017 closure?

- Low returns of Klamath River fall Chinook closed the fishery between Horse Mountain, CA and Florence, OR
- Prediction of impacts could potentially inform aid decisions
- Quantifying economic impact is challenging—estimates for 2008-9 closure varied by an order of magnitude.



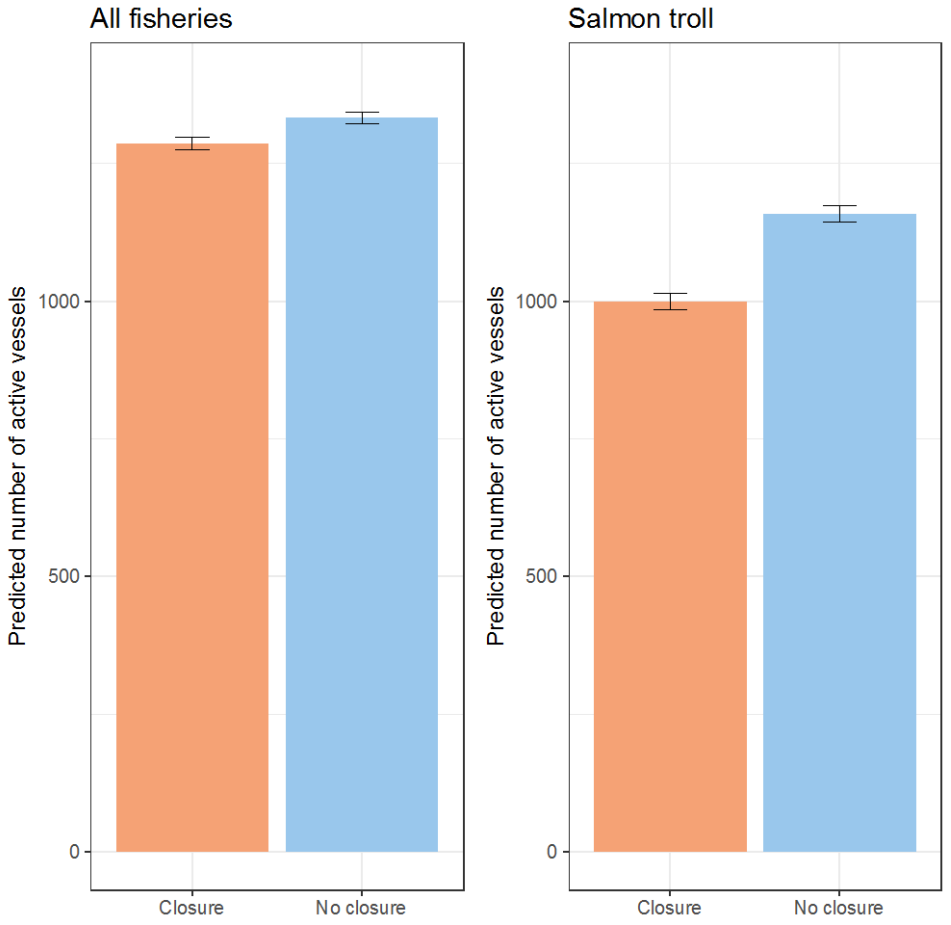
What are the predicted impacts of the 2017 closure?

- Make predictions about behavior
  - Fish that year?
  - If so, participate in salmon fishing?

- Link to I/O model
  - Generate predicted income, sales, and jobs under closure and no closure scenarios
  - Assume non-salmon revenue is equal to 5-year mean

What are the predicted impacts of the 2017 closure?

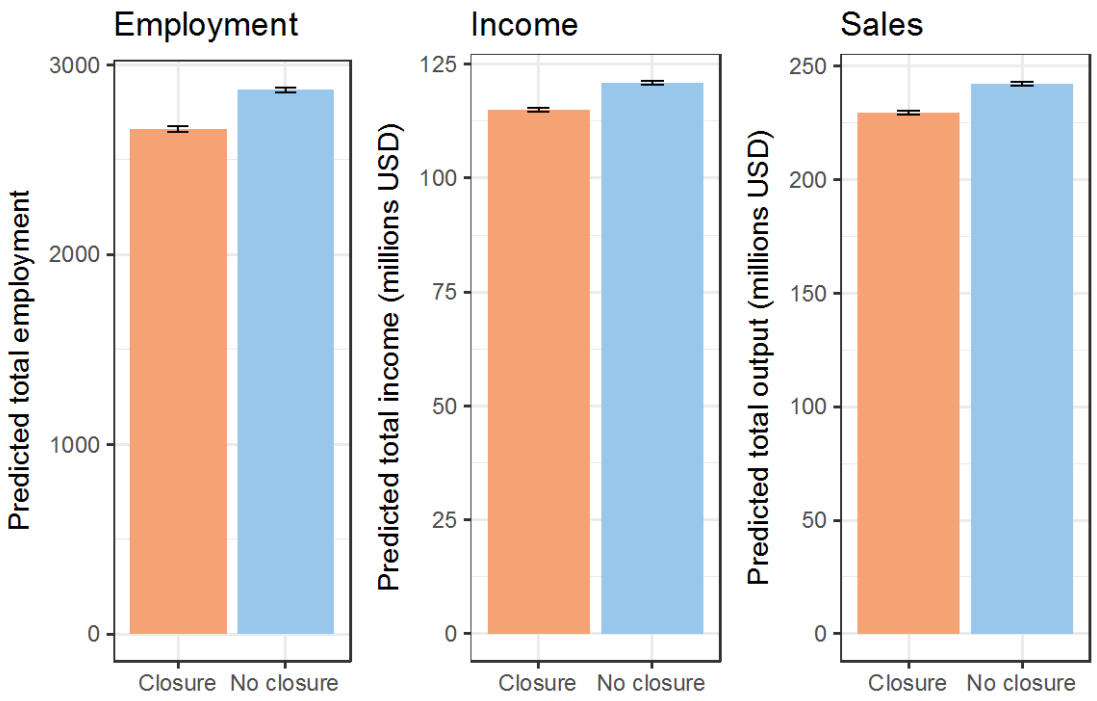
- ~50-75 vessels predicted not to fish at all
- ~160 would fish, but not for salmon



What are the predicted impacts of the 2017 closure?

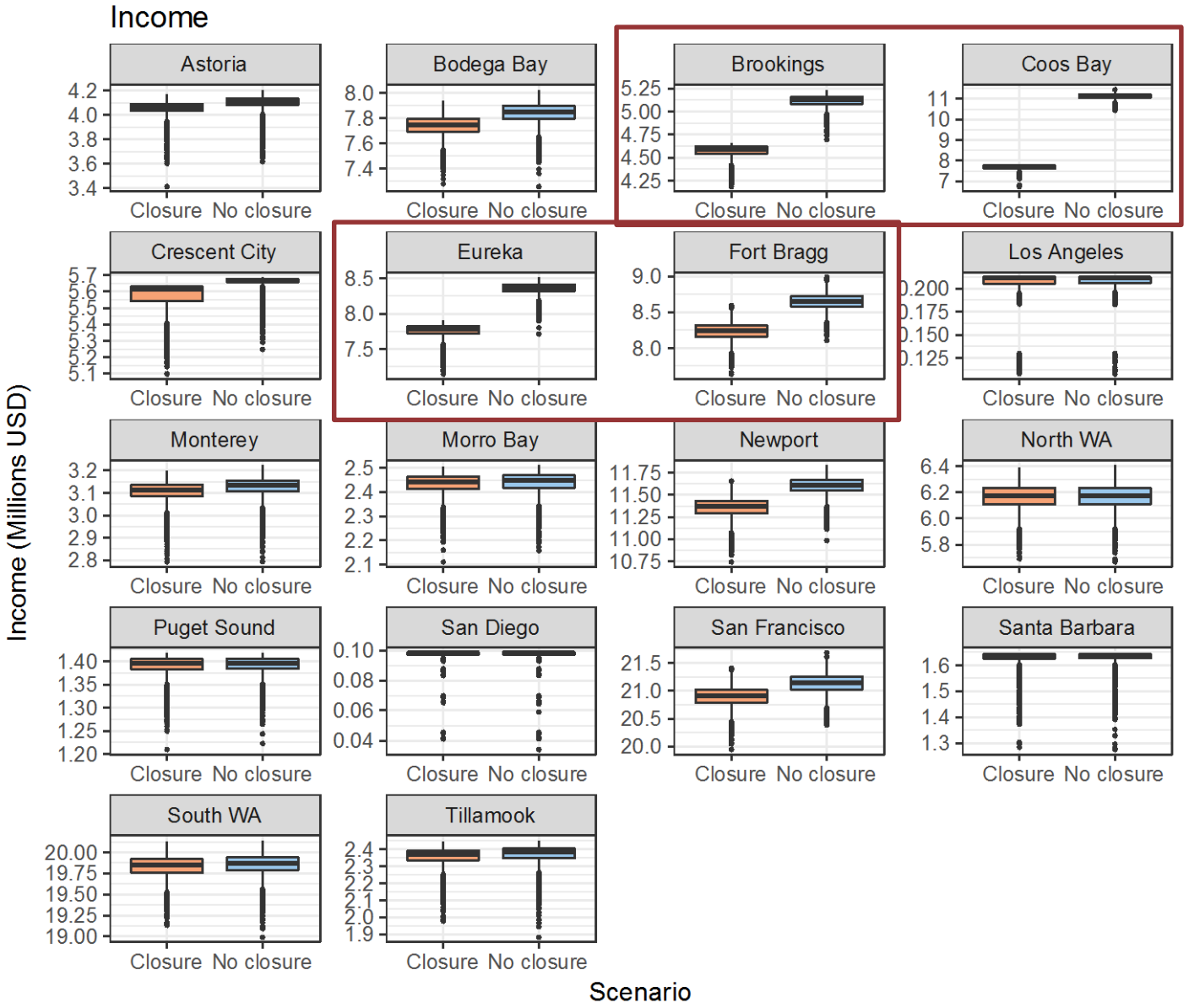
- Predicted loss:

- $5.8-$8.9 million in income
- $12.8-$19.6 million in sales
- 200-330 jobs



Note this is not a complete estimate of the closure impacts

What are the predicted impacts of the 2017 closure?



What are the predicted impacts of the 2017 closure?

- Should have data to test predictions soon!

Prices the only bright spot for Pacific salmon trollers

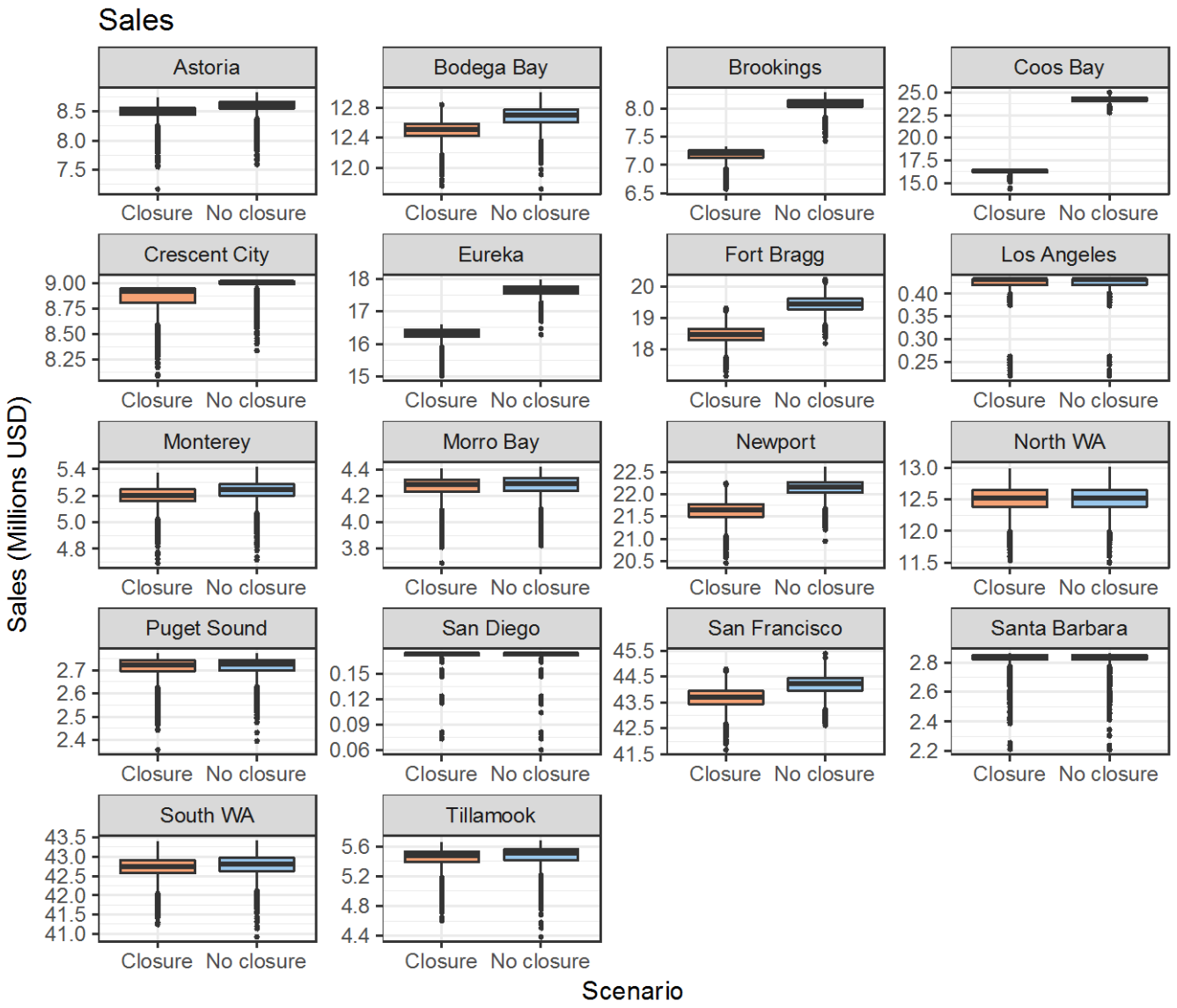
By Charlie Ess | February 20, 2018

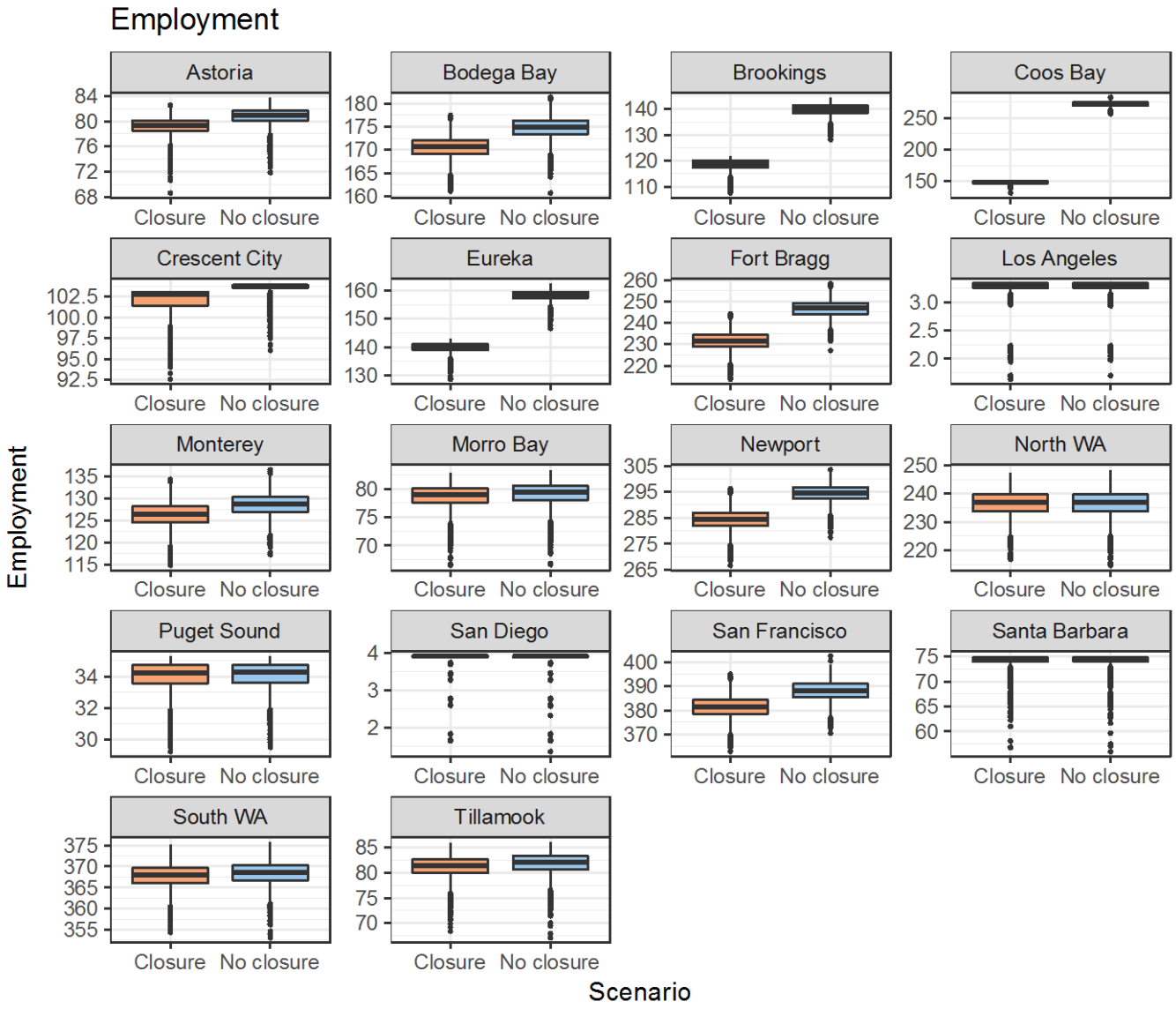
2018 season looks bleak

According to Noah Oppenheim, executive director of the Pacific Coast Federation of Fishermen's Associations in San Francisco, the shortage of fish in the 2017 season drove ex-vessel prices skyward as buyers lined up to secure supplies for restaurants and other retail outlets.

"By all accounts, it was only prices that kept guys from swinging from the rafters," said Oppenheim.


GATE CITY


Sales
Astoria
Bodega Bay
Brookings
Coos Bay
Crescent City
Eureka
Fort Bragg
Los Angeles
Monterey
Morro Bay
Newport
North WA
Puget Sound
San Diego
San Francisco
Santa Barbara
South WA
Tillamook
Closure
No closure
Sales (Millions USD)
Scenario


Employment
Astoria
Bodega Bay
Brookings
Coos Bay
Crescent City
Eureka
Fort Bragg
Los Angeles
Monterey
Morro Bay
Newport
North WA
Puget Sound
San Diego
San Francisco
Santa Barbara
South WA
Tillamook
Closure
No closure
Employment
Scenario