NAAFE 2023 WOODS HOLE

Science and Governance for Sustainable Fisheries in a Changing Ocean

The NAAFE Forum in Woods Hole

May 23–26, 2023

About NAAFE

North American Association of Fisheries Economists

NAAFE is an international group of industry, government, and academic practitioners of fisheries economics. The purposes of NAAFE are to facilitate communication among North American fisheries and aquaculture economists in industry, academia, government, and other areas, to promote dialogue between economists and stakeholders interested in fisheries and aquaculture, and to advance fisheries and aquaculture economics and its useful applications.

About WHOI

Woods Hole Oceanographic Institution

Woods Hole Oceanographic Institution is the world's leading, independent non-profit organization dedicated to ocean research, exploration, and education. Our scientists and engineers push the boundaries of knowledge about the ocean to reveal its impacts on our planet and our lives.

About NOAA NEFSC

NOAA Northeast Fisheries Science Center

The Northeast Fisheries Science Center has conducted a comprehensive marine science program in the region since 1871. We study fishery species and fisheries, monitor and model ocean ecosystems, and provide reliable advice for policy makers.

Organizing Committees

LOCAL ORGANIZING COMMITTEE

- Kathryn Bisack, NOAA NEFSC Social Sciences Branch
- Ann Devenish, WHOI Marine Policy Center
- Di Jin, WHOI Marine Policy Center
- Min-Yang Lee, NOAA NEFSC Social Sciences Branch
- Yaqin Liu, WHOI Marine Policy Center
- Alison Maksym, WHOI Marine Policy Center
- Tammy Murphy, NOAA NEFSC, Chief of the Social Sciences Branch
- Michael Neubert, WHOI Biology Department
- Kilaparti Ramakrishna, Director of WHOI Marine Policy Center
- Eric Thunberg, NOAA NMFS Office of Science and Technology
- Michael Weir, WHOI Marine Policy Center
- Ciara Willis, MIT-WHOI Joint Program

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- German Ponce Diaz, CICIMAR
- Erin Steiner, NOAA Fisheries
- Olivier Thebaud, IFREMER
- Eric Thunberg, NOAA Fisheries
- Kanae Tokunaga, Gulf of Maine Research Institute
- Michael Travis, NOAA Fisheries
- Hirotsugu Uchida, University of Rhode Island
- Smit Vasquez Caballero, Research Triangle Institute
- Michael Weir, Woods Hole Oceanographic Institution

Opening Plenary

Wed, May 24

Redfield Auditorium

Moderator: **Dr. Kilaparti Ramakrishna**, Director of Marine Policy Center, Woods Hole Oceanographic Institution

Welcome (8:30am - 9:10am)

Dr. Christopher Anderson, NAAFE President and Professor, University of Washington

Dr. Michael Simpkins, Chief, Resource Evaluation & Assessment Division, NOAA Northeast Fisheries Science Center

Dr. Richard Murray, Deputy Director and Vice President for Science and Engineering, Woods Hole Oceanographic Institution

Keynote Speech (9:10am - 9:50am)

Dr. Scott Barrett, Professor, Columbia University

Title: Property Rights to the World's Ocean Fisheries in International Law

Best Student Paper Award Presentation (9:50am - 10:00am)

Keynote Speech

Property Rights to the World's Ocean Fisheries in International Law

Scott Barrett

Columbia University
&
London School of Economics

Abstract. Property rights to the world's ocean fisheries include the Exclusive Economic Zone and the freedom to fish on the high seas. I present a simple model in which these rights emerge endogenously in customary international law, and contrast these rights with the outcomes that would have arisen from national self-interest alone. The model also identifies the trigger for changes in property rights; explains the reason choice of a particular limit, like the current 200-mile zone, is arbitrary; and illuminates how the scope of the EEZ for highly migratory species came to be determined. Finally, I use the model to evaluate proposals for changing the current arrangements. I find that proposals to nationalize the seas or ban fishing on the high seas are neither efficient nor supportable in customary law. Further advancements in fisheries management may have to come from improvements in the design and implementation of cooperative fisheries agreements.

NAAFE Forum 2023 in Woods Hole

Program

by **Day and Time**

Tuesday, May 23, 2023

- **8:30 AM - 2:00 PM**

  - **NAAFE Board Meeting**
    Closed meeting
    Redfield 204

- **1:00 PM - 5:00 PM**

  - **Marine Resources Center Tour**
    Tours
    Marine Resources Center

  - **Registration**
    Registration
    Redfield

- **5:00 PM - 7:30 PM**

  - **Reception**
    Social
    MBL Quad Tent and NOAA Aquarium

Wednesday, May 24, 2023

- **7:30 AM - 5:00 PM**

  - **Registration**
    Registration
    Redfield

- **8:30 AM - 10:00 AM**

  - **Opening Plenary**
    Plenary
    Redfield Auditorium

- **10:00 AM - 10:30 AM**

  - **Coffee Break**
    Break/Meals
    Redfield Auditorium

- **10:30 AM - 12:00 PM**

  - **Fisheries Management 1**
    Concurrent
    Swope Meigs Room

  - **Markets & Trade 1**
    Concurrent
    Smith Conference Room

  - **Transboundary and Migratory Fisheries**
    Concurrent
    Redfield Auditorium

- **12:00 PM - 1:00 PM**

  - **Lunch**
    Break/Meals
    Redfield Tent

  - **Lunch Meeting 1: Discussion on FEUS**
    Break/Meals
    Discovery Center

- **1:00 PM - 2:30 PM**

- **Fisheries Management 2**
  Concurrent
  Swope Meigs Room

- **Integrating Social Science in Climate and Ocean System Models**
  Concurrent
  Redfield Auditorium

- **Markets & Trade 2**
  Concurrent
  Smith Conference Room

- **2:30 PM - 3:00 PM**

- **Coffee Break**
  Break/Meals
  Redfield Auditorium

- **Coffee Break**
  Break/Meals
  Smith Conference Room

- **Coffee Break**
  Break/Meals
  Swope Meigs Room

- **3:00 PM - 4:30 PM**

- **Bioeconomic Models 1**
  Concurrent
  Smith Conference Room

- **Ecosystem-based Management/Marine Spatial Planning**
  Concurrent
  Swope Meigs Room

- **Special Session 1: Economics and the Woods Hole Science Community**
  Special Session
  Redfield Auditorium

- **5:00 PM - 7:00 PM**

- **Poster Session and Mixer**
  Posters
  Swope Center

Thursday, May 25, 2023

- **8:00 AM - 5:00 PM**

- **Registration**
  Registration
  Redfield

- **8:30 AM - 10:00 AM**

- **Fishing Communities 1**
  Concurrent
  Smith Conference Room

- **Special Session 2: Early Career Researchers in Fisheries Economics Associations**
  Special Session
  Redfield Auditorium

- **Special Session 3: Aquaculture Performance Indicators**
  Special Session
  Swope Meigs Room

- **10:00 AM - 10:30 AM**

- **Coffee Break**
  Break/Meals
  Swope Meigs Room

- **Coffee Break**
  Break/Meals
  Redfield Auditorium

- **Coffee Break**
  Break/Meals
  Smith Conference Room

- **10:30 AM - 12:00 PM**

- **Aquaculture 1: Markets**
  Concurrent
  Swope Meigs Room

- **Bioeconomic Models 2**
  Concurrent
  Smith Conference Room

- **Fisheries Management 3**
  Concurrent
  Redfield Auditorium

- **12:00 PM - 1:00 PM**

- **Lunch**
  Break/Meals
  Redfield Tent

- **1:00 PM - 2:30 PM**

- **Aquaculture 2**
  Concurrent
  Swope Meigs Room

- **Rights-based Fishery Management 1**
  Concurrent
  Redfield Auditorium

- **Special Session 4: Amplifying New Voices: Supporting an Inclusive, Equitable, and Diverse Community in Natural Resource Economics**
  Special Session
  Smith Conference Room

- **2:30 PM - 3:00 PM**

- **Coffee Break**
  Break/Meals
  Swope Meigs Room

- **Coffee Break**
  Break/Meals
  Redfield Auditorium

- **Coffee Break**
  Break/Meals
  Smith Conference Room

- **3:00 PM - 4:30 PM**

- **Aquaculture 3: Production & Disease Economics**
  Concurrent
  Swope Meigs Room

- **Recreational Fisheries 1**
  Concurrent
  Smith Conference Room

- **Rights-based Fishery Management 2**
  Concurrent
  Redfield Auditorium

- **5:00 PM - 8:00 PM**

- **Banquet**
  Social
  Swope Center

Friday, May 26, 2023

8:30 AM - 10:00 AM

- **Fisheries Management 4**
  Concurrent
  Redfield Auditorium

- **Fishing Communities 2**
  Concurrent
  Swope Meigs Room

- **Recreational Fisheries 2**
  Concurrent
  Smith Conference Room

8:30 AM - 12:00 PM

- **Registration**
  Registration
  Redfield

10:00 AM - 10:30 AM

- **Coffee Break**
  Break/Meals
  Swope Meigs Room

- **Coffee Break**
  Break/Meals
  Redfield Auditorium

- **Coffee Break**
  Break/Meals
  Smith Conference Room

10:30 AM - 12:00 PM

- **Fisheries Management 5**
  Concurrent
  Swope Meigs Room

- **Markets & Trade 3**
  Concurrent
  Redfield Auditorium

- **Performance Measures & Efficiency**
  Concurrent
  Smith Conference Room

- **12:00 PM - 1:30 PM**

- **Plenary Closing Ceremonies**
  Plenary
  Redfield Auditorium

- **2:00 PM - 3:00 PM**

- **WHOI Tours**
  Tours
  WHOI

NAAFE Forum 2023 in Woods Hole

Program

by **Date and Conference Room**

NAAFE Forum 2023 in Woods Hole Program

Concurrent Sessions

Transboundary and Migratory Fisheries

Wednesday, May 24 (10:30 AM to 12:00 PM), Redfield Auditorium

53	Pamela Woods	A research plan for using Simple Ecological Systems approach to analysing management options in international pelagic fisheries
115	Christopher Dumas	Comparing Alternative Adaptive Management Strategies for Shifting Fish Stocks in the Western North Atlantic
88	Ciara Willis	Costs and Benefits of Western & Central Pacific Tuna Harvest Strategies for Coral Triangle Countries
16	Ragnar Arnason	Can there be cycles of international fishing game co-operation? Simple modelling

Integrating Social Science in Climate and Ocean System Models

Wednesday, May 24 (1:00 PM to 2:30 PM), Redfield Auditorium

30	Hing Ling Chan	How climate change and climate variability affected trip distance of a commercial fishery
21	Kanae Tokunaga	How will different harvester business models in Maine's American lobster fishery perform under climate change?
80	Olivier Thébaud	Integrating economics into fisheries science and advice: progress, needs and future opportunities
22	Michael Weir	Ocean Literacy and Willingness to Pay for Ocean Twilight Zone Conservation
77	Di Jin	Understanding the relationship between scallop stock condition and fishing location choice

Special Session 1: Economics and the Woods Hole Science Community

Wednesday, May 24 (3:00 PM to 4:30 PM), Redfield Auditorium

| 3 | Min-Yang Lee | Economics and the Woods Hole Science Community |

Markets & Trade 1

Wednesday, May 24 (10:30 AM to 12:00 PM), Smith Conference Room

73   Yaturo Sakai   How would different kinds of seafood traceability information affect people's MWTP?

37   Ruth Pincinato   Influence of Peruvian anchoveta size composition on fish oil prices

35   Ryan Kueber   A Hedonic Regression to Estimate the Value of Commercial Catch Method: A Case Study using the Japanese Commercial Swordfish Fishery

15   Julia Bronnmann   Certify or not? The effect of the MSC label on the ex-vessel prices for Atlantic cod in Norway

Markets & Trade 2

Wednesday, May 24 (1:00 PM to 2:30 PM), Smith Conference Room

122 Natalie Meyer   New Englander Willingness to Adopt to Shifting Fish Availability Due to Climate Change

96   Samantha Werner   The Cost of Price Models: An Examination of the Accuracy and Transferability of Ex-vessel Seafood Price Models in the Northeast United States

131 Benjamin Fissel   The determinants of U.S. retail seafood inflation

55   Stephen Stohs   Fresh Catch Auctions as a Model of First Receivership for US Commercial Fisheries

Bioeconomic Models 1

Wednesday, May 24 (3:00 PM to 4:30 PM), Smith Conference Room

20   Akbar Marvasti   An Assessment of the Growth Effects Productivity of Oil Rigs as Artificial Reefs in the Gulf of Mexico

6   Sturla Kvamsdal   An intraannual stock index based on the two-stage generalized model for Norwegian demersal fisheries

63   Erica Chuang   Ecosystem Services on the Half Shell: A Bioeconomic Model of Impure Public Goods Production

85   Seleni Cruz   A Bioeconomic Modeling Approach to Studying Reproductive Limitations for Blue Crabs in the Delaware Bay

Fisheries Management 1

Wednesday, May 24 (10:30 AM to 12:00 PM), Swope Meigs Room

62	Scott Crosson	Expanding fishing opportunities for the U.S. South Atlantic snapper-grouper fishery by minimizing discards
12	Qingran Li	Adaptive Fisheries Management under Climate Change: a closer look at the opportunities and challenges
117	Yaqin Liu	Economic Gains from Individual Fishing Quotas: The Norwegian Coastal Groundfish Fisheries
130	Abby Schamp	Processor Market Share in the Pacific Cod Fishery during Rationalization
32	Karl Aspelund	Who Gets the Fish? Labor Market Sorting and Efficiency in Regulating the Commons

Fisheries Management 2

Wednesday, May 24 (1:00 PM to 2:30 PM), Swope Meigs Room

92	Birgir Runolfsson	Measuring Quality of Property Rights: Development of User Rights Quality in the Icelandic Fisheries
71	Yutaro Sakai	Ex-ante Diversification, Limited Entry Permit Portfolio, and Fishers' Participation Decisions
78	Yaturo Sakai	Fishery Management Evaluation of Offshore Danish Seine Fishery in the Pacific Ocean, Hokkaido, Japan, Using Fishery Performance Indicators
43	Melissa Krigbaum	Gear-specific operating cost models for US West Coast Sablefish
7	Kaiwen Wang	Fleet Restructuring, Capacity Reduction, and Fisheries Subsidies Reform of China

Ecosystem-based Management/Marine Spatial Planning

Wednesday, May 24 (3:00 PM to 4:30 PM), Swope Meigs Room

19	Yaturo Sakai	The Potential of Communication Devices for Estimating Fishing Efforts of Collaborative Purse Seine Fleets
50	Pamela Woods	Métier analysis of a large industrial demersal trawl fleet in Iceland
47	Dan Holland	Diversification and Participation Trends of West Coast and Alaska Fishing Fleets Over Forty Years
18	Lisa Pfeiffer	Development of spatial data to support ecosystem management initiatives and economic impact analyses of offshore energy siting

Special Session 2: Early Career Researchers in Fisheries Economics Associations

Thursday, May 25 (8:30 AM to 10:00 AM), Redfield Auditorium

58 Dan Lew   Early Career Researchers in Fisheries Economics Associations

Fisheries Management 3

Thursday, May 25 (10:30 AM to 12:00 PM), Redfield Auditorium

13 Huu-Luat Do   Ghost fishing – how scary is it? A case study of the Norwegian snow crab fishery in the Barents Sea

89 Birgir Runolfsson   Landings control in ITQ fisheries; misreporting of catch in the Icelandic fisheries

116 Doug Lipton   Managing Risk and Asset Value: Summer Flounder Harvest Control Rules

127 Ralph Townsend   Evidence on harvester ability to fish selectively

Rights-based Fishery Management 1

Thursday, May 25 (1:00 PM to 2:30 PM), Redfield Auditorium

54 Andrew Ropicki   Analyzing Trends in Quota Lease and Ex-vessel Prices in Multispecies Catch Shares Managed Fisheries to Evaluate Stock Conditions

111 Michael De Alessi   Back to the Future of Fisheries: Assessing the Long-Term Triple-Bottom-Line Performance of Quota Managed Fisheries with Historical Reconstructions of Fishery Performance Indicators (FPIs)

86 Alexander Gordan   Can Fish Tags be Harvest Neutral

104 Andrew Steinkruger   Examining the evolution of access to Alaska's halibut IFQ fishery

Rights-based Fishery Management 2

Thursday, May 25 (3:00 PM to 4:30 PM), Redfield Auditorium

59 Jordan Moor — Renewable resource market responses under rights-based management: linkages in Gulf of Mexico fisheries.

75 Keita Abe — Self-selection into Individual Transferable Quota Management

125 Matthew Reimer — Structural Evaluation of Quota Market Performance in Catch Share Fisheries: Evidence from the Northeast Multispecies Sector Program

42 Kathryn Connelly — Who Is Benefiting from the IFQ Program? A Review of the 2019-2021 Quota Share Owners Survey in the Pacific Coast Groundfish IFQ Program

2   Dan Lew — Public Benefits of Endangered Species Protection: Measurement and Model Integration for Policy and Management

Fishing Communities 1

Thursday, May 25 (8:30 AM to 10:00 AM), Smith Conference Room

48	Catherine Courtier	Local area employment multipliers from commercial fishing: estimates from US West Coast ports
114	Angela Muench	Social vulnerability indicators: An application for English and Welsh coastal communities
57	Amanda Phillips	Socioeconomic comparisons in the West Coast Groundfish Trawl Fishery based on vessel and fisher characteristics.
91	Juan Agar	Caribbean Queen Conch: Productivity and Technical Efficiency Analysis

Bioeconomic Models 2

Thursday, May 25 (10:30 AM to 12:00 PM), Smith Conference Room

123	Minling Pan	Maximum Economic Yield and Non-Linear Catchability
4	Sandra Rybicki	Spatial choice modeling of the Icelandic Northeast Atlantic mackerel fishery – What drives the behaviour?
29	John Walden	Measuring Fishing Capacity with Quantile Data Envelopment Analysis
51	Olivier Thebaud	Adaptive fisheries may lead to climate maladaptation in the absence of access regulations

Special Session 4: Amplifying New Voices: Supporting an Inclusive, Equitable, and Diverse Community in Natural Resource Economics

Thursday, May 25 (1:00 PM to 2:30 PM), Smith Conference Room

4	Tammy Murphy	Amplifying New Voices: Supporting an Inclusive, Equitable, and Diverse Community in Natural Resource Economics

Recreational Fisheries 1

Thursday, May 25 (3:00 PM to 4:30 PM), Smith Conference Room

132 Robby Fonner   The effect of management changes on fishing site choice, trip frequency, and angler welfare in a recreational steelhead fishery

40   Andrew Carr-Harris   Climate-Induced Species Shifts and Catch Dependence in Recreational Fisheries

61   Andrew Scheld   Valuing shoreline habitats for recreational fishing

70   Frank Lupi   Comparing Aquatic Recreation Demand and Valuation Across Probability and Non-Probability Samples

Special Session 3: Aquaculture Performance Indicators

Thursday, May 25 (8:30 AM to 10:00 AM), Swope Meigs Room

2   Håkan Eggert   Aquaculture Performance Indicators

Aquaculture 1: Markets

Thursday, May 25 (10:30 AM to 12:00 PM), Swope Meigs Room

135 Minyan Shen   Consumer Preference for Farmed and Wild Fish Products in the Context of Beef and Chicken Products - a case study in Seattle

17   Sterenn Lucas   Does negative environmental information on salmon aquaculture modify consumer behavior?

129 Chris Anderson   Lessons from a Blind Tasting of Farmed and Wild Salmon

108 Félix Lavoie   The Quest for Exceptional Growth

Aquaculture 2

Thursday, May 25 (1:00 PM to 2:30 PM), Swope Meigs Room

90   Megan Rector   Aquaculture eco-certification and reputational benefits in communities with and without salmon farms

103 Andreea Cojocaru   A Flexible Policy Instrument to Encourage Externality Abatement Technologies in Salmon Aquaculture

105 Lijun Liu   Riskier Than You Think? Uncertainty in Shrimp Aquaculture

134 Minyan Shen   The impact of High profile salmon related ecosystem disruptions on the demand for salmon in Puget Sound

Aquaculture 3: Production & Disease Economics

Thursday, May 25 (3:00 PM to 4:30 PM), Swope Meigs Room

136 Marcus Hartley   Sablefish Aquaculture: An Assessment of Recent Developments and Their Potential for Enhancing Profitability

8   Dengjun Zhang   The Impact of Parasitic Sea Lice on Harvest Quantities and Sizes of Farmed Salmon

14   Ingrid Pettersen   Is capture-based aquaculture viable? The case of Atlantic cod in Norway

41   Adams Ceballos   Invasion Externalities and Firm Heterogeneity: The Case of Sea Lice

Fisheries Management 4

Friday, May 26 (8:30 AM to 10:00 AM), Redfield Auditorium

5	Ragnar Arnason	On the Economic Distortion of Rent Taxation in Natural Resource Based Industries
56	Kailin Kroetz	Evaluating the Design and Performance of the United States' Fisheries Disaster Aid Policy
99	Greg Ardini	Redirection of Effort from the Northeast Multispecies (Groundfish) Fishery
49	Nils-Arne Ekerhovd	Tax as a tool for fleet structuring
36	Xiurou Wu	Testing the spatial dynamic model of commercial fishing trip decision-making

Markets & Trade 3

Friday, May 26 (10:30 AM to 12:00 PM), Redfield Auditorium

27	Sunny Jardine	Fishing Portfolio Response to a Climate Shock
121	Martin Smith	The Seafood Trade and Nutritional Access
38	Atle Oglend	The Economic Value of Norwegian Seafood Trade
31	Kaitlyn Lee	The Seafood Trade Reporting Gap

Recreational Fisheries 2

Friday, May 26 (8:30 AM to 10:00 AM), Smith Conference Room

25	Melina Kourantidou	Assessing the value of Harmful Algal Bloom forecasts for the benefit of recreational shellfishing in the Pacific Northwest
102	Richard Woodward	Toward Valuation of Energy Rigs for Recreational Anglers: Case of Texas and Louisiana
34	Bijeta Bijen Saha	Florida Red Tide and Recreational Fishing Activities – Assessing the Economic Impacts
98	Brenna Jungers	Money can't buy me fish: Lessons from an incentivized harvest program*
39	Andrew Carr-Harris	The Effect of Fishery Interviewers on Recreational For-hire Vessel Reporting Behavior in the Northeast U.S.

Performance Measures & Efficiency

Friday, May 26 (10:30 AM to 12:00 PM), Smith Conference Room

128	Christopher Liese	Estimating Economic Profits and Resource Rent in Federal Commercial Fisheries in the U.S. Southeast: Preliminary Results
46	Erin Steiner	Impacts of sampling design in cost and earnings data collections
68	Elizabeth Conley	Commercial Cost Data Collection in the Northeast Region of the United States: Updates on an Ongoing Effort
137	Tannaz Alizadeh Ashrafi	The effect of quota portfolio scenarios on optimal harvest strategy and profitability of multi-species trawl fishery
28	John Walden	The Price is Right! Profits, Productivity and Price Change in the Northeast Scallop Fishery.

Fishing Communities 2

Friday, May 26 (8:30 AM to 10:00 AM), Swope Meigs Room

24	Anna Birkenbach	Joint Modeling of Fishing and Landing Location Choices
45	Connor Lewis-Smith	Drivers of Health Insurance Status in the West Coast Commercial Fishing Fleet
119	Jennifer Meredith	Keeping it in the Family: Gender and Inheritance Norms in a Rural Alaskan Salmon Fishery
79	Monica Galligan	Economic viability of fishery-to-food bank programs

Fisheries Management 5

Friday, May 26 (10:30 AM to 12:00 PM), Swope Meigs Room

138	Gakushi Ishimura	The estimation of fishery resource abundance and distribution by integrating satellite-based estimates of fishing vessel behaviour and market transaction data.
141	Chao Zou	The Evaluation of the Economic Impact on Maine Lobster Fishery from Lobster Management Area 1 (LMA 1) Restricted Area
87	Lauran Brewster	Using Portfolio Theory to Improve the Management of Living Marine Resources
126	Ralph Townsend	Increased Electronic Monitoring and Deemed Values
120	Yaqin Liu	The Effect of Live-coral Loss on Great Barrier Reef Fish Stocks

Session Chairs

NAAFE 2023 - Session Title	Day	Room	Time	Session Chair
Transboundary and Migratory Fisheries	24-May	Redfield	10:30	Kathryn Bisack
Markets & Trade 1	24-May	Smith	10:30	Rosemary Kosaka
Fisheries Management 1	24-May	Meigs Room	10:30	Scott Miller
Integrating Social Science in Climate and Ocean System Models	24-May	Redfield	1:00	Angela Meunch
Markets & Trade 2	24-May	Smith	1:00	Tara Scott
Fisheries Management 2	24-May	Meigs Room	1:00	Scott Crosson
Special Session 1: Economics and the Woods Hole Science Community	24-May	Redfield	3:00	Min-Yang Lee
Bio-economic Models 1	24-May	Smith	3:00	Eric Thunberg
Ecosystem-based Management & Marine Spatial Planning	24-May	Meigs Room	3:00	Michael Weir
Special Session 2: Early Career Researchers in Fisheries Econ Assoc	25-May	Redfield	8:30	Dan Lew
Fishing Communities 1	25-May	Smith	8:30	Yaquin Liu
Special Session 3: Aquaculture Performance Indicators	25-May	Meigs Room	8:30	Håkan Eggert
Fisheries Management 3	25-May	Redfield	10:30	Kathryn Bisack
Bio-economic Models 2	25-May	Smith	10:30	Akbar Marvasti
Aquaculture 1: Markets	25-May	Meigs Room	10:30	Diego Valderrama
Rights-based Fishery Management 1	25-May	Redfield	1:00	Stephen Stohs
Special Session 4: Amplifying New Voices: Supporting an IED Comm.	25-May	Smith	1:00	Tammy Muphy
Aquaculture 2	25-May	Meigs Room	1:00	Håkan Eggert
Rights-based Fishery Management 2	25-May	Redfield	3:00	George Silva
Recreational Fisheries 1	25-May	Smith	3:00	Cliff Hutt
Aquaculture 3: Production & Disease Economics	25-May	Meigs Room	3:00	Carlos Chávez
Fisheries Management 4	26-May	Redfield	8:30	Chad Demarest
Recreational Fisheries 2	26-May	Smith	8:30	Scott Steinback
Fishing Communities 2	26-May	Meigs Room	8:30	Juan Agar
Markets & Trade 3	26-May	Redfield	10:30	Kanae Tokunaga
Performance Measures & Efficiency	26-May	Smith	10:30	Marcus Hartley
Fisheries Management 5	26-May	Meigs Room	10:30	Eric Thunberg

Abstracts

NAAFE Forum 2023 in Woods Hole Poster Session

Poster Session

Wednesday, May 24 (5:00 PM to 7:00 PM)

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Consumers' judgment of fish freshness based on appearance
Li Penglong[1], **Yutaro SAKAI[2] (a-sakai@g.ecc.u-tokyo.ac.jp)**, Nobuyuki Yagi[3]
[1]Graduate School of Agricultural and Life Sciences, The University of Tokyo, Bunkyo, Tokyo, Japan, [2]the University of Tokyo, Tokyo, Tokyo, Japan, [3]University of Tokyo, Bunkyo-ku, Tokyo, Japan

The freshness of fish is an important basis for consumers to make purchasing decisions. In everyday purchases, consumers have to judge the freshness of fish by appearance. To simulate a real purchasing scenario, we purchased 242 whole horse mackerel from 100 fresh fish retailers in Tokyo selected randomly and immediately photographed the fish with the same background, followed by the measurement of their freshness using a Fish Analyzer. We then invited 529 participants to rate the freshness of these fish based on the pictures. The objective of this study was to explore the factors influencing consumers' judgment on the freshness of fish based on appearance and the reliability of these judgments. First, to identify which aspects of appearance influence consumers' judgments of freshness based on appearance, we estimated the correlation between consumer scores and the appearance attributes of the fish. We found that whereas correlations between consumer scores and appearance attributes were hardly observed among all participants, there were differences in the judging of freshness among different types of consumers. Second, to clarify whether the freshness judgment based on appearance is reliable, we compared the freshness scores given by consumers based on pictures of fish with those given by a Fish Analyzer. We found a significant difference between the two, suggesting that freshness judgments based on appearance may be unreliable.

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Income Inequality of Fishing Captains in the Northeast United States
Min-Yang Lee[1] (min-yang.lee@noaa.gov), Cameron Speir[2]
[1]NOAA Fisheries, Woods Hole, MA, [2]NOAA Fisheries, Santa Cruz, California

The distribution of individual income from capture fisheries is linked to individual skill, physical capital, fish stocks, and fisheries polices. We describe income inequality and mobility among captains in the Northeast US to begin to understand these linkages. We then examine the extent to which fisheries management has contributed to observed changes in the distribution of income. Many strategic fisheries policies (such as limited access or rationalization) are designed to solve a commons problem. These typically increase the inequality of opportunity; a result that may be contrary to management objectives or societal goals.

Our analysis extends over a 19 year period from 2001-2020. The number of captains in the region has declined during this time. This decline can mostly be traced to the groundfish and monkfish fishery; both of which are catch shares or limited access fisheries. Participation in the dogfish and skate fisheries has increased; both of which are open-access fisheries.   The iconic groundfish fishery has experienced increased income inequality; however, trends before and after the catch share implementation appear similar. Increasing inequality in groundfish appears to be due to continued exit from the fishery and possibly a modest decline in mobility among the remaining participants. In contrast, the General Category Scallop fishery, which also started IFQ management in 2010, exhibits no clear trends in income inequality and decreases in income mobility after rationalization.

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The age distribution of fishing captains in the northeastern United States and implications for the graying of the fleet

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The "graying of the fleet" refers to the age distribution of fishery participants becoming older over time. Aging of the workforce could reduce the human capital necessary for sustaining the industry and may be symptomatic of fewer opportunities for new entrants. Alternatively, because workers accumulate job-specific human capital over time, graying of the commercial fishing industry may simply reflect increasing returns to knowledge and experience. In this paper, we analyze changes in the age distribution of fishing vessel captains over an 18 year period beginning in 2001. We use data on captain licenses, which include date of birth, linked to landings in the northeastern United States to examine the graying of the fleet. We ask: is the age distribution of captains changing such that the fleet is older than historical norms? Are observed changes consistent with changing demographics in other segments of society (e.g. working populations in general, other natural resource sectors, or marine economic sectors)? Further, we examine whether any observed "graying of the fleet" indicates a reduction in opportunity for younger industry participants. The number of active fishing captains has declined over the time period of the analysis. Preliminary results indicate that the median age of captains and the ratio of older to younger captains have steadily increased over time. The civilian labor force in the US has shown similar trends over the same time period, although the population of fishing vessel captains is aging at a faster rate. Comparison with comparable industry groups is ongoing.

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Fish Rules: Leveraging data from a private recreational fishing application to begin to understand potential impacts from offshore wind development

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The development of offshore wind energy in the U.S. necessitates a sound understanding of trade-offs across ocean uses. Location data on private recreational fishing has been a glaring gap in understanding how society uses marine resources globally, despite the sector's economic importance. In this study we use a novel data set to start to fill that knowledge gap. We employ spatial scan statistics on data from Fish Rules, a smartphone application which provides georeferenced species level regulations, to understand whether species-level data is clustered spatially. Originally developed for epidemiological studies of disease clusters, the Kulldorff circular scan statistic employed in this study uses a Bernoulli likelihood ratio test to assess the size, number, and significance of clusters in presence/absence data for recreational species. We use a second data set of known fishing locations to validate that the clusters identify private recreational fishing activity. We employ a Kolmogorov-Smirnov type test of first order stochastic dominance developed by Barrett and Donald to assess whether the rate of harvest for a species within the associated Fish Rules data clusters is significantly higher than the rate of harvest outside of the clusters. We then discuss the analysis in the context of wind lease areas in the region, highlighting the approach's value in a management context.

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Stability of Sportfishing Demand in the Gulf of Mexico

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Estimates of the value of recreational fishing are widely used in policy analysis. For example, NOAA Fisheries includes predictions of the change in economic value anticipated with every proposed change in saltwater fishing regulations. Studies to generate new estimates of economic value are costly and time consuming. It is, therefore, important to understand the stability of value estimates over time in order to know when a study needs to be replicated to remain relevant for policy analysis. We replicated a sportfishing demand study 3 times in the Gulf of Mexico from 2018 to 2021 and compared the demand model parameters and related measures of willingness to pay. The study period included times of substantial economic change, including the international Covid-19 Pandemic. Our results suggest that the demand for and value of recreational fishing was stable over the study period.

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Economic Impacts of Offshore Wind Farms on Fishing Industries: Perspectives, Methods, and Knowledge Gaps

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Offshore wind farms (OWFs) are rapidly developing as an alternative energy source globally as well as in the Greater Atlantic region of the United States. Despite the pace of development, there are still many uncertainties surrounding best practices in assessing the economic impacts of offshore wind on regional fishing industries. This work aims to provide an overview and assessment of industry perceptions, methods, results, and knowledge gaps pertaining to economic areas of concern related to interactions between offshore wind farms and fishing industries in the region.

We provide a compilation of studies focusing on industry perceptions and impacts of OWFs on the fishing industry, focusing on four key economic areas of interest: fuel expenditures; insurance costs; fishing industry revenues, income and livelihoods; and fishing support businesses. Our findings suggest there are four overarching knowledge gap themes which persist across all economic areas of focus. This article aims to build awareness in areas where interdisciplinary collaboration can take place as well as serve as a foundation for informing best practice guidance as it pertains to assessing economic impacts imposed by OWFs on the fishing industry.

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Economic Value of Energy Rigs to Recreational Fishing in the Gulf of Mexico

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Fishery managers and recreational anglers have argued that recreational angling can be negatively affected by a decrease in the number of energy platforms in the Gulf of Mexico. While some of the decommissioned rigs have been converted to artificial reefs under the BSEE Rigs-to-Reefs program, their replacement rate has been disproportionate due to engineering and environmental limitations. This paper uses the random utility framework and the choice experiment method to estimate anglers' demand model and marginal willingness to pay for offshore fishing locations including standing rigs, reefed rigs, and other artificial reefs that provide similar environmental services. We employ a mixed logit model to investigate sources of heterogeneity in anglers' preferences. Using the latent class model, we examine if there is evidence of behavioral heterogeneity of attribute non-attendance for our model attributes (i.e., primary fishing destination, water depth, pelagic species catch rate, groundfish species catch rate, and distance). We find that reefed rigs are valued highly, more highly than the active rigs from which they were created. This suggests that Rigs-to-Reefs programs have been successful in offsetting, at least to some extent, the economic loss that has been felt by recreational fishing as oil and gas platforms have been removed. We find that anglers have differential preferences toward water depth, pelagic species, and groundfish species catch rate, which is accounted for in our welfare estimation. This study provides input for policy decisions such as promoting or demoting the Rigs-to-Reefs programs that sustain desirable fishing locations for recreational anglers.

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Using natural capital information to support fisheries management: the case of the European sea bass (Dicentrachus labrax)

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Natural capital concepts are becoming more widely understood, and there is growing interest in use of the approach in a range of marine policy and management contexts from local byelaws and protected areas to marine plans and fisheries strategies. However, each context has different needs, opportunities and challenges that vary with factors including the specific objectives, temporal and spatial scales, the data and resources available, the existing legislative framework, and the capacity of stakeholders and partnerships. It is essential, therefore, that a range of different applications are considered when developing methods, guidance and tools for the practical application of the natural capital approach, to ensure that these are robust and fit for purpose. In this study, the full suite of services and benefits provided by the commercial and recreational sea bass fisheries was mapped using a natural capital framework, particularly in terms of how these can provide an uplift to coastal communities, and quantitative and qualitative evidence on the scale of the associated values were compiled. A systems model has been extended to provide information that can be included in the framework alongside semi-quantitative information on wider cultural and health and well-being benefits. Different policy measure that change future stock sizes as well as the accrued benefits from harvesting the stock by commercial and recreational sea bass fisheries were assessed. The outputs of this work will be discussed in the context of the development of UK Fisheries Management Plans and efforts to conserve natural capital.

Analysis of the Carrying Capacity of Fishery Resources in the Yangtze River Basin

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The research calculated the maximum sustainable yield through the non-equilibrium production model and the logistic regression, using statistical methods to construct a fishery resource carrying capacity model for the Yangtze River Basin, focusing on the assessment of the carrying capacity of fishery resources in the basin.

The results of the assessment of the carrying capacity of fishery resources in the Yangtze River Basin show that the overload years accounted for 91.7% of the total survey years. The possible causes of this problem are overfishing, illegal fishing and environmental problem such as hydraulic operation, water pollution, waterway development, river hardening, etc.

To address overfishing and illegal fishing, at the end of 2019, the Ministry of Agriculture and Rural Affairs of the People's Republic of China issued a notice on the scope and duration of the ban on fishing in key waters of the Yangtze River basin, announcing the implementation of a 10-year ban on fishing in the Yangtze River starting from midnight on January 1, 2020.

According to the result of the implementation of the existing fishing policy, a time series prediction model is established in this article, through SPSS, respectively for the Yangtze River Basin in fishery catches and fishing boats power. Prediction results from the use of our time prediction model show that the fishing numerical results of changes in the end is close to zero value. To some extent, it proves the effectiveness of the Yangtze River fishing ban policy.

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Assessing the economic potential for a mesopelagic fishery as an additional source of fishmeal for global aquaculture

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The aquaculture industry is playing an increasingly important role for global food security. A preferred source of aquafeed is fishmeal made from pelagic forage fish; however, ecological limitations make increasing production infeasible, thus prompting the need for novel sources of aquafeed. Fish in the mesopelagic zone (200-1000m in depth) is being considered as a source of fishmeal due to their abundance and robust nutritional profile. Some countries are evaluating the economic viability of mesopelagic operations, but none have been commercially successful thus far. In this study, we adapt a bioeconomic model to examine the economic implications for global aquaculture from including the mesopelagic as a fishmeal source. We run a 10-year simulation, examining how existing pelagic fishmeal production systems are impacted when a hypothetical, commercially-viable mesopelagic fishery enters the fishmeal industry. Results of the study show that including the mesopelagic fishery would increase the total fishmeal production, consequently reducing its market price, making it more accessible to aquaculture farmers. The lower selling price would reduce pelagic fisheries' profitability, which also marginally reduces their fishing efforts. We predict that pelagic fisheries operating close to maximum fishing effort would lower their effort due to lowered profits, and instead diversify into mesopelagic operations. This would reduce fishing pressure on pelagic forage fish stocks, and lead to an overall healthier ocean ecosystem. As our simulation only investigated an economic linkage between the production systems, further work should examine the ecological and economic ramifications of a combined pelagic and mesopelagic operation in the same region.

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Exploring the Temporal Variation in Mesopelagic Food Webs

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The mesopelagic (200-1000m) has a global distribution and contains a largely unexploited population of fish and zooplankton. Many residents in this layer participate in diel vertical migrations to the surface- presumably to feed- and many economically and ecologically important species have been shown to dive to mesopelagic depths on a regular basis. Consequently, this layer acts as a bridge between surface and deep-water communities. This project examines the largely undefined food webs of mesopelagic fish and zooplankton communities utilizing compound specific stable isotope analysis of amino acids across several years and two seasons. This project shows a temporal shift in the source of carbon for these food webs. Additionally, There is evidence that the larger fish from the bathypelagic zone migrate up into the mesopelagic to target those species that participate in diel vertical migration. This work will be essential to inform fisheries management practices as the mesopelagic is explored as a potential fishery.

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Environmental DNA-based biodiversity assessments to inform policy and management decision making

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Overfishing, pollution, ocean acidification, and rising temperatures have caused a rapid decline in global marine biodiversity that threatens essential ecosystem services. The recent UN High Seas Treaty is a global recognition of the need to conserve and protect 'Biodiversity Beyond National Jurisdiction' (BBNJ). Policy decisions on managing high seas resources must be based on the best available science. Environmental and biodiversity changes in the surface ocean are well-studied. In contrast, the subsurface mesopelagic or ocean twilight zone (OTZ), remains relatively unexplored primarily due to limited accessibility and technological capabilities for deep water exploration and research. The OTZ plays a critical role in climate regulation and harbors a diverse array of fish. Growing interest in exploiting the resources of the OTZ, as well as the potential impacts of climate change on this zone, highlights the need for new tools to study and manage this ecosystem. Environmental DNA (eDNA) can generate new ecological insights on ecosystem biodiversity and function to inform ocean policy. Preliminary results suggest that metabarcoding of the Northeast U.S. Continental Shelf waters could identify unique depth-dependent community composition from the surface down to the mesopelagic. Thus, eDNA can be a useful tool to assess OTZ biodiversity to inform ocean management decision making, such as the establishment of MPAs to conserve 30% of the ocean by 2030, and the assessment of environmental impacts associated with ocean use activities.

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Socioeconomic Disruptions of Harmful Algal Blooms in Indigenous Communities: The Case of Quinault Indian Nation

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Harmful algal blooms (HABs) have been a pervasive challenge across coastal communities of the U.S. West Coast in recent years negatively affecting local economies and livelihoods. We focus on the effects of HABs to the Quinault Indian Nation (QIN) triggered by *Pseudo-nitzschia* that produce the toxin domoic acid (DA) accumulating in filter feeders and posing threats to human health via shellfish consumption. Consumption of razor clams with high levels of DA and Dungeness crab that prey on them can cause amnesic shellfish poisoning in humans and therefore requires closure of commercial, recreational and subsistence fisheries, postponing or limiting harvesting seasons. These disruptions result in significant losses in revenues along with negative effects to sociocultural dimensions of key importance to coastal communities. Livelihoods and wellbeing of tribal communities are affected disproportionately due to higher vulnerability and reliance on these marine resources for subsistence. We assess these effects at multiple levels for the QIN and discuss and reflect, through a tribal lens, upon advances and opportunities for impact mitigation and adaptation in the face of HABs, along with persisting challenges.

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Aquaculture 1: Markets

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Consumer Preference for Farmed and Wild Fish Products in the Context of Beef and Chicken Products - a case study in Seattle
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An extensive corpus of literature in fishery economics is focused on comparing consumer preferences between farmed fish and wild fish. Another large selection of food and agriculture literature pays heed to consumer preferences for beef or chicken attributes individually. However, in daily life, when consumers are making animal protein decisions, they are usually faced with a choice set of beef, chicken, and fish. This study uses a choice experiment to investigate consumer preference and willingness-to-pay (WTP) for fish filet, chicken breast and beef steak. Data were collected from an in-person survey that took place across seven farmers markets in Seattle between June and September 2019, with a sample of 1274 regular consumers of animal proteins. A random parameter logit model was utilized, and WTP coefficients were calculated based on model estimation results. Compared to conventionally-farmed beef, respondents were willing to pay a $5.45 per pound and $10.89 per meal premium for farmed fish; a $8.89 per pound and a $17.78 per meal premium for conventionally-farmed chicken. When compared with free-range beef, respondents are willing to pay a $4.32 per pound and $8.65 per meal premium for free-range chicken and $7.93 per pound and a $15.85 per meal premium for wild fish. In general respondents don't prefer farmed animal proteins. Respondents are willing to pay more for certifiably sustainable, fresh, or local/domestically produced animal protein products. Among respondents who put serious consideration of the environmental impact into their food choices, significant results showed that farmed fish would increase the utility of

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Does negative environmental information on salmon aquaculture modify consumer behavior?

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Salmon is the most-consumed farmed fish species in France, and it's mainly originated from Norway. At the same time, Norwegian aquaculture is regularly highlighted in the press for its negative environmental impacts. But do more inform consumers will take this information into account in their preferences for salmon? To answer this question, we work on data collected from French consumers online in 2021. We run two waves a month apart to measure the impact of information on medium-term behavior. The first wave covers 3,000 respondents, spread in three groups. One third received a negative information about the environmental impact of Norwegian salmon aquaculture. One third received a dramatic negative information. The last third didn't receive any information. The second wave covers 1,500 respondents already included in the first wave and equally allocate across the groups. A discrete choice experiment is run to evaluate consumer preferences concerning salmon origin (Norway, Ireland and Scotland), price, and environmental labeling. First results suggest that negative information impacts negatively the Norwegian salmon perception but the effect remains significant in time only for the dramatic information. This negative effect impacts not only the consumer choice of Norwegian salmon, but also the choice of other origins tested. It means that negative information about Norwegian aquaculture is perceived as negative information on all aquaculture products regardless of the origin. Furthermore, the choice of environmentally labeled products is increased by the negative information treatment. Labeling can be a way to reinsure consumers, as environmental dimensions are credence attributes.

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Lessons from a Blind Tasting of Farmed and Wild Salmon

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Students in a Masters-level class on Economics for Resource Management and Policy have participated in a blind tasting of salmon and trout. Each year, four fish were presented from what was currently available at the supermarket (in December): fresh farmed Atlantic salmon, fresh farmed steelhead trout, frozen wild sockeye salmon, and wild king salmon (fresh in one year, frozen in others) were each prepared in exactly the same way. Tasters were asked to identify their favorite fish; which they thought was most expensive; whether they thought each was fresh; and whether they thought each was wild. When king salmon sample was frozen, 79% of tasters preferred the farmed fish over the wild fish, largely because it is fresh. Many tasters erroneously attributed the bright, clean flavors and flaky texture they preferred to being wild: 39% of tasters thought the fresh steelhead was wild, though it is farmed. Still, the strongly flavored and lean sockeye was preferred by about a quarter of the tasters, despite being frozen. This mismatch between taste attributes and seafood labeling implies an opportunity for aquaculture producers to expand their market.

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The Quest for Exceptional Growth

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Norwegian aquaculture adopted the "traffic light system" to modulate the speed of the growth in production according to each region's impact on the environment, thus far measured in terms of salmon lice impact on wild salmonids stocks. Every two years, there is a round of adjustments in the capacity of licenses according to their region's impact status (low, moderate, high). Low impact (green) regions will be allowed to grow, while high impact (red) regions will get a reduction in their licenses' capacity. Firms may obtain an exemption from the reduction for a license attached to a location if it can prove that it met very strict environmental standards, and therefore be allowed to grow even in red or yellow regions. This paper investigates the characteristics and behaviors of the applicants for this exceptional growth. We use a difference-in-difference approach to inquire how a region's impact status influences lice mitigation behaviors at the farm level. We find that farms in yellow regions are particularly active in seeking this exceptional growth, and that the expected negative change in a region's status can be a powerful driver for extra lice prevention effort. We conclude that the system creates incentives aligned with the environmental goals of the policy.

Aquaculture 2

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Aquaculture eco-certification and reputational benefits in communities with and without salmon farms

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Aquaculture eco-certification is associated with some producer-level benefits including consumer willingness-to-pay and market access; however, reputational benefits from eco-certification are unclear. A public survey was used to understand the effect of eco-certification on opinion of salmon farming in two Canadian provinces (British Columbia and Nova Scotia) and differences between communities where farms are located (communities of place) and communities geographically distant from farms (communities of interest). Eco-certification had an overall positive effect on opinion, especially amongst people with a negative opinion of salmon farming who value far-reaching social outcomes of farming. Communities of interest had a more negative opinion of salmon farming and eco-certified salmon farming and were more concerned about local environmental impacts than communities of place while the latter valued economic outcomes more than communities of interest. The role of eco-certification in public acceptance of aquaculture is limited by a lack of trust in eco-certification and failure to address local issues including conflict amongst marine users.

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A Flexible Policy Instrument to Encourage Externality Abatement Technologies in Salmon Aquaculture

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Aquaculture has been identified as a food sector with potential to provide protein and essential micronutrients to a growing global population, with salmon often viewed as a leader in aquaculture technology. Despite the broad range of negative externalities in salmon aquaculture, sea lice infestations remain the most harmful of environmental issues within the industry. In response to these challenges and driven by the need for a higher degree of control over the production conditions, salmon producers in Norway have been heavily investing in new technologies that are perceived as the only remaining option for addressing sea lice. The challenge is to design a regime that encourages innovation toward a sustainable mix of production technologies in the future. Feed-in tariffs, a dynamic Pigouvian subsidy extensively considered in the energy sector, emerge as an alternative policy instrument that can work to promote investments in abatement technologies in aquaculture production.

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Riskier Than You Think? Uncertainty in Shrimp Aquaculture
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Aquaculture has been the world's fastest-growing sector for food production and contributes significantly to rural development and food security in many countries. Despite its proliferation, the uncertainties in aquaculture have not been well addressed. In this paper, we develop a stochastic simulation model to explore the effects of risky economic and biological variables on the profitability of whiteleg shrimp (*Penaeus vannamei*) aquaculture. The profitability is measured with the probability distribution of the net present value of aquaculture production in the short term (a production cycle) and the long term (10 years). With the best knowledge available, we construct two scenarios reflecting the semi-intensive and intensive shrimp aquaculture practices, respectively. For each system, we examine how the various risks (e.g., chronic disease, random shocks, input and output price fluctuation, discount rate, unsecured land rights, etc.) will impact the success of the aquaculture business. We also conduct sensitivity tests to understand the contribution of each risk to the overall uncertainty of the scenarios. With minimal data required, our model aims to 1) make realistic inference on challenges and opportunities for aquaculture development and 2) identifies critical fields for risk management.

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The impact of High profile salmon related ecosystem disruptions on the demand for salmon in Puget Sound
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Events affecting fishery production systems can draw consumer attention to features of various products, and drive changes in consumption patterns. We study the effects of two high profile events affecting salmon in the Puget Sound (Seattle) area, where consumers are known to focus on environmental impact and sustainability.

First, in 2017 there was a 300,000 fish Atlantic salmon net-pen spill that happened at Cypress Island's fish farm. Second, in 2018, Tahlequah, a mother in a culturally significant pod of orcas, carried her dead calf for 17 days around Puget Sound highlighting starvation and other challenges for the king salmon-dependent species.

We evaluate how Puget Sound consumers reacted to these ecosystem disruptions with 2016 - 2020 meat and seafood weekly scanner data from a local Puget Sound grocery store chain. Demand system estimation shows the "salmon spill" event has little impact on farmed salmon but leads to significant increase in non-salmon seafood expenditure share in the short run and in the long run there are significant increases in responsible-raised chicken and conventional pork market shares. The "orca mom" event leads to a drop in king salmon market share and significant increase in farmed salmon and conventional poultry market shares in the short run. This shows that fishery ecosystem events do drive consumer choices, and allows us to identify what they buy instead to assess whether their alternatives are in fact better for their health or the environment.

Aquaculture 3: Production & Disease Economics

Thursday, May 25 (3:00 PM to 4:30 PM)

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Sablefish Aquaculture: An Assessment of Recent Developments and Their Potential for Enhancing Profitability

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Sablefish is a highly marketable fish due to its flesh characteristics and buttery flavor. Despite a consistent, conservative management approach in North American sablefish fisheries, both stock biomass and landings have shown an overall downward trend—global harvests averaged over 50,000 mt per year from 1987–90, but, since 2010, annual harvests have averaged only 20,000 mt.

Because of its limited commercial availability, highly marketable characteristics, and potential to be grown in farming operations, there is strong interest among aquaculture producers and investors in sablefish. The current study was undertaken to describe the present status of sablefish aquaculture in the U.S. and elsewhere, and to perform an initial assessment of the financial viability of a sablefish aquaculture industry that utilizes existing technology, including use of all-female rearing stocks that have been developed at NMFS's Northwest Fisheries Science Center. Specifically the study:

- Provides an historic overview of sablefish aquaculture.
- Documents technological advancements in developing successful breeding and hatchery operations, including the development of "neomale" broodstock and female monosex fingerlings.
- Assesses the potential financial benefits to the sablefish aquaculture operations from the utilization of female monosex rearing stocks.
- Summarizes the international and domestic markets for sablefish.
- Summarizes the status of commercial harvest fisheries for sablefish in Alaska British Columbia and the US West Coast
- Estimates potential price effects of an increased supply of sablefish by updating and revising the econometric model of the sablefish fishery originally developed by Huppert and Best (2004).

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The Impact of Parasitic Sea Lice on Harvest Quantities and Sizes of Farmed Salmon

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Sec lice infections are recognized as a primary challenge for salmon farming and adjacent stocks of wild salmon and sea trout triggering strict regulations regarding the monitoring of sea lice numbers and delousing operations. For example, in 2017 the Norwegian government implemented the Traffic Light System (TLS) where green, yellow, and red lights imply that salmon farmers can raise, maintain, or must reduce production quantities depending on sea lice levels. Past research has explored the impacts of sea lice on the growth rate of salmon, indicating a possible link between sea lice numbers and harvest practices. This study evaluates the impact of sea lice numbers on salmon farmers' harvest behavior focusing on production quantities and fish sizes, while controlling for market prices for salmon and fish meal. We also investigate whether, and to what extent, harvest behavior was influenced by the TLS implementation in 2017. Our empirical results indicate that farmers tend to harvest faster in response to increasing levels of sea lice and slower during delousing operations. The implementation of the TLS strengthened the negative impacts of delousing operations on harvest quantities. Fish sizes at harvest are negatively associated with sea lice levels and delousing operation, regardless of the implementation of the TLS. Control variables, such as seawater temperature, salmon prices, and fish meal prices, also influence harvest quantities and fish sizes.

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Is capture-based aquaculture viable? The case of Atlantic cod in Norway

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Capture-based aquaculture (CBA) is an important branch of the aquaculture industry that differs from closed cycle farming in that the stocking material consists of captured wild fish or other aquatic organisms. By skipping the difficult early production stages of fish farming, producers can test whether assumed market advantages such as high quality and consistent supply result in higher prices – and whether these are high enough to incentivize further development of CBA and eventually close the production cycle. CBA-initiatives can also be supported by different policy measures to stimulate activity. Since these measures involve costs, it is important to know at what level and for how long these measures should be implemented to promote economically sustainable CBA activities. We study CBA of Atlantic cod (*Gadus morhua*) in Norway and find an average price premium of 26% compared to wild harvested cod, but with large interannual variation. However, declining quantities of cod from CBA following reductions in a quota bonus scheme to stimulate activity, indicates that the price premium is not sufficiently large to incentivize further development of the CBA branch of the Norwegian cod industry.

41
Invasion Externalities and Firm Heterogeneity: The Case of Sea Lice

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Aquaculture is a rapidly growing food production technology, primarily in developing countries, and now accounts for over 50% of global seafood production. While aquaculture provides nutritious food and can alleviate poverty, diminish income inequality, and increase food security, significant environmental impacts and disease concerns exist. Environmental externalities are generally addressed with government regulations, although the extent to which this is possible depends on a country's governance capacity. However, many environmental challenges in aquaculture are not pure externalities but also have private incentives, e.g., lower disease pressure and faster growth with improved water quality. Hence, industry structure may also be important as these private benefits incentivize firms to collaborate. However, collaboration becomes more difficult as the number of stakeholders increases. Therefore, if they collaborate, one would expect externalities to be reduced in regions with fewer separate firms.

We research this hypothesis for salmon, the second largest aquaculture species globally by value and an industry that has experienced major disease challenges. Here we show that the prevalence of the most harmful negative externality in Chile and Norway, sea lice, is significantly reduced in regions with a higher degree of ownership concentration. This result is significant in countries with limited governance capacity as it suggests that self-governance concerning environmental challenges can be facilitated by how production sites are divided between producers. Furthermore, there is often a strong focus on developmental policies geared toward small-scale farmers, which unintendedly increases firm heterogeneity. As a result, our research suggests that this may not be environmentally optimal.

Bioeconomic Models 1

Wednesday, May 24 (3:00 PM to 4:30 PM)

20
An Assessment of the Growth Effects Productivity of Oil Rigs as Artificial Reefs in the Gulf of Mexico
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I investigate the impact of oil rigs on the biomass and growth of the red snapper stock in the Gulf of Mexico. While the role of oil rigs in aggregating reef fish is well documented, the research on whether oil rigs increase growth or abundance is limited and typically focuses on individual rigs. I use both time-series and panel data to estimate the effects of oil rigs. The panel data analysis relies on the difference-in-difference method, where the South Atlantic red snapper is the control group. In an alternative panel data, I divide the Gulf stocks into East vs. West. This aggregate model for the role of all oil rigs in a region differs from typical ecological studies of individual oil rigs by evaluating their effect on the regional population rather than at specific sites. I will also test the argument advanced by Strelcheck, Cowan, and Shah (2005) that too many artificial reefs may have an adverse effect on biomass by examining non-linearity in the effect of the density of oil rigs. Estimates of the magnitude of the aggregate effect of oil rigs on red snapper stock abundance will allow a broad cost-benefit analysis of removing decommissioned oil rigs in the future and help more accurate stock assessments. This analysis also helps evaluation the wind energy turbines in the Federal waters.

6
An intraannual stock index based on the two-stage generalized model for Norwegian demersal fisheries
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Relevant bioeconomic models require a relevant empirical foundation. Bioeconomic models with a solid empirical grounding may, for example, inform estimates of natural capital, support management target decisions, and infer implied losses from restrictions to quota trade. Using trip-level data on landings combined with satellite track data for fishing vessels, we estimate a generalized Gordon-Schaefer model for Norwegian demersal fisheries. The econometric approach has two stages, one estimating a production function in a panel setting with area-, gear-, and time fixed effects, and a second estimating the stock dynamics. We contrast the generalized Gordon-Schaefer model to the classical Gordon-Schaefer model, and to other generalized specifications. We thus shed light on the role of some of the key assumptions in the generalized Gordon-Schaefer model. We also find evidence in conflict with assumptions of the classical Gordon-Schaefer model. Our results may aid reflection over the maximum sustainable yield management target. We further provide an intraannual stock index valid across areas and gears. The index imply massive differences in intraannual abundance but captures interannual variation surprisingly well.

63
Ecosystem Services on the Half Shell: A Bioeconomic Model of Impure Public Goods Production

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The consumption of renewable resources provides benefits through direct use to consumers, but can also provide ecosystem benefits, available to all without exclusion. Termed impure public goods or mixed goods, these have both private and public characteristics from the perspective of the consumer. A key example are bivalve shellfish, which filter the water as they grow. Excess nitrogen loads in surface water emitted from nearby agricultural areas can lead to algae blooms and hypoxic conditions, which are detrimental to marine life. The production of shellfish such as oysters may be able to mitigate the effects of nutrient pollution. Here I present a dynamic bioeconomic model of the production of an impure public good, using Pacific oyster aquaculture on the West Coast of the United States as the primary case study for empirical implementation. The model will take into account 1) innovations in physical capital, 2) innovations in natural capital, such as seeds, 3) the existence of technical inefficiencies, and 4) market-based and regulatory instruments that can internalize the benefits of ecosystem services for producers. The modelling framework will allow for analysis of the implications of different structures for public investment in impure public goods, extensions to other renewable resources that provide ecosystem benefits, and applications to other country settings with smallholder primary food production.

85
A Bioeconomic Modeling Approach to Studying Reproductive Limitations for Blue Crabs in the Delaware Bay

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Feedback mechanisms between fishing decisions and reproductive dynamics pose a challenge for effective fisheries management. Size-dependent pricing is common in fisheries and can result in the selective harvesting of a population subset, often differentiated by size or sex. In the mid-Atlantic blue crab fisheries, research suggests that market incentives to harvest large male crabs may negatively affect population dynamics by limiting sperm and operational sex ratios. In this paper, we simulate the effect of selective harvesting on the Delaware Bay blue crab population and compare the behavioral response of fishers to hypothetical new gear/catch limits, seasonal closures, and other policy scenarios. We develop a unique bioeconomic model that links size-dependent market incentives to population productivity in order to assess how policy scenarios could affect the sustainability of the fishery. Crab growth is simulated using an individual-based population model, which we link to an economic model in which fishers maximize the net present value of harvest by choosing levels of effort for each market category distinguished by shell status, size, and sex. Our model captures intra-seasonal dynamics by incorporating different marginal costs of fishing, prices, and gears used at different points in the season. Our policy scenarios, which are informed by recent management changes in the Chesapeake Bay to protect declining blue crab populations, are designed to explore the balance and tradeoffs between economic and biological sustainability in this important fishery.

Bioeconomic Models 2

Thursday, May 25 (10:30 AM to 12:00 PM)

123
Maximum Economic Yield and Non-Linear Catchability

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Schaefer's model with fixed catchability and associated linear catch-per-unit-effort (CPUE) does not reflect the variable nature of catchability resulting from technological progress and schooling behavior, leading to a biased estimation of maximum economic yield (MEY) or economic optimal biomass (B_{MEY}). This could be the reason that few implementations of MEY are found in real world fishery management. This study improves on Schaefer's bioeconomic model by incorporating nonlinear CPUE into the model to define MEY and its relationship with MSY.

The study shows MEY depends on biomass relationships with catchability and CPUE. Biomass relationships with catchability and CPUE determinate the stock effect (the economic benefit of leaving more fish in the water); consequently, they determinate the MEY position in relation to MSY. In general, MEY might be closer to or further away from MSY (compared to Schaefer's MEY) when we consider nonlinear CPUE performance in response to biomass changes in individual fisheries. The less sensitive CPUE is in response to changes in biomass, the lower the stock effect, and the closer the economic optimum B_{MEY} is to the biological optimum B_{MSY}. When CPUE is constant (or increasing) with decreasing biomass, MEY is shown analytically to be the same as the biological optimal yield (MSY), implying MEY = MSY and the related optimal biomasses are equivalent, BMEY = BMSY. On the other hand, when CPUE is sensitive to changes in biomass, the stock effect is more noticeable and MEY could be much less than MSY.

4

Spatial choice modeling of the Icelandic Northeast Atlantic mackerel fishery – What drives the behaviour?

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There is an increasing demand to understand the mechanisms driving changes in fishing behaviour in addition to ecosystem dynamics in order to facilitate the evaluation of management decisions and to reduce or avoid drastic and unintended socio-economic consequences. Socio-economic models, that can incorporate social and psychological knowledge, are useful tools to understand how and why short-term individual fishing decisions are made. Most existing studies focus on demersal fisheries, which are usually less selective than pelagic fisheries and target a larger number of species for which they have quota as well as a market channel. Yet, it is important to understand the behavior of pelagic fisheries, especially in the context of climate change. An expansion of Northeast Atlantic mackerel (*Scomber scombrus*) towards the northwest partly resulting from increased biomass brought a new fishery to Iceland, generating 8% of Iceland's total catch in 2016. In this study, we first investigated the fleet structure in order to identify the major socio-economic attributes affecting vessel behavior. To understand the impact of biological as well as socio-economic changes on individual fisheries behavior and to therefore predict fishing behavior, we fit a spatial choice model using fish density, expected catch and distances (as a fuel/variable cost indicator), vessel attributes (as fixed costs indicators), fish price and processing type (frozen on board/ landed fresh) as explanatory variables. The results provide an overview of the socio-economic and biological drivers of the mackerel fishery in Icelandic waters.

29

Measuring Fishing Capacity with Quantile Data Envelopment Analysis

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Data Envelopment Analysis (DEA) has been used extensively to estimate fishing vessel capacity, technical and economic efficiency. However, DEA has often been criticized because of the influence outliers, or noisy data, can have on the DEA estimates. Recently, Quantile Data Envelopment Analysis (QDEA) was introduced as a method to address issues caused by data outliers by endogenously identifying potential outliers, and eliminating them from a given vessels's DEA reference set. In this study, we utilize QDEA to estimate fishing vessel and fleet capacity for vessels operating in the northwest Atlantic illex squid fishery during 2019. We present methods for implementing the QDEA model that we think are practical and can be adapted for fishing fleets worldwide. Results show lower capacity estimates using the QDEA model than what the standard capacity model would yield. Our results are quite encouraging in terms of utilizing the QDEA model in future work.

51
Adaptive fisheries may lead to climate maladaptation in the absence of access regulations

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Adaptive fishery responses to climate-induced changes in marine fish populations may lead to fishery maladaptation. Using a stylised bio-economic model of the global fishery, we demonstrate the importance of adaptive management regimes. We show how the losses resulting from poor access regulation increase in a fishery system negatively impacted by environmental change, and demonstrate the proportional benefits provided by management strategies that control the levels and allocation of fishing effort. Indeed, under poor to inexistent access regulation, highly adaptive actors can generate significant bio-economic losses. This might lead to foregone benefits and cascading economic and ecological losses, whereas well-designed adaptive management regimes may enable making the most of the best, and the least of the worst, climate-induced outcomes for fisheries. These findings emphasize the need for integrated assessment approaches to the impacts of climate change on fisheries, that should incorporate not only ecological responses but also the industry and management responses.

Ecosystem-based Management/Marine Spatial Planning

Wednesday, May 24 (3:00 PM to 4:30 PM)

19

The Potential of Communication Devices for Estimating Fishing Efforts of Collaborative Purse Seine Fleets

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Fishing efforts and the underlying fishing behaviors are the keys to the implementation of ecosystem-based fisheries management, yet accurate information on these is difficult to obtain, especially for purse seiners. To address the challenge of accurate fisheries data, this study exploited the GPS data collected by real-time communication devices equipped on fishing fleets. The advantage of this data over those collected by existing monitoring systems for fisheries is that it is high-frequency and continuous, and has corresponding onboard visual records which allowed GPS-based estimations to be verified. Another feature of this data is that it can link various vessels in a fleet, thus providing an opportunity to study the collaboration behavior within a fleet.

Based on this unique data collected for two Japanese purse seine fleets, this study revealed a range of features related to fishing events of purse seine fleets, including patterns of a series of GPS-based covariates, key phases in fishing operations, and the collaboration behaviors within a fleet. General additive models were built to estimate the fishing efforts of purse seiners and the best predictive models were selected. It was found that these best models could accurately estimate the fishing efforts of purse seiners by capturing key behaviors that are highly correlated to fishing events. The method proposed in this study has the potential to contribute to sustainable fisheries as the communication device described can be applied over wide regions and over a long period to collect accurate fisheries data.

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Métier analysis of a large industrial demersal trawl fleet in Iceland

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The necessity for ecosystem-based management has its foundations in the recognition that species interactions in fishing are often unavoidable and fishing one species may have other impacts on cohabiting species or the ecosystem. Vessels can control species mixtures by switching gears and fishing locations in response to local ecological conditions; however, there are also economic considerations such as regulations, costs, and expected uncertainty that affect target species catch compositions. Realized species compositions are therefore the result of various ecological and economic factors and can be described and quantified using métier analysis. In this study, we performed a métier analysis of logbook data submitted by a large industrial demersal trawl fleet in Iceland (over the years 2015-2019). This fishery is regulated mainly by an individual transferrable quota system that spans all demersal fisheries and allows for relatively high flexibility in matching catches to quota (Woods et al. 2015). Frequency, seasonality, and spatial location of métier usage by individual vessels was then used to determine whether vessels have consistent or specialized enough behavior to be considered 'fleet segments,' and whether this behavior is related to vessel attributes. Port of landing is also analysed to determine whether how specialization may affect resilience of smaller fishing communities in the face of climate change.

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Diversification and Participation Trends of West Coast and Alaska Fishing Fleets Over Forty Years

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Spreading fishing across species (species diversification) and across weeks of the year (temporal diversification) have both been shown to reduce interannual variation of fishing revenue, an indicator of financial risk. We evaluate how species diversification and temporal diversification of revenue for vessels fishing in Alaskan and West Coast fisheries have changed over forty years, updating the analysis of Abbott et al. (2022) to cover a longer (and more recent) period and broader geography. We distinguish the effects of changes in fleet composition associated with exit and entry from adaptive changes driven by changes in individual vessels' fishing strategies. Our results show that species diversification of fishing revenue began to decline by the mid 1990's, coinciding with implementation of limited entry regimes. Temporal diversification continued to increase until 2014, enabled in part by continued reductions in the fleet that allowed remaining vessels to fish more. However temporal diversification declined steeply after 2014 caused in part by decline or compression of key fisheries as well as Covid-19. Reductions in temporal diversification may also relate to aging of vessel owners, more than half of which are over 60 years old. Declines in both species and temporal diversification for the fleet as a whole were mitigated by compositional changes as new entrants tended to be more diverse than vessels exiting. This masked steeper and earlier declines in diversification for individual vessels persisting in the fishery.

18
Development of spatial data to support ecosystem management initiatives and economic impact analyses of offshore energy siting

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Offshore wind energy development has the potential to change the landscape for commercial and recreational fishers and the communities that benefit from these activities. There is a compelling need to accurately and comprehensively evaluate economic tradeoffs of fishery operations and offshore energy development in an ecosystem management framework, yet data are generally not available in a format that facilitates such analysis.

We combine VMS, AIS, Observer, logbook, and other types of spatial fishing data that are often available but do not have fleet-wide coverage and may not be representative of a particular fishing fleet. We analyze the coverage rates and extent of overlap of different data sources to provide guidance on how representative spatial data is for individual fisheries. We show that VMS and AIS can augment fishery management data to provide information about the location of catches, gear placement, and fishing effort in fisheries where the fishery management data is inadequate to do so, and fishery management data can augment VMS/AIS to identify fishing behaviors and determine the utility of VMS/AIS data to describe fishing effort in a particular fishery. We use overlapping data sets to build models of fishing location and expand our ability to map the footprints of fisheries in the Pacific. This project provides the building blocks for the development of economic models of effort location choice to evaluate opportunities to adapt fishing strategies to changing fishery conditions, ecosystem dynamics, and reduced access to fishing areas due to competing uses such as wind energy development.

Wednesday, May 24 (10:30 AM to 12:00 PM)

62
Expanding fishing opportunities for the U.S. South Atlantic snapper-grouper fishery by minimizing discards

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From 1992 to the present, the snapper-grouper fishery in the U.S. South Atlantic has experienced an increase in discarding due to increased effort and regulatory actions such as individual species closures, minimum size limits, bag limits, and trip limits. Discarding is now severely restricting the full biological and economic potential of the fishery. Multiple key species that are frequently co-caught are either undergoing overfishing or already in rebuilding plans. Stakeholders and Council members would prefer to convert these discarded fish into retained fish. The only way to achieve that is to introduce drastically different regulatory regimes for this multi-species fishery that would essentially trade hooks out of the water for increased retention when vessels are actively fishing. We report our progress so far on modeling the biological and economic effects of a limited number of temporal, geographic, and retention requirements for commercial and recreational vessels engaged in South Atlantic reef fisheries. We also outline our methodology for conducting a number of small-scale regulatory experiments in 2024 to determine the preferred regulatory environment for anglers.

12
Adaptive Fisheries Management under Climate Change: a closer look at the opportunities and challenges

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Climate change is altering the productivity and the geographic range of global fish stocks, which has led to increased uncertainty and complexity in fisheries management. Scientific work predicting those changes provides opportunities to implement adaptive fisheries management under climate change. In this paper, we examine the optimal harvest pathways (up to year 2100) of 915 fish species stocks solved from dynamic optimization given information on predicted fish habitat/carrying capacity under four climate RCPs. We find economic-optimal harvest strategy (i.e., maximizing the discounted net fishery profit) generates significantly higher economic and biological gains, as opposed to the biological-optimal strategy. However, the economic-optimal strategy incurs greater velocity in fishery catch, suggesting a lower-level of harvest in the near term (2020-2040), and a higher-level in the medium and long term (2060-2080) with greater variations across species over time. While the biological-optimal strategy suggests moderate and steady harvest till a rapid decline later (2060-2080). The two strategies therefore have different implications for the global seafood supply. Based on our results, we discuss the challenges to attain the economic and biological gains under the economic-optimal strategy. First, sound scientific research in predicting climate impact on fish resources is required. Second, accommodating development in complementary seafood production, such as aquaculture, is needed to counterbalance the near-term velocity and long-term variations in capture fisheries supply.

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Economic Gains from Individual Fishing Quotas: The Norwegian Coastal Groundfish Fisheries

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Rights-based management systems are becoming more widely used in fisheries. Many rights-based systems use Individual Fishing Quotas (IFQs) that allocate shares of total allowable catch to individual fishers, vessels, or groups of fishers. Economic benefits of IFQs include removing incentives for competitive fishing, better handling of the fish, and longer harvesting season. If the IFQs are transferable, they may also give incentives to reduce capacity. Here we analyze the performance of a IFQs introduced in the Norwegian coastal groundfish fisheries. We use data of the Norwegian groundfish fisheries in the period when two similar fishing groups were treated with different forms of rights-based management: one that had IFQs largely in name only and another that had binding IFQs. We treat one group as a control group for identifying treatment effects. Our difference-in-difference results show IFQs contributes to higher catch per unit effort and price per unit effort of the main groundfish species. Our results suggest that many of the expected productivity gains from first-best rights-based policies that allow transferability can materialize in second-best policies that limit transferability.

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Processor Market Share in the Pacific Cod Fishery during Rationalization

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We model and test the effect of season lengthening on processing sector market share and rent. Many fisheries experience longer seasons that threaten inefficient (high cost) processing plants when rationalizing quota to individual transferable quota (ITQ) fishing rights. Policies to maintain processor market share, including cooperatives and processor assigned quota, are not fully understood but may be suggested, for instance in the Pacific Cod fishery. We model processor quasi rents as a fishery rationalizes from a total allowable catch (TAC) fishery to an ITQ fishery. We additionally conduct a behavioral experiment to measure processor profits and market share based on harvest and processing incentives. We consider a standard ITQ game, an ITQ game with cooperatives, an ITQ game with processor assigned quota, and an ITQ game with both treatment arms. We find that processing rent increases with the treatments as compared to the ITQ game.

32
Who Gets the Fish? Labor Market Sorting and Efficiency in Regulating the Commons
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Reacting to depleted fisheries, governments design regulations that reduce extraction from the commons through the exit of firms and workers. A motivation to ease disruptions in local communities—i.e. maintaining jobs—might make a government keep less productive firms in the commons while lowering the cost of transitions in local communities. The tension depends on the assortative matching of firms to workers and the existing frictions in the labor market. I investigate this tension in the Icelandic fisheries, where a comprehensive ITQ scheme was put in place and it is possible to link individual fishers both to their vessels' catch and characteristics and to comprehensive tax data that tracks their employment and earnings histories even outside of the fisheries. With this unique data, I can investigate the earnings and employment outcomes of fishers who sort into different firms and/or exit the fishery after the ITQ system is imposed, to understand the nature of the outside options available to fishers across a variety of demographic characteristics. I will outline how to assess productivity at the firm and worker level, relying in part on a Roy model of sorting, to show the degree to which the market-based scheme caused the most productive firms to exit and how that relates to the exit of the most productive workers. The correlation between the comparative advantage of workers and the productivity of firms will inform how counterfactual regulations targeting firms of different productivities would impact labor markets.

Fisheries Management 2

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Measuring Quality of Property Rights: Development of User Rights Quality in the Icelandic Fisheries
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In recent decades there has been a substantial movement towards rights based fisheries management. Property rights in fisheries may alternatively be referred to as user rights in fisheries, as they are the rights of fishers to harvest from fish resources. In terms of attributes of exclusivity, security, duration and transferability these rights can be strong or they can be weak. TURFs and ITQs may be classified as strong user rights, while non-transferable vessel quotas and limited open access based on permits are weak user rights. The different attributes mentioned may be measured on a scale from 0 to 1. An attribute's measure of zero means that the property right holds none of that attribute, and a measure of unity means that the property right or holds that attribute completely. Together these attributes give a Quality measure of a property right. This flexible numerical measure of property rights quality is the so-called *Q*-measure of property rights quality proposed by Arnason (2000) and a high Q-score indicates property rights that correspond to the efficiency of a fishery.

Here we develop the Q-measure and the attributes further and then attempt to measure the quality of property rights in an actual fishery. We apply this to the development user rights in Icelandic fisheries management, as it evolved from open access fishery in the 1970s to a full fledged ITQ system in the 1990s and 2000s. We show that with stronger user rights efficiency increased over time, as seen in the higher value of ITQs.

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Ex-ante Diversification, Limited Entry Permit Portfolio, and Fishers' Participation Decisions
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While diversification is considered key for fishers to cope with external shocks, measuring the impact of diversification is challenging due to its ex-ante nature. We use the limited entry permit portfolio in the previous year to construct an ex-ante measure of diversification. Our measure is strongly correlated with ex-post measures of diversification, but they tend to deviate when external shocks hit the west coast. Focusing on the US west coast during 1995-2016, we find that ex-ante more diversified vessels are more likely to participate in the following year, and they exhibit a smaller coefficient of variation in gross revenue.

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Fishery Management Evaluation of Offshore Danish Seine Fishery in the Pacific Ocean, Hokkaido, Japan, Using Fishery Performance Indicators

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Fishery Performance Indicators (FPI) is a framework for comprehensive fishery management assessment from three aspects: ecology, economics, and community. In accordance with the manual on page 197, scores were evaluated on a scale of 1 to 5 (the higher the score, the higher the evaluation).This paper evaluates the management of the Pacific offshore Danish seine fishery in Hokkaido, Japan. The main target species is pollock, which is the fifth largest fishery in Japan. This paper use the FPI and compares it to assessments of 175 fisheries in Japan and overseas. The ecology score was 4.25, ranking 32nd out of 176 fisheries, and the community score was 4.28, ranking a very high 28th. The economic score was 3.48, ranking 77th, which was not very high. This result may reflect the characteristics of Japanese-style fishery management, which emphasizes community rather than economic aspects of fisheries.

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Gear-specific operating cost models for US West Coast Sablefish

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Sablefish is a commercially important species with catch allocated across multiple sectors and gear types on the U.S. West Coast. Since 2011, the shorebased trawl fishery has been managed by an Individual Fishing Quota (IFQ) program, which importantly includes a "gear-switching" provision to allow trawl fishery participants the flexibility to use fixed gear (long lines or pots) to target sablefish more selectively. Sablefish quota also facilitates landing of other jointly-caught under-utilized groundfish species in the multi-species IFQ program. Without further policy restrictions on gear-switching, tradeable quota has allowed the total allocation of effort between gear types to vary across years based on the relative economic success of various sablefish operations. Fisheries managers therefore seek a better understanding of the relative profitability and cost structures of vessels that target sablefish both inside and outside the IFQ program, which vary greatly based on operation size, gear and other species targeted. This research is a portion of a larger project that aims to incorporate economic performance metrics and behavioral dynamics in a Sablefish management strategy evaluation that examines the gear-switching policy. This presentation will focus on our modeling of fuel and bait costs for trawl, longlines and pot gear operations. We will outline the implications for relative profitability by gear-type and assess the predictive power of these models using out-of-sample prediction. Additionally, we will discuss the challenges of utilizing annual-level cost data in a multi-species fishery, with many vessels participating in multiple fishing sectors.

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Fleet Restructuring, Capacity Reduction, and Fisheries Subsidies Reform of China

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Subsidies are criticized widely in fisheries management for aggravating overcapacity and overfishing, resulting in the recent agreement among members of the WTO to eliminate harmful subsidies. However, there have been no empirical studies of subsidy reforms to inform us about their likely quantitative impacts. China is the largest harvester and subsidizer in global marine fisheries with few empirical research on its management performance for lack of data. In this paper, we investigate the impact of subsidy reductions on fleet capacity for the large-scale limited-entry domestic trawl fishery of China. We compile a unique dataset for a fleet of more than 9000 trawlers from archives of the Vessel Administrative Database. We use this vessel-level administrative dataset to exploit the natural experiment associated with the nationwide 2016 fishery subsidy reform, which cut the fuel subsidies and raised the buyback prices simultaneously for capacity control. Using difference-in-difference and difference-in-discontinuity strategies, we compare the vessel disposal responses of fishers assigned with different levels of post-reform fuel subsidy payments, and quantify the impacts of subsidy reduction on fleet restructuring. In the fleet of our study, a 1% lower fuel subsidy leads to a 0.15 percentage-point increase in the probability of a vessel scrapping, with older and smaller vessels more responsive to the subsidy reduction.The counterfactual policy analysis based on estimation results reveals that the reduction of harmful subsidies was only partly responsible for reducing fleet capacity and the potential effectiveness of subsidy changes on fleet capacity depends on the complexity of supporting management regimes.

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Ghost fishing – how scary is it? A case study of the Norwegian snow crab fishery in the Barents Sea

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Most studies of ghost fishing argue that retrieval programs to extract abandoned, lost or otherwise discarded fishing gear (ALDFG) from the ocean are beneficial when compared to the lost market value of ghost fishing. In this paper we critique the comparisons made in previous studies between the costs and benefits of retrieval programs, applying a case study of the Norwegian snow crab fishery. A simple economic assessment of retrieval of lost snow crab fishing gear is compared to the estimated upper and lower bounds of benefits of reduced ghost fishing resulting from retrieval. The results show greater cost of retrieval compared to gains at the lower bound, but the opposite at the upper bound. However, retrieval costs should be compared to the *net* benefit of reduced ghost fishing, after also costs of fishing are subtracted. In this case the retrieval program seems less efficient, also in relation to the upper bound. Nonetheless, other negative externalities than those resulting from fisheries losses should be included to holistically assess the effects of ALDFG compared to the value of retrieval programs and other costly ALDFG reducing measures. That ghost fishing catches may be large, economically wasteful and socially unacceptable is nonetheless undisputed.

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Landings control in ITQ fisheries; misreporting of catch in the Icelandic fisheries

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For any system of fisheries management an accurate measure of landings is essential. In Iceland fisheries management builds on ITQs and all catch is weighed on officially approved scales at landing and recorded by certified persons. Emphasis in recent times on improving quality of landings, where fishing vessels use ice to chill the catch, complicates the weighing of landings and the gross weights at the official scales must be adjusted. Many fish buyers have permission to reweigh the fish they buy, allowing the separation of ice and fish and report the net weight to officials. This also maintains the incentive for vessels to use ice. About half of all landings go through reweighing. Reweighing opens the opportunity of overreporting ice in the landings. The incentive would be high for integrated firms, who both harvest and process the catch. Although the Directorate of fisheries monitors some reweighing, their ability to detect fraudulent reporting is limited.

We present a case-control analysis of monitored reweighing of landings versus unmonitored reweighing of landings to estimate the extent of misreporting of ice in 2012-2022. Results indicate that there is much fraudulent reporting but limited to a small group of firms. Analysis of the effects of various factors, such as vessel type, location, fishing season, and integration level of firm, are presented and the effectiveness of initiatives to reduce the level of misreporting. The results have policy implications regarding how best to combat this problem while maintaining the incentive for to use ice for catch quality.

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Managing Risk and Asset Value: Summer Flounder Harvest Control Rules

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We use management strategy evaluation to analyze the welfare effects of different harvest control rules on the U.S. mid-Atlantic summer flounder fishery. We evaluate eight different harvest control rules that vary based on how the probability of overfishing is implemented: constant or varied (ramped or stepped) depending on the ratio of current biomass to biomass at maximum sustainable yield. Ramped or stepped control rules were also varied as to inflection and limit points. We compare simulations for a thirty year time period using the discounted sum of commercial fishery profits, consumer surplus and recreational compensating variation, essentially the asset value of the fishery. If we assume stock productivity remains at recent levels, the asset value of the stock can vary by 3%, depending on the harvest control rule chosen. If, due to environmental factors the stock becomes more productive in the future, the asset value will vary be 4.6%, and by 6% if the stock becomes less productive. The current ramped harvest control rule performed poorly, whereas, a stepped harvest control rule that allowed for a greater probability of overfishing when biomass was above the maximum sustainable yield level, performed the best under most scenarios.

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Evidence on harvester ability to fish selectively

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Economists who study fisheries generally agree that harvesters often have considerable ability to fish selectively when appropriate incentives are created. While economists may agree on that point, fisheries regulations on bycatches are very often built upon the assumption that harvesters have limited control over bycatch. (The term bycatch is used broadly here, to include both catches of commercially valuable species and non-commercial catches of protected species.) Harvester testimony at hearings about bycatch typically tells regulators that bycatches are unavoidable. Regulations to address bycatch often focus upon technological solutions (such as excluder gear or season/area closures), rather than economic incentives like well-enforced ITQs. This paper examines the available empirical evidence about the ability of harvesters to fish selectively. There are a few compelling case studies of how harvesters dramatically altered bycatches when appropriate incentives were created. Especially notable are some cases where trawlers in multispecies groundfish fisheries have achieved very restrictive targets for overfished stocks by managing where, when, and how they fish. However, evidence also suggests that harvesters may struggle to manage very low probability events, such as catches of endangered marine mammals. Expanding the evidence on fishing selectivity could improve regulatory appreciation of the potential role of incentives in bycatch management.

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On the Economic Distortion of Rent Taxation in Natural Resource Based Industries
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ON THE ECONOMIC DISTORTION OF RENT TAXATION IN NATURAL RESOURCE BASED INDUSTRIES

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It is often taken for granted that taxing economic rents in a fishery or other natural resource-based industries is economically non-distortive. Apparently on this basis of this belief, special taxation of economic rents in fisheries and mariculture has been advocated.

In this paper, the veracity of the contention that rent taxation in natural resource-based industries is non-distortive is examined. It is shown that the proposition is not true in general. Several sources of economic distortion stemming from resource rent taxation are identified and the process of distortion described. Finally specific cases where economic distortion may not occur are examined leading to a statement of a non-distortionary theorem which specifies conditions under which resource rent taxation will not be economically distortionary.

Keywords: Economic rents, economic rents in fisheries, taxation of economic rents, economic distortion of rent taxation.

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Evaluating the Design and Performance of the United States' Fisheries Disaster Aid Policy

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Projected increases in stock variability and shifting stocks due to climate change undermine fishery management goals associated with maintaining fisher livelihoods and sustained fishing community well-being. Given that fishers are unable to insure against a bad year, government-supported disaster aid policies that provide cash payouts to fishers in instances where stocks collapse are a potential mechanism to meet these goals. To explore the performance of the United States' disaster aid policy, we link publicly available data on fishery disaster requests, Stock SMART time series data on estimated stock size and total allowable catch, and Fisheries of the United States landed revenue and quantity data to estimate ex-vessel price and fishery revenue. This yields a panel dataset of stock revenue from 1992 to 2020. During the period we observe 96 commercial fishery disaster requests, with 69 approved. Analyzing performance of the policy relative to stated goals, we identify fisheries that would have been eligible under the policy and for which no request was submitted as well as fisheries for which a request was submitted that do not meet the criteria for a disaster. We also use data on price, quantity, and stock variability to investigate the policy design, identifying some of the deficiencies of a threshold-based policy with revenue as the outcome variable. Specifically, we identify instances where price drives changes in revenue, and not ecological variability. We also identify cases where disasters were declared, but where stock decreases would have been reasonably anticipated based on past stock variability.

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Redirection of Effort from the Northeast Multispecies (Groundfish) Fishery

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The Northeast multispecies (groundfish) fishery is a commercially important fishery in the Northwest Atlantic, with catch occurring primarily in the Gulf of Maine and Georges Bank. Since 2010, the fishery has been managed through a cooperative catch share program known as sectors. When sectors were implemented, some consolidation of quota and reduction in the number of vessels harvesting groundfish was expected. Reductions in effort have continued (Murphy *et al*. 2018; New England Fishery Management Council 2021) due in part to low biomass estimates and quotas for a number of groundfish stocks.

In general, effort reductions have been viewed in the context of the groundfish fishery alone. By considering other fisheries in which these vessels may continue to engage in, a more complete view of metrics such as regional employment in commercial fishing can be illustrated. Previous studies have shown potential benefits associated with commercial fishers diversifying their catch (Anderson *et al*. 2017; Cline *et al*. 2017).

This presentation highlights the primary fisheries in which effort has shifted into since the implementation of groundfish sectors. Vessel-level effort shifts are presented in the context of historical dependence on groundfish as a source of revenue, as defined by the Herfindahl index. Lastly, the applicability of results to other catch share fisheries, recognizing the unique management system of groundfish sectors, is discussed.

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Tax as a tool for fleet structuring

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In this article we focus on an alternative approach, namely to use the
tax system as an instrument to limit effort by reducing the profitability
for the agents. Rent capture is then only a useful side effect of the
imposed tax and therefore represents a sort of double dividend.
We present a generic model that can be fitted to almost any fishery. Then
we apply this model on a fisheries management stylized on the Norwegian
fisheries, where there exist a lot of data that can be used. We look at
a simple tax on the first-hand value of fish landed as this is a tax that is
easy to administer and handle. The more flexible such a tax is, the more it
can be applied alone as the only instrument (in addition to a TAC). If, however,
high flexibility of the tax is difficult to implement for political or other reasons,
additional instruments may be required. An alternative to licensing schemes and/or
individual quotas can be to use financial instruments such as the tax system. However,
in most of the literature on fisheries economics, use of the tax system has mainly
focused on the purpose of collecting tax revenue. The model is practical
and easily applicable for managers who want specific advice for their actions.

Testing the spatial dynamic model of commercial fishing trip decision-making

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Spatial restrictions are increasingly considered policy instruments for allocating access to maritime areas with the development of marine spatial planning. Generally, spatial restrictions apply uniformly to all fishing vessels, with heterogeneous response mechanisms determining the potential redistribution of fishing effort and associated welfare impact. Most of the literature to date has investigated the impacts of closure on specific fleets and has not considered the full suite of potential impacts.

We construct a model to understand the heterogeneous impact when vessels are different in technology constraints (fuel and hold capacity) and the degree of forward-looking (myopic, partially myopic, or dynamic). The model also looks at all the trip-level decisions vessels make simultaneously including fishing location, fishing effort, and trip length.

Simulation results show that technology constraints endogenously determine the trip length and impose a shadow price on trip-level decisions for all vessels. The dynamic fisher allocates fishing effort so that the marginal profit equals the shadow price of the binding technology constraint across fishing sites. This fishing behavior, however, doesn't hold for the myopic and the partially myopic fisher.

The model leads to two hypotheses that could be tested using simulated data and the datasets such as the microlevel data in the Gulf of Mexico reef fish fishery utilized by O'Farrell et al.(2019). We will first test the existence of a nonzero shadow price of the binding technology constraint. The second test aims to differentiate the fishing behaviors of dynamic fishers from those of myopic fishers or partially myopic fishers.

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The estimation of fishery resource abundance and distribution by integrating satellite-based estimates of fishing vessel behaviour and market transaction data.

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Despite their importance, conventional fisheries stock assessments are time-consuming, costly, and challenging to conduct across large areas of the ocean and across a wide variety of fish species. Nevertheless, if data could be easily obtained on fishing effort and resulting catches of a large number of fishing vessels over a large area of ocean, Catch Per Unit Effort (CPUE) can be calculated by integrating these data as a measure of the abundance of fisheries resources, which would greatly improve management of current fisheries resources. With the list of detailed information of individual Japanese fishing vessels as a key to link data to calculate CPUE, this study develops an algorithm to integrate two sets of fisheries data, namely the estimated fishing behaviour of individual fishing vessels and the commercial transaction data of catches by individual fishing vessels. Fishing behaviour data are estimated by machine learning of the satellite vessel monitoring developed by Global Fishing Watch. The commercial transaction data accumulated under the unique Japanese institution of fish wholesale market operated by fishery cooperatives are utilized. Spatial selection bias is required to be adjusted for through the active selection of fishing grounds by commercial fisheries. Once, however, the algorithm has been established, the integration of the two sets of data will allow the estimation of the distribution of fishery resources over broad ocean areas in real-time, as long as commercial fishing activities occur. This study will discuss the challenges in the development of this algorithm and the results of a trial CPUE

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The Evaluation of the Economic Impact on Maine Lobster Fishery from Lobster Management Area 1 (LMA 1) Restricted Area

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In September 2021, NOAA Fisheries published the final rule to modify the Atlantic Large Whale Take Reduction Plan, which includes an annual restricted area in Maine LMA 1 waters from Oct 1 to Jan 31. This area covers 967 square miles of waters in Maine lobster Zone C, D and E outside the 12 nm line. All lobster trap/pot vessels are restricted from fishing with persistent buoy lines in this area. Using the 2015-2017 Maine state fishing harvester reports and dealer reports, we estimate that on average this restricted area would directly affect 60 vessels with a total catch of 3.1 million pounds of lobsters during the closing months. All the impacted vessels were assumed to move into either adjacent zones or inshore waters because they do not have access to the LMA 3 waters further offshore. The economic impact of fuel savings and catch losses was estimated to be about $0.6 to $1.3 million. Next, we would like to incorporate fishing data from 2021 and 2022,after the rule was implemented, to evaluate the movement of fishing effort during closure months and throughout the year to understand the actual economic impacts of this rule to the Maine lobster fishery.

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Using Portfolio Theory to Improve the Management of Living Marine Resources

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Management of most fisheries is currently based on single species and does not account for multispecies interactions. Failure to account for these interactions can lead to suboptimal yields and overfishing. Ecosystem-based fisheries management (EBFM) uses a holistic approach to resource distribution and considers species in aggregate. Portfolio theory is a commonly applied financial tool that considers covariance between assets that comprise an investment portfolio to reduce the risk of achieving target levels of economic returns. This method can be adapted to EBFM for balancing risk with expected benefits for a portfolio of species. Portfolio management considers species interdependencies (covariances), uncertainty and sustainability constraints. We apply portfolio theory to publicly available commercial fisheries landings and revenue data for two US fisheries management regions. We describe some data challenges and decisions for consideration when conducting portfolio analysis to derive annual efficient frontiers (tradeoffs between revenue risk and return) for three portfolio configurations in each region: the top 30 species and 90th percentile by landings weight, the New England multispecies groundfish fishery and the South Atlantic snapper-grouper complex. For each configuration we calculate the risk gap between historic portfolios and the EBFM frontier to assess past fishery performance. Preliminary results show that the portfolio approach typically outperformed single-species management and there was forgone economic yield for the associated risk taken in the single species approach. Results will be of interest to fisheries management councils currently exploring the use of EBFM tools.

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Increased Electronic Monitoring and Deemed Values

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Like some other jurisdictions, New Zealand has committed to full camera coverage of its inshore finfish fleet. New Zealand, somewhat uniquely, uses deemed values to allow after-landing balancing while providing appropriate incentives to acquire annual catch entitlements. The question arises about whether the administration of deemed values should change in some way as cameras are introduced. This paper addresses that question by applying the idea that deemed values define for harvesters a marginal cost of overfishing function. Cameras create strong incentives to reduce discards. Reductions in discards have the effect of reducing fishing mortality for any given total allowable commercial catch (TACC), so the marginal social cost of exceeding the TACC will likely be reduced. This creates an argument that deemed values could be reduced to reflect this lower social impact of overfishing, if TACCs are unchanged when cameras are introduced. In the long run, TACCs should be increased to reflect both the reduced short-run impact of fishing and any stock rebuilding that may result from lower discards. But in the short run, while information to support higher TACCs is being generated, deemed values arguably could be used as a transitional tool. This analysis reflects a more general principle that deemed value setting and TACC setting should be an integrated.

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The Effect of Live-coral Loss on Great Barrier Reef Fish Stocks

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At the species level, much uncertainty exists about the long-term effect of coral degradation on reef fishery yields. Previous studies have addressed this issue on the biological side examining fish assemblage but have yet accounted for human harvest in the stock dynamics. We developed a bio-econometric model that integrates the fish biology, human, and coral habitat effects. By analyzing the coral coverage and fisheries harvest data of the Great Barrier Reef, we tested coral association at the species level and quantified the potential fish yields reduction under live coral losses. The results suggest that some stocks are negatively affected by live-coral loss. The impact of continuing loss on the maximum sustainable yield of these stocks is explored.

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Local area employment multipliers from commercial fishing: estimates from US West Coast ports

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This study estimates the change in employment that results from changes in commercial fishery revenue in fishing ports on the west coast of the United States. We use econometric methods to estimate county- and region-specific multipliers representing direct effects on employment in the fishing sector, indirect effects on sectors within the marine economy (e.g., seafood product preparation and packaging, fish and seafood markets, and fish and seafood merchant wholesalers) and indirect or induced effects on sectors within the wider economy. Our models estimate changes in annual sector-level employment as a function of changes in port-specific changes in commercial fishery ex vessel revenue and are based on local economic multiplier models in Moretti (2010), Van Dijk (2018), and Watson et al. (2021). We estimate ordinary least squares, instrumental variables, and panel data models and use variation in employment and fishery revenue within and between counties and regions to identify local area employment multipliers. We use county level employment data from the WholeData series from the W.E. Upjohn Institute for Employment Research and commercial fishery landings data from the Pacific States Marine Fisheries Commission from 1998 to 2016. Preliminary results indicate that:

1) Commercial fishing makes measurable, significant contributions to local economies;

2) Impacts may be smaller than previous estimates in fisheries (e.g., Watson 2021) and other natural resource industries (e.g., natural gas extraction, Weber 2021);

3) Employment multipliers vary in magnitude across regions and may be related to community fishing dependence and local economic and social structure (e.g., rural versus urban).

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Social vulnerability indicators: An application for English and Welsh coastal communities

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Social vulnerability and fishing engagement and reliance of coastal communities was assessed by modifying an approach that has been used to generate similar indicators for Northeast and Southeast USA. Spatial factor analysis was used to generate three social vulnerability indexes based on 13 variables for 158 local authority districts in England and Wales that were on the coast or bordered coastal districts. Similarly, factor analysis was employed to generate three indices to measure fishing engagement and reliance based on 9 variables for 121 local authority districts at the coast of England and Wales.

The three indexes indicating social vulnerability explained together about 70% of the variation in the social data. Factor 1 (Housing affordability index) mainly captured characteristics of the housing market, while Factor 2 (Social dependency index) indicated vulnerability of the population to social disruption and Factor 3 (Employment opportunity index) captured facets of the labour market. The three indexes measuring the fishing reliance and engagement of the local community explained about 73% of the variation in the data. Factor 4 (Fishing engagement index) captured mainly commercial and recreational fishing infrastructure, Factor 5 (Commercial fishing value index) captured the value generated by the commercial fleet and its supply chain in the area, Factor 6 (Commercial fishing activity Index) captured commercial fishing activity levels of the local area compared to its capacity.

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Socioeconomic comparisons in the West Coast Groundfish Trawl Fishery based on vessel and fisher characteristics.

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Response to technological advances, management actions, or environmental conditions can have substantial impacts on size and structure of fishing fleets and in turn on the individuals and communities participating in the fishery. The impacts of these changes, however, are not likely to be evenly distributed among fishers and vessels. Aggregate summaries of fishing fleets can mask these differences, and the experiences of some vessels and fishers may get left behind as a result. We looked specifically at these issues for the vessels and fishers that participate in bottom trawl fishery methods in the West Coast groundfish trawl fishery (IFQ program). Utilizing fish tickets and economic data to capture vessel revenue and size, fishery participation, and ownership, we group vessels using hierarchical clustering analysis while fishers are clustered using sociocultural data. We use these two clustering methods to identify how vessel and fisher-level characteristics relate to experiences in the IFQ program and the impacts of structural changes on different fisher and vessel groups. Identifying the vessel and/or fisher characteristics that result in the greatest success or the greatest challenge can inform future management action and improve the ability to address equity issues across fisheries on the West Coast.

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Caribbean Queen Conch: Productivity and Technical Efficiency Analysis

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One pressing issue affecting the management of small-scale fisheries relates to the development of harvest control rules that aim to protect and rebuild overexploited stocks but also minimize its short-run impacts on the profitability of fishing operations and the livelihoods of fishing communities. One key piece of information necessary for the development of such policies is a thorough understanding of fleet's productivity and technical efficiency levels and the main sources of technical inefficiency. In this study, we estimate a revenue function using a stochastic production frontier to evaluate the productivity and technical efficiency of the small-scale queen conch fleet in Puerto Rico. Preliminary results suggest that the queen conch fleet has significant levels of inefficiency suggesting that the fleet could increase their gross revenues by using current input levels and technology more efficiently. This study also identifies those factors of production that are most suitable to increase the productivity of the fleet, as well as the key determinants of technical inefficiency. We also explore the policy implications arising from these results.

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Joint Modeling of Fishing and Landing Location Choices

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The two main spatial decisions fishers make on a given trip are where to fish and where to land their catch. Fishing locations provide understanding of the distribution of fishing effort across space, while landing locations connect raw output to the rest of the seafood supply chain. It is easy to imagine reasons why the two choices may be linked: for example, the desire to minimize travel costs, maximize freshness at the point of sale, or take advantage of fisher-buyer relations and familiarity with certain sites and routes. Yet, while fishing locations have been explored extensively and landing locations are beginning to receive attention in the literature, the two decisions have not been jointly modeled. In this paper, we use data from the main whitefish fishery in northern Norway to test multiple models of commercial fishing and landing site choices. We seek to shed light on the drivers of these choices and relationship between them by comparing predictions based on different assumptions and nesting structures. Our findings have important efficiency and distributional implications for coastal communities impacted by demographic shifts toward cities, fishing industry consolidation, and climate-induced shifts in fish stocks.

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Drivers of Health Insurance Status in the West Coast Commercial Fishing Fleet

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In the commercial fishing industry, harvesters face elevated physical and financial occupational risk. Here we examine harvesters' risk mitigation with health insurance, utilizing 2017 and 2020 survey responses from over 1400 U.S. West Coast fishing vessel owners. Harvester health insurance coverage is compared with their county level communities' US Census Bureau Small Area Health Insurance Estimates (SAHIE). We then explore potential drivers of purchasing health insurance using a logistic regression model, categorizing drivers as corresponding to either the costs or the benefits of insurance. Despite elevated occupation risk, we find empirical evidence that health insurance coverage for West Coast commercial harvesters is lower than the general population of their county level communities. We also find that health insurance uptake is primarily driven by variables associated with health insurance costs rather than benefits, providing evidence against adverse selection. These insights provide potential mechanisms for management regimes that could benefit well-being in fishing communities.

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Keeping it in the Family: Gender and Inheritance Norms in a Rural Alaskan Salmon Fishery
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In the Bristol Bay salmon fishery, harvesting technology and the corresponding access rights are gendered. Women are more likely to participate in the less capital-intensive set gillnet sector while drift gillnet permits with higher market value are predominantly fished by men. Both types of transferable permit are a large proportion of household assets in rural fishing-dependent communities, and thus their sale and inheritance may drive intrahousehold bargaining. Households where both spouses received permits in the initial allocation engage in joint decision-making about their sale. Regardless of the gender of the initial permit holder, households engage in rational profit-maximizing behavior and are more likely to sell the permit that has brought in less revenue per family member. Since the drift gillnet fishery is over-capitalized, this has led to a disproportionate sale of male access rights by rural families and an increase in sons taking over their mothers' harvesting operations. Secondly, relative to households where only the father received a permit, descendants of families with a maternal permit are more likely to still be engaged in local harvesting operations. Lastly, exploiting random variation in the gender of children born under different permit allocations, when a child is born that matches the traditional gender norms of the harvesting capital, the parents are less likely to invest in the education of that child and more likely to nudge them towards fishing. Quantifying the distributional consequences of transitioning fisheries to rights-based management hinges on a thorough understanding of gender norms and intrahousehold dynamics.

79
Economic viability of fishery-to-food bank programs
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The COVID pandemic brought devastation, disruption, and also opportunity to the seafood industry. Seemingly overnight, seafood producers saw their markets evaporate, while food banks faced an urgent upsurge in demand. Throughout North America and further afield, innovators seized the moment, addressing these challenges by forging inspired connections. While a few fishery-to-food bank programs had existed for decades, many fresh endeavors emerged amid great enthusiasm, providing local seafood to hungry new fans. These programs, and the circumstances surrounding them, continue to evolve. Some programs are becoming comfortably institutionalized while others require additional support.

In this paper, I assess the economic viability of fishery-to-food bank programs, considering the programs' history, current status, challenges, and future prospects. Through this investigation, I intend to identify endogenous and exogenous factors that have promoted (or indeed, hindered) the programs' success, then share the findings to support related efforts worldwide.

Integrating Social Science in Climate and Ocean System Models

Wednesday, May 24 (1:00 PM to 2:30 PM)

30
How climate change and climate variability affected trip distance of a commercial fishery

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Changes in climate factors affect the distribution of various tuna species differently due to their unique physiological adaptations and preferred habitats. As the resulting spatial distributions of tunas alter in response to climate change and climate variability, the distribution of fishing effort will, in turn, be affected. This study uses a quantitative model to estimate the impacts of SST and ENSO events on trip distance of the Hawaii deep-set longline fleet between 1991 and 2020. The results show that the higher the SST of the fishing grounds of the Hawaii longline fleet, the longer trip distance; and the fishing location shifted toward higher latitude and eastward from the Honolulu fishing port. This is consistent with the poleward shift in tuna habitat that occurred in the North Pacific Ocean during the period of warming ocean and the increasing trend of longline catches of tropical tuna in the subtropical areas of the western Pacific Ocean in the past four decades. Alternatively, ENSO events could result in shorter trip distance, possibly due to changes in catch rates of different tuna species through spatial redistribution during El Niño and La Niña events. This result suggests that the Hawaii longline fleet took advantage of the changes in spatial distribution of different tuna species during ENSO events, and utilized its locational advantage to travel in different directions in the Pacific Ocean to achieve higher CPUE that occurred closer to the Honolulu port, thereby shortening their travel distance.

21
How will different harvester business models in Maine's American lobster fishery perform under climate change?

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Climate change is expected to negatively impact American lobster fishery in the US waters through changes in lobster habitat and productivity. Our literature survey found a surge of studies in the past 5 years that show future projections of American lobster biomass and habitat suitability changes with different spatial and temporal scales. This study assesses 19 natural science studies for their usefulness in economic studies by evaluating their assumptions on landings and fishing mortality embedded in their projections. By synthesizing findings from these studies, interviewing active harvesters, and building on our previous work that identified five distinct business models in Maine's American lobster fishery and benchmarked their performance in the pre-warming period, we examine how each of the five fishing models will perform under climate change. While economists are usually interested in evaluating the outcomes of harvesting behavior changes on biomass stock, the biomass and habitat projections modeled landings as proxies for stock recruitment or simply as year fixed effects. These assumptions need to be reconciled when using these projections in economic studies. There are also tradeoffs between spatial granularity and time-series length present in existing projections. Preliminary findings suggest certain business models (e.g., less frequent trips with more intensive trap hauls per trip) perform better under climate change. We aim to contribute to harvesters making better investment decisions by suggesting how one might modify their fishing practices to adapt to warming-induced habitat and biomass changes.

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Integrating economics into fisheries science and advice: progress, needs and future opportunities

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While the science supporting fisheries management has generally been dominated by the natural sciences, there has been a growing recognition that managing fisheries essentially means managing economic systems. Indeed, over the past seven decades, economic ideas and insights have increasingly come to play a role in fisheries management and policy. As an illustration of this, the International Council for the Exploration of the Sea (ICES) has been actively seeking to expand the scope of its scientific expertise beyond natural sciences. In particular, the recently created ICES Working Group on Economics set out to review current work and key future needs relating to economic research and management advice on marine capture fisheries. We will present the results of this review, and how economic research can be incorporated into the science of ICES, to provide integrated perspectives on fisheries systems that can contribute to the provision of advice in support of policy development and management decision-making for sustainable uses of living marine resources.

22
Ocean Literacy and Willingness to Pay for Ocean Twilight Zone Conservation

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The ocean twilight zone, or OTZ, is the part of the open ocean ~200-1000m (~650-3300ft) deep. The OTZ is home to a variety of aquatic species, many of which make daily migrations to the surface of the ocean to feed at night. OTZ species make up a key component of the diet of several commercially important predator species, such as tuna, and provide important services to the broader ecosystem. Species that live in the OTZ play a fundamental role in global climate by transporting significant amounts of carbon from the upper ocean into the deep sea. In addition, species populations in the OTZ are estimated to be larger than total catches of all other fisheries in the world today. There is a growing interest in harvesting fish from the OTZ, but little is known about public perceptions of OTZ conservation. Further, while "ocean citizens" are expected to make informed choices to minimize negative impacts on ocean health, there is inconsistent evidence on the effectiveness of information campaigns to close the so-called "attitude-behavior gap" between improved ocean literacy and sustainable behavior. In this study, we distribute a contingent valuation survey among U.S. residents to capture willingness to pay for OTZ biodiversity conservation and explore heterogeneity in support for OTZ resource exploitation as a function of individual-level ocean literacy. Better understanding of the link between public knowledge and perception of OTZ conservation is essential for formulating effective OTZ fishery management strategies with broad stakeholder support.

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Understanding the relationship between scallop stock condition and fishing location choice

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The Atlantic sea scallop fishery on the Northeast U.S. Shelf generated over $669 million ex-vessel revenues in 2021, making it one of the most valuable fisheries in the United States. Recent studies indicate that climate change will continue to exert significant impacts on the scallop stock. The maximum shell height will gradually decrease under rapid warming in the next several decades and ocean acidification will cause dramatic shrinkage of sea scallop habitats in the Mid-Atlantic Bight This will lead to considerable changes in fishing operation and the wellbeing of the fishing communities along the coast. In this study, we deepen our understanding of the relationship between scallop stock condition and fishing location choice using a unique data set of high spatial resolution, which integrates VTR, VMS, and scallop survey records from 2000 to 2015. We focus our analysis on vessels from three major scallop ports (New Bedford, MA; Cape May, NJ; and Hampton & Newport News, VA). As expected, the results show a strong connection between large scallops and vessel fishing location. The results will be useful for estimating climate change impacts and formulating future fishery manage strategies in response to changes in scallop stock size and spatial distribution.

Markets & Trade 1

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How would different kinds of seafood traceability information affect people's MWTP?

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Establishing seafood traceability is an important goal spanning many domains, including food safety, resource conservation, and human rights. However, the traceability system has not been enough developed in global seafood markets, including Japan. In order to identify an effective approach to promote seafood sustainability, we conducted an onsite choice experiment on October 26-27th at an event space in Shibuya, Tokyo.

We randomly divided the participants into four groups and provided different types of information packages: A) "safety guarantee," B) "safety guarantee + resource conservation", C) "safety guarantee + human rights" and D) "safety guarantee + disguised places of origin". The total number of participants is 248 people.

We found that the marginal willingness to pay (MWTP) for the traceability label is the largest for the group that was told that traceability can help eliminate human rights violations in the seafood industry. Additionally, people with high altruism in all groups have higher MWTP than people with low altruism.

In contrast, people who are less altruistic showed a larger MWTP when they are told that traceability can help eliminate seafood with disguised places of origin. People with low altruism tend to reduce the risk for themselves by knowing the seafood's origin through traceability when decision-making.

In conclusion, there is a possibility that seafood traceability has the effect of adding value to seafood products. To enhance people's MWTP for traceability, adding information on the "human rights" and "disguised places of origin" risk reduction could contribute to improving the seafood traceability system effectively.

37
Influence of Peruvian anchoveta size composition on fish oil prices

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The anchoveta fishery of Peru is one of the largest fisheries worldwide in terms of biomass output and can be considered as one of the most complex adaptive management systems. Globally, Peru is the most important producer of fishmeal and fish oil. In contrast to fish meal, fish oil production depends not only on the quantity of caught and processed fish, but also on the composition of the catch. In general, adult fish (fish > 12 cm) leads to a higher fish oil production than juveniles (fish < 12 cm). Thus, in addition to the frequently fluctuations in the Peruvian anchoveta production, due to the oceanography aspects in the region where they are caught (e. g. El Niño periods), fish oil prices may also be influenced by the catch size composition. Using regression analysis, our study is the first which explicitly takes the effects of size composition on fish oil and fishmeal prices into account. Indeed, our results indicate that a high share of adults in landings is negatively correlated with fish oil prices. Moreover, the effect of an increasing adult share is higher at a relatively lower landing level than at high landings level.

35
A Hedonic Regression to Estimate the Value of Commercial Catch Method: A Case Study using the Japanese Commercial Swordfish Fishery

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As fisheries managers increasingly concern themselves with designing policy that harvests fish in socially efficient and sustainable ways, quantitative information on the ex-vessel price effects of catch method become increasingly valuable. We utilize a dataset of swordfish (Xiphias gladius) sold at auction in Japan to estimate a hedonic model. The model measures the effect of the method of catch on price separately from the influence of other variables that may cause the price to vary. As such, the results of this research may reveal possible adjustments to current catch methods that improve the overall quality and value generated from managed fisheries. Additionally, this research may reveal currently unexploited opportunities for stakeholders to arbitrage the price-quality relationship by increasing the utilization of gears that deliver higher quality fish to market. This may help promote sustainability by creating an incentive to maximize quality in order to capture the auction quality premium.

15
Certify or not? The effect of the MSC label on the ex-vessel prices for Atlantic cod in Norway

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It is known that ecolabeled seafood commands a price premium in the retail market in European countries. However, there is significant uncertainty with respect to whether these premiums are transmitted upstream to the fishers. This is important because producer benefits are required to provide incentives for sustainable fishery management and fishing practices. This study investigates whether fishers obtain price premiums for certified cod in Norway, in the largest single cod fishery in the world. An ideal setting for the study was created when the fishery within the Norwegian territorial waters recently lost its certification by the Marine Stewardship Council (MSC). Using a difference-in-difference model analyzing a large and detailed dataset we find that on average there is no premium for MSC, and that other factors are more important. However, when controlling for byer types we find a small price premium for cod sold to producers who make fillets for northern European markets, but no premium for other buyer types.

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New Englander Willingness to Adopt to Shifting Fish Availability Due to Climate Change

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Rising ocean temperatures driven from climate change are impacting the variability of fish stocks. Fish scientists predict that the species caught and landed will change over time, with familiar species being replaced by unfamiliar species. It is unclear whether seafood consumers will accept these unfamiliar species when they enter the market, which will directly impact the resiliency of fishing communities. To investigate how the market might respond to this change, we focused on 14 unfamiliar seafood species that are predicted to become more abundantly available in southern New England due to rising ocean temperatures. An online survey was conducted to determine consumers baseline seafood consumption habits and to gauge consumers awareness, attitudes, and preferences for unfamiliar seafood species. A choice experiment was utilized to estimate consumers' value for four of the 14 unfamiliar species which included Atlantic cod as a benchmark. Preliminary results (N = 846) reveal consumers' awareness of these species are mixed; species like triggerfish and redrum are less known compared to blue crab and fluke. Random parameters mix logit regression results from the choice experiment revealed that, compared to Atlantic cod, consumers are willing to pay less for all four unfamiliar fish species we analyzed. Consumers placed a higher value on local fish compared to non-local fish, and are willing to pay more when purchasing the seafood at local grocery stores and farmers markets compared to large chain grocery stores. Our results suggest there will be a challenge marketing these species when they arrive in the region.

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The Cost of Price Models: An Examination of the Accuracy and Transferability of Ex-vessel Seafood Price Models in the Northeast United States

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Forecasting ex-vessel prices of fish and shellfish in the Northeast United States is necessary for properly interpreting the impacts of fisheries management alternatives. Analysts, however, are at a disadvantage given the strict deadlines set for enacting new policies. This has often led to the use of price models which have not been peer reviewed and without fully understanding the economic implications of those modeling decisions. This project compares various ex-vessel price modeling techniques across a suite of species in the Northeast U.S. to better understand the trade-offs between model choice and their external validity. We present preliminary results from fixed-effects specifications, and challenges posed by model selection when forecasting prices, along with resulting monetary differences which can impact policy decisions, in an effort to improve the price models used to inform management decisions.

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The determinants of U.S. retail seafood inflation

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The U.S. retail market has undergone substantial changes over the past three years. Retail seafood sales have reached record levels, the COVID-19 pandemic shifted demand and seafood spending pattern, supply chains were disrupted, and price inflation across nearly all goods. This research investigates U.S. retail seafood prices from IRI and import and export seafood trade prices between 2016 and 2022 with a focus on the 2020 to 2022 time period. Vector autoregressive models and asymmetric price transmission models are used characterize the dynamic relationship between these series across broad species and product form categories and to infer whether changes in retail prices stemming from demand are being transmitted up the supply chain to trade prices, or the converse suggesting that increased production and delivery costs are flowing down the supply chain increasing prices in retail markets.

55
Fresh Catch Auctions as a Model of First Receivership for US Commercial Fisheries

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Auctions have long brought together fishermen with fish buyers to support sales of fresh catch at a mutually agreed price. While fresh catch auctions are common in developed economy fisheries around the world, they are relatively limited in the US. The reasons for the disparity between the prevalence of auctions internationally versus their rarity in the US are not immediately obvious.

Among the potential advantages of fresh catch auctions are promoting market efficiency and incentivizing quality. Assuming no reserve price, each fish sold at auction goes to the highest bidder, clearing the market, avoiding waste, and minimizing storage requirements. The quality sorting mechanism of an auction may lead to a higher price per pound than if fish are sold in bulk quantities without quality grading. A win-win may result for fishermen, who capture the price premium for quality improvements, and consumers, who gain access to a higher-quality product.

This research compares the economics of auction markets to other models of landing catch to a processor / first-receiver, with a focus on differences between US domestic fisheries and other developed world fisheries. The project has several goals:

1. Examine and compare the features of existing auctions around the developed world.
2. Explore reasons for the limited use of auctions as a model of first receivership in the US.
3. Identify possible advantages of auctions versus other first receivership models.
4. Explore the feasibility of increased use of auctions in US commercial fisheries operations.

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Friday, May 26 (10:30 AM to 12:00 PM)

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Fishing Portfolio Response to a Climate Shock

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Fishing portfolio diversification has been identified as a mechanism to mitigate risk exposure for harvesters operating in wild-capture fisheries. However, there is a fundamental difference between diversification in fisheries and diversification in financial markets that may limit the risk-mitigating benefits of fishing portfolios. Specifically, there is no possibility of a passive (i.e., buy-and-hold) investment strategy for fisheries harvesters, which several strands of the financial economics literature has shown to be advantageous to investors in financial markets. Here we use a case study of an observed and high-profile climate shock in the California Dungeness crab fishery to estimate the impact of active diversification through portfolio shifts and the extreme decision to exit the fishery for the season, in response to the shock. We find robust evidence of negative revenue impacts from active diversification.

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The Seafood Trade and Nutritional Access

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Seafood is a major contributor to global food security, provides critical macronutrients and micronutrients for human nutrition , and is heavily traded internationally with a large net flow of value from developed to developing countries. This value imbalance raises questions about whether low-value seafood is less nutritionally dense and whether low-income countries exacerbate nutritional deficits by trading away healthy seafood. Here we analyze prices and nutritional content of internationally traded seafood and assess whether international trade is likely to enhance or erode nutritional security for low-income countries. We link global trade data containing seafood product information with two data sets containing detailed nutritional information by fish species. We analyze seafood prices and nutrients from six countries that are major contributors to the global seafood trade (three developing and three developed), containing transactions with 200 nations and 7,000 unique fish products/importer/exporter combinations. We find that that the global seafood trade may actually increase nutritional access for developing nations. As expected, our analysis shows that important macronutrients and micronutrients in seafood are positively valued in the market, holding everything else constant. However, developing countries receive an overall discount on nutrition. Lower income nations pay lower prices for the same amount of nutrient content. The discrepancy in high-value imports into wealthy nations and low-value imports into low-income nations does not reflect lower quality in the form of lower nutritional content; instead, the value difference stems from non-nutritional attributes such as product form and trophic level.

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The Economic Value of Norwegian Seafood Trade

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Seafood is one of Norway's biggest export sectors and Norway is a major player in international seafood trade. We use customs data on the 15 largest Norwegian seafood products to estimate the surplus value generated by Norwegian seafood trade from 2004 to 2018. We analyze developments in market surplus over time, and decompose surplus growth into volume and unit profit growth. Results show substantial growth in aquaculture surplus, but only moderate growth in wild fish surplus. The majority of aquaculture surplus growth has come from growing producer and consumer unit profits, not production growth. On the other hand, the majority of wild fish surplus variation is due to volume changes. All products show a balanced division of surplus between producers and consumers of seafood, suggesting mutual benefits from trade.

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The Seafood Trade Reporting Gap

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Misreporting of seafood trade poses a challenge for the sustainable governance of the globalized seafood market, as systematic misreporting may be indicative of deeper policy problems such as tariff evasion, mislabeling, or smuggling – especially of illegal, unregulated, or unreported (IUU) catch. While the magnitude of misreporting may be difficult to quantify, we examine what can be learned from the fact that official trade statistics report trade flows between any pair of countries twice: once from the perspective of the importer and once from the perspective of the exporter. In principle country A's reported exports to country B should be close to country B's reported imports from country A, with the difference primarily reflecting transportation costs. However, we find (consistent with other areas of the trade literature) that the reporting gap for seafood is often systematic and much larger than can be explained by trade costs alone.

In this research we utilize an extensive panel of UN Comtrade data to examine the geographical and temporal dimensions of the seafood trade reporting gap across countries, products, and time. We identify importer/exporter pairs and commodity types with large reporting gaps and also identify trends in the trade gap over time. Finally, we examine individual case studies (e.g., the smuggling of Ecuadorian shrimp into China via Vietnam) where independent corroboration of illicit behavior combined with variation in its drivers (e.g., changes in tariff rates) allow us to scrutinize the utility of the trade reporting gap as a signal of the presence of illicit.

Performance Measures & Efficiency

Friday, May 26 (10:30 AM to 12:00 PM)

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Estimating Economic Profits and Resource Rent in Federal Commercial Fisheries in the U.S. Southeast: Preliminary Results

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Over the last two decades, economists with NOAA Fisheries Southeast Fisheries Science Center have developed and implemented a system of economic surveys to collect cost and earnings data for the major federal fisheries in the U.S. Southeast, including shrimp, snapper-grouper, reef fish, mackerels, and some smaller fisheries. These data allow for the explicit calculation of financial and economic measures at the (sampled) vessel level; and the estimation of these measures for the overall fisheries. This proposed research uses cleaned trip- and vessel-level revenue and cost data, standardized across fisheries, to estimate productivity, profitability, and "resource rent" generated by each fishery and overall. The research will compare the economics of these fisheries to each other, as well as look at the evolution of these measures over time. Using a regression approach, we will try to discern the factors that impact the productivity and profitability across fisheries and time. Factors of interest include among others the fish price, fuel price, hurricane activity, management regime, and interactions among them.

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Impacts of sampling design in cost and earnings data collections

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Economic data serve a vital role in modern science-based management of fisheries. These data, including costs and revenues related to commercial fishing most commonly are collected through participant surveys. The sampling design of these surveys can affect the ability to analyze or report data at the scale appropriate to answering a specific management or research question. Sampling design can take many forms, including non-random sampling, stratified sampling and conducting a full census. Researchers must make tradeoffs between decreasing bias and variance with the increased costs of administering additional surveys. In this study, we explored the effects of sampling design on bias and variance of key economic indicators including profit and wages and the ability to report for key subpopulations. The data for this study consisted of a census of all U.S. west coast groundfish trawl catch share catcher vessel participants (2009-2020), providing a unique opportunity to simulate hypothetical sampling plans and directly calculate measures of bias, variance, and the ability to report data at the scale appropriate for making fisheries management decisions. We find significant biases in estimates of average economic indicators under some stratified sampling designs, but not all; and that a 50% sampling rate results in a 25% reduction in the number of subpopulations that can be reported.

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Commercial Cost Data Collection in the Northeast Region of the United States: Updates on an Ongoing Effort

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Collecting business cost data from commercial fishing vessel owners is a significant challenge. In the Northeast region of the United States, costs are collected through a voluntary survey sent out every few years. Response rates have fluctuated, with a notably low response rate the last time the survey was implemented in 2016 (Ardini et al. 2022). Currently, a survey is in the field to collect costs incurred by owners of commercial fishing vessels during 2022. In order to increase the response rate from the previous survey implementation, a number of changes were made to shorten and streamline the survey instrument. A personal interview option to respond to the survey has been added; gear-based surveys (trawl, scallop dredge, pot/trap, etc.) have been developed; and a cost data visualization tool that allows interested parties to query costs by gear type was recently released. The goal of these changes is to increase both the quantity and quality of commercial fishing cost data in the Northeast region of the United States. This presentation will provide an update of results so far including a breakdown of the response rate by survey mode.. As the number of survey participants who will opt for the personal interview option is uncertain,this presentation will offer the first findings of the propensity of individuals to respond via that mode, compared to the traditional hard copy and online surveys. Lastly, a preliminary comparison of costs categories collected for 2022 vs. earlier survey years will also be summarized.

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The effect of quota portfolio scenarios on optimal harvest strategy and profitability of multi-species trawl fishery

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Variations in the components of the quota portfolio can create additional economic dis/incentives that would alter intra-annual optimal harvest strategy and profitability. This study develops a vessel-based spatio-temporal bioeconomic framework to examine how different scenarios regarding restrictive quotas for codfish influence the effort allocation decisions and accrued profit for small and large bottom-trawl vessels in the Norwegian fisheries. Our analysis confirms that the alternations in components of the quota portfolio influence the adopted harvest strategies of the small and large trawl vessels in distinct ways probably due to the differences in vessel- specific characteristics. Surprisingly, despite the differences in the adopted harvest strategies of the small and large vessels in each scenario, the generated profits are almost the same for these two vessel groups. The study also finds out that the economies of scale in the trawl industry is being eroded as the shares of higher-priced species in the quota portfolio decreases. The benefits of economies of scale cannot be reaped as trawlers respond to the reduction in profit by redirecting effort from the offshore areas of the Arctic to the nearshore waters as well as staying ashore. Likewise, having small amount of high-priced species in the quota portfolio diminishes the effectiveness of the IVQ system in meeting management objectives, in some cases, could perverse sustainability outcomes. Our results also demonstrate that the intensity at which fishers react to the fluctuations in the prices as well as fishers' perceptions about location attractiveness are influenced by the components of qouta portfolio.

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The Price is Right! Profits, Productivity and Price Change in the Northeast Scallop Fishery.

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Profitability change for fishing vessels depends on both productivity and price change. Since individual vessels have little influence on prices in either output or input markets, productivity change is usually considered the most important determinant of profitability change. When assessing economic performance of fishing vessels and fleets, this reliance on productivity change may lead to erroneous conclusions about economic performance. In this study, we use a recently developed index number decomposition method to identify the drivers of profitability, price, and productivity change for vessels operating in the U.S. northeast scallop fishery between 1996 and 2015. Our main finding is that increases in profitability over the study period were primarily due to increases in prices for scallops, combined with favorable biomass change. Fishing vessels were able to get higher prices for their harvest because of an innovative spatial harvest strategy that resulted in catches of large, premium-priced scallops. Remarkably, this system resulted in both an increase in vessels harvesting scallops, and large increases in profitability.

Recreational Fisheries 1

Thursday, May 25 (3:00 PM to 4:30 PM)

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The effect of management changes on fishing site choice, trip frequency, and angler welfare in a recreational steelhead fishery

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Steelhead provide a valuable recreational resource in Washington state, USA despite steep declines in wild steelhead populations from historical levels. Due to these population declines, five steelhead populations in the state are listed under the Endangered Species Act, and regulations prohibit retention of wild steelhead. To provide harvest opportunities for anglers, marked hatchery fish are released in many Washington rivers. However, hatchery steelhead negatively affect wild populations through competition and genetic interactions, and these effects need to be accounted for when planning hatchery releases. Thus, management of this fishery may involve weighing trade-offs between steelhead conservation and the recreational opportunities afforded to anglers. In practice, fishery managers balance recreational and conservation objectives through their decisions on hatchery releases, season timing, and season length for each steelhead river in the state.

We report on results from a model of fishing behavior for steelhead that was developed using data from a stated preference survey of Washington steelhead anglers. The survey included a discrete choice experiment to estimate preferences for steelhead fishing trip attributes, and follow-up contingent behavior questions to estimate how changes in site attributes influence the number of trips taken in a season. Together, the discrete choice and contingent behavior data facilitate estimation of linked site choice and trip frequency models, respectively. The model estimates yield insights into how changes to hatchery releases and season lengths influence angler welfare and trip-taking behavior. We present results from the linked model of recreational steelhead fishing and discuss implications for management.

40

Climate-Induced Species Shifts and Catch Dependence in Recreational Fisheries

Andrew Carr-Harris[1] **(acarrharris@gmail.com)**, Jorge Holzer[2], Geret S. DePiper[3], Scott Steinback[4]
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To be effective in response to warming oceans, fisheries management must account for the shifting distributions of and connections between marine species. In this work we estimate the welfare implications of alternative management scenarios under the progressive northward shift of summer flounder, one of the top five recreationally landed species in the country. We use data from a 2022 choice experiment survey conducted on the East Coast U.S. to specify and estimate a mixed logit model of anglers' preferences. We then integrate these preferences into a bioeconomic model of the summer flounder and black sea bass recreational fishery to simulate scenarios associated with alternative ocean warming patterns and management options.

Unlike previous studies, we explicitly incorporate the impact of changing ocean temperatures on the spatial distribution of both species and thus on their co-occurrence in recreational trip catch. Specifically, we estimate the effect of species' shifting spatial distributions on the joint catch of these species using conditional copulas. As a conditioning variable, we alternatively specify: (i) the average monthly bottom ocean temperature in each state's marine waters, and (ii) the rank correlation between catch-per-unit-of-effort of summer flounder and black sea bass in trawl surveys conducted annually by NOAA. With this approach we are able to quantify the bias in welfare estimates associated with policy interventions when assuming, as in most previous studies, that the catch-per-trip for the two species is independent regardless of their degree of spatial overlap.

61

Valuing shoreline habitats for recreational fishing

Andrew Scheld[1] **(scheld@vims.edu)**, Donna Bilkovic[2], Sarah Stafford[3], Kathleen Powers[4], Susanna Musick[2], Amanda Guthrie[5]
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Recreational anglers' site choices and satisfaction are generally thought to depend on anticipated catch rates and catch composition, regulations, congestion, aesthetics, and costs. Habitat characteristics may influence angling decisions and derived value directly through aesthetic qualities of fishing sites or indirectly by influencing catch rates, fish availability, and travel costs. In Maryland and Virginia, saltwater anglers record over 13 million trips each year, with ~75% occurring in nearshore coastal and estuarine waters and frequently utilizing shoreline habitats. While site choice models are common in the literature, information on utilization and preferences with respect to specific habitat types or features is limited. Improved information on shoreline habitat use and valuation by recreational anglers would increase efficiency in habitat conservation and shoreline management decisions. This project collected information on habitat use and associated preferences from ~1,500 licensed anglers in the Middle Peninsula, Virginia. Open water, marshes and living shorelines, and man-made bottom structure were most frequently selected as habitats visited when fishing for target species. However, differences in habitat utilization and access, as well as tradeoffs between trip expenditures and travel time, were observed for anglers based on primary fishing mode. A mixed logit model was used to estimate habitat preferences from responses to a discrete choice experiment. Marshes and living shorelines were found to be the highest valued shoreline habitat, with preliminary estimates of USD 6.6M in annual benefits provided by this habitat with respect to recreational fishing in this region of Virginia.

70
Comparing Aquatic Recreation Demand and Valuation Across Probability and Non-Probability Samples

Frank Lupi (lupi@msu.edu), Michigan State University, East Lansing, MI

This paper comparing reveled preference aquatic recreation demand modelling results between an addressed-based probability sample and two non-probability online samples. The specific research compares values for freshwater ecosystem services such as fishing using large multi-site recreation demand systems to model demand and values for sites and for water quality. The probability sample is an address-based sample (ABS) of Michigan's general population from the USPS postal delivery file that was implemented in a push-to-web mail-invitation design, which received a 23% response yielding ~2,500 observations. The two Michigan non-probability online samples include 1,237 respondents from MTurk and 3,095 from Qualtrics. Demand models were estimated using both nested and mixed logit specifications, and all models use 64 fixed effects for sites to control for unmeasured characteristics. I find that while the sample sources differ in several key demographics, such as the relative youth of the MTurk respondents, across 95% of several attitudinal variables collected, the samples were substantively very similar. Importantly though, the samples differed in their estimated economic value of aquatic recreation sites and typical trips, with the non-probability value being over 30% larger. Specifically, in the ABS sample the estimated value per trip for a typical trip is about $32, whereas it is 33% larger ($42) for the Qualtrics sample. The difference is due in part to differences in the travel distances for trips in the two samples. The MTurk recreation demand modeling is currently underway. The results will be of audience interest due to the utility of fishery valuation results and the relative costs of the methods.

Recreational Fisheries 2

Friday, May 26 (8:30 AM to 10:00 AM)

25
Assessing the value of Harmful Algal Bloom forecasts for the benefit of recreational shellfishing in the Pacific Northwest

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Over the past few decades, fisheries and livelihoods on the coasts of Washington and Oregon have been severely impacted by the presence of Harmful Algal Blooms (HABs), that produce domoic acid, a neurotoxin that accumulates in shellfish and endangers public health. Among others, recreational harvests of razor clams along the Pacific Northwest (PNW) have been negatively affected, jeopardizing the economies of coastal communities that depend on tourist revenues and income generated through visits of harvesters in the region. The PNW HAB Bulletin, launched in 2008, publishes forecasts on incoming HAB events, which has enabled managers to increase toxin monitoring in high-risk locations and proceed with selected harvesting at safe beaches and delays or closures of fishing seasons as required. In light of the value of the HAB Bulletin to local managers and communities, this work attempts to assess the value of information (VOI) for the predictions provided by the Bulletin. Discussions with local managers and assessment of how testing increases following the HAB predictions, all indicate that it is an indispensable tool in the hands of management authorities seeking to protect public health and strengthen resilience of coastal communities. The VOI framework described here, drawing from testing and decisions on when, where and how to open shellfish harvesting, contributes to policy making and sound management for the benefit and wellbeing of PNW coastal communities as well as of the general public.

102
Toward Valuation of Energy Rigs for Recreational Anglers: Case of Texas and Louisiana

Mona Ahmadiani[1], **Richard T. Woodward[1] (r-woodward@tamu.edu)**
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The number of energy platforms in the GOM has decreased in the last two decades. While some of the decommissioned rigs have been converted to reefs to continue supporting recreational fisheries, their replacement rate is disproportionate due to engineering and environmental limitations. We combine catch and effort surveys of Texas and Louisiana (from TPWD, LWFD, and NOAA) and the geolocations of standing rigs and artificial reefs from 1990 to 2021 to estimate the marginal impact of changes in the number of these fishing destinations on recreational anglers. We conduct heterogeneity analysis to identify segments of the anglers' population that are likely to be affected by the partial or complete removal of energy rigs. We study whether rigs and artificial reefs are substitutes or complements in terms of their effect on recreational fishing. We exploit the uneven spatial spread of artificial reefs in Texas and Louisiana and examine the change in the collective behavior of anglers over time. We find that despite the lower number of artificial reefs compared to standing rigs across the Gulf, they offer greater positive values to recreational anglers. Differentiating types of trips, standing rigs within 50 miles of shore have a larger marginal impact on offshore trips than inshore trips. We find private angling is more likely to benefit from closer-to-shore artificial reefs than for-hire angling. We also draw a conclusion on the substitution or complementary nature of standing rigs and artificial reefs to help managers of artificial reefing programs prioritize between eligible platforms.

34
Florida Red Tide and Recreational Fishing Activities – Assessing the Economic Impacts

Bijeta Bijen Saha (bijetabijen@ufl.edu), University of Florida, Fort Myers, Florida

Algal blooms that produce dangerous toxins that are detrimental to the plants, animals, people, and ecosystems in the affected areas are known as harmful algal blooms (HABs). Several types of naturally occurring HABs exist in the Gulf of Mexico, including those caused by the marine dinoflagellate Karenia brevis, commonly known as red tide. During a red tide event, environmental and water quality, and aesthetic and safety factors are diminished due to the toxins produced by the bloom. The compromised environmental conditions can have significant repercussions for the state of Florida, which is the top destination for marine recreational fishing in the U.S. and a top destination globally as well. This paper addresses the adverse economic impacts in terms of change in recreational fishing activities associated with red tide occurrences along Florida's western coast. For our empirical analysis, we combine data from the HAB monitoring database available from the FWC's Fish and Wildlife Research Institute (FWRI) and the Marine Recreational Information Program (MRIP) datasets available from the NOAA's National Marine Fisheries Service, based on calendar dates and geographic coordinates, resulting in an unbalanced panel data set consisting of data from 2003 through 2019. The results indicate a significant decrease in both average number of trips and average total catch for non-shore mode practices of recreational fishing for the coastal counties that experienced a red tide event during that month/wave of the year as compared to the counties that were not exposed to any red tide events during that same period. However, the number of average total trips and average total catch in red tide exposed areas were not significantly different from the unexposed areas for the shore mode practices. This research provides quantitative evidence that are relevant for informed decision-making regarding the prevention or mitigation of red tide events.

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Money can't buy me fish: Lessons from an incentivized harvest program[*]

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Incentivized harvest programs are an increasingly popular policy tool for managing invasive species populations. Resource managers pay recreational hunters and fishers to remove members of an invasive species by offering a payment for each individual removed. We perform a program evaluation of an incentivized harvest program for brown trout in the Lees Ferry fishery, both to investigate this program's efficacy and to contribute to the broader but sparse literature on incentivized harvest program design and barriers to adoption. We employ a novel analytical strategy in which we calculate additional, program-induced removals by separately estimating the bounty's impact on three margins which multiplicatively comprise removals: fishing trips taken, catch-per-trip, and retention rate. This approach allows us to investigate barriers to participation at different behavioral intervention points and to utilize margin-specific counterfactual estimation approaches that control for the differential effects of COVID-19 and other program-independent shocks. We find that the Lees Ferry program, which had the goal of increasing brown trout harvest by 2,500 fish per year, only induced additional harvest of 88 brown trout in year one. Our disaggregated analytical approach reveals that this underperformance is due to a compositional shift within the fishery; the incentive program drew in new anglers who were eager to retain brown trout for payment but ineffective at catching brown trout. These new anglers also appear to have crowded out the more effective veteran anglers.

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The Effect of Fishery Interviewers on Recreational For-hire Vessel Reporting Behavior in the Northeast U.S.

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[1]*NOAA Fisheries, Woods Hole, MA, [2]NOAA / National Marine Fisheries Service, Woods Hole, MA*

In the Northeast U.S., for-hire vessel trip reports and traditional creel survey data are used together to produce estimates of recreational catch and effort and inform fisheries management. However, the use of vessel-reported data can be problematic due to a number of potential behavioral and cognitive biases associated with self-reporting. While such biases have been well-documented in commercial fisheries, there are few studies examining the accuracy of and potential biases associated with self-reporting in the recreational sector. In this study, we compare self-reported estimates of angler effort from for-hire vessel trip reports to direct observations of angler effort recorded by official fishery interviewers. We use statistical matching techniques to identify the influence of interviewer presence on vessel-reported effort. Importantly, we consider in our estimator the stratified random sampling approaches used to assign fishery interviewers to specific sites or vessels. Our results suggest that vessel-reported effort is about six percent greater on headboat trips that carry an interviewer. This seemingly small but significant effect translates to roughly 25,000 unreported angler trips per year.

Rights-based Fishery Management 1

Thursday, May 25 (1:00 PM to 2:30 PM)

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Analyzing Trends in Quota Lease and Ex-vessel Prices in Multispecies Catch Shares Managed Fisheries to Evaluate Stock Conditions

Andrew Ropicki[1] (aropicki@ufl.edu), Jordan Moor[2], Adams Ceballos[2]
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In 2019, NOAA Fisheries decreased the commercial quota for red grouper in the Gulf of Mexico by 61%. In October 2018 commercial fishermen, through public testimony to the Gulf of Mexico Fishery Management Council, indicated that the red grouper stock had declined and could not support the commercial quota catch levels in place at the time. A review of red grouper IFQ and ex-vessel markets shows that the quota lease price dropped approximately 66% and the ex-vessel price of fish increased 12% from 2016 to 2018. Assuming competitive equilibrium, the lease price of a pound of quota in an ITQ fishery should equal the ex-vessel price of the pound of fish less the marginal cost of catching the fish. Given this relationship, the drop in red grouper lease prices was likely due to increased costs to harvest the fish; and the absence of appreciable increases in fishing input costs (bait, ice, fuel, labor) indicates increased harvest costs were likely due to decreased abundance of red grouper on the fishing grounds. In this paper we examine trends in the relationship between quota lease prices and ex-vessel prices in the Gulf of Mexico Grouper-Tilefish and Red Snapper IFQ Programs to see if a trend discontinuity was present in the relationship that could have alerted fishery managers earlier to issues with the stock of red grouper. The research evaluates the potential of using the quota lease price to ex-vessel price ratio as a stock monitoring tool for multispecies catch shares managed fisheries.

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Back to the Future of Fisheries: Assessing the Long-Term Triple-Bottom-Line Performance of Quota Managed Fisheries with Historical Reconstructions of Fishery Performance Indicators (FPIs)

Michael De Alessi[1] (mdealessi@gmail.com), Chris Anderson[1]
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Since their introduction roughly ten years ago, Fishery Performance Indicators (FPIs) have assessed the ecological, economic, and social performance of over 200 fisheries worldwide. Well-established quota management systems that are often cited as models for fishery management reform were mostly created in the 1980s and 1990s, predating the FPI approach. While ecological, social, and economic analyses of these fisheries are common, there has yet to be a cross-cutting triple-bottom-line assessment of their performance. We identified a set of quota-managed fisheries in the United States, New Zealand, Australia, and Iceland where historical reconstructions of FPIs were possible 5 years before and 5 years after quota management took effect. Combining historic data with recent interviews of experienced fishers, managers, processors, and scientists, we collected FPIs going back from the present as far as 1979 for Iceland and the early 1980s and 90s for the U.S., New Zealand, and Australia. With three FPIs for each fishery (one present and two past) we (1) assess the triple-bottom-line performance of quota-managed fisheries in the present and in the years before and after quotas were introduced, (2) identify the necessary enabling conditions and management institutions for wealth generation, positive ecological outcomes, and social sustainability in these fisheries, and (3) discuss the implications of our findings for the design and implementation of future quota management systems.

86
Can Fish Tags be Harvest Neutral
Alexander Gordan (alexander.gordan@noaa.gov), NMFS, Miami, Florida

Recreational harvest tags have been widely discussed in the fisheries economics literature as a way to improve the efficiency of recreational harvest. The path from the status quo of regulated open access to widespread use of harvest tags likely needs to involve smaller pilot programs to demonstrate their feasibility and efficacy. In designing such a program, it is necessary to consider the impact it will have on total harvest of the target species, and if it will increase harvest then it is necessary to set aside quota to fund the program. Programs that will not increase harvest I refer to as harvest neutral, and I consider that these programs may be simpler and more likely to put into practice due to the lack of a need for quota set asides. I develop a simple theoretical framework for considering the impact of a harvest tag program on total harvest. Specifically, I consider lottery-rationed harvest tag programs with a given number of tags assigned to each participating angler, and under plausible assumptions about angler behavior I obtain an equation that gives the change in total harvest from the program as a function of the number of tags. This equation can be estimated given simple survey data on angler fishing activity and preferences for the harvest tag program. I consider simulated survey data to illustrate the use of this equation, and the conditions under which harvest tag programs may or may not be harvest neutral.

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Examining the evolution of access to Alaska's halibut IFQ fishery
Andrew Steinkruger[1] (andrew.steinkruger@noaa.gov), Marysia Szymkowiak[2]
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In fishing communities, livelihoods and well-being depend on sustaining access to key resources through changes in fisheries management. In Alaska, the rationalization of the commercial fishery for Pacific halibut (*Hippoglossus stenolepis*) in 1995 led to the consolidation of the halibut fleet. The high costs of halibut catch shares are a crucial barrier to prospective entrants, especially small-scale operations with few options for portfolio diversification. However, quantitative approaches to understanding that barrier face an information gap: datasets on harvest and catch share ownership in fisheries lack common identifiers for individuals. We match individuals across harvest and quota data from 1991 through 2019, enabling a detailed examination of entrants and non-entrants – those who acquire or do not acquire halibut catch shares over the time series. We compare fisheries portfolios in terms of participation and earnings through duration, dissimilarity, and network analyses. Differences over time and between entrants and non-entrants emerge across analyses. For both groups, cohorts of participants shrink and real individual earnings increase over the time series. However, entrants' cohorts have decreased further relative to historical participation, while entrants' real earnings and fisheries portfolio compositions have diverged from those of non-entrants. Our results reveal broad differences in Alaska fisheries participants' access to a critical fishery, underscoring the role of catch shares in shaping fishing communities' opportunities and resilience in the face of social and environmental change.

Rights-based Fishery Management 2

Thursday, May 25 (3:00 PM to 4:30 PM)

59
Renewable resource market responses under rights-based management: linkages in Gulf of Mexico fisheries.
Jordan Moor (Jordanmoor@ufl.edu), University of Florida, Gainesville, Florida

When commodity prices are connected to large or international markets, price signals of local goods may be an inaccurate representation of local market conditions. This may also hold true for prices of derived assets such as in rights-based natural resources such as fisheries, where expected price signals in quota markets due to environmental changes or resource abundance may be muted due to their connection to the global market. The implications of inconsistent price signaling include inaccurate signaling of stock abundance and associated knock-on effects on overfishing and economic inefficiency. This paper explores whether these concerns are founded on theoretical and empirical evidence in an ITQ fishery context. For our case study, the Gulf of Mexico (GoM) grouper fishery, we empirically investigated market integration and estimated price-flexibilities for both landing and quota lease prices. Results indicate that all three GoM species groups compete in the same market and are, at the very least, imperfect substitutes. Further, lease prices were found to be inflexible to supply changes on both aggregate and species-by-species levels, in both absolute terms and relative to landing price flexibilities. These findings suggest that GoM grouper ITQ prices exhibit reduced responsiveness due to market linkages and may not accurately transmit information on resource supply as a result of, but not limited to, changes in environmental characteristics.

75
Self-selection into Individual Transferable Quota Management
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While rights-based management has empirically proven to be an effective management tool for natural resources, one of its drawbacks is the distributional consequences. In fisheries, ITQs are mainly decided to be implemented by managers and are often opposed by existing fishers. In this study, we focus on a group of fishing vessels that were given the option of belonging to a group that enforces the ITQ or to a group of small-scale fishers that does not, at the time of the introduction. We analyze which heterogenous characteristics define their preferences for ITQs. The result shows that both those who exit quickly and those who buy quotas chose participating in the group under ITQ. The ITQ is preferred by not only most efficient ones, but also the least efficient and potentially exiting fishers.

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Structural Evaluation of Quota Market Performance in Catch Share Fisheries: Evidence from the Northeast Multispecies Sector Program

Anna M. Birkenbach[1], Min-Yang Lee[2], **Matthew Reimer[3] (mnreimer@ucdavis.edu)**
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Catch share programs have become increasingly adopted into fisheries management regimes. Most programs allow for the exchange of short-term and permanent rights to catch shares through quota markets, which are important for coordinating fishing behavior to use fishery resources efficiently. However, in practice, quota markets fail to operate efficiently for several reasons, such as imperfect information or transaction costs. One difficulty in evaluating the performance of existing quota markets is that we do not know what quota prices or fishery outcomes would be if quota markets operated efficiently. We address this shortcoming in evaluating the quota markets for fisheries managed under the Northeast Multispecies Sector Program. We estimate a trip-level model that explains targeting behavior as a function of expected revenue and opportunity costs that can be used to simulate fishery outcomes. Using observed quota prices, we can recover the structural parameters governing trip behavior, and in turn, combine our trip-level model with a quota-market model to estimate the counterfactual quota prices that would exist if the quota market operated efficiently. Comparing the observed quota prices to those predicted under an efficient market serves as an indicator of the performance of the current quota market. Furthermore, predictions of catch and revenue that would occur under a well-functioning quota market provide insight into the potential gains from reducing transaction costs associated with quota exchanges.

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Who Is Benefiting from the IFQ Program? A Review of the 2019-2021 Quota Share Owners Survey in the Pacific Coast Groundfish IFQ Program

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The Pacific groundfish trawl fishery has been under catch share management since 2011, when quota shares were distributed to permit owners according to historical participation. The Northwest Fisheries Science Center's Economic Data Collection (EDC) Program fielded the first Quota Share Owner Survey (QS-EDC) from October to December 2020, and repeated the survey in 2021 and 2022. Two types of information are requested on the annual survey: the dollar amount quota share owners earned from leasing out their quota and descriptions of each owner's past and present fishery participation. This presentation details the survey development and fielding and presents findings from combining the data collected through this new survey with preexisting data collections, including ownership interest and the EDC's cost and earnings surveys (CE-EDC). Quota share owners reported a total of $3.7 million in earnings from leasing quota on the QS-EDC in 2019. Combined with the quota lease earnings reported on CE-EDC surveys of all vessels owners in the fishery, quota lease revenues totaled $6.6 million dollars in 2019. The survey results indicate that capital owners (owners of fishing vessels or shorebased processors) earned approximately 64% of this $6.6 million. A smaller fraction of earnings, approximately 27%, accrued to individuals with active participation in the fishery (fished or worked in processing facilities). Other recipients of quota lease earnings include individuals with no other capital or active participation in the fishery, as well as trusts, estates, quota banks, not-for-profits, and government entities.

2
Public Benefits of Endangered Species Protection: Measurement and Model Integration for Policy and Management

Dan Lew (Dan.Lew@noaa.gov), NOAA Fisheries, Davis, CA

The Cook Inlet beluga whale (CIBW) is found in waters off the state of Alaska and is protected under the U.S. Endangered Species Act. The federal recovery plan estimates the total costs to recover the species to be $73 million (in 2013 dollars). In this research, we use data from a stated preference discrete choice experiment (CE) study to estimate the aggregate benefits of recovering the CIBW and generally for improving its conservation status and reducing the risk of its extinction. CE models are estimated that account for utility scale heterogeneity, attribute non-attendance, self-selection bias, and demographic effects. Aggregation methods that differ in adjustments made to the mean household welfare and/or to the number of population units are compared by assessing their impact on the resulting aggregate welfare. Aggregate welfare estimates suggest the roughly quarter million Alaska households are on average willing to pay between $34 million (95% CI of) and $99 million) for full recovery of the CIBW, depending upon the model and aggregation assumptions. While some of the aggregate state-level recovery value estimates are below the total cost of combined federal and state recovery actions, accounting for welfare benefits beyond Alaska easily justify recovery actions by the benefit-cost criterion. We also illustrate an approach that links welfare values with predicted quasi-extinction risks from a population viability assessment model, which reveals public values associated with a range of potential population dynamics changes that could be brought about by species recovery actions.

Transboundary and Migratory Fisheries

Wednesday, May 24 (10:30 AM to 12:00 PM)

53

A research plan for using Simple Ecological Systems approach to analysing management options in international pelagic fisheries

Catherine Chambers[1], Bjarki Þ. Elvarsson[2], Unn Laksá[3], Magni Laksáfoss[3], Sandra Rybicki[4], Anna H. Ólafsdóttir[5], **Pamela J. Woods[6] (pamela.woods@hafogvatn.is)**
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MarineSabres is an EU Horizon Europe research grant which aims to develop and demonstrate a generally applicable framework for supporting ecosystem-based management and marine spatial planning in a rapid and integrative manner, with co-design and co-production by stakeholders. The approach is based on systems analysis to describe as simply as possible the baseline system function, and use it to test scenarios, identify options for adaptation, and set goals and objectives for the fishery. International pelagic fisheries (including mackerel, herring, capelin, and blue whiting) in the Northeast Atlantic and Arctic will be used as one of several demonstration areas to which the methodology will be applied. Stakeholders from Iceland, Faroe Islands, Greenland, and Denmark will be invited to participate to design a system that delineates strengths and weakness of a system dependent on industrial fishing and vertically integrated companies that operate internationally, compete internationally, and yet depend on international cooperation for long-term sustainability and continued access to fisheries with shifting distributions. Scenarios will be designed to analyse motivations and identify opportunities for behavioural change that could strengthen sustainability or have other positive social impacts. This demonstration area contrasts greatly from other common implementations of tools used to implement ecosystem-based management in fisheries as it does not from the outset include quantitative ecological modeling nor a place-based approach, but instead has the potential to reveal drivers of competition, cooperation, and adaptation among large business operations.

115
Comparing Alternative Adaptive Management Strategies for Shifting Fish Stocks in the Western North Atlantic

Christopher F. Dumas[1] (dumasc@uncw.edu), Scott Crosson[2], Rod Fujita[3], Juliano Palacios-Abrantes[4], Olaf P. Jensen[5], Arielle Levine[6], CATHERINE LONGO[7], Ashley Trudeau[8], Nicky Roberts[9]
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Fishery management regimes that rely on spatial boundaries can be poorly adapted to climate-induced shifts in species distributions. Transitioning to dynamic allocation rules in spatial fisheries management is an alternative solution for mismatches between species distributions and spatial management boundaries. Palacios-Abrantes et al. (2023) examined the distributions of three fish stocks over time in the western North Atlantic and found that the distributions changed relative to the years used to determine the current state-level fishing quota allocations. A comparison of two alternative approaches to designing the spatial regulatory boundaries used to allocate a fish stock to individual states found that the choice of regulatory boundary design approach was more important than seasonality in determining allocations, especially at latitudinal extremes. We extend the analysis by adding models of fishing behavior at the vessel level and economic impacts at the state level to the models of shifting fish stocks and regulatory unit definition. We compare a range of static and dynamic fish stock allocation rules in simulations using the historical stock shifts. Our results inform the development of efficient and equitable stock allocation policies in a world of shifting fish stocks.

Reference: Palacios-Abrantes J, Crosson S, Dumas C, Fujita R, Levine A, Longo C, et al. (2023). Quantifying fish range shifts across poorly defined management boundaries. PLoS ONE 18(1):e0279025. https://doi.org/10.1371/journal.pone.0279025

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Costs and Benefits of Western & Central Pacific Tuna Harvest Strategies for Coral Triangle Countries

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Tuna resources in the Coral Triangle region provide employment, economic prosperity and food security. The extent to which these benefits can be amplified, or even sustained, is in question however, in part due to climate change uncertainty, but also due to the increasing need to limit effort and catch and promote sustainable tuna fisheries through time. To that end, the Western and Central Pacific Fisheries Commission (WCPFC) has been discussing harvest strategies and harvest control rules for the conservation and management of tropical tuna species within their jurisdiction. What implementation of these harvest strategies might mean for Coral Triangle countries is unknown, in terms of the benefits and conservation burdens that may be taken on. The aim of this study is to systematically explore the outcomes of harvest strategy implementation via bioeconomic modelling of the multi-species multi gear fishery that exists in the WCPFC area jurisdiction.

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Can there be cycles of international fishing game co-operation? Simple modelling

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Can there be cycles of international fishing game co-operation?

Simple modelling
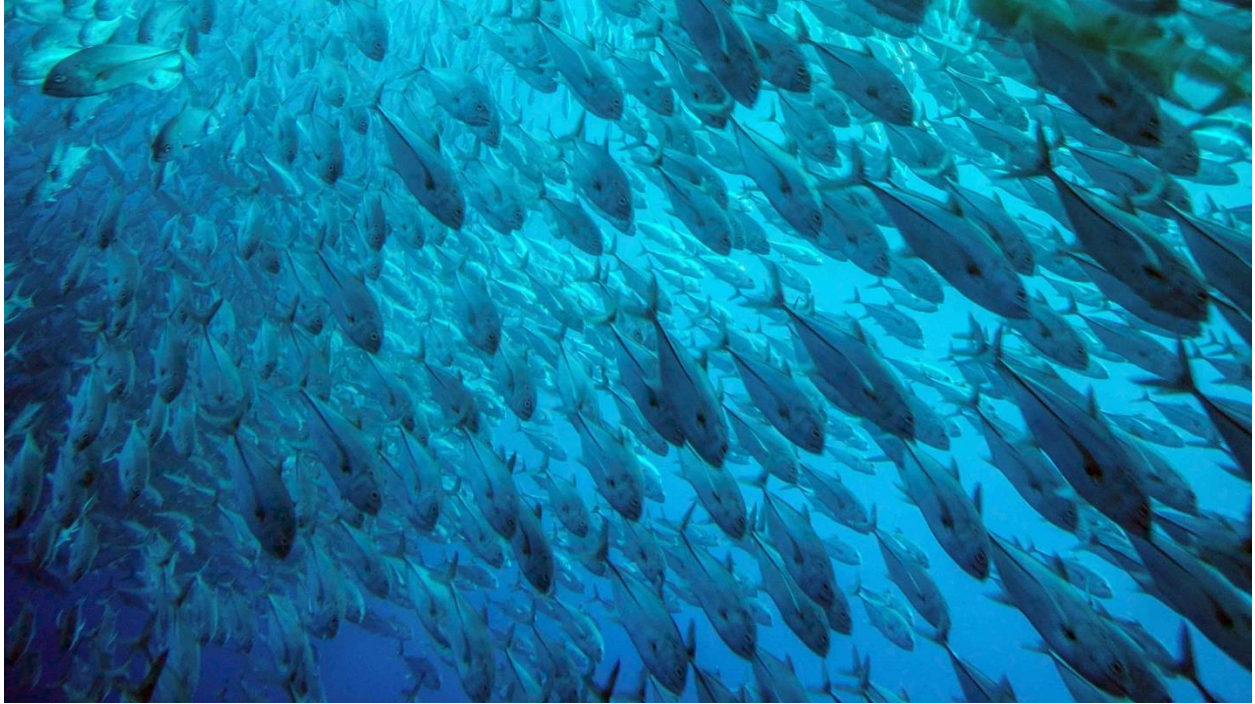
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ABSTRACT

The history of cooperation/non-cooperation in the North Atlantic pelagic fisheries recounted in Bjorndal et al. 2022 exhibits periods of high degree of cooperation between the fishing nations involved followed by break-downs in co-operation and periods of relatively little cooperation. Moreover, as discussed in chapter in Bjorndal et al. 2022, there are indications that cooperation is more likely to occur when the stocks are depressed. These observations, limited as they are, suggest that the North-Atlantic pelagic fisheries game may be characterized by cyclical cooperation.

In this paper, it is attempted to develop a simple but plausible model of an international fishery that is capable of generating cycles of relative cooperation and non-cooperation. The dynamic properties of this model are explored and demonstrated that it may exhibit endogenous cycles. The empirical relevance of this model and its relationship with standard fishing game theory are discussed.

Keywords: International fishing games, cyclical cooperation in shared fisheries, stability of international fishery cooperation.