Atlantis and IOPAC collaboration

From krill to convenience stores: economic & ecological effects of fisheries management and global change

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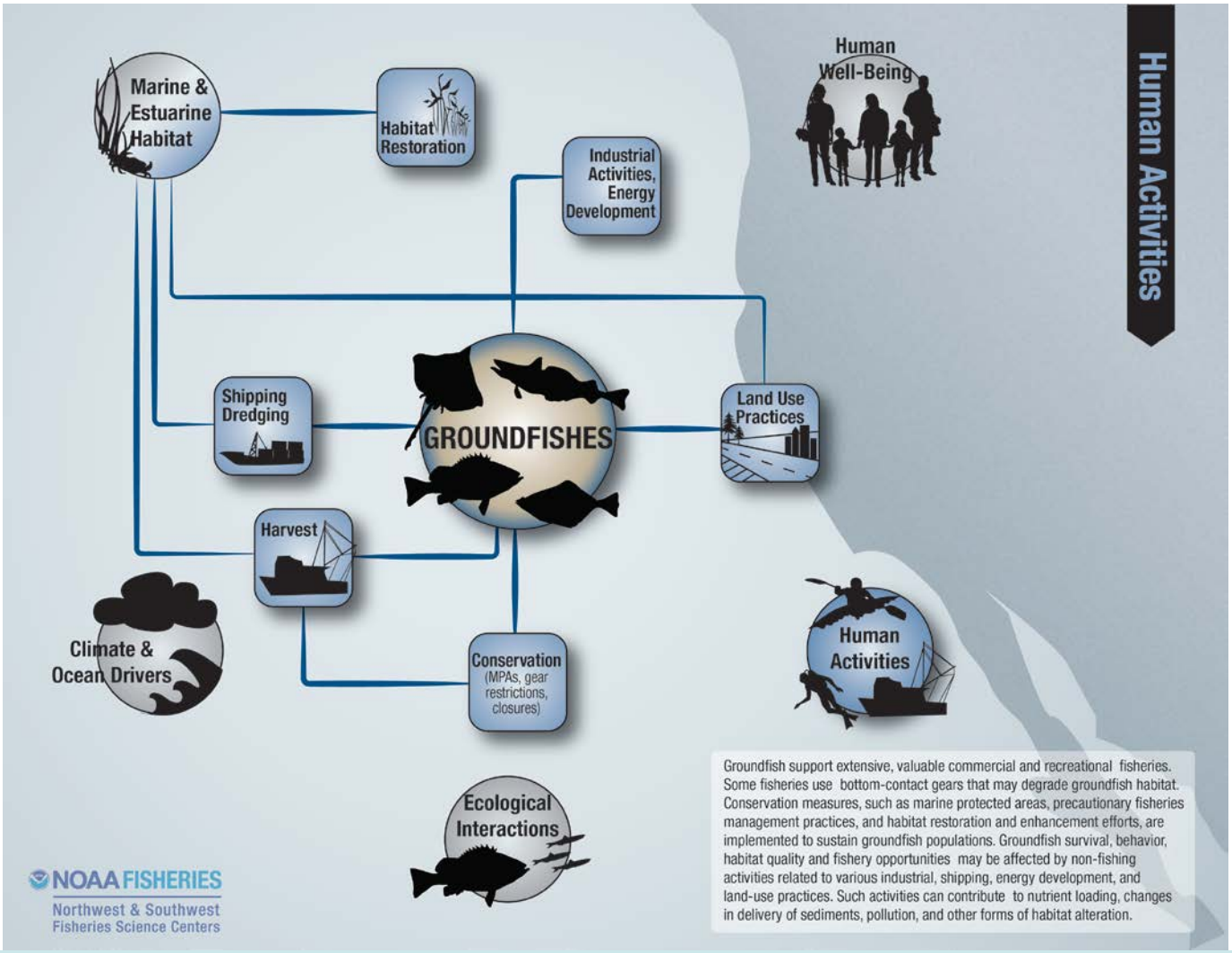
DAY 3 SESSION 8. ECOSYSTEM ECONOMICS AND SOCIAL SCIENCE

Context for work

•Groundfish and Humans for Integrated Ecosystem Assessment (IEA)



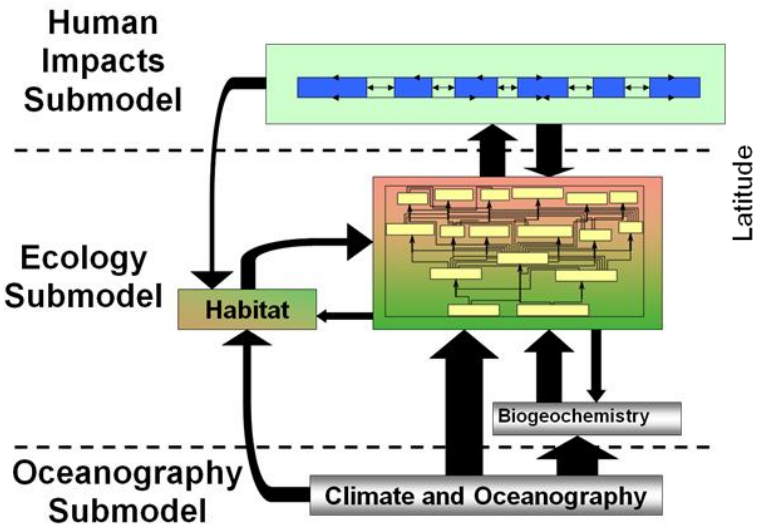
Ranking Alternative management strategies

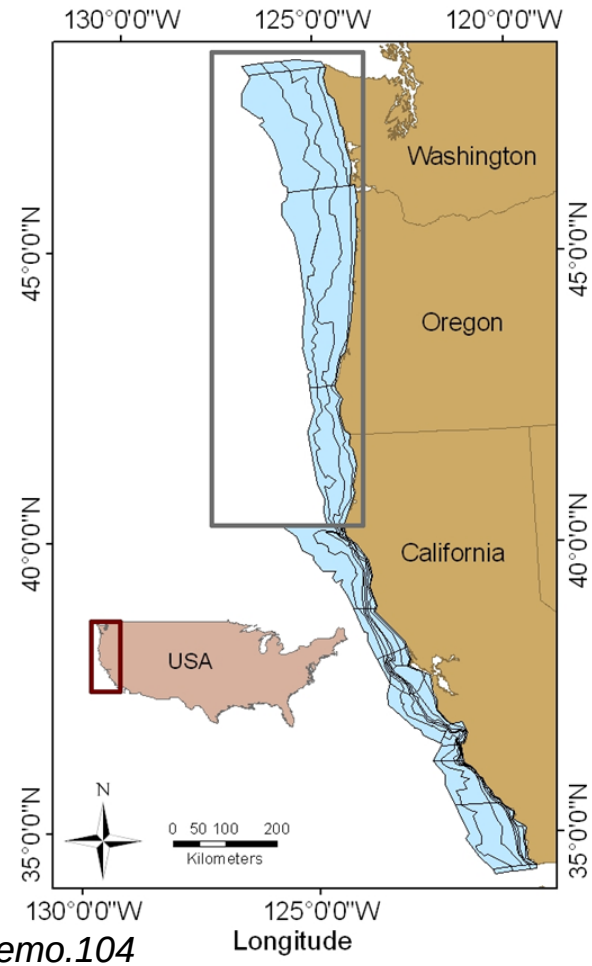
(Kaplan, Horne, Levin (2012). *Progress in Oceanography*
Kaplan and Leonard (2012) *Marine Policy*)

Atlantis ecosystem model allows us to consider the strategies available for fisheries management:

- Spatial management
- Gear switching (shift away from bottom trawl)
- Examine Trade-Offs of Alternate Management Strategies
  - --Ecological
  - --Socio-Economic

Atlantis Ecosystem Model





Horne et al. (2010) NOAA-NMFS-NWFSC Tech Memo.104
Kaplan et al. (2013) Environmental Conservation.
Kaplan et al. (2012) Fish and Fisheries.

Alternative management strategies

1. Status Quo

Gear Shift

2. Gear Shift From Trawl to Pot and Longline

Spatial Management

3. Prohibit All Bottom-Contact Gear in Rockfish Conservation Area (RCA)

4. Consolidate Spatial Management (protect Essential Fish Habitat on shelf)

Trade-Offs

--Ecological (2011 IEA; and Kaplan et al. 2012 *Prog. Oceanography*)

--Economic (Kaplan and Leonard 2012 *Marine Policy*)

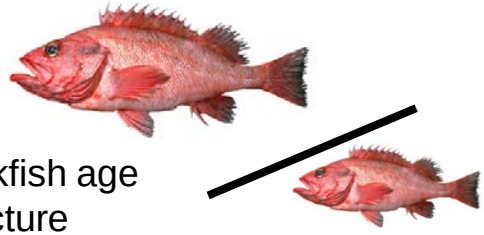
Performance of Four Management Strategies

Habitat

Jobs

Rockfish

Fishery revenue

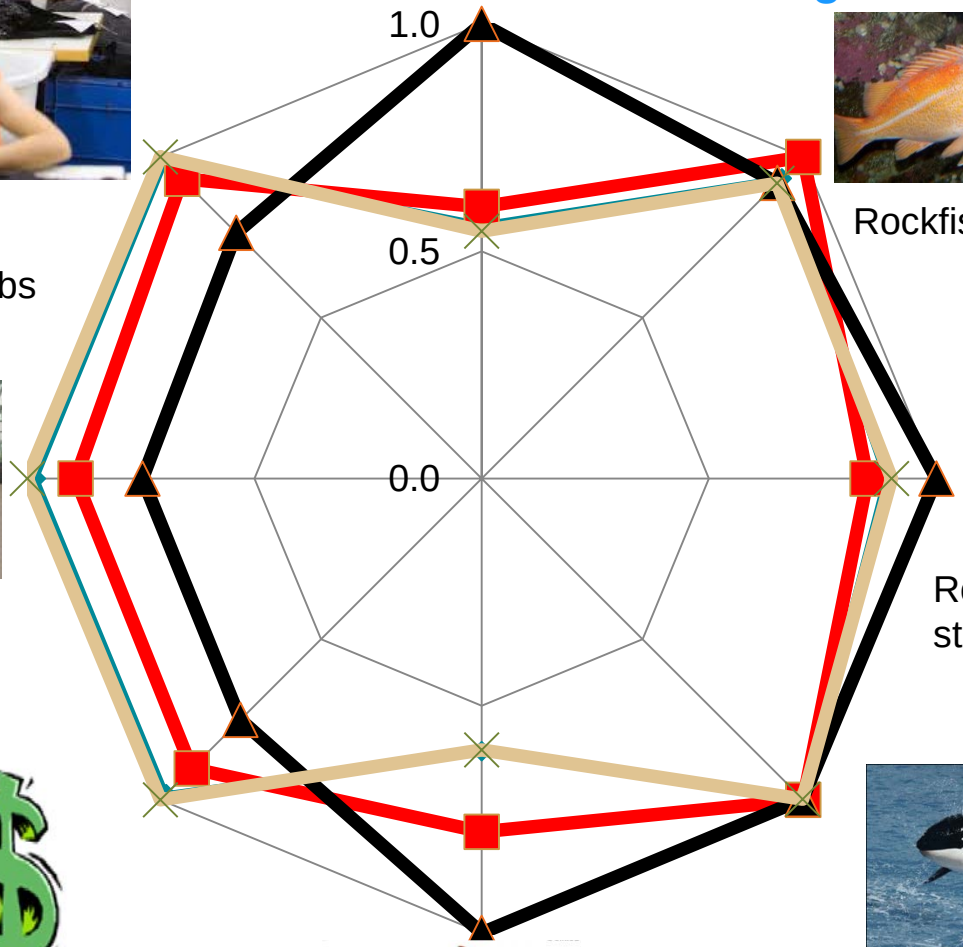


Rockfish age structure

Economic impact

Marine mammals and birds

Avoid rockfish bycatch



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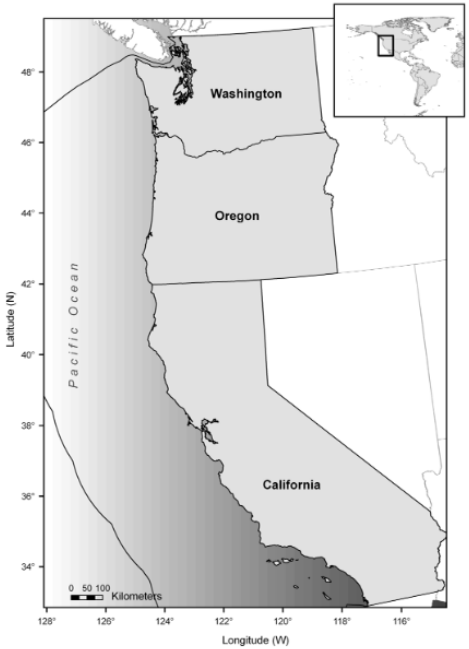
Summary of biology and revenue results from fixed management strategies

- These moderate management changes led to <10% biomass responses in most cases. Stock rebuilding common.
- "Consolidate Spatial Management" scenario is very similar to Status Quo
- No silver bullet – tradeoffs always required
- Gear shift scenario was a compromise, but still at potential cost to habitat

IOPAC: Input-Output Model for Pacific Coast Fisheries



Leonard, J. and P. Watson (2011, NOAA Tech. Memo)

Table 13. Impact of Reduced Harvest among Sablefish Fixed Gear Vessels (continued)

Aggregated Income Impact Report (2009 dollars)

Industry and NAICS Code	Direct	Indirect	Induced	Total
11 Ag, Forestry, Fish & Hunting	0	-1,503	-1,417	-2,919
21 Mining	0	-1,160	-1,098	-2,258
22 Utilities	0	-3,613	-5,195	-8,808
23 Construction	0	-3,431	-5,526	-8,957
31-33 Manufacturing	-105,975	-7,276	-16,613	-129,864
42 Wholesale Trade	0	-49,052	-17,758	-66,810
48-49 Transportation & Warehousing	0	-13,888	-8,489	-22,378
44-45 Retail trade	0	-10,078	-34,885	-44,961
51 Information	0	-4,282	-9,862	-14,144
52 Finance & insurance	0	-16,076	-27,855	-43,930
53 Real estate & rental	0	-8,674	-17,159	-25,833
54 Professional- scientific & tech services	0	-15,844	-16,241	-32,084
55 Management of companies	0	-19,737	-4,371	-24,108
56 Administrative & waste services	0	-6,528	-8,181	-14,710
61 Educational services	0	-95	-5,315	-5,410
62 Health & social services	0	-4	-50,076	-50,080
71 Arts- entertainment & recreation	0	-3,852	-4,693	-8,545
72 Accommodation & food services	0	-2,141	-14,488	-16,628
81 Other services	0	-3,416	-11,813	-15,229
92 Government & non NAICs	0	-2,797	-89,935	-92,732
Sablefish fixed gear	-356,014	0	0	-356,014
Bait Ship	0	-8,709	0	-8,709
Wholesale Seafood	-11,828	0	0	-11,828
Total	**-473,817**	**-182,152**	**-350,970**	**-1,006,939**

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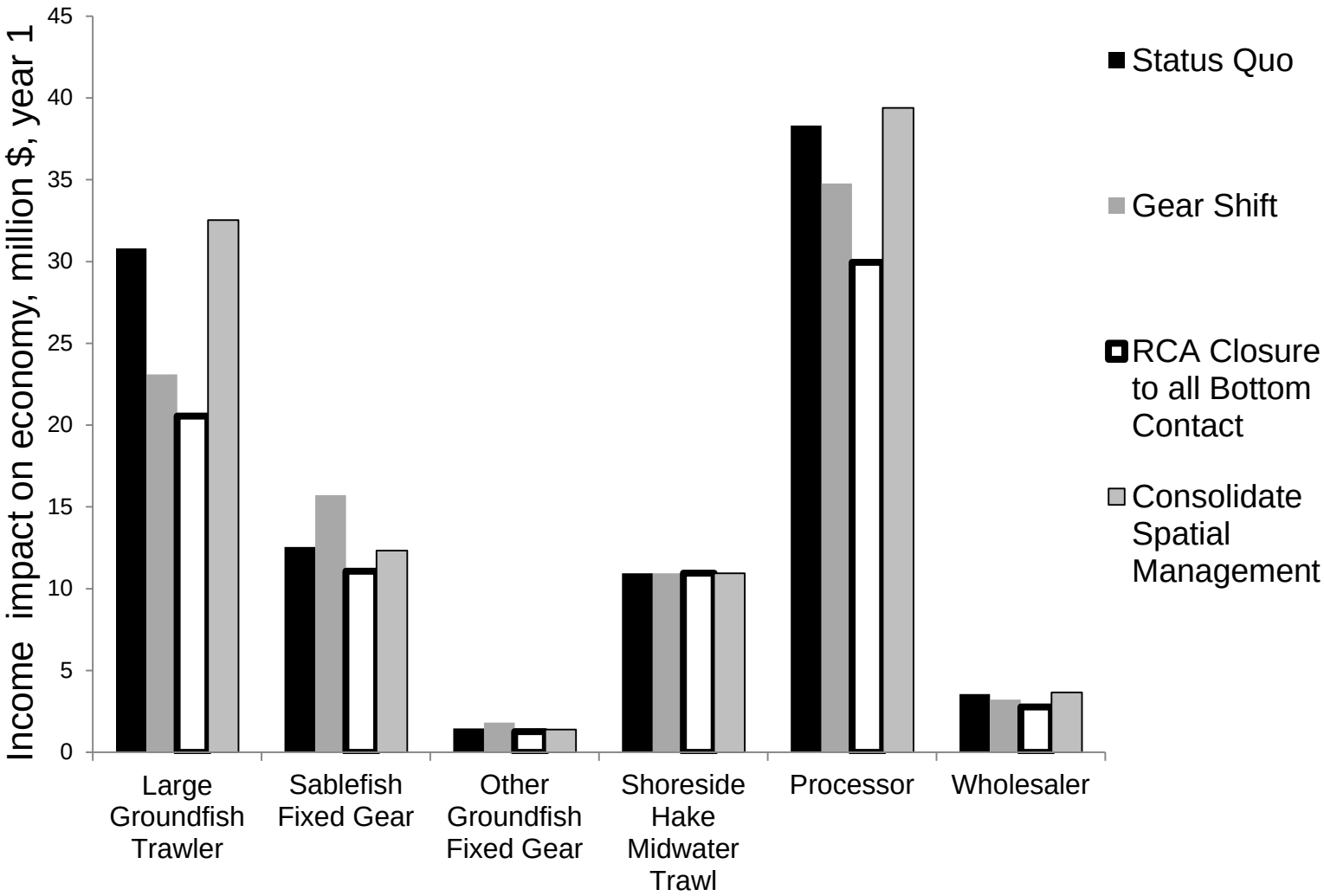
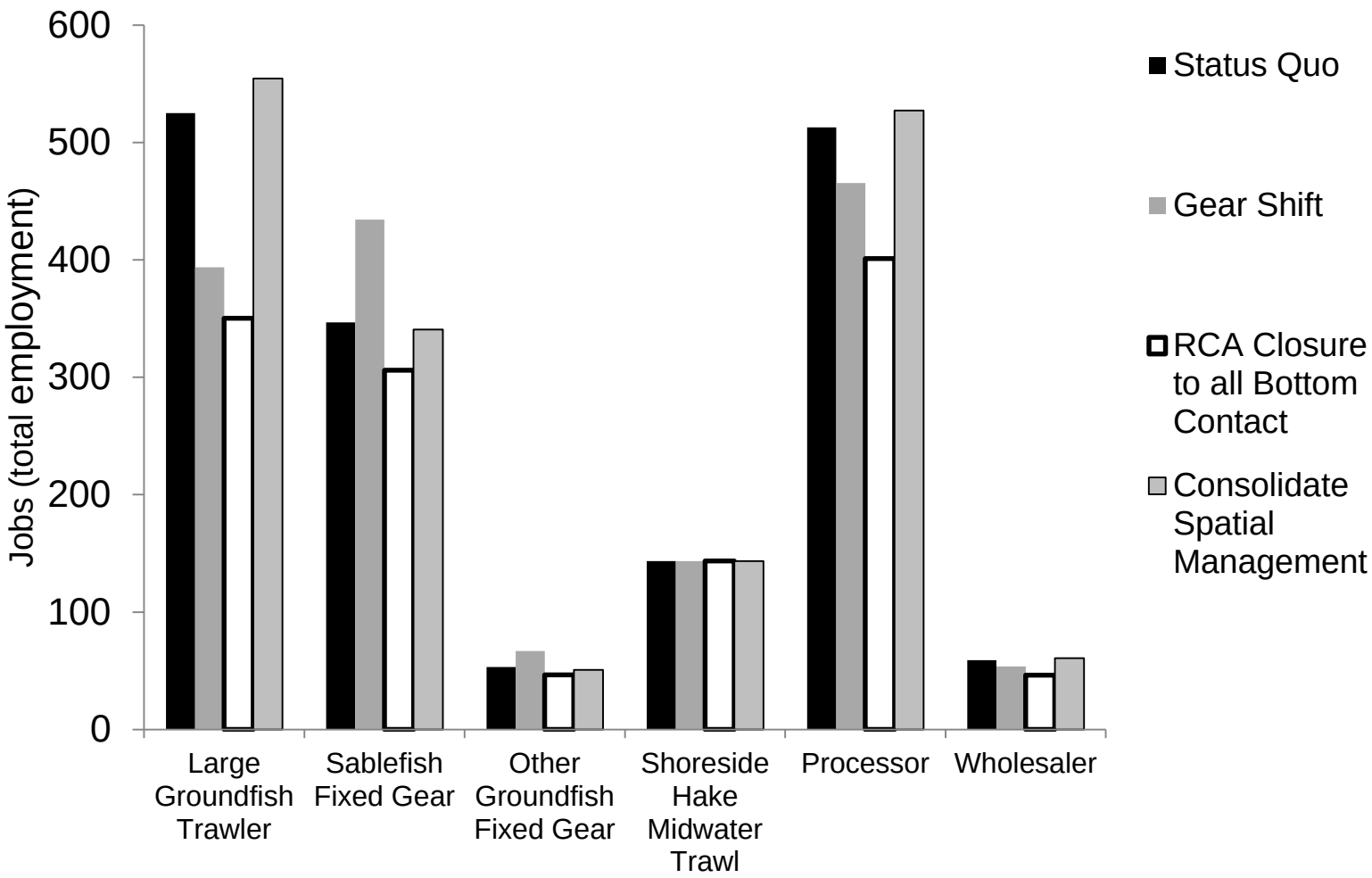
Impact on Economy (Wages and Other Income)



Fleet or sector causing income effects on economy

Employment Effects



Fleet or sector causing employment effects on economy

Economic Summary

- Bottom trawl revenue declines up to 40% with RCA spatial closure, 25% in gear shift
- Other fleets vary between -13% and + 25% of Status Quo, depending on management scenario
- Processor and wholesaler revenue tracks bottom trawl
- Income impacts approx = revenue
- Stock rebuilding leads to 23-33% increases in revenue, economic impact, and jobs (~ $25 million, 400 jobs)

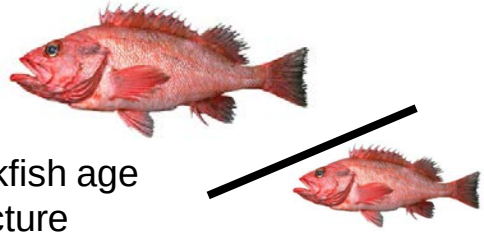
Performance of Four Management Strategies

Habitat

Jobs

Rockfish

Fishery revenue



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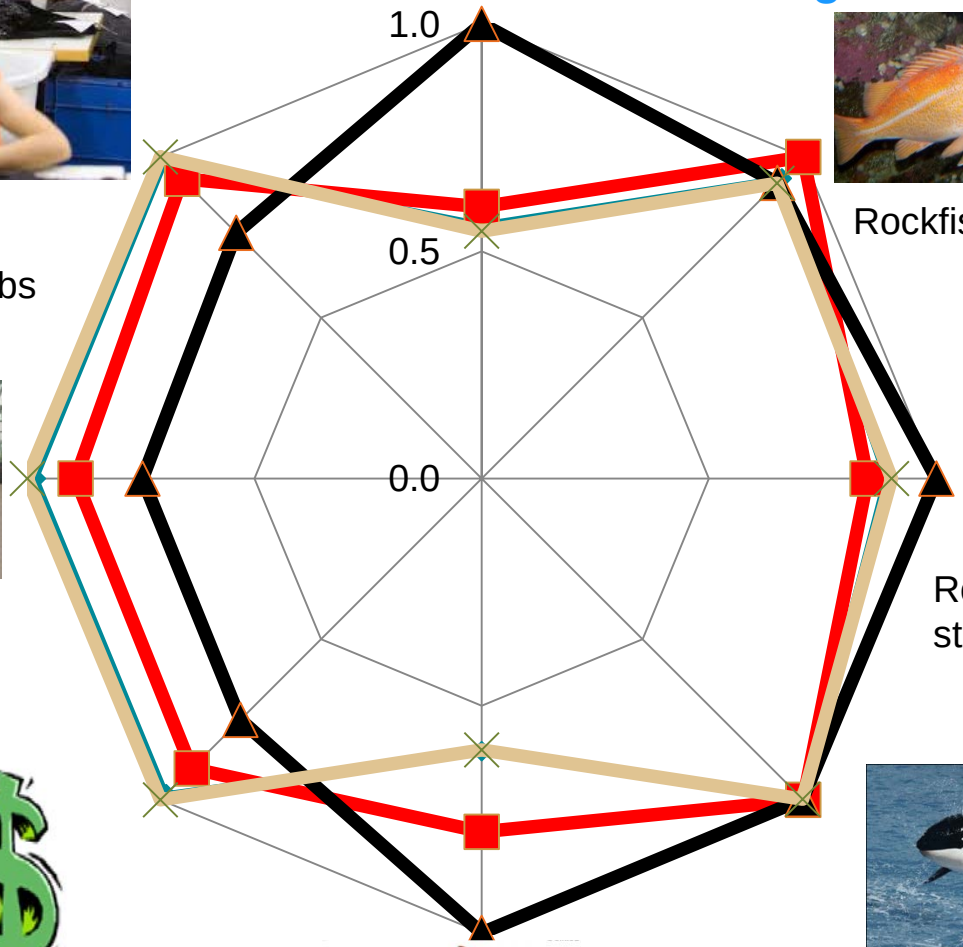

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Strengths

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

Challenges

- Input-output models assume no substitution of inputs, and no change in prices
- For long term projection, computable general equilibrium models may be more appropriate
- Simple assumptions make input-output results transparent, and a starting point

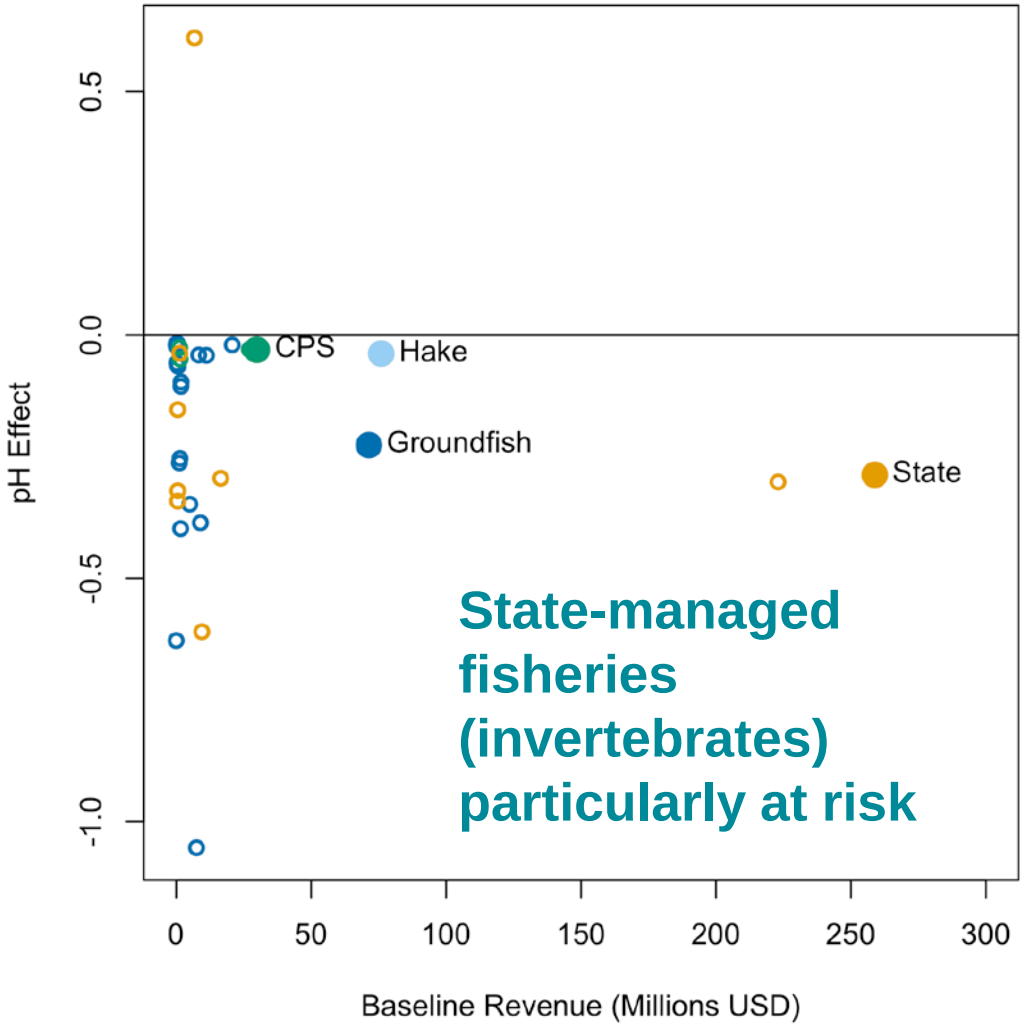
Opportunities: Improvements to IO-PAC

- Data updates from expanded cost earnings (CE) surveys (mandatory trawl catch shares and voluntary)
- Expanded scope of model
  - Coverage of more fisheries
    - At-Sea groundfish
    - Salmon
    - Crab
    - Shrimp
- Processor sector specified through mandatory data

Improvements applied to address risks of ocean acidification by port and gear (Hodgson et al., submitted), following on projections of biology (Marshall et al. 2017)

Projected Effects of Ocean Acidification

Effect on catch or abundance versus baseline revenue, by species and management plan

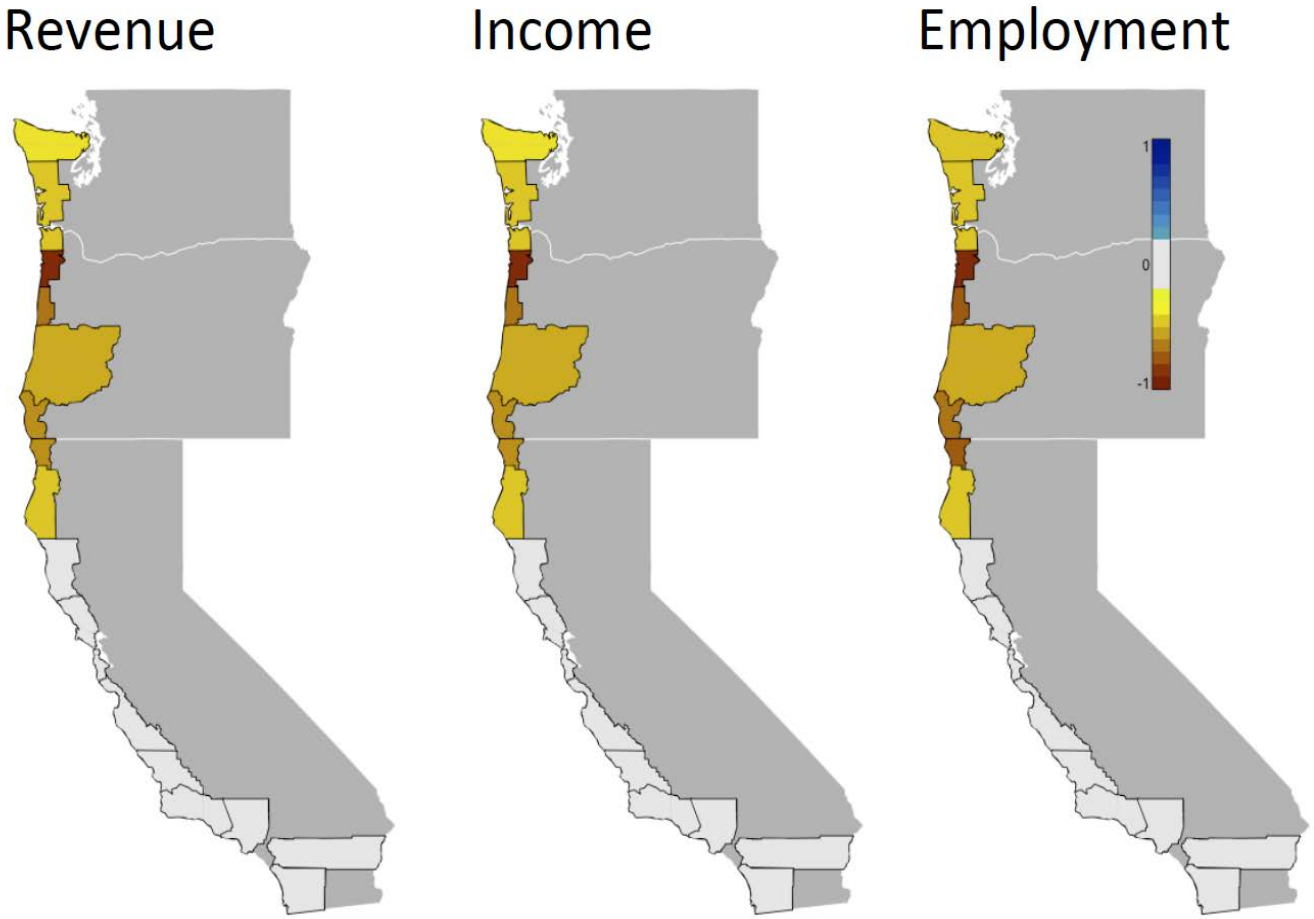


State-managed fisheries (invertebrates) particularly at risk

K.N. Marshall et al. (2017) Global Change Biology

Projected Effects of Ocean Acidification

Effect by port and gear



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

E.E. Hodgson et al. (submitted)

Linkage to NOAA mission: Ecosystem Based Fishery Management Roadmap

- An important challenge as we implement EBFM is to advance our understanding of processes as we discern the relative importance to fishery resources. NOAA Fisheries will work to better understand a broader suite of ecosystem processes, drivers, and threats, including:
- Social and economic considerations, such as:
  - Social and economic factors that influence fishermen, seafood farmers, and other users of the marine environment
  - Economic welfare and social well-being of resource users and dependent communities
  - Community vulnerability and resilience
  - Non-market and existence values of marine mammals, turtles, seabirds, forage species, corals, and other marine species
  - Seafood production
  - Employment
  - Long-term social and economic impacts of resource depletion and recovery