Developing multi-regional economic impact models for Alaska fisheries

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Economic impact analysis

- Estimates change in economic activity from a policy or an external shock.

- Measures changes in output (sales), employment, factor income, and government revenue.

- Uses input-output (IO), social accounting matrix (SAM), or computable general equilibrium (CGE) models.

Direct, indirect, and induced effects

- Direct effect – initial change in the amount of fish caught

- Indirect effect – change in related industries (e.g., fuel, repair service, insurance)

- Induced effect – additional effect from change in household spending

- Total effect = direct + indirect + induced

Multiplier

- Multiplier = total effect / direct effect
- Example:
  - Output multiplier = 1.4 means that one dollar worth of fish landed in an area generates a total of 1.4 dollars worth of total industry output in the area.

Paths of impact generation
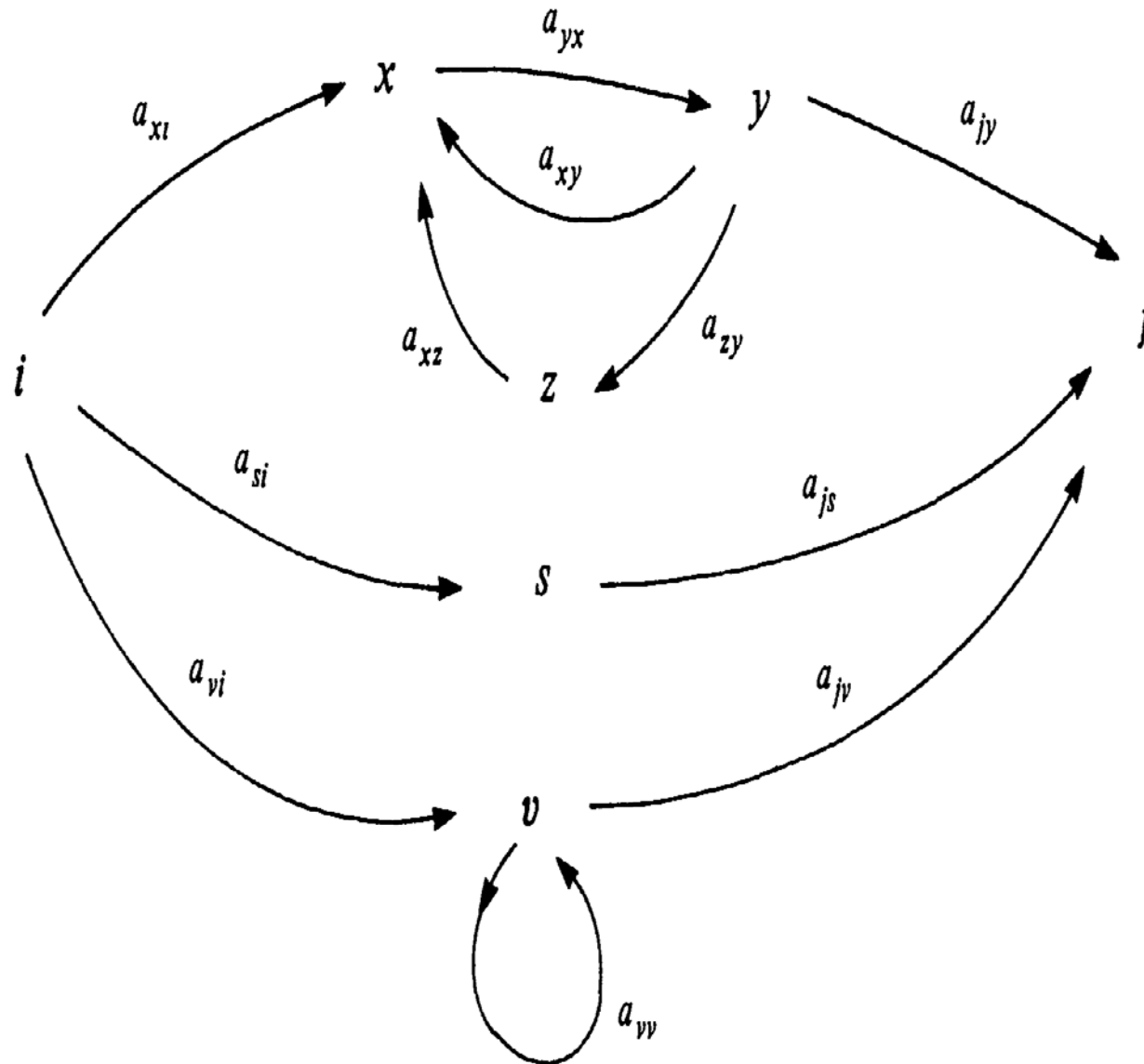
Problems with IMPLAN seafood industry data

- Only two seafood industries (1 harvesting, 1 processing)
- An industry's production technology for a region is the same as the national average
- Understates employment level in commercial fishing sectors
- Does not capture correctly leakages of factor income and imports
- These problems require collecting data from industries

Multi-regional social accounting matrix (MRSAM) models

- Overcome weaknesses of single-region / IO models
- Developed
    - 3 region MRSAM (3-MRSAM) model – Alaska (AK), West Coast (WC), and rest of US (RUS)
    - 10 region MRSAM (10-MRSAM) model – six Southwest Alaska (SWAK) boroughs and census areas (BCAs), At-sea "region", and three non-SWAK US regions.

Basic MRSAM structure

	Alaska	West Coast	Rest of U.S.	Rest of the World
Alaska	Alaska Economy	WC purchases from AK	RUS purchases from AK	AK Exports
West Coast	AK purchases from WC	West Coast Economy	RUS purchases from WC	WC Exports
Rest of U.S.	AK purchases from RUS	WC purchases from RUS	RUS Economy	RUS Exports
Rest of the World	AK Imports	WC Imports	RUS Imports	

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3-MRSAM model

- Each region has 97 endogenous accounts ➔ 291 (97 × 3)
- 97 endogenous accounts:
  - 42 industries
  - 48 commodities
  - 3 value-added accounts
    - labor
    - capital
    - indirect business tax
  - 3 household types
  - a combined state and local government.
- CP sector is split into harvesting and processing activities

3-MRSAM model (continued)

- 42 industries
  - 9 seafood industries (6 harvesting and 3 processing)
  - 33 non-seafood industries.
- Six harvesting industries
  - CPs (harvesting)
  - Trawlers
  - Longliners
  - Crabbers
  - Salmon Netters
  - Other harvesters.

3-MRSAM model (continued)

- Three processing industries
  - CPs (processing)
  - Motherships (non-stationary floating processors)
  - Shore-based processors
- 48 commodities
  - 14 fish species
  - 1 processed seafood commodity
  - 33 non-seafood commodities.
- 14 fish species: Pacific whiting, Atka mackerel, flatfish, Pacific cod, pollock, rockfish, sablefish, crab, halibut, herring, other finfish, other invertebrates, other shellfish, and salmon.

10-MRSAM model

Improvements made to 3-MRSAM model:

- Data from a formal survey
- SWAK disaggregated into six fishing-dependent regions
- At-sea sector treated as a region
- Both gear-based (GB) and species-based (SB) versions developed
- SB version: Seafood industries are defined according to species caught / processed.

10-MRSAM model (continued)

Ten regions
- At-sea
- Aleutians West Census Area (AWCA)
- Aleutians East Borough (AEB)
- Lake and Peninsula Borough (LPB)
- Bristol Bay Borough (BBB)
- Dillingham Census Area (DCA)
- Kodiak Island Borough (KIB)
- Rest of AK (RAK)
- West Coast (WC)
- Rest of US (RUS)

Gear-based model

- 466 endogenous sectors

- Six harvesting sectors: Trawl, Hook and Line, Groundfish Pot, Salmon Gillnet, Crabbers, and Other Gear.

- Each harvesting sector catches some combination of eleven aggregated species:

  - Tanner Crab, King Crab, Other Crab, Pacific cod, Pollock, Sablefish, Rockfish, Flatfish, Salmon, Halibut, and Other.

Species-based model

- 574 endogenous sectors
- A harvesting / processing industry is dedicated to harvesting / processing a single type of fish.
  - Example: Pollock harvesting industry catches only pollock.

At-sea sector

- Treated as a "region"
  - Activities of CPs, mothership processors, and catcher vessels delivering to motherships occur.
- No non-seafood industries, no households, no government
- All industry inputs (primary inputs and intermediate inputs) are imported from other (nine) regions.

Web-based software application

- Motivation
  - No regional economic models by AFSC have been utilized by the analysts for actual policies.
- Reasons:
  - Time gap between analysts' need and AFSC's model construction.
  - Analysts are not familiar with the models.
- Developed a web-based software application for 3-MRSAM model
- Will develop a similar application for 10-MRSAM model.

3-MRSAM model software

- User-friendly
- Compute impacts of fishery management actions or environmental shocks (natural disasters or climate change).
- Types of shocks
  - Commodity-based shock
  - Industry-based shock
  - Combined commodity and industry shocks
- Show the web tool (https://nwecon.psmfc.org) at this point.

Commodity-based shock example

A reduction in Alaska pollock TAC in 2007

- Decrease in ex-vessel value: $40 million
  - ➔ Shock to Pollock-C
- Decrease in first wholesale value: $120 million
  - ➔ Shock to Seafood-C

https://nwecon.psmfc.org

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Example application of 10-MRSAM model

- Evaluate economic impacts of 2018 Gulf of Alaska (GOA) Pacific cod fishery disaster
- Use species-based version model
- Consider both:
  (1) negative effects of a reduction in Pacific cod harvest and
  (2) offsetting effects from an increase in the price of the fish.

Deriving shock vectors

- Based on the real data

- Estimated quantities of GOA Pacific cod fish landed, ex-vessel values, quantities of processed fish, and first-wholesale revenues for years 2017 and 2018 for each BCA / region (Lee 2019)

- Changes in revenues are decomposed into quantity and price changes

Shock vectors (initial impacts, Lee 2019) ($million)

	Harvesting sector		Processing sector	
	Quantity shock	Price shock	Quantity shock	Price shock
AEB	-11.7	1.3	-23.0	3.0
AWCA	-0.4	0.1	-1.4	-0.1
KIB	-7.7	1.2	-15.6	0.6
RAK	-0.9	0.5	-3.3	1.2
AT-SEA (CP + MS)	-4.0	0.8	-9.8	0.4

Net economic impacts

	AT-SEA	AWCA	AEB	LPB	BBB	DCA	KIB	RAK	WOC	RUS
Industry output ($million)	-12.6	-2.0	-32.5	0.0	0.0	-0.1	-25.8	-11.0	-37.5	-43.9
Employment (workers, jobs)	-75	-15	-319	0	0	-1	-268	-60	-200	-221
GRP(value added, $million)	-2.9	-0.5	-15.1	-0.3	0.0	-0.1	-11.9	-8.0	-32.1	-28.1
HH income ($million)	0.0	-0.2	-2.1	-0.1	0.0	0.0	-4.4	-5.2	-21.7	-19.0

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Estimating impacts on smaller geographical areas

- Downscale BCA-level impacts to different sub-BCA areas based on shares of changes in ex-vessel values.

- Assumption: The economic structures of the areas are the same.

Future plan

- Develop a web tool for 10-MRSAM model
- Add a feature enabling calculation of impacts from recreational fishing (charter sector)
  - Can be used to estimate the net impacts of reallocating Pacific halibut between commercial and charter sectors in IPHC Area 2C and Area 3A.

References

- https://nwecon.psmfc.org

- Seung, C. and S. Miller. 2018. Regional Economic Analysis for North Pacific Fisheries. NOAA Tech Memo NMFS-AFSC-38

- Seung, C., E. Waters, and M. Taylor. 2020. Developing a Multi-Regional Social Accounting Matrix (MRSAM) for Southwest Alaska Fisheries. NOAA Tech Memo NMFS-AFSC-399

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