A quantitative metric to identify critical elements within seafood supply networks under a changing climate

Éva Plagányi
Ingrid van Putten, Alistair Hobday, Stewart Frusher, Greta Pecl, Olivier Thébaud, James Innes, Lilly Lim-Camacho, Ana Norman-López, Rodrigo H. Bustamante, Anna Farmery, Aysha Fleming, Bridget Green, Eriko Hoshino, Sarah Jennings, Sean Pascoe, Peggy Schrotback, Linda Thomas
Climate adaptation down under

The Hobo-Dyer Equal Area Projection

This map belongs to the family of Cylindrical Equal Area projections in which the latitude and longitude lines form a rectangular grid. Other projections in this family include the Lambert, Gall, Behrmann, Edwards, and Peters projections. In the present case the "cylinder" is assumed to wrap around the globe and cut through it at 47° north and south, in order to preserve the equal area property the shapes of the landmasses become progressively flattened towards the poles, yet shapes between 41° north and south are well preserved.
Critical components in supply chains | Eva Plaganyi

SURF (Supportive Role To Fishery ecosystems)

Need methods for identifying “key” prey species such as forage fish, upon which upper trophic level predators depend

Weights food web connectance by the importance of trophic connections, so that higher scores indicate a greater potential for indirect food web effects of forage fish fisheries

When the SURFS up, Forage fish are key

\[
SURF_i = \frac{\sum_{j=1}^{S} p_{ij}^2}{L}
\]

\( p_{ij} \) = diet fraction of predator \( j \) on prey \( i \)

\( L \) = total no. of linkages in a food web
What is a supply chain?

The people, businesses, and organisations involved in getting fish from those that catch it to the consumer

A system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer
Climate adaptation in marine fisheries

Need to make supply chains climate-smart in part by analysing their connectivity and identifying which links or nodes may be fragile (Levermann 2014)

Maintain market and be resilient to (climate change driven) change

Need highly efficient and effective supply chains

Future climate changes are likely to be ongoing and uncertain, requiring whole supply chains to be more flexible and adaptable as shocks and challenges become more frequent and difficult
Supply chains and climate change

Growth through reducing vulnerability to shocks

Minimising vulnerability and instability in the supply chain

by identifying critical elements and internal vulnerabilities that can be addressed by industry or government actions

Being prepared

Opportunities and challenges

www.marinehotspots.org
Supply chains and climate change

Where are there vulnerable elements and links in the supply chain?

How does the resilience of this supply chain compare to another one?

A new approach, based on network analysis

Increasing resilience to climate change might involve diversifying the network.
**Why focus on fisheries supply chains**

Seafood is BIG Business

Most commonly traded food commodity globally

In 2011-12, Australian seafood exports to China and Hong Kong were $465 million

Globally trade is worth over US$100 billion

Many fisheries have a long and complex supply chain handling delicate products with many opportunities for things to go wrong.
What do the supply chains for seafood look like?

Southern Rock lobster (SRL)
We looked at 6 supply chains

Southern Rock Lobster

Western Rock Lobster

Tropical Rock Lobster

Wild caught prawns

Commonwealth trawl

Sydney rock oyster
Tasmanian Southern Rock Lobster (SRL)

Fish receivers (drop off points)

Local storage facilities

Processors (North & South Tas)

Burnie airport & Hobart Airport

Primary wholesale

=5%

2%

3%

Bass Strait ferry

Road transport

80%

85%

20-40 %*

Melbourne and Sydney fish market

20-40 %*

50-70 %*

Air-freight

Interim transport

Road transport

Tasmanian retailers

Tasmanian consumers

Tasmanian Restaurants

Lease quota fishers

Quota owner operators

Day fishers

Local storage facilities

Tasmanian consumers

Domestic consumers

Tasmanian restaurants

Tasmanian retailers

Interstate retailers

Interstate Restaurants

Internat’l Importer

Hong Kong Importer

USA, Japan, internat’l consumers

Chinese consumers

50-70 %*

1 %*

1 %*

* Australian sales and export figures vary by year

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Supply chains

can be represented in similar way to

Social networks

&

Food webs
Identify critical elements in the supply chain

\[ \text{Links per node} = \frac{L}{n} \]

\[ \text{Connectance} = \frac{L}{n^2} \]

\[ S_{ji} = \text{proportion of product that flows into element} \]
Compare supply chains
Supply Chain Index (SCI\textsubscript{j}) per receiver

Standardised SCI for supply chain

Less resilient: SCI=0.11

More resilient: SCI=0.02

Smaller number is better
Identify critical elements in each supply chain

Burnie & Hobart airport
Processors (North & South)
Chinese consumers
Hong Kong importer
Sydney & Melbourne market

Relative critical element score
Banana Prawn (Northern Prawn Fishery) with colour coding to highlight key elements identified using the Supply Chain Index (SCI)
Critical elements in different places

Information can inform discussion about building climate resilience to shocks and long-term change and can be tested with scenarios.
| Fishery                  | # of elements | # of links | SCI  | Demand / supply side | 1st key element               |
|-------------------------|---------------|------------|------|-----------------------|-------------------------------|
| Southern Rock Lobster   | 17            | 22         | 0.092| supply                | Hobart airport                |
| Western Rock Lobster    | 22            | 33         | 0.048| demand                | Chinese consumer              |
| Tropical Rock Lobster   | 15            | 16         | 0.084| demand                | Chinese importer              |
| Wild caught prawns      | 15            | 28         | 0.023| demand                | Super markets                 |
| Commonwealth trawl      | 14            | 18         | 0.110| supply                | Co-op business                |
| Sydney rock oyster      | 13            | 19         | 0.140| supply                | On farm storage               |
| Australian aquaculture prawn | 10            | 16         | 0.069| demand                | Domestic consumer              |
Summary

Identify and address vulnerable elements and links in supply chains

Compare across seafood supply chains to identify synergies and improve demand and supply side networks

Increasing resilience to climate change might involve diversifying the network

Increasing value from existing production – value adding, or focussing on the more profitable markets or products, and reducing waste along the supply chain

Economic growth achieved through reducing vulnerability to shocks
A Quantitative Metric to Identify Critical Elements within Seafood Supply Networks

Éva E. Plagányi1*, Ingrid van Putten2, Olivier Thébaud1, Alistair J. Hobday2, James Innes1, Lilly Lim-Camacho1, Ana Norman-López1, Rodrigo H. Bustamante1, Anna Farmery3, Aysha Fleming2, Stewart Frusher3, Bridget Green3, Eriko Hoshino3, Sarah Jennings3, Gretta Pecl3, Sean Pascoe1, Peggy Schrobbback4, Linda Thomas2

Oceans and Atmosphere Flagship
Dr Éva Pláganyi
CSIRO, Brisbane

t +61 7 3833 5955
e eva.plaganyi-lloyd@csiro.au
w www.csiro.au