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

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Australian Government
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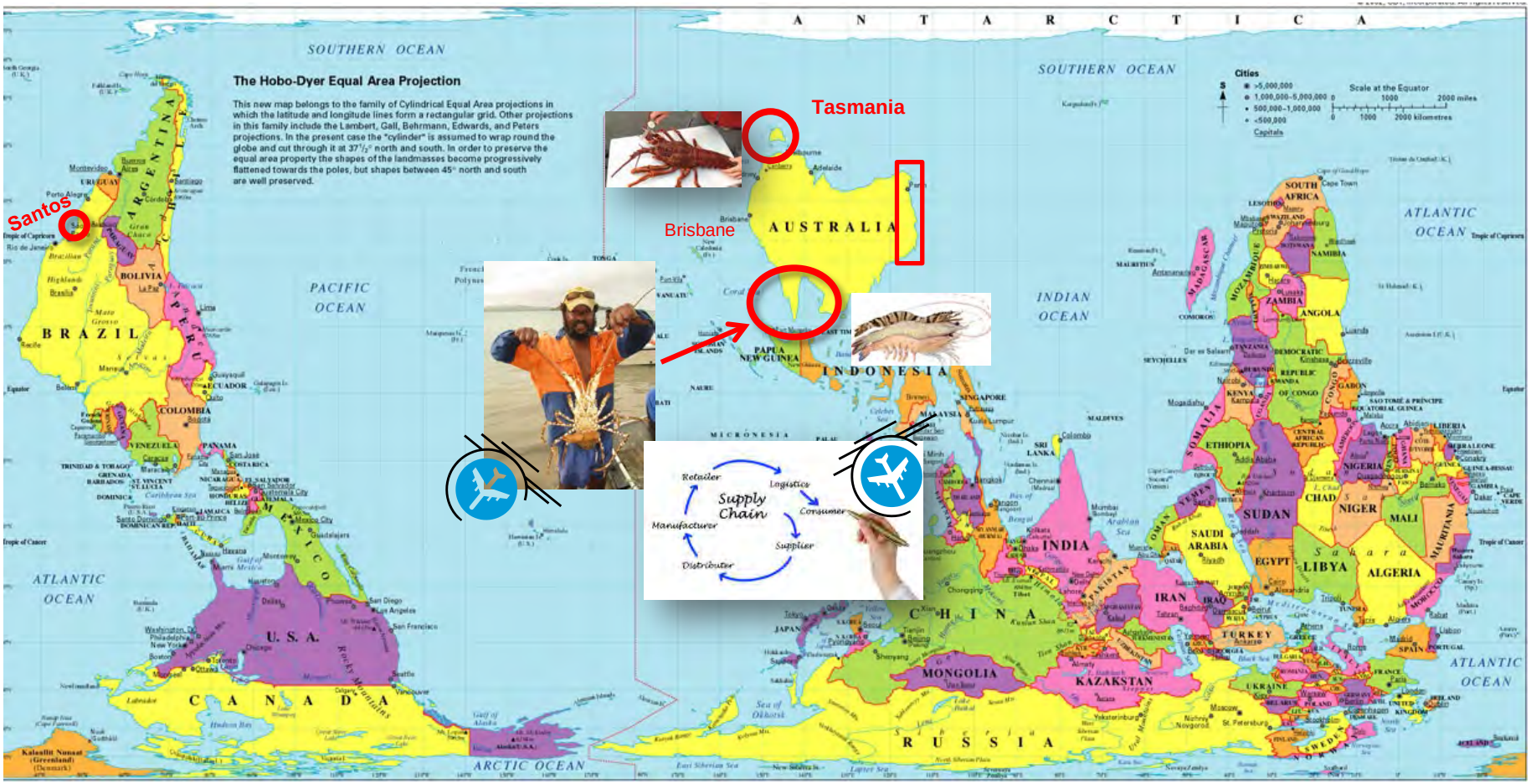
Climate adaptation down under



SURF (Supportive Role To Fishery ecosystems)

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

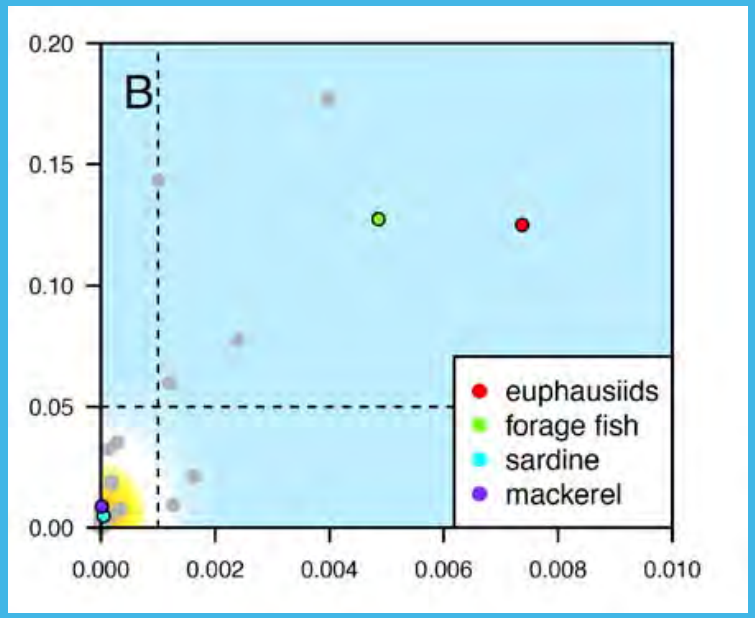
Weights food web connectance by the importance of trophic connections, so that higher scores indicate a greater potential for indirect food web effects of forage fish fisheries

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*

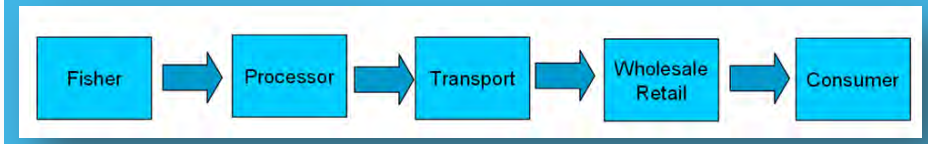
L = total no. of linkages in a food web



Plaganyi & Essington 2014

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

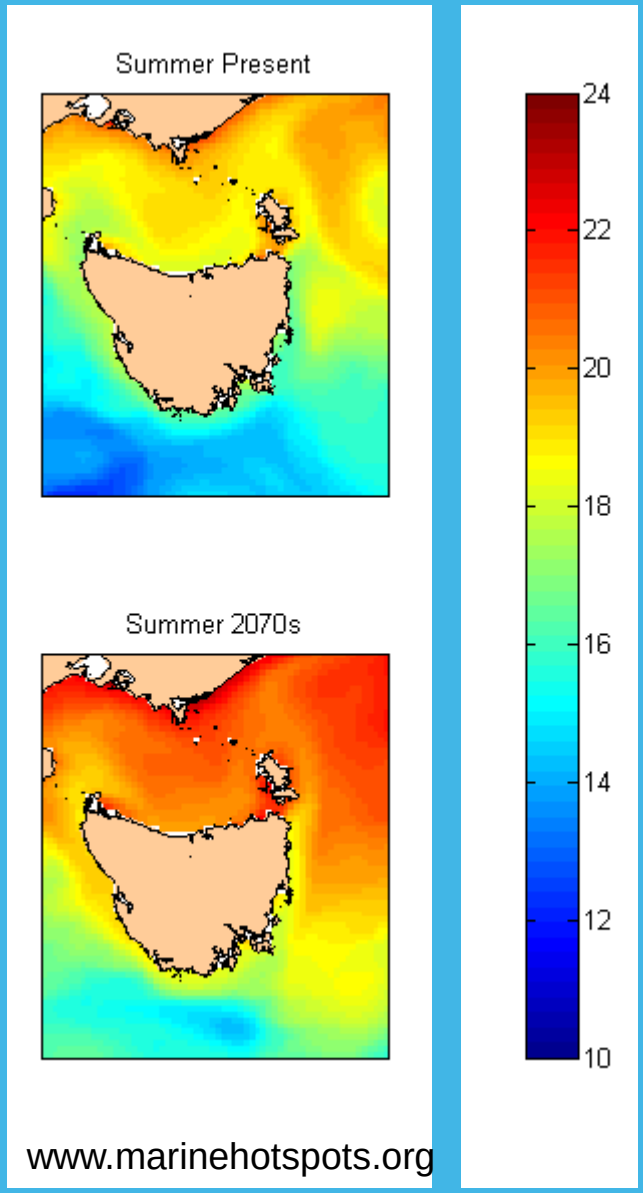
Supply chains and climate change

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



Hobday et al 2014 Marine NARP project funded by FRDC / NCCARF / DCCEE

Global learning for local solutions: Reducing vulnerability of marine-dependent coastal communities: GULLS / Belmont forum

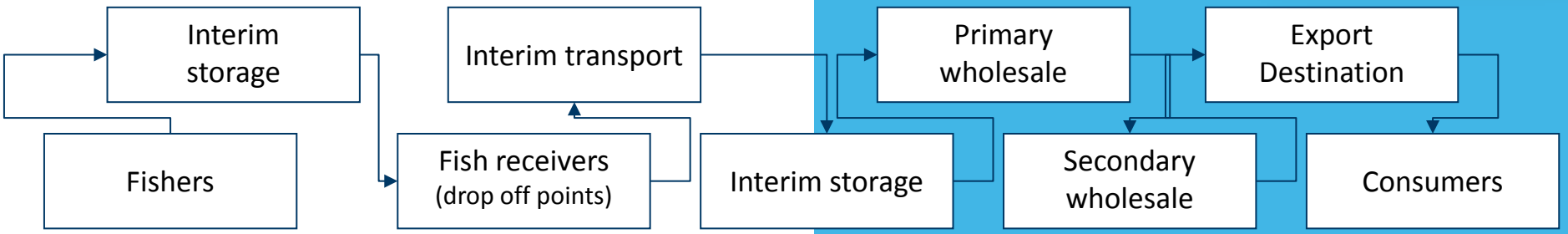
Supply chains and climate change

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

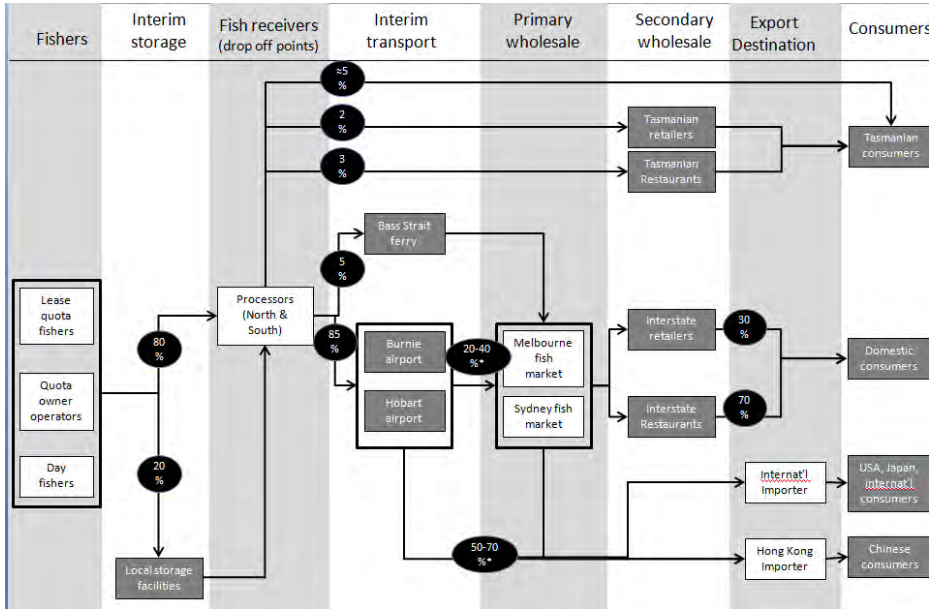
In 2011-12, Australian seafood exports to China and Hong Kong were $465 million

Globally trade is worth over US$100billion

Many fisheries have a long and complex supply chain handling delicate products with many opportunities for things to go wrong.

Developing a sustainable export platform for Australian seafood to China
Jayne Gallagher Manager Product and Market Development

What do the supply chains for seafood look like?



Southern Rock lobster (SRL)

We looked at 6 supply chains

Southern Rock Lobster

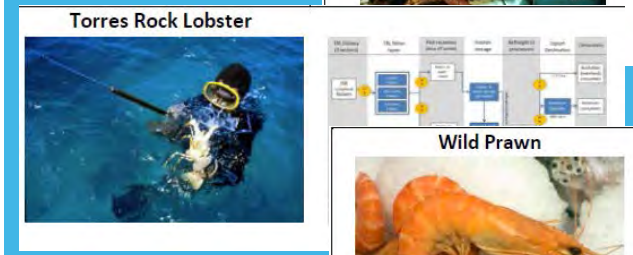
Western Rock Lobster

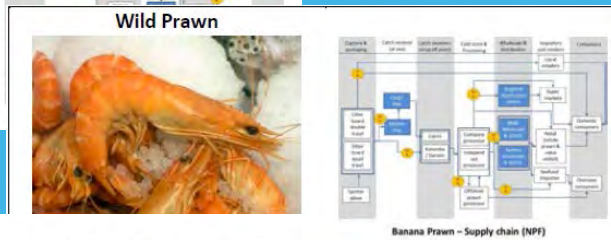
Tropical Rock Lobster

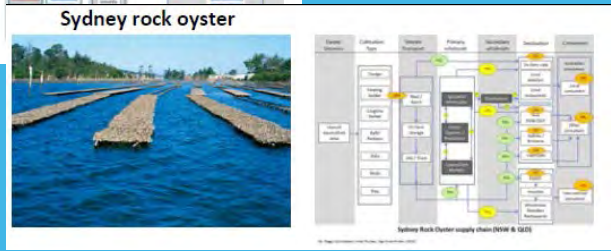
Wild caught prawns

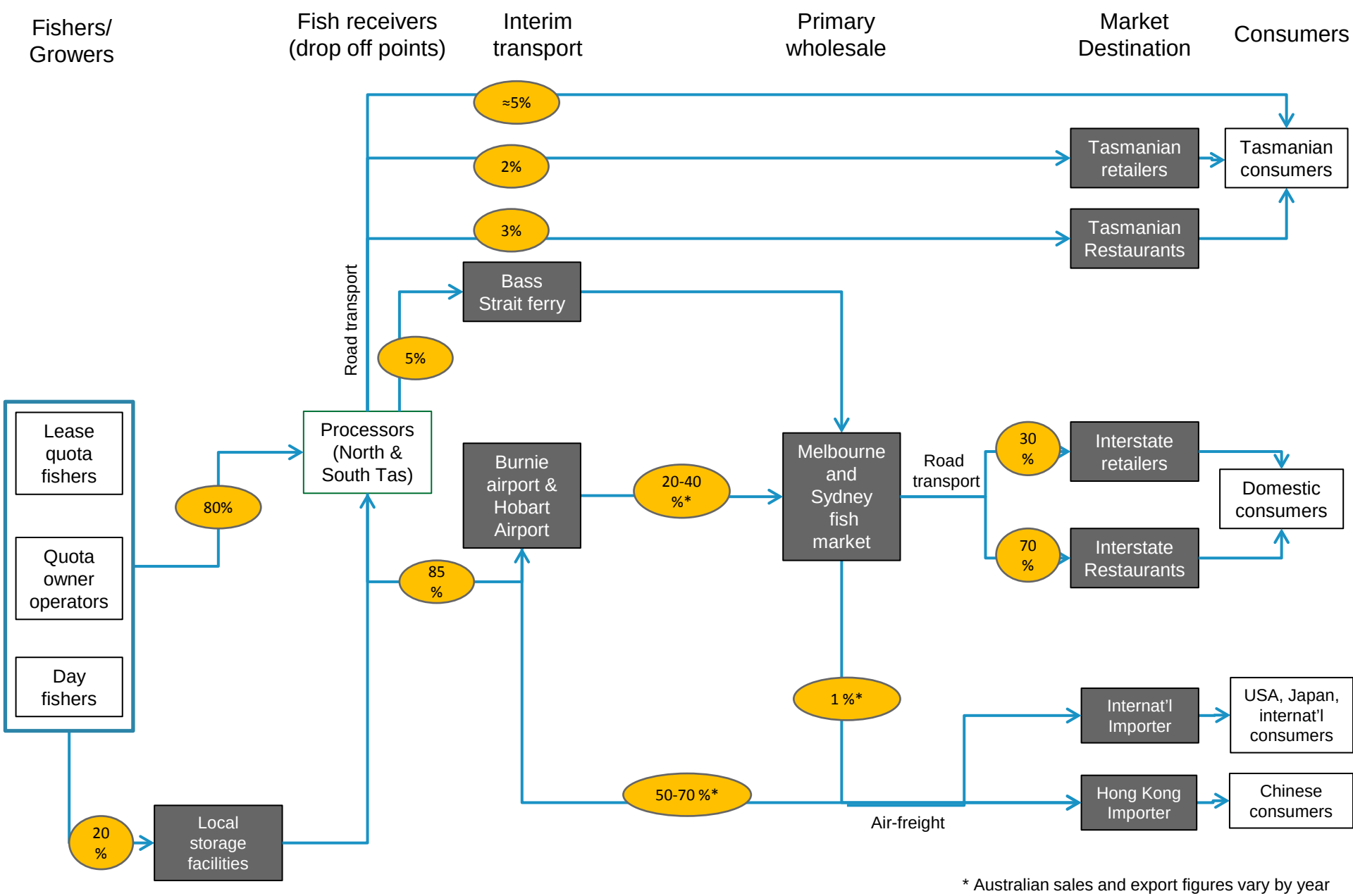
Commonwealth trawl

Sydney rock oyster





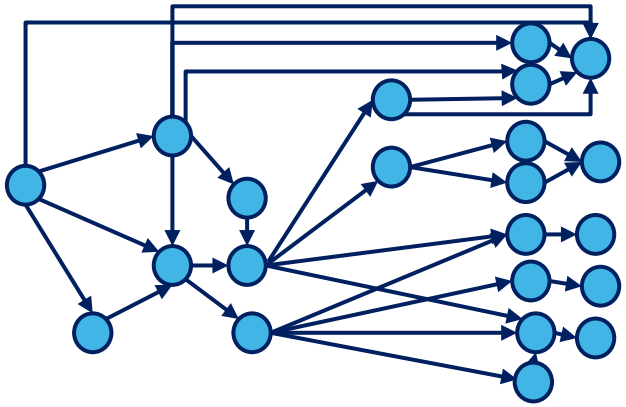




* Australian sales and export figures vary by year

Tasmanian Southern Rock Lobster (SRL)

Supply chains

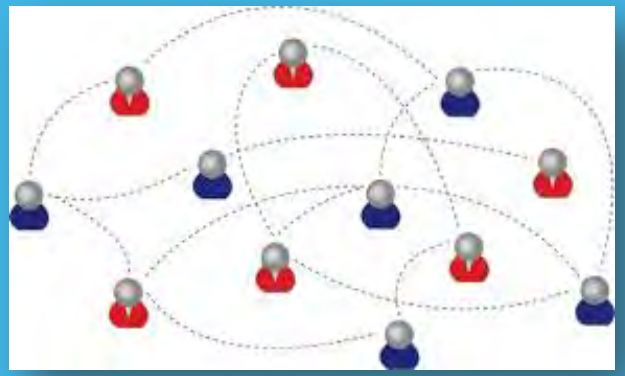


can be represented in similar way to

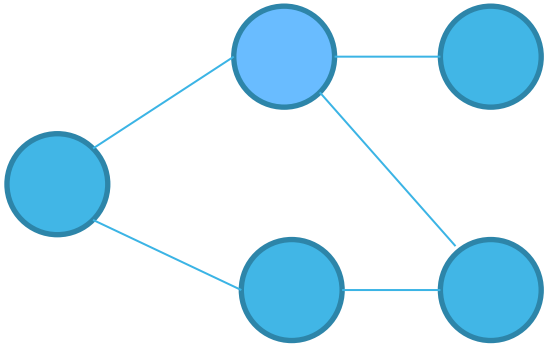
Social networks

&

Food webs

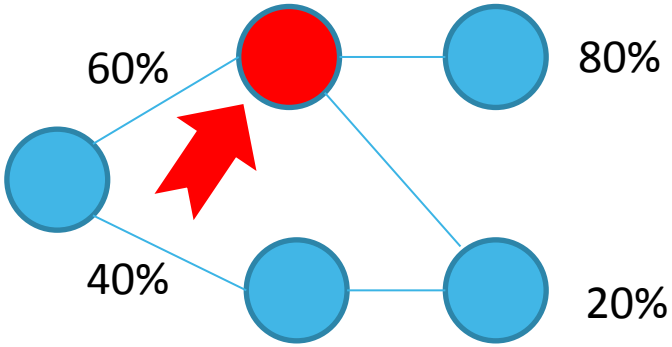


Identify critical elements in the supply chain



n=elements (here 5)
L=links (here also 5)

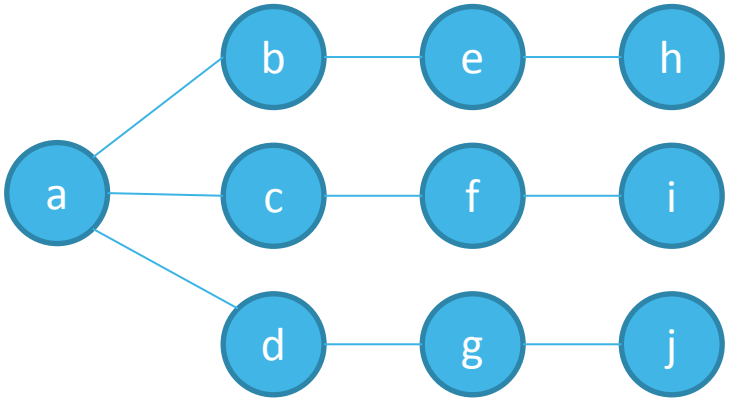
Links per node = L/n
Connectance = L/n2

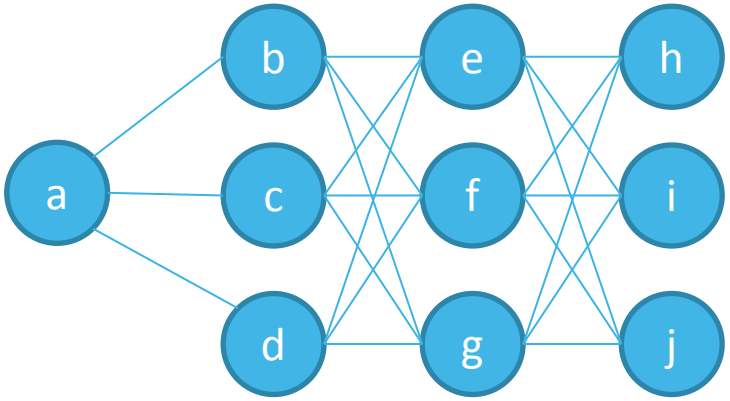


S_{ji} = proportion of product that flows into element

Compare supply chains

Supply Chain Index (SCI_j) per receiver





Standardised SCI for supply chain

$$SCI_j = \sum_{i=1}^{n} s_{ji} p_j^2$$

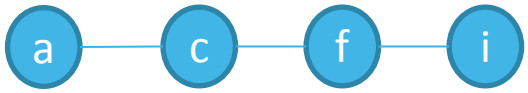
$$SCIT = \sum_{i=1}^{n} SCI_j$$

$$SCI = \frac{SCIT}{L}$$

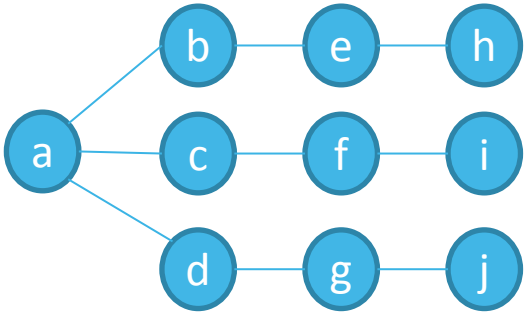
Less resilient:
SCI=0.11

More resilient:
SCI=0.02

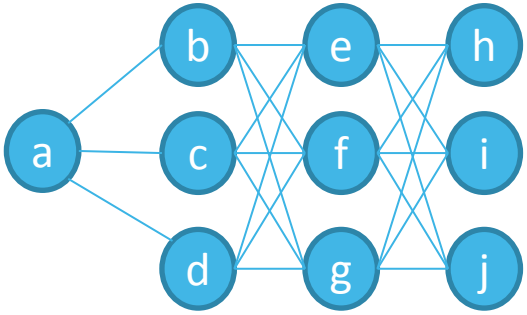
Smaller number is better



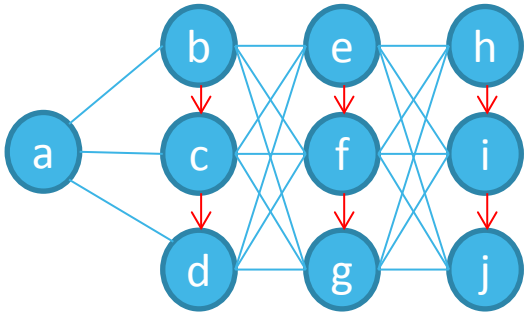
n=4, L=3,
SCI=1



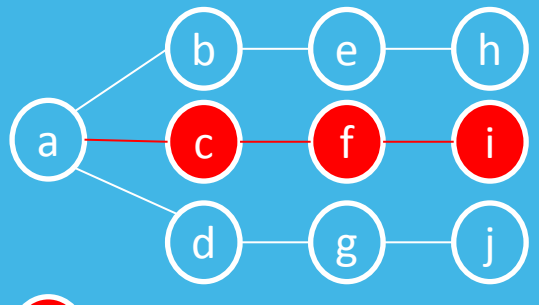
n=10, L=9,
SCI=0.11



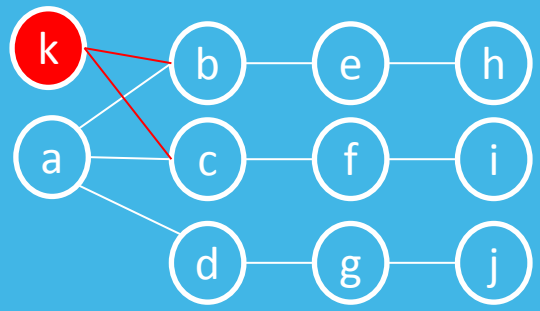
n=10, L=21,
SCI=0.02



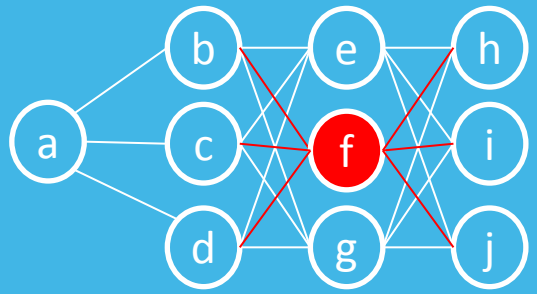
n=10, L=27,
SCI=0.01



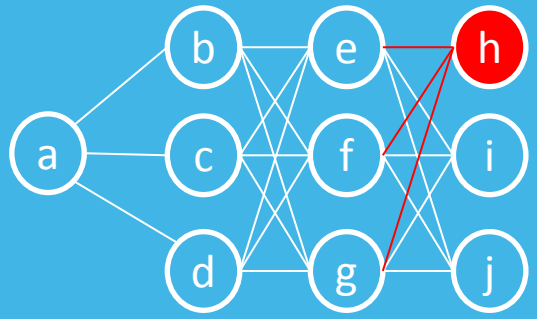
n=7, L=6,
SCI=0.21



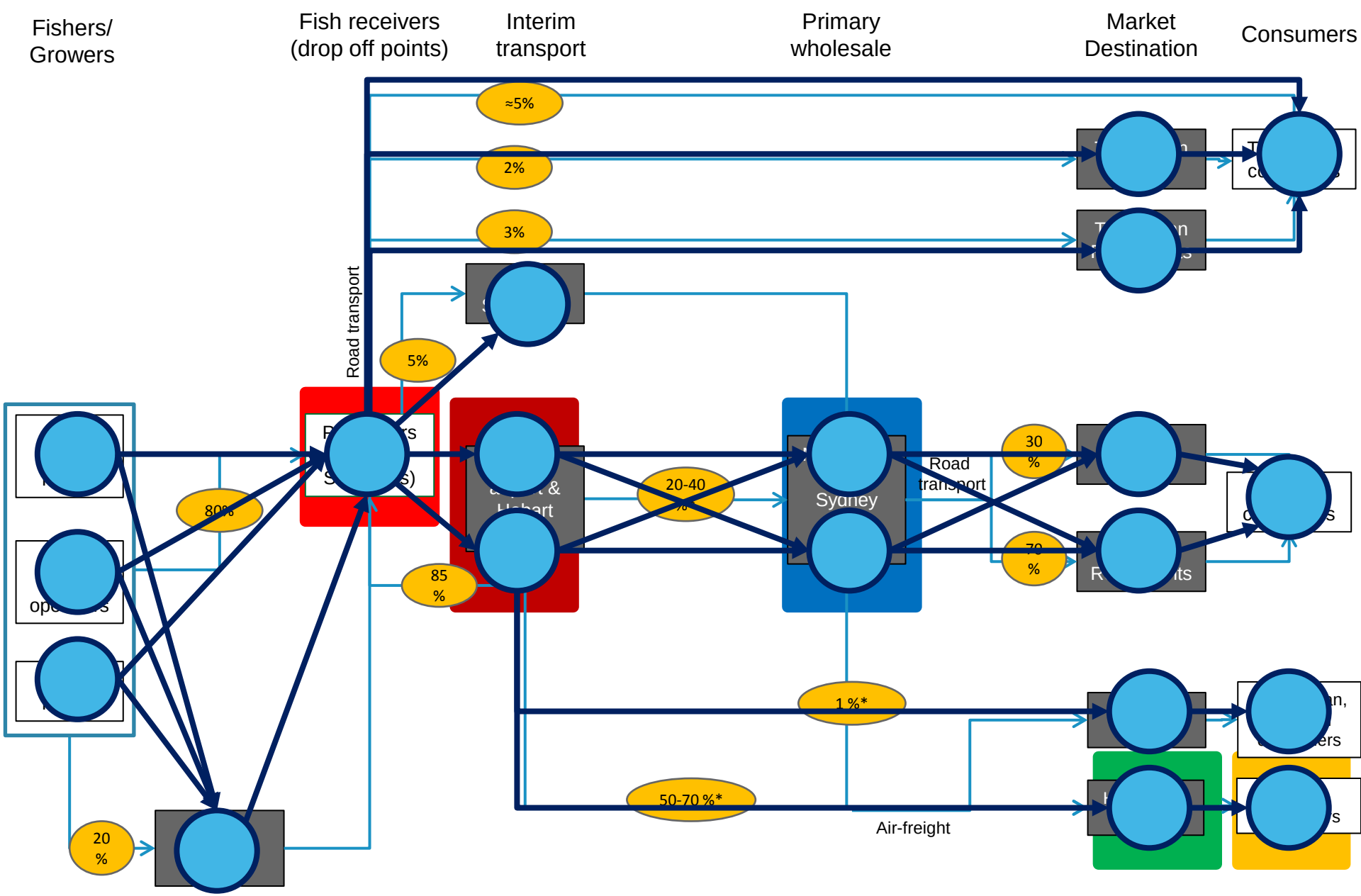
n=11, L=11,
SCI=0.08



n=9, L=15,
SCI=0.03



n=10, L=21,
SCI=0.05

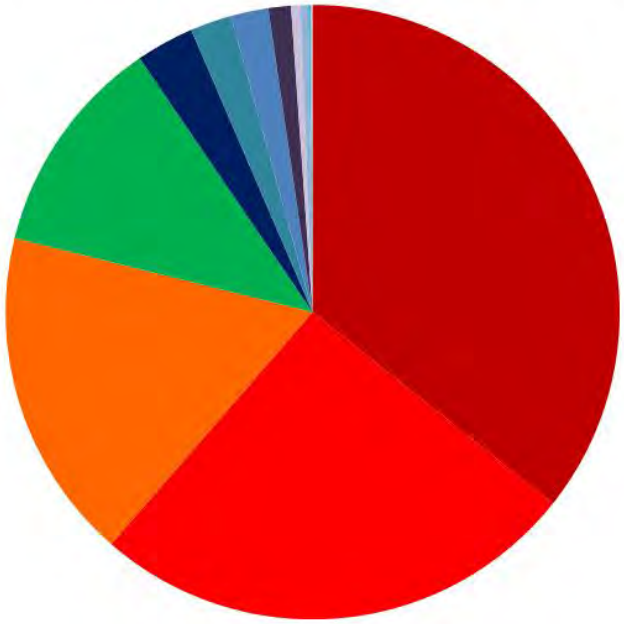


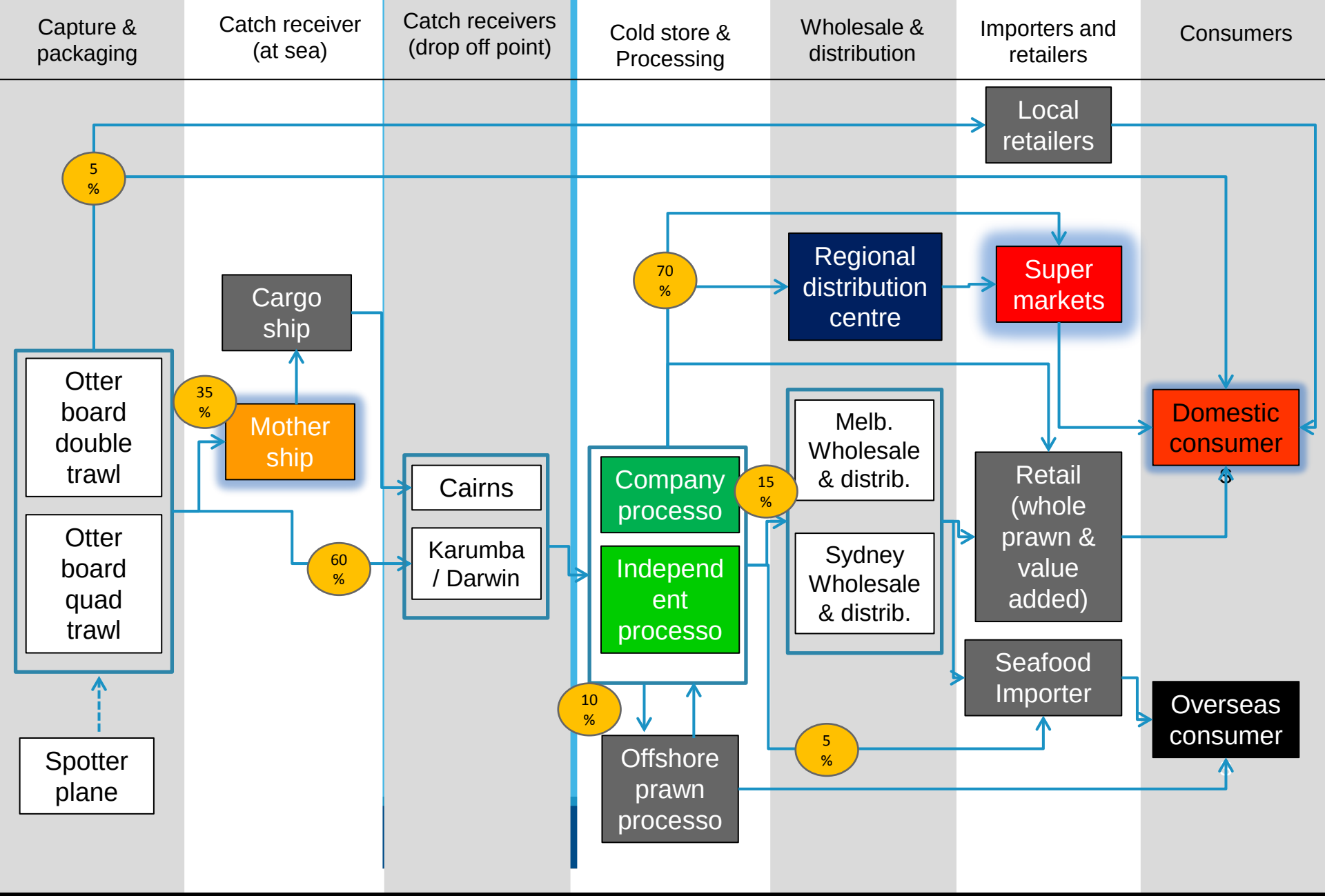
Tasmanian Southern Rock Lobster (SRL)

Identify critical elements in each supply chain

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

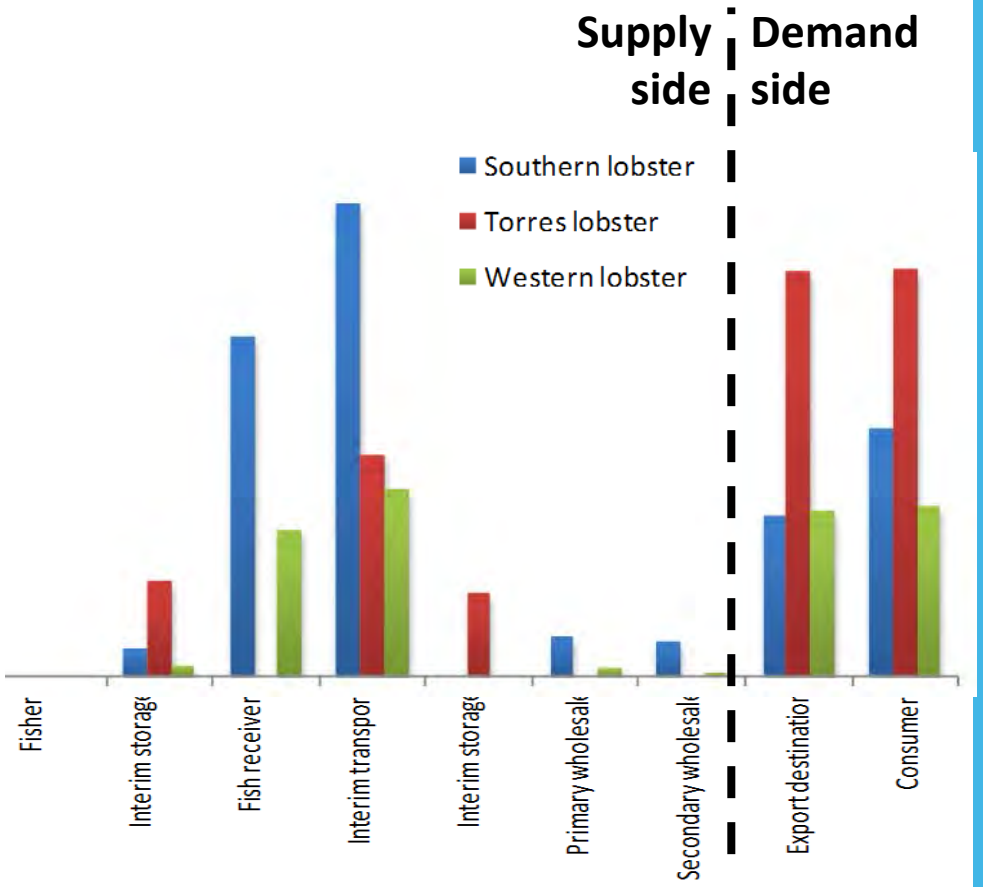
Relative critical element score





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

Learning from other fisheries supply chains (comparisons)

	# 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

OPEN ACCESS Freely available online

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A Quantitative Metric to Identify Critical Elements within Seafood Supply Networks

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