Can molecular techniques be used as cost-effective tools for understanding change in marine ecosystems?

Workshop

Biochemical Tracers for Use in Fisheries Research including Ecosystem Based Fisheries Management

December 3, 2008, at CMAR Hobart

Tasmanian Aquaculture and Fisheries Institute

UTAS

Tasmania
Explore the possibilities

CSIRO

Australian Government
Department of the Environment, Water, Heritage and the Arts
Australian Antarctic Division

TAFI is a joint venture between the State Government and the University of Tasmania

Marine ecosystems (below the surface) are difficult and expensive to monitor (especially in deep water).

A multi-pronged approach is often required.

An important component for understanding ecosystem processes is to understand the trophodynamic links within ecosystems

In a recent review of trophodynamic indicators, it was emphasized that no single metric (e.g. trophic level) could adequately cover the bottom-up effects of climate and the physical environment of the ocean, and the top-down effects of fishing.

Metrics of trophodynamics are considered important ecosystem indicators for measuring the strength of interactions between different living components, and of structural ecosystem changes resulting from exploitation or climate change.

We suggest that a combined molecular approach has the potential to be a cost effective method to monitor trophodynamic change in ecosystems.

The combined approach includes:

- **Stable isotopes**
- **Fatty acids**
- **DNA markers**

- **Stable isotopes** can indicate the food at the base of a consumer diet and the trophic level upon which a consumer depends.

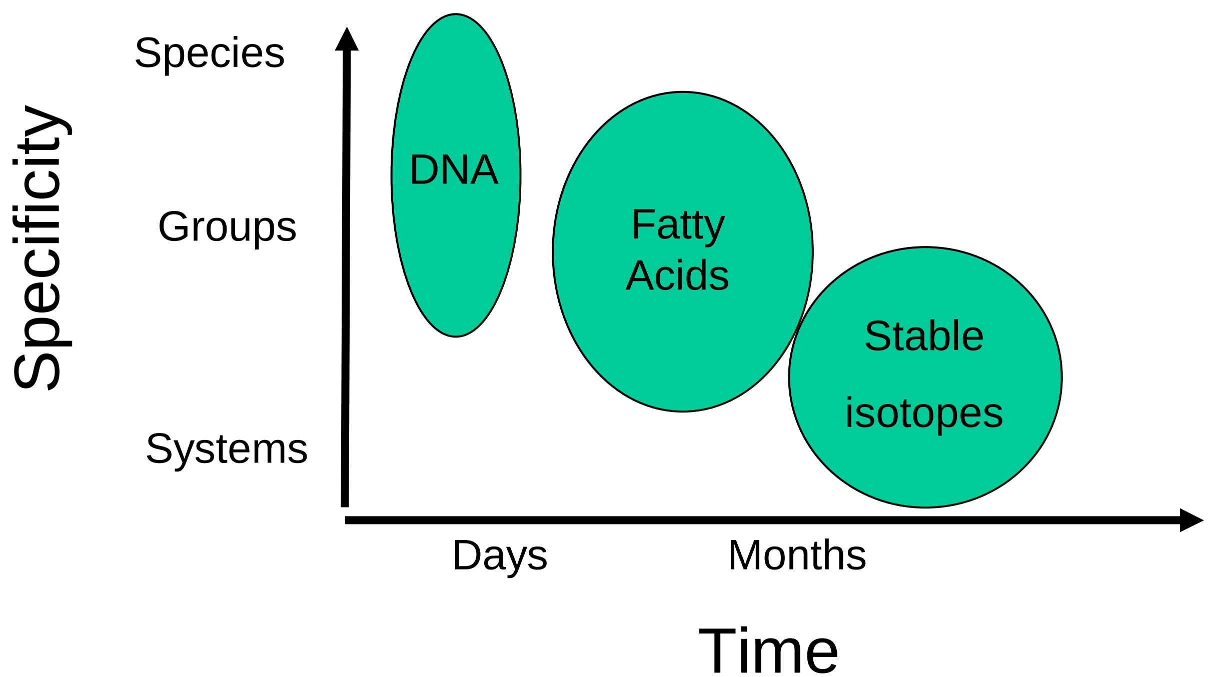
- **Lipid/fatty acid** analysis can convey information about the nutritional condition of a consumer and lipid signatures reveal information about consumer diets

- **DNA** can detect specific dietary items eaten

Advantageous over a single method:

- DNA markers are useful for obtaining precise identification of prey ingested over daily cycles

- Stable isotopes and fatty acids provide a time integrated representation of diet over weekly to monthly intervals.



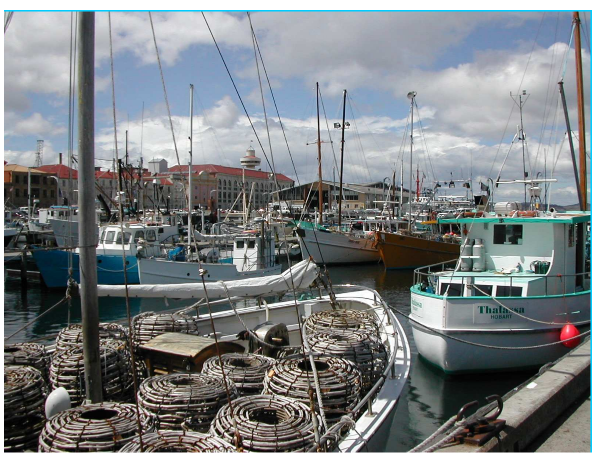
Internationally it has been recognized that higher trophic level predators are the most vulnerable to fishing pressure and trophodynamic shifts due to ecosystem change.

Changes at the base of the ecosystem are expected to be magnified up the food chain.

There is opportunity to collaborate with the fishing industry to obtain samples during routine fishing operations

(SI-small flesh portion; FA-small flesh portion & liver; DNA-stomach or intestine)

(e.g. freeze offal in individual bags)



Cost effectiveness:

Small sample sizes (SI = 10/sp; FA = 20/sp; DNA = 100/sp)

By-product from fishing activities (liver, intestine and muscle tissue [head])

For example: Select key fished species

Demersal	**Large pelagic**	**Small pelagic**
Trevalla	Yellowfin tuna	Redbait
Ling	Swordfish	Jack mackerel
Dogfish	Shark	?

Select food items (~5/species) & obtain DNA specific markers

Use / Measureability:

1. Single Environmetric (e.g. water quality measurements)

    Combination of relative values (scaled 0 -1)

    Combination of weighted relative values

2. Individual absolute or relative values

    Carbon and nitrogen (sulphur) isotopes

    Essential fatty acid profiles

    Lipid signatures

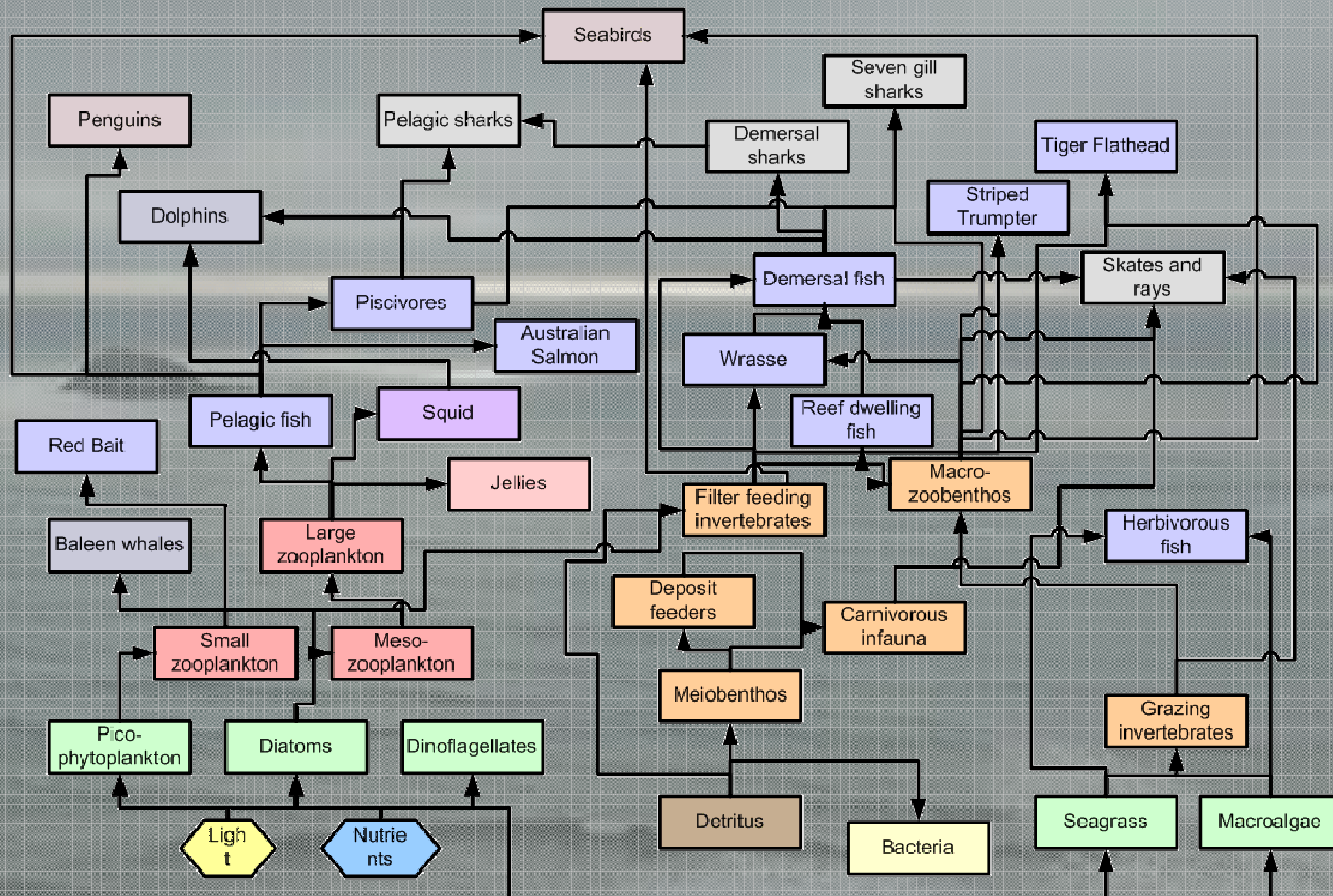
    Presence and/or quantification of species contribution to diets

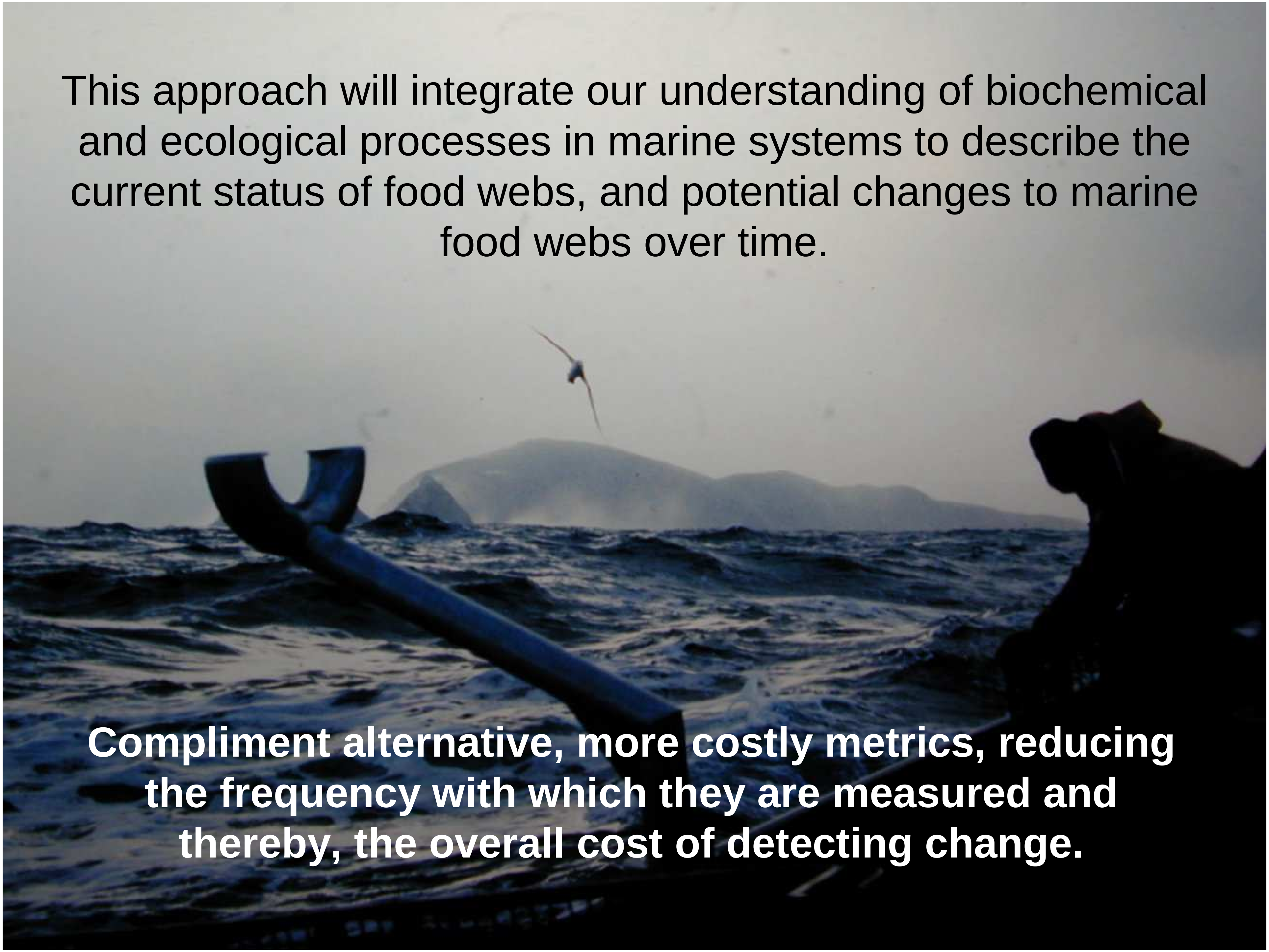
3. Relative change in a suite of indicators

	Stable isotopes			Fatty Acids			DNA			
	Trophic level	Source of carbon	Potential contribution	Group 1	Group 2	Condition	Sps 1	Sps 2	Sps 3	Species complex
Compared to reference level/baseline	Green	Yellow	Yellow	Red	Green	Yellow	Green	Green	Red	Yellow
Compared to last year	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Green
Compared to X years ago	Green	Green	Yellow	Green	Green	Yellow	Green	Green	Yellow	Yellow

- Green: 0-10% change
- Yellow: 10-20% change
- Red: > 20% change

4. Inform ecosystem models of trophic links




This approach will integrate our understanding of biochemical and ecological processes in marine systems to describe the current status of food webs, and potential changes to marine food webs over time.
Compliment alternative, more costly metrics, reducing the frequency with which they are measured and thereby, the overall cost of detecting change.