

Seasonal forecasting: supporting marine fishers and managers in a changing climate

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with

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Further information

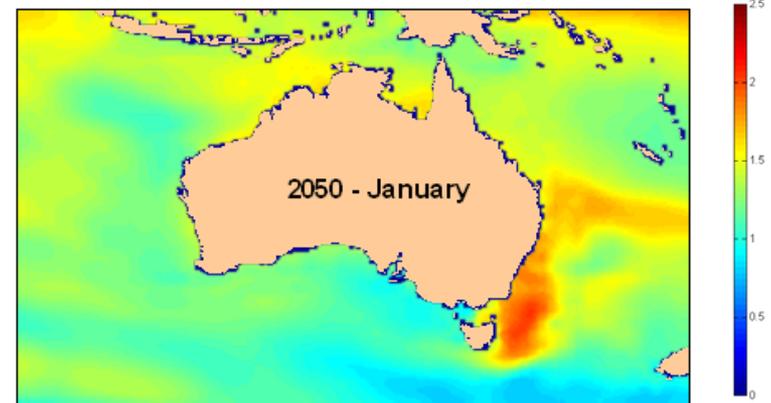
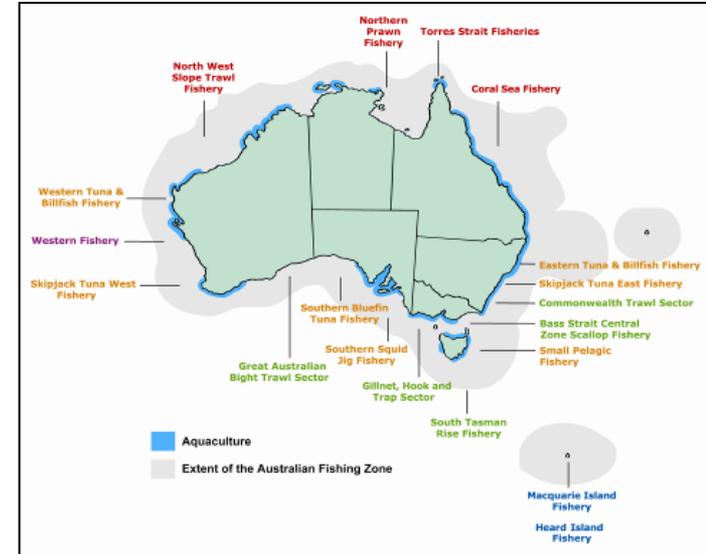
- Hobday et al. (2016) *Fisheries Oceanography*
- Eveson et al (2015) *Fisheries Research*
- Spillman & Hobday (2014) *Climate Risk Management*
- Spillman et al. (2015) *Aquaculture*
- Hobday et al (2010) *Fisheries Oceanography*
- Hobday and Hartmann (2006) *Fisheries Management and Ecology*.
- Hobday et al. (2011) *CJFAS*
- Little et al (2015) *Climate Risk Management (Derivatives)*
- Vanhatalo et al (2016) *Ocean Modelling (downscaling and extrapolation)*

- POAMA: <http://poama.bom.gov.au>
- Forecasts – website examples:
 - Tuna - GAB: www.cmar.csiro.au/gab-forecasts
 - Prawns - http://poama.bom.gov.au/marine_mw/prawn_project.shtml

Long-term climate risk to seafood sector

Biophysical impacts include:

- Range changes (best location)
 - Species move (+ / -)
- Growth changes
 - Positive and negative
- Environmental changes
 - ↑ upwelling (↑ productivity?)
 - Disease risk
- Extreme events
 - ↑ storms (freshwater, turbidity)



Hobday and Lough 2011

The future will be different...

- Climate change is leading to a future where past experience is of reduced value.
- Past patterns will not be repeated: novel combinations of physics, chemistry, and biology
- Need to make decisions that are generally ok even if the details change, based on the best information available at the time
- Risk management approach is useful

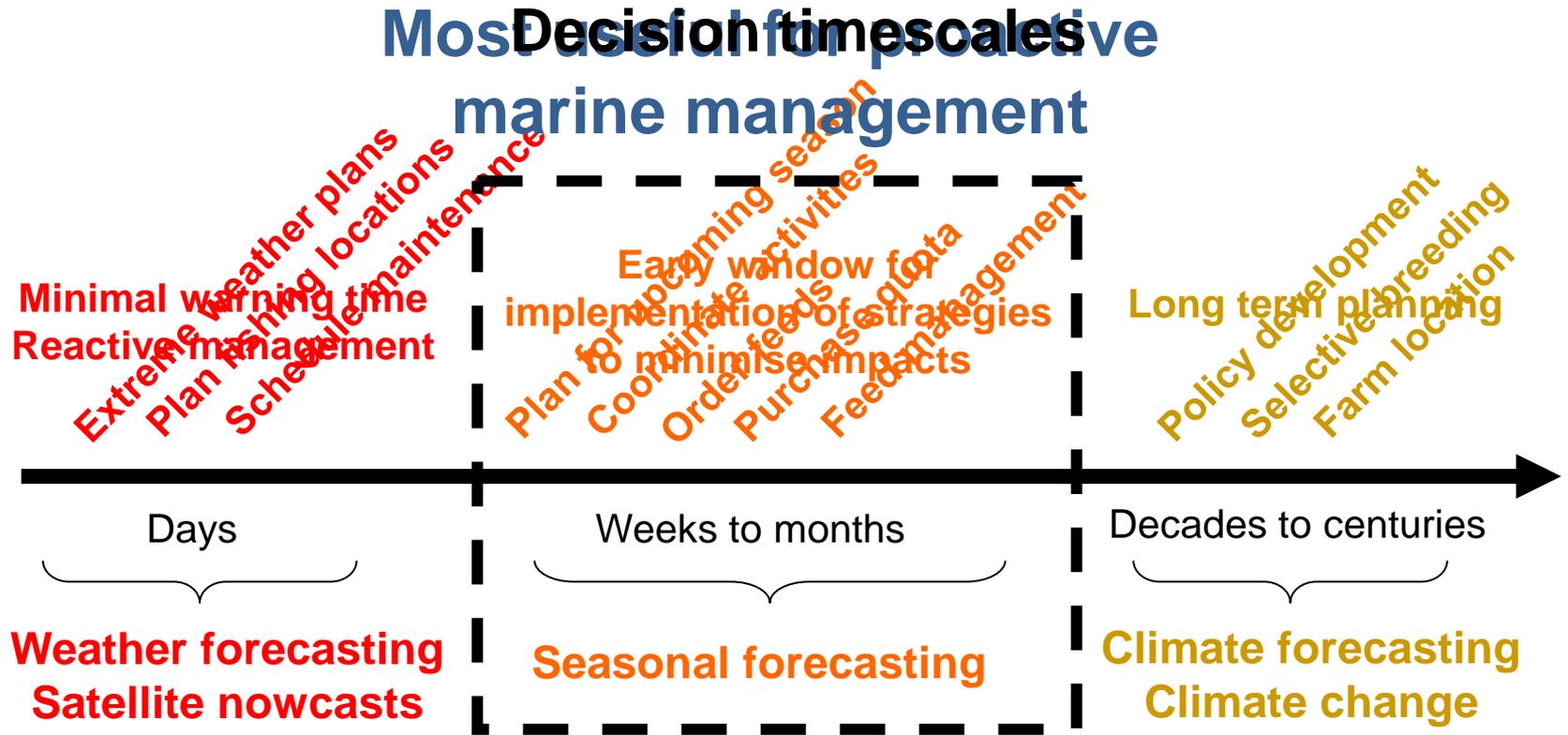


Climate variability vs. climate change

In fisheries and aquaculture, coping with climate variability is “business as usual” to many...

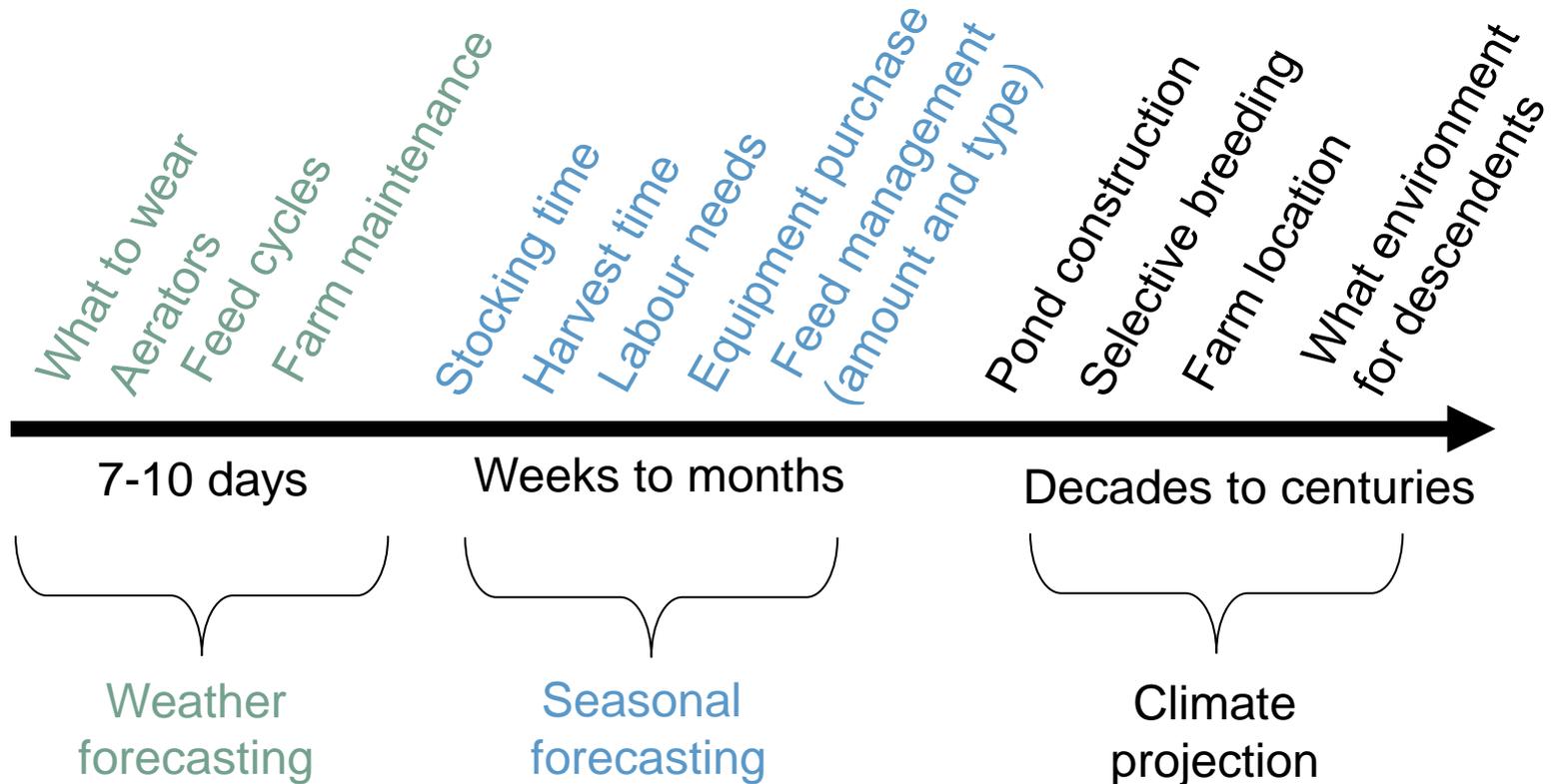
- Coping with climate variability is **responsive** adaptation
Cost effective? Does it allow for “opportunity” to be recognised?
- Climate change is a new factor for a range of businesses
Can it just be managed as for climate variability?
 - ➔ Anticipating climate variability & change is **proactive** adaptation
 - ➔ Business performance could be improved with predictions about the future

Recognize relevant time scales

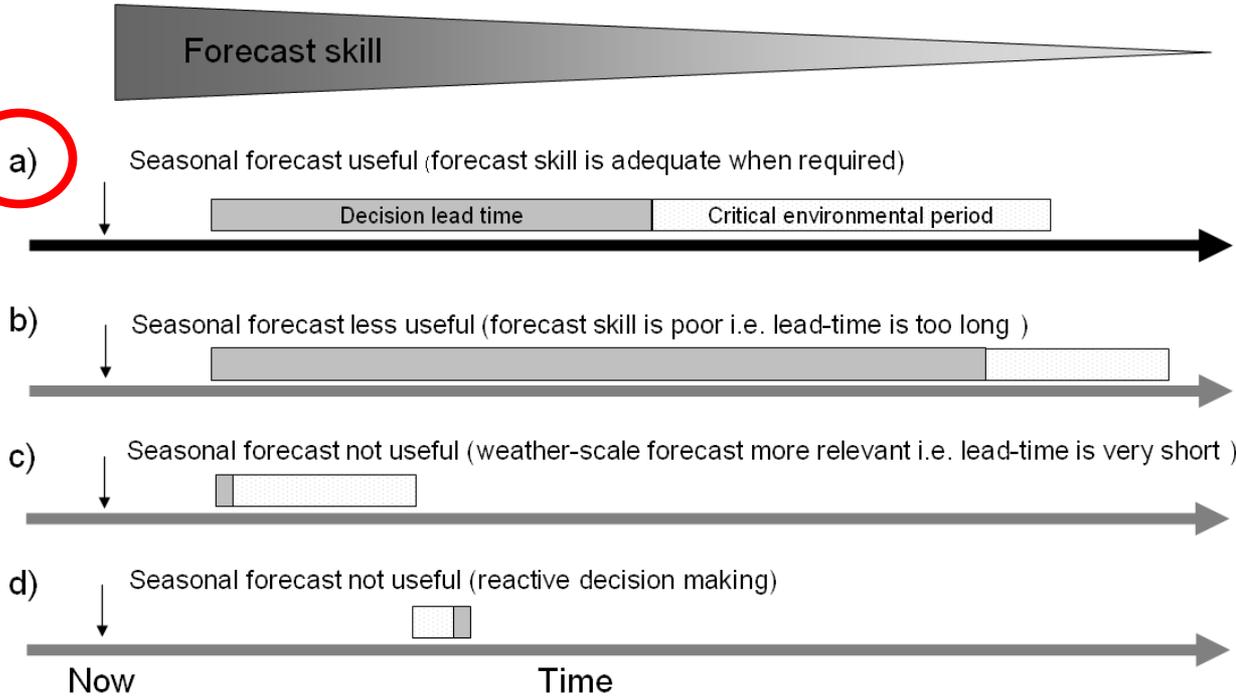


Better managed marine resources have improved resilience under climate change

Recognize relevant time scales - with your end users



When is seasonal forecasting useful?



Usefulness depends on the timing of both the **management decision** to be made and that of the **critical environmental period** affecting the decision, together with **forecast accuracy** at that time.

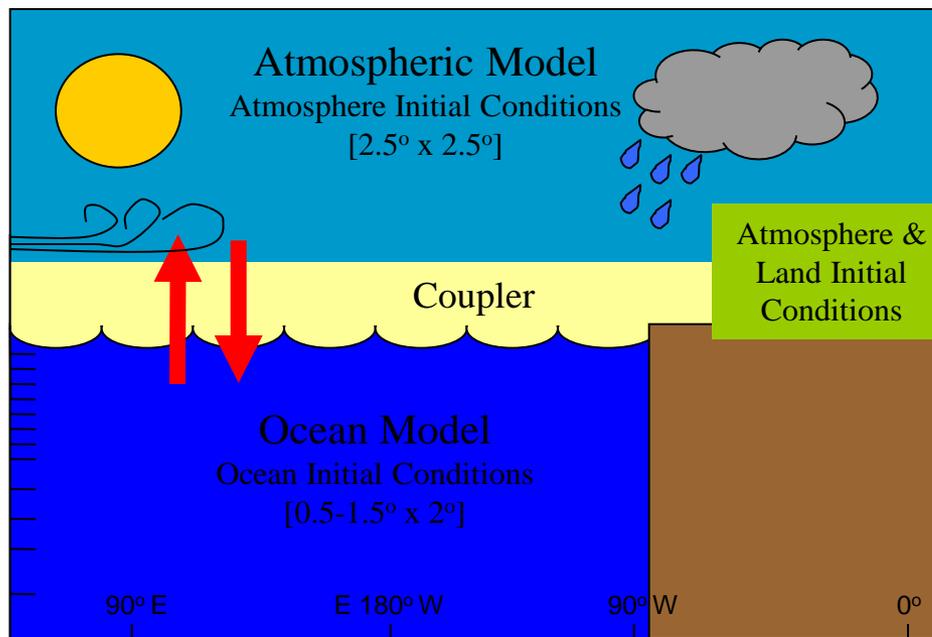
When the lead-time required to make a decision is such that the forecast skill for the critical environmental period is adequate, a seasonal forecast may be useful (a).

Seasonal forecasting



Predictive Ocean Atmosphere Model for Australia

Global dynamical coupled ensemble ocean-atmosphere and data assimilation seasonal prediction system



- Forecasts out to 9 months
- Weekly to seasonal multi-model predictions
- Ocean and atmosphere products available
- 33 member ensemble
- Probabilistic forecasts
- Run operationally x2 weekly

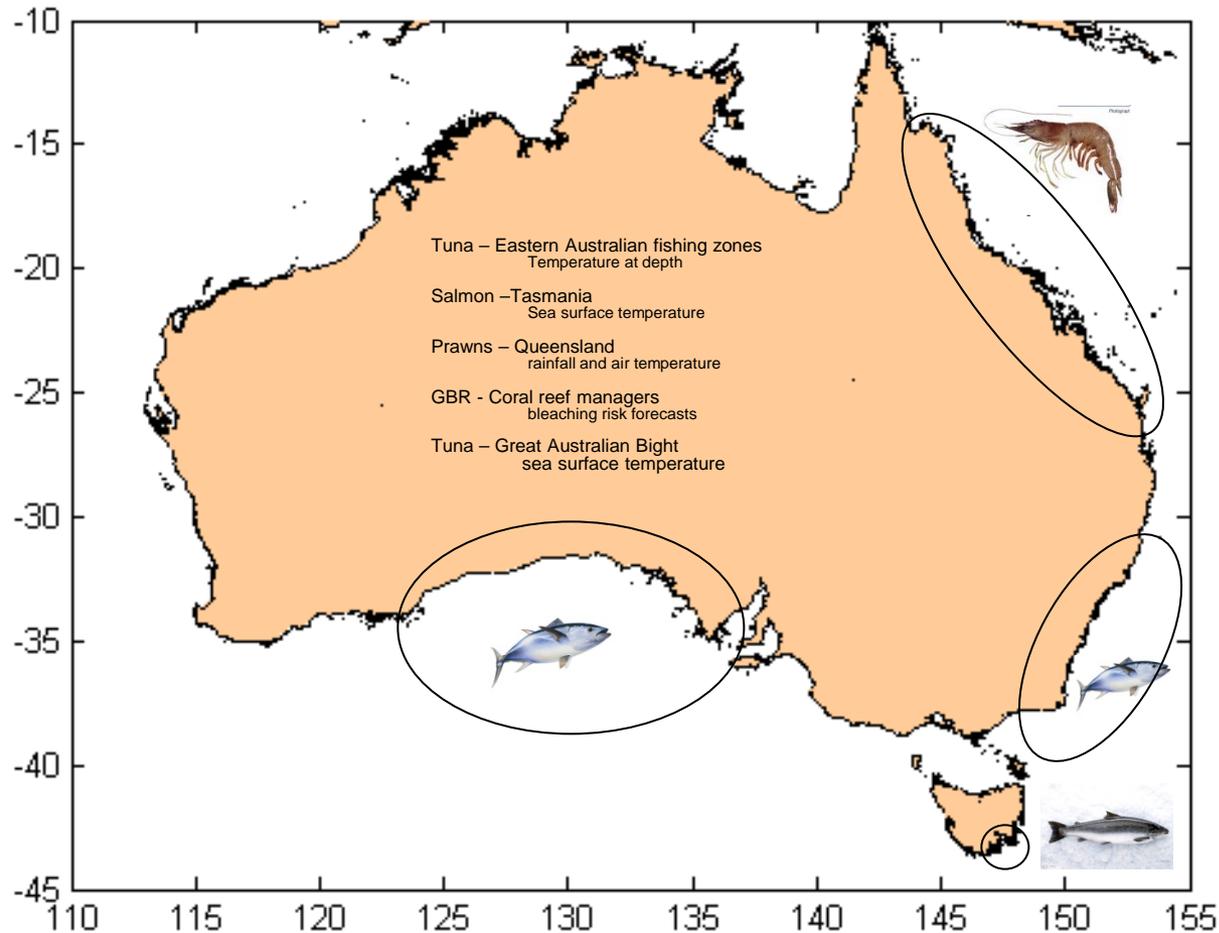
<http://poama.bom.gov.au>



Australian Government
Bureau of Meteorology



Fisheries and aquaculture seasonal forecasts (primary variable & “habitat”)



Development stages for fishery & aquaculture forecast tools

A. Assess needs

Define management or industry need



Determine critical variables & decision timescales

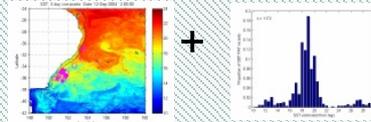
Verification data



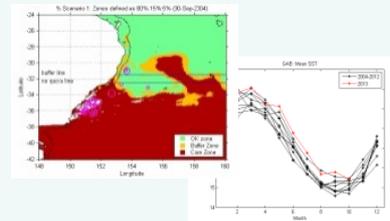
B. Development

Assess skill using POAMA hindcast

Produce habitat distribution forecast



Forecast products



C. Implementation

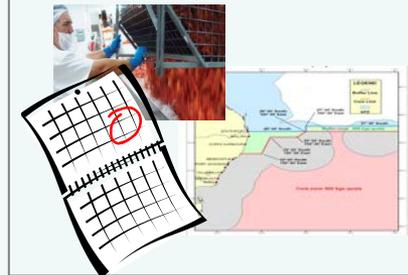
Forecast delivery



Support & education



End user decision



User feedback

Southern bluefin tuna fishery example #1

Issue:

Changing SBT distributions

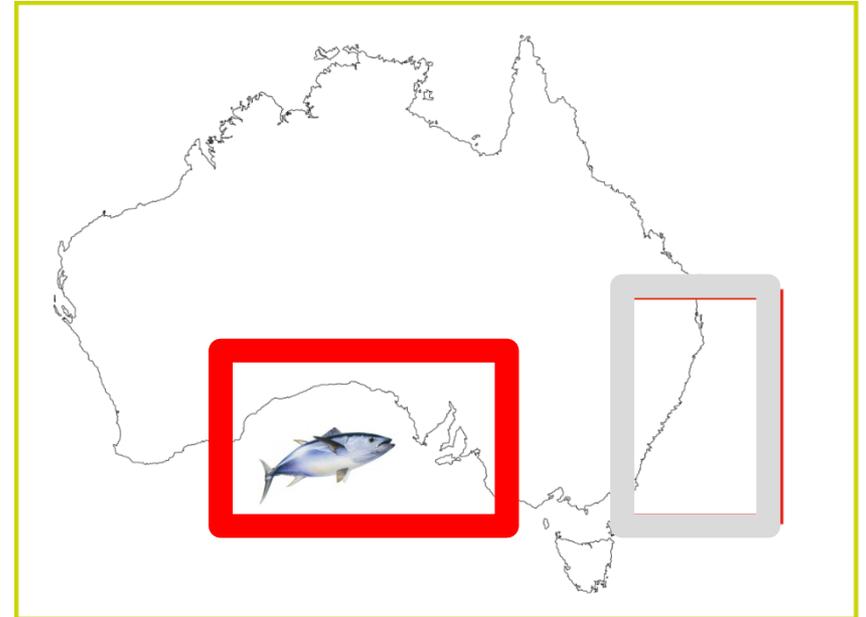
Need:

Improve efficiency of industry

Solution:

Invest in research and fisher education

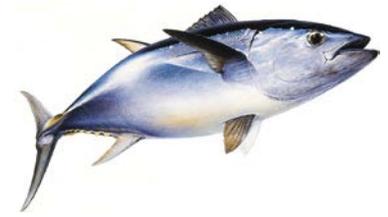
Seasonal forecasts to improve operational planning of fishers



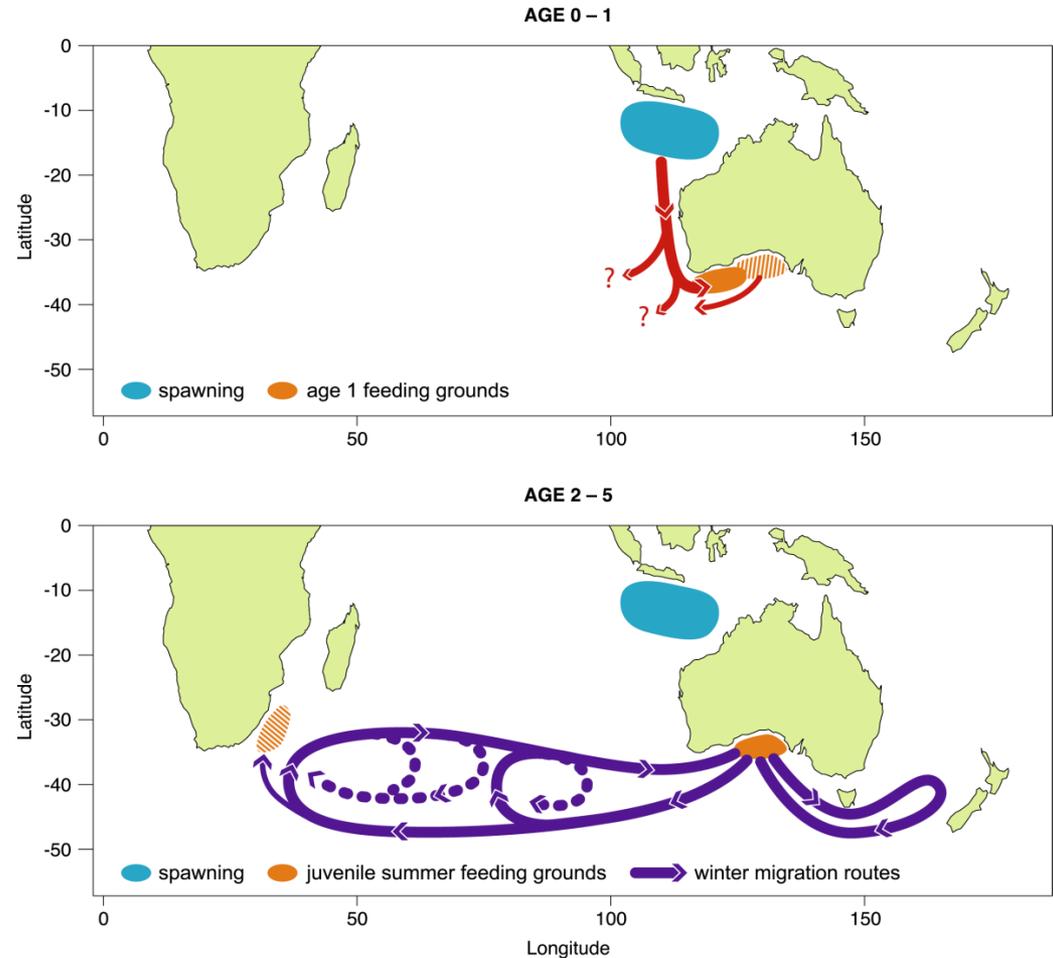
Helping fishers – economic efficiency

Quota-managed fishery so does not increase catch

Juvenile southern bluefin tuna



- Juveniles (age ~2-5) make annual cyclic migrations
- Spend winters across southern ocean
- Spend summers in GAB (Dec-Apr)
- Purse-seine fishery worth ~\$60M/yr occurs in GAB in summer

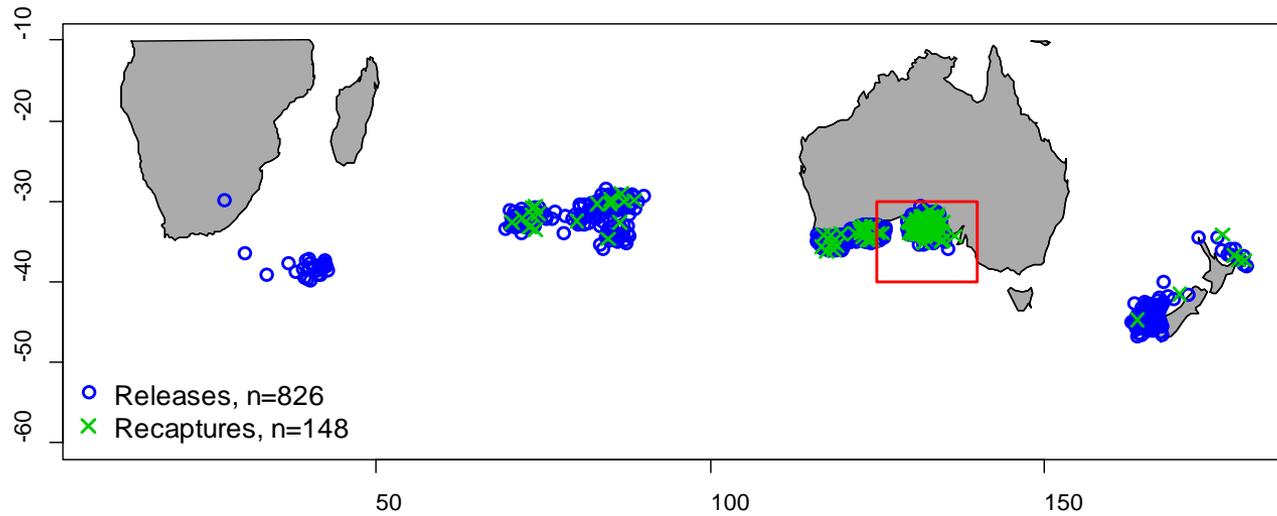








Data: Archival tagging of juvenile SBT



- Tags released in 1998-2008
- Released at ages 1-4
- Recaptured at ages 2-6
- 42% of releases and 78% of recaptures occurred in the GAB (red box)
- Can get environmental conditions for each day

A\$250 REWARD* • A\$250 for returned archival tags
• T-shirt, cap or mug for each dart tag

Southern Bluefin Tuna
ARCHIVAL TAGGING PROGRAM or a digital camera of the same value

Please return tag with the information below:
Fax to: 02 6261 6100 Fax to: 02 6261 6100
ACT 2608, Australia
Phone: +61 2 6261 6104 Fax: +61 2 6261 6107
email: tag@dmprdc.org

Date captured _____
Position captured (lat/long) _____
Length/height _____
Tag number _____
Your name _____
Your postal address _____
Recall name _____

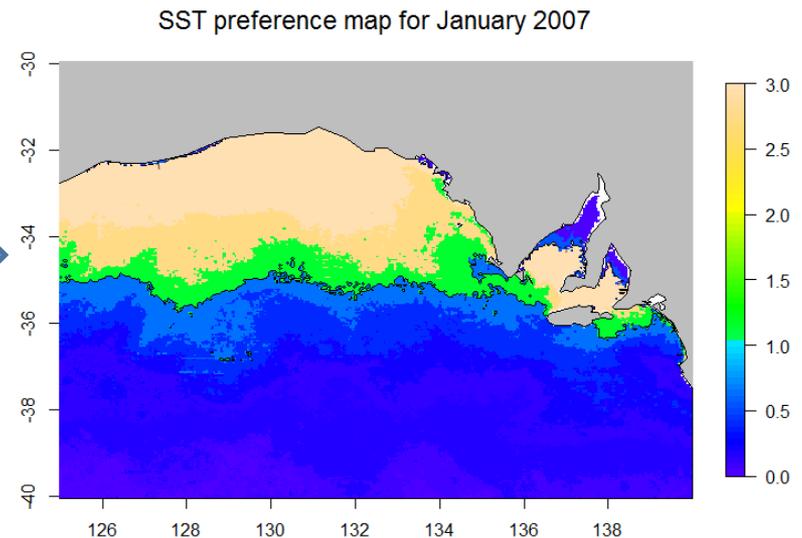
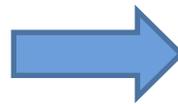
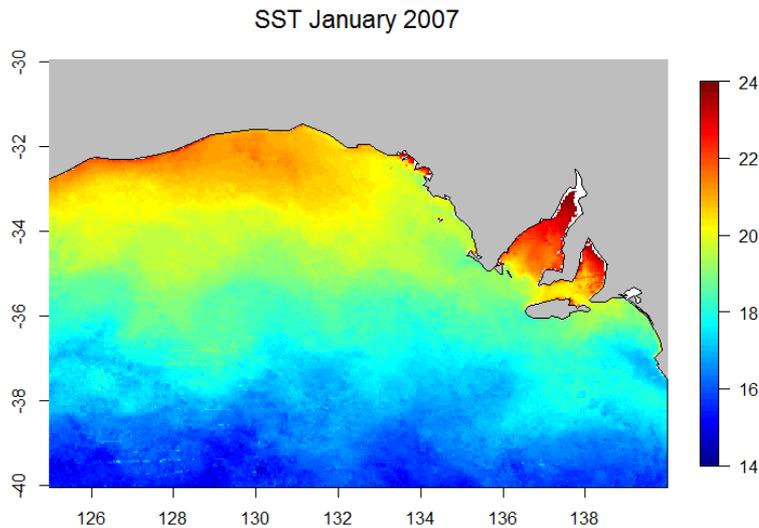
Remove the tag by making a small cut in the body in front of the stalk – be careful not to cut the stalk. Do not try to remove the tag by pulling on the stalk – it will break.

Eveson et al 2015.

Preferred habitat maps – based on electronic tag data

- Get a set of fish observation (e.g. Get environmental conditions for that time period)
- Look up preference value corresponding to environmental conditions at each location
- Produce map showing regions of preferred habitat for any given time period

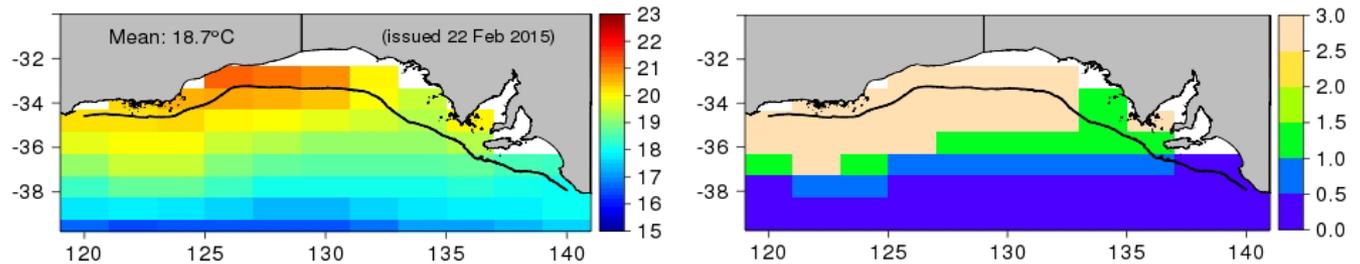
SST only



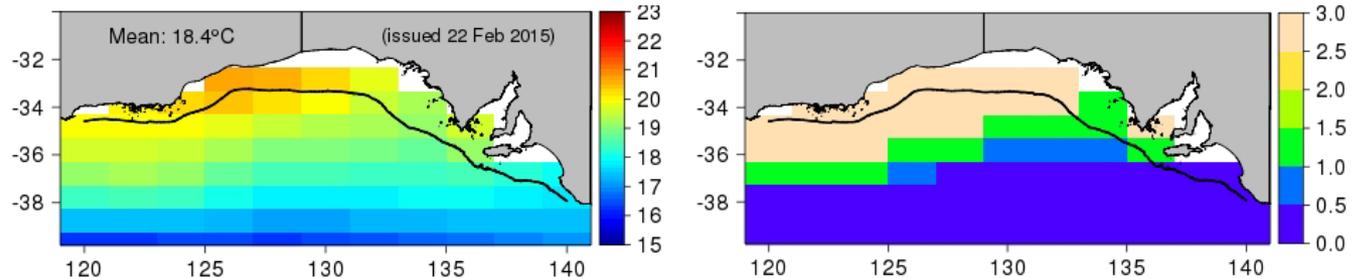
Eveson et al 2015.

Forecast example

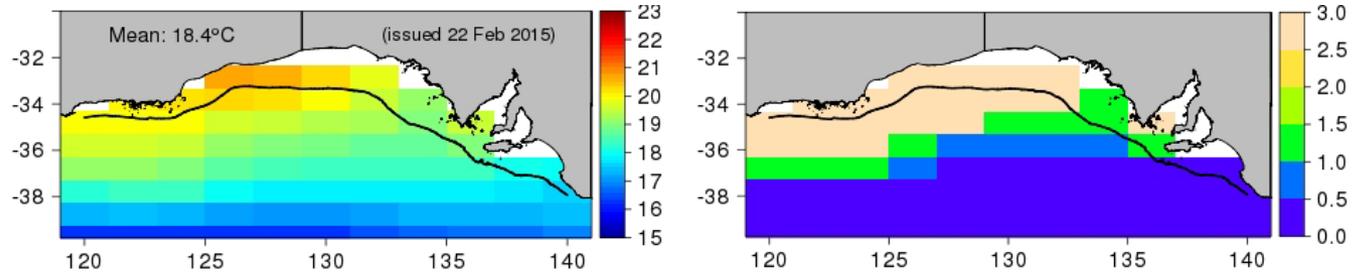
Fortnight 1:
22 Feb – 7 Mar



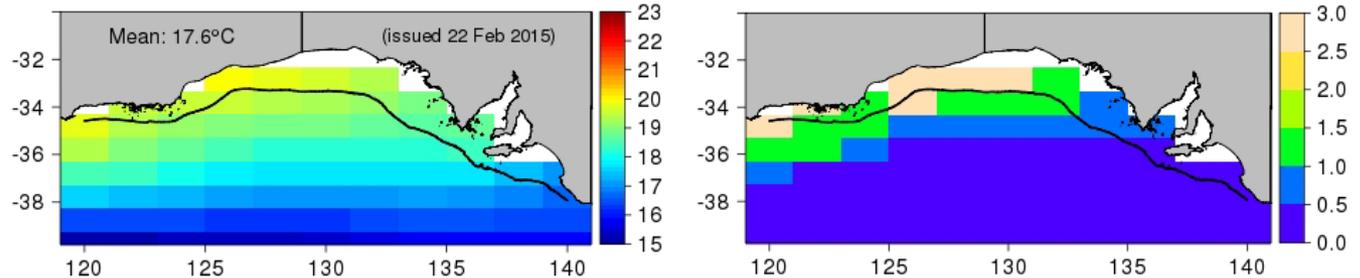
Fortnight 2:
8 Mar – 21 Mar



Month 1:
March

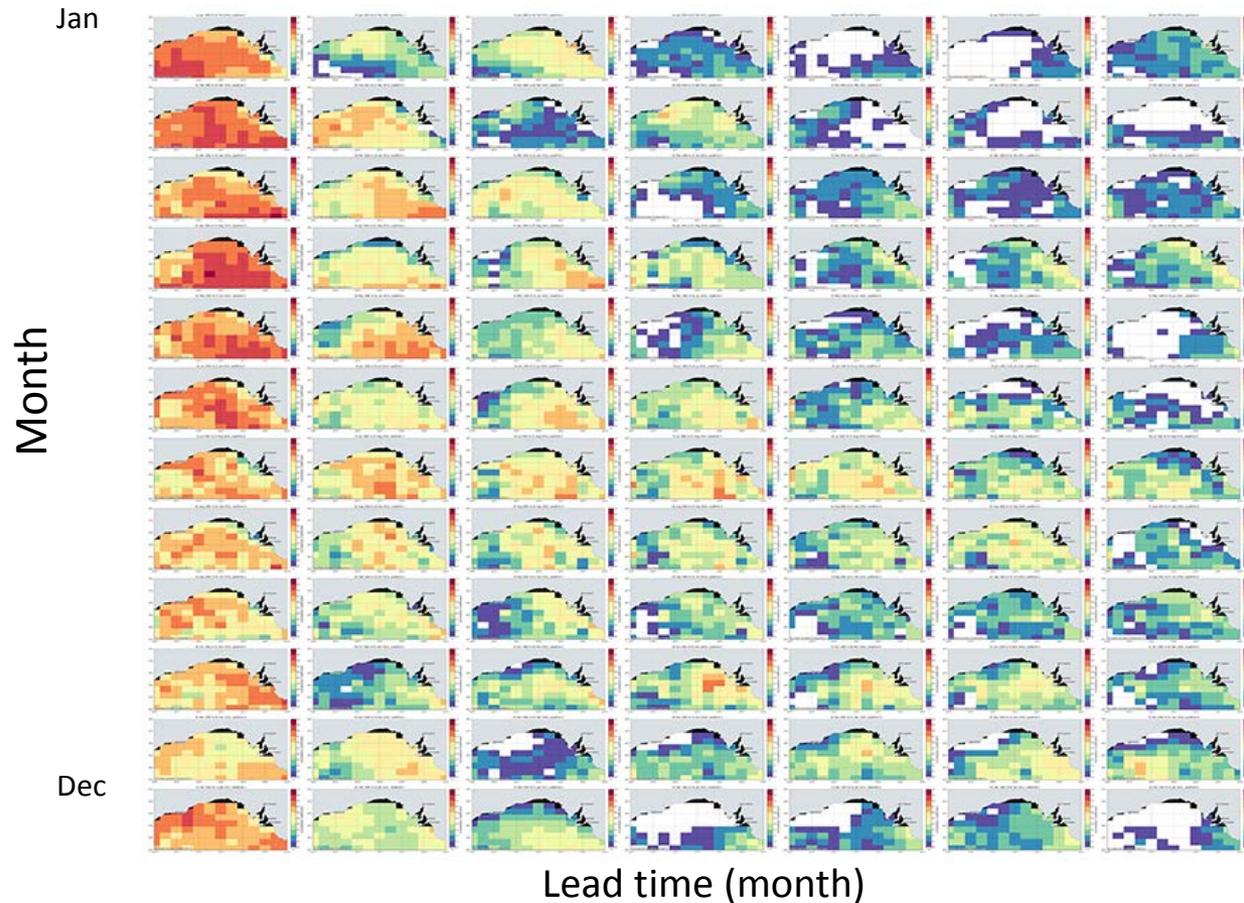


Month 2:
April



Forecast skill – important to evaluate

1. Validate environmental forecast (Jan-Mar, OK to ~2 months)



2. Validate habitat forecast (use independent observations)

Delivery - www.cmar.csiro.au/gab-forecasts

Uptake

In the first year

10 major fishing companies

- All used website

8 used in decision-making

- 6 made different decision
- 2 made “do nothing different” decision
- (when and where to fish)
- (economic benefits)

Forecasting Southern Bluefin Tuna Habitat in the Great Australian Bight

Home
Observed conditions
SST forecasts
Habitat preference forecasts
Historical SST
Case studies
Estimating habitat preferences
Useful links

Forecasting Southern Bluefin Tuna Habitat in the Great Australian Bight

About the project

This project is a collaboration between CSIRO, the Australian Southern Bluefin Tuna Industry Association (ASBTIA) and the Bureau of Meteorology (BoM), co-funded by the Fisheries Research and Development Corporation (FRDC Project 2012/239).

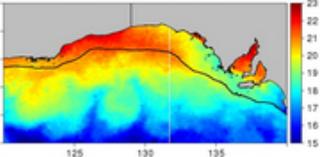
Project Aim: To investigate habitat preferences of southern bluefin tuna (SBT) in the Great Australian Bight (GAB) based on historical archival tag, catch and aerial survey data, and to provide forecasts of habitat distribution.

Motivation: The project was initiated in response to observed changes in spatial distribution of SBT in the GAB through recent fishing seasons.

Planned Outcome: Forecasts of seasonal environmental conditions such as sea surface temperature (SST) should improve operational planning of SBT fishers targeting surface schools for value-adding of a quota restricted resource.

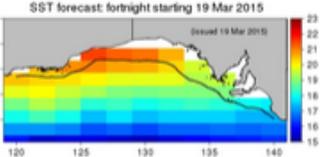


Observed SST: 20 March 2015



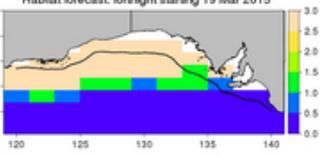
Observed environmental conditions
For maps of recently observed conditions in the Great Australian Bight, go to:
[Observed conditions](#)

SST forecast: fortnight starting 19 Mar 2015
(issued 19 Mar 2015)



Forecasted sea surface temperature
For forecasts of SST in the Great Australian Bight over the next fortnight up to 2 months in future, go to:
[SST forecasts](#)

Habitat forecast: fortnight starting 19 Mar 2015



Preferred habitat forecasts
For maps of expected areas of preferred habitat for juvenile southern bluefin tuna in the Great Australian Bight, go to:
[Habitat preference forecasts](#)

Eveson et al (2015)

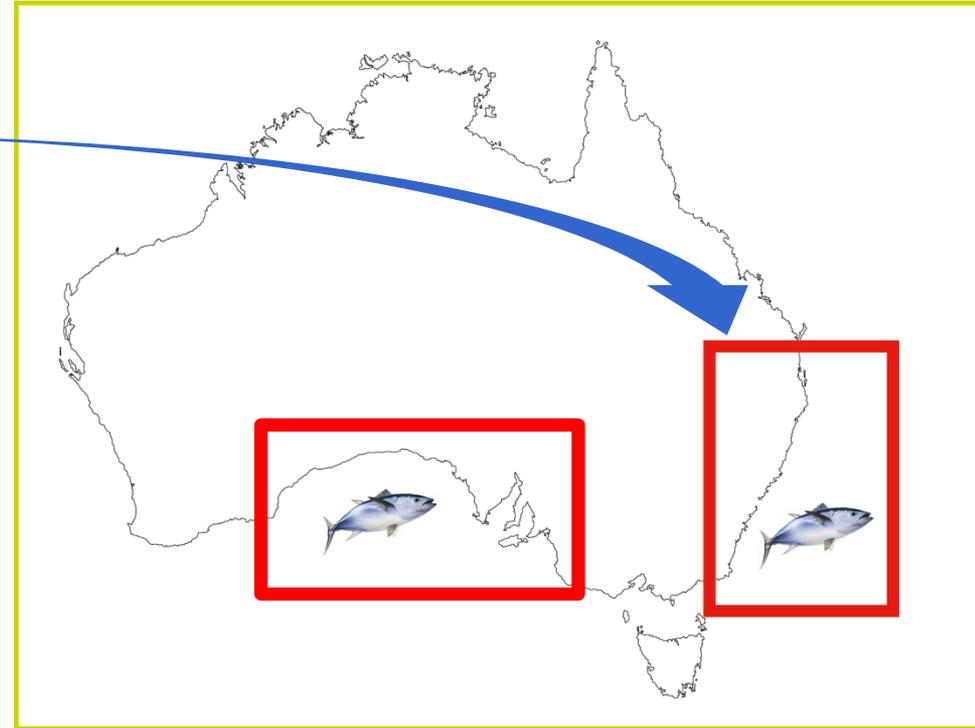
Southern bluefin tuna fisheries – example 2

Management issue:
Quota managed species

Management need:
Reduce non-quota capture

Management solution:
Spatial zoning to regulate fisher access

Management support:
Seasonal forecasts to assist future planning
of zones



Helping management – minimise unwanted bycatch

Real time habitat “prediction” (since 2003)

Reduce bycatch of SBT

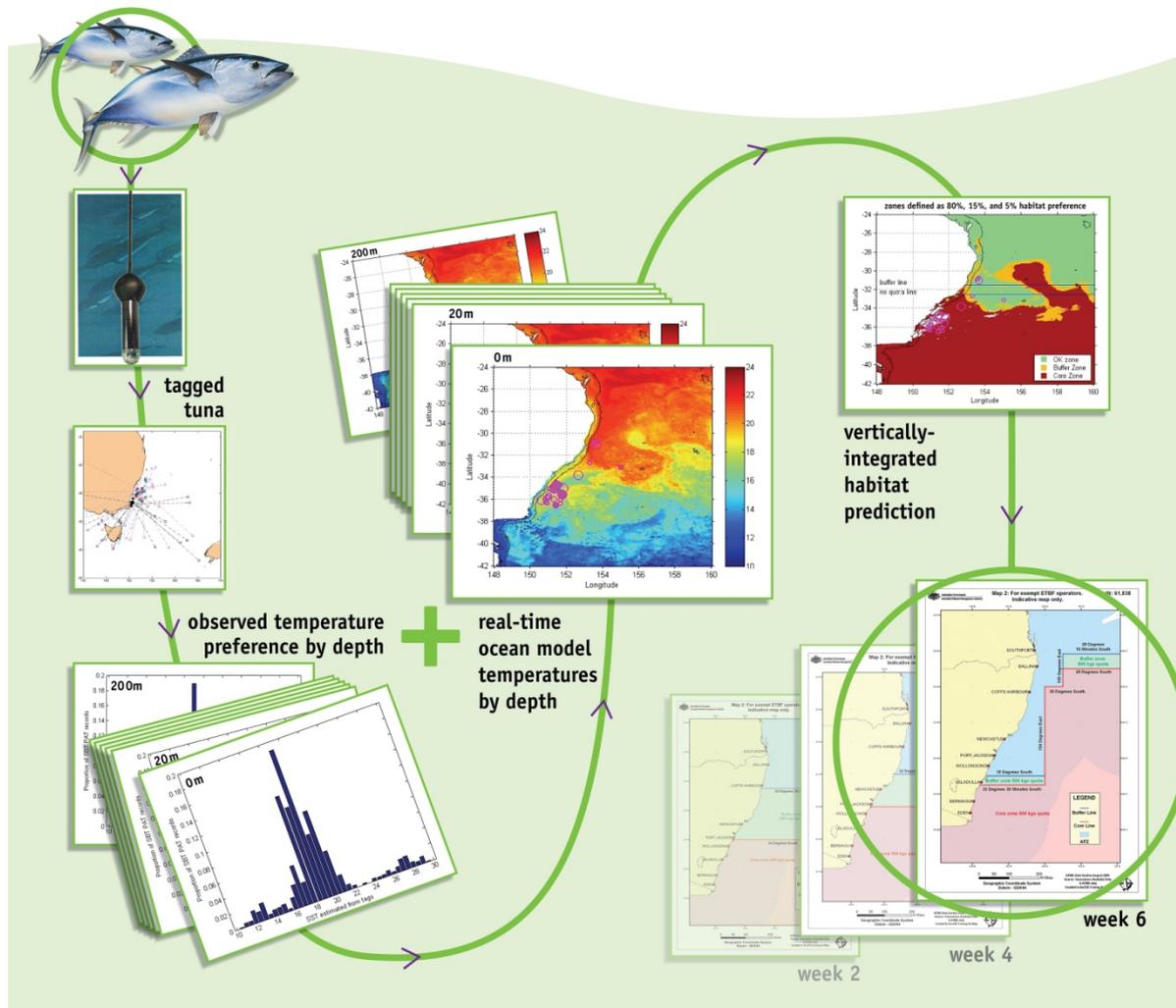
Three zones based on the expected distribution of SBT.

Report sent to fisheries management on a fortnightly basis

Action

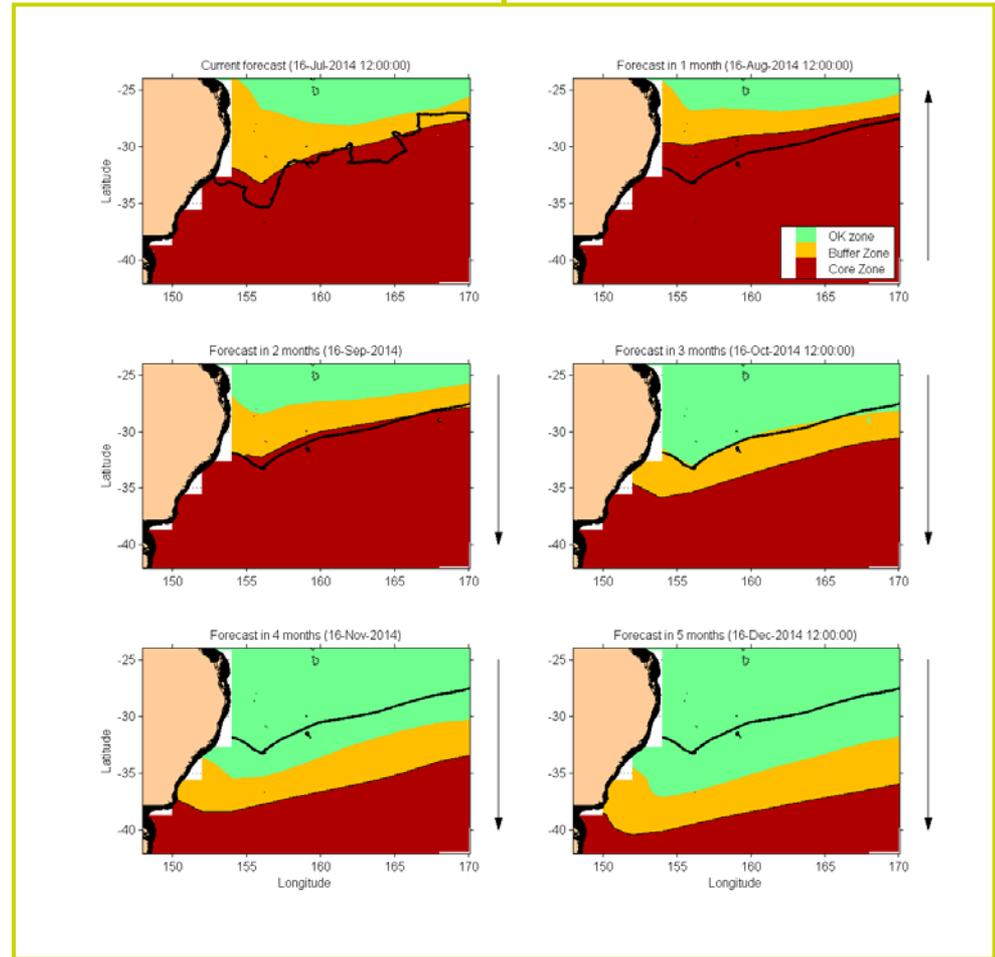
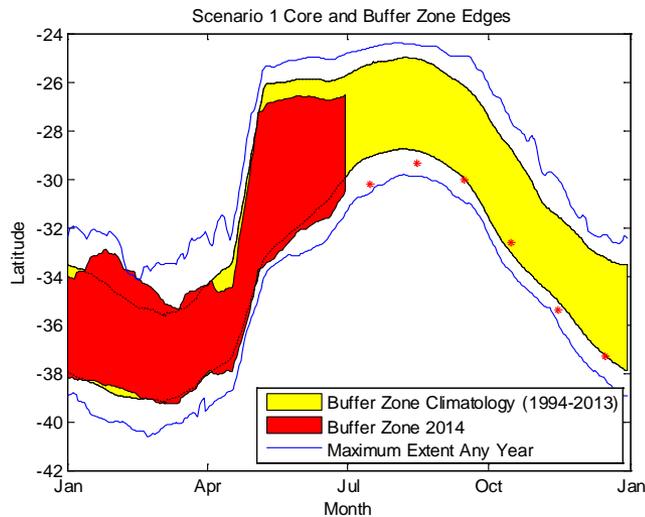
AFMA regulates spatial access of long line vessels to the fishery based on quota holdings.

Observers required in the core zone.



Seasonal Habitat Prediction

- Predictions of SBT habitat out to 5 months.
- Offers managers and fishers the potential to plan for upcoming restrictions, and strategically modify their fishing activities.



2. Salmon aquaculture



Tasmanian Salmon

Management issue:

Farmed salmon grown towards upper thermal limit in summer.

Sea temperatures linked to salmon growth and health.

Management need:

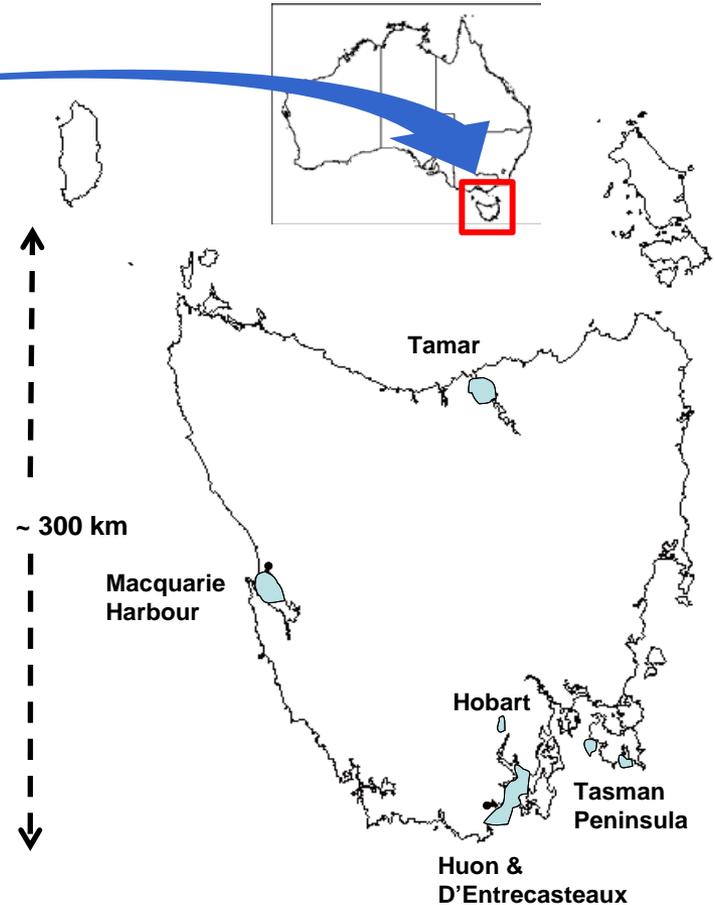
Reduce vulnerability to temperature extremes under climate change

Management solution

Freshwater bathing, diet

Management support:

Seasonal forecasts to assist future planning activities



3. Prawn aquaculture



Queensland Prawns

Management issue:

Farmers wish to optimize prawn growth and yield

Management need:

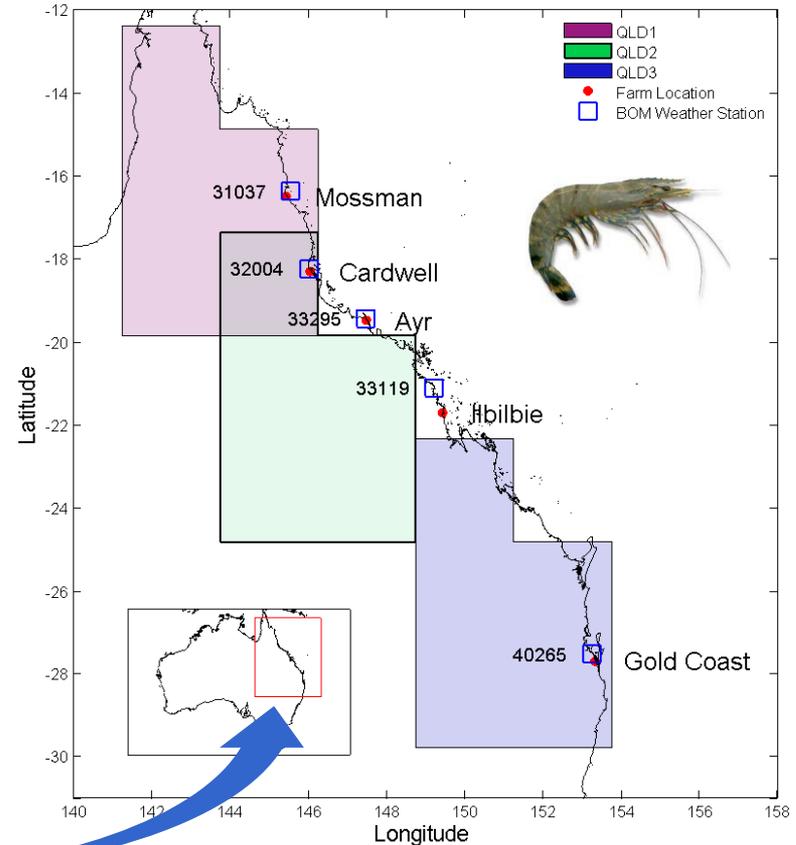
Reduce vulnerability to cool temperature & rainfall extremes

Management solution:

Timing of stocking & harvesting, diet, ordering supplies in advance,

Management support:

Seasonal forecasts to assist future planning activities



Range of delivery outputs

- Websites
- Emails
- Summary sheets
- Publications
- Conferences
- Industry meetings

The collage consists of five overlapping presentation slides:

- Southern Bluefin Tuna in the Great Australian Bight:** A slide titled "Southern Bluefin Tuna in the Great Australian Bight" by Paige Eveson, Alistair Hobday, Jason Hartog, Claire Spillman & Kirsten Rough. It features a map of the Great Australian Bight and text about the "South Australian Southern Bluefin Tuna Fishery" with an industry worth of AU\$160 million annually.
- Seasonal Forecasting to Support Australian Fisheries and Aquaculture:** A slide titled "Seasonal Forecasting to Support Australian Fisheries and Aquaculture". It includes a diagram of "Decision timescales and forecast usefulness" and text explaining "What is seasonal forecasting?" and "Why seasonal forecasting?".
- SBT habitat distribution:** A slide titled "SBT habitat distribution" showing a map of Australia with a red box highlighting the Great Australian Bight. It includes text about "ASISO REWARD" and "SBT data for habitat mapping (archival tags, aerial surveys)".
- Seasonal Forecasting for Queensland Prawn Aquaculture:** A slide titled "Seasonal Forecasting for Queensland Prawn Aquaculture" for the "Queensland prawn aquaculture" industry, worth AU\$70 million annually. It features a map of Queensland and text about "National ENSO & tropical cyclone outlooks".
- Salmon Aquaculture in Australia:** A slide titled "Salmon Aquaculture in Australia" for "Tasmanian salmon aquaculture" with an industry worth of AU\$500 million annually. It includes a map of Tasmania and text about "Tailored salmon farm forecast products" and "Farm specific forecasts".

At the bottom of the collage, there is a footer with logos for the Australian Government Bureau of Meteorology, Centre for Australian Weather and Climate Research, and POAMA (predictive ocean atmosphere model for australia).

Why has seasonal forecasting worked?

- Pre-conditioning
 - Novel conditions (sometimes a shock)
 - Dynamic realtime habitat forecasting (since 2003)
 - Mature forecast model (POAMA)
- Project team
 - Trust and knowledge in domain
 - Decision context is clear
 - Partnership with physical model maker (BOM)
 - End user engagement & co-production

Lessons learned

Essentials:

- Strong industry engagement and partnership
- A clear understanding of the end user skills and how they might use forecast product
- A model with useful skill in the region of interest
- Forecast product delivery mechanism that suits the end user
- Industry feedback for refinement of forecast products

Very useful:

- Industry advocate or liaison officer
- Farm visits and face-to-face end user meetings
- Historical industry data

