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

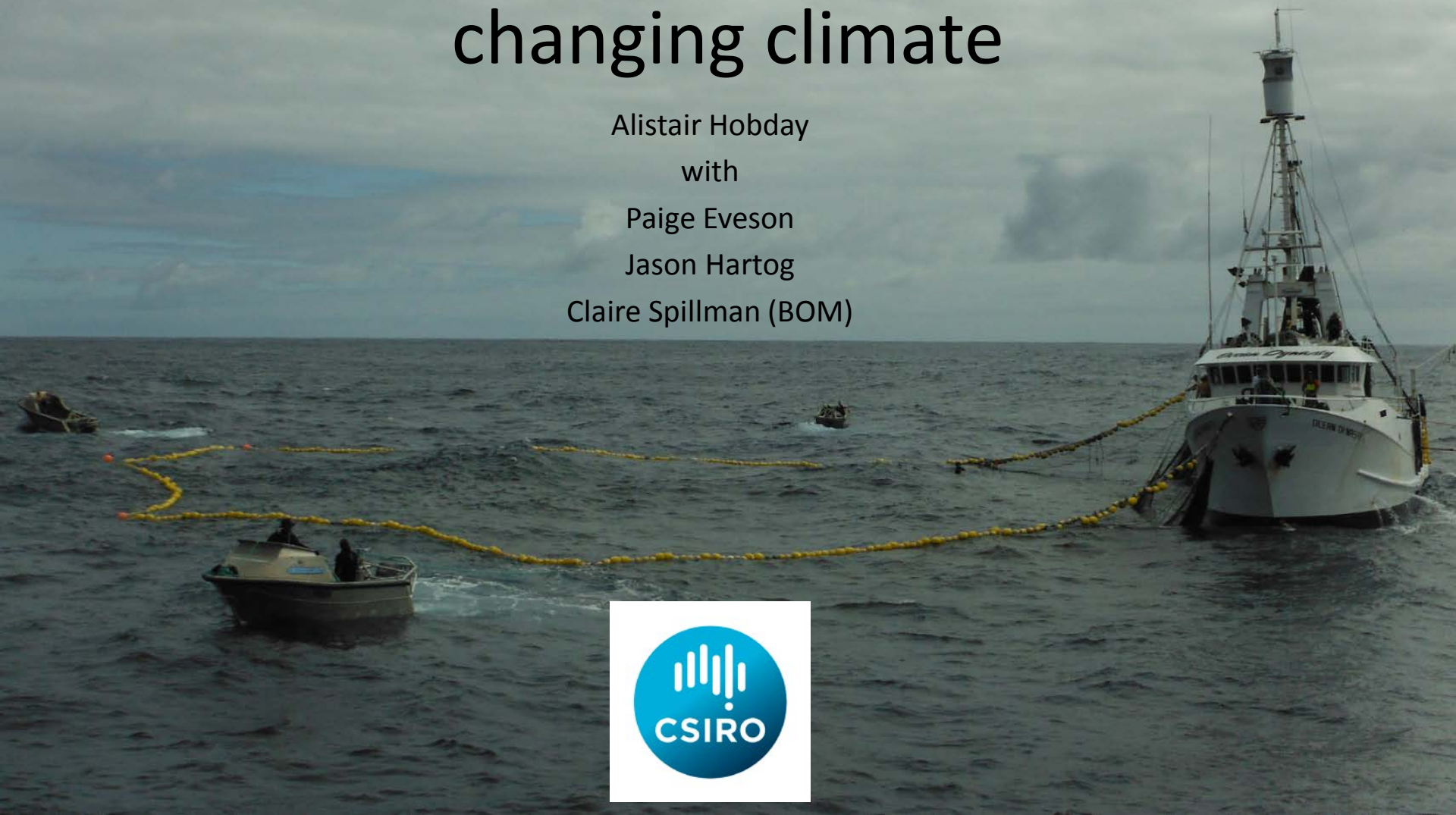
Alistair Hobday

with

Paige Eveson

Jason Hartog

Claire Spillman (BOM)



Further information

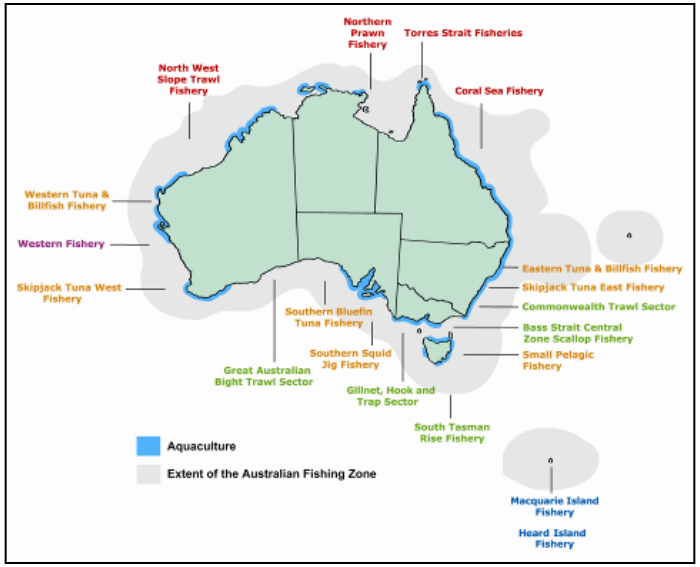
- Hobday et al. (2016) *Fisheries Oceanography*
- Eveson et al (2015) *Fisheries Research*
- Spillman & Hobday (2014) *Climate Risk Management*
- Spillman et al. (2015) *Aquaculture*
- Hobday et al (2010) *Fisheries Oceanography*
- Hobday and Hartmann (2006) *Fisheries Management and Ecology*.
- Hobday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

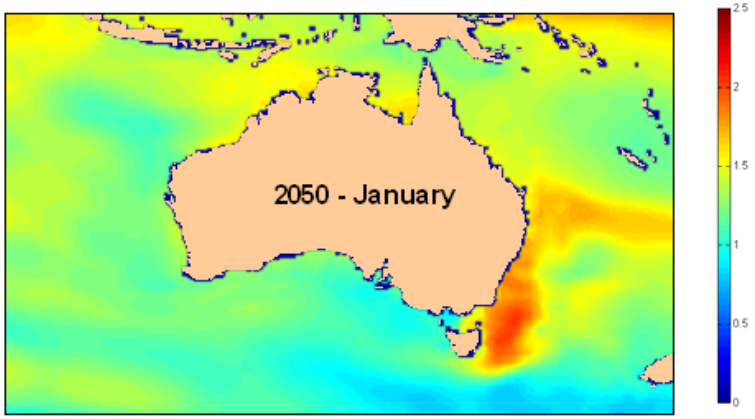
- POAMA: http://poama.bom.gov.au
- Forecasts – website examples:
  - Tuna - GAB: www.cmar.csiro.au/gab-forecasts
  - Prawns - http://poama.bom.gov.au/marine_mw/prawn_project.shtml

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

Preliminary Assessment of Climate Change Impacts for Australian Fisheries & Aquaculture (Hobday et al 2008)

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?

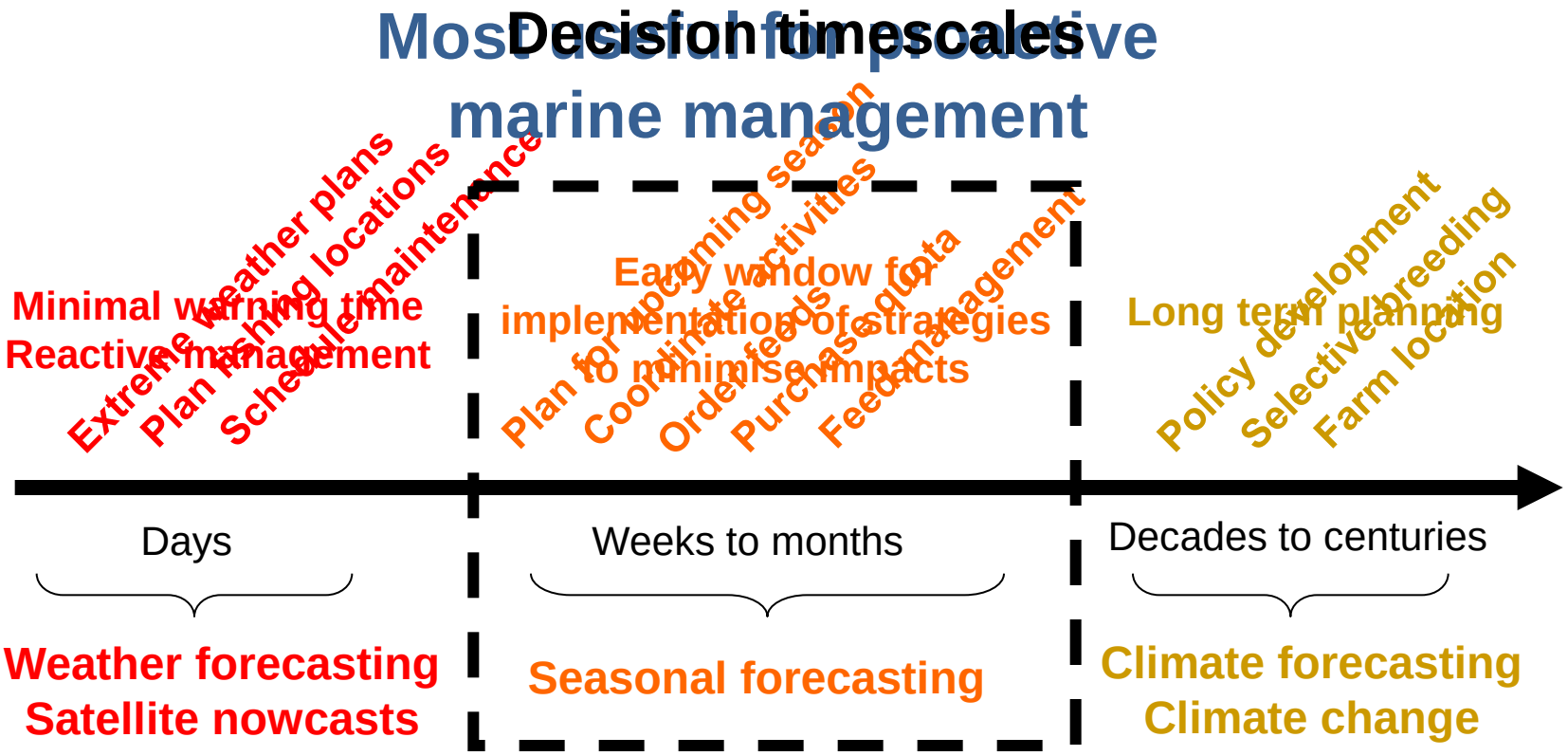
- Climate change is a new factor for a range of businesses

  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

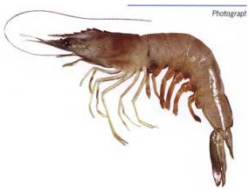
Recognize relevant time scales



Better managed marine resources have improved resilience under climate change

Hobday et al, 2016

Recognize relevant time scales - with your end users



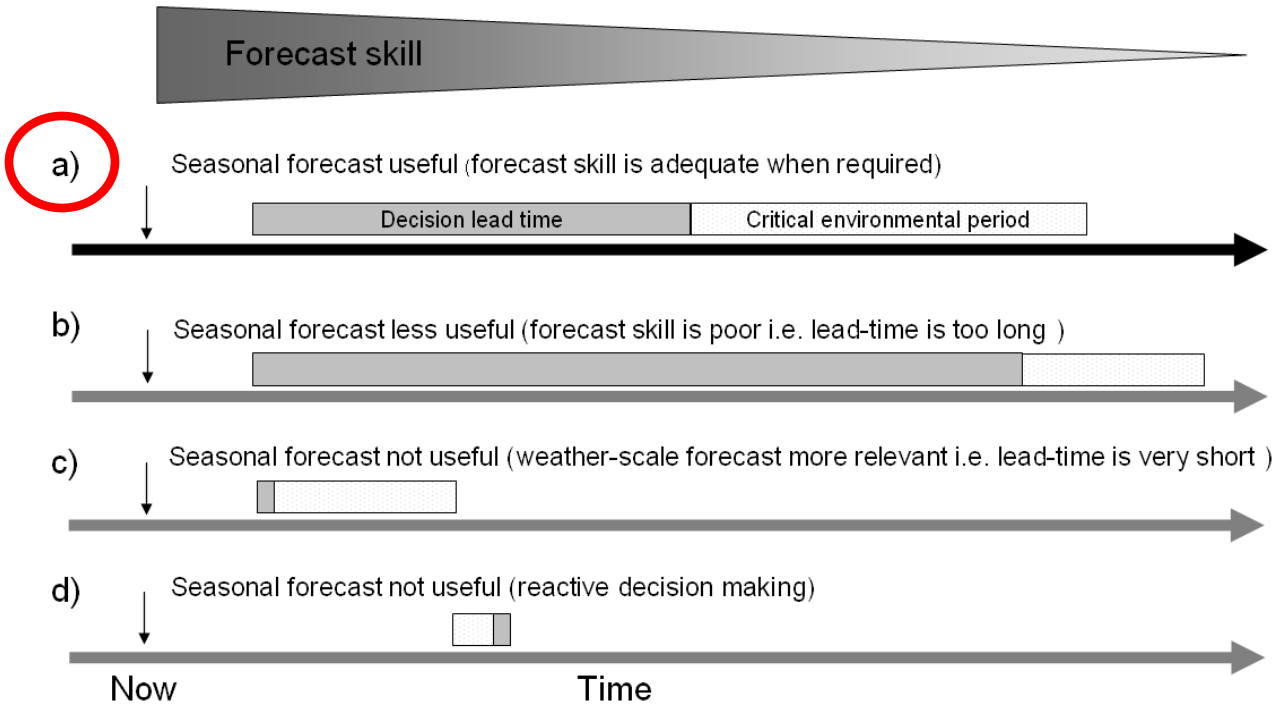
What to wear
Aerators
Feed cycles
Farm maintenance
Stocking time
Harvest time
Labour needs
Equipment purchase
Feed management (amount and type)
Pond construction
Selective breeding
Farm location
What environment for descendents

7-10 days
Weeks to months
Decades to centuries

Weather forecasting
Seasonal forecasting
Climate projection

Hobday et al 2016

When is seasonal forecasting useful?

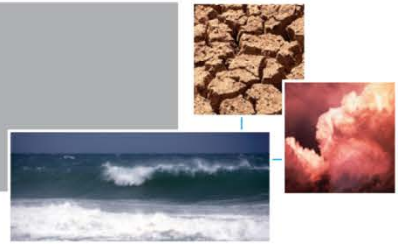


Usefulness depends on the timing of both the **management decision** to be made and that of the **critical environmental period** affecting the decision, together with **forecast accuracy** at that time.

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).

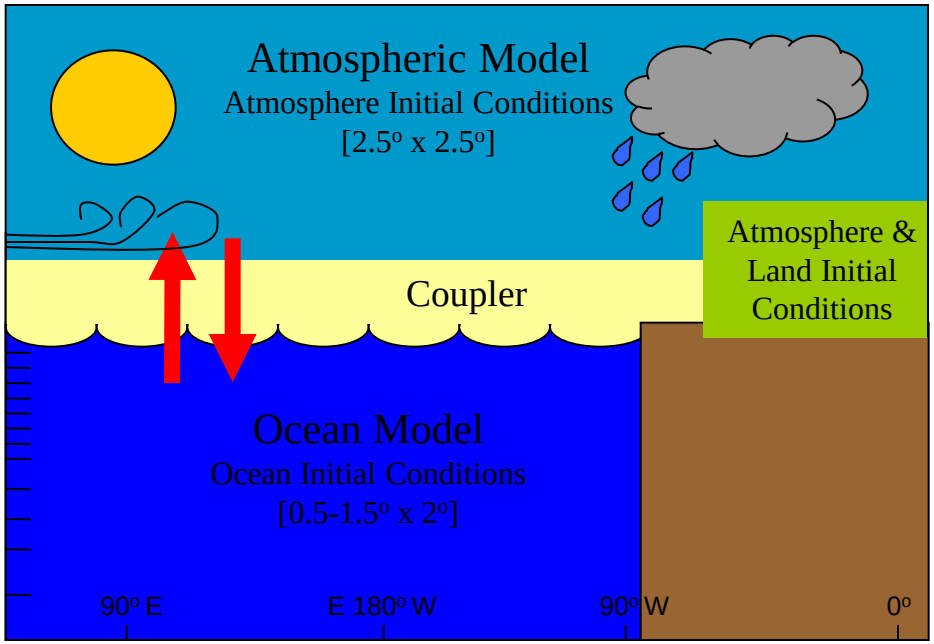
Hobday et al 2016

Seasonal forecasting



Predictive **O**cean **A**tmosphere **M**odel for **A**ustralia

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

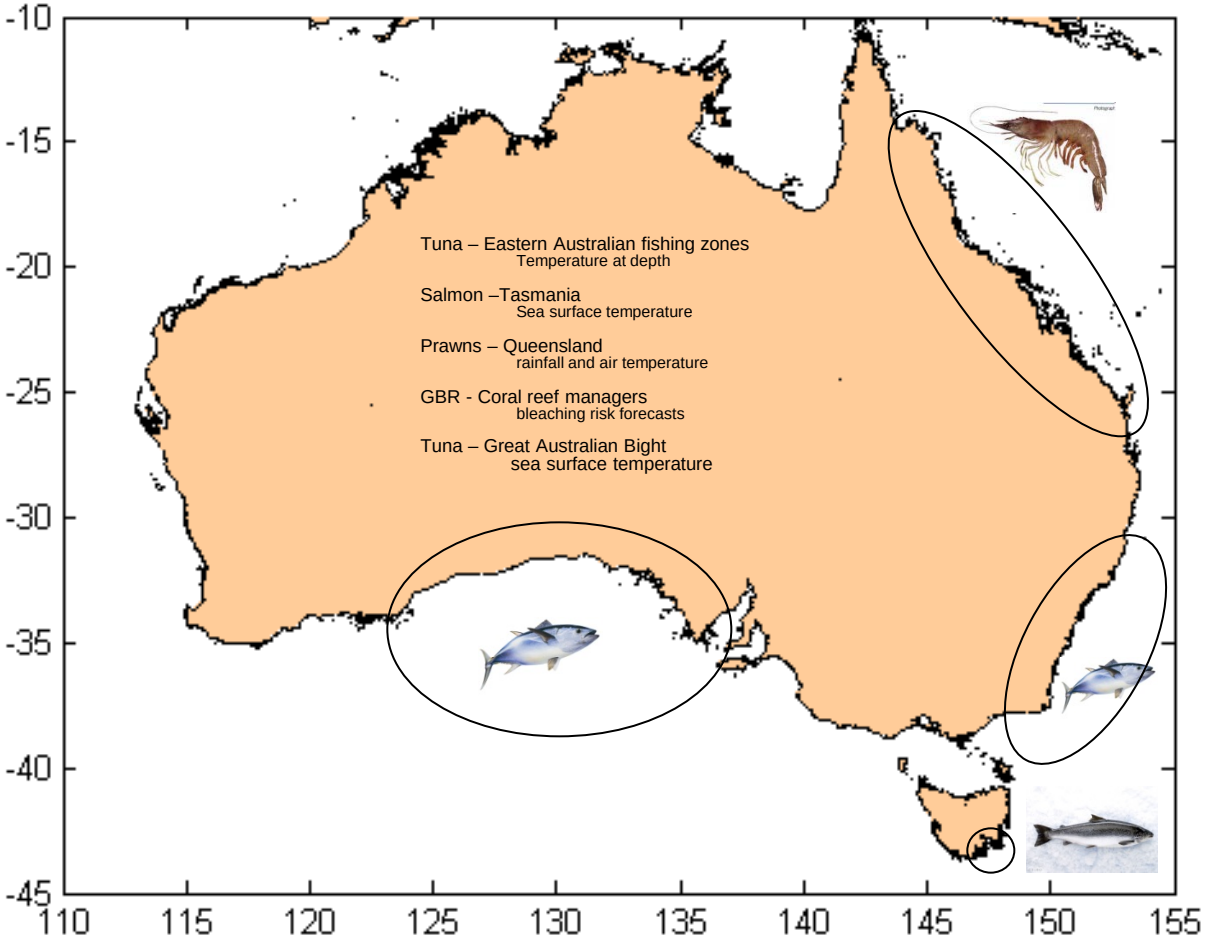
Spillman & Alves 2009, Spillman 2011, Hudson et al 2013

Australian Government
Bureau of Meteorology

CSIRO

Fisheries and aquaculture seasonal forecasts

(primary variable & “habitat”)



Development stages for fishery & aquaculture forecast tools

A. Assess needs

Define management or industry need

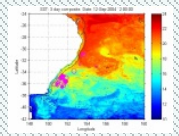
Determine critical variables & decision timescales

Verification data

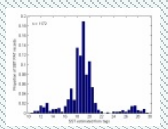
B. Development

Assess skill using POAMA hindcast

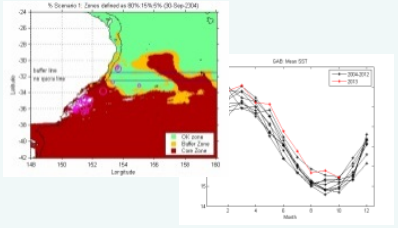
Produce habitat distribution forecast



+



Forecast products

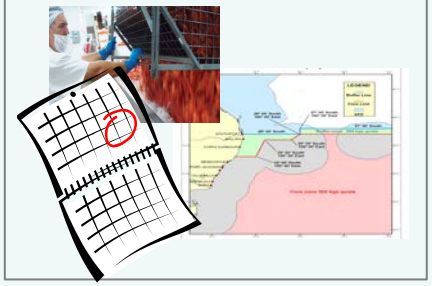


C. Implementation

Forecast delivery

Support & education

End user decision



User feedback

Hobday et al 2016

Southern bluefin tuna fishery example #1

Issue:

Changing SBT distributions

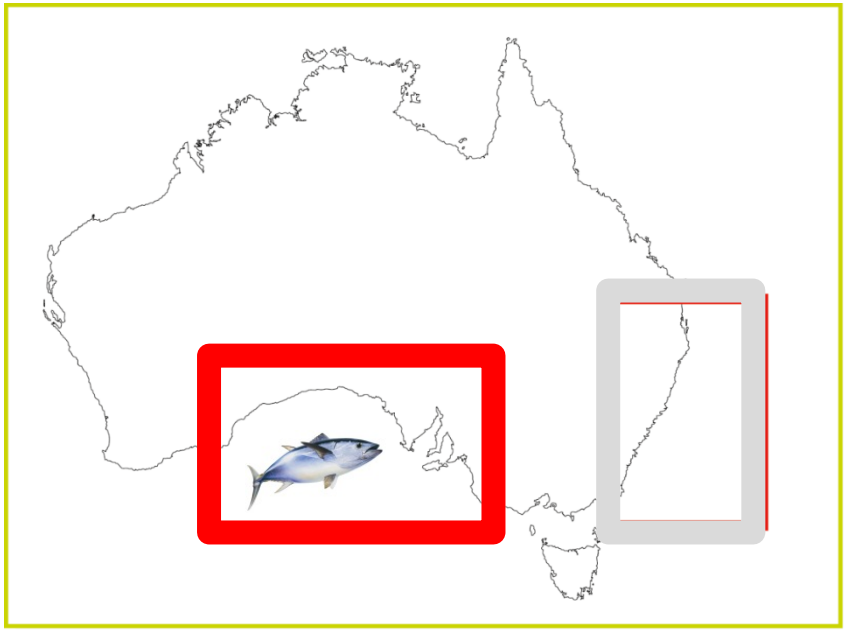
Need:

Improve efficiency of industry

Solution:

Invest in research and fisher education

Seasonal forecasts to improve operational planning of fishers

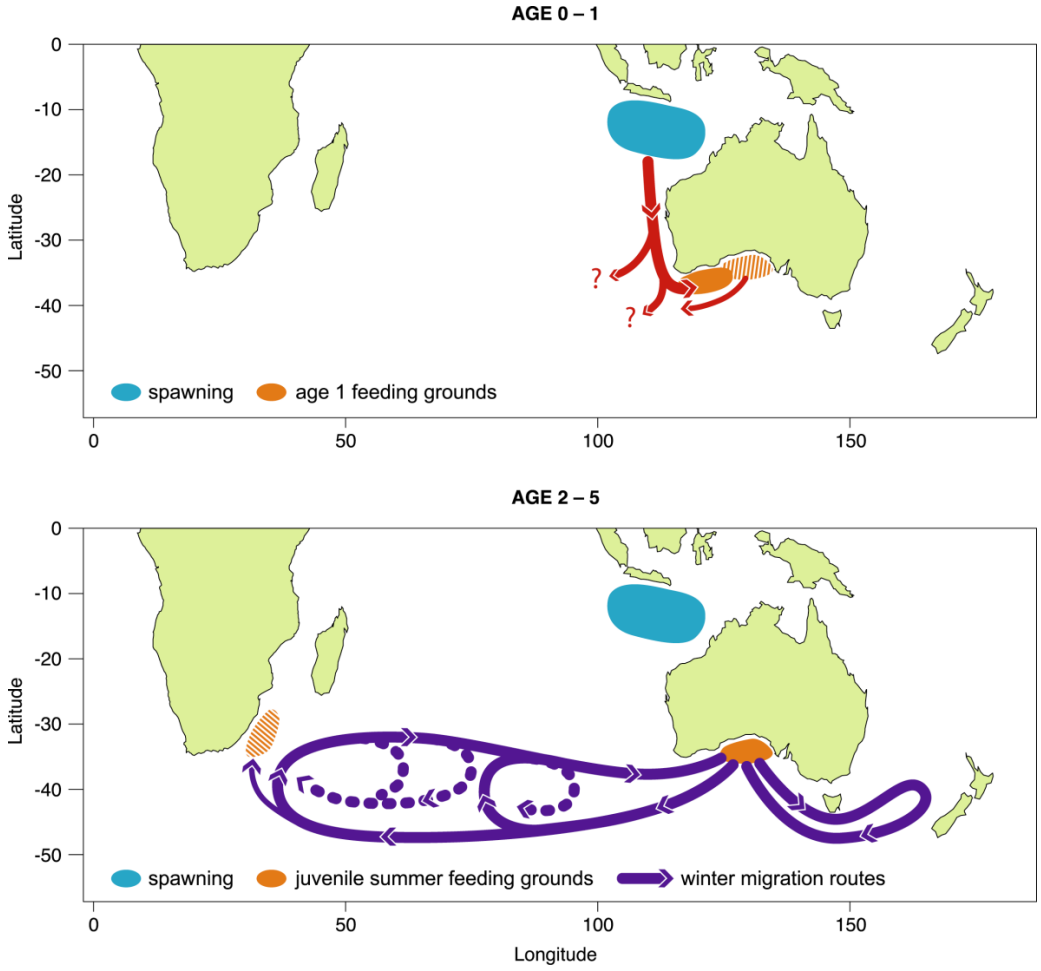


Helping fishers – economic efficiency

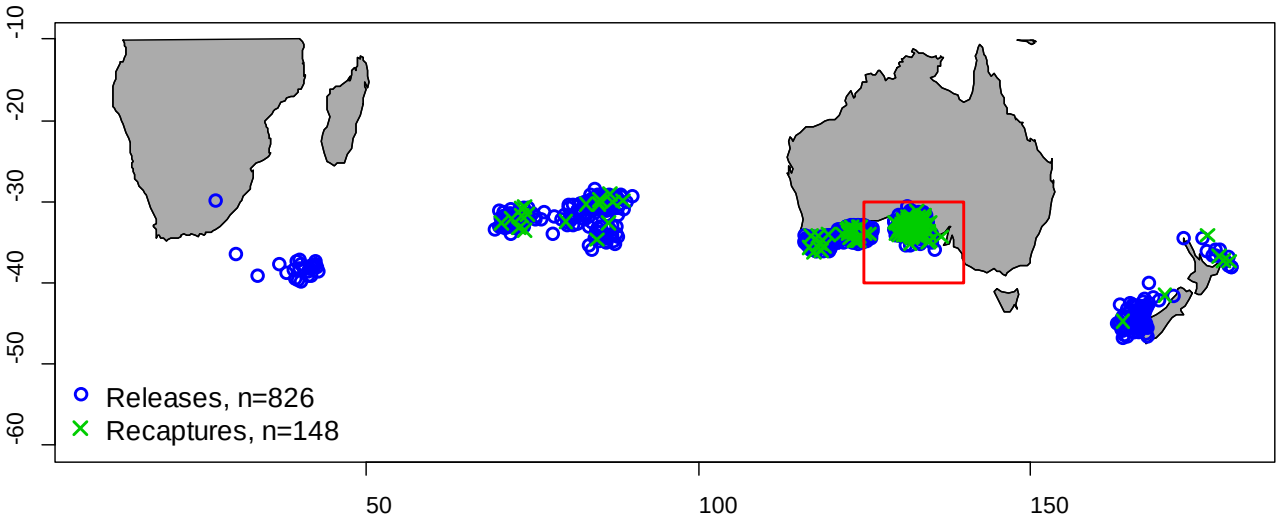
Quota-managed fishery so does not increase catch

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



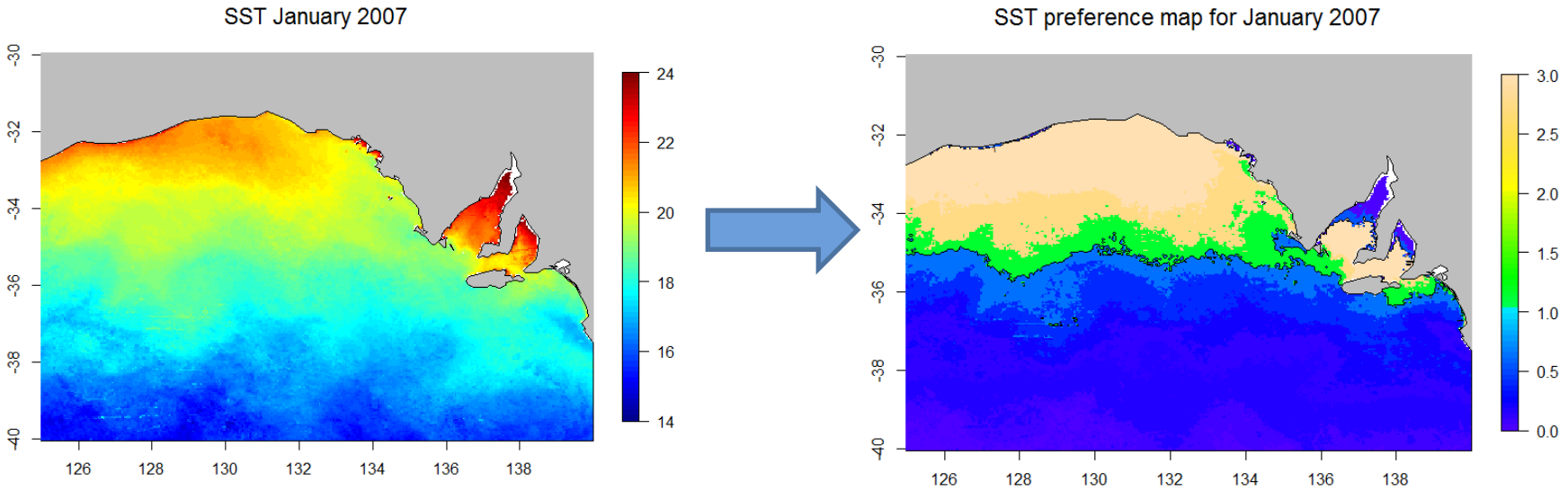
- Tags released in 1998-2008
- Released at ages 1-4
- Recaptured at ages 2-6
- 42% of releases and 78% of recaptures occurred in the GAB (red box)
- Can get environmental conditions for each day

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.

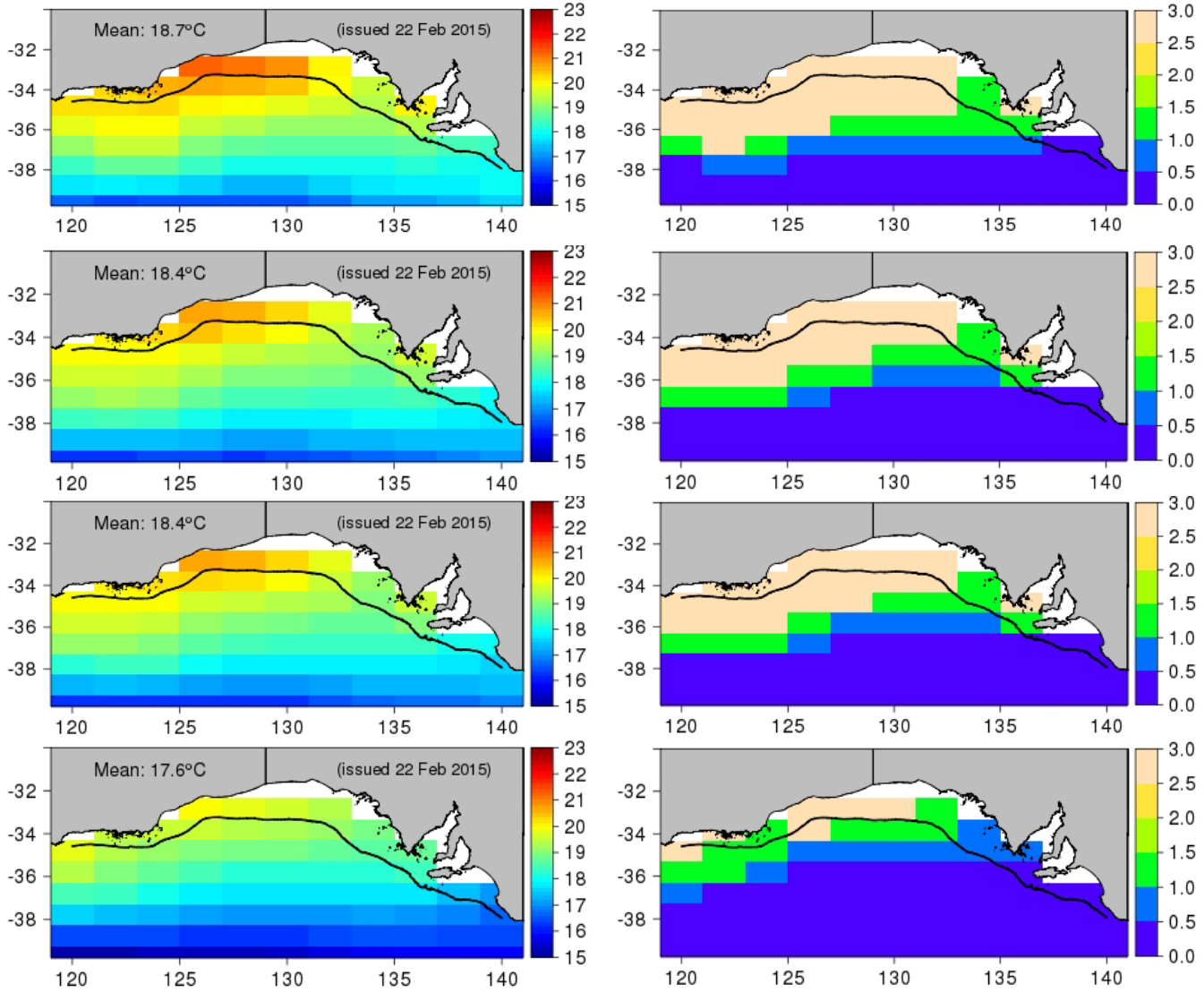
Forecast example

Fortnight 1:
22 Feb – 7 Mar

Fortnight 2:
8 Mar – 21 Mar

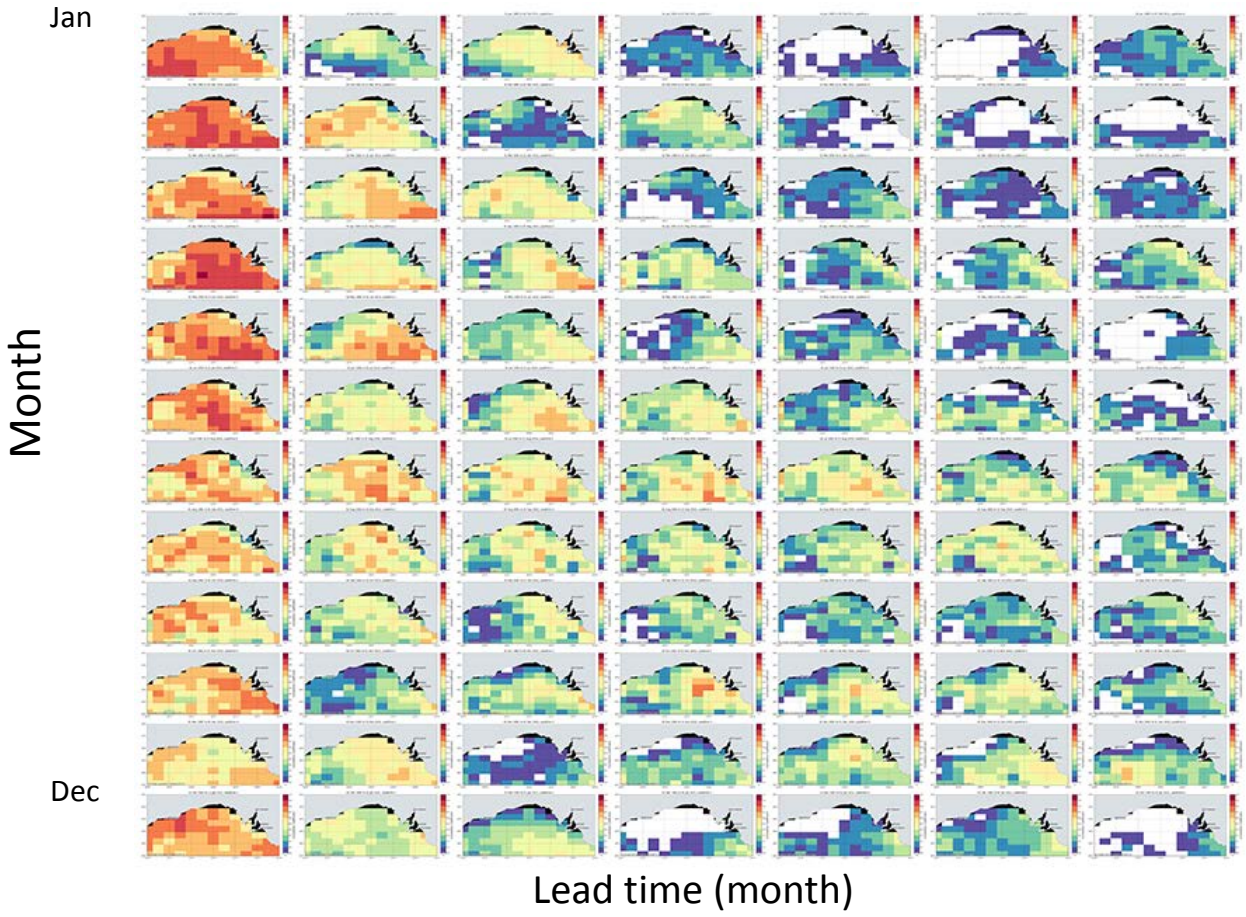
Month 1:
March

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)

Eveson et al (2015)

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

Uptake

In the first year

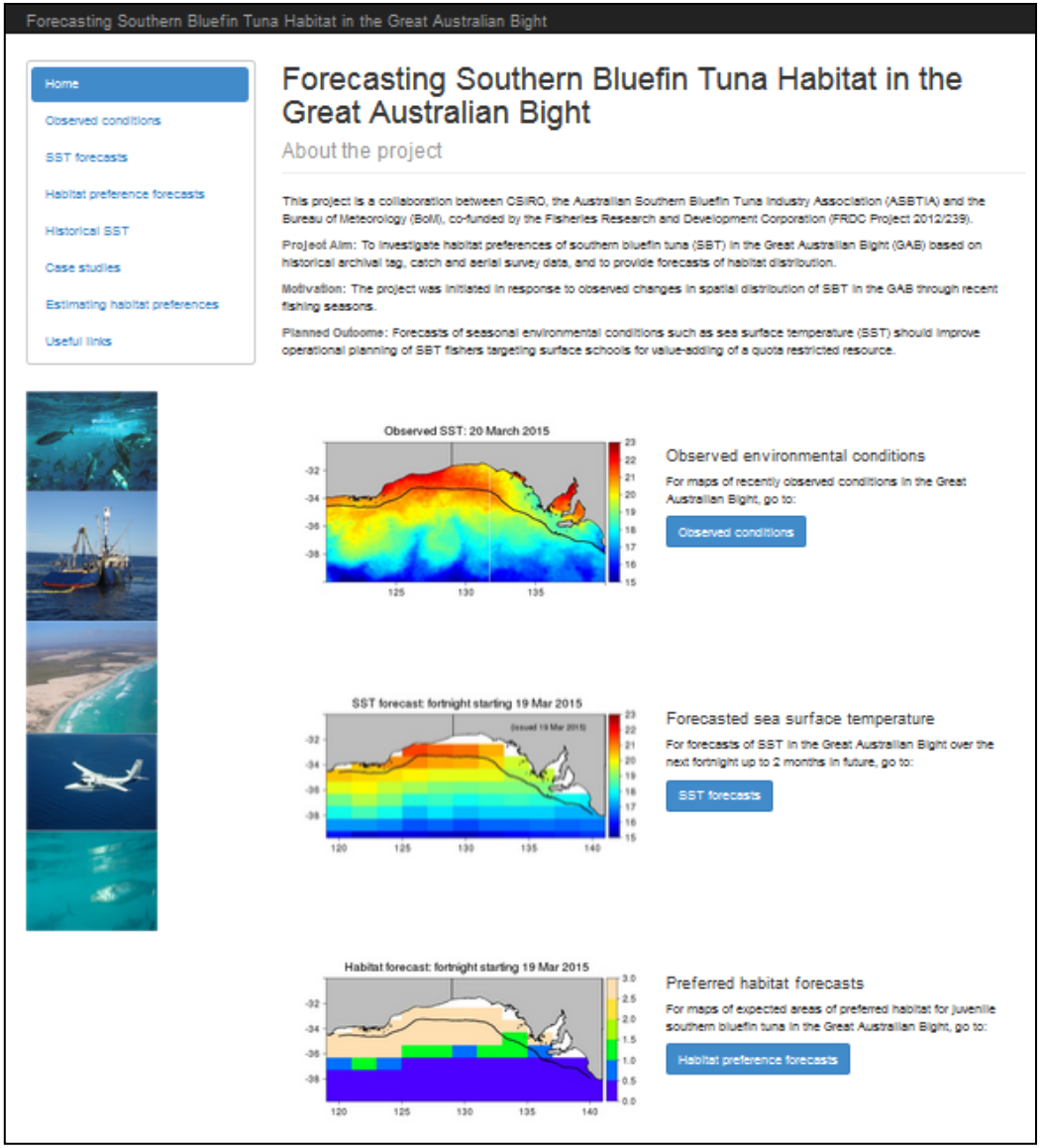
10 major fishing companies

- 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)



Eveson et al (2015)

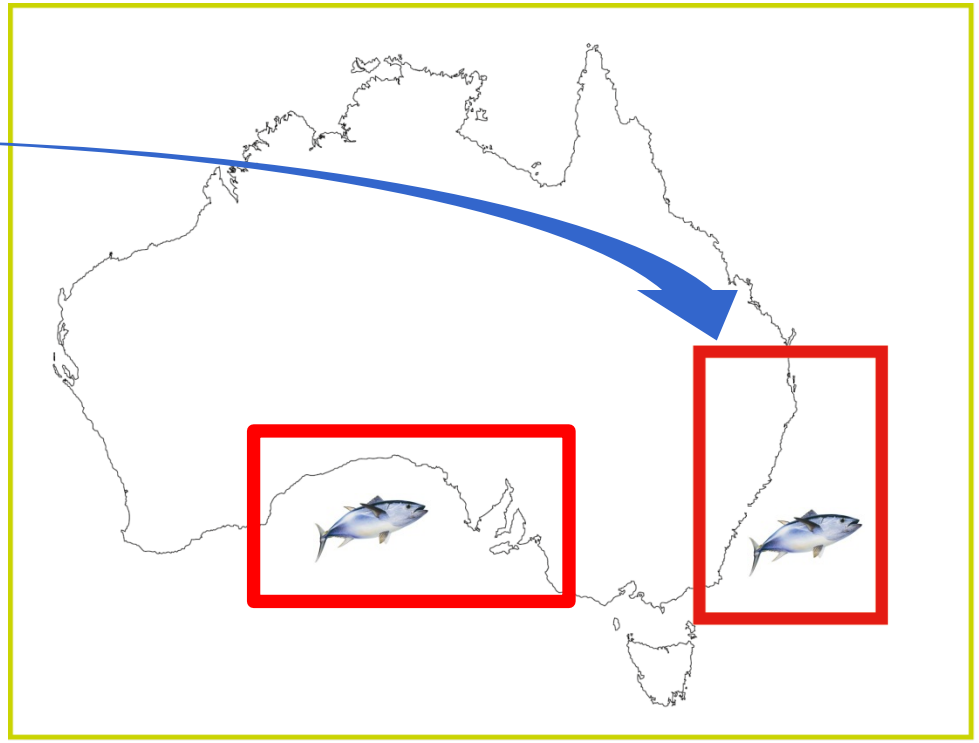
Southern bluefin tuna fisheries – example 2

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

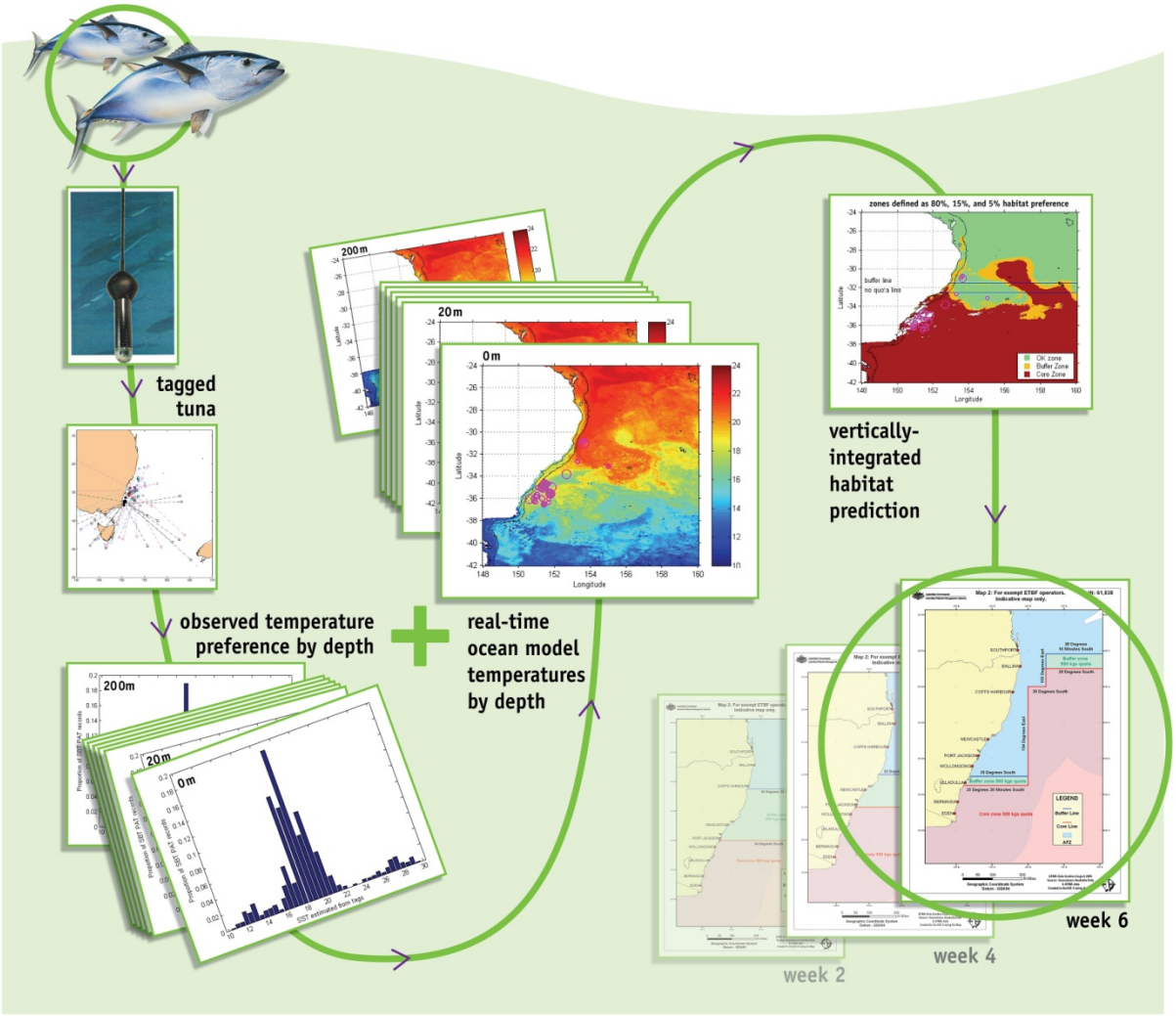
Three zones based on the expected distribution of SBT.

Report sent to fisheries management on a fortnightly basis

<u>Action</u>

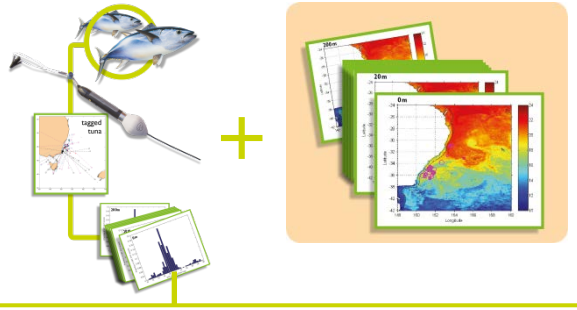
AFMA regulates spatial access of long line vessels to the fishery based on quota holdings.

Observers required in the core zone.



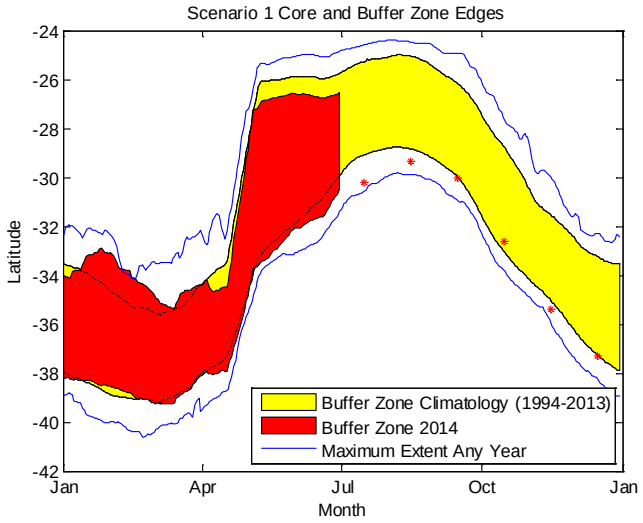
Hobday and Hartmann 2006; Hartog and Hobday (in press)

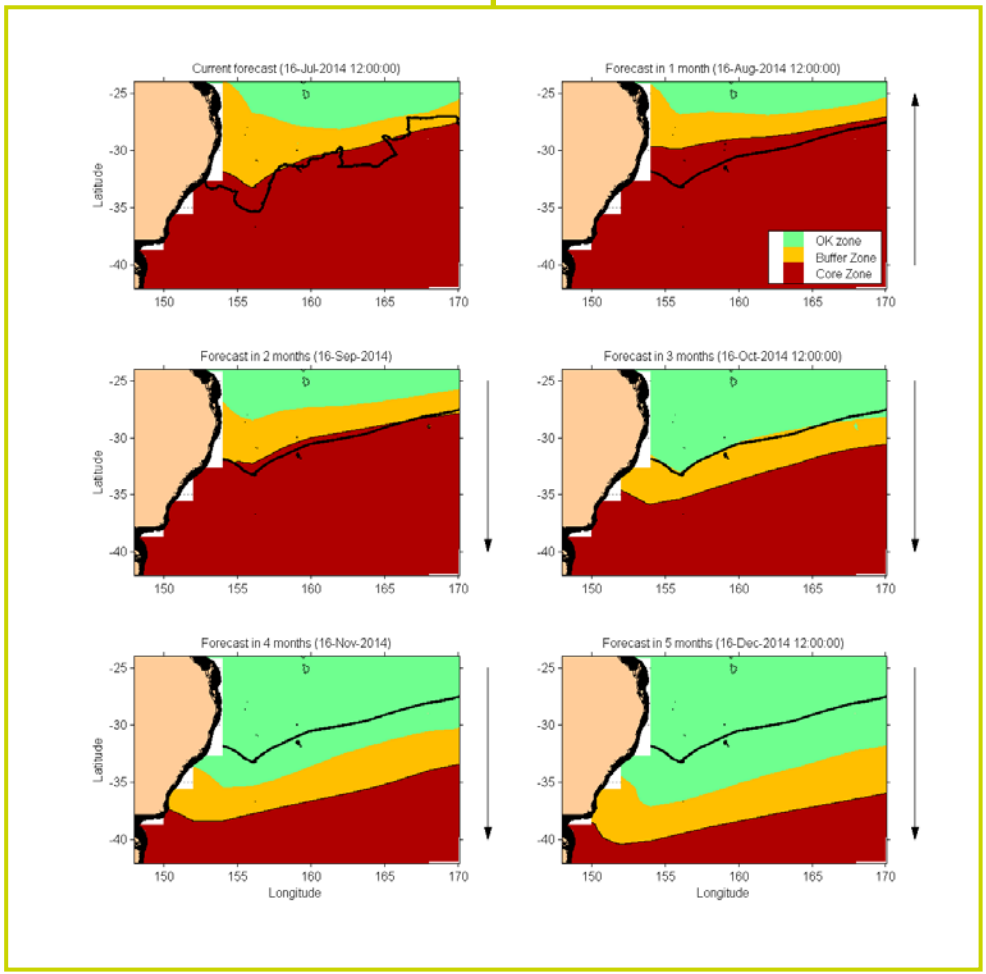
Seasonal Habitat Prediction



- 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.





Hobday et al 2011

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:

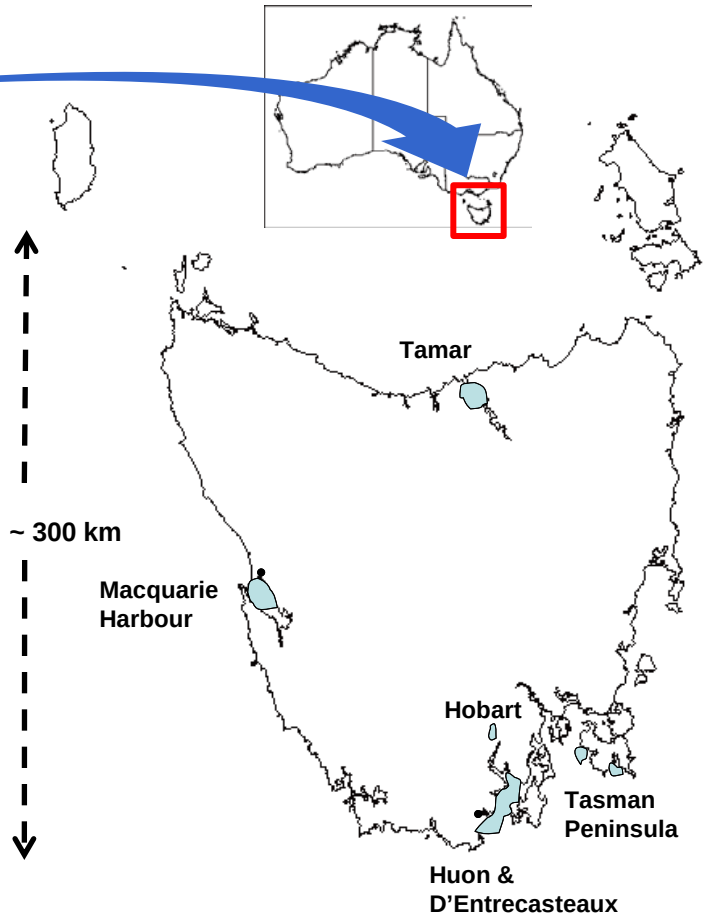
Reduce vulnerability to temperature extremes under climate change

Management solution

Freshwater bathing, diet

Management support:

Seasonal forecasts to assist future planning activities



Australian Government
Bureau of Meteorology

Spillman & Hobday 2014

CSIRO

3. Prawn aquaculture

Queensland Prawns

Management issue:

Farmers wish to optimize prawn growth and yield

Management need:

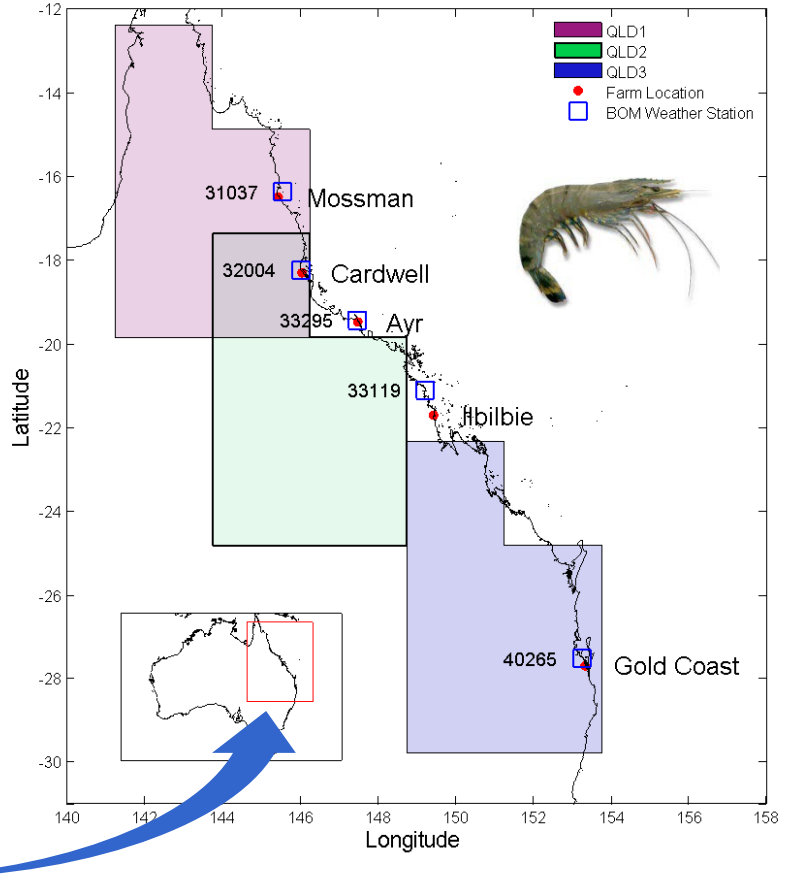
Reduce vulnerability to cool temperature & rainfall extremes

Management solution:

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

Management support:

Seasonal forecasts to assist future planning activities



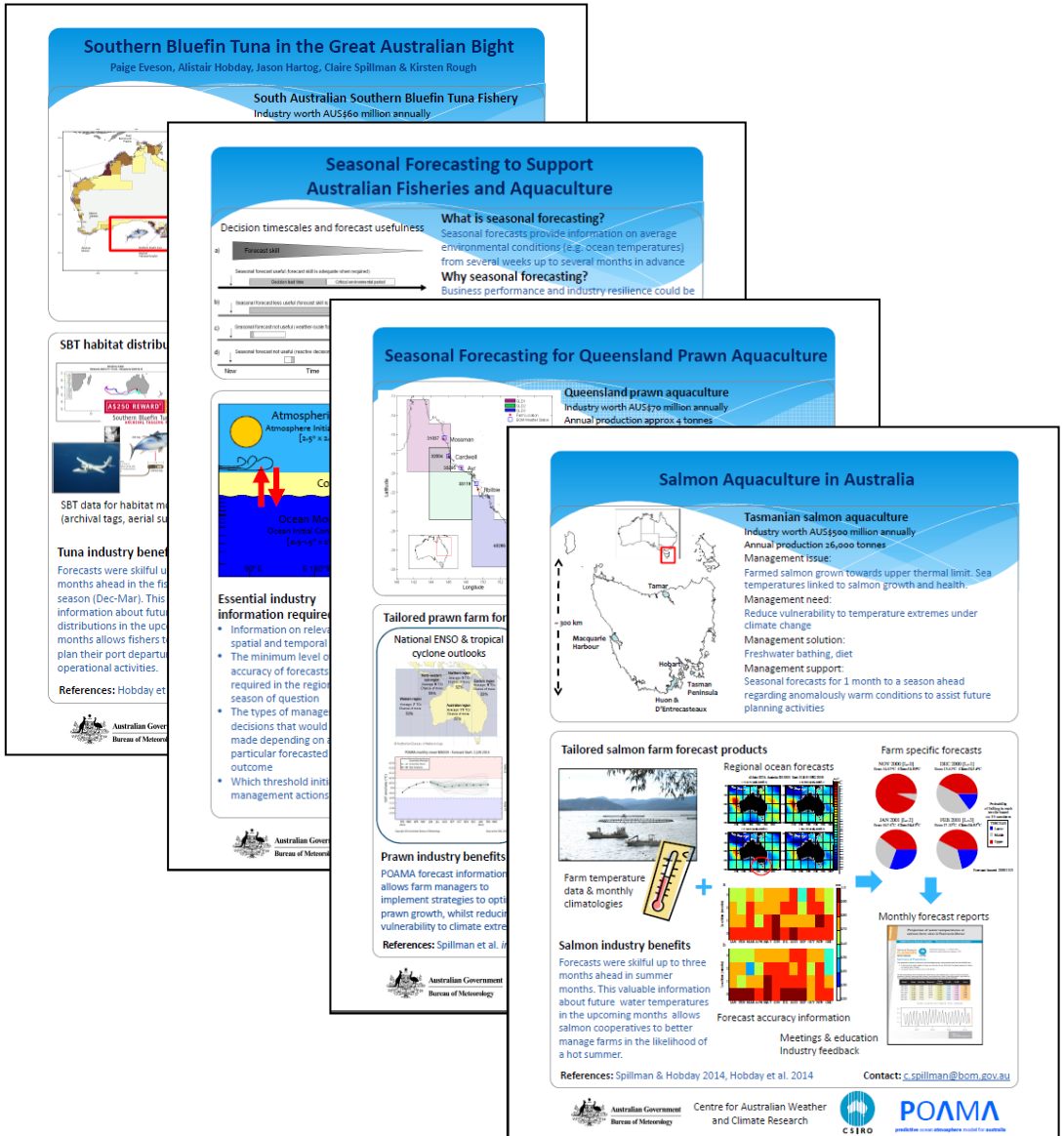
Spillman et al 2015

Australian Government
Bureau of Meteorology

CSIRO

Range of delivery outputs

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



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

Hobday et al 2016.