

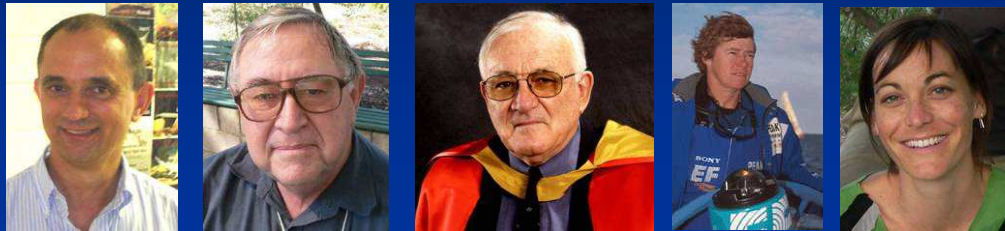
Population biology and modelling studies on recreationally-important finfish species at the Centre for Fish and Fisheries Research (Murdoch University)

Alex Hesp, Norm Hall and Ian Potter



The Centre for Fish and Fisheries Research

<http://cffr.murdoch.edu.au/>



Formed in 2000

Over 20 staff

Students

20+ PhD

5 - 10 Honours/yr

Research Themes

Fisheries and ecosystems

Biodiversity

Biological and evolutionary processes



Talk outline

Aspects of the biology of:

West Australian Dhufish

Western Blue Groper

Two modelling projects

Management strategy evaluation

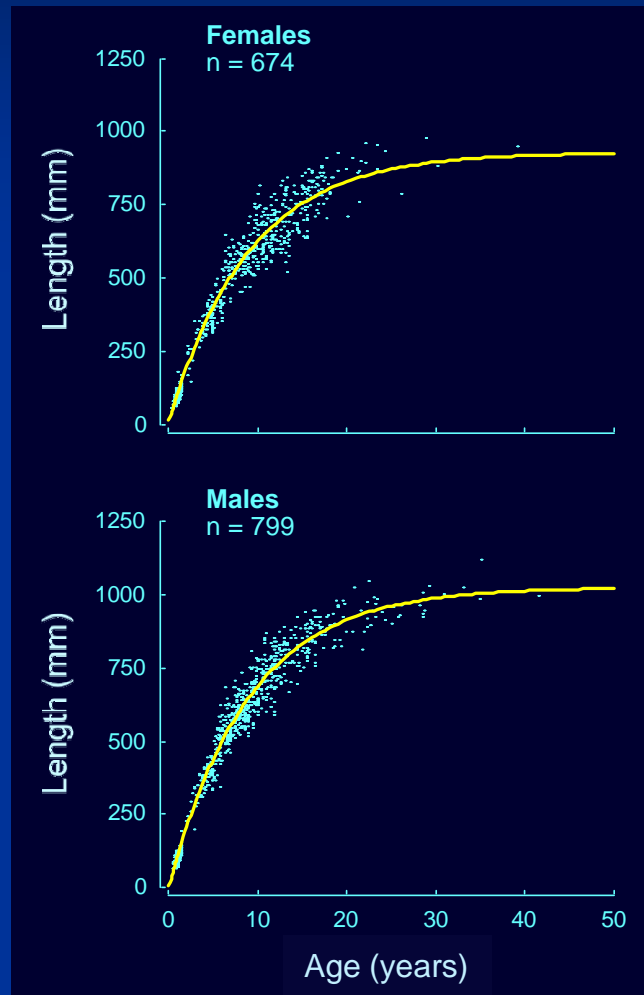
Agent-based model

Examples of Murdoch life cycle studies on important recreational fish species

- Western Australian Dhufish
- Mulloway
- Western Blue Groper
- Blue Morwong
- Foxfish
- Breaksea Cod
- Whiting (seven species, including King George Whiting)
- Australian Herring
- Silver (Skipjack) Trevally and Sand Trevally
- Silver Bream (tarwhine) and Western Yellowfin Bream
- King Wrasse, Maori Wrasse and Brown-Spotted Wrasse
- Snapper (or Pink Snapper) (- with DoF, WA)
- Samson Fish (- with DoF, WA)
- **Black Bream**
- Cobbler ... and many more species

Biology of West Australian Dhufish (1996-99)

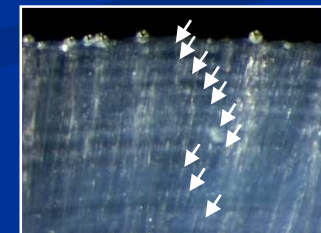
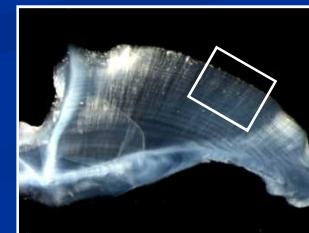
Growth curves for the 2 sexes



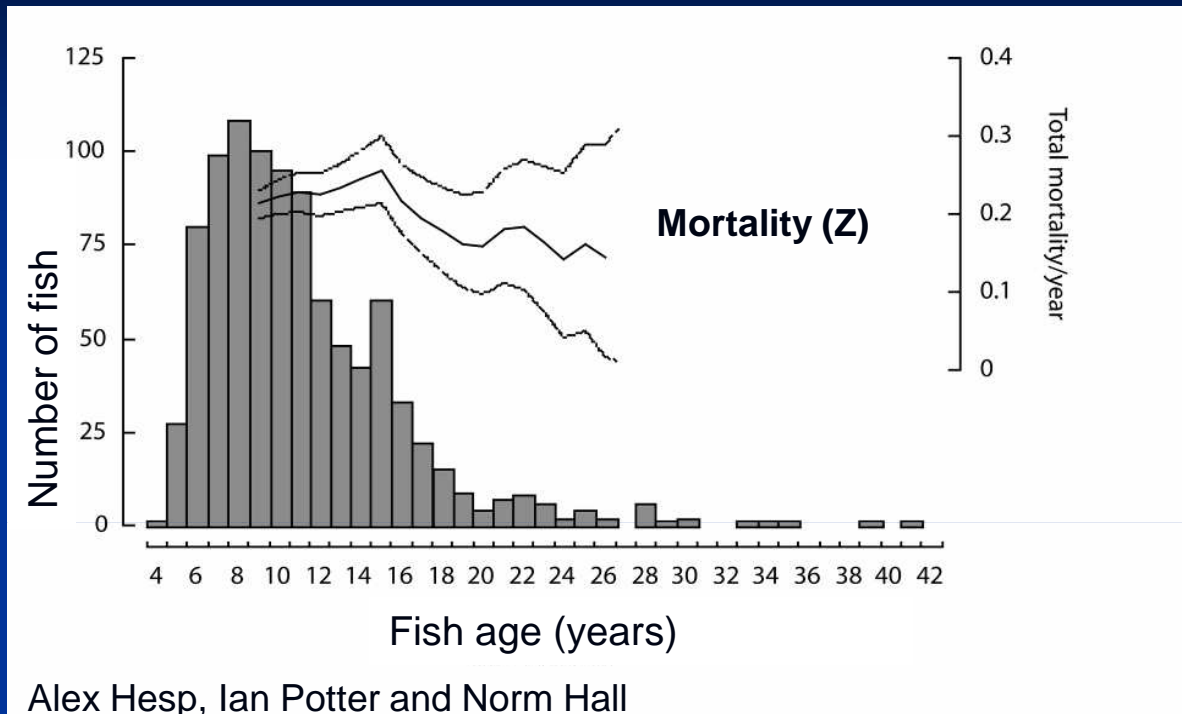
First reliable information on growth and reproduction

- Maximum age = 41 years!
- spawn during summer (mainly Dec-Feb) and mature at ~ 4 years and 300 mm
- reach legal size at 6-7 years

Dhufish otoliths – used for ageing fish



Early stock assessment information (1996-99)



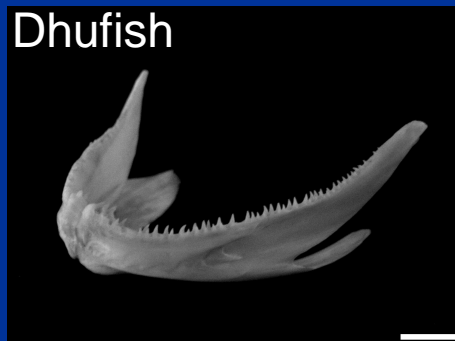
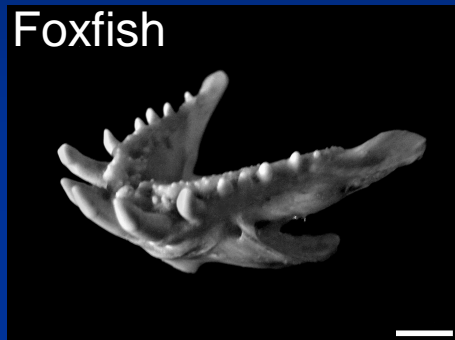
First scientific data on stock status

Provided a warning that the stocks of Dhufish were under pressure

Provided important benchmark information for future stock assessments

Recent dietary study of Foxfish, Dhufish and Breaksea Cod

Lower jaw and dentition

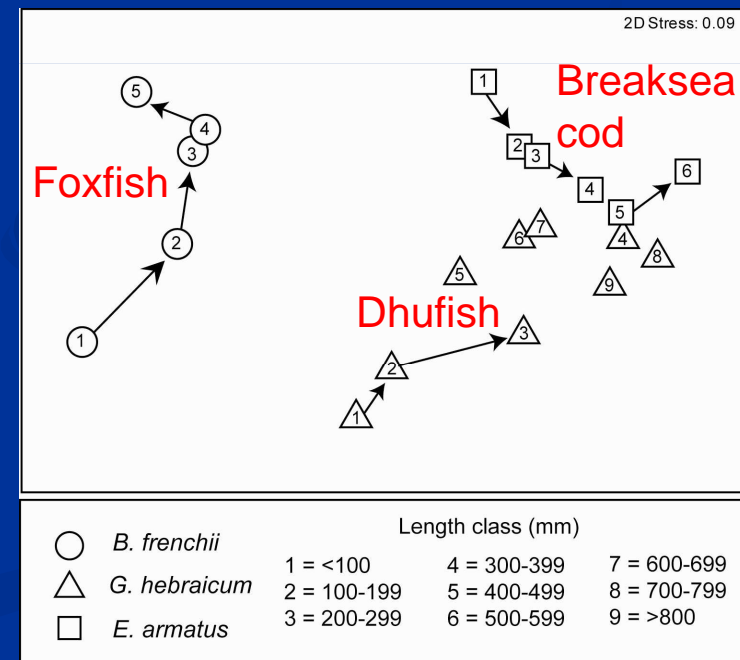


Foxfish: bivalves, gastropods, changing to echinoderms

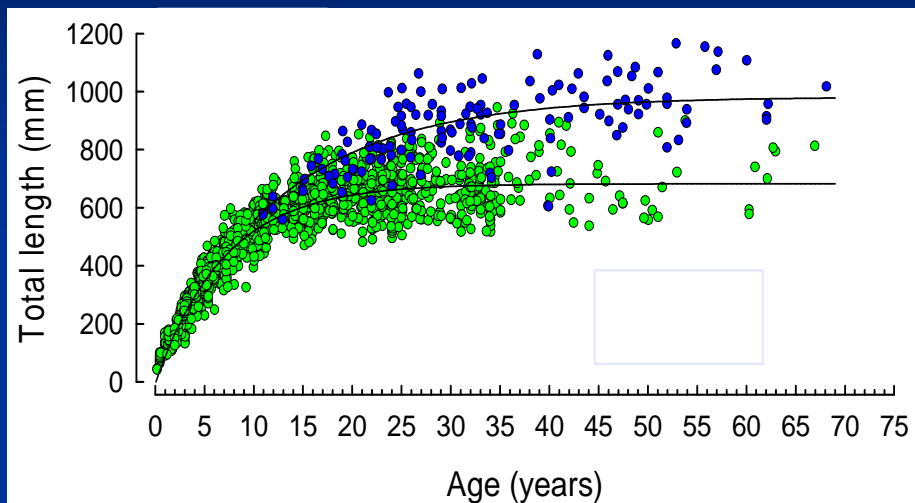
Breaksea cod: decapods, changing to fish prey

Dhufish: small crustaceans, changing to fish prey

We have explored the extent to which the diets differ between these species, different-sized fish of the same species



Biology of Western Blue Groper



- previously, very little information on Western Blue Groper

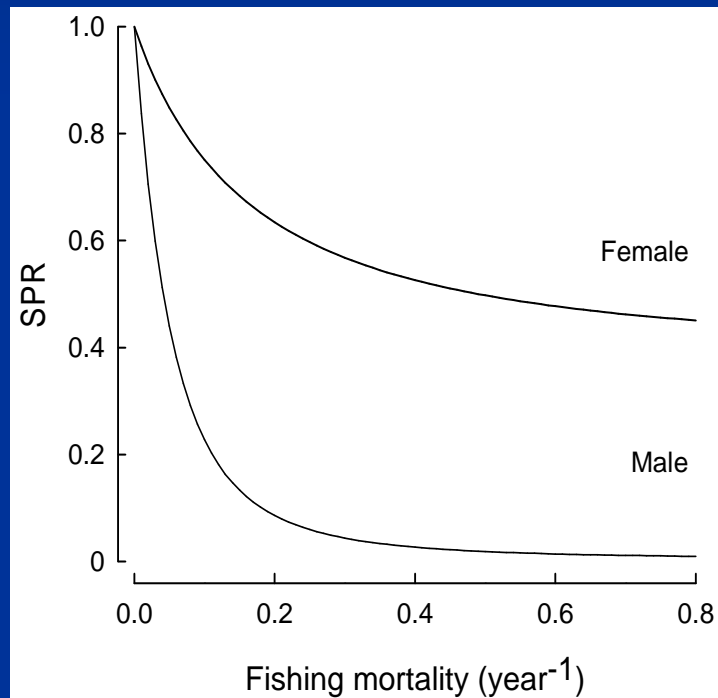
- other fishes in the same family typically short lived (< 10 years)

- our findings were of great surprise – maximum age = 70 years



Western Blue Groper changes sex from female to male

Relationship between fishing pressure and relative female and male spawning biomass



- average size at which females change to become males is 820 mm (= 37 years!)

- fishing likely to impact more on the abundance of males than females

- Results suggest Western Blue Groper will need careful monitoring in the future!



A few brief notes about modelling

- What is a model?

- a simplified version of reality; a representation of a thing or concept
 - a physical model – a model car
 - a diagrammatic model – a road map
 - a mathematical model – fisheries stock assessment model
- Mathematical models : mathematical representation of some part or aspect of a system

about modelling cont..

Why construct models?

- synthesise information and identify gaps in knowledge
- compare alternative assumptions/hypotheses
- evaluate effectiveness of alternative management strategies
- better design experiments and sampling regimes

Some quotes about modelling!

- “All models are wrong, but some are useful”
-generally attributed to the statistician George Box
- “Nonsense. Given that a model is, by definition, *a simplified representation of the real world*, then it must be possible to have models that are right.”
- Some models are useful even though we know they are wrong
- All models are inaccurate in some aspects, some models are useful despite that, and for a given purpose some models are more useful than others.

Modelling projects at Murdoch

Centre for Fish and Fisheries Research is involved in a number of modelling projects

The two projects I am currently involved in:

1. Management strategy evaluation model (2.5 years)

Alex Hesp, Norm Hall, Emily Fisher, Brent Wise*, Steve Newman* (*DoF, WA)

2. Agent-based model (1 year)

Alex Hesp, Norm Hall, Calais Tink, Rowena Burch, Kane Moyle* (*RecFishWest)

1. Both projects are about **half-completed** : (models require further development and testing)

Management Strategy Evaluation

A “management strategy evaluation”(MSE) model is used to predict, through computer simulation, the likely effectiveness of alternative management strategies for individual fish species e.g. dhufish, snapper, etc...

Type of model is a “state of the art” fish stock assessment tool

No other MSE model currently exists for (single) WA fish species.

Example: What would be the likely effect of a large increase in fishing effort (with no change in management controls), for a long-lived species such as dhufish, where initially the stock was moderately-fished



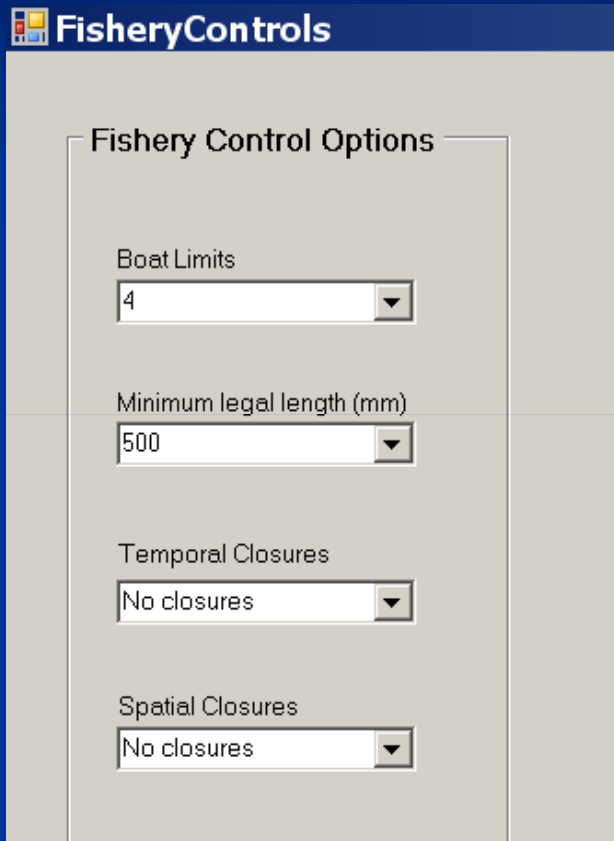
Biological input data for the fish species

InputStockParameters

Maximum age Maximum age (years) <input type="text" value="41"/>	Reproductive strategy <input type="text" value="Gonochoristic"/>	Gear selectivity parameters <table border="1"><thead><tr><th></th><th>Females</th><th>Males</th></tr></thead><tbody><tr><td>L50 (mm)</td><td><input type="text" value="461"/></td><td><input type="text" value="469"/></td></tr><tr><td>L95 (mm)</td><td><input type="text" value="696"/></td><td><input type="text" value="654"/></td></tr></tbody></table>		Females	Males	L50 (mm)	<input type="text" value="461"/>	<input type="text" value="469"/>	L95 (mm)	<input type="text" value="696"/>	<input type="text" value="654"/>															
	Females	Males																								
L50 (mm)	<input type="text" value="461"/>	<input type="text" value="469"/>																								
L95 (mm)	<input type="text" value="696"/>	<input type="text" value="654"/>																								
Growth <table border="1"><thead><tr><th></th><th>Females</th><th>Males</th></tr></thead><tbody><tr><td>L infinity (mm)</td><td><input type="text" value="929"/></td><td><input type="text" value="1025"/></td></tr><tr><td>k (year-1)</td><td><input type="text" value="0.111"/></td><td><input type="text" value="0.111"/></td></tr><tr><td>Tzero (years)</td><td><input type="text" value="-0.141"/></td><td><input type="text" value="-0.052"/></td></tr><tr><td>StDev L infinity (mm)</td><td><input type="text" value="20"/></td><td></td></tr><tr><td>StDev k (year-1)</td><td><input type="text" value="0.02"/></td><td></td></tr><tr><td>StDev Tzero (years)</td><td><input type="text" value="0.02"/></td><td></td></tr><tr><td>StDev Length at age</td><td><input type="text" value="5"/></td><td></td></tr></tbody></table>		Females	Males	L infinity (mm)	<input type="text" value="929"/>	<input type="text" value="1025"/>	k (year-1)	<input type="text" value="0.111"/>	<input type="text" value="0.111"/>	Tzero (years)	<input type="text" value="-0.141"/>	<input type="text" value="-0.052"/>	StDev L infinity (mm)	<input type="text" value="20"/>		StDev k (year-1)	<input type="text" value="0.02"/>		StDev Tzero (years)	<input type="text" value="0.02"/>		StDev Length at age	<input type="text" value="5"/>		Sex change L50 (mm) <input type="text"/> L95 (mm) <input type="text"/> Maximum proportion of terminal sex (mm) <input type="text"/>	Barotrauma Probability of death after release <input type="text" value="0.5"/>
	Females	Males																								
L infinity (mm)	<input type="text" value="929"/>	<input type="text" value="1025"/>																								
k (year-1)	<input type="text" value="0.111"/>	<input type="text" value="0.111"/>																								
Tzero (years)	<input type="text" value="-0.141"/>	<input type="text" value="-0.052"/>																								
StDev L infinity (mm)	<input type="text" value="20"/>																									
StDev k (year-1)	<input type="text" value="0.02"/>																									
StDev Tzero (years)	<input type="text" value="0.02"/>																									
StDev Length at age	<input type="text" value="5"/>																									
Length-weight parameters <table border="1"><thead><tr><th></th><th>a</th><th>b</th></tr></thead><tbody><tr><td></td><td><input type="text" value="2.5972E-0"/></td><td><input type="text" value="2.9308711"/></td></tr></tbody></table>		a	b		<input type="text" value="2.5972E-0"/>	<input type="text" value="2.9308711"/>	Sex ratio Proportion of females at birth (mm) <input type="text" value="0.5"/>	<input type="button" value="Read Parameters"/>																		
	a	b																								
	<input type="text" value="2.5972E-0"/>	<input type="text" value="2.9308711"/>																								
Size at maturity <table border="1"><thead><tr><th></th><th>Females</th><th>Males</th></tr></thead><tbody><tr><td>L50 (mm)</td><td><input type="text" value="331"/></td><td><input type="text" value="324"/></td></tr><tr><td>L95 (mm)</td><td><input type="text" value="509"/></td><td><input type="text" value="454"/></td></tr></tbody></table>		Females	Males	L50 (mm)	<input type="text" value="331"/>	<input type="text" value="324"/>	L95 (mm)	<input type="text" value="509"/>	<input type="text" value="454"/>	Fecundity parameters <table border="1"><thead><tr><th></th><th>a</th><th>b</th></tr></thead><tbody><tr><td></td><td><input type="text" value="10.432"/></td><td><input type="text" value="0.0841"/></td></tr></tbody></table>		a	b		<input type="text" value="10.432"/>	<input type="text" value="0.0841"/>	<input type="button" value="Write Parameters"/>									
	Females	Males																								
L50 (mm)	<input type="text" value="331"/>	<input type="text" value="324"/>																								
L95 (mm)	<input type="text" value="509"/>	<input type="text" value="454"/>																								
	a	b																								
	<input type="text" value="10.432"/>	<input type="text" value="0.0841"/>																								
	Recruitment parameters Virgin recruitment <input type="text" value="100"/> Steepness <input type="text" value="0.7"/> Recruitment variability <input type="text" value="0.2"/>	<input type="button" value="Next"/>																								
		<input type="button" value="Back"/>																								

Existing knowledge for the fish species (determined in past studies) is inputted into the model, in the form of “parameter values” (in some cases - with uncertainty).

Specify management controls



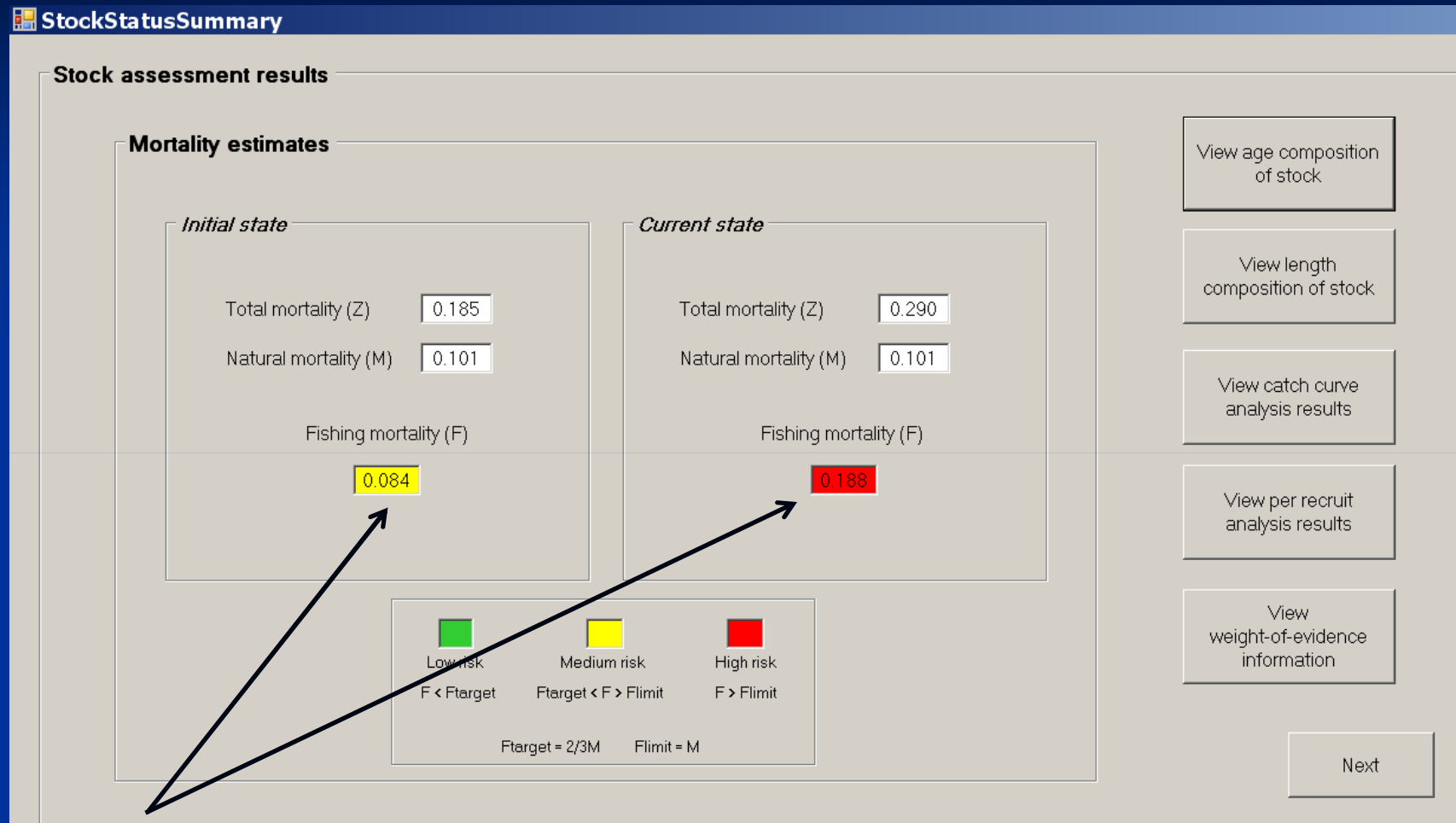
The screenshot shows a software window titled "FisheryControls" with a "Fishery Control Options" section. It contains four dropdown menus: "Boat Limits" set to 4, "Minimum legal length (mm)" set to 500, "Temporal Closures" set to "No closures", and "Spatial Closures" set to "No closures".

Control Option	Value
Boat Limits	4
Minimum legal length (mm)	500
Temporal Closures	No closures
Spatial Closures	No closures

Management controls are specified by the user and can be changed during the computer simulation to see the effects of those changes

Assumptions need to be made about the way in which each control influences effective fishing effort

Summary results, based on fishing mortality



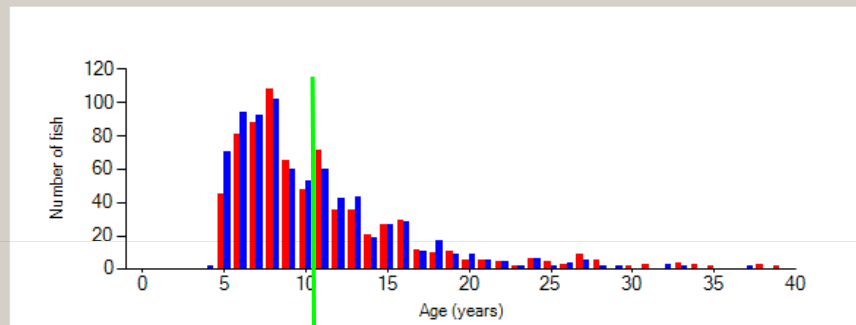
An assessment has been made as to whether, at the end of the simulation projection period, the “hypothetical” fish stock is lightly-exploited (**green**), moderate or fully-exploited (**yellow**) or overfished (**red**) according to stipulated “reference points”

Change in age composition and results of “catch curve” analysis

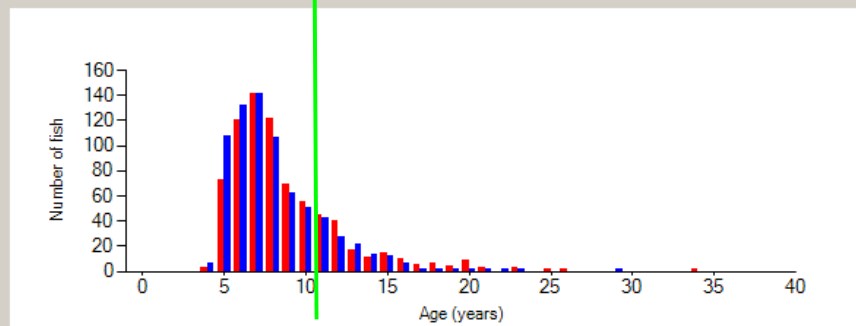
StockStatusAgeComposition

Stock assessment results - Age compositions

Initial state



Current state



Reduction in the numbers of older fish in the population (as a result of higher fishing mortality)

Program also records changes in length composition, and a range of measures of stock status – i.e. YPR, SSB/R and EPR

In summary

Management strategy evaluation models can predict the likely consequences of different combinations of management controls

For example, what is the likely effectiveness of a fishery closure of 1, 2 or 3 months etc...? combined with a change in bag limit of 4 to 3 or 2, etc...

What is the least disruptive combination of management controls for fishers, which will still be effective in achieving a certain management goal, e.g. reduce fishing mortality to a certain level, e.g. to $2/3$ natural mortality?

Agent-based modelling study

Project initiated by RecFishWest . The agent-based model computer program will be made freely available for fishers to download from the internet

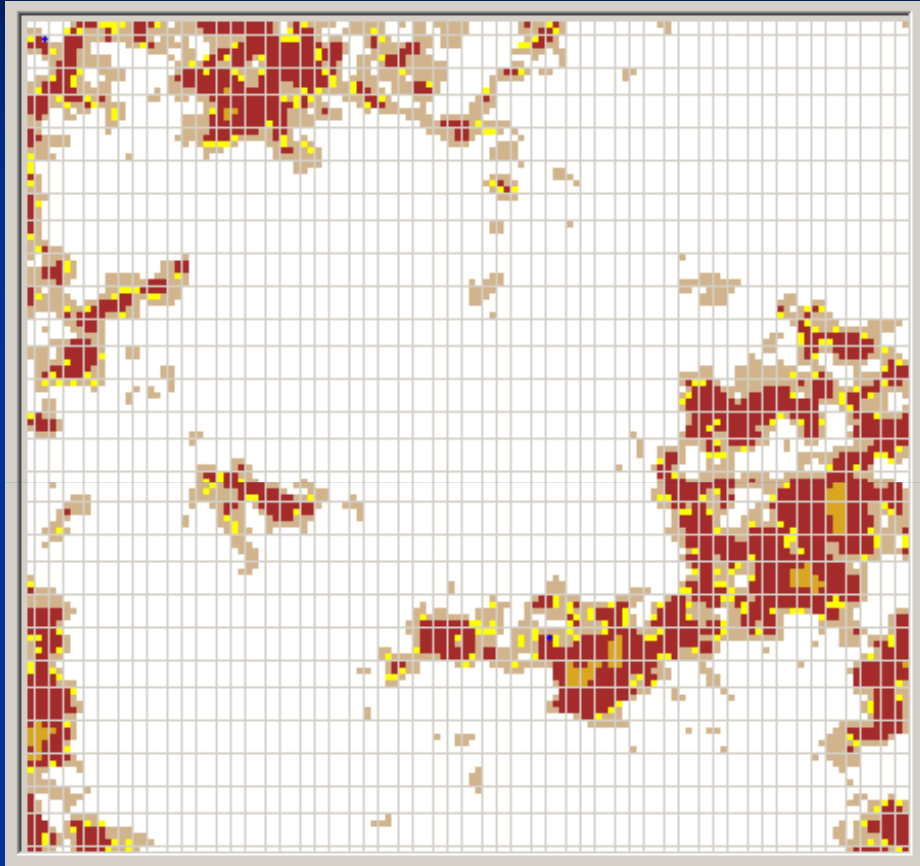
Agent-based models represent a “bottom-up” approach to modelling

Our model simulates the movements, and interactions between recreational fishers and demersal fish species

The model will be used to explore the overall consequences of localised interactions between fish and fishers



Generation of habitat landscapes

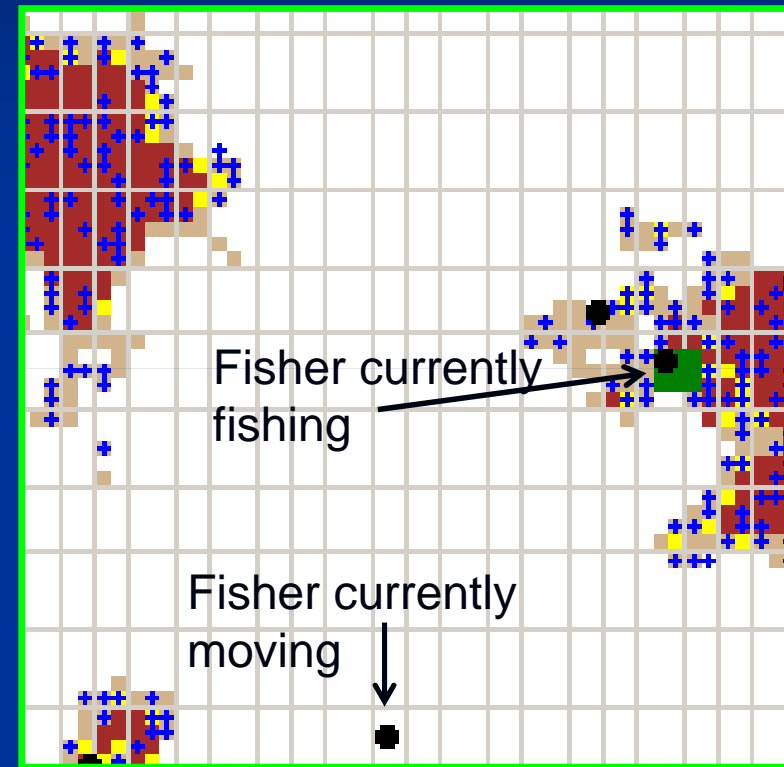
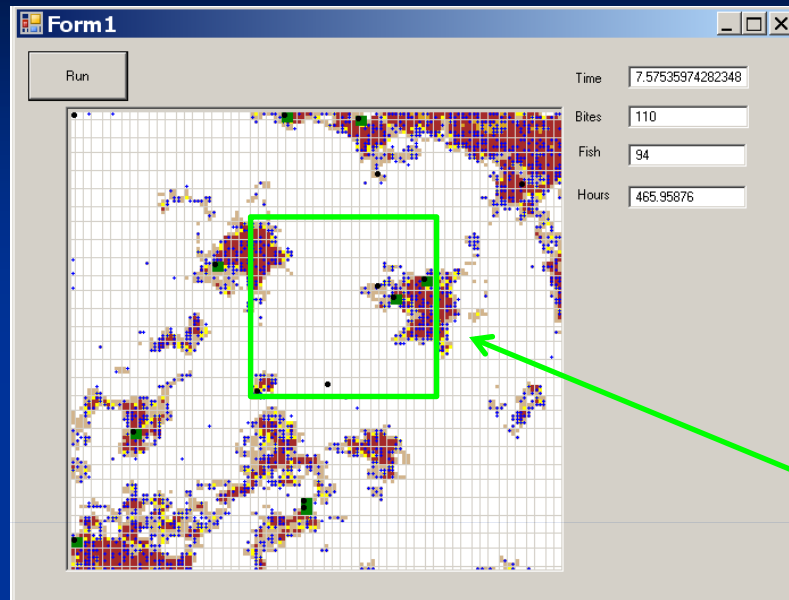


Legend: habitat types considered

- White square: Sand
- Tan square: Reef edges
- Yellow square: Reef edge hotspots
- Red square: Reef top
- Orange square: Reef top hotspots

An “artificial landscape” is generated at the beginning of the simulation, according to specified habitat types and habitat “patchiness”

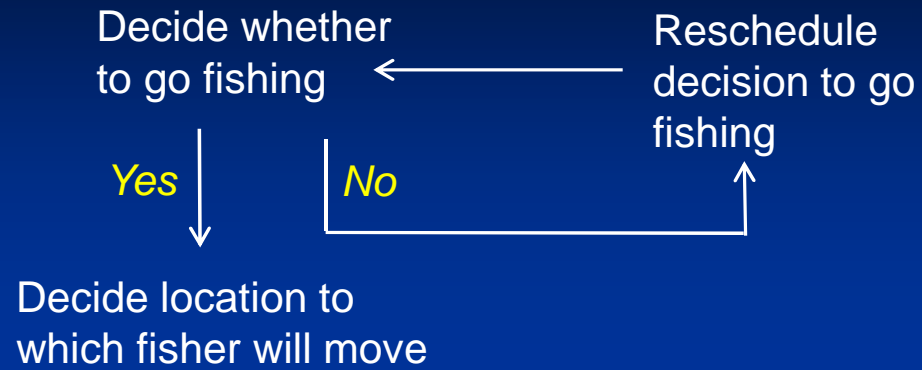
Simulation of movements of, and interactions between fish and fishers



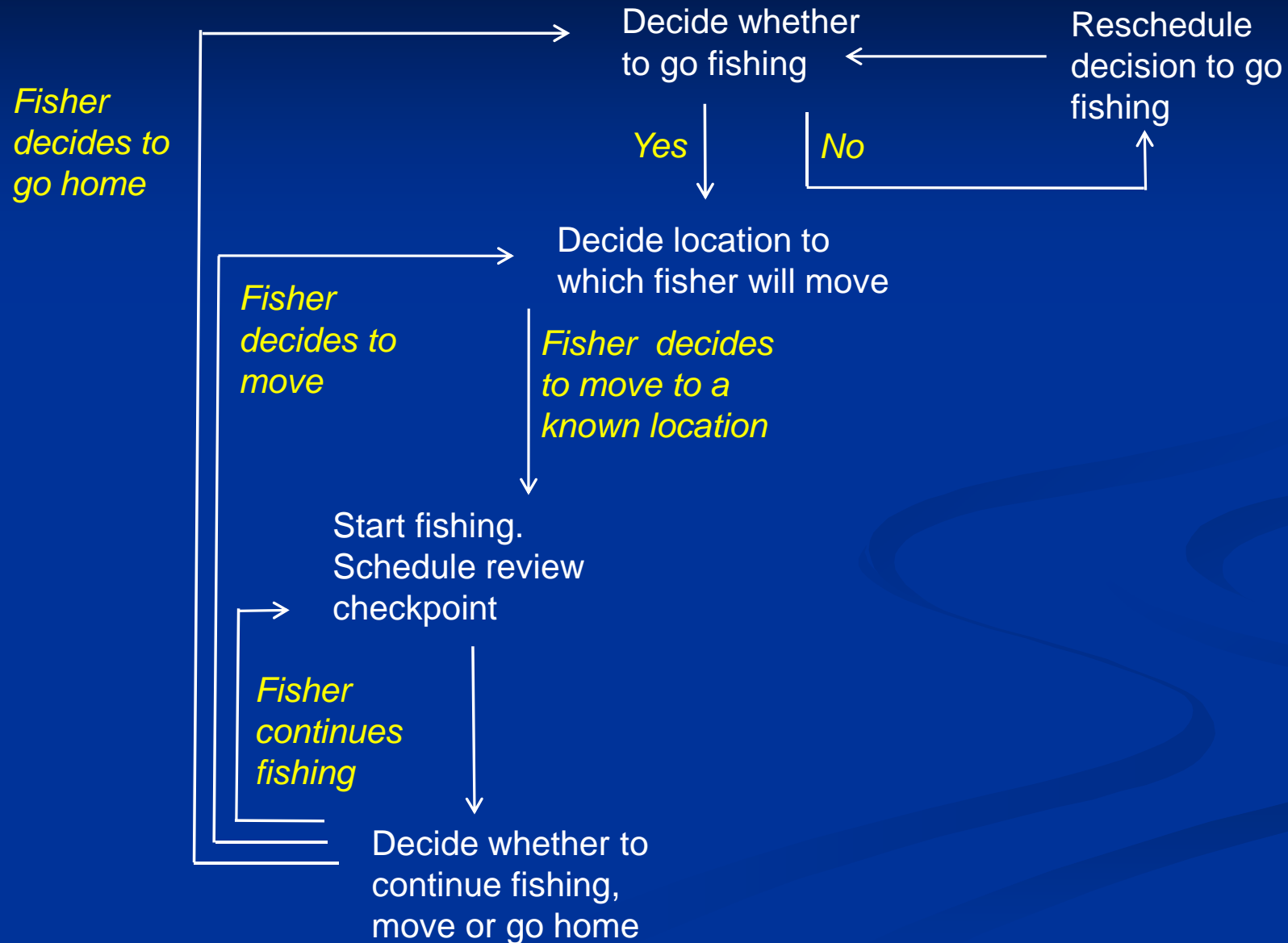
The landscape grid is populated with fish and fishers, according to behavioural “rules”

Statistics are generated, e.g. number of bites, fish caught, catch rates, length and age composition of catch etc...

Preliminary conceptual diagram of fisher decision pathways



Preliminary conceptual diagram of fisher decision pathways



What we need to know to make our model more reliable

To “parameterise” the model, we require information on the ways in which fishers target fish, and also on the biology, movements and habitat preferences of the fish species.

Some (but not all) of the parameters for fish are reasonably well understood, e.g. pattern of growth, age structure etc...

The ways in which recreational fishers target dhufish and snapper **are not well understood (by us)**.

We are asking you to kindly help us address this lack of knowledge by filling out our survey and then discussing the survey with us tonight.



Research Ethics Office
Division of Research and Development

www.murdoch.edu.au

Chancellery Building
South Street
MURDOCH WA 6150
Telephone: 0800 5677
Facsimile: 0800 5686
human.ethics@murdoch.edu.au
www.research.murdoch.edu.au/ethics

Monday, 20 July 2009

Dr Alex Hesp
65A The Promenade
Mt Pleasant
6153

Dear Alex,

Project No.	2009/114
Project Title	Development of an agent-based model to communicate implications of recruitment variability of finfish to recreational fishers

Thank you for addressing the conditions placed on the above application by the Murdoch University Human Research Ethics Committee. On behalf of the Committee, I am pleased to advise the application now has:

OUTRIGHT APPROVAL

Approval is granted on the understanding that research will be conducted according to the standards of the National Statement on Ethical Conduct in Human Research (2007), the Australian Code for the Responsible Conduct of Research (2007) and Murdoch University policies at all times. You must also abide by the Human Research Ethics Committee's standard conditions of approval (see attached). All reporting forms are available on the Research Ethics web-site.

I wish you every success for your research.

Please quote your ethics project number in all correspondence.

Kind Regards,

Dr. Erich von Dietze
Manager of Research Ethics

cc: Prof Norm Hall, Miss Calais Tink, Miss Rowena Burch

HREC Approval Number: 2009/114

CRICOS Provider Code: 00125J
ABN: 63 416 369 313

Murdoch University has a human ethics committee, which exists to ensure that studies with human participants are carried out appropriately

In order to obtain university permission to undertake this survey, we have followed strict protocols

1. Please make sure to ask any questions you have about our survey and discussions after the survey
2. Please first read our information letter before filling out the survey
3. Please sign our consent form before filling out the survey

Acknowledgements

Recreational fishers: Ron LoPresti, MAAC and MOFC fishers

RecFishWest

DoF, WA researchers

Murdoch University Honours and PhD students

Fisheries Research and Development Corporation

