Development of a user-friendly desktop tool based on existing Atlantis runs

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Contents

List of Figures

List of Tables

1. NON TECHNICAL SUMMARY

2010/043	Development of a user-friendly desktop tool based on existing Atlantis runs

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OBJECTIVES:

1. Develop an easily accessible desktop software application to allow fisheries stakeholders to analyse ecosystem model output and gather information on potential ecological and economic impacts of changes in the fisheries system due to alternative fisheries management arrangements.

NON TECHNICAL SUMMARY:

OUTCOMES

The **sea**view model portal has been made public, so that industry and managers a like can explore potential futures for Australia's federal fisheries, beginning with the Southern Eastern Scalefish and Shark Fishery. This should provide easily accessible insights into how the fishery and ecosystem may fare under alternative management regimes and external pressures, like climate change. While the site has only recently gone live, at a workshop with AFMA managers, so far there has been a very positive response. Any one interested in the modelling, or providing feedback, they can access it at http://www.csiro.au/seaview/ or contact seaview@csiro.au.

Fisheries Managers often need to rapidly explore possible impacts of a range of potential changes to a fishery. These may take the form of changes in fuel and fish prices, environmental shifts (e.g. climate change) or alternative fisheries management regulations.

Like flight simulators, ecosystem models can show what might happen if the environment changes or if managers make a decision to move management of the fishery in one way or another. Unfortunately, it can take years (and cost millions) to build models of system as complex as any one of Australia's federal fisheries. This is simply too slow to be of use for many of the rapid turn around questions management bodies are presented with on a daily basis. Nevertheless, the decisions still need to be made and would benefit from system-level strategic information if it were available. Managers and the fishing industry alike would gain significant insights into the fishery if they had the ability to explore potential changes without the need to undertake specific research projects.

This need was identified in 2010 by AFMA managers, leading to a call for tools to fill this gap. In response a library of ecosystem model runs has been drawn together that spans a large number of potential management strategies and environmental scenarios. These runs have been accessible via a user-friendly portal (web interface) that can be explored from the user's desktop.

In the short term this tool is applied around a library of runs set up for south eastern Australian waters (the Southern Eastern Scalefish and Shark Fishery), but other regions will be added to the library as models become available for those regions (over the next couple of years). In addition, other data sources used by fisheries managers and the fishing industry could potentially be served up in the same portal. Making it a one-stop data portal for fisheries relevant information; providing the means to interrogate complex information about marine systems and gain general insights into their function and implications of different forms of management – ultimately supporting sustainable management of Australia's fisheries and biodiversity.

KEYWORDS: Atlantis, ecosystem modelling, desktop portal, sustainable management.

2. ACKNOWLEDGMENTS

Development of a user-friendly desktop tool (a web portal for accessing Atlantis runs) was based on existing Atlantis runs and is supported by funding from the FRDC on behalf of the Australian Government.

3. BACKGROUND

For ongoing sustainable management of Australia's marine environment it is important to supply both managers and industry members with information that will allow for informed decisions. This will allow for the fishery members to be prepared and responsive to future system shifts and policy challenges. Tools of most use for information support in this context are those founded on a sound risk-based and integrated approach. End-to-end ecosystem models have been recognized as an effective tool that has just such a grounding. One such model, Atlantis, explicitly includes the major driving processes from the physical realm, up through the biogeochemistry of nutrient cycling and production, to the spectrum of ecological processes and components that form marine ecosystems and on to the social and economic drivers shaping the behaviour and outcomes for commercial and recreational fisheries sectors active in the marine realm. At present these kinds of models require expert interpretation and specialist commission on a case-by-case basis, which can prove a drawn out and costly enterprise. Communication of their content would be much more effective if it were in a form where anybody could integrate it and it could be deployed rapidly as new (short turn around) issues arose. One way of doing that is to create a library of any existing runs (augmented by a select set of addition runs to cover any existing potential policy gaps and the range of most likely future issues) that can be interrogated quickly as needed. This will obviously not cover every single possible future situation, but should still be able to provide considerable insight for a wide range of possible questions and can form the core of a library that could be periodically augmented in the future as new issues (not covered in the original library) come onto the policy horizon.

A key component of such a tool would be ease of use. Fortunately, over the last 10 years there have been significant advancements in the visualization and presentation of complex information to stakeholders (from the general public through to senior departmental advisers). With the correct use of summary statistics and visualisations complex information on the state of the environment and the industries dependent on it can be effectively communicated. This means that it is now feasible to effectively link a visualization interface to a library of pre-run simulations that cover a broad set of potential management options and conditions.

The advent of broadly available fast internet access has also made web delivery of such services a viable option, reducing the need to handle installation of software and maintenance of upgrade distributions. Thus web browsers will be used as the portal platform to allow access to the interface and library. The basic form of the interface and the library infrastructure behind it is generic and deployable in any location with an Atlantis (or potentially other multispecies) model. As a case study example the marine waters in southeastern Australia are currently uniquely placed to benefit from tools like this. This is because there has already been a significant investment in implementing and employing Atlantis-SE (an Atlantis for the SESSF), which is currently the most advanced and well tested of any in the world. The waters around southeastern Australia are amongst some of the most productive in Australia, but they are also some of the most intensively exploited within the EEZ and they are also expected to be some

of the most significantly affected by global change. The Atlantis model developed for these waters, both for Commonwealth and State jurisdictions, includes the broader regulatory context of the system (including closures, incentive-based structures and gear controls). Consequently, insights drawn from Atlantis-SE can provide information on the implications of potential changes to the SESSF in terms of biophysical as well as social and economic impacts. Importantly the insights gained from interrogating Atlantis-SE are not constrained to only being applied in that immediate region. While any findings would need to be applied with care to other ecosystems, general findings on potential sensitivities of different forms of management and the resilience of different ecological structures and social and economic situations could be informative, as background or supporting information, for other systems where large management questions have arisen. As a result investment in visualization software for a library of existing runs will have broad scale benefits, both directly (for providing infrastructure that can be extended into the future for new scenarios and systems) and indirectly (by providing generic insights that can inform management decisions across many systems).

4. NEED

Fisheries Managers often need to rapidly explore possible impacts of a range of potential changes to a fishery (for example, changes in fuel and fish prices, biophysical, environmental and economic drivers of the fishery, and alternative fisheries management regulations). Unfortunately, the preparation and implementation time involved in an end-to-end ecosystem modeling project (e.g. the Alternative Management strategies for commonwealth fisheries) means that delivery time is typically years (likely 3-4 years) at a potential cost of millions. This is simply too slow to be of use to many of the rapid turn around questions management bodies are presented with. However, the decisions that need to be made would benefit from system-level strategic information if it were available; and fisheries managers and other stakeholders, including the fishing industry, would gain significant insights into the fishery from the ability to explore such changes without the need to undertake specific research projects.

To this end the best approach is to pre-emptively create a library of runs that span a large number of potential management strategies and scenarios of interest and to have it to hand as an accessible data source through a user-friendly interface that can be explored from the user's desktop. This need has been identified by key stakeholders, like the AFMA managers and lead to the ComFRAB call for this project. In the short term this tool is best developed and applied around a library of runs set up for southeastern waters and the SESSF, but the benefit can be much broader than that – both in terms of creating a framework for future use with other Atlantis (or multispecies) model output and indirectly by providing a way of interrogating a complex marine system to gain general insights into their function and implications of different forms of management.

Concerns about computing resources and administration issues reinforced the need for a generic, web-based interface which could be extended to new locations and new models (including serving up stock assessment or multispecies or habitat models) as they become available.

5. OBJECTIVES

The single objective of the project was to develop an easily accessible desktop software application to allow fisheries stakeholders to analyse ecosystem model output and gather information on potential ecological and economic impacts of changes in the fisheries system due to alternative fisheries management arrangements.

6. METHODS

The project was made up of two parts:

1) Creation of a set of simulations to act as the core of the library - to cover a broad range of management strategies and contextual scenarios.

2) Creation of visualisation portal (GUI) for interacting with the virtual library of runs.

Both of these will be summarised briefly below.

6.1 Simulation Library

The simulations used to populate the library of simulations were of two forms. A first set of simulations was drawn together as the foundation of the virtual library (see Table 1). This set has come form two sources.

The first are updated version of previous simulations requested by the Australian Fisheries Management Authority. Many of these simulations had been performed based on a model calibrated to the state in 2005, but a lot has changed in the fishery since then due to the federal restructure. Consequently it proved necessary to recalibrate the fishery and management sub-models to match the current state of management in the SESSF.

The second set of simulations were drawn together through email conversations with AFMA and in a one-day workshop held on Feb 22nd 2011 at AFMA in Canberra. This workshop was also used to gain feedback on the first prototype of the GUI.

Table 1: List of Atlantis runs included in virtual simulation library to date. Simulations marked with "AMS" were originally created for the Alternative Management Strategies for Commonwealth Fisheries (SESSF) project. And those marked "new" were run in response to requests from AFMA during the life of this project.

Option	Note	Details
Management Strategy		
Status Quo 2000	AMS	
Status Quo 2010	New	
Quota management dominated	AMS	Quota management extended to majority of groups
Extensive spatial management	AMS	85% of all current fishing grounds closed
Integrated management	AMS	Mix of management levers used
Small homeranges vs marine reserves		Gulper shark home ranges (150km) vs extent of spatial closures (various sizes from 8 to 40% with reserves either single large contiguous closures or a mosaic across the SESSF)
Large homeranges vs marine reserves		Gulper shark home ranges (1000km) vs extent of spatial closures (various sizes from 8 to 40% with reserves either single large contiguous closures or a mosaic across the SESSF)
Small pelagics fisheries management		Alternative options for extent and kinds of management for small pelagics fishery (with the intensive exploitation of squid, small pelagic fishes, mesopelagic fishes and mackerel
Spatial management – South Australian waters shut to gillnet	New	Large fisheries specific closure
Spatial management – longlining on shelf	New	Large scale change in spatial management, with longlining allowed in all shelf boxes
Taxes on bycatch groups		Taxes applied on bycatch species ($1/kg for whales and seals and $5/kg for dolphins)
Deemed values for bycatch		Using deemed values as a means of changing incentives on excess catch of target species (0.5 * sale price / kg)
Quotas on bycatch		Extension of quotas to bycatch species (7t for whales caught in shark net fisheries; 750kg of dolphins for seine fleet and 250kg for the shark net fleet; halving vs values in 2010 for seals for all fleets that incidentally capture seals)
Effort penalties to reduce bycatch		Use of individual transferable effort and differential effort penalties in areas with high bycatch levels
Companion quota – strong link		Companion quotas based on the most robust stocks
Companion quota – weak link		Companion quotas based on the most vulnerable stocks
Gear shifts – reduced discards	New	Forced reduction in discards for specific gear types
Gear shifts – altered catchability	New	Forced changes in catchabilities for specific gear types
Seasonal management – closures	New	Introduction of seasonal closures (e.g. around spawning periods)
Seasonal management – limited effort		Introduction of seasonal rules on days at sea
Seasonal management – input controls		
Seasonal management – time of day fished		
Multi-year TACs	New	As for status quo, but the TAC can be caught over a period of 3 years instead of in a single year

Option	Note	Details
Harvest control rules – tier 3	New	All species are treated as tier 3 in the harvest control rule
Harvest control rules – tier 4	New	All species are treated as tier 4 in the harvest control rule
Change in size limits	New	
Change in trip limits	New	
Altered frequency of stock assessments		Stock assessments performed annually, or every 2 or 5 years
Change in quotas – one step reduction		For example reduction in blue-eye quota by 20%
Change in quotas – slow reduction		For example reduction in blue-eye quota by 5% per year for 5 years
Climate Scenarios		
No climate change		Conditions between 1990-2005 repeated through time with no climate change shift in the environment
Climate effects – temperature shifts		Running forward status quo 2010 simulation under climate conditions defined by global climate models
Climate effects – acidification		Running forward status quo 2010 simulation with ocean acidification impacts
Climate effects – cumulative effects		Running forward status quo 2010 simulation under climate conditions defined by global climate models, with ocean acidification impacts
System Specifications		
Low overall productivity (pessimistic)		To cover system uncertainty – system productivity at the lower bound of observed levels
Intermediate productivity		To cover system uncertainty – system productivity at most likely level based on observed levels

6.2 Visualisation Portal

The visualisation method used was to create a web portal for accessing a range of data, stored in a database and distributed over the web from a central server. The visualisation software has been based around a the structure given in Figure 1. With the virtual library maintained on CSIRO servers delivered to the desktop of interested parties via webservices.

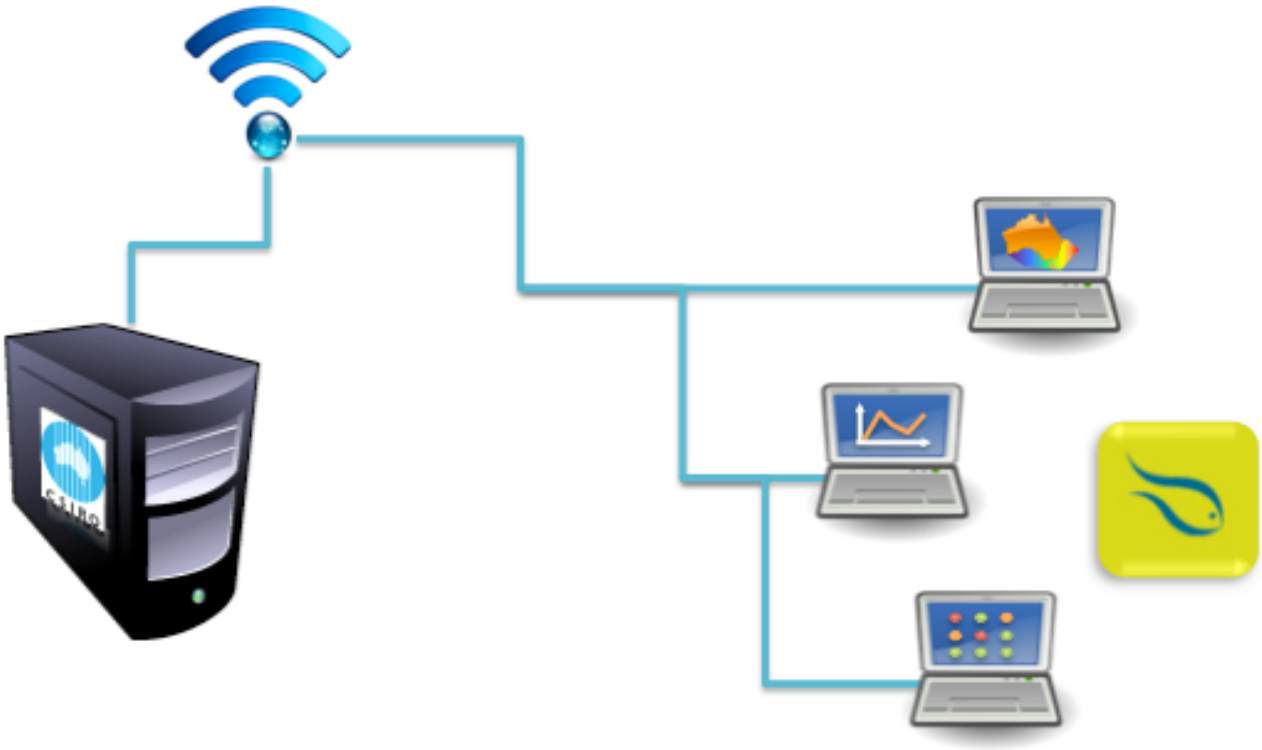


Figure 1: General conceptual structure of the software

The webservice includes everything needed to interrogate the library of runs. The five main components of this software are documentation and help pages to outline how to use the software, what the different views are presenting and how to contact the development team to request new simulations or identify bugs.

The other four sections of the software are for reporting results from the simulations. These sections are:

(i) A status table view (Figure 2) that allows users to identify system scenarios, management strategies of interest and key indicators of interest and how the indicators map versus objectives under each of the scenario-strategy combinations. Based on the traffic light approach (red = objective not met, amber = objective on the margin, green = objective met) after consultation with AFMA we have moved to arrows. This decision was made to ensure that even colour blind people will immediately recognise the visual cues for the indicator status. Mouse overs will also indicate information on management strategies, indicators and deviation of the indicator from the objective (and associated uncertainties).

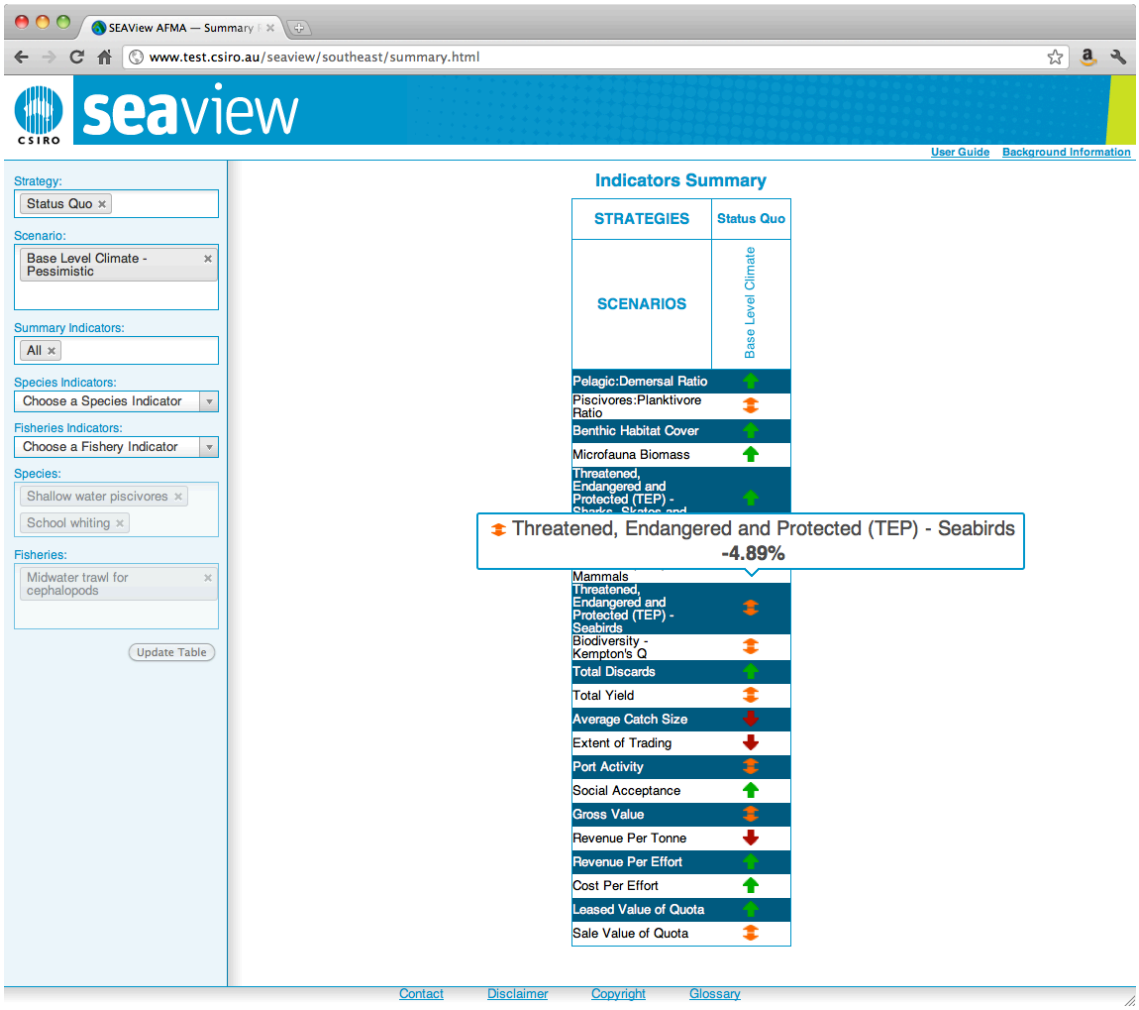


Figure 2: Example of the status table view. Indicators (scenarios and strategies of interest) are selected from the menus on the left; arrows indicate degree of change of the indicator from the start of the scenario and by hovering the mouse over the arrow it is possible to the exact level of change.

(ii) A time series aggregate view that provides users a view of indicators at the whole of system (i.e aggregate) level (Figure 3).

(Iii) A map view (Figure 4) that allows users to explore the spatial outcome of the model runs. A time slider allows for exploration through time. It is also possible to bring up multiple maps (e.g. from different management strategies) to see how the results differ in the different cases (Figure 5). It is also possible to click on a specific location and bring up a time series for that indicator at that location (Figure 6).

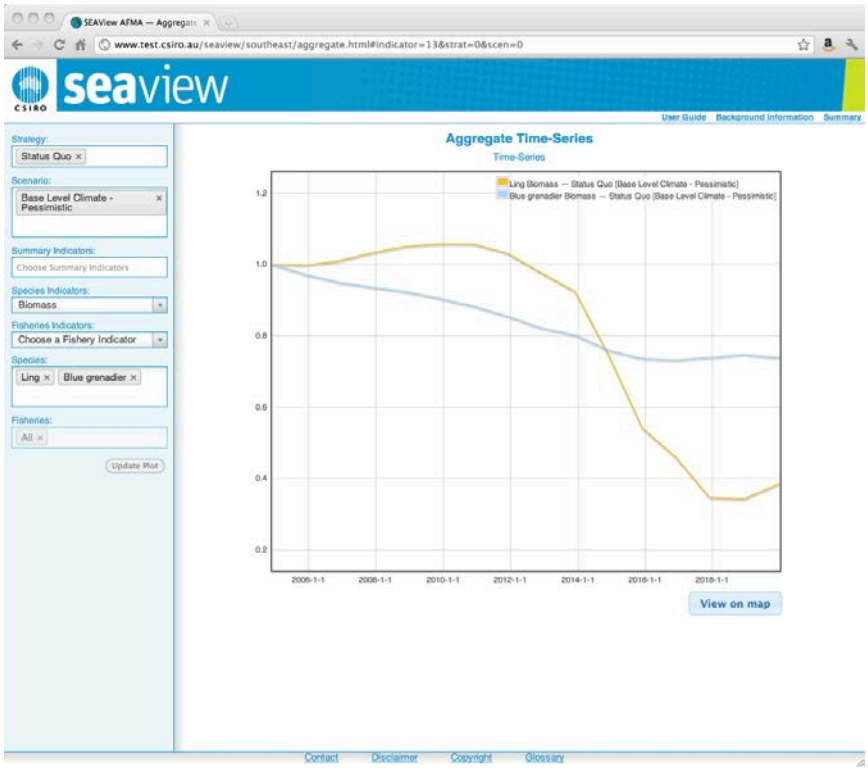


Figure 3: Example of the aggregate time series view, showing relative change through time in the indicators.

Figure 4: Example of the map view, which can display relative spatial distributions through time.

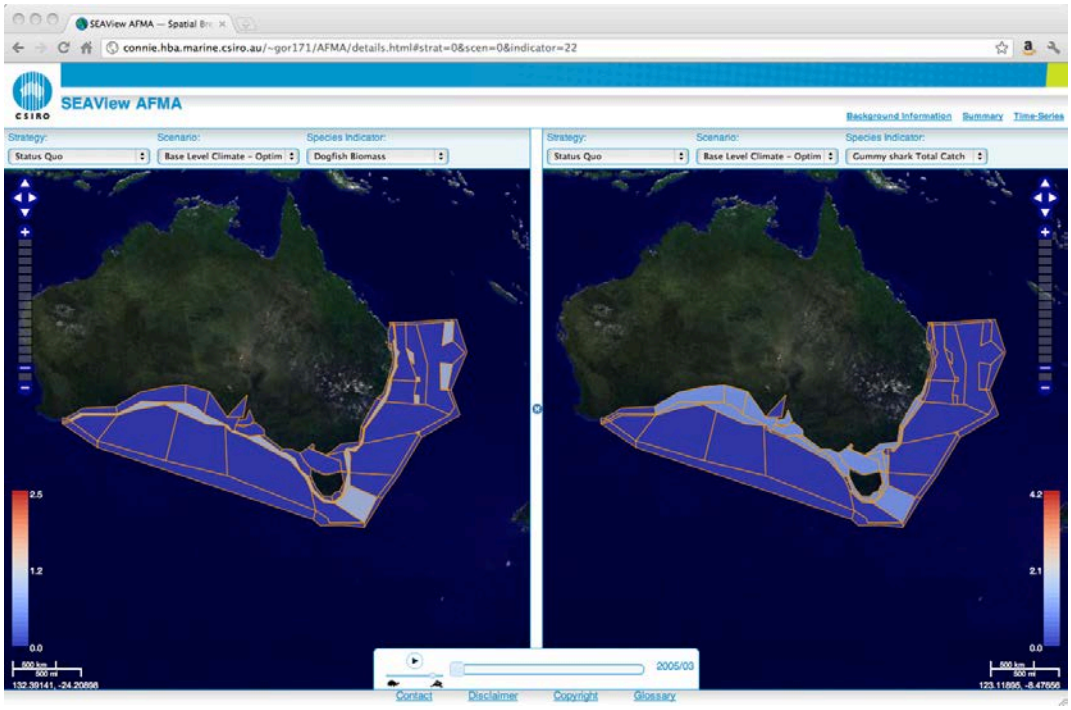


Figure 5: Example of multiple view for comparing different runs and indicators.

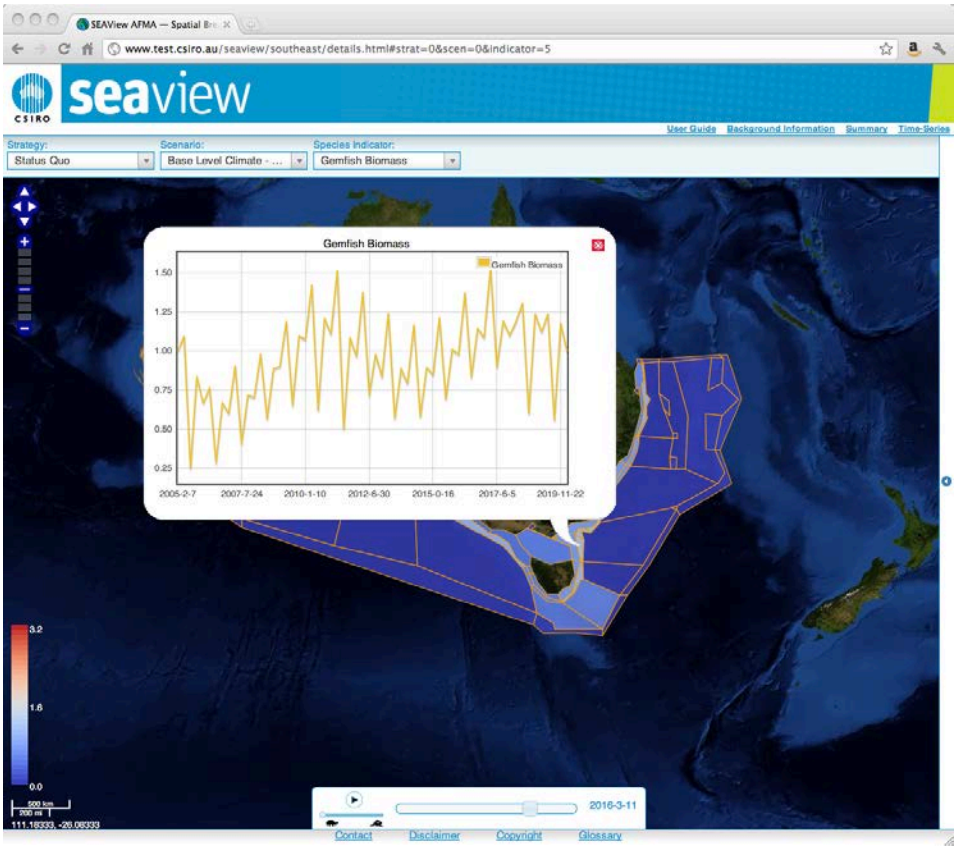


Figure 6: Example of time series view that shows users a time series for that indicator either at a specific location (accessed by clicking the map page).

7. OUTPUTS

This is not a typical research project, rather it produced a web portal. The portal has been distributed to AFMA and is publically available, if industry wants to evaluate options too. To date it has been used to provide information to AFMA and industry as topical issues arise and to supply information on potential climate change implications for southeast fisheries. More broadly the true magnitude of the outputs and outcomes of this project can only be judged into the future, as people become more familiar with it and it really begins to see use. The re-use in the SEAP project (and the favourable response gained there), as well as interest internationally – from the US National Oceanic and Atmospheric Administration, for delivery of the US Atlantis products to NOAA's local stakeholders – indicates that the work has provided a good foundation for rapid model delivery and that the objectives have been well met.

8. BENEFITS AND ADOPTION

To date AFMA managers have been the major beneficiaries. Industry members or representatives have discussed access as part of SEAP (e.g. Martin Exel of the Commonwealth Fisheries Association, Neil Stump of the Tasmanian Fishing Industry Council) or more generally (e.g. Ian Knuckey of Fishwell, Simon Boag of SETFIA) and Ian Knuckey is helping the project team organise targeted industry training sessions and briefings in early 2013.

As people more readily see the benefit of the approach when they have a specific question to ask the industry uptake has been greatest in relation to seaview's use in the SEAP climate adaptation project. SEAP project workshops (which include regulators and industry representatives) focus on simulation exploration using seaview and this has proved how successful the approach is – with follow up questions being directed to us as a result. In addition, the portal is being used as a major means of delivering those results to a broad audience – both at port visits but also via regular email updates or all known users when new sets of scenarios are uploaded.

Again it is too early to know whether the access to model results will lead to operational level in behaviour and prices, though it is likely that the biggest impacts would be through evidenced based decision making. The true uptake and impact will only become clear with time, as the tool is used. However an early indication of the potential of the approach can be seen in the following beneficiary responses from Ian Knuckey:

> I have viewed and operated the Seaview front-end of the Atlantis model developed by Dr Beth Fulton. It is reasonably easy to use and intuitive once you understand a few basic steps. It has a good glossary, background information and user guide to assist people in understanding what can be modelled and what it means. I am impressed with the huge level of information and research that has gone into the Atlantis project, but what makes it special is that the web-based Seaview front end allows simple management scenarios to be quantitatively evaluated against

> various indicators for specific species / species groups as well as other important fishery indicators. I would like to thank Dr Fulton for recognising that too often access to tools such as Atlantis is restricted to the few with programming capacity or government/agency connections. The construction of the SeaView front end to Atlantis brings these tools within reach of a far broader group of end users. I look forward to the extension and broader use of this package, but will be very interested to see how it is used (constructively or not) by various stakeholders. If information/knowledge is power, then open access to Seaview will definitely "Give power to the people".

And Martin Exel (Chair, Commonwealth Fisheries Association):

> Thanks for our second interactive session yesterday on SEAP [using seaview]. I think it's going to be an invaluable tool for industry, science, conservation groups, and management alike. I believe it will be instrumental as a tool for education on climate change scenarios, as well as a powerful information base for consideration of future management actions.
>
> The Seaview approach for analyses with pictorial outputs and its ease of use is particularly valuable, as it provides interested operators, scientists and managers the opportunity to evaluate different risk scenarios and strategies themselves, when determining their views on future options. In addition, it provides the perfect base for "beginning the conversation" amongst all groups, and information can be continually added to the program as it becomes available.
>
> Thanks again for the work you've done on drawing this information to together. I'm looking forward to the final version and gaining a much improved understanding of future changes in marine resources as a result of climate change in the south-east region of Australia.

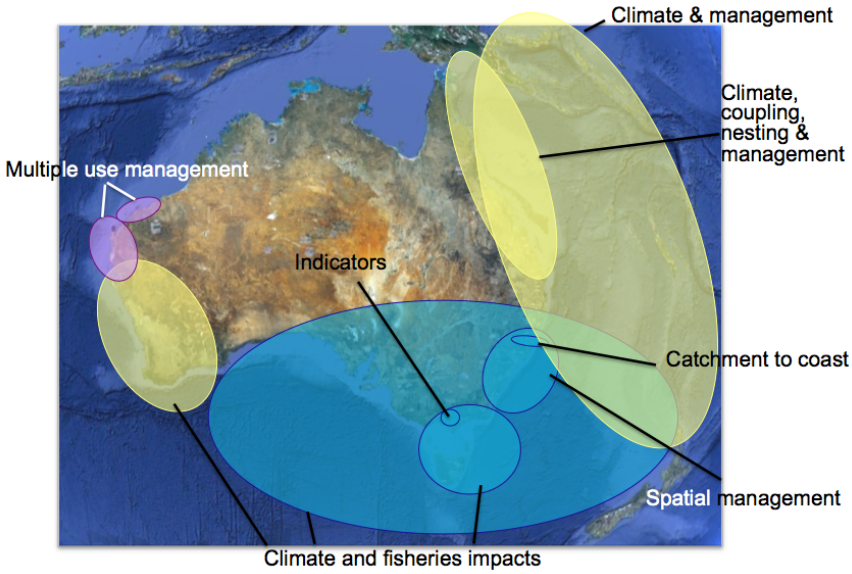
9. FURTHER DEVELOPMENT

There is much scope for future development of the portal in response to new opportunities and feedback from users. The two major potential directions of future development mirror the two major aspects of the project.

First is the expansion of the library of simulations. At present the library only contains runs from Atlantis-SE. Obviously new scenarios and management strategies run for that region can be easily uploaded. In fact, this library of runs is already expanding in response to conservation (e.g. gulper sharks) and climate issues. The library can be further expanded by adding in new regions as models become available. For instance, models for Victorian and Tasmanian coastal waters and the Clarence River in NSW will be added quite rapidly. Moreover, a large proportion of Australian waters are being modelled using Atlantis (Figure 7), with new models being developed in northeast and southwest Australia. These will automatically be added to the library once complete.

The second major potential expansion is the extension to new data types or to other models. For example monitoring data streams, other multispecies models (e.g. ELFSim, Little et al 2007) or assessment models (such as Wayte and Fay 2007 or those summarised in Smith and Wayte 2003) could all be delivered through the one portal, if that was considered useful by users.

(a)



(b)

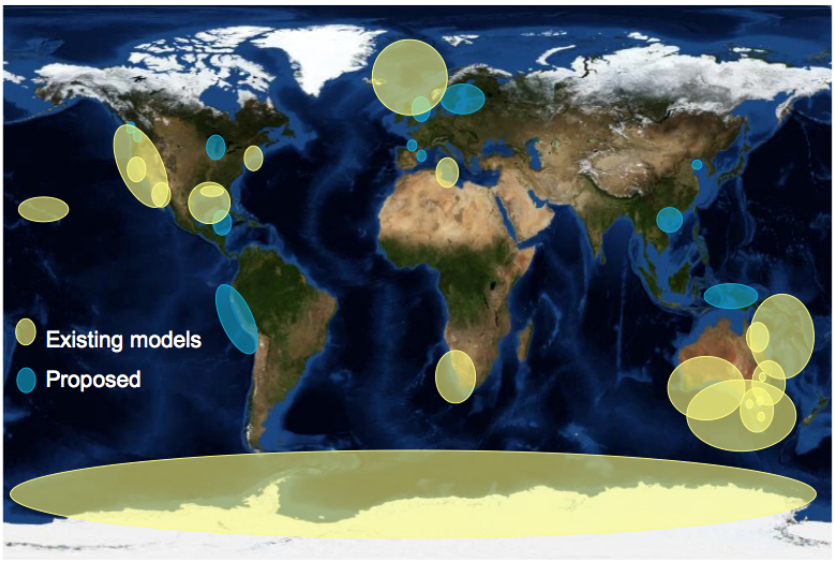


Figure 7: Coverage of ecosystem models (a) around Australia and (b) around the world. Such coverage (once loaded into the portal) means that even if the specific system of interest is not covered then an analogous one may be accessible (as a first source of insights). Yellow represents functioning models, blue models under active development and purple ones are areas covered with the whole of system model InVitro, which can also be served up using the portal.

10. PLANNED OUTCOMES

The compilation of the library of runs, the post processing of those runs and the construction of the visualization software has delivered to the following project outcomes:

(i) Two half day workshops with AFMA have begun to provide and understanding for AFMA managers about how changes in a complex system (including changes to management, but also components of the system like environmental variability, fuel prices etc.) translate to implications for fisheries and aquaculture and their markets. This understanding will grow through training exercises (some were held in 2012, with more to come in 2013) and more exposure to the portal, as it becomes a more regularly used tool.

(ii) Discussions held during the second workshop (November 2011) indicated that the more senior managers rapidly benefited from exposure to the portal, increasing their understanding sensitivity and risks and ecological, economic and social impacts of changes. Less experienced managers will need on-going support and additional training. It is anticipated that online training sessions (2012) and port trips to be held in 2013[1], will likewise show a differential speed of uptake and appreciation of uncertainty amongst industry.

(iii) Post workshop discussions again showed that more experienced managers more readily identified issues around system adaptive capacity highlighted by the modelling results. Intended support will help less experienced users learn about this for the model runs; and this form of learning has been made a central component of consideration for the Atlantis-based SEAP project (where the portal is being used as a means of conveying the results of climate runs and alternative adaptive strategies to a broad audience).

Given that Atlantis-SE is the only model currently available via the portal, it is likely that those managers associated with decision-making in the SESSF region will be the primary beneficiaries. However, the general level of interest already shown (particularly by bycatch managers) during the workshops indicates that the benefits extend beyond the SESSF to generalised insights that can be more broadly applied across AFMA's jurisdiction. To date only a limited number of RAG or industry members have seen the portal in detail, but the invitation is open and familiarisation workshops will be run in conjunction with SEAP workshops in 2012/2013.

While it will remain to be seen what the true level of use of the portal is long term, based on initial feedback it looks like the interface has the potential to inform managers and substantially reduce the risk of the unsustainable harvest (or other adverse

[1] These port visits will initially target industry with interest in the south east of Australia – e.g. SETFIA, Seafood Industry Victoria, state fisheries bodies (e.g. for rock lobster, abalone, prawns and scallop) in Tasmania, Victoria and South Australia.

impacts) on a species and to improve the cost efficiency of the industry (associated with their effort allocation behaviour) and management.

11. CONCLUSIONS

Fisheries Managers often need to rapidly explore possible impacts of a range of potential changes to a fishery. These may take the form of changes in fuel and fish prices, environmental shifts (e.g. climate change) or alternative fisheries management regulations.

Like flight simulators, ecosystem models can show what might happen if the environment changes or if managers make a decision to move management of the fishery in one way or another. Unfortunately, it can take years (and cost millions) to build models of system as complex as any one of Australia's federal fisheries. This is simply too slow to be of use for many of the rapid turn around questions management bodies are presented with on a daily basis. Nevertheless, the decisions still need to be made and would benefit from system-level strategic information if it were available. Managers and the fishing industry alike would gain significant insights into the fishery if they had the ability to explore potential changes without the need to undertake specific research projects.

This need was identified in 2010 by AFMA managers, leading to a call for tools to fill this gap. In response a library of ecosystem model runs has been drawn together that spans a large number of potential management strategies and environmental scenarios. These runs have been made accessible via a user-friendly portal (web interface) that can be explored from the user's desktop, meeting in full all of the objectives of this first step data and model delivery project.

In the short term the seaview model portal has been made public based on a model of the SESSF fishery; this is so that industry and managers a like can explore potential futures for that particular fishery, but also garner more general insights into the complex dynamics of a large exploited marine ecosystem. In addition, other data sources used by fisheries managers and the fishing industry could potentially be served up in the same portal. Making it a one-stop data portal for fisheries relevant information; providing the means to interrogate complex information about marine systems and gain general insights into their function and implications of different forms of management – ultimately supporting sustainable management of Australia's fisheries and biodiversity.

While the site has only recently gone live, at a workshop with AFMA managers, so far there has been a very positive response. Any one interested in the modelling, or providing feedback, they can access it at http://www.csiro.au/seaview/ or contact seaview@csiro.au. Workshops to raise awareness about the tool in the broader fishing community will be held in 2012/2013 in conjunction with a series of meetings held as part of the SEAP modelling work (where the portal will be used to deliver the outcome of Atlantis modelling done to provide insight into climate adaptation and forms of potentially robust fisheries management).

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APPENDIX 1 – INTELLECTUAL PROPERTY

The new intellectual property created in this study was the portal, which used new coded webservices or existing open source webservices.

The Atlantis modelling framework already existed and is the intellectual property of CSIRO and funding bodies – primarily FRDC, but it has also been supported by grants from a range of bodies including NOAA (US) Gordon and Betty Moore Foundation and the David and Lucille Packard Foundations.

APPENDIX 2 – STAFF

The list of team members who worked on this project are: Beth Fulton (Elizabeth Fulton), Mark Hepburn, Bec Gorton and Penny Johnson. All employed by CSIRO Marine and Atmospheric Research.

APPENDIX 3 – TECHNICAL DOCUMENT: USER GUIDE

The following document is the user guide for using the portal, also available via a link on the portal so that it is easily accessible by users

User Guide

seaview Software Team
email: seaview@csiro.au

This user guide is for use with the seaview visualisation software; created by the CSIRO with the support funding from the Fisheries Research and Development Corporation on behalf of the Australian Government

Enquiries should be addressed to:
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APPENDIX C - CONTENTS

1. BACKGROUND

1.1 What is seaview?

Fisheries Managers often need to rapidly explore possible impacts of a range of potential changes to a fishery (for example, changes in fuel and fish prices, biophysical, environmental and economic drivers of the fishery, and alternative fisheries management regulations). For ongoing sustainable management of Australia's marine environment it is important to supply both managers and industry members with information that will allow for informed decisions. This will allow for the fishery members to be prepared and responsive to future system shifts and policy challenges. **sea**view was created to help fill this role; it is a visualisation tool for exploring the output of models of marine ecosystems.

Marine ecosystem models are typically quite complicated, typically taking years to develop. This is simply too slow to be of use to many of the rapid turn around questions management bodies are presented with. In addition, until now these kinds of models have required expert interpretation and specialist commission on a case-by-case basis, which can prove to be a drawn out and costly enterprise. It does not make sense however, to put so much effort into their creation and then keep them stored away and little used. Fishery members are regularly faced with decisions that would benefit from system-level strategic information. Thus the communication of the content of marine ecosystem models would be much more effective if it were in a form where anybody could integrate it and it could be deployed rapidly as new (short turn around) issues arose. One of the best ways of doing that is to pre-emptively create a library of runs that span a large number of potential management strategies and scenarios of interest (augmented the library new runs to cover potential policy gaps and future issues as they arise) that can be interrogated quickly as needed. **sea**view was created to fill this communication role; presenting summary statistics and map-based visualisations on the state of the environment and the associated fisheries through a user-friendly interface that can be explored from the user's desktop.

seaview is generic and deployable in any location where there is a model. While originally developed for ecosystem models like Atlantis or InVitro, it is generic enough it could load the output from any model, including assessment models or simpler multispecies models. This means that **sea**view could be come a model "data portal" allowing managers and industry members to go to a single location (and use the one piece of software) to access all model based information on the system, or question, of interest. The first model loaded is the Atlantis implementation in southeastern Australia, this will rapidly expand to include more locations and more model types. Users are encouraged to check regularly for updates or to contact seaview@csiro.au to register for update notices.

1.2 The concept of Management Strategy Evaluation

The models supplying the data to **sea**view are based on the Management Strategy Evaluation (MSE) approach. This is a simulation technique based on modelling each part of the adaptive management cycle (the natural world, including the fished stocks, the industry,

reporting and monitoring, assessment and management decision and enforcement processes – see Figure 1). The method does not try to find some optimal solution based on a single model. Instead the consequences of alternative hypotheses (typically management strategies) are evaluated by checking for robustness of the results within the simulated system. This is like using the model as a "flight simulator", or test bed, trialling the management strategy in the model to see how well it delivers in absolute terms and relative to alternative strategies.

MSE was originally developed more than 20 years ago for considering alternative fisheries management strategies and is now accepted internationally (e.g. by the FAO) as a best practice approach for considering management questions. A detailed review of the history of the technique can be found in Butterworth and Punt (1999)[2] and Sainsbury et al. (2000)[3].

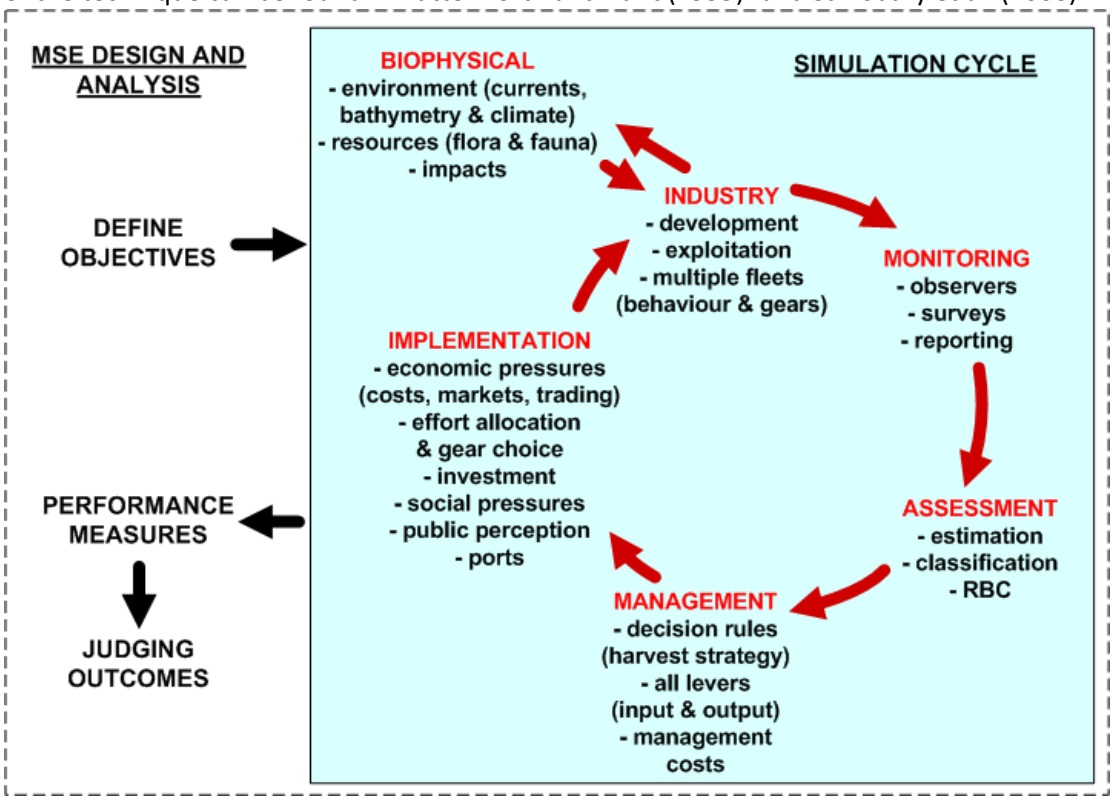


Figure 1: The management strategy evaluation cycle

1.3 Atlantis

End-to-end (or whole of system) ecosystem models, like Atlantis, have been recognized as an effective tool for providing a risk-based assessment of management options. Atlantis is called "end-to-end" as it explicitly includes the major driving processes from the physical realm, up through the biogeochemistry of nutrient cycling and production, to the spectrum of ecological processes and components that form marine ecosystems and on to the social and economic drivers shaping the behaviour and outcomes for commercial and recreational

[2] Punt, A. E., and Smith, A. D. M. (1999) Harvest strategy evaluation for the eastern gemfish (*Rexea solandri*). *ICES Journal of Marine Science*, 56: 860–875.

[3] Sainsbury, K.J., Punt, A.E. and Smith, A.D.M. (2000) Design of operational management strategies for achieving fishery ecosystem objectives. *ICES Journal of Marine Science*, 57: 731–741

fisheries sectors active in the marine realm (see Figure 2 for a conceptual diagram of all Atlantis' component parts).

NOTE: While models like Atlantis can provide insights into the relative merits and potential unintended consequences of different management strategies, they must still be used with caution. Models are only ever cartoons of a system. Moreover, ecosystems are highly complex things and it is highly unlikely that a model can capture the complete set of the nuances of their function. Consequently, there are times (e.g. new sets of conditions) when their projections will be off the mark, miss some never before seen feedback dynamic. This means that model output should only ever be used as one source of information on a topic and not the only source. Furthermore, large-scale models like Atlantis are only robust when used in the kind of relative ranking and comparative mode that underlies the MSE approach. **Atlantis should not be used to set tactical management targets (e.g. quotas).**

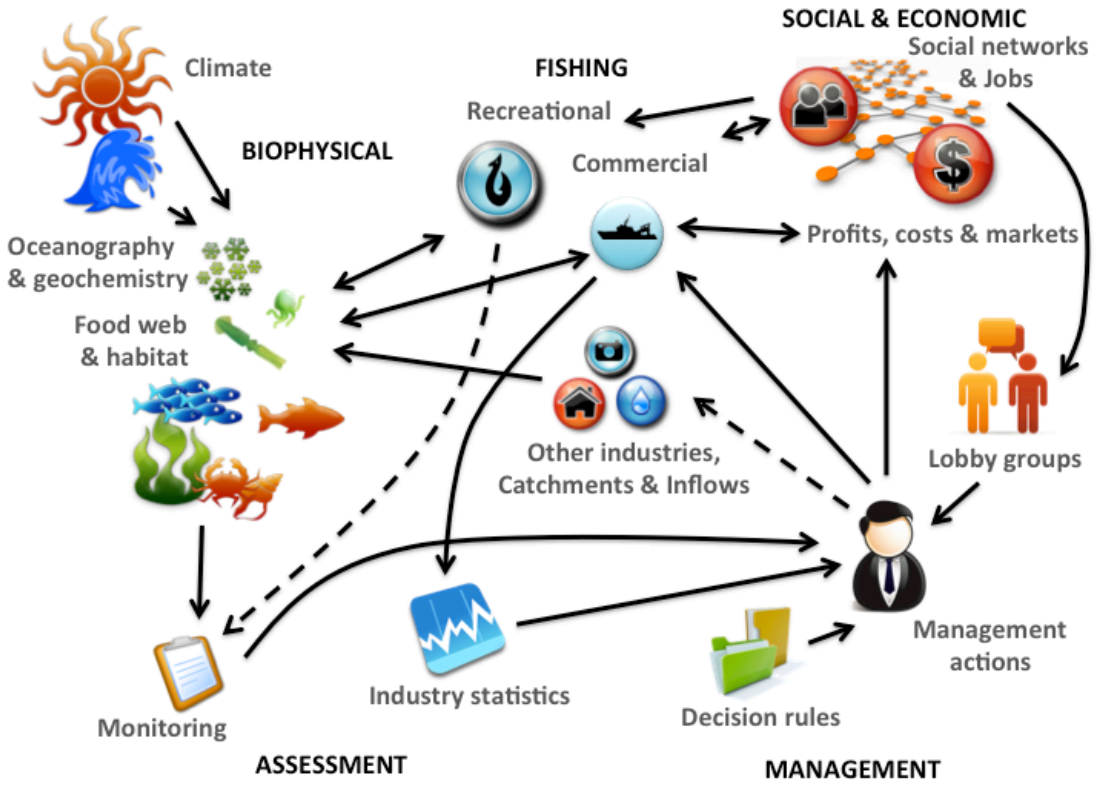


Figure 2: Conceptual model of Atlantis components and connections

1.4 Using a case study to garner general results

The first model loaded into seaview was an Atlantis model located in southeastern Australia, which is the only location globally where the full Atlantis suite has been applied (with the environment, biological groups and social and economic processes and feedbacks all fleshed out). This reflects a significant investment in implementing and employing Atlantis-SE (an Atlantis for the Southern and Eastern Scalefish and Shark Fishery (SESSF)), a decade of effort has been put into making the model, refining it, testing it and updating it with new data on an annual basis. While the model obviously has immediate application in the SESSF, the insights gained from interrogating Atlantis-SE are not constrained only to immediate region. While any findings would need to be applied with care to other ecosystems, general findings

on potential sensitivities of different forms of management and the resilience of different ecological structures and social and economic situations could be informative, as background or supporting information, for other systems where large management questions have arisen. The waters around southeastern Australia are amongst some of the most productive in Australia, but they are also some of the most intensively exploited within the EEZ and they are also expected to be some of the most significantly affected by global change. The Atlantis model developed for these waters, both for Commonwealth and State jurisdictions, includes the broader regulatory context of the system (including closures, incentive-based structures and gear controls). Consequently, insights drawn from Atlantis-SE can provide information on the implications of potential changes to the SESSF in terms of biophysical as well as social and economic impacts.

2. GETTING STARTED

The following sections will describe the different parts of **sea**view and act as a guide to **sea**view's use. The screen shots are from an earlier version, but all of the functionality and directions is the same. If you have any issues or suggested changes around this user guide please contact us at seaview@csiro.au.

2.1 Entering seaview

seaview is accessible at http://www. csiro.au/seaview/

The first page is an introduction to the idea behind seaview. To continue to the viewer itself click **Enter**.

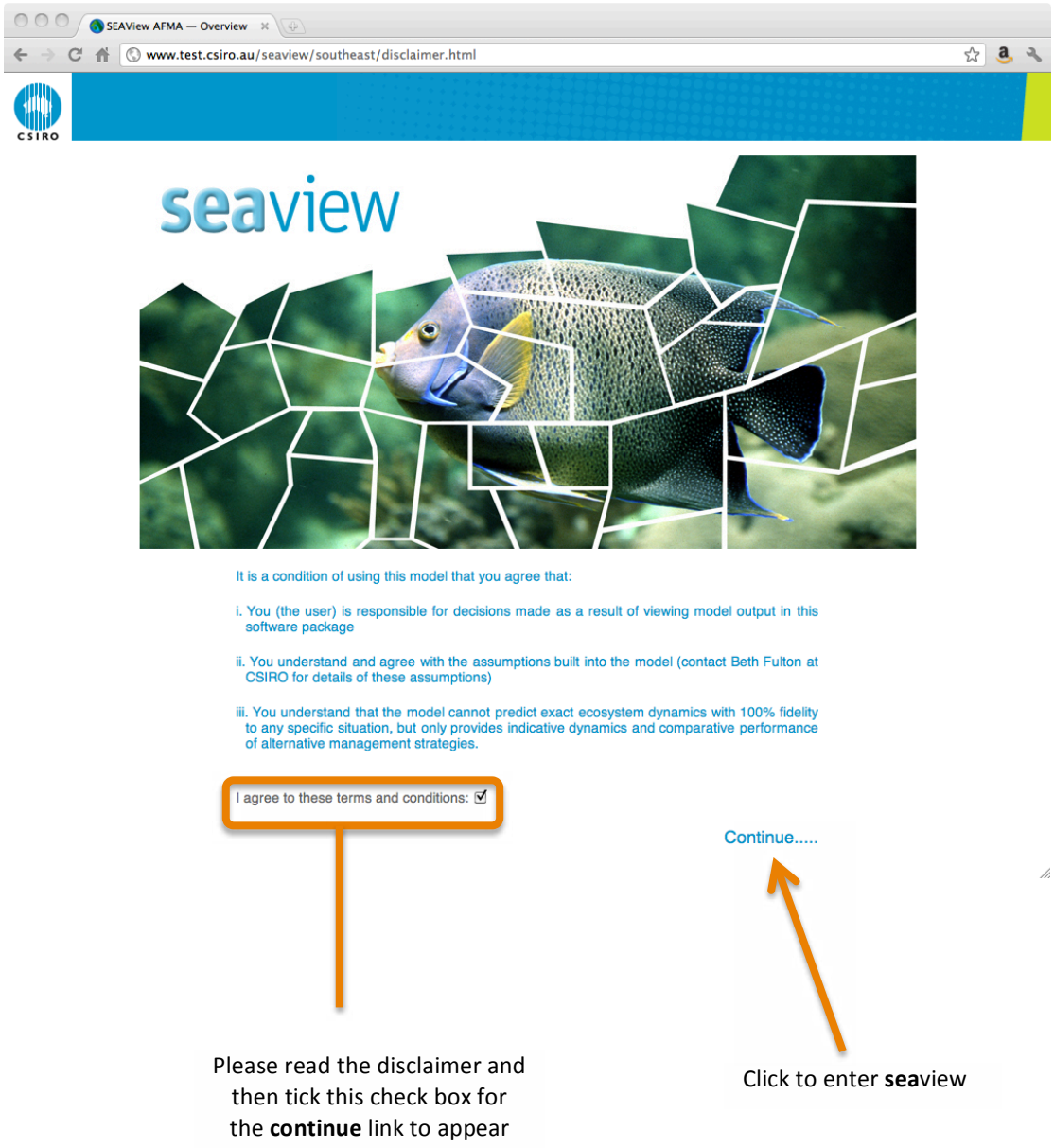
Some of the greatest challenges to sustainable management are accounting for uncertainty, dealing with cumulative effects and unintended consequences, and dealing with mismatches between objectives across different sectors or user groups. Setting and meeting environmental, economic and social objectives requires system understanding. Models are a good tool for providing understanding of systems and the implications of different management options. The aim of decision support tools, such as Atlantis is to provide a science-based foundation for those involved in the use and management of natural resources. The idea is to use the Atlantis model to explore potential futures under a wide range of development scenarios and management options. Essentially the model can be used as a 'test-beds' for management actions ahead of time, to try and gain insights and avoid potential missteps. This website is a means of exploring the library of outputs from Atlantis.

Enter.....

Click to enter **sea**view

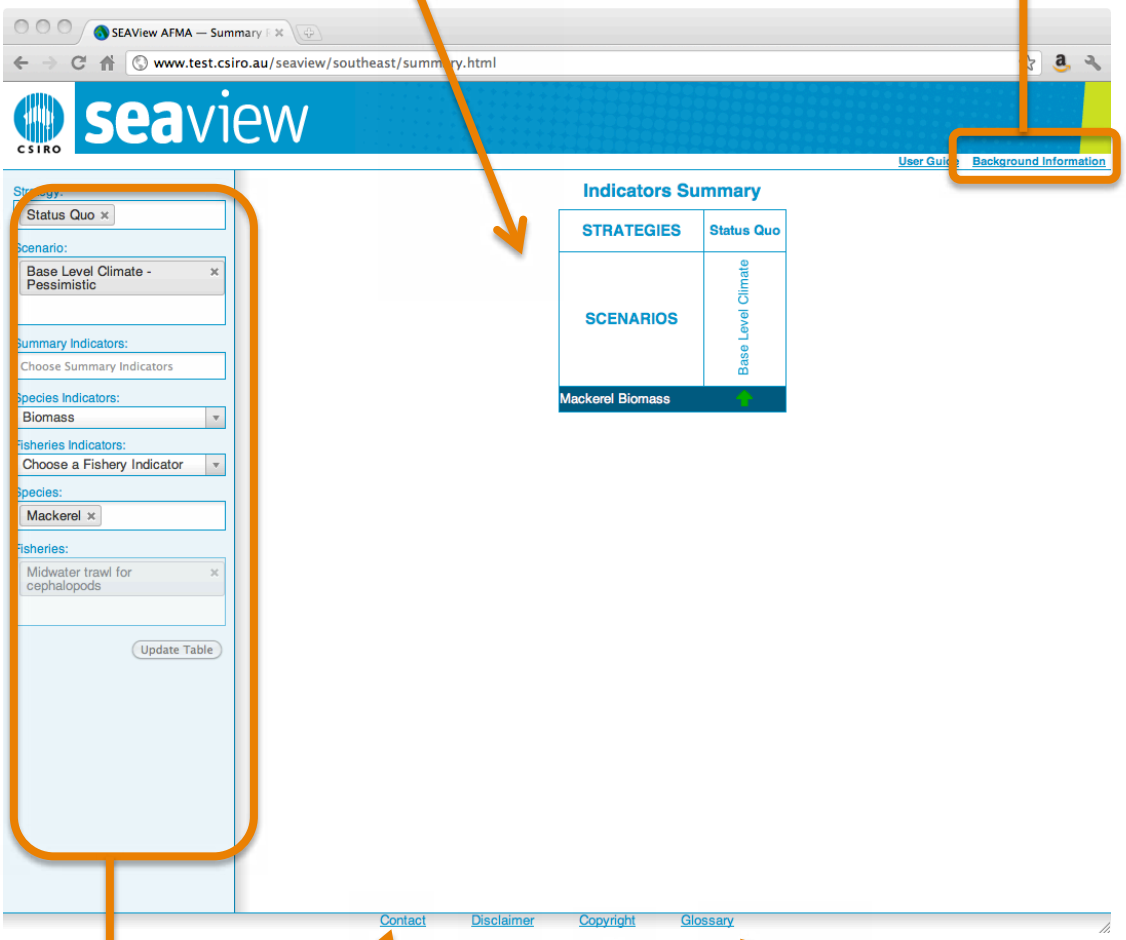
2.2 Disclaimer – what does it mean?

It is important that users understand that the models behind **sea**view (e.g. Atlantis) are not crystal balls, they are only models. Thus we have tried to drive home that seaview must be used with careful though, and as only one source of information, by putting conditions of use up front. Once you have read these conditions, **tick the "I agree to these terms and conditions" check box** and a continue link will appear. Click **Continue** to enter the main part of **sea**view.



3. SUMMARY PAGE

The first real content page of seaview is the summary page.



3.1 Selecting the data

To select data to display in the Indicators Summary table, **click on items in the menus** on the left of the page (marked with the orange box below). You must choose at least one entry from each menu of the Strategy and Scenario menus and then chose the specific indicators from the other menus. Note that at present it is not possible to simultaneously select Summary, Species and Fisheries indicators

There is a separate menu for each part of the choice:

(i) Management strategy: a description of the details of what management options are used in each strategy can be found in the glossary.

(ii) Scenario: these set the broader context for the simulations (e.g. background climate state) and a description of what is entailed in a scenario can be found in the glossary.

(iii) Summary Indicators: these are whole of system indicators, more details about these indicators and whether they are ecological, economic, social or industry based can be found in the glossary. Multiple indicators may be selected.

(iv) Species indicators: these are the types of actual indicators to plot (e.g. biomass, catch etc.), more information on these indicators can be found in the glossary.

(v) Fisheries indicators: these are fisheries indicators to plot (e.g. effort or CPUE), more information on these indicators can be found in the glossary.

(vi) Species: for species-specific indicators species of interest must be selected (e.g. if you select the Biomass indicator you also need to select the species you want the biomass for). Multiple species may be selected.

(vii) Fisheries: some of the indicators refer to specific fisheries so the fishery of interest must be selected (e.g. if you select the Effort indicator you also need to select the fishery you want the effort for). Multiple fisheries may be selected.

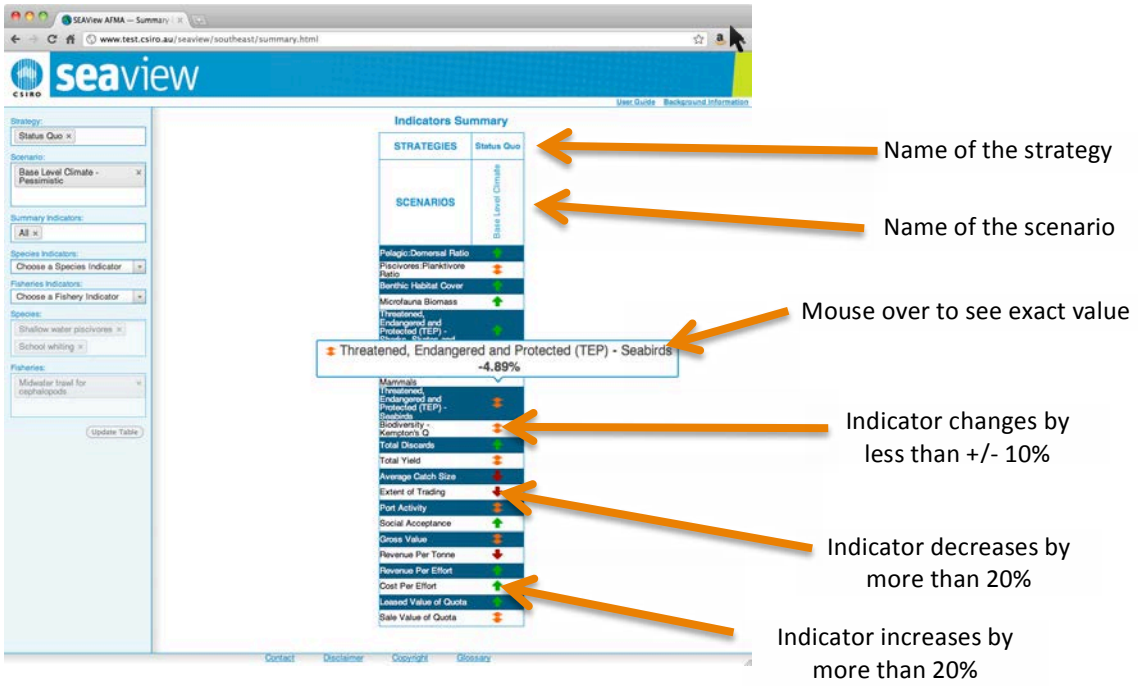
Once the menu choices are complete **click Update Table** to display the final table of results.

Click to update table
(if greyed out then the table is up to date, make a new selection to reactivate the button)

3.2 Summary table

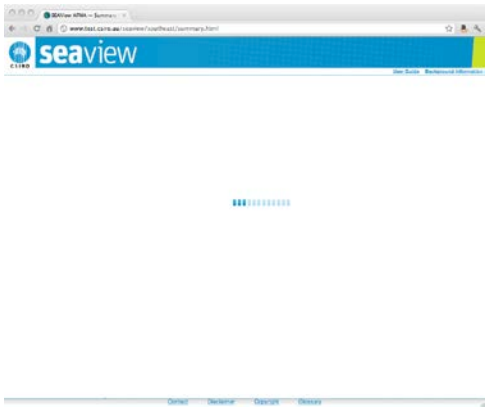
The selected indicators are shown in the **Summary Table**. There is one column for each strategy or scenario and one row for each indicator selected (in the case of species or fisheries specific indicators there is one row for each indicator for each species/fishery.

If the value of the indicator increases by more than 10% from the start of the run to the end a green upward pointing arrow is shown; if the indicator decreases by more than 10% this is shown by a red downward point arrow; if the change is less than +/-10% an orange two headed arrow is used instead. If you hover the mouse over an arrow and a text box will pop up showing the exact increase/decrease in the value of that indicator.



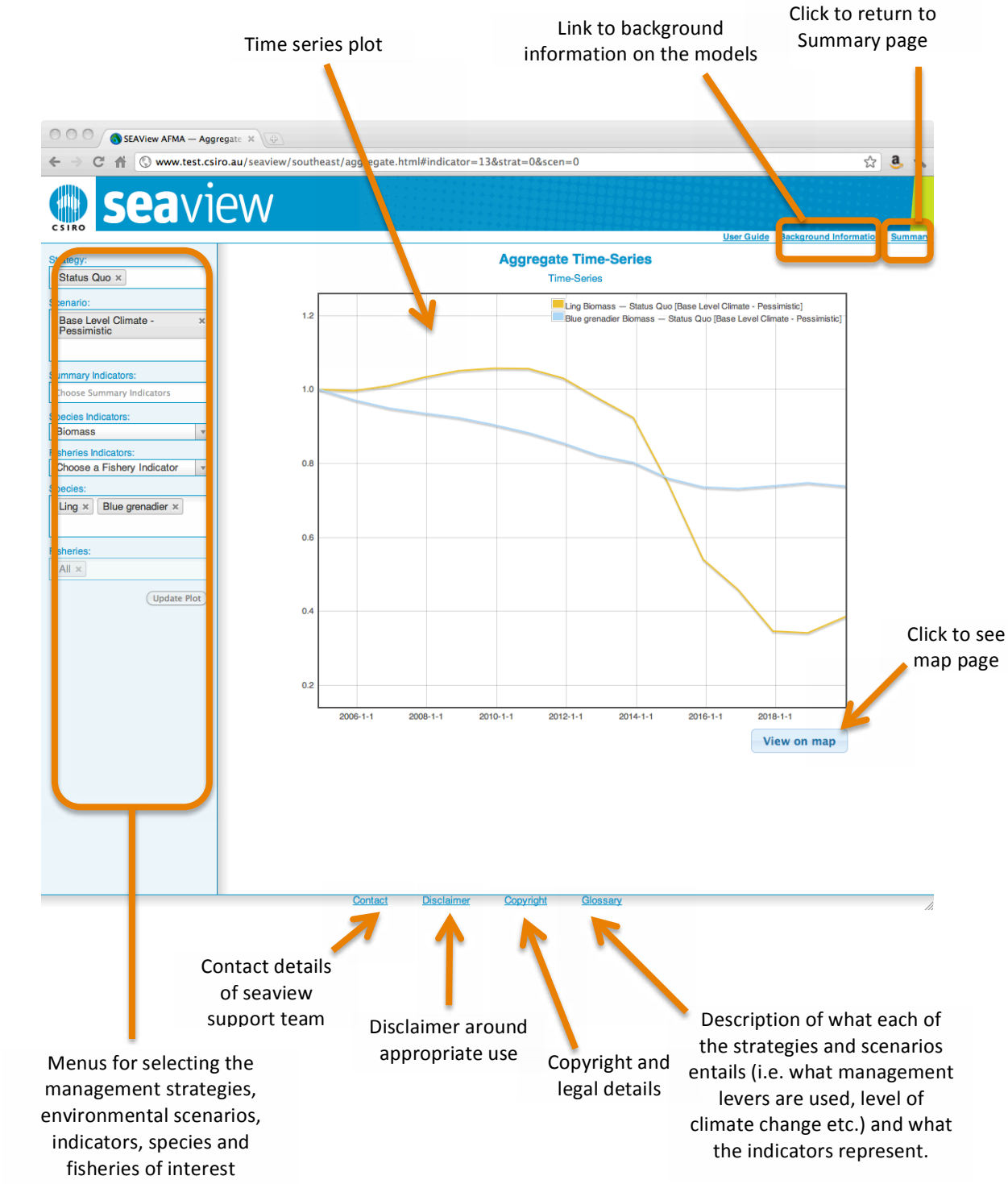
3.3 Moving to time series

To move from the Indicator Summary page to the Time Series page (to see a time series for an indicator) click on the arrow for that indicator in the Indicator Summary Table. A loading page is shown while the time series data is loaded (this may take some time as the virtual library of run grows).



4. TIME SERIES PAGE

Sometimes a summary is not enough and a time series for the indicator(s) is desired.



4.1 Selecting the data

To select data to display in the Indicators Summary table, **click on items in the menus** on the left of the page (marked with the orange box below). You must choose at least one entry from each menu of the Strategy and Scenario menus and then chose the specific indicators from the other menus. Note that at present it is not possible to simultaneously select Summary, Species and Fisheries indicators

There is a separate menu for each part of the choice:

(i) Management strategy: a description of the details of what management options are used in each strategy can be found in the glossary.

(ii) Scenario: these set the broader context for the simulations (e.g. background climate state) and a description of what is entailed in a scenario can be found in the glossary.

(iii) Summary Indicators: these are whole of system indicators, more details about these indicators and whether they are ecological, economic, social or industry based can be found in the glossary. Multiple indicators may be selected.

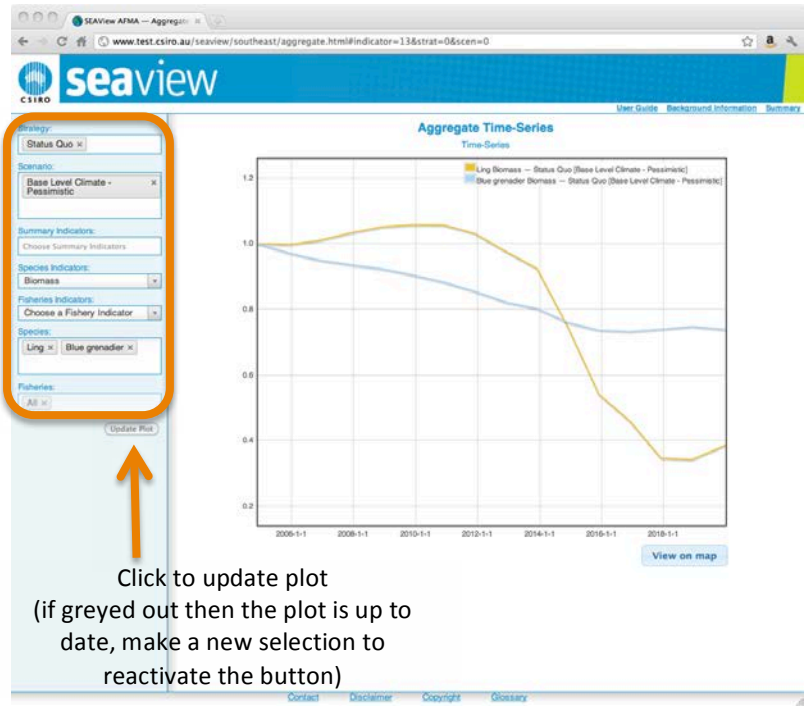
(iv) Species indicators: these are the types of actual indicators to plot (e.g. biomass, catch etc.), more information on these indicators can be found in the glossary.

(v) Fisheries indicators: these are fisheries indicators to plot (e.g. effort or CPUE), more information on these indicators can be found in the glossary.

(vi) Species: for species-specific indicators species of interest must be selected (e.g. if you select the Biomass indicator you also need to select the species you want the biomass for). Multiple species may be selected.

(vii) Fisheries: some of the indicators refer to specific fisheries so the fishery of interest must be selected (e.g. if you select the Effort indicator you also need to select the fishery you want the effort for). Multiple fisheries may be selected.

Once the menu choices are complete **click Update Plot** to display the final plot of the results.



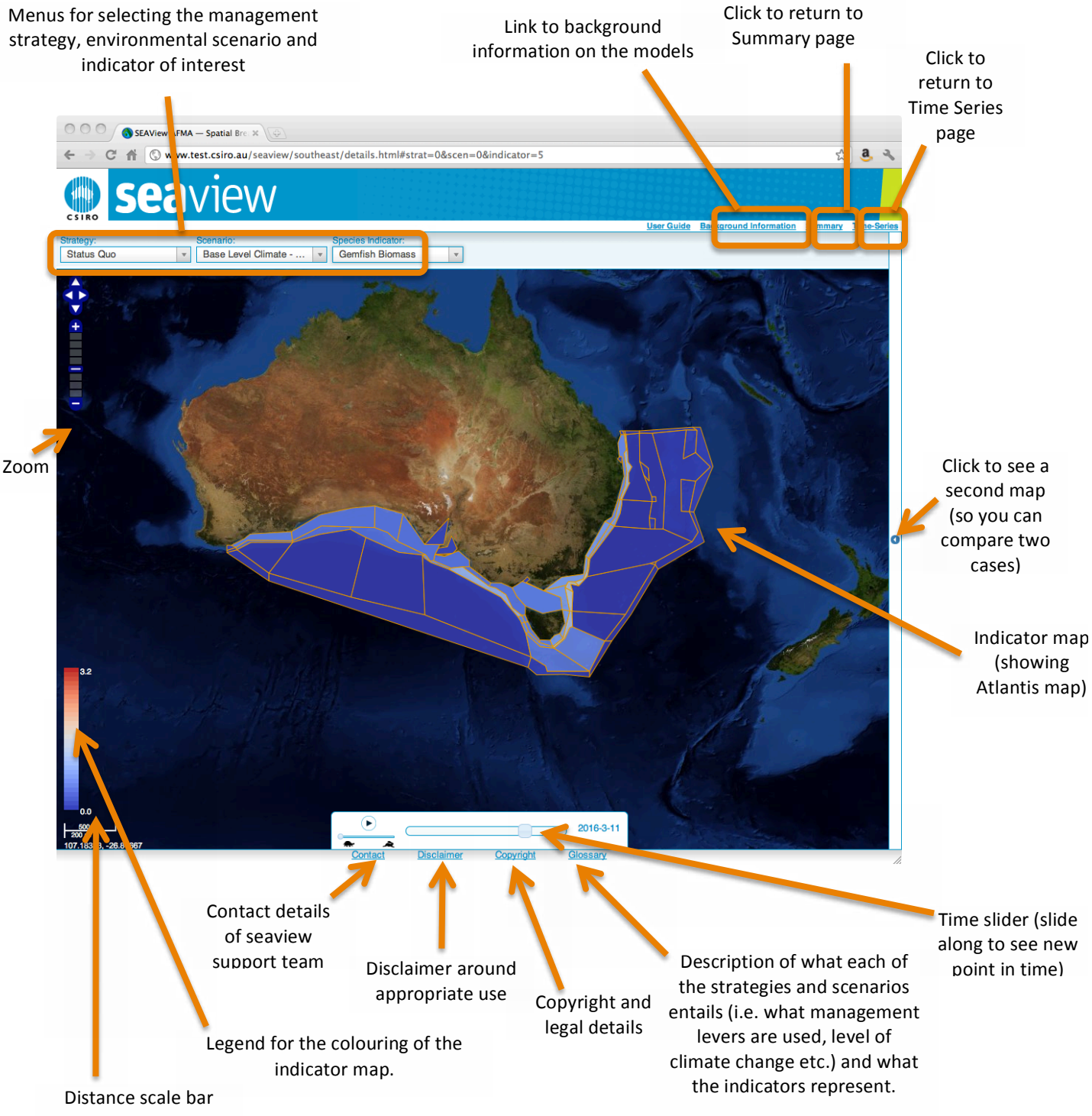
4.2 Time series plot

The selected indicators are shown in the **Aggregate Time-Series** plot. The y-axis is the relative value of the indicator (value at time t relative to the starting value). The legend is shown in the top right corner.

Click on  to see a spatial map of the indicators. A loading page is shown while the map data is loaded (this may take some time as the virtual library of run grows).

5. MAP PAGE

Spatial time series can be important for some indicators, especially of there are strong changes in the distribution seasonally or through time.



5.1 Selecting the data

To select data to display in time series plot, **click on items in the menus** along the top left of the page (marked with the orange box below). You must choose one entry in each menu.

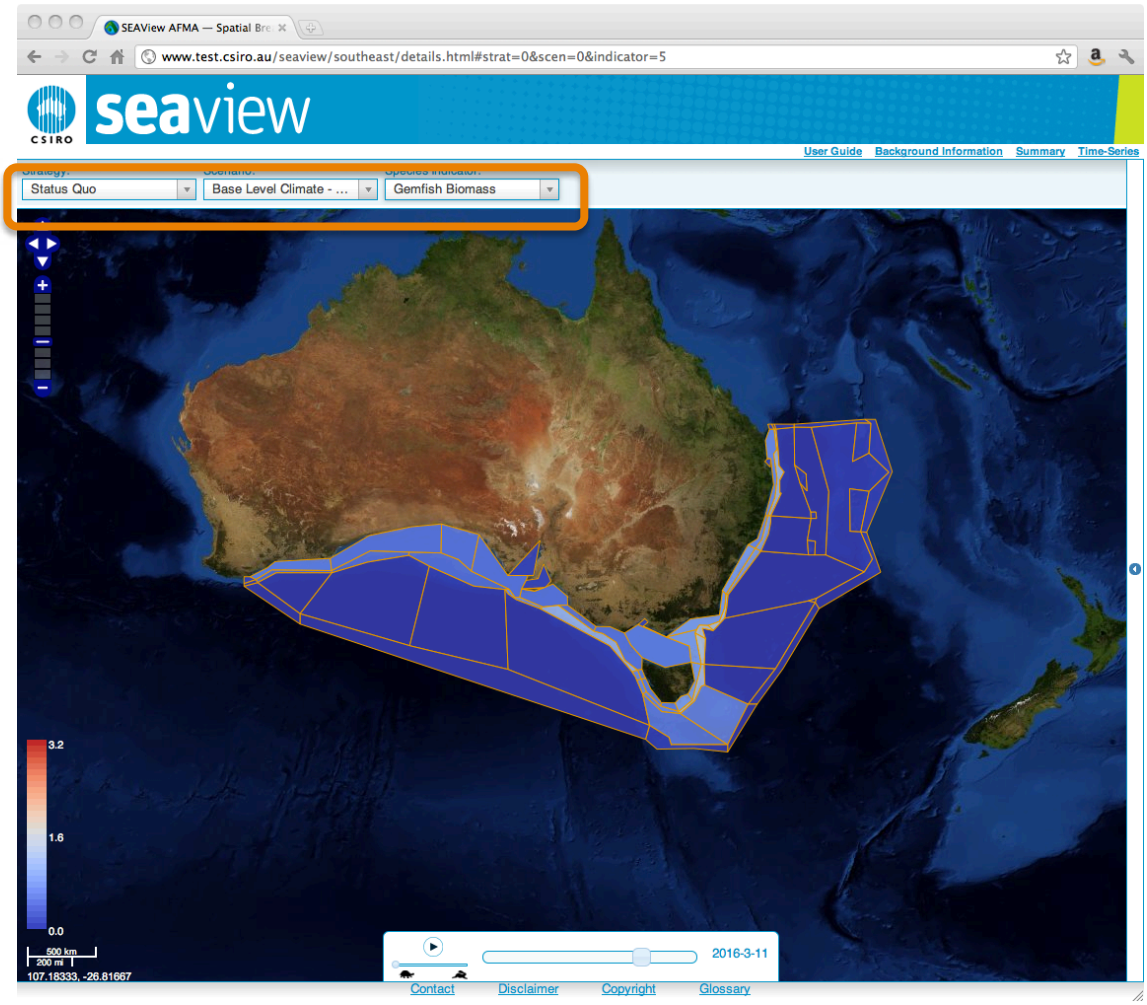
There is a separate menu for each part of the choice:

(i) Management strategy: a description of the details of what management options are used in each strategy can be found in the glossary.

(ii) Scenario: these set the broader context for the simulations (e.g. background climate state) and a description of what is entailed in a scenario can be found in the glossary.

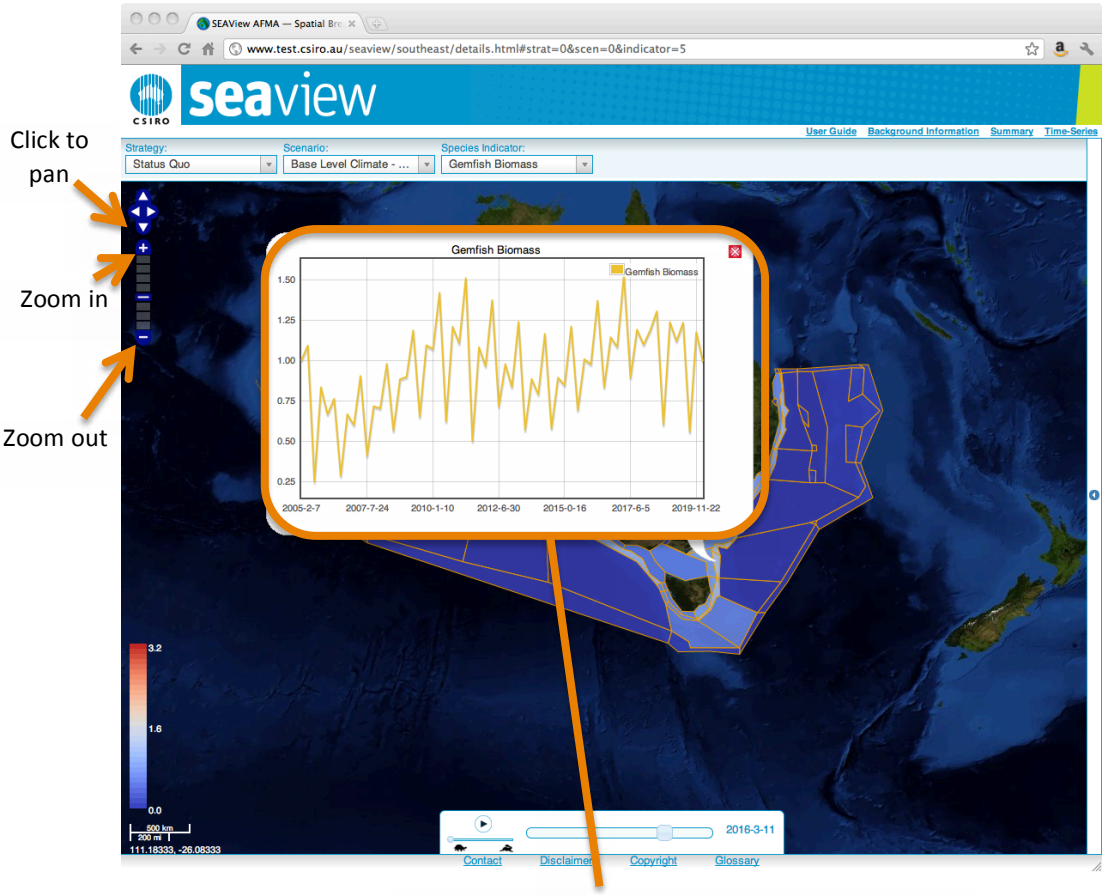
(iii) Indicator type: these are the actual indicators to plot (e.g. biomass, catch etc.), more information on the full list of indicators and whether they are ecological, economic, social or industry based can be found in the glossary.

Once the menu choices are complete the map plot will automatically redraw itself.



5.2 The map details

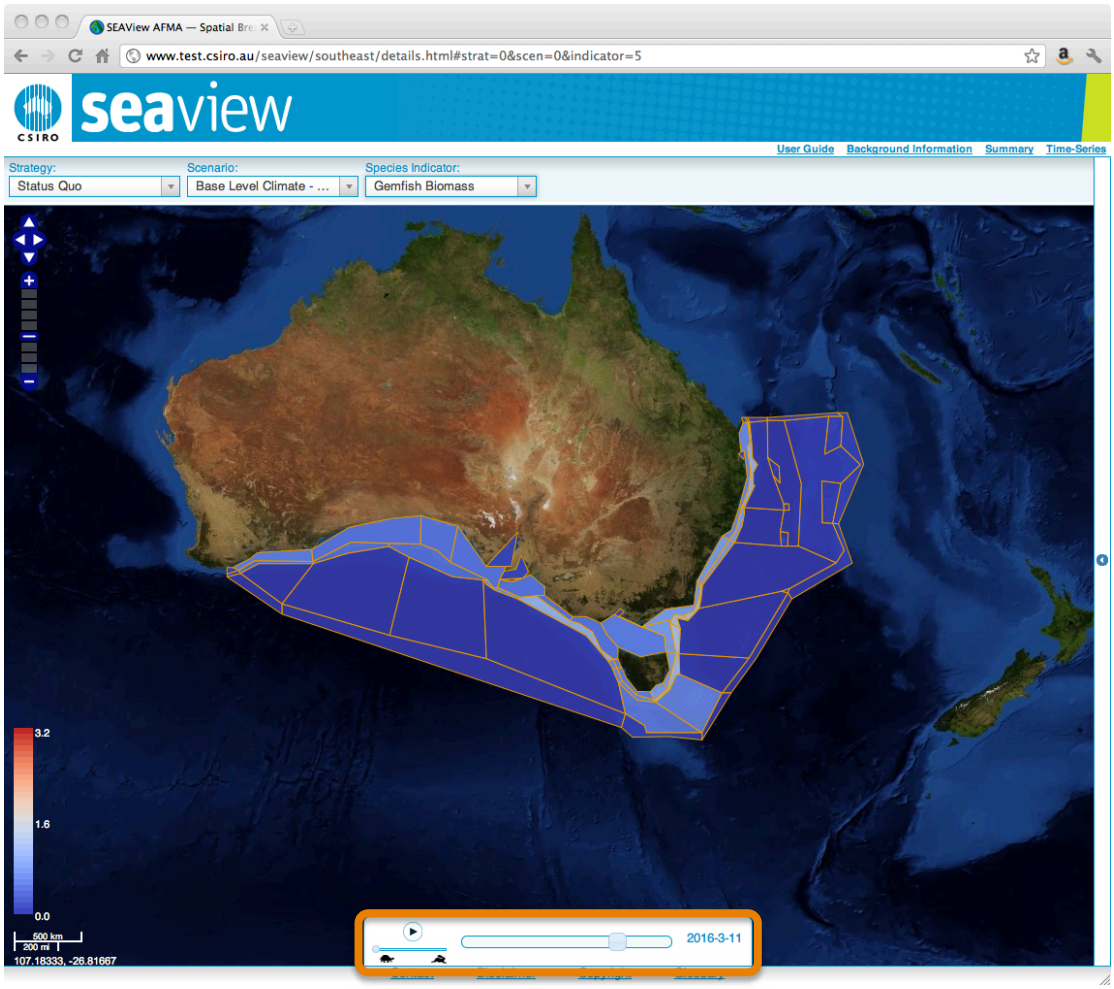
There are a number of map controls to help get more finely resolved details. To see a time series plot of the indicator in a specific box click on that box (click in the top right corner of this time series plot to close that view). To zoom or pan the map use the control on the left hand side of the page, which works quite like that of google earth and other mapping programs – press the + to zoom in and – to zoom out, to pan the page press on the compass arrows.



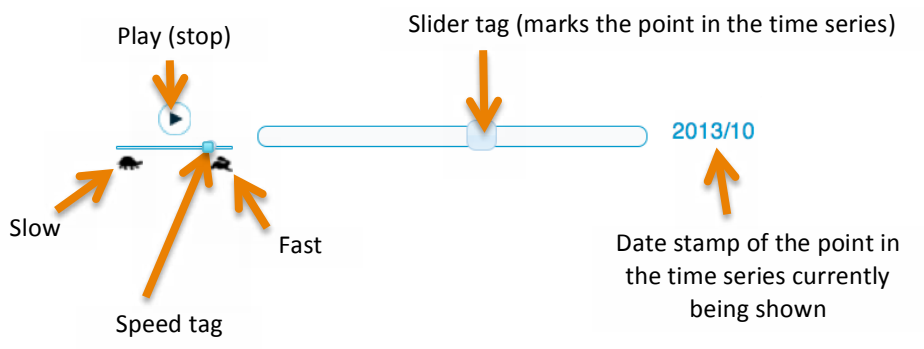
Detailed time series plot (click on a box to open this view and then click the small red cross on the top right corner to close it again).

5.3 Moving through time

To move the map through time use the time slider at the bottom of the page (see orange box below).
You can manually move the slider to a specific time by dragging on the slider tag, or you can



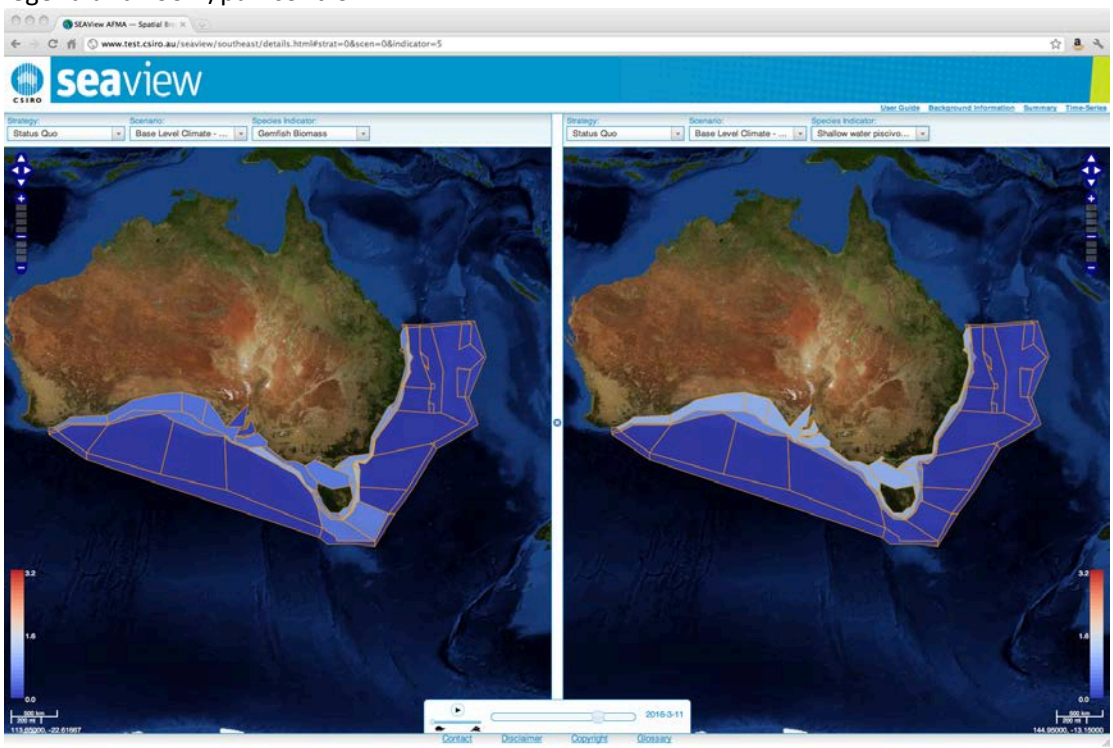
play the spatial time series by pressing the play button. The speed of the play back is set by dragging the speed tag between the tortoise (slow) and the hare (fast). To stop the play back press the stop button (the play button swaps to the stop button and vice versa as it is pressed).



5.4 Comparing outcomes

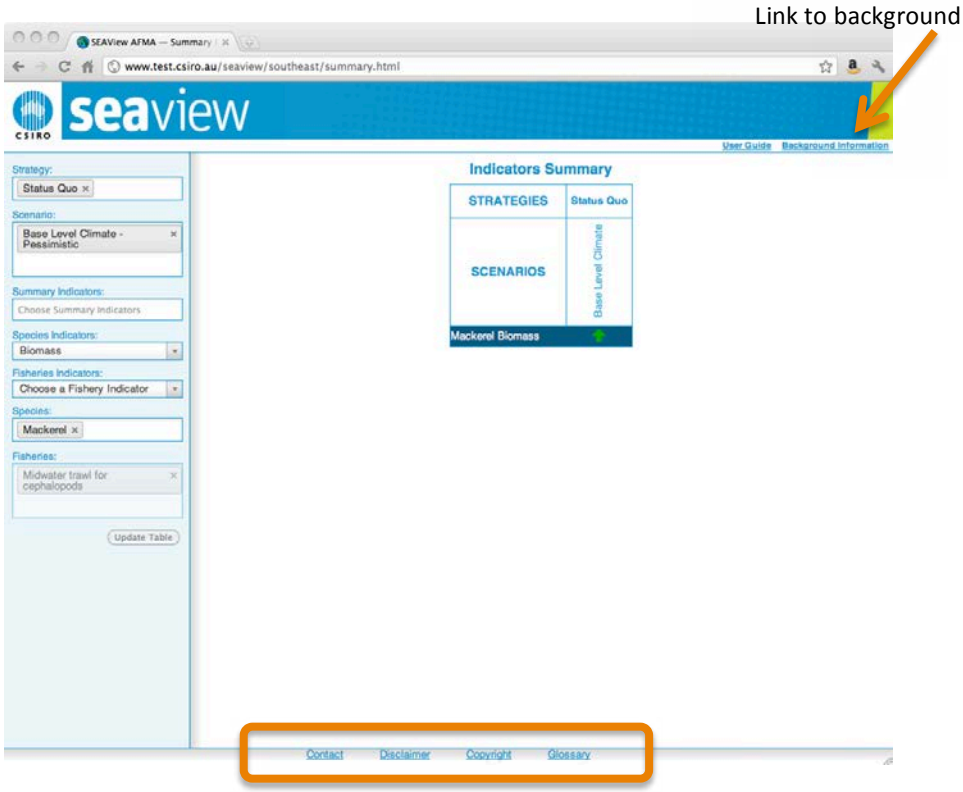
It is possible to compare to indicators (either two indicators from the same strategy-scenario or the same indicator from different strategies or a mix). To expose the second map click the small dot on the right of the map page.

This second map is controlled in the same way as the first map. The two maps use the same time slider, but each map has its own indicator menus (at the top of the individual maps), legend and zoom/pan control.



6. GETTING HELP

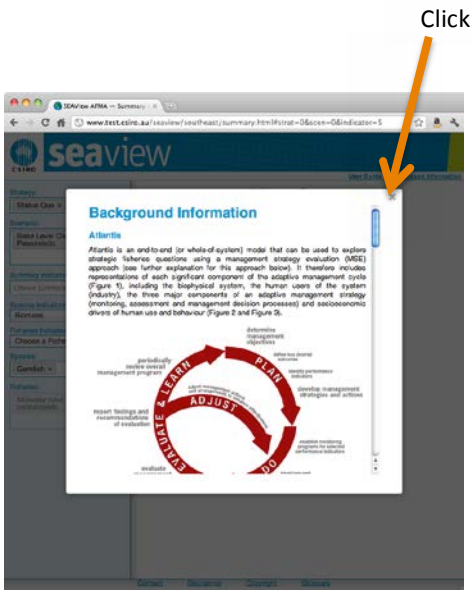
Background information on the models behind seaview is available via a link in the top right of each screen (see orange arrow below), while a glossary of terms, contact details, a copyright statement and a disclaimer are all accessible from every page of seaview via the links at the bottom of the page (e.g. see the links marked with the orange box below).



6.1 Background information

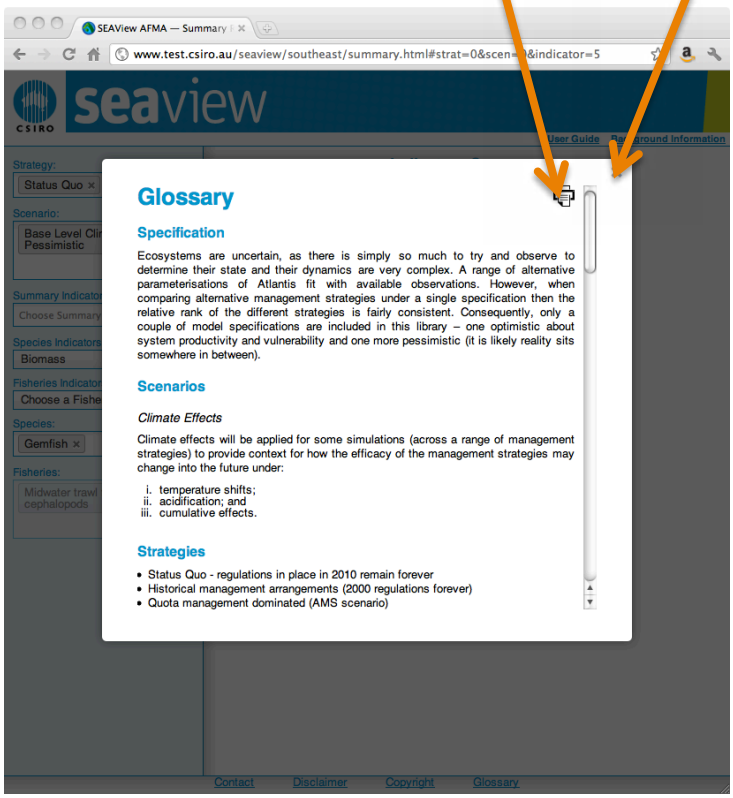
The background information will open in a popup window. This window provides some of the same background as the first part of this user guide, but also provides a bit of a description of Atlantis, adaptive management in general and the management strategy approach – including some potentially useful references and papers on how Atlantis has been used in the past (e.g. in the SESSF).

Once you are finished with the background information click the cross in the top right corner to close it and return to the main pages of **sea**view.



6.2 Glossary

There is a lot of jargon and definitions used around ecosystem models and management that can be hard to keep track of. To make it easier we have included a **glossary** of terms, which is accessible by a link on the bottom of all the main pages in **sea**view.



The glossary contains a short description of each of the environmental scenarios and management strategies used. The full paramerisations aren't provided here, if these are required please contact the seaview team at seaview@csiro.au. Note that when comparing results its helpful to have a reference case to anchor the evaluation. In that case we would recommend the Status Quo 2010 strategy, as this is how the system would play out if all of the regulations in 2010 continued on unchanged into the future.

One concept described in the glossary that may be new is that of model "specification". This is how ecological uncertainty is handled in the model – how the world is specified. Ecosystems are uncertain, as there is simply so much to try and observe to determine their state and their dynamics are very complex. A range of alternative parameterisations of Atlantis is provided, which all fit with available observations but may have alternative future implications. Its

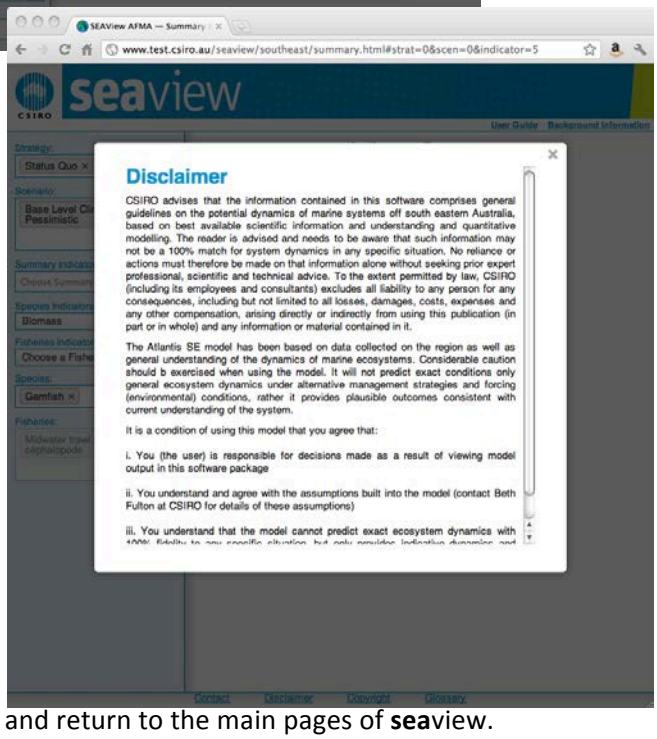
comforting to note however, that, for the most part, when comparing alternative management strategies under a single specification then the relative rank of the different strategies is fairly consistent. Consequently, only a couple of model specifications are required to give a feel of the broad potential influence of ecology on the model outcomes. We have included one that is "optimistic" about system productivity and vulnerability, one that is more pessimistic and one that sits in between. Based on available data we think reality sits somewhere amongst all of these.

The final part of the glossary lists the indicators that can be viewed in **sea**view. There are literally thousands of indicators that could be used to summarise the results. We have included a shorter list (around 30), which are both relevant (in terms of the most frequently stated social, economic and ecological objectives for the system) and have previously been fund to robustly characterise the state of the system.

Once you're finished with the glossary, click the cross in the top right corner to close the popup and return to the main pages of **sea**view.

6.3 All things legal

If you are interested in the **copyright** or the legal **disclaimer** associated with using seaview, there are links to those terms at the bottom of any of the main pages in seaview. In each case if you click the link a popup will appear and display either the copyright or disclaimer information.



Click the cross in the top right corner to close the popup and return to the main pages of **sea**view.

6.4 Contacting Us

Clicking on the **Contact** link opens a popup with a mailto link to Beth Fulton, the project leader of **sea**view. If you ever need to contact the **sea**view team you should use the email seaview@csiro.au. We have tried to make **sea**view as user friendly and self supporting as possible, but if you have any troubles please contact us.

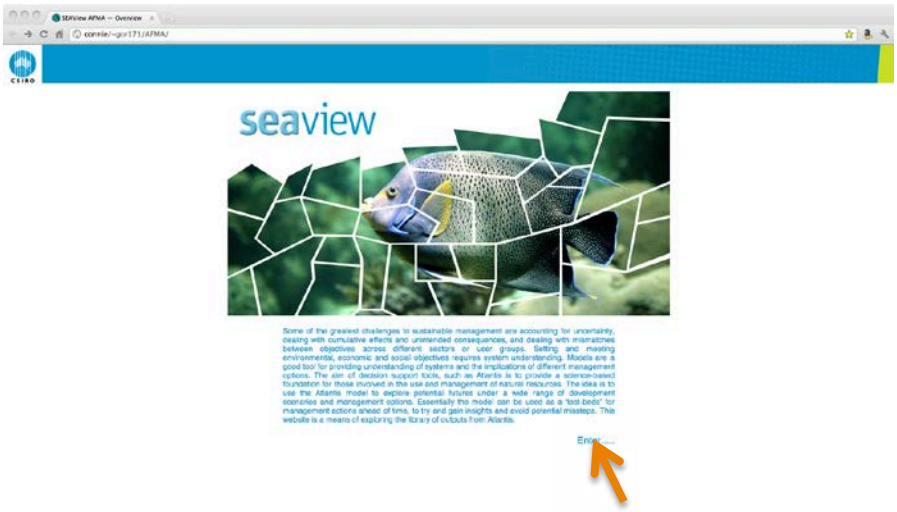
Once you've finished with the contact page, click the cross in the top right corner to close the popup and return to the main pages of **sea**view.

6.5 Are we missing a key scenario, strategy or indicator?

If you feel that there is a major gap in the scenarios, strategies or indicators in seaview please contact us at seaview@csiro.au. New simulations are easily loaded into the library without any additional installs required at the user end. Users are encouraged to check regularly for updates or to contact us and register for update notices.

7. WORKED EXAMPLE

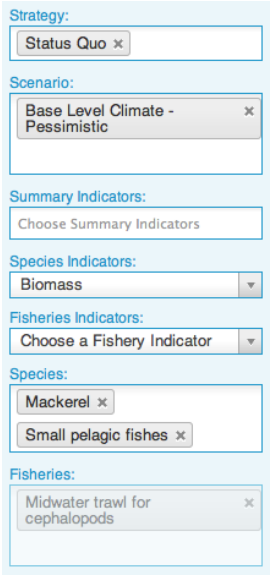
1. Click **Enter** on the introduction page



2. Read the disclaimer
3. Check “I accept to these terms and conditions”
4. Click **Continue**

First lets learn how to pick a single strategy, scenario and indicator type

5. Select the **Strategy** *Status Quo*
6. Select the **Scenario** *Base Level Climate – Pessimistic*
7. Select the **Species Indicators** type *Biomass*
8. Select the **Species** *Mackerel* and *Small pelagic fishes*
9. Click **Update Table**



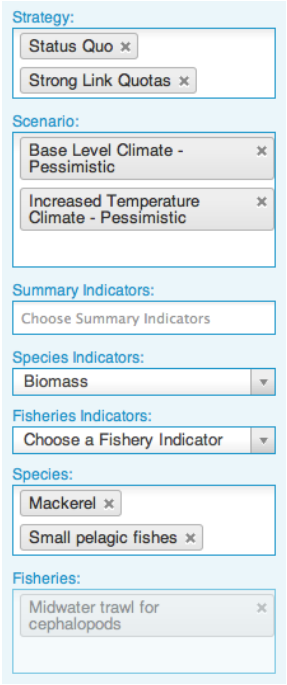
This should look like the panel to the right here and should result in the summary table below being displayed. Hover the mouse over the arrows to see the exact value.

Indicators Summary

STRATEGIES	Status Quo
SCENARIOS	Base Level Climate
Mackerel Biomass	↑
Small pelagic fishes Biomass	↕

Next lets try selecting multiple strategies

10. Select the **Strategy** *Status Quo* and *Strong Link Quotas*
11. Select the **Scenario** *Base Level Climate – Pessimistic* and *Increased Temperature Climate*
12. Select the **Species Indicators** type *Biomass*
13. Select the **Species** *Mackerel* and *Small pelagic fishes*
14. Click **Update Table**



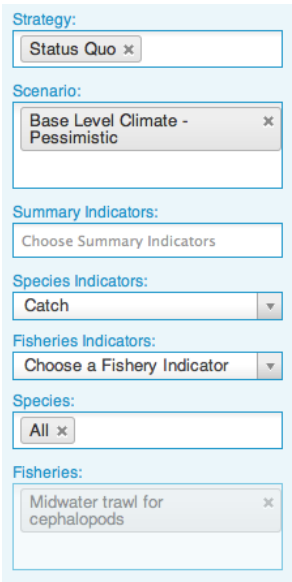
This should look like the panel to the right here and should result in the summary table below being displayed.

Indicators Summary

STRATEGIES	Status Quo		Strong Link Quotas
SCENARIOS	Base Level Climate	Increased Temperat	Base Level Climate
Mackerel Biomass	↑	↑	↑
Small pelagic fishes Biomass	↕	↕	↕

If you are interested in see all species for an indicator select the **All** case under the **Species** menu. For instance try:

15. Select the **Strategy** *Status Quo*
16. Select the **Scenario** *Base Level Climate – Pessimistic*
17. Select the **Species Indicators** type *Catch*
18. Select the **Species** *All*
19. Click **Update Table**



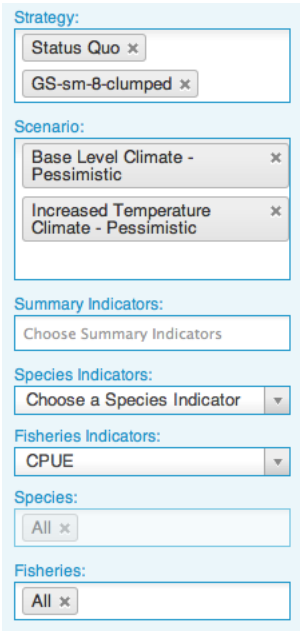
This should look like the panel to the right here and should result in the summary table below being displayed.

Indicators Summary

STRATEGIES	Status Quo
SCENARIOS	Base Level Climate
Mackerel Total Catch	↑
Small pelagic fishes Total Catch	⇄
Shallow water piscivores Total Catch	↓
Tuna and Billfish Total Catch	↓
School whiting Total Catch	↓
Gemfish Total Catch	↓
Blue warehou Total Catch	↓
Spotted warehou Total Catch	↓
Shallow demersal fish Total Catch	↓
Flathead Total Catch	↑
Morwong Total Catch	↓
Redfish Total Catch	↓
Deep demersal fishes Total Catch	↓
Ling Total Catch	↓
Blue grenadier Total Catch	↓
Blue-eye trevalla Total Catch	↓
Ribaldo Total Catch	↓
Orange roughy Total Catch	↓
Cardinalfish Total Catch	↓
Baleen whales Total Catch	↓
Gummy shark Total Catch	↓
School shark Total Catch	↓
Dogfish Total Catch	↓
Demersal shark Total Catch	↓
Pelagic shark Total Catch	↓
Skates and rays Total Catch	⇄
Squid Total Catch	↑
Prawns Total Catch	↑
Abalone and Urchins Total Catch	↑
Rock lobster Total Catch	↑
Scallops Total Catch	⇄
Mesopelagic fishes Total Catch	↓
Seabirds Total Catch	↓
Pinnipeds Total Catch	↓
Dolphins Total Catch	↓
Shallow benthic filter feeders Total Catch	↑

To access the **Fisheries** menu select an Industry indicator (like CPUE or effort – for now catch and discards are associated with the **Species** menu only). For example:

20. Select the **Strategy** *Status Quo* and *GS-sm-8-clumped* (check the **Glossary** link at the bottom of the page to see what that strategy entails)
21. Select the **Scenario** *Base Level Climate – Pessimistic Pessimistic* and *Increased Temperature Climate*
22. Select the **Fisheries Indicators** type *CPUE*
23. Select the **Fisheries** *All*
24. Click **Update Table**

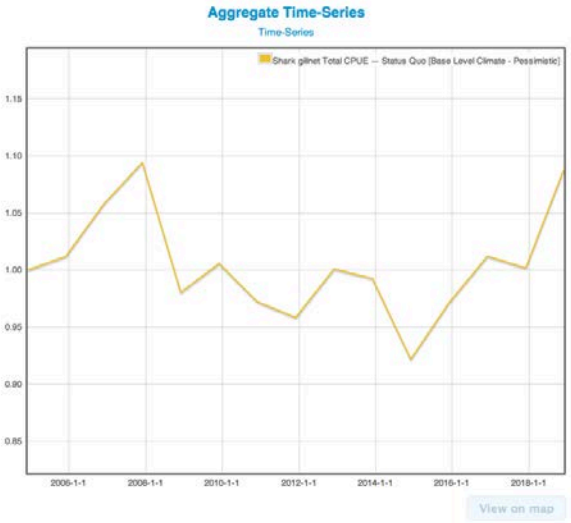


This should look like the panel to the right here and should result in the summary table below being displayed.

Indicators Summary

STRATEGIES	Status Quo		GS-sm-8-clumped
SCENARIOS	Base Level Climate	Increased Temperat	Base Level Climate
Midwater trawl for cephalopods Total CPUE	↑	↑	↑
Jig for cephalopods Total CPUE	↑	↑	↑
Midwater trawl for small pelagics Total CPUE	↕	↕	↕
Scallop dredge Total CPUE	↕	↕	↕
Demersal finfish gillnet Total CPUE	↕	↕	↕
Shark gillnet Total CPUE	↕	↕	↕
Pelagic longline for large pelagics Total CPUE	↓	↓	↓
Purse seine for large pelagics Total CPUE	↓	↓	↓
Purse seine for small pelagics Total CPUE	↕	↕	↕
Lobster pots Total CPUE	↑	↑	↑
Traps for finfish Total CPUE	↓	↓	↓
Crab trawl Total CPUE	↑	↑	↑
Bottom trawl for cephalopods Total CPUE	↑	↑	↕
Bottom trawl for deepwater demersal fish Total CPUE	↑	↑	↑
Bottom trawl for flathead Total CPUE	↑	↑	↑
Bottom trawl for orange roughy Total CPUE	↕	↕	↑
Midwater trawl for finfish Total CPUE	↑	↑	↑
Danish seine Total CPUE	↑	↑	↑
Demersal line for deepwater demersal fish Total CPUE	↓	↓	↓
Demersal line for deepwater piscivorous fish Total CPUE	↑	↑	↑
Demersal line for deepwater shark Total CPUE	↕	↕	↕
Abalone divers Total CPUE	↑	↑	↑
Purse seine for piscivorous fish Total CPUE	↓	↓	↓
Pinniped harvest Total CPUE	↓	↓	↓
Midwater prawn trawl Total CPUE	↓	↓	↓
Prawn trawl Total CPUE	↑	↑	↑
Bottom trawl for benthopelagics Total CPUE	↕	↕	↕
Midwater krill trawl Total CPUE	↓	↓	↓
Traps for shallow water finfish Total CPUE	↓	↓	↓
Demersal line for shallow water finfish Total CPUE	↓	↓	↓
Gillnet for shallow water finfish Total CPUE	↓	↓	↓
Mowing kelp Total CPUE	↓	↓	↓
Recreational fishing Total CPUE	↓	↓	↓

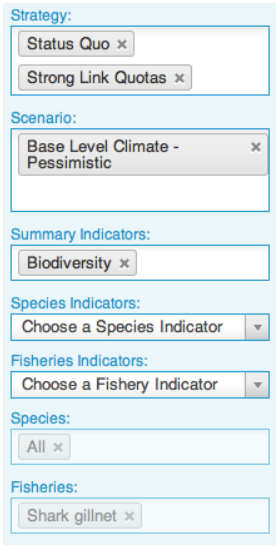
25. To get to the Time Series page click on an indicator, try Shark Gillnet Total CPUE. You should see the plot below.

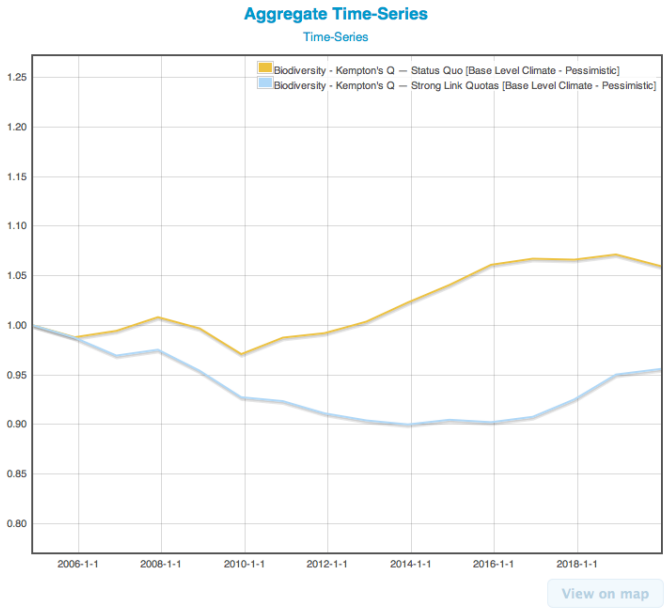


You are now on the Time Series page. The menus on this page work like those on the Summary page. For example:

26. Select the **Strategy** *Status Quo* and *Strong Link Quotas*
27. Select the **Scenario** *Base Level Climate – Pessimistic*
28. Select the **Summary Indicators** type *Biodiversity*
29. Click **Update Plot**

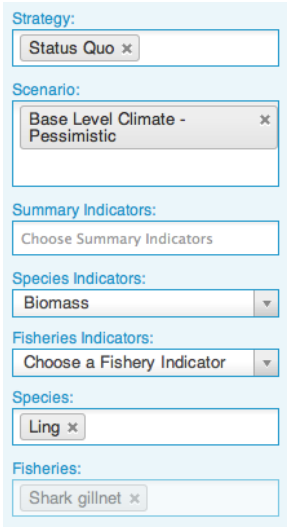
This should look like the panel to the right here and should result in the plot below.



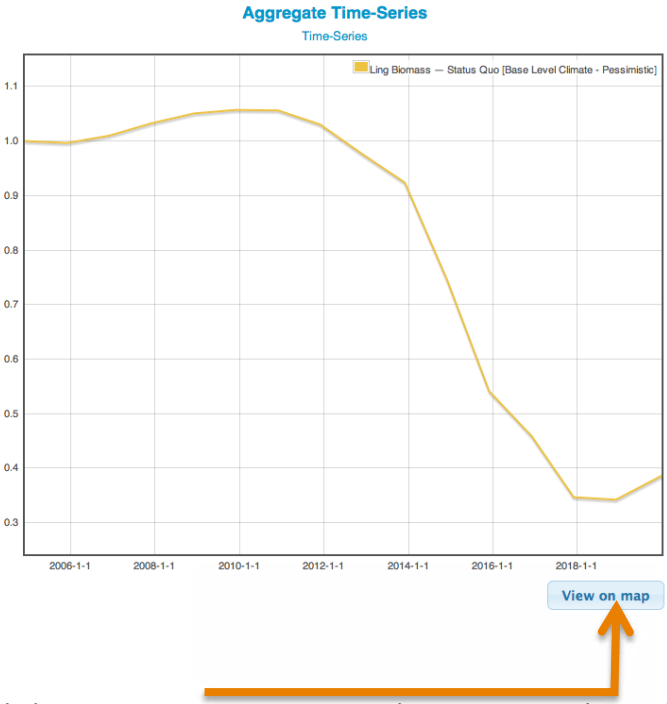


Some selections will also activate the **View on map** button. For instance, try:

30. Select the **Strategy** *Status Quo*
31. Select the **Scenario** *Base Level Climate – Pessimistic*
32. Select the **Species Indicator** type *Biomass*
33. Select **Species** *Ling*
34. Click **Update Plot**

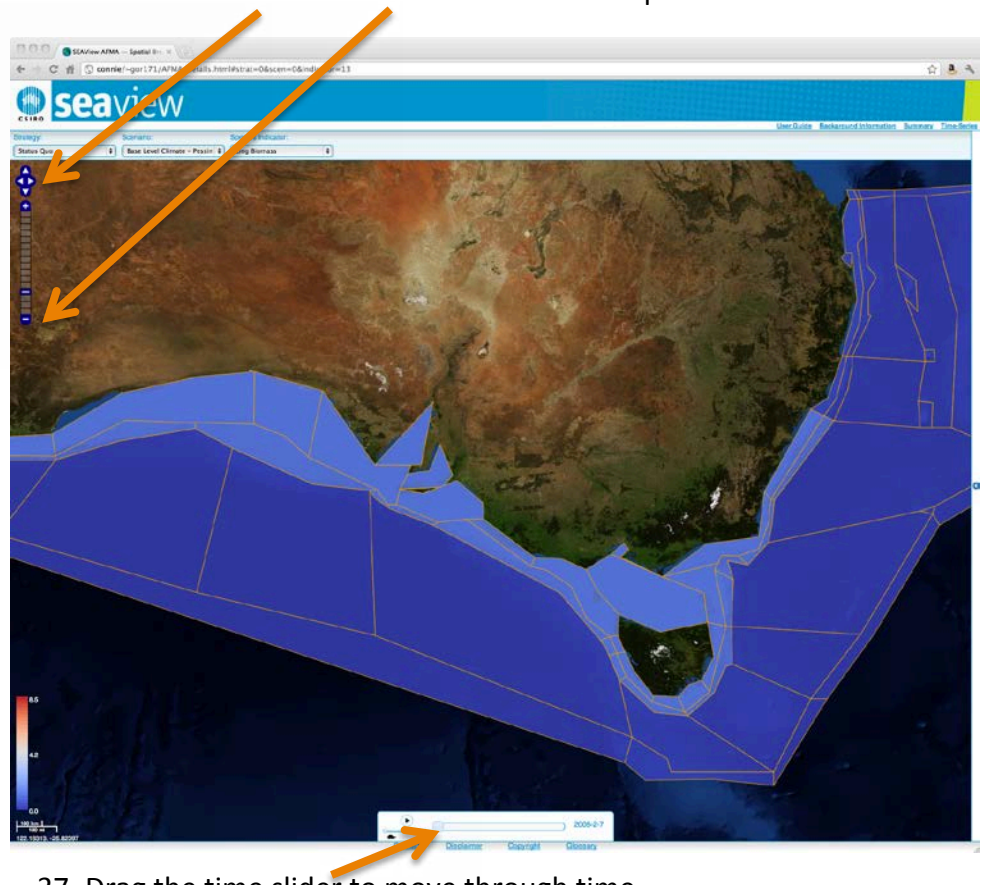


This should look like the panel to the right here and should result in the plot shown on the next page. Notice that the **View on map** button is now active.



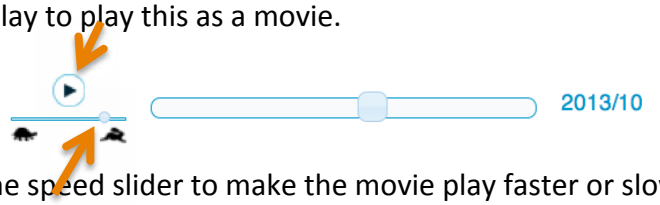
35. Click **View on map** to move to the map page shown below.

36. Click on the Pan and Zoom to move the map around



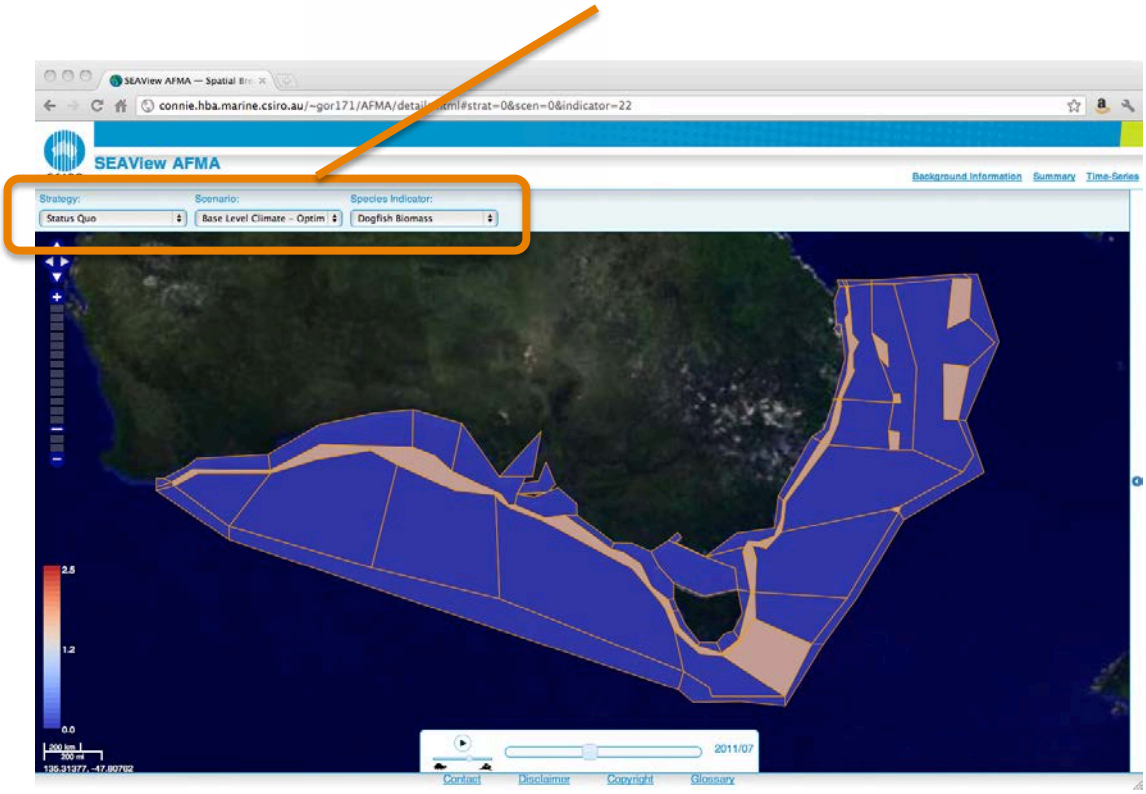
37. Drag the time slider to move through time.

38. Press play to play this as a movie.



39. Drag the speed slider to make the movie play faster or slower

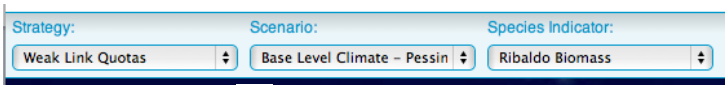
Now to explore the spatial output use the menus at the top of the screen.



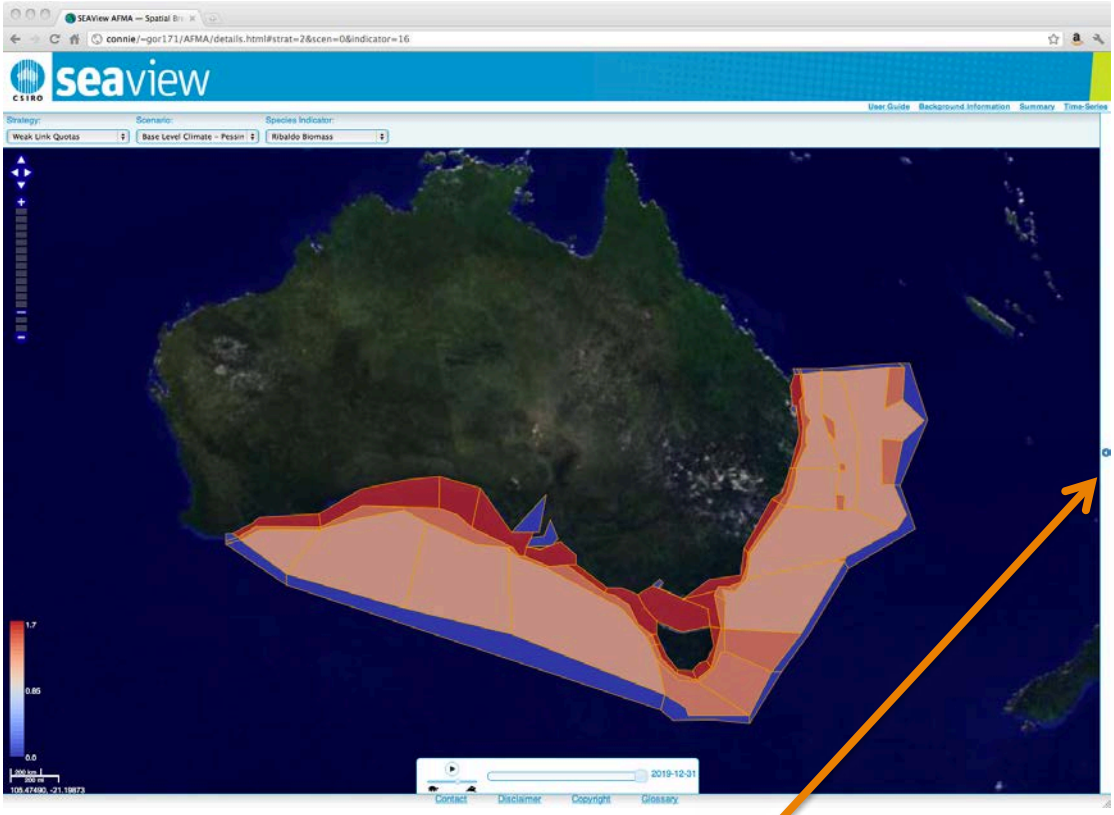
For example

40. Select the **Strategy** *Weak Link Quotas*
41. Select the **Scenario** *Base Level Climate – Pessimistic*
42. Select the **Indicator Type** *Ribaldo Biomass*

This should look like the panel below.

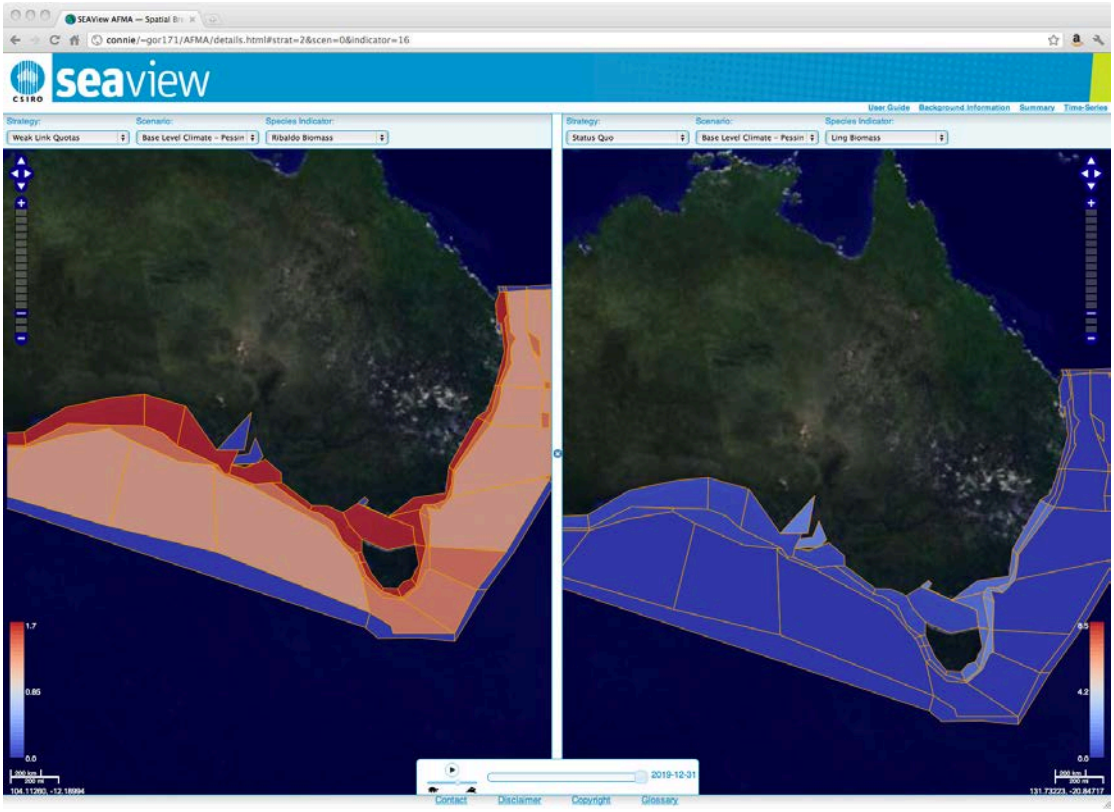


43. Press play to watch how the map changes through time or drag the slider to the far right and you should see the map shown on the next page.



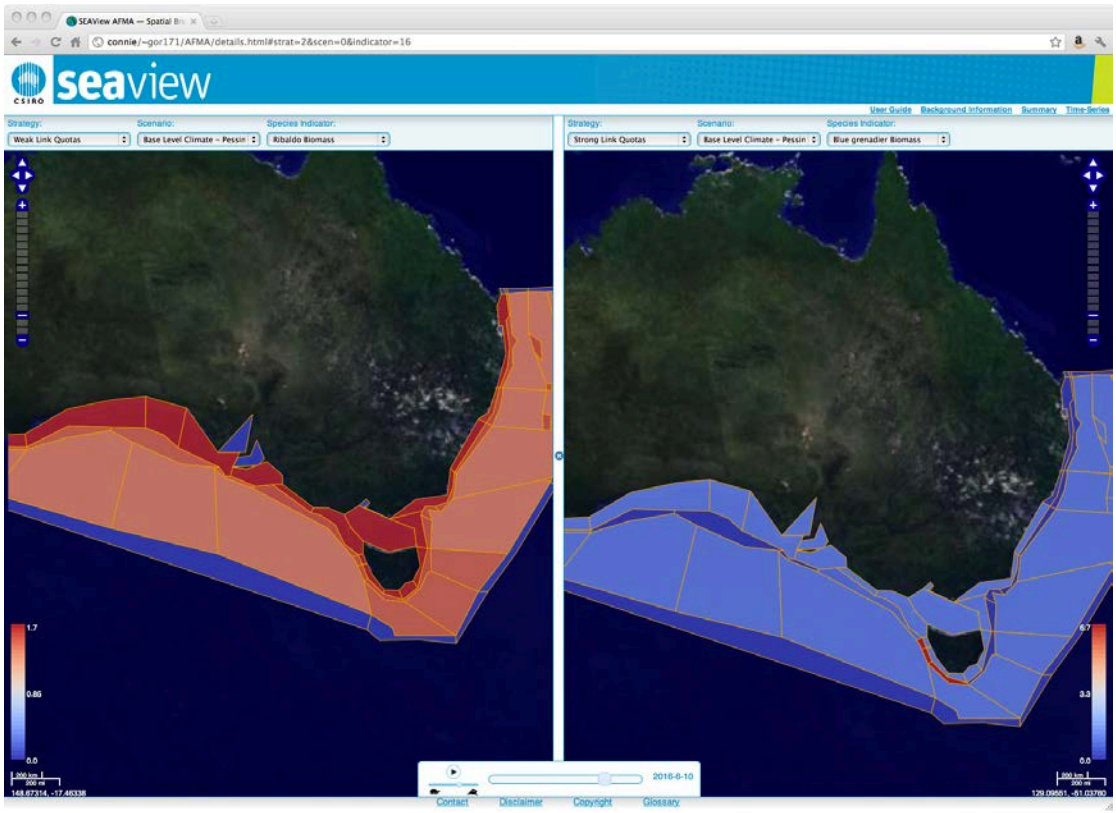
The final map page feature is the ability to compare two maps

44. Click on the small tab on the right side of the page. You should see the two maps side by side like below.



The second map is controlled with its own set of menus, pan and zoom. The two maps share a common time slider.

45. On the right hand map select the **Strategy** *Strong Link Quotas*
46. Select the **Scenario** *Base Level Climate – Pessimistic*
47. Select the **Indicator Type** *Blue grenadier Biomass*
48. Let it play through time. And you should see something like the maps below.



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