

## Ecopath with Ecosim 6: the sequel

*by Villy Christensen and Sherman Lai*

The Ecopath with Ecosim (EwE) approach, which has been primarily developed at the UBC Fisheries Centre, was in 2007 named as one of the ten biggest scientific breakthroughs in NOAA's 200-year history (<http://celebrating200years.noaa.gov/toptens.html#categories>). The citation highlighted that Ecopath "revolutionized scientists' ability worldwide to understand complex marine ecosystems". Behind this lay a couple of decades of development work accompanied by a strong dedication to user support and training, resulting in some 6000 registered users in 155 countries. The many years of development have, however, also had a less-desirable effect. As we have been expanding the approach, the software implementing it has grown to be a rather complicated entity, with limited ability for customization, e.g., through addition of alternative calculation modules by other developers. Also, making things worse, the development environment

(Microsoft VB6) we have used since the late 1990s is no longer supported. EwE5 was technically reaching its limits, and we were faced with a difficult decision of whether to carry on while the going was good, refurbish or rebuild.

Motivation to overhaul is one thing; being able to see it through is something quite different. Too many successful scientific softwares have faced sudden death when they were redeveloped. Adding to such concern is that, while it is feasible to obtain funding for application of tools and models, it is extremely difficult to get funding for tool development. We have been fortunate, however, to get support from the Lenfest Ocean Program ([www.lenfestocean.org](http://www.lenfestocean.org)) for redeveloping EwE over a two-year period 2005-2007. The outcome of this is a new release of EwE (6), developed in a new, integrated software environment (.NET) and totally restructured so that

Ecopath with Ecosim version 6 (EwE6) is available for free download from [www.ecopath.org](http://www.ecopath.org)

only the key computational parts have been ported, while all other parts, module structure, data handling, user interface, etc. have been re-programmed as fully object-oriented programming.

The new EwE6 has been restructured to modularize its individual components, and we have completely separated the user interface from the computational core so that we can implement different interfaces - not just the standard scientific but also, for instance, gaming interfaces. Doing so was actually the main reason for embarking on the redevelopment and this is where the focus will be for the next phase of the Lenfest Ocean Futures Project

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([www.lenfestoceanfutures.org](http://www.lenfestoceanfutures.org)). The Lenfest Ocean Futures Project is designed to explore ways in which current fisheries management approaches can be modified to become more responsible from social and economic as well as ecological perspectives. The project is developing a new approach to evaluation of fisheries management through an EwE-based ecosystem modeling and visualization methodologies, aimed at exploring management scenarios in policy and management workshops. The project relies on development of three technical components: optimisation of the ecological software system, Ecopath with Ecosim (EwE); development of interactive gaming software; and visualization of the impact humans have on ecosystems

through fishing activities. The activity will thus serve to support ecosystem-based management of fisheries, while offering a possibility for a group of managers to quickly explore alternative scenarios and evaluate the potential outcome.

During the many years we have developed EwE, it has grown to a very complex and capable software for evaluation of ecosystem-based management of aquatic ecosystems (or for an ecosystem-approach to fisheries as FAO calls it). As discussed above, this has led to very widespread use of EwE, to the degree that there are now active projects and very capable modelers using the approach in most fisheries countries of the world. The group of developers has, however, remained quite small, with most being attached to the UBC Fisheries Centre. This, we find, is related to how the 'old' EwE5 was structured with one big, interlinked coding block. If a developer, as has happened, wanted to create a new module for EwE5, this entailed going into the existing code, finding the variables of interest, adding new forms, etc. While this was all very feasible and indeed straightforward to do, there was a major hurdle: maintenance. Whenever the core developer group (i.e., Carl

**E**wE6 has been developed by Joe Buszowski, Villy Christensen, Fang Gao, Joe Hui, Sherman Lai, Jeroen Steenbeek, Carl Walters and Will Walters, Carie Hoover and Robyn Forrest.

Walters and Villy Christensen) updated the master source code, the 'private' versions would be left behind and the developer had to download the new master code and then integrate the new modules again. This process had to be repeated numerous times, and we see this as a major reason for why the group of EwE developers remained quite small.

With EwE6, we have broken with the past. The programming of the new version is fully object-oriented, which ensures code integrity and enables multiple developers to work on the code simultaneously. We have thus had a team of developers (see box above) working on the source code in parallel, and updating the code daily through a web-based version control system.

To enable external developers (who can get access to the web-based source code on request) to create and easily maintain new modules, we have

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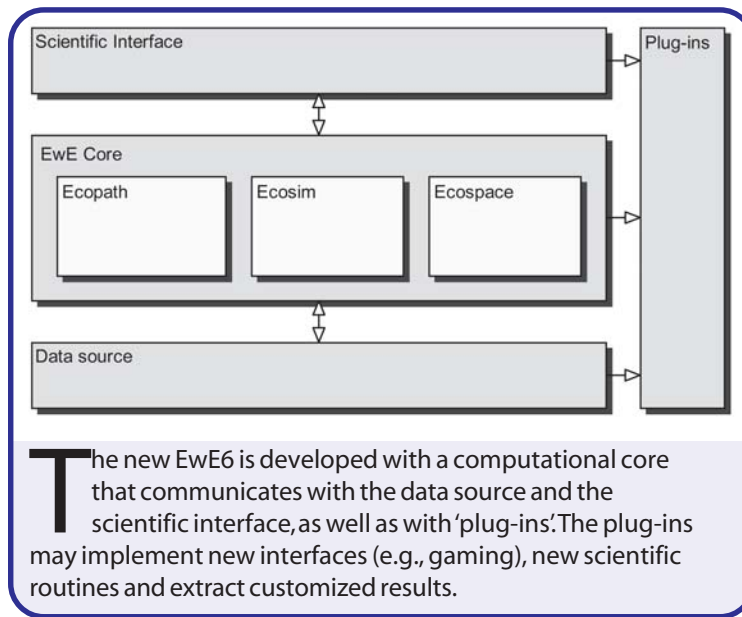
The *Sea Around Us* website may be found at [www.seaaroundus.org](http://www.seaaroundus.org) and contains up-to-date information on the project.



**T**he *Sea Around Us* project is a Fisheries Centre partnership with the Pew Charitable Trusts of Philadelphia, USA. The Trusts support nonprofit activities in the areas of culture, education, the environment, health and human services, public policy and religion. Based in Philadelphia, the Trusts make strategic investments to help organisations and citizens develop practical solutions to difficult problems. In 2000, with approximately \$4.8 billion in assets, the Trusts committed over \$235 million to 302 nonprofit organisations.

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developed a 'plug-in' system, which makes it possible to query the computational core at a number of breakpoints, and then to replace sequences of the calculations, perform new calculation, obtain or pass on variable values (for instance to display results or modify the program flow in other ways). The plug-in system is also capable of accepting new modules, which if dropped in the program folder that holds EwE6, will integrate in the Navigator and menu-system of EwE6, without a recompilation of the program being necessary.



The new EwE6 is developed with a computational core that communicates with the data source and the scientific interface, as well as with 'plug-ins'. The plug-ins may implement new interfaces (e.g., gaming), new scientific routines and extract customized results.

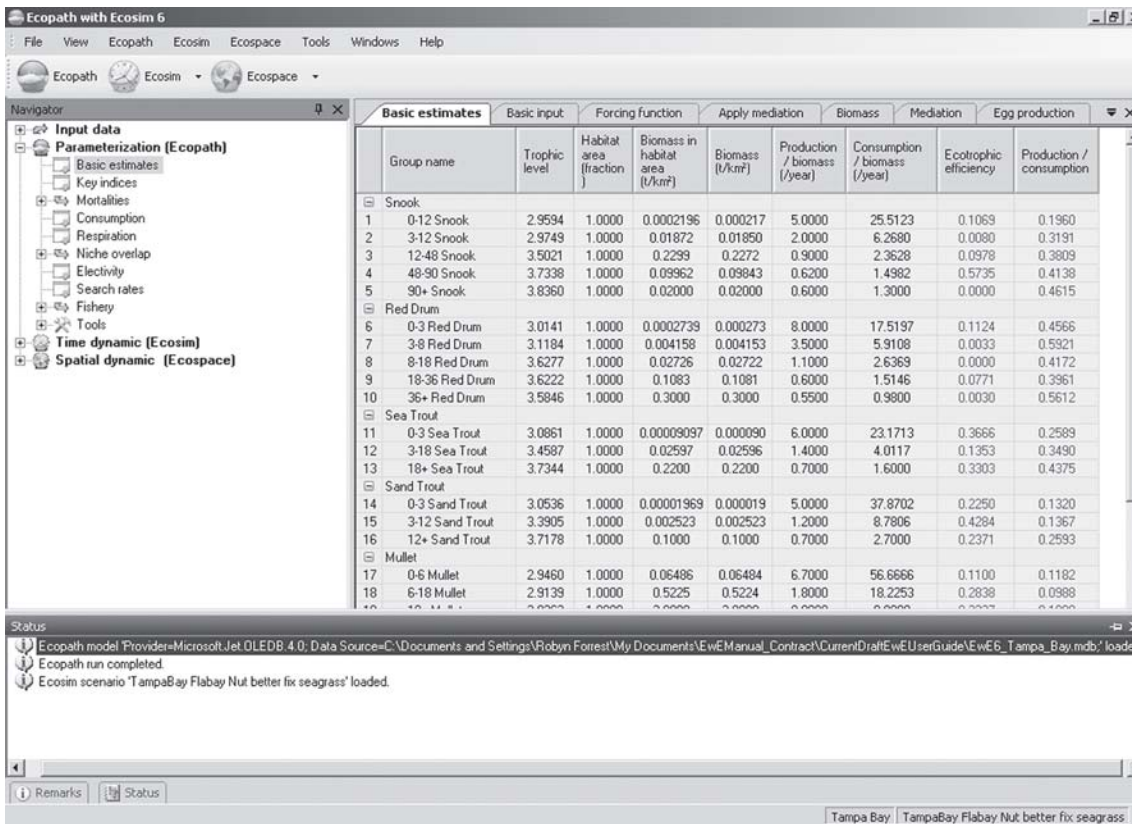
*A major aspect that is being facilitated through EwE6 is that it allows for customization of the approach*

It is thus now a major aspect of EwE6 that it allows for customization of the approach. For example, if an agency office wants to present some specific analysis and results to a fisheries management council, they can

straightforwardly develop a new interface for EwE6, and it can be customized with exactly what needs to be included. It can thus be under the control of the agency; yet, they can benefit from the shared facilities in the

form of data storage systems, etc., which will facilitate both development and management as well as making it easier to cooperate with other agency offices working with other versions.

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The new EwE6 interface – a new look and feel offering increased flexibility. The 'Navigator' in the left panel has replaced the previous versions' button-bar navigation.

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EwE6 can also be called from other programming environments, for instance from R. Given the rapid development of this environment (from which we have learned in the design of EwE6), we see this as an especially promising avenue. It is thus possible to create routines for analysis in R that can call the EwE6 libraries, for instance to run Ecosim, while giving and obtaining parameter estimates. We are also able to couple EwE6 to other models using Internet protocols and this is especially of interest for linking to UNIX-based

biogeochemical models. Our focus with the redevelopment has, up to now, been on porting/redeveloping the existing capabilities of EwE5, and as we are about to declare this part of the development done ("Mission Accomplished", you remember), we can focus on new elements. One development worth noting is a zoning tool, Ecosed, which will form part of the EwE6 spatial modeling approach, Ecospace. This development is being funded by the David and Lucile Packard Foundation through the Duke University EBM-Tools Development Innovation Fund,

and involves building a 'bridge' between Ecospace and MARXAN, a very widely used zoning tool.

While the development of EwE6 will continue for the foreseeable future, we are now reaching the stage with it where we can start thinking about user support. Two initial training courses are thus planned for early 2008. One will be in South East Asia and will focus on participants in the GEF/LME projects in the region, while the second will be hosted by the Guinea Current LME project in Ghana, and likely will involve participation from 19 West African countries.



*The Ocean Hero Award is given to those who make contributions through their professional work to improve the health of the world's oceans*

## Daniel Pauly wins 2007 Ted Danson Ocean Hero Award

**D**aniel Pauly has been awarded the Ted Danson Ocean Hero Award at Oceana's 2007 Partners Event. The event is held annually in Los Angeles to honour individuals who have made outstanding contributions to protection of the oceans. There are two awards: the Partners Award and the Ocean Hero Award. The Ocean Hero Award is given to those who make contributions through their professional work to improve the health of the world's oceans. Previous honorees include James Cameron, Jean-Michel Cousteau and Julie Packard.

The 2007 Partners Award was presented to Former U.S. Vice President and Nobel Prize winner, Al Gore. The Partners Award was established in 1994 by American Oceans Campaign to honour individuals who have made outstanding contributions through their personal



*Daniel Pauly, Oceana CEO Andy Sharpless, Anjelica Huston, Vice President Al Gore, Mary Steenburgen and Ted Danson.*

*Photo by Eric Charbonneau. Reproduced with permission from Oceana.*

commitment to the cause of protecting the world's oceans. Former honorees include Pierce Brosnan, Ron Howard, Hillary Rodham Clinton, Bill Clinton and Ted Danson (founder of American Oceans Campaign).

For more on Oceana, see <http://oceana.org/international-home-nao/>.