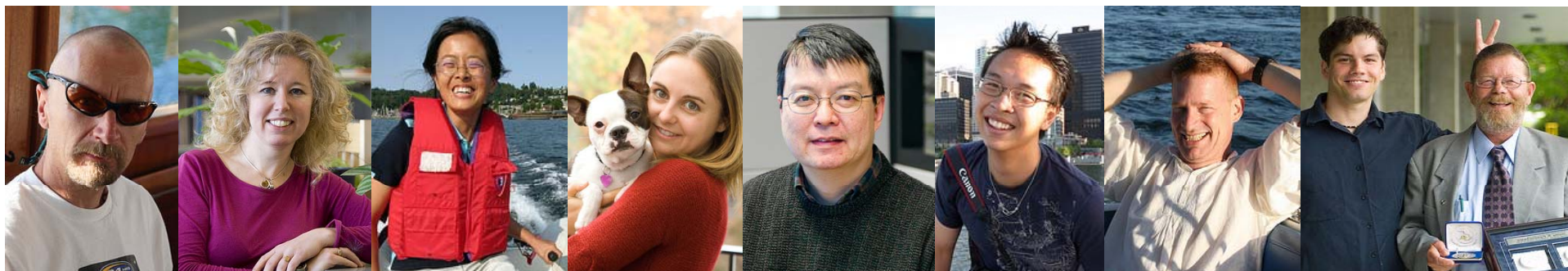


Ecopath with Ecosim 6: New generation ecosystem modeling package

Villy Christensen, Joe Buszowski, Robyn Forrest, Fang Gao,
Carie Hoover, Joe Hui, Sherman Lai, Jeroen Steenbeek,
William Walters and Carl Walters



PICES 16th Annual Meeting, Victoria, October 30, 2007

CCCC/FIS Topic Session S3

**Towards ecosystem-based management:
Recent developments and successes in multi-species modeling**



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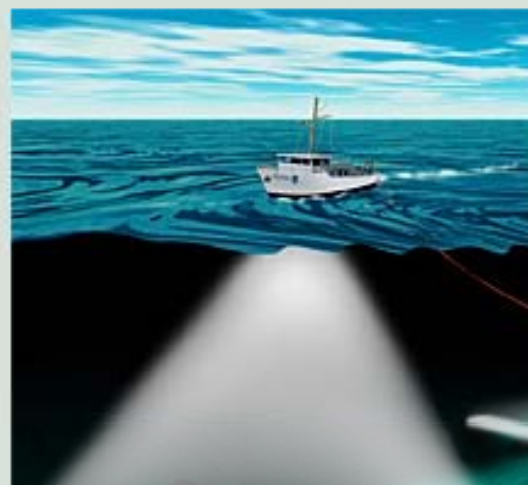
[Top Tens](#): The Breakthroughs

The Breakthroughs

"The [ECOPATH] model's simplicity and its ability to accurately identify ecological relationships have revolutionized scientists' ability worldwide to understand complex marine ecosystems."

"In the late 1960s, NOAA's Geophysical Fluid Dynamics Laboratory ...developed the first-of-its-kind general circulation climate model that combined both oceanic and atmospheric processes. Scientists were now able to understand how the ocean and atmosphere interacted with each other to influence climate."

"While ecologists have long studied and taught the concept of ecosystems, the concept of large marine ecosystems is a breakthrough in understanding how best to manage large ocean areas for sustained biological productivity."



Multibeam sonar (illustrated below the ship) was a major breakthrough in hydrographic surveying. Data acquired with multibeam sonar have revolutionized human understanding of the seafloor and the efficiency of NOAA's Office of Coast Survey offshore surveying.

View Top Tens

[History Makers](#)

[The Breakthroughs](#)

[Historic Events](#)

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Also View:

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[Honorable Mentions](#)

Top Ten Breakthroughs

[Climate Model](#)

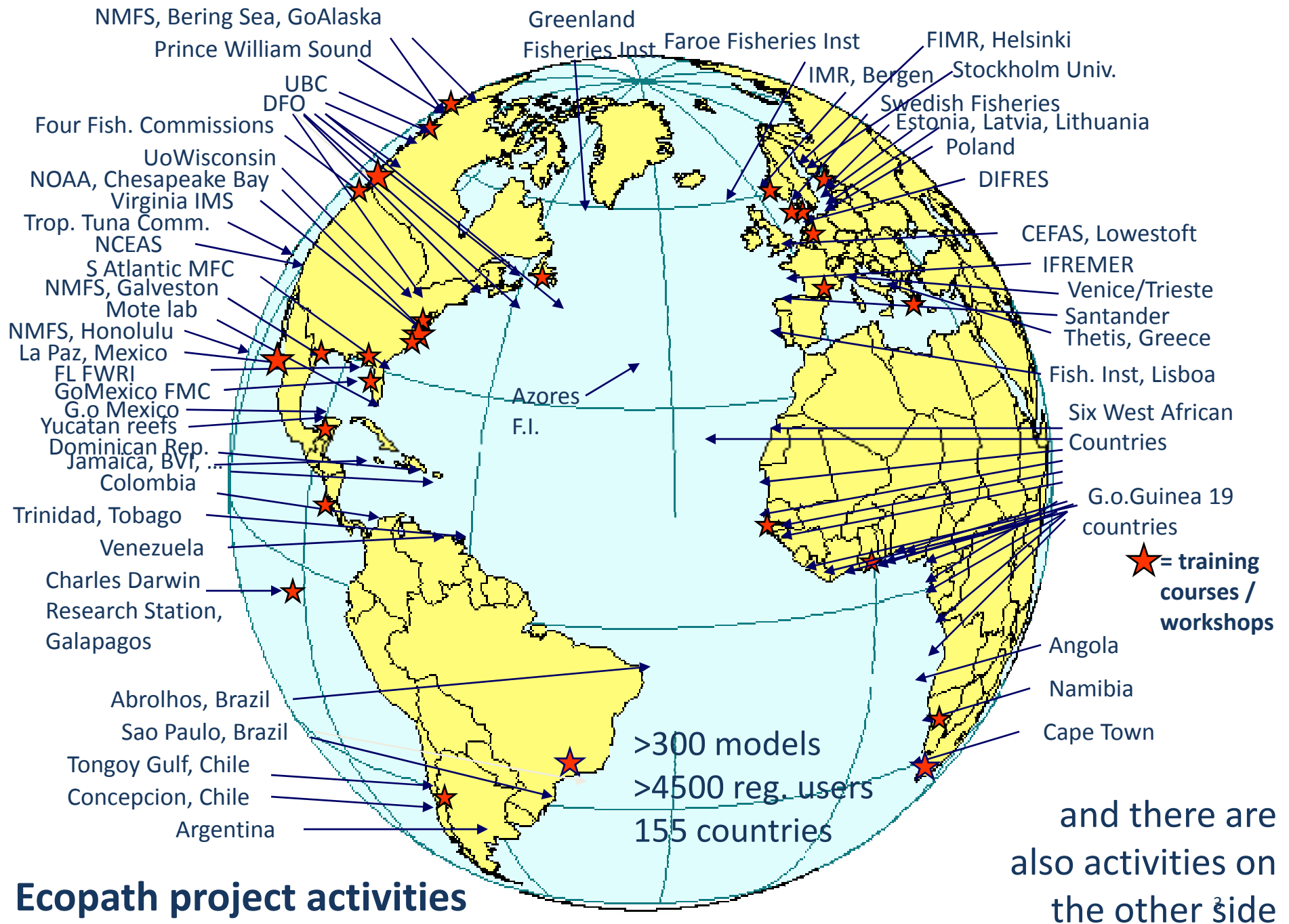
[Coronagraph in Space](#)

[ECOPATH Modeling](#)

[Global Positioning System](#)

[Hydrographic Survey Techniques](#)

[Large Marine Ecosystems](#)



EwE

data, models, and uses

Abundance, mortality, catches, feeding rates, diets, growth, interaction terms, carrying capacity, persistent pollutants, habitats, nutrient loading, climate indicators, migration, dispersal, occurrence, distribution, costs, subsidies, prices, values, existence values, employment

Parameterization
Ecopath

Time-dynamics
Ecosim

Spatial-dynamics
Ecospace

Persistent
pollutant
dynamics

Environmental assessments, network analysis, ecological theory, fisheries management, adaptive management, culling, ecosystem manipulation, protected areas, spatial zoning, policy exploration, fisheries sector optimization, conflict reduction, climate scenarios, gaming, ...

The new Ecopath with Ecosim (6)

- Four year project funded through Lenfest Ocean Program
- Lenfest Ocean Futures Project:
 - EwE6 released Sep 2007
 - *Ocean Summits* methodology 2009



- Customized versions facilitated
- User Ownership

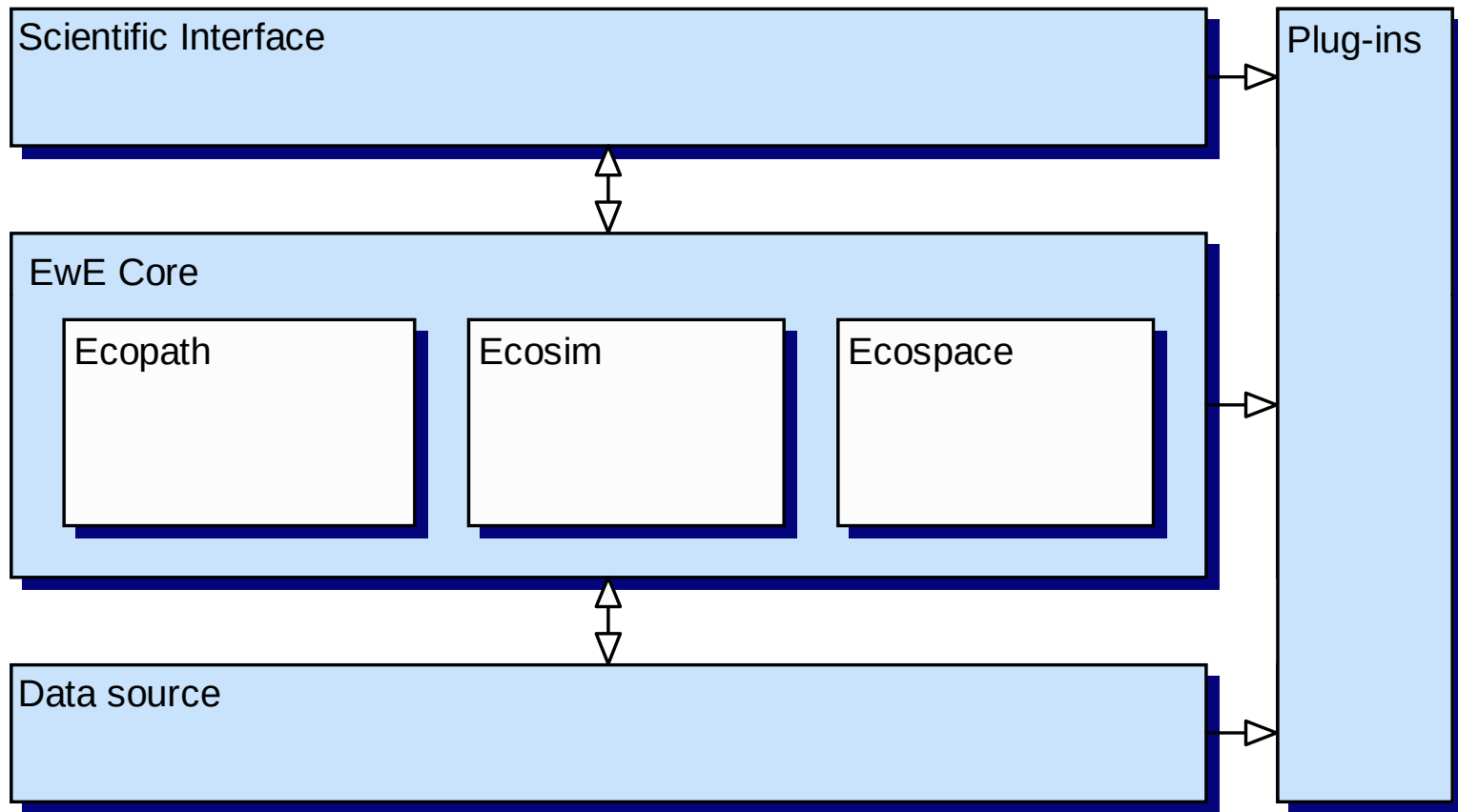


New in EwE6

- Object oriented implementation
- Usability improvements:
 - Navigation tree
 - Improved visualization tools
- “More uncertainty”
- Plug-ins
- Alternative interfaces
- Linkages
- Localization



EwE6 overview



Source code (live) available for download through cvs



Ecopath with Ecosim 6

File View Ecopath Ecosim Ecospace Tools Windows Help

Ecopath Ecosim Ecospace

Navigator

- Input data
 - Basic input
 - Diet composition
 - Detritus fate
 - Other production
 - Fishery
 - Tools
- Parameterization (Ecopath)
 - Basic estimates
 - Key indices
 - Mortalities
 - Consumption
 - Respiration
 - Niche overlap
 - Electivity
 - Search rates
 - Fishery
 - Tools
- Time dynamic (Ecosim)
 - Input
 - Ecosim parameters
 - Group info
 - Vulnerabilities
 - Time series
 - Mediation
 - Forcing function
 - Egg production
 - Fleet size dynamics
 - Output

Ecospace parameters Dispersal Time series Start **Basic input** Run Ecosim Basemap

Set:

	Group name	Habitat area (fraction)	Biomass in habitat area (t/km ²)	Production / biomass (/year)	Consumption / biomass (/year)	Ecotrophic efficiency	Production / consumption	Unassimil. / consumption	Detritus import (t/km ² /ye.
[-]	Snook								
1	0-12 Snook	1.000	0.000217	5.000	25.512			0.200	
2	3-12 Snook	1.000	0.0185	2.000	6.268			0.200	
3	12-48 Snook	1.000	0.227	0.900	2.363			0.200	
4	48-90 Snook	1.000	0.0984	0.620	1.498			0.200	
5	90+ Snook	1.000	0.0200	0.600	1.300			0.200	
[-]	Red Drum								
6	0-3 Red Drum	1.000	0.000274	8.000	17.520			0.200	
7	3-8 Red Drum	1.000	0.00415	3.500	5.911			0.200	
8	8-18 Red Drum	1.000	0.0272	1.100	2.637			0.200	
9	18-36 Red Drum	1.000	0.108	0.600	1.515			0.200	
10	36+ Red Drum	1.000	0.300	0.550	0.980			0.200	
[-]	Sea Trout								
11	0-3 Sea Trout	1.000	0.0000909	6.000	23.171			0.200	
12	3-18 Sea Trout	1.000	0.0260	1.400	4.012			0.200	
13	18+ Sea Trout	1.000	0.220	0.700	1.600			0.200	
+	Sand Trout								
+	Mullet								
+	Mackrel								
+	Ladyfish								
24	Jacks	1.000		0.600		0.600	0.300	0.200	
25	Bay Anchovy	1.000		2.530	14.000	0.600		0.200	
26	Pin Fish	1.000	0.320	1.019	8.000			0.200	
27	Snout	1.000	0.690	1.100	12.000			0.200	

Status

- Ecopath model 'Provider=Microsoft.Jet.OLEDB.4.0; Data Source=C:\Documents and Settings\v.christensen.AERL\Desktop\EwE6_Tampa_Bay.mdb;' loaded.
- Ecopath run completed.
- Ecocosim scenario 'TampaBay Flabay Nut better fix seagrass' loaded.
- Ecospace scenario 'TampaBay2km' loaded.

Status Remarks

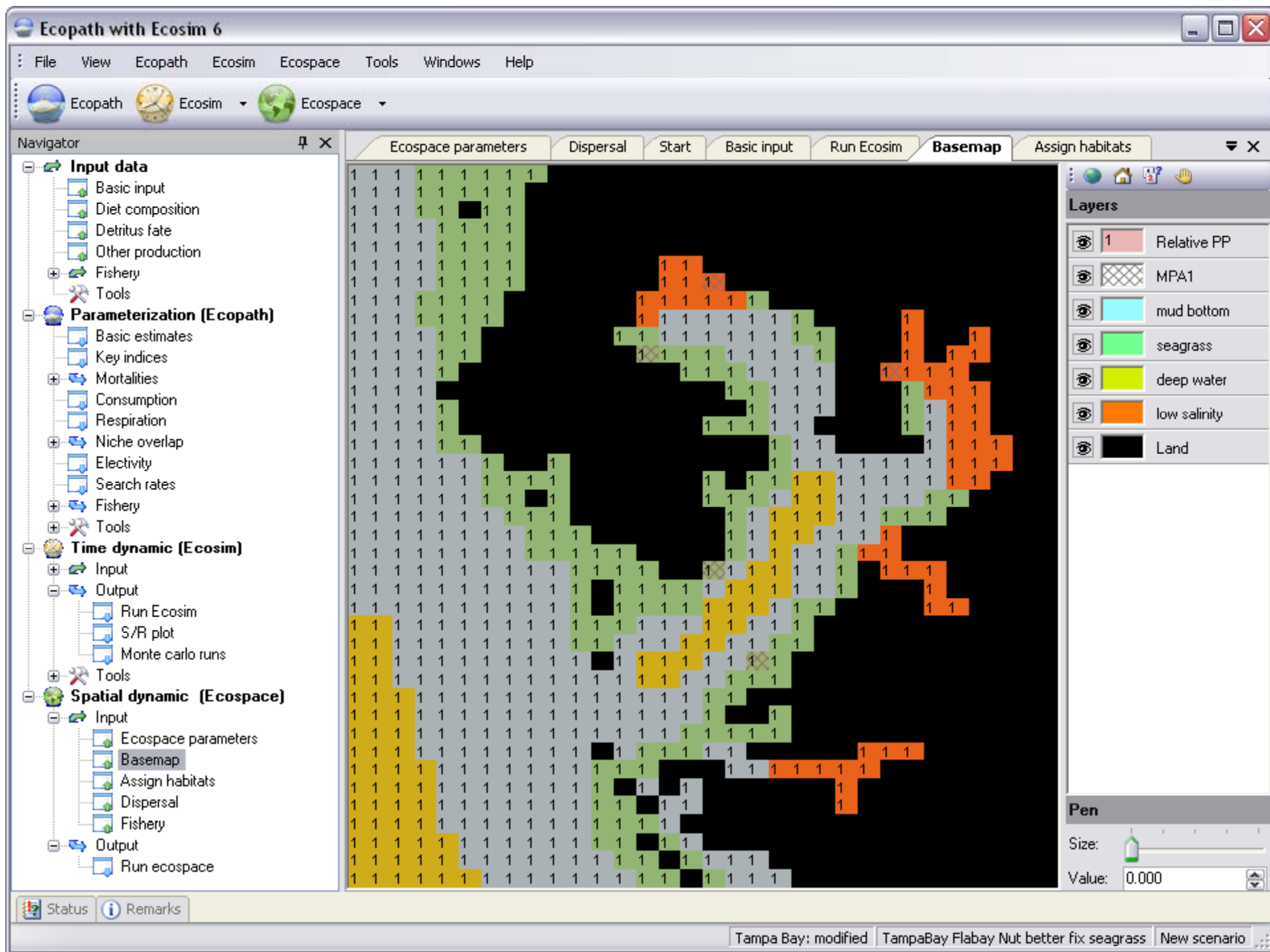
Tampa Bay: modified TampaBay Flabay Nut better fix seagrass New scenario

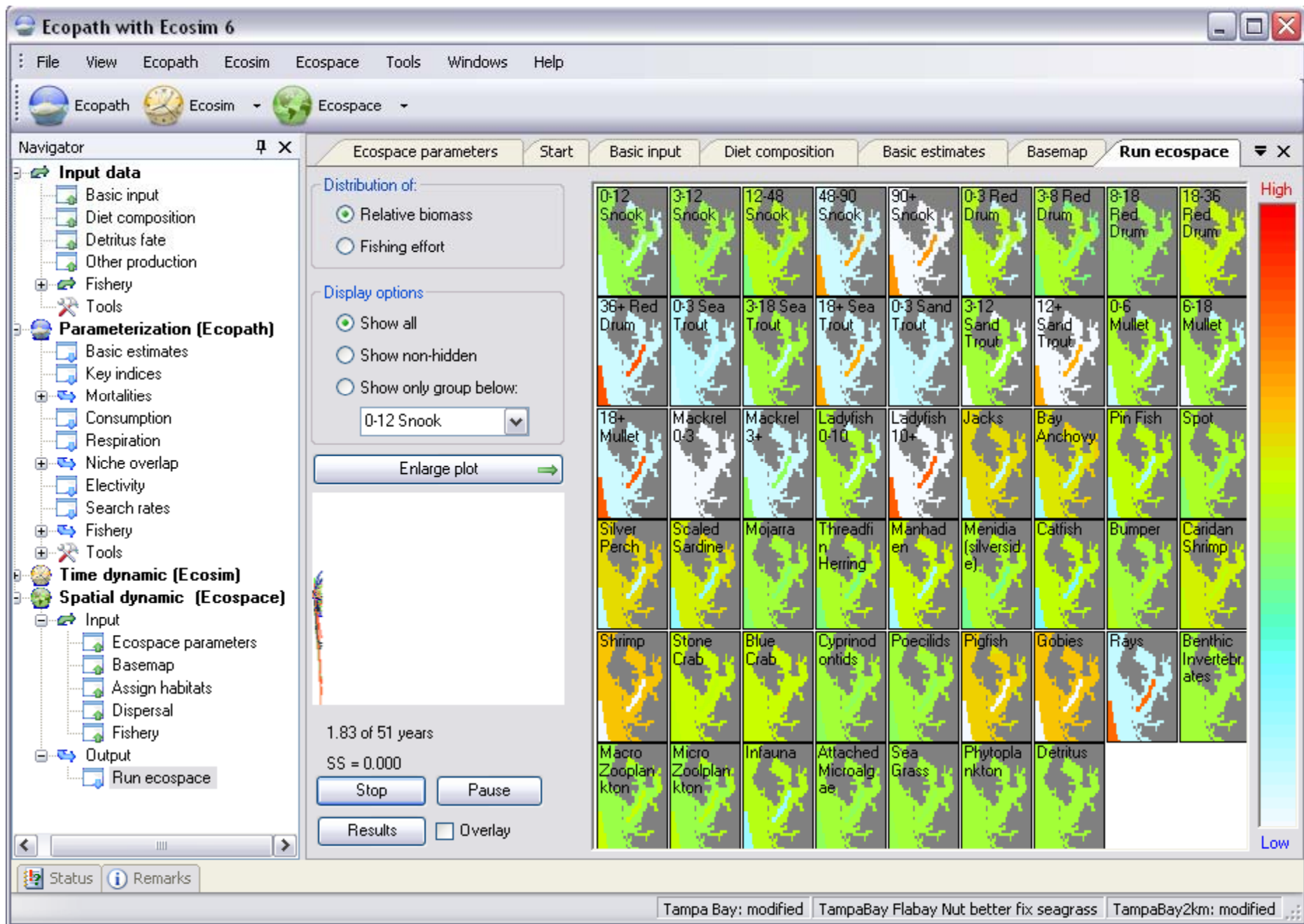


EwE6: Spatial modeling

- EwE5 short cuts for differentiation no longer needed
- Ecospace now models multi-stanza groups properly
- Option for IBM for multi-stanza groups incorporated (with Kenny Rose)
- Threading to multiple processors

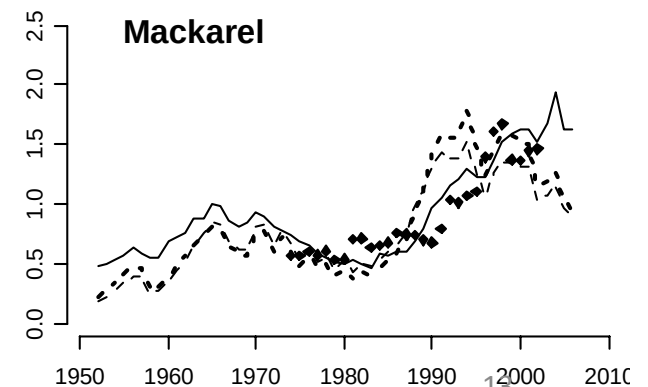
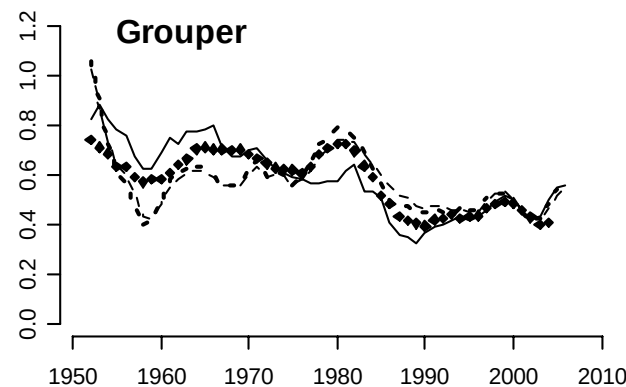
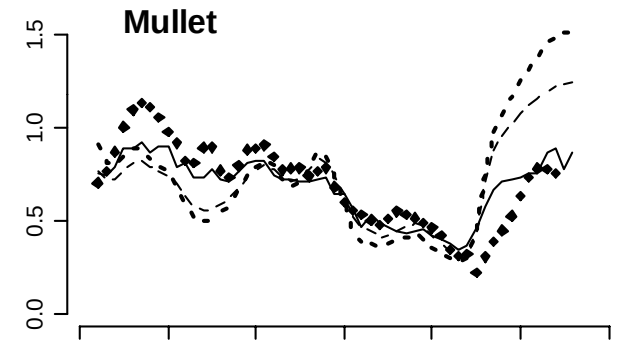
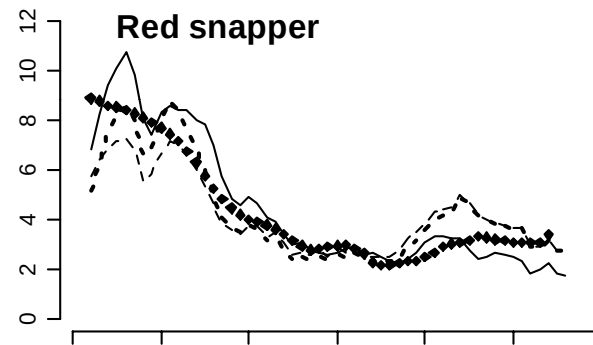
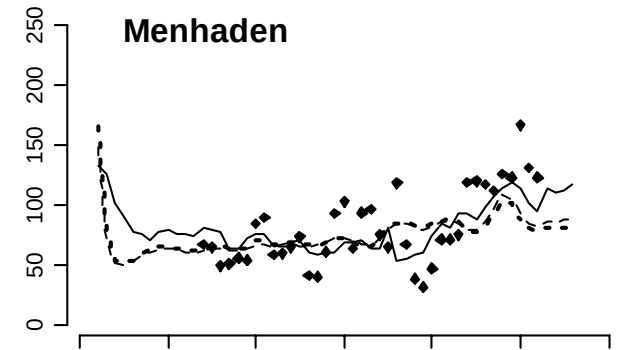
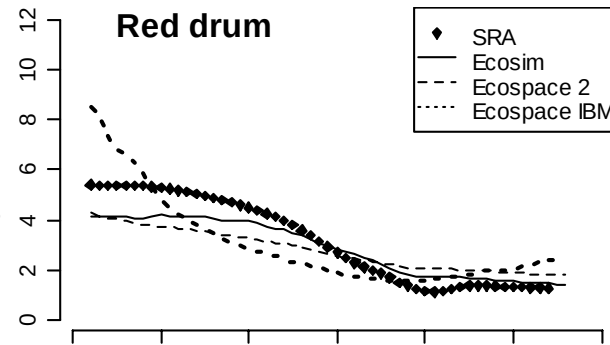






Gulf of Mexico FMC

- Ecosim results similar to results from single species model (SRA)
- Ecospace versions similar to Ecosim and SRA



Fitting to time series: learning from ecosystem history

- Numerous EwE models have in recent years produced credible fit to historical data, and made plausible policy predictions
 - requires inclusion of environmental as well as fisheries impact

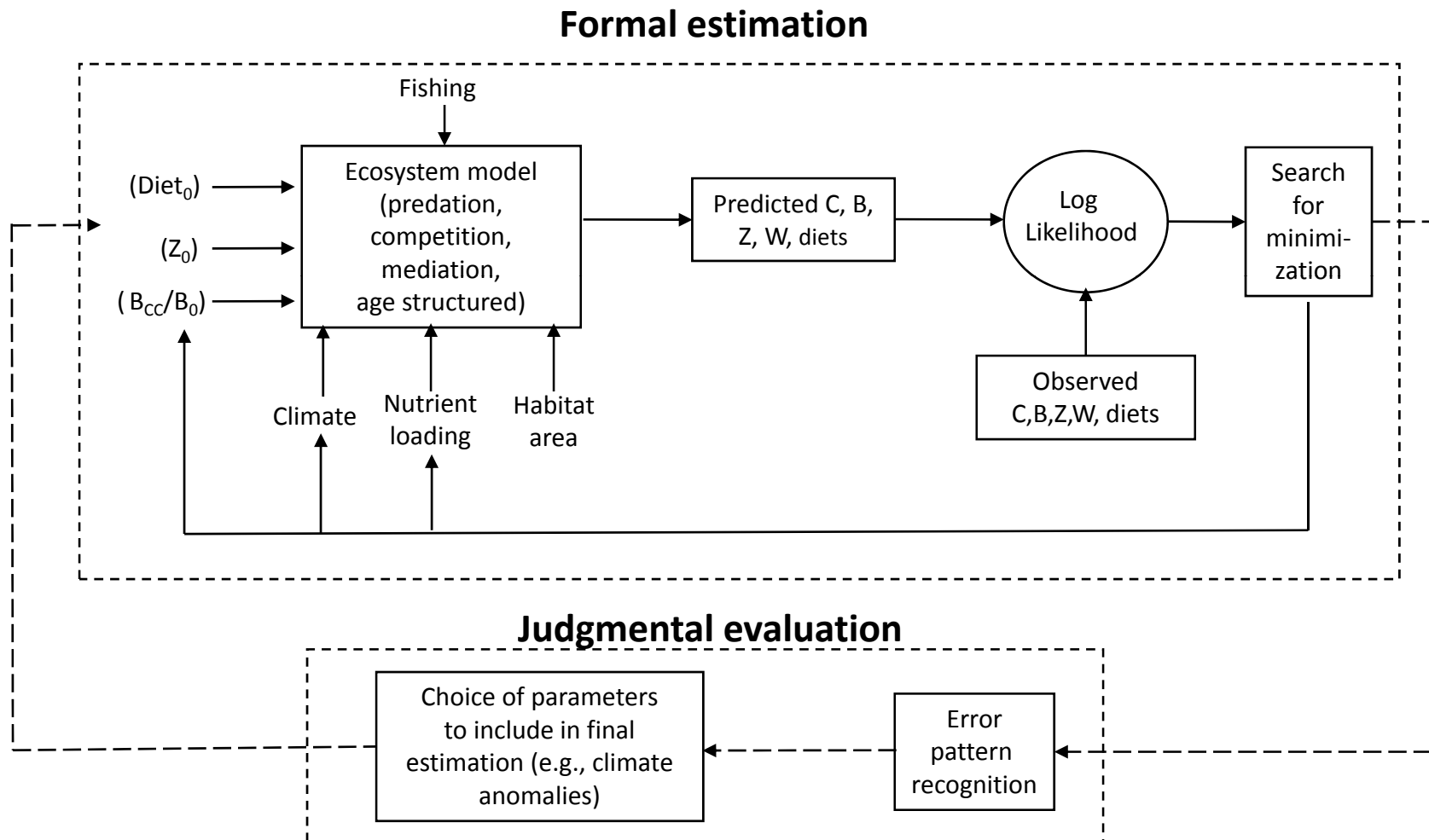


Ecosystems where EwE models have been tested with historical trend data

- E Bering Sea
- Aleutian Islands
- W&C GoAlaska
- E GoAlaska
- W Vancouver Island
- Hecate Strait
- British Columbia Shelf
- Strait of Georgia
- NE Pacific
- CN & ET Pacific
- NWHI, Hawaii
- Gulf of California
- Central Chile
- Bay of Quinte
- Oneida Lake
- Scotian Shelf
- Chesapeake Bay
- Tampa Bay
- US Gulf of Mexico
- S Brazil Bight
- Norwegian Sea
- North Sea
- Baltic
- S Benguela
- Gulf of Thailand
- South China Sea



Modeling process: fitting & drivers

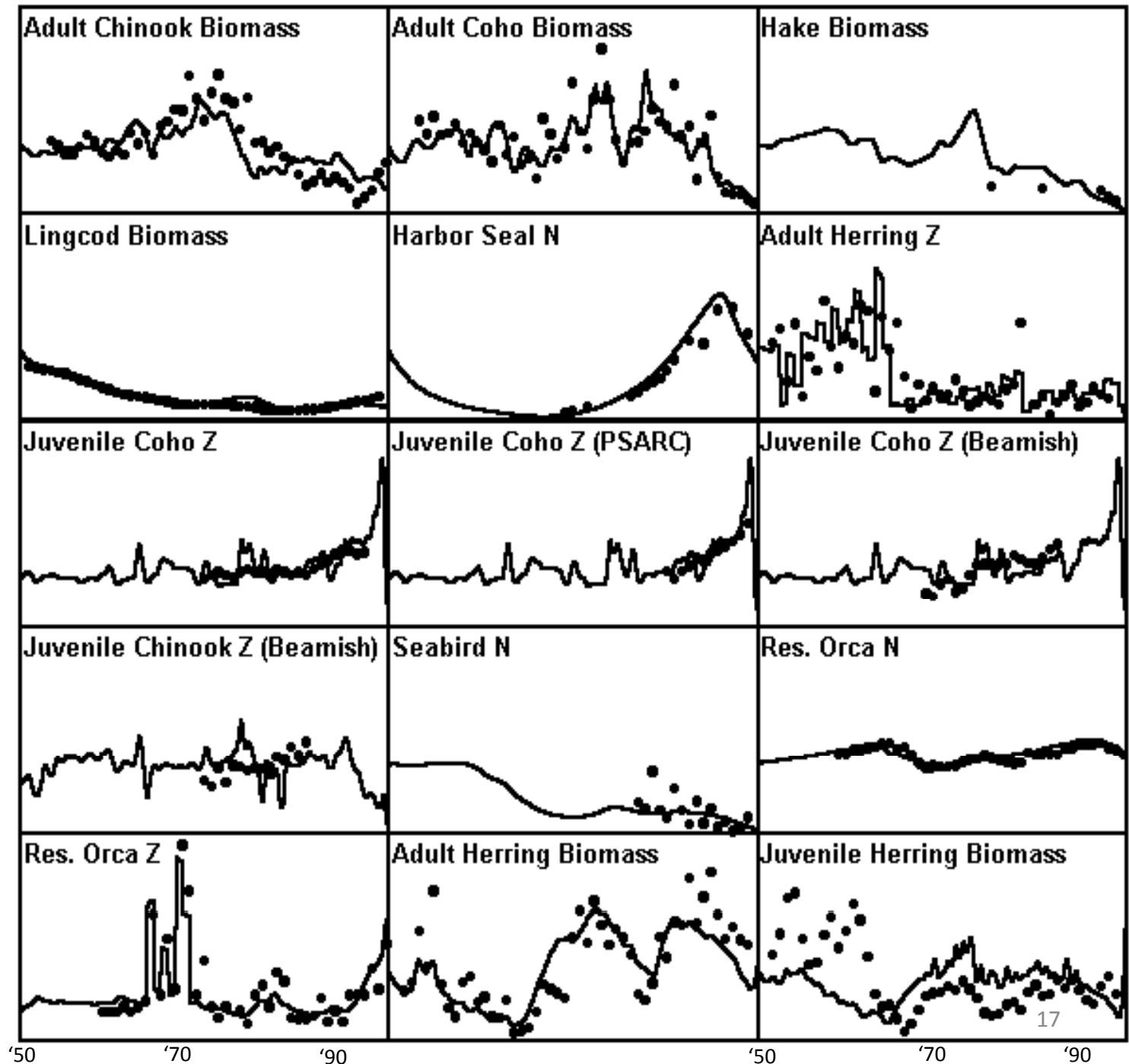


Are seals
causing fish
declines in
the Georgia
Strait?

Is it fishing?

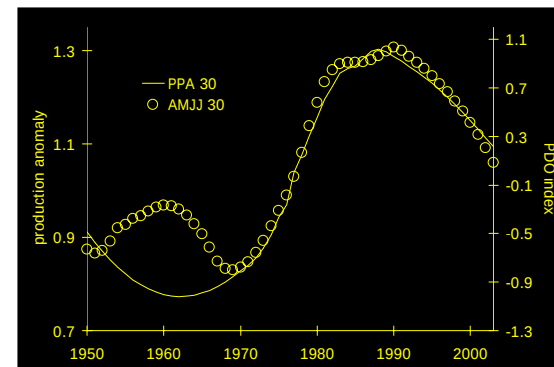
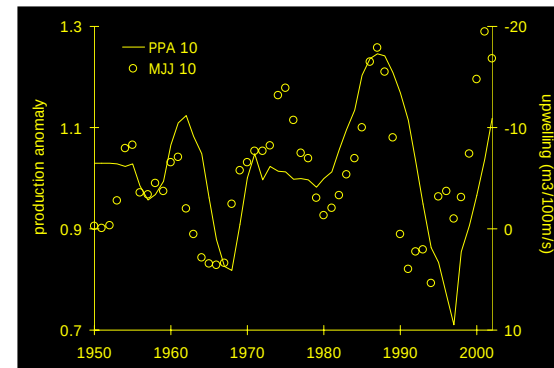
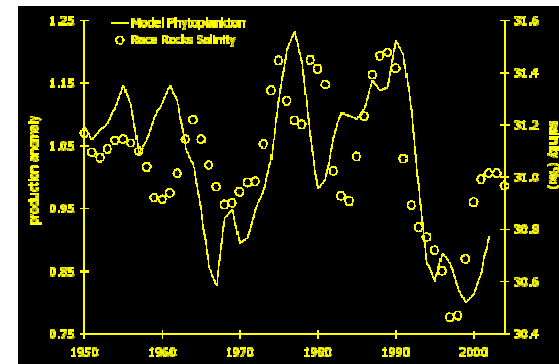
Is it environ-
mental
change?

Or, is it all
three?



PP anomaly and climate indicators

- Strait of Georgia
 - Race Rocks Salinity Feb-May
- BC shelf
 - Upwelling, May-July), 54°N
- NE Pacific
 - PDO, April-July



Preikshot (UBC FCRR) 2007

What are models used for?

- Lyne Morisette contacted registered EwE users:
325 models constructed or under construction
 - 42% ecosystem structure;
 - 30% fisheries management;
 - 11% theoretical ecology;
 - 6% protected area evaluations



Use of EwE for fisheries management

- Evaluate impact of shrimp trawling, GoCalifornia;
- Evaluate impact of bycatch, GoCalifornia;
- Shrimp bycatch issues, Gulf of Mexico FMC
- Evaluate impact of predators on shrimp, GoMexico;
- Demonstrate ecological role of species, GoMexico;
- Impact of proposed fisheries interventions, Namibia
- South Africa pelagic fisheries
- EIA of proposed fisheries interventions, Bering Sea;
- EIA of alternative TAC's, Bering Sea and GoAlaska;
- Target species response to TACs, Bering Sea
- Closed area sizing, Great Barrier Reef, Australia
- Valuation of cormorant impact, Ortobello, Italy
- Evaluation of cormorant impact, Ringkobing, Denmark

So why aren't ecosystem models used more for management?

- Lack of experience using ecosystem models for predictive purposes;
- Ecosystem modeling is for strategic management, and supplements the tactical single species assessment;
- Fisheries management process is focused on tactical management;
- Strategic decisions are virtually non-existing.

Our empirical knowledge is limited

- Habitat and environmental changes (including those caused by fishing) and intensive fishery removals create novel situations
 - We do not to understand the ‘mechanics’ of ecological response well enough to be able to predict all important responses to novel situations;
 - Make models one can play with;



Current developments

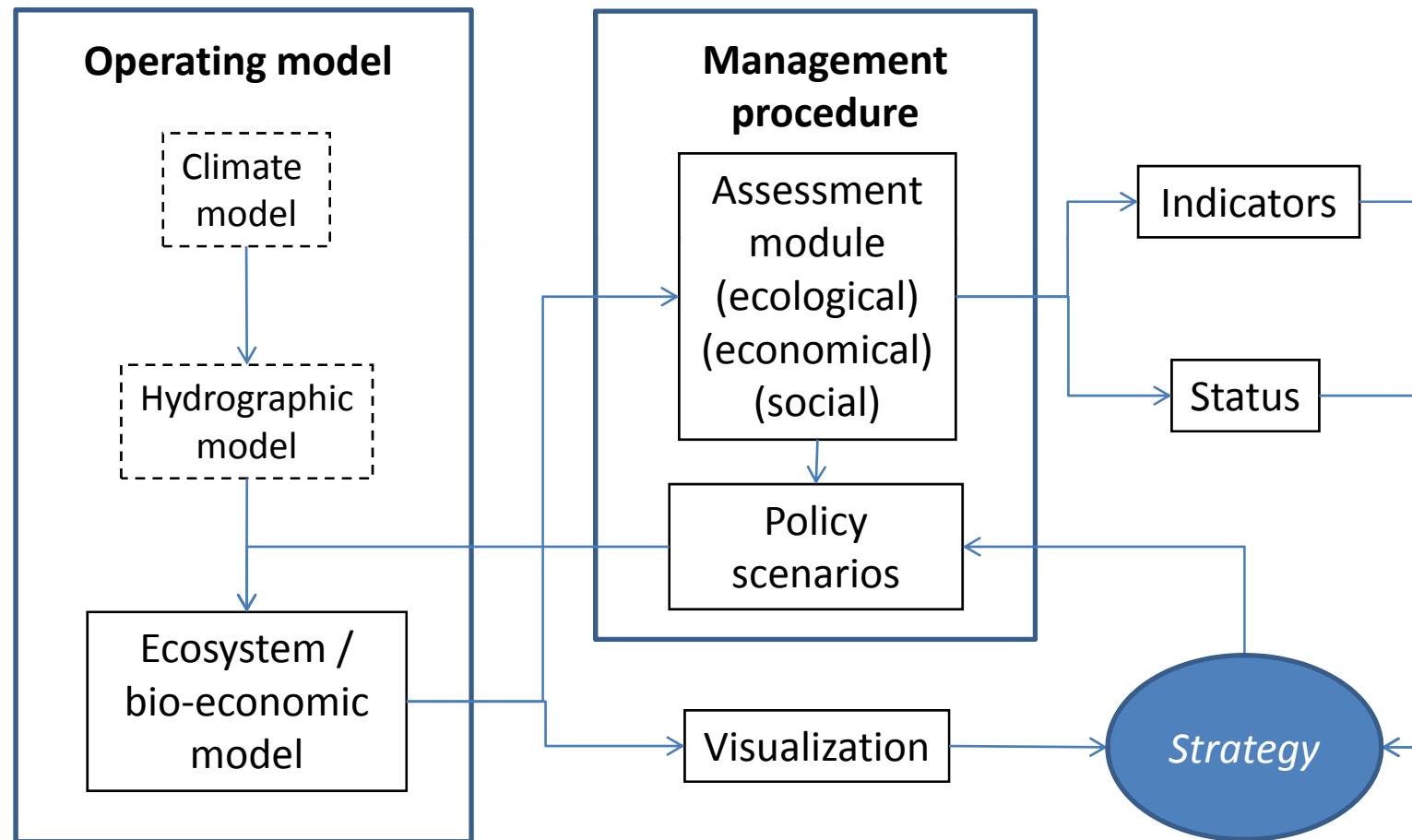
- Make Your Own Module
- Model linkages ...

Model linkages

- ROMS/NPZ and climate models
 - NOAA GFDL/Princeton
 - FLEM (2 layer hydrographic model)
 - ERSEM
- Tracking persistent pollutants & isotopes
- Spatial zoning (Ecoseed & MARXAN Bridge)
- Database-driven model generation (GEF/LME)
- Global scenario modeling (UNEP/OECD)
- Visualization and gaming: Ocean Summits
(Lenfest Ocean Futures Project)



Adaptive Management Procedure for *Ocean Summits - EwE*



The strategy is set by the participants; arrows indicate flow of information



