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Ecopath as a Means to an End: Modeling Fishing Dynamics and Marine Reserves in an Ecosystem Context

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Presentation

- **Cooperative Project**
- **Project Basics**
 - *Generalized model*
 - *Specific models*
 - *Status*
- **Where do we go from here?**

Ecopath with Ecosim

• Ecopath

- *Static, mass-balanced snapshot of ecosystem resources and their interactions*
- *Trophically linked biomass pools*

	Fishery Catches
+	Predation Mortality
+	Biomass Accumulation
+	Net Migration
+	Other Mortality
	<hr/> Production

• Ecosim

- *a complex simulation model for evaluating the impacts of different fishing regimes*

• Ecospace

- *Non-homogeneous spatial behavior*
 - Preferred habitats
 - Habitat driven migration
 - Marine reserves/zones

Ecopath Inputs

Parameter estimates

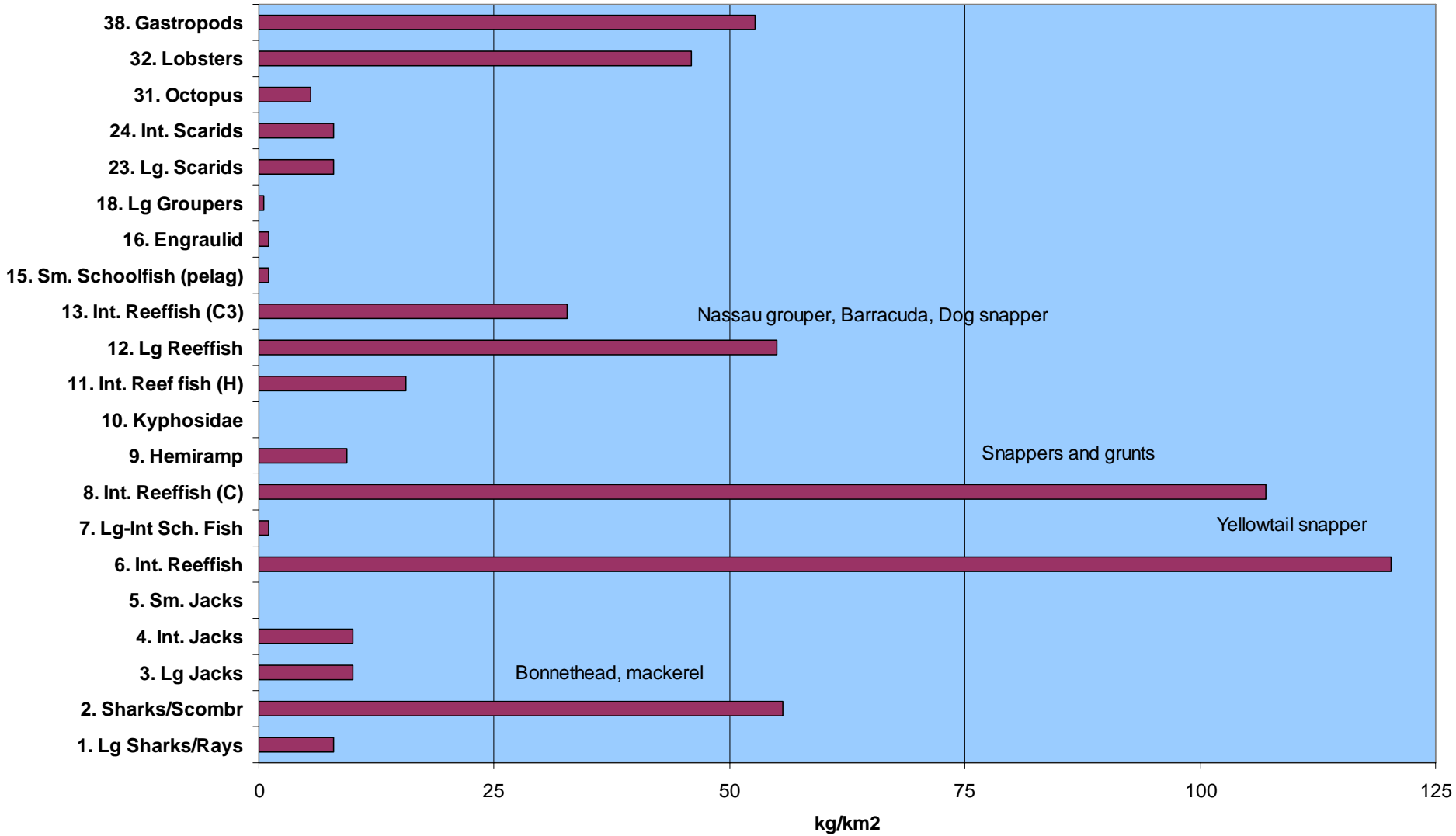
	Group name	Trophic level	Habitat area	Biomass in habitat area (t/km ²)	Biomass (t/km ²)	Prod./biom. (/year)	Cons./biom. (/year)	Ecotrophic efficiency	Production / consumption
1	F1 SHARKS/RAYS	3.84	1.000	1.000	1.000	0.240	4.900	0.962	0.049
2	F2 SCOMBR/JACKS	3.86	1.000	4.400	4.400	0.480	8.900	0.952	0.054
3	F3 SCHOOLFISHLG	3.71	1.000	20.000	20.000	0.830	12.700	0.909	0.065
4	F4 REEFFCARNBG	3.41	1.000	75.000	75.000	0.640	7.300	0.970	0.088
5	F5 SCHOOLFISHSM	3.80	1.000	30.000	30.000	1.800	20.050	0.942	0.090
6	F6 REEFFCARNSM	2.92	1.000	10.000	10.000	1.600	12.800	0.953	0.125
7	F7 BIGGROUPERS	4.10	1.000	4.000	4.000	0.370	2.300	0.817	0.161
8	F8 REEFFHERBSM	2.01	1.000	10.000	10.000	1.820	37.450	0.999	0.049
9	F9 REEFFHERBLG	2.01	1.000	100.000	100.000	1.050	22.800	1.000	0.046
10	B1 SEA BIRDS	4.61	1.000	0.015	0.015	5.400	80.000	0.163	0.068
11	R1 SEA TURTLES	2.79	1.000	0.070	0.070	0.200	3.500	0.374	0.057
12	I1 CEPHALOPODS	3.88	1.000	8.000	8.000	3.100	11.700	0.863	0.265
13	I2 ECHINODERMS	2.40	1.000	600.000	600.000	1.200	4.000	0.522	0.300
14	I3 CRUSTACEA	2.98	1.000	120.000	120.000	1.600	10.000	0.895	0.160
15	I4 WORM/MOLLUSC	2.35	1.000	430.000	430.000	2.500	7.000	0.935	0.357
16	I5 SESS.ANIMALS	2.06	1.000	1000.000	1000.000	0.800	9.000	0.947	0.089
17	I6 ZOOPLANKTON	2.80	1.000	30.000	30.000	45.000	165.000	0.896	0.273
18	I7 DECOM/MICROF	2.00	1.000	60.000	60.000	100.000	215.000	0.793	0.465
19	Phytoplankton	1.00	1.000	25.000	25.000	70.000	-	0.775	-
20	Benthic prod.	1.00	1.000	1375.000	1375.000	13.250	-	0.295	-
21	Detritus	1.00	1.000	2000.000	2000.000	-	-	0.994	-

Basic estimates | Key indices | Mortalities | Consumption | Respiration | Niche overlap | Electivity | Search rates | Fishery

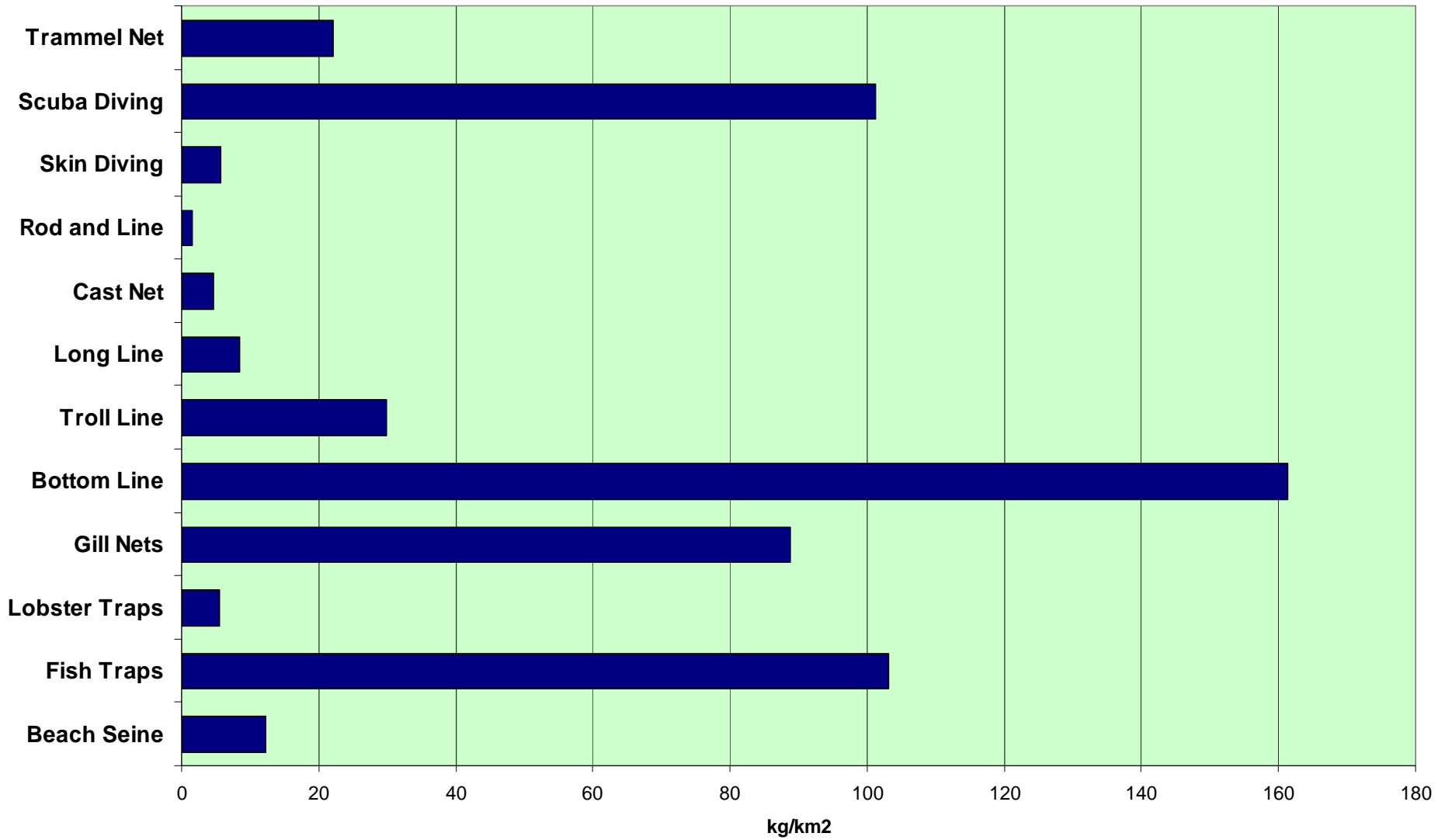
Model Trophic Groups (after Opitz)

- LGE SHARKS/RAYS C
- SHARKS/SCOMBRID
- LGE JACKS C
- INT JACKS C
- SMALL JACKS C
- INT REEFFISH C 1
- LGE-INT SCHOOLFISH P
- INT REEFFISH C 2
- HEMIRAMPHIDAE H
- KYPHOSIDAE H
- INT REEFFISH H
- LGE REEFFISH C
- INT REEFFISH C 3
- SM REEFFISH C 1
- SM SCHOOLFISH PEL
- ENGRAULIDAE H
- SM REEFFISH C 2
- LGE GROUPERS C
- INT REEFFISH C 4
- SM REEFFISH O 1
- SM REEFFISH O 2
- SM REEFFISH O 3
- LGE SCARIDAE H
- INT SCARIDAE H
- SM SCARIDAE H
- BLENNIIDAE H
- SM GOBIIDAE C
- SEABIRDS
- SQUIDS
- SEATURTLES
- OCTOPUS
- LOBSTERS
- CRABS
- SHRMP/HCRB/STOM
- SM BENTHARTHROP O
- ASTEROIDS
- ECHINOIDS
- GASTROPODS
- CHITONS/SCAPHOP
- POLY/PRIA/OPHIU
- HOL/SIP/ECH/HEM
- BIVALVES
- ASCI/BARN/BRYOZ
- SPONGES
- CORALS/ANEMONES
- ZOOPLANKTON
- DECOMP/MICROFAU
- Phytoplankton
- Benthic prod.
- Detritus

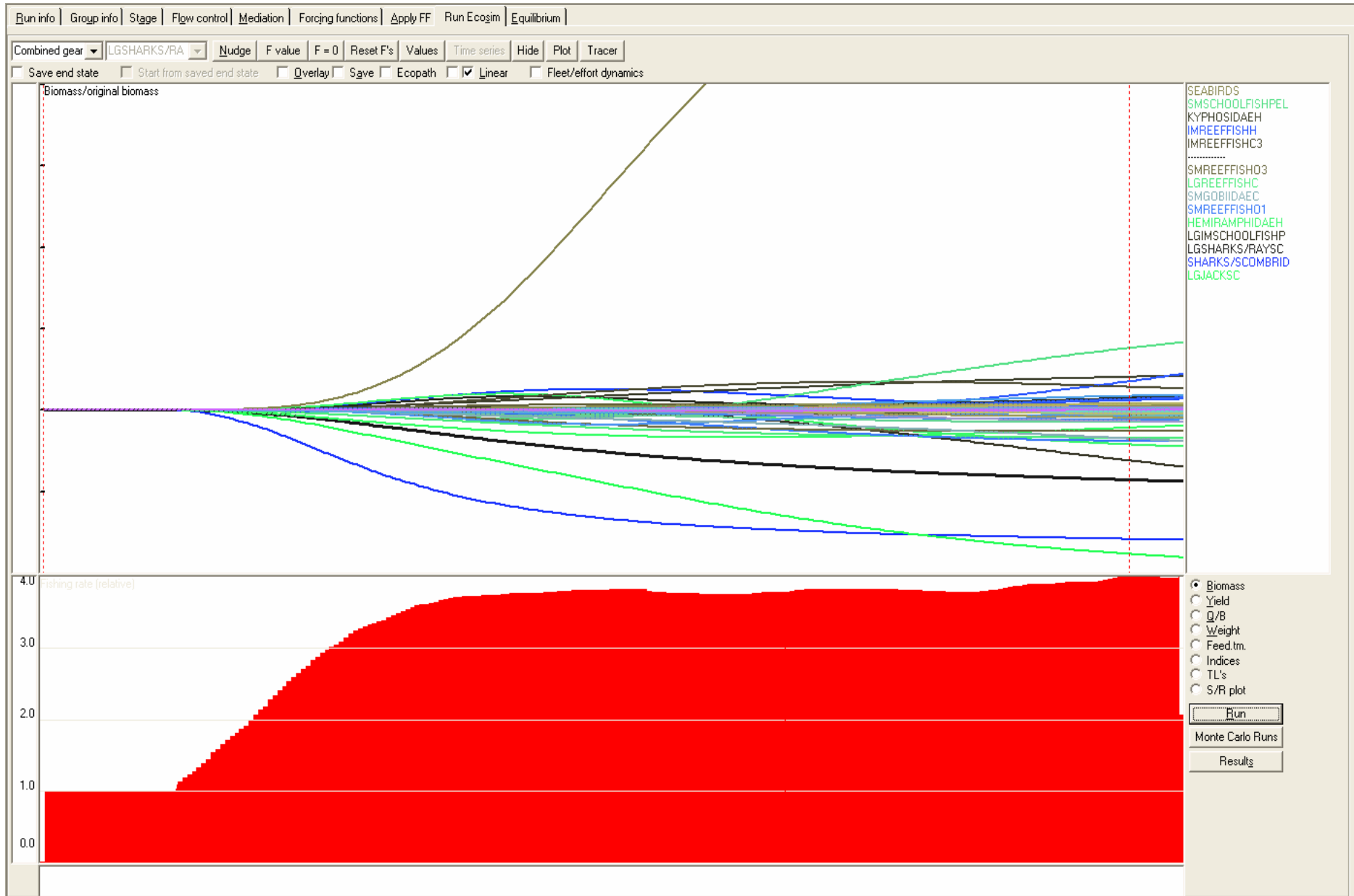
Landings by Trophic Group (2001)



Fishery Landings 2001

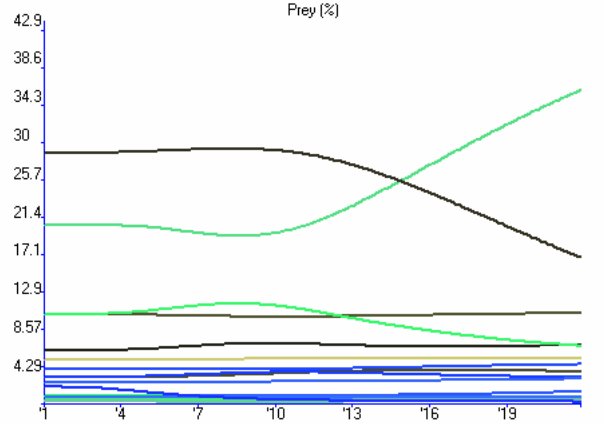
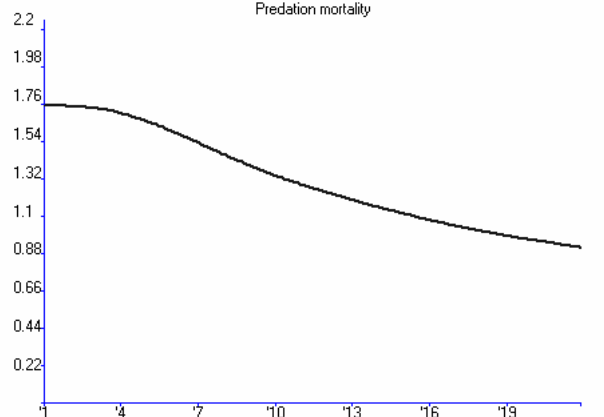
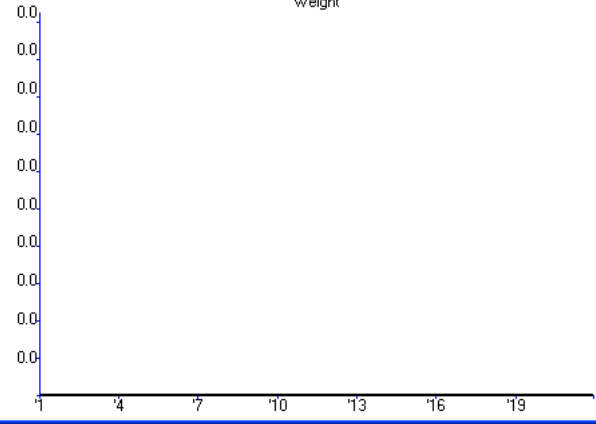
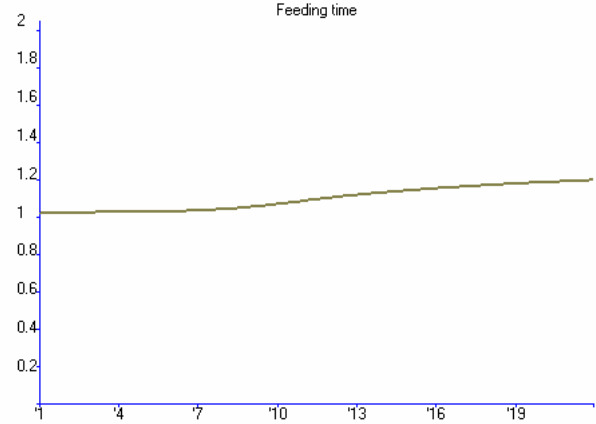
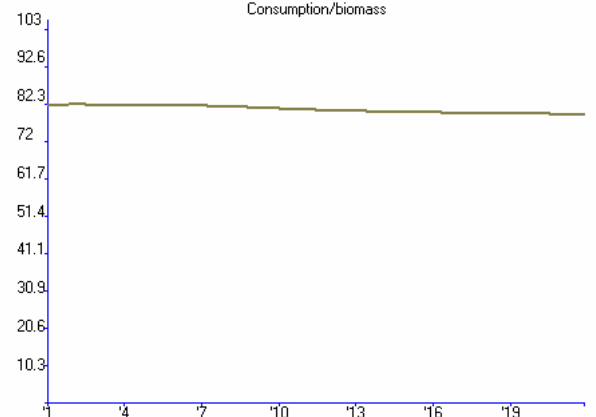
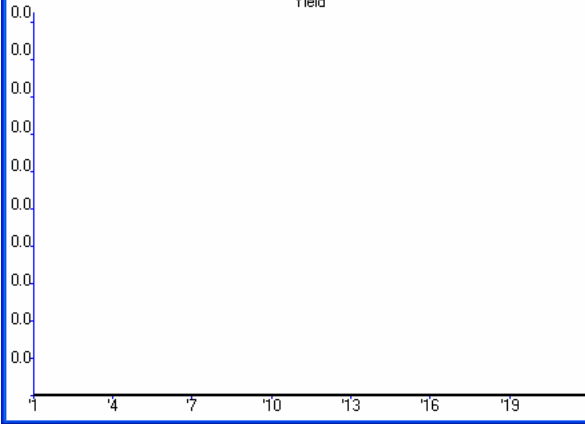
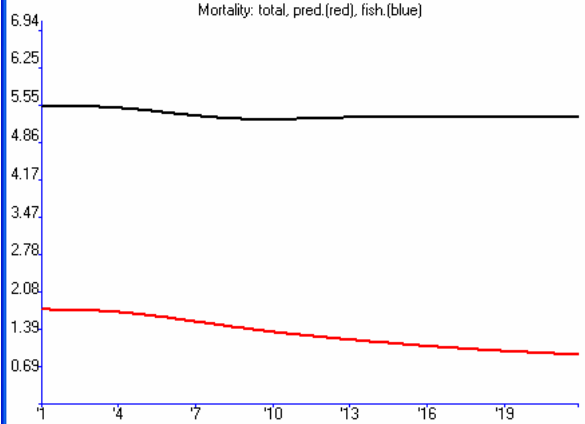
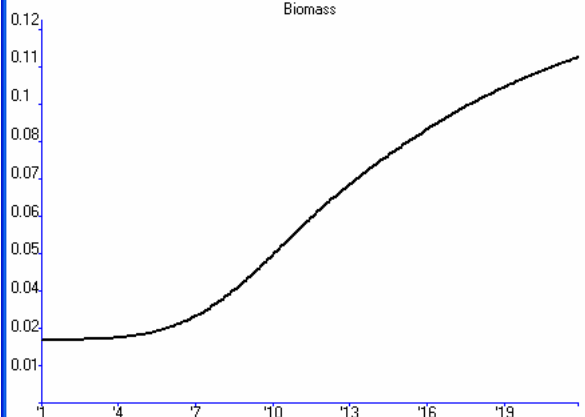


Ecosim Simulation



Save 28. SEABIRDS

SEABIRDS

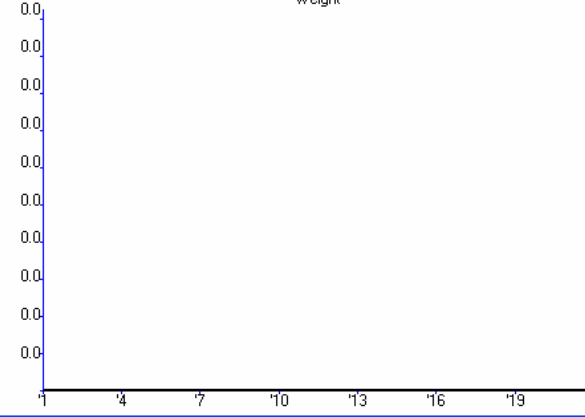
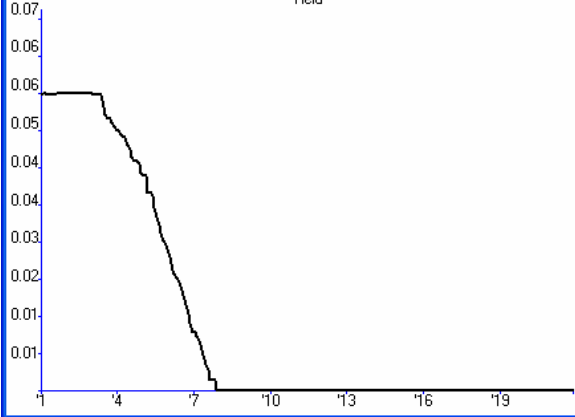
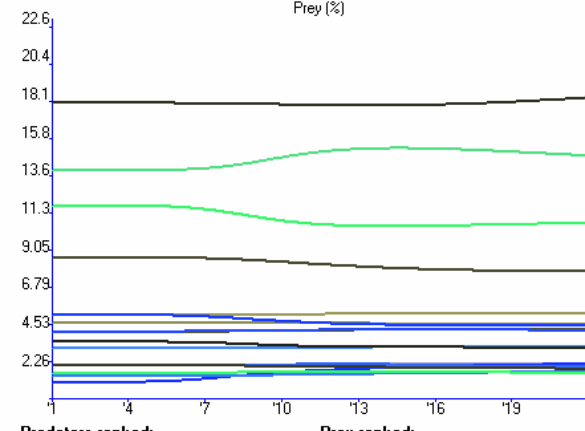
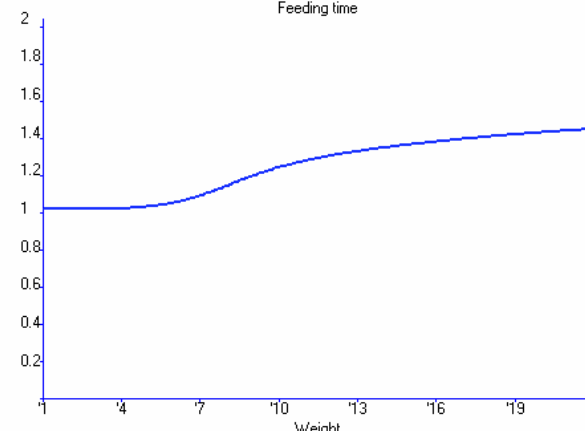
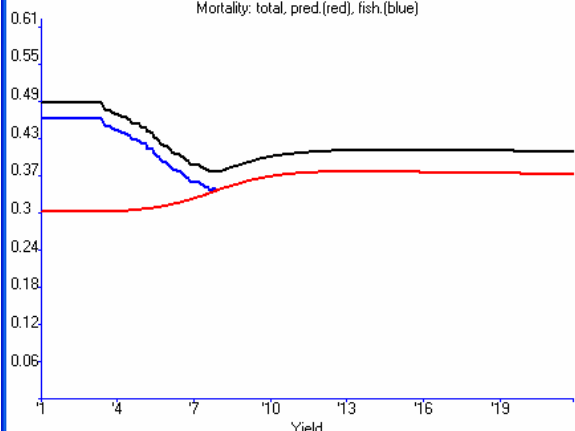
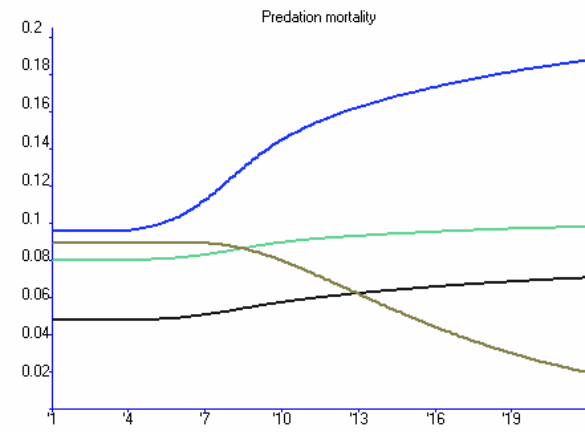
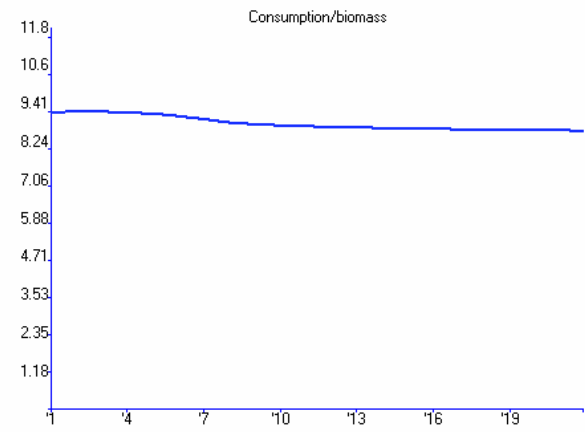
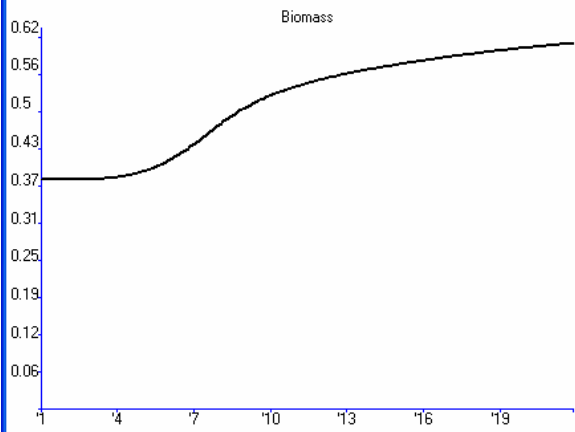


Predators ranked:
LGSHARKS/RAYSC

Prey ranked:
SMSCHOOLFISHPEL
LGIMSCCHOOLFISHP
ENGRAULIDAEH
IMJACKSC
HEMIRAMPHIDAEH
ZOOPLANKTON
IMREEFFISHC2
IMREEFFISHC3
SMJACKSC
SMREEFFISHC1
IMREEFFISHH
IMREEFFISHC1
SMREEFFISHC2
IMREEFFISHC4
IMSCARIDAEH
SMREEFFISHO1
LGREEFFISHC
SMREEFFISHO2
SHARKS/SCOMBRID

Save 2_SHARKS/SCOMBRID

SHARKS/SCOMBRID



Predators ranked:
 SHARKS/SCOMBRID
 LGGRUUPERSC
 LGSHARKS/RAYSC
 SEABIRDS

Prey ranked:
 LGIMSCHOOLFISHP
 SMSCHOOLFISHPEL
 HEMIRAMPHIDAEH
 IMREEFFISHC3
 SHRMP/HCRB/STOM
 OCTOPUSES
 SMJACKSC
 ENGRAULIDAEH
 IMREEFFISHC2
 LGSCARIDAEH
 IMJACKSC
 IMREEFFISHH
 CRABS
 SHARKS/SCOMBRID
 SMREEFFISHC1
 SMREEFFISHC2
 KYPHOSIDAEH
 SMREEFFISHO1
 IMREEFFISHC1

Optimum Fishing Pattern

Nonlinear search procedure for optimum fishing pattern over time

Search: Discount rate: 0.04 Gen. disc. rate: .1 No of runs: 1 Max # eval.: 200

Initialize using: Ecopath base F's Current F's Random F's

Search using: Fletch DFPmin

Search using Fishing rate parameter block codes (black=omit from search)

Set every gear: Set max # blocks: Years/block: 20

Use row/column number clicks, or hold mouse down and move to sketch blocks

Simulation year: 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0

Beach Seine
Fish Traps
Lobster Traps
Gill Net
Bottom Line
Troll Line
Long Line
Cast Net
Rod and Line
Skin Diving
Scuba Diving
Trammel Net

Iteration results: Objectives Effort Table

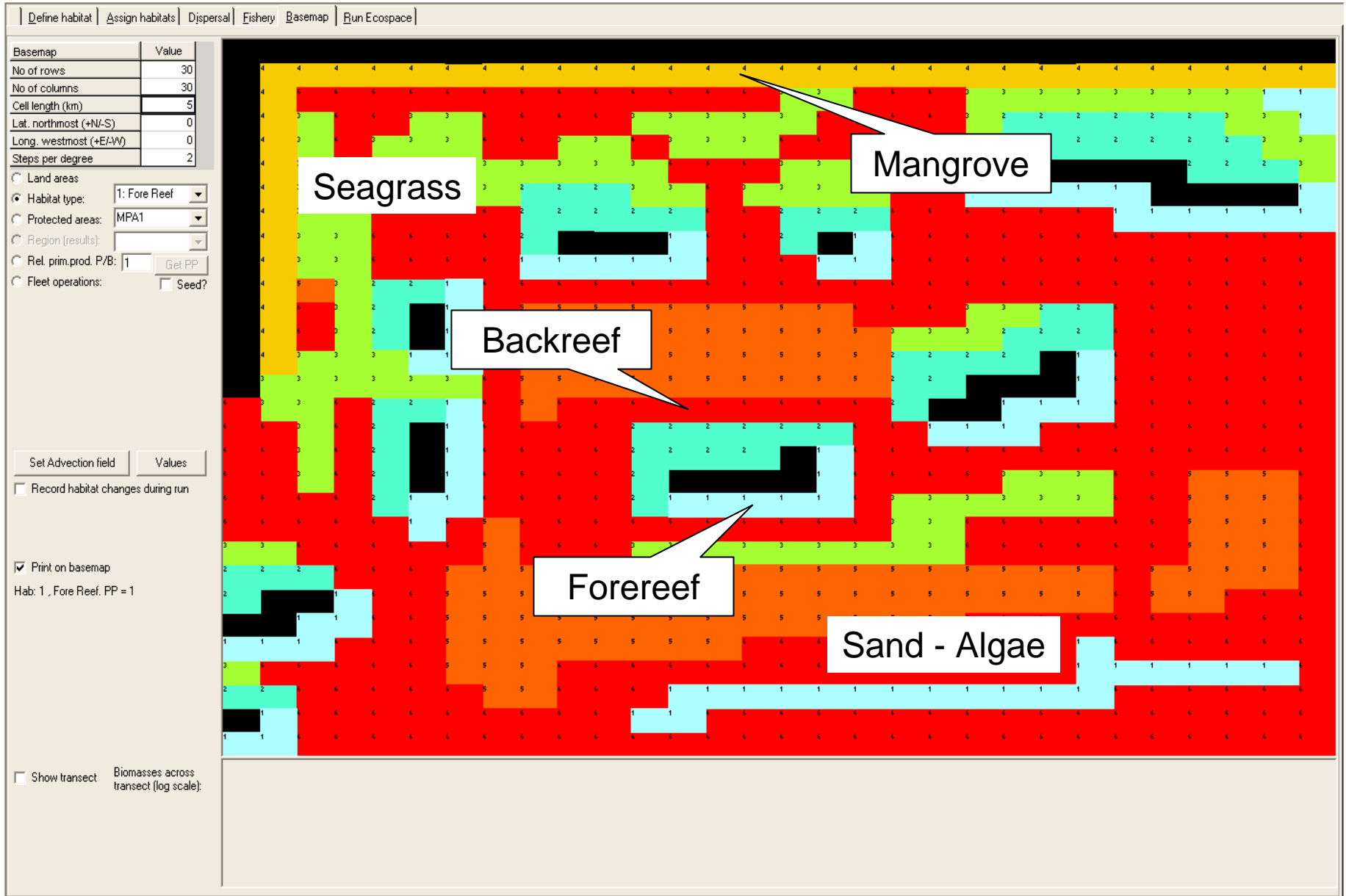
Value component	Rel. weight
Net economic value	0
Social value (employment)	0.00000
Mandated rebuilding	0.00000
Ecosystem structure	1

Fleet/gear	Jobs/catch value
Beach Seine	1
Fish Traps	1
Lobster Traps	1

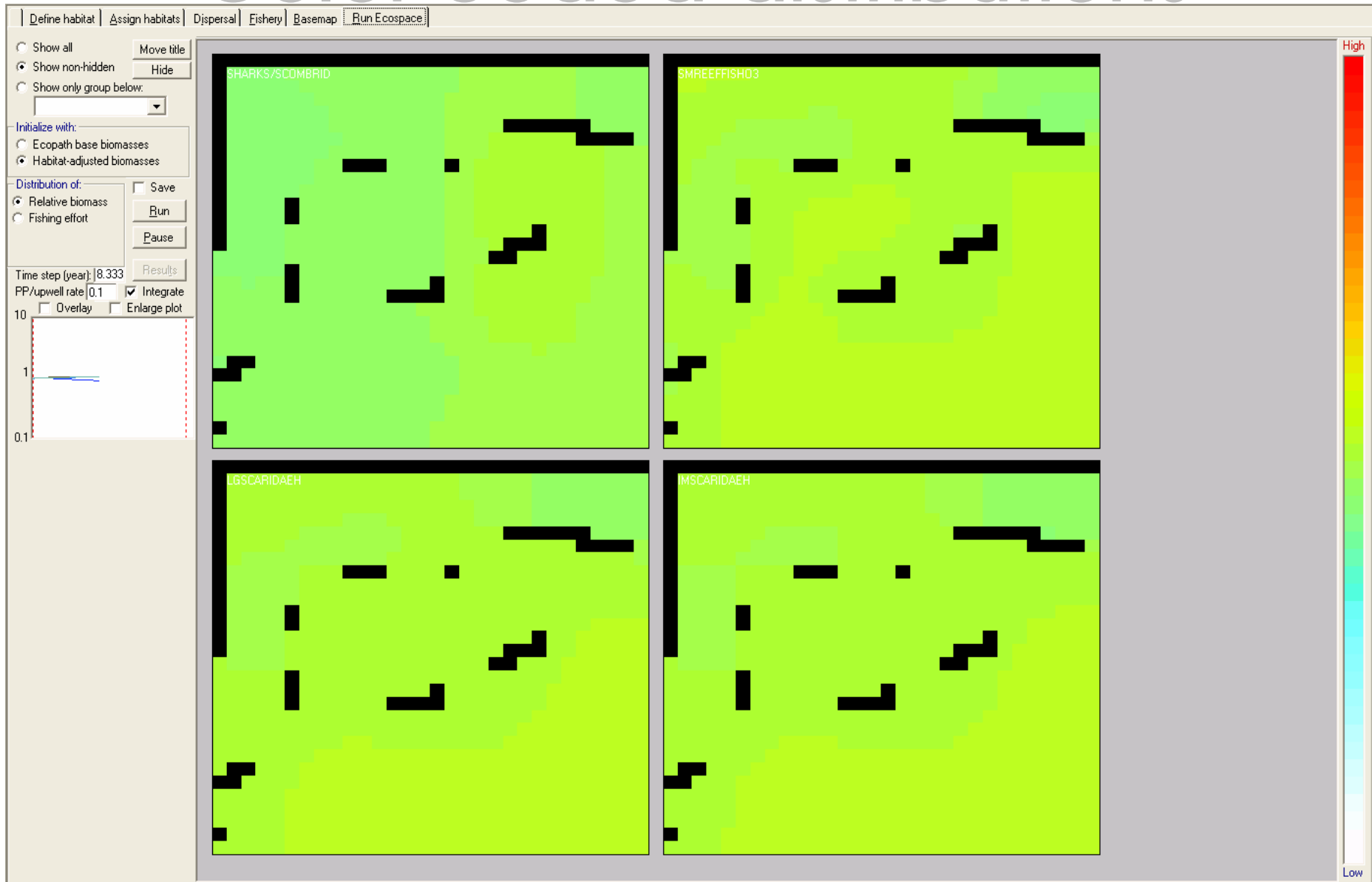
Group	Mandated rel. biom.	Structure rel. weight
LGSHARKS/RAY	0.0	4.2
SHARKS/SCOMB	0.0	3.0
LGJACKSC	0.0	2.0
IMJACKSC	0.0	0.8
SMJACKSC	0.0	1.2
IMREEFFISHC1	0.0	1.8
LGIMSCHOOLFIS	0.0	1.4
IMREEFFISHC2	0.0	0.8
HEMIRAMPHIDAI	0.0	0.8
KYPHOSIDAEH	0.0	1.6
IMREEFFISHH	0.0	1.4
LGREEFFISHC	0.0	2.6
IMREEFFISHC3	0.0	1.6
SMREEFFISHC1	0.0	0.6
SMSCHOOLFISHI	0.0	0.2
ENGRAULIDAEH	0.0	0.4
SMREEFFISHC2	0.0	0.2
LGGRDUPERSC	0.0	2.8
IMREEFFISHC4	0.0	1.8
SMREEFFISHO1	0.0	0.6
SMREEFFISHO2	0.0	0.6
SMREEFFISHO3	0.0	0.4
LGSCARIDAEH	0.0	1.2
IMSCARIDAEH	0.0	0.8
SMSCARIDAEH	0.0	1.0
BLENNIIDAEH	0.0	0.4
SMGOBIIDAEAC	0.0	0.4
SEABIRDS	0.0	0.2
SQUIDS	0.0	0.8
SEATURTLES	0.0	6.6
OCTOPUSES	0.0	0.6
LOBSTERS	0.0	1.0
CRABS	0.0	0.6
SHRMP/HCRB/S	0.0	0.4
SMBENTHARTHFI	0.0	0.2
ASTERIODS	0.0	2.0
ECHINOIDS	0.0	1.0
GASTROPODS	0.0	0.4

#Calls	Total	Econ.	Social	Mandat	Ecol.	1	2	3	4	5	6	7	8	9	10	11	12
0																	
13	0.99977	1.00945	1.00946	0.00000	0.99977	1.01005	1.01005	1.01005	1.01005	1.01005	1.01005	1.01005	1.01005	1.01005	1.01005	1.01005	1.01005
32	1.00740	0.71783	0.71773	0.00000	1.00857	0.80583	0.87854	0.91799	0.64920	0.52561	0.59914	0.92269	1.00797	0.82477	1.00876	0.84406	0.65966
47	1.00899	0.57486	0.57475	0.00000	1.01252	0.68946	0.79224	0.86154	0.47404	0.32908	0.40914	0.86536	1.00610	0.71608	1.00921	0.74456	0.49196
68	1.00899	0.57486	0.57475	0.00000	1.01252	0.68946	0.79224	0.86154	0.47404	0.32908	0.40914	0.86536	1.00610	0.71608	1.00921	0.74456	0.49196
82	1.00899	0.57486	0.57475	0.00000	1.01252	0.68946	0.79224	0.86154	0.47404	0.32908	0.40914	0.86536	1.00610	0.71608	1.00922	0.74456	0.49196
96	1.00899	0.57486	0.57475	0.00000	1.01252	0.68946	0.79224	0.86155	0.47403	0.32908	0.40914	0.86536	1.00610	0.71608	1.00922	0.74457	0.49196
110	1.00899	0.57486	0.57475	0.00000	1.01252	0.68946	0.79224	0.86155	0.47403	0.32908	0.40914	0.86536	1.00611	0.71608	1.00922	0.74457	0.49196
137	1.00920	0.58524	0.58513	0.00000	1.01287	0.75375	0.77263	0.91885	0.47237	0.31193	0.35722	0.76742	1.14003	0.77876	0.98964	0.84558	0.55139
151	1.00920	0.59050	0.59039	0.00000	1.01298	0.78205	0.76440	0.94312	0.47204	0.30550	0.33826	0.73109	1.19761	0.80591	0.98210	0.88962	0.57718
167	1.00921	0.58926	0.58915	0.00000	1.01295	0.77907	0.76974	0.94151	0.47250	0.30671	0.34323	0.74007	1.18411	0.80006	0.98225	0.87575	0.56843
185	1.00921	0.58926	0.58915	0.00000	1.01295	0.77907	0.76974	0.94152	0.47250	0.30671	0.34323	0.74006	1.18413	0.80007	0.98224	0.87577	0.56843
199	1.00921	0.58926	0.58915	0.00000	1.01295	0.77907	0.76974	0.94152	0.47250	0.30671	0.34322	0.74005	1.18413	0.80007	0.98224	0.87577	0.56843
230	1.00921	0.58926	0.58915	0.00000	1.01295	0.77907	0.76974	0.94152	0.47250	0.30671	0.34322	0.74005	1.18413	0.80007	0.98224	0.87577	0.56843
257	1.00921	0.58926	0.58915	0.00000	1.01295	0.77907	0.76974	0.94152	0.47250	0.30671	0.34322	0.74005	1.18413	0.80007	0.98224	0.87577	0.56843
283	1.00921	0.58926	0.58915	0.00000	1.01295	0.77907	0.76974	0.94152	0.47250	0.30671	0.34322	0.74005	1.18412	0.80007	0.98224	0.87577	0.56843
290	1.00921	0.58926	0.58915	0.00000	1.01295	0.77907	0.76974	0.94152	0.47250	0.30671	0.34322	0.74005	1.18412	0.80007	0.98224	0.87577	0.56843

Ecospace Base Map



Color coded distributions



Ecopath/Sim/Space

- **Data Management**
 - *Interactions*
 - Predator-Prey
 - Fisheries
 - *Compatibility*
 - Trophic Groups
 - Fishery Stats
- **Management Policy Exploration Tool**
 - *Ecosim*
 - *Ecospace*

PR-VI Ecosystem-based Mgmt.

- La Parguera Model (1970s and 2000)
- Multiple Models
 - *PR South-West vs PR North*
 - *PR East/USVI vs St. Croix*
- Adjust Data Collection
 - *Fisheries*
 - *Ecological*
 - *Diet Composition*

**Is the system the model; is
the model the system?**