



Incorporating the Ecopath modeling approach into United States fisheries management



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Summary

Whole food-web modeling approaches such as *Ecopath with Ecosim* can be used as systematic frameworks for integrating ecosystem considerations into fisheries management. Few management agencies, however, have successfully included such ecosystem approaches into their normal management process. Our goal is to explicitly incorporate *Ecopath* modeling into the promulgated fisheries management process employed by the South Atlantic Fishery Management Council. We are using a refined *Ecopath* model of the continental shelf adjacent to the Southeastern United States.

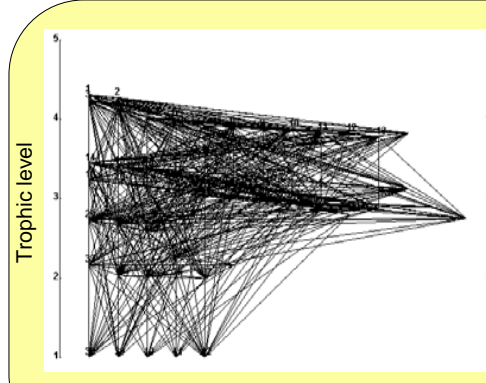


Fig. 1. Preliminary trophic web of the Atlantic continental shelf adjacent to the Southeastern United States

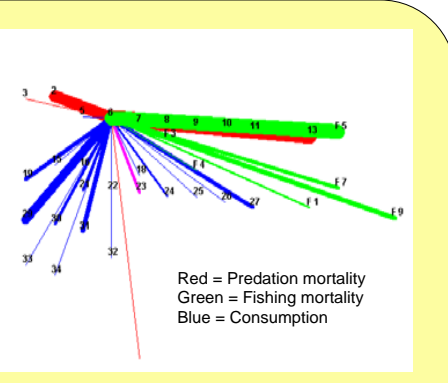


Fig. 2. Trophic interactions of groupers of the Atlantic continental shelf

Table 1. Basic parameters of the preliminary Ecopath model of the South Atlantic States continental shelf.

Group	Trophic level	OT	Biomass (t.km ⁻²)	P/B (year ⁻¹)	Q/B (year ⁻¹)	EE
1 Billfishes	4.3	0.37	0.01	0.44	1.29	0.98
2 Sharks (k. alligators)	4.3	0.30	0.10	0.43	4.18	0.63
3 Tuna	4.2	0.32	0.02	0.85	12.00	0.80
4 Toothed cetaceans	4.1	0.17	0.06	0.10	27.00	0.00
5 Mackerel	4.0	0.07	0.21	0.38	8.00	0.94
6 Groupers	4.0	0.20	0.11	0.70	5.00	0.93
7 Jacks	3.9	0.11	0.07	0.56	9.20	0.85
8 Snappers	3.9	0.23	0.13	0.57	5.40	0.93
9 Pelagic piscivores	3.9	0.27	0.23	0.86	13.50	0.84
10 Octopods	3.9	0.19	0.09	1.10	3.10	0.98
11 Demersal piscivores	3.8	0.19	0.20	0.84	8.10	0.93
12 Marine birds	3.8	0.72	0.001	0.10	80.00	0.80
13 Benthic piscivores	3.8	0.34	0.13	0.70	8.73	0.93
14 Drum and croaker	3.4	0.25	0.72	0.47	7.34	0.92
15 Benthic invertebrates	3.4	0.16	0.21	1.74	13.57	0.93
16 Squid	3.4	0.21	1.90	2.43	33.00	0.07
17 Flounder	3.3	0.15	0.45	0.30	9.46	0.93
18 Benthic ray/skates	3.3	0.45	0.17	0.40	8.96	0.77
19 Labrers	3.2	0.33	0.36	0.90	8.20	0.93
20 Hallow whalers	3.2	0.21	0.14	0.05	10.90	0.00
21 Demersals	3.1	0.06	0.11	2.60	10.00	0.98
22 Sea turtles	3.1	0.41	0.01	0.19	3.50	0.47
23 Dem. invertebrates	3.1	0.47	2.42	0.77	8.71	0.93
24 Stomatopods	3.0	0.45	2.85	1.54	7.43	0.98
25 Pelagic planktivores	3.0	0.30	0.42	0.89	8.54	0.98
26 Other fishes	3.0	0.09	22.24	0.70	7.04	0.98
27 Forage fishes	2.9	0.20	25.07	0.93	13.88	0.99
28 Idlles	2.8	0.16	0.27	40.00	80.00	0.93
29 Crabs	2.7	0.32	9.26	1.38	8.50	0.98
30 Shrimp	2.7	0.27	7.64	1.20	7.10	0.71
31 Demersal omnivores	2.6	0.38	0.80	1.47	21.87	0.93
32 Echinoderms	2.5	0.23	25.50	1.20	1.70	0.71
33 Scudic amphipods	2.2	0.14	78.81	0.80	9.00	0.85
34 Benthic macroc.	2.0	0.04	67.31	5.08	21.57	0.99
35 Bivalves	2.0	0.01	55.00	1.25	23.00	0.81
36 Manatee	2.0	0.00	0.00	0.10	36.50	0.00
37 Zooplankton	2.0	0.00	15.00	11.74	43.30	0.91
38 Microalgae	1.0	0.00	22.10	4.00	-	-
39 Microphytobenthos	1.0	0.00	37.00	33.57	-	0.30
40 Phytoplankton	1.0	0.00	2.85	33.82	-	0.99
41 Sea grasses	1.0	0.00	28.51	7.30	-	0.58
42 Detritus	1.0	0.00	318.00	-	-	0.34

Notes: Values in bold have been calculated with the Ecopath software; other values are empirically based inputs. Omnivory index = variance of prey trophic levels is denoted by OT. P/B = the ratio of production to biomass; Q/B = the ratio of consumption to biomass; EE = ecotrophic efficiency—the proportion of production not consumed or exported.

Background

Ecosystem-based fisheries management (EBFM) is the management of human activities in an aquatic ecosystem with the goal of protecting a broad set of values including those that are beyond the short term economic value of a single stock. The approach is not new (1-5), but it is emerging as the conceptual cornerstone of modern fisheries management (6-9) in response to concerns about marine and aquatic ecosystem degradation (e.g., 10, 11). Various approaches have been suggested for implementing EBFM (12-17) but whole-ecosystem modeling approaches are particularly promising (8, 18-22). Fluharty and Cyr (23) summarized an approach by the congressionally established Ecosystem Principles Advisory Panel to implement EBFM in the context of U.S. federal fisheries management. Following this approach, Field and his colleagues (24) developed an *Ecopath* model of the Northern California Current expressly for incorporation into a Fishery Ecosystem Plan for that region. Similarly, we are transforming the South Atlantic Fishery Management Council's Habitat Plan (29) into a Fishery Ecosystem Plan, in part, by integrating the *Ecopath with Ecosim* approach.

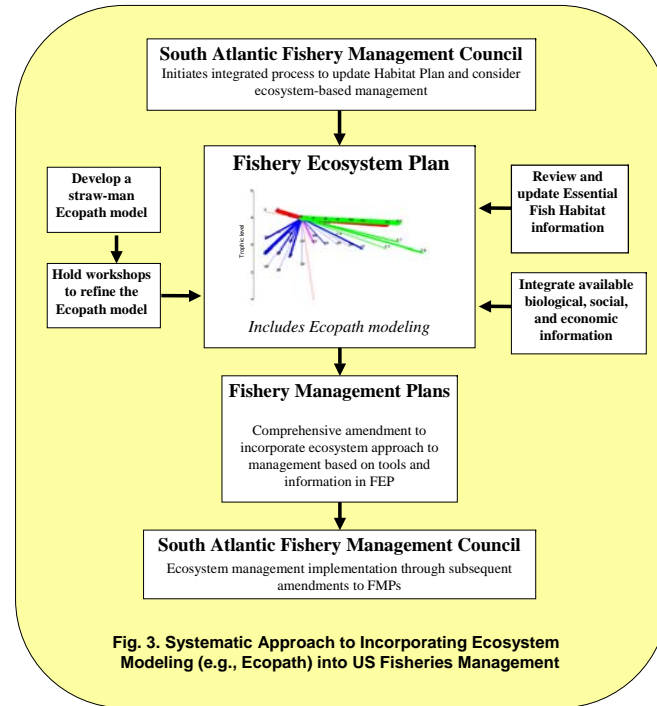


Fig. 3. Systematic Approach to Incorporating Ecosystem Modeling (e.g., Ecopath) into US Fisheries Management

Approach

A preliminary *Ecopath* model of the Atlantic continental shelf of the Southeastern United States (25) is being refined by a broad range of experts to characterize the ecosystem and explore the potential ecosystem effects of management. Incorporation of the *Ecopath with Ecosim* approach (19, 26-28) will allow the South Atlantic Fishery Management Council to provide insights into ecosystem effects of fisheries based on an integration of the best of information available. The model extends from Cape Hatteras, NC through the Florida Keys and from the upper wetlands to the 1000-m isobath.

Outlook

The refined *Ecopath* model will be explicitly incorporated into the South Atlantic Fishery Management Council's Fishery Ecosystem Plan. Thus, it will help the Council and other decision makers identify information gaps and direct future research while providing insight into ecosystem level effects of fisheries. This will facilitate the use of ecosystem modeling in the policy and management decision making process and provide a more comprehensive understanding of the biological, social, and economic impacts of fishery management actions.

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