Table 1. Summary of the NEFSC ecosystem models with notations of salient features.

		Main Purpose of Model	Major Strengths	Major Weaknesses	Stochastic or deterministic outputs	Analytical or Statistical	Primary model intent- simulation, estimation, scenario testing, pattern detection, etc.	Static or Dynamic	Predictions or Forecasts (Y or N)	(Tactical, Strategic, Both, Heuristic, N/A) output use wrt Mgt Advice	Major Assumptions	Reference/s	Empahsized in this Review (Y or N)
Model Class	ESAM MRMs- Ecology												
Model	S-R	Augment SS Assessment Models with Ecological Interactions	Enhanced ecological realism; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context; misses other processes and dynamics	Both	Both	Estimation	Both	Y	Tactical	A stock-recruitment relationship exists and can be fitted; predation or cannibalism is distinct from depensation/compensation	Tyrrell et al. 2011, Lucey & Alade unpubl. data	N
Model	SS Prod	Augment SS Assessment Models with Ecological Interactions	Enhanced ecological realism; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context; misses other processes and dynamics	Both	Both	Estimation	Both	Y	Tactical	Usual for production models, esp. some equilibrium assumptions; consumption is equal to or greater than fisheries removals, has a distinct pattern/trend than fisheries removals, helps scale magnitude of pop estimates	Tyrrell et al. 2011, Link & Idoine 2009, Moustahfid et al. 2009a, NEFSC 2007a, Overholtz and Link 2007, Overholtz et al. 1999	N
Model	Age Structured	Augment SS Assessment Models with Ecological Interactions	Enhanced ecological realism; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context; misses other processes and dynamics	Both	Both	Estimation	Both	Y	Tactical	Usual for age/stage structured models; consumption-at-age is estimable; consumption is equal to or greater than fisheries removals, has a distinct pattern/trend than fisheries removals, helps scale magnitude of pop estimates	Tyrrell et al. 2011, Overholtz et al. 2008, Moustahfid et al. 2009b, NEFSC 2011, NEFSC 2010	N
Model	Ecological Footprints	Context for SS Assessment Models with Ecological Interactions- Usually consumption	Enhanced ecological realism, based on copious FH data	Mainly just contextual	Deterministic	Statistical	Estimation	Both	N	Heuristic	Consumption estimates are representative of the population; parameters are reasonable, esp. Beta about 0.11 based on experiments and sensitivity analyses	Tyrrell et al. 2007, NEFSC 20007b, Overholtz and Link 2007, NEFSC 2010b, DFO 2010	N

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		Main Purpose of Model	Major Strengths	Major Weaknesses	Stochastic or deterministic outputs	Analytical or Statistical	Primary model intent-simulation, estimation, scenario testing, pattern detection, etc.	Static or Dynamic	Predictions or Forecasts (Y or N)	(Tactical, Strategic, Both, Heuristic, N/A) output use wrt Mgt Advice	Major Assumptions	Reference/s	Empahsized in this Review (Y or N)
Model Class	ESAM MRMs- Environmental												
Model	S-R	Augment SS Assessment Models with Environmental Considerations	Enhanced environmental realism; common outputs as SS models	Env-Fish relationships tend to decouple; Precision vs Accuracy Uncertainty Debate in SS Assessment Context; misses other processes and dynamics	Both	Both	Estimation	Both	Y	Tactical	A stock-recruitment relationship exists and can be fitted; environmental drivers are distinct from depensation/compensation; environmental covariates imply an understood mechanism	Hare et al. 2010, Keyl & Wolff 2008	N
Model	SS Prod	Augment SS Assessment Models with Environmental Considerations	Enhanced environmental realism; common outputs as SS models	Env-Fish relationships tend to decouple; Precision vs Accuracy Uncertainty Debate in SS Assessment Context; misses other processes and dynamics	Both	Both	Estimation	Both	Y	Tactical	Usual for production models, esp. some equilibrium assumptions; environmental covariates imply an understood mechanism; environmental covaraties provide distinct pattern/trend in addition to fisheries	Keyl & Wolff 2008	N
Model	Age Structured	Augment SS Assessment Models with Environmental Considerations	Enhanced environmental realism; common outputs as SS models	Env-Fish relationships tend to decouple; Precision vs Accuracy Uncertainty Debate in SS Assessment Context; misses other processes and dynamics	Both	Both	Estimation	Both	Y	Tactical	Usual for age/stage structured models; environmental covariates imply an understood mechanism; environmental covaraties provide distinct pattern/trend in addition to fisheries	Keyl & Wolff 2008	N

Table 1, continued. Summary of the NEFSC ecosystem models with notations of salient features.

			Main Purpose of Model	Major Strengths	Major Weaknesses	Stochastic or deterministic outputs	Analytical or Statistical	Primary model intent- simulation, estimation, scenario testing, pattern detection, etc.	Static or Dynamic	Predictions or Forecasts (Y or N)	(Tactical, Strategic, Both, Heuristic, N/A) output use wrt Mgt Advice	Major Assumptions	Reference/s	Empahsized in this Review (Y or N)
Model Class	Mutlispecies MRMs													
	Model	MS PROD	Simulate BRPs for multiple SS that include various interactions- Ecological	Enhanced ecological realism; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context	Both	Analytical	Simulation	Dynamic	Y	Both	Prey switching is always possible: no feedback on predator abundance by prey; group and system carrying capacities can be exceeded given unrealistic parameterization; functional form of spp interactions is loosely Lotka-volterra and fishing is linear	Gamble and Link 2009	Y
	Model	MSYPR	Estimate BRPs for multiple SS that include various interactions- Technical	Enhanced ecological realism; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context; can miss other processes and dynamics	Deterministic	Analytical	Estimation	Dynamic	N	Both	Stock-recruitment relationships exist and can be estimated; technical interactions are consistent across gears	Murawski 1984	N
	Model	MVTS-Gompertz	Nonlinear, Non parameteric estimate BRPs for multiple SS that include various interactions- Ecological	Enhanced ecological realism; minimal statistical assumptions; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context; can miss other processes and dynamics	Stochastic	Statistical	Estimation	Dynamic	Y	Tactical	Intrinsically linear dynamics	Fogarty and Liu in prep.	Y
	Model	MS SPMW	Estimate BRPs for multiple SS that include various interactions- Ecological	Enhanced ecological realism; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context; can miss other processes and dynamics	Both	Analytical	Estimation	Dynamic	Y	Tactical	Usual for production models, esp. some equilibrium assumptions; ecological interactions have a distinct pattern/trend than fisheries removals, helps scale magnitude of pop estimates	Link et al. 2010, Mueter & Bohyaboy & Bundy et al. unpubl. data	Y
	Model	MSVPA-X	Estimate BRPs for multiple SS that include various interactions- Ecological	Enhanced ecological realism; common outputs as SS models	Precision vs Accuracy Uncertainty Debate in SS Assessment Context; can miss other processes and dynamics	Both	Statistical	Estimation	Dynamic	Y	Both	Usual for age/stage structured models; feeding sub-model assumes functional form of Type II or III functional response; selectivity of prey is primarily size-based, but with some type preferance; mortalities are separable across fleets and predators; consumption helps scale magnitude of pop estimates	Tyrrell et al. 2008, Garrison et al. 2010, NEFSC 2006, Garrison and Link 2004, White et al. 2003	N

Table 1, continued. Summary of the NEFSC ecosystem models with notations of salient features.

		Main Purpose of Model	Major Strengths	Major Weaknesses	Stochastic or deterministic outputs	Analytical or Statistical	Primary model intent- simulation, estimation, scenario testing, pattern detection, etc	Static or Dynamic	Predictions or Forecasts (Y or N)	(Tactical, Strategic, Both, Heuristic, N/A) output use wrt Mgt Advice	Major Assumptions	Reference/s	Emphasized in this Review (Y or N)
Model Class	Aggregate Production												
Model	AggPROD v of MS PROD	Simulate BRPs for Aggregate Groupings	Aggregate Properties Conserved, Simple Data Needs, Scenario Testing; common outputs as SS models	Amalgamating across spp may obfuscate life history factors	Both	Analytical	Simulation	Dynamic	Y	Tactical	Prey switching is always possible: no feedback on predator abundance by prey; aggregate properties of groups do not overly amalgamate spp information	Gamble and Link 2009, Link 2003	Y
Model	ASP-SPMW	Estimate BRPs for Aggregate Groupings	Aggregate Properties Conserved, Simple Data Needs, Scenario Testing; common outputs as SS models	Amalgamating across spp may obfuscate life history factors	Both	Statistical	Estimation	Static	N	Tactical	Usual for production models, esp. some equilibrium assumptions; covariates help scale magnitude of pop estimates; aggregate properties of groups do not overly amalgamate spp information	Mueter and Megrey 2006, Link et al. 2010	Y
Model	ASP-SPMW-Dynamic	Estimate BRPs for Aggregate Groupings	Aggregate Properties Conserved, Simple Data Needs, Scenario Testing; common outputs as SS models	Amalgamating across spp may obfuscate life history factors	Both	Analytical	Estimation	Dynamic	Y	Tactical	Covariates help scale magnitude of pop estimates; aggregate properties of groups do not overly amalgamate spp information; no equilibrium assumptions	Bohaboy et al. unpubl. data, Link et al. 2010	Y
Model	Agg v of ASPIC	Estimate BRPs for Aggregate Groupings	Aggregate Properties Conserved, Simple Data Needs, Scenario Testing; common outputs as SS models	Amalgamating across spp may obfuscate life history factors	Both	Analytical	Estimation	Dynamic	Y	Tactical	Usual for production models, esp. some equilibrium assumptions; covariates help scale magnitude of pop estimates; aggregate properties of groups do not overly amalgamate spp information	Overholtz et al. 2008	Y
Model	Agg Mod - Overholtz/SAS	Estimate BRPs for Aggregate Groupings	Aggregate Properties Conserved, Simple Data Needs, Scenario Testing; common outputs as SS models	Amalgamating across spp may obfuscate life history factors	Both	Statistical	Estimation	Dynamic	N	Tactical	Usual for production models, esp. some equilibrium assumptions; covariates help scale magnitude of pop estimates; aggregate properties of groups do not overly amalgamate spp information	Overholtz et al. unpubl. Data	Y
Model	Agg Testing of MS PROD	Simulate BRPs for Aggregate Groupings	Aggregate Properties Conserved, Scenario Testing; common outputs as SS models	Amalgamating across spp may obfuscate life history factors	Stochastic	Analytical	Simulation	Dynamic	Y	Heuristic	Underlying dynamics of MS-PROD are able to be amalgamated into different groups; some equilibrium assumptions; mainly minimal as a similulator	Gaichas, Fogarty et al. unpubl. data	N

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			Main Purpose of Model	Major Strengths	Major Weaknesses	Stochastic or deterministic outputs	Analytical or Statistical	Primary model intent- simulation, estimation, scenario testing, pattern detection, etc.	Static or Dynamic	Predictions or Forecasts (Y or N)	(Tactical, Strategic, Both, Heuristic, N/A) output use wrt Mgt Advice	Major Assumptions	Reference/s	Emphasized in this Review (Y or N)
Model Class	Energy Transfers (TL transfer, food web, network, etc.)													
	Model	Linear Production Potential	Estimate Fishery Production Potential	Aggregate Properties Conserved	Amalgamating across spp may obfuscate life history factors	Deterministic	Statistical	Pattern Detection	Static	N/A	Heuristic	Static transfer efficiencies across TLs; amalgamated properties within TL; catches distributed precisely across TL; PP estimable and partionable among new and recycled	Fogarty et al. 2008, NEFSC 2008	Y
	Model	Stochastic Production Potential	Estimate Fishery Production Potential	Aggregate Properties Conserved	Amalgamating across spp may obfuscate life history factors	Stochastic	Statistical	Estimation	Static	Y	Tactical	Variable transfer efficiencies across TLs; amalgamated properties within TL; catches distributed precisely across TL; PP estimable and partionable among new and recycled	Fogarty et al. unpubl. data, Fogarty et al. 2008	Y
	Model	Ecopath	Estimate Fishery Production Potential; Network Structure	User Friendly, good balancing tools	Too user friendly, hard to tell when balancing complete	Deterministic	Analytical	Estimation	Static	N/A	Strategic	Mass balance constraint; equilibrium assumption; vital rates germane as amalgamated across groups; transfers among groups reasonable estimatable/verifiable; balancing based off of multiple criteria here, not just EE	Link et al. 2006, 2008a, 2008b, 2009, Gaichas et al. 2009, Link 2010, Byron et al. in press; Walters et al. 1997; Christensen and Pauly 1992	Y
	Model	Econetwrk	Estimate Fishery Production Potential; Network Structure	User Friendly, good balancing tools	Too user friendly, hard to tell when balancing complete	Deterministic	Analytical	Estimation	Static	N/A	Strategic	Mass balance constraint; equilibrium assumption; vital rates germane as amalgamated across groups; transfers among groups reasonable estimatable/verifiable; balancing based off of multiple criteria here, not just R/B	Link et al. 2006, 2008a, 2008b, 2009; Ulanowicz 2004	Y
	Model	GOMAGG	Estimate Fishery Production Potential; Network Structure	Flexible/adaptable to myriad scenarios; based upon tuned networks	Not user friendly, assumptions on donor control not widely used in fisheries	Deterministic	Analytical	Simulation	Dynamic	Y	Strategic	Mass balance constraint; donor-controlled dynamics; vital rates germane as amalgamated across groups; transfers among groups reasonable estimatable/verifiable	Overholtz & Link 2009	N
	Model	Topological Webs	Explore food web structure	Presence or absence needed; based on FH copious data	Not widely used nor applicable as DSS in fisheries	Deterministic	Statistical	Pattern Detection	Static	N/A	N/A	Linkages among groups detectable; network structure representative	Link et al. 2005, Link 2002, Link 1999	N

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Model Class	Full System													
	Model	Atlantis	Simulate E2E full marine ecosystem	Flexible/adaptable to myriad scenarios; able to handle multiple processes, factors, and functional forms; highly modular; very inclusive	Not user friendly; very onerous to parameterize, initialize, and calibrate	Both	Analytical	Simulation, Scenario Testing	Dynamic	Y	Strategic	An entire ecosystem can modeled concurrently; myriad processes have multiple functional forms and these can be aptly chosen; many for each specific process being modeled	Link et al. 2010, Fulton et al. in press, Link et al. in press, Fulton et al. 2004	Y
Model Class	Misc													
	Model	AAC	Estimate alpha ijs (spp interaction terms)	Addresses a commonly needed but hard to estimate parameter	Requires inputs that may not be extant	N/A	N/A	Calculate Parameters	Static	N/A	N/A	Growth rate, clearance rate/handling time, assimilation efficiency & consumption rate all have requisite info avaible and are estimable; assumes a Type II functional response of feeding, with variable forms available but harder to calculate	Gamble & Link unpubl. data	N
	Model	Donut Selectivity Model	Estimate diet composition	Estimates DC based on 1st principles; surprisingly accurate; simple to use	Only gives selectivity if no prey field relative abunance available	N/A	N/A	Calculate Parameters	Static	N/A	N/A	Just provides preference in absence of ambient prey field (relative proportion); underlying framework based off of Hollings components of predation	Link 2004, Link & Keen 1999	N
	Model	PSA	Determine susceptibility of biota; DSS	Straightforward ranking	Overly simplistic rankings or categories can lead towards scores tending towards central estimates	Deterministic	N/A	Estimation	Static	N/A	Strategic	Risk, susceptability, and productivity can be deconstructed into salient, component features; there is enough contrast among spp to delinate levels of risk; the ranking categories are sufficient to detect risk	Patrick et al. 2010, 2009	N
	Model	LeMans	Simulate size (length) structure of food web	Explores dynamics based on size structure	Missing other dynamics	Deterministic	Analytical	Simulation	Dynamic	Y	Heuristic	Dynamics of a fish community are driven largely by size of spp; else minimal as a simulating tool	Hall et al. 2006	N
	Model	Size Spectra	Estimate size structure of food web	Based on copious data; Explores size structure	Missing other dynamics	Deterministic	Statistical	Pattern Detection	Static	N/A	Heuristic	Decay of abunance with size is due to known mechanisms; change in rate/slope represents perturbations; slope is robust in aquatic ecosystems	Methratta & Link 2006, Link 2005	N

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Model Class	Misc												
Model	CCA/CanCorr	MV Statistics to explore relationships among response & explantory variables	Based on copious data	Usual MV statistical assumptions	Deterministic	Statistical	Pattern Detection	Static	Y	N/A	MV normality and linearity; minimal collinearity and redundancy; statistically significant canonical relationships not necessarily causal	Link et al. 2002, Link et al. 2009a	N
Model	DFA/MAFA	MV TS Statistics to explore relationships among response & explantory variables	Based on copious data	Usual MV statistical assumptions	Deterministic	Statistical	Pattern Detection	Static	Y	N/A	MV normality; minimal collinearity and redundancy; signicant canonical time series combined represent common responses, but not necessarily causal from covariates	Nye et al. 2009, Shackell et al. unpubl. data, Link et al. 2009b	N
Model	PCA/MDS	MV Statistics to explore relationships among variables	Based on copious data	Usual MV statistical assumptions	Deterministic	Statistical	Pattern Detection	Static	N	N/A	MV normality and linearity for PCA, more robust for non-parametric MDS; minimal collinearity and redundancy; fairly robutst methods to detect patterns	Link et al. 2002, Methratta & Link 2006	N