

EwE tools for MSP – EwE model guidelines for MSP gameplay

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1 Introduction

EwE models need to adhere to specific rules when running in the Maritime Spatial Planning Challenge framework, where temporal drivers are replaced by game player actions, and specific environmental pressures need to impact the ecological model in realistic fashion.

Although scientific accuracy should be maintained as much as possible, EwE models will require modifications to be made fit for running within the MSP framework. For instance, the MSP framework is a spatial-temporal explicit model requiring fast run times, which limits the number of functional groups and fleets in a model. MSP game players will introduce external perturbations to Ecospace to which the Ecospace model will need to respond with ecological realism. This requires introduction of responses to new external drivers, but this also means that the EwE scenario cannot run with any type of conventional environmental or fishing forcing.

This document stipulates these rules for EwE modellers wishing to make their models fit for MSP gameplay.

2 Model guidelines

2.1 Choice of model

To provide scientific credibility for the ecological component of the MSP framework, only consider using EwE models for MSP gameplay that:

- Are representative of the MSP game play scenario by covering the same area and period;
- Have been proven ecologically sound (peer-reviewed, fitted to time series, or validated by other means);
- Have been fitted to time series;
- Capture all trophic levels in the food web, and fleets of interest for the MSP gameplay

2.2 Ecopath

When reworking an EwE model for MSP purposes, Ecopath needs to meet the following criteria:

1. The model balances;
2. The number of functional groups in the model should be kept as low as possible to ensure fast Ecospace run times. As an approximation, a model should probably have twenty-five, and not have more than thirty, functional groups covering all trophic levels;
3. The functional groups in the model must define the simplest possible representative, robust and resilient food web;
4. The functional groups in the model must be relevant to address MSP game objectives;
5. The functional groups in the model must be able to provide desired MSP game outputs;
6. The number of fishing fleets should be kept as low as possible to ensure fast Ecospace run times;
7. Each fishing management unit relevant to the MSP game objectives must be represented by an individual fishing fleet;
8. Biomass accumulation should be avoided where possible;

9. The model is rebuilt according to best practices guidelines (Heymans et al., 2016), and is validated using PreBal diagnostics (Link, 2010).

2.3 Ecosim

When reworking a EwE model for MSP purposes, Ecosim needs to meet the following criteria:

1. After restructuring the Ecopath functional groups and fleets, the model should be fitted to time series again;
2. After this fitting, all temporal drivers should be removed: time series will not be loaded for the MSP game and all forcing functions (including fishing effort and fishing mortality) should be reset to 1;
3. Mediation effects and egg productions are left in place;
4. Vulnerabilities resulting from the model fitting are left in place;
5. The model runs flat without temporal drivers.

2.4 Ecospace

When reworking a EwE model for MSP purposes, Ecospace needs to meet the following criteria:

1. The Ecospace map should correspond to the MSP game area with just enough resolution to see 'local' effects, but still ensuring fast run times. As an approximation, the map should not exceed 100x100 cells;
2. The Ecospace scenario should be set to run for a long time, longer than any conceivable MSP gameplay duration. As a recommendation, Ecospace should be set to run for 1000 years.
3. Ecospace must run at 12 time steps per year;
4. The Ecospace fishing model should be set to "predict effort", and should use standard effort multipliers of 1 for each fleet;
5. All external spatial-temporal drivers should be removed;
6. Ecospace groups can be spatially confined to observed distribution ranges via habitat affinity and/or environmental responses;
7. Environmental drivers such as "Noise", "Surface disturbance", and "Bottom disturbance" limit the usefulness of cells to functional groups, affecting the foraging capacity of these groups through the Ecospace habitat foraging capacity model. Add all driver layers delivered by the MSP game to your scenario, and make sensitive groups respond via functional responses;
8. Habitats such as "Artificial Substrate" increase the usefulness of cells to functional groups, increasing habitat surface in cells. Through habitat affinity this habitat must impact the foraging capacity model of benefitting functional groups. Add all artificial habitats to your Ecospace scenario and set habitat affinities;
9. For every fishing fleet separately managed in the MSP game, the Ecospace scenario must contain a dedicated MPA where that fleet is not allowed to fish (but all other fleets are).

2.5 MSP configuration

Using the MSP tools plug-in for EwE, Ecospace and MSP should be connected as follows:

- All relevant MSP pressures are connected to their Ecospace driver counterparts;
- All relevant MSP ecological outputs are populated from Ecospace estimates;

- The Ecospace model can include a spin-up period of a configurable number of years to ensure stable starting conditions;

When configuring a model for MSP game play, consider the following:

- Ecospace driver layers must contain start-up pressure content, as computed from the spatial input layers to the MSP game;
- Run the model and note the time step that Ecospace takes to stabilize. The spin-up period length (in years) must cover this time step to ensure that there are no significant fluctuations in the ecology when the game starts and users take no actions. Enter this spin-up period length in MSP tools;
- Functional groups display “ecologically realistic” distributions in accordance to available observation data around the MSP start year. This realism includes:
 - realistic magnitude and speed of decline given a certain pressure
 - realistic speed of recovery when the pressure is removed
 - realistic cascade effects through the food-web
 - realistic resilience of the system to high pressures, for limited time, and realistic collapse and lack of recovery for excessive pressure, or high pressure sustained for a long time
- In consultation with MSP stakeholders identify scenarios of plausible mild and extreme player actions. These scenarios form the basis for validating your model, both in MSP tools and when running acceptance tests;
- For testing through MSP tools, ask NHTV to generate pressure layers to reflect these scenarios, or if this is not (yet) possible, create pressure maps that reflect these scenarios in EwE. Through MEL Emulator in MSP tools, apply these pressures and make sure the model responds with ecological realism

2.6 Test plan

For local testing, make sure to test the following:

- Use a stepwise testing approach to test pressures. Apply and test pressures one by one, and test combinations of pressures, to find model weaknesses;
- Make sure that the model produces realistic responses. These include: realistic magnitude and speed of decline given a certain pressure; realistic speed of recovery upon relieve of the pressure; realistic cascade effects in the food-web; realistic resilience of the system to high pressure, for limited time, and realistic collapse and lack of recovery for excessive pressure, or high pressure sustained for a long time; realistic spatial cascade to stressors, artificial habitats and MPAs;
- While testing , occasionally check the content of outcome layers by writing them to drive (via MSP tools) and validate their content. Just looking at Ecospace maps and graphs in the Ecospace run forms may not provide enough detail to assure that Ecospace is indeed behaving well.
- When MSP tools test are sound, proceed to test the functioning of the ecological model through the entire MSP software. Do this in collaboration with stakeholders and the MSP team, and be aware that model output tends to look different when displayed by another software. At this stage your model should be structurally sound, and structural changes should not be necessary. However, it may be necessary to strengthen or weaken the responses of specific groups to game player actions.

In generic terms, a EwE model is good enough for MSP gameplay purposes when:

- The model runs flat after the spin-up period when not perturbed through changing pressures;
- Ecospace shows ecologically realistic responses to individual pressures and to combinations of pressures (see above);
- The food-web is stable, and individual groups do not slide out of control over time, unless this is an expected response to extreme pressure values.

3 Deployment

3.1 Packaging the model for inclusion in MSP

To package a model for inclusion in MSP, please check the following:

- Pressure and output names really, really, really correspond to the definitions in the game;
- MSP tools does not report any possible conflicts and errors;
- MSP tools shows correct metadata for the game. Please make sure to properly document changes in MSP tools. The documentation should contain a version number and date. This will greatly help tracking down version issues, if needed, once the game is distributed;
- Make sure all changes are saved, and from the EwE file menu, export the EwE model to an XML file;
- Deliver the .eiixml file of your model for inclusion in the MSP game.

3.2 User acceptance testing

The full dynamics of the EwE model cannot be appraised in MSP tools / MEL emulator alone. A full integration test, using the full MSP software, is needed to see how the model responds. You can sign off on the work when:

- The MSP clients are happy with what they see.

3.3 Reporting

Even though MSP is not an official policy advice tool (yet), EwE efforts should always be treated as verifiable academic exercises. This means the following:

- Changes to the initial published model, and justifications for those modifications, must be documented citing utilized data sources. The choice of medium for this description (peer reviewed publication, technical report or other grey literature) will depend on the commissioner of the MSP game that contains the reworked EwE model.

4 References

Heymans, J.J., Coll, M., Link, J.S., Mackinson, S., Steenbeek, J., and Christensen, V. (2016). Best practice in developing, balancing, fitting and using Ecopath with Ecosim food-web models for ecosystem-based management. *Ecol. Model.* *331*, 173–184.

Link, J.S. (2010). Adding rigor to ecological network models by evaluating a set of pre-balance diagnostics: A plea for PREBAL. *Ecol. Model.* *221*, 1580–1591.