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The multi-stanza representation of juvenile and adult biomasses was originally included in Ecosim to allow representation of trophic ontogeny (big differences in diet between juveniles and adults). To implement this representation, we found that it was necessary to include population numbers and age structure, at least for juveniles, so as to prevent 'impossible' dynamics such as elimination of juvenile biomass by competition/predation or fishing without attendant impact on adult abundance (graduation from juvenile to adult pools cannot be well represented just as a biomass 'flow').

When we elected to include age-structured dynamics, we in effect created a requirement for model users to think carefully about the dynamics of compensatory processes that have traditionally been studied in terms of the 'stock-recruitment' concept and relationships. To credibly describe the dynamics of multi-stanza populations, Ecosim parameters for split pools usually need to be set so as to produce an 'emergent' stock-recruitment relationship that is at least qualitatively similar to the many, many relationships for which we now have empirical data (see data summary in www.mscs.dal.ca/~myers/data.html). In most cases, these relationships are 'flat' over a wide range of spawning stock size, implying there must generally be strong compensatory increase in juvenile survival rate as spawning stock declines (otherwise less eggs would mean less recruits on average, no matter how variable the survival rate might be).

When Ecosim users create multi-stanza dynamics, they need to be careful in setting model parameters that define/create compensatory effects. This begins with the Ecopath input parameters; in order for the juvenile dynamics to Figure compensatory mortality changes, at least two conditions are needed or helpful:

- the juvenile group(s) must have relatively high *P/B*, i.e. high total mortality rate (see Edit multi-stanza groups);
- the juvenile group(s) must have either relatively high EE (so that most mortality is accounted for as predation effects within the model) or else the user must specify a high (near 1.0) value in the Ecosim Group info form entry for the juvenile group's 'Proportion of other mortality sensitive to changes in feeding time' column.

Compensatory effects can be increased (the recruitment relationship is flat over a wider range of adult stock sizes, with a steeper slope of recruitment curve near the origin) by:

i. Limiting the availability of prey to juveniles (forcing juveniles to use small 'foraging arenas' for feeding) by setting all elements of the Ecosim Vulnerabilities form column for the juveniles to a small value (1.5-5); or
ii. Setting a higher value for the juvenile group's 'Feeding time adjustment rate' parameter on the Ecosim *Group info* form, which causes the effective time exposed to predation while feeding to drop directly with decreasing juvenile abundance (i.e., simulates the possibility that when juveniles are less abundant, remaining ones may be able to forage 'safely' only in refuge sites without exposing themselves to predation risk). This option should be used only if you are fairly sure from field natural history observation that the juveniles do in fact restrict their distribution to safe habitats when at very low abundance.

It is especially important to test alternative values for the vulnerability of prey to juveniles (point i). If vulnerability is too high, the Ecosim emergent stock-recruitment relationship is likely to look almost like a straight line out of the origin, i.e. without compensatory effect. If vulnerability is too low, the relationship may develop a 'spurious' dome-shape.

Note that in Ecosim multi-stanza groups, the 'Adult' group is always the oldest stanza. The stock-recruitment relationship between this adult stage and each of the younger stages separately is calculated using the Stock recruitment (S/R plot) form.

A stock-recruitment exercise in Ecosim

Always check the stock-recruitment curve shape, and play with Group info and Stage parameters that may affect it, before proceeding to other policy analysis. The simplest way to check this shape while minimizing complicating and confounding effects of trophic interactions is to set up Ecosim for a fairly long time scenario (40+ yrs):

i. Go to the Run Ecosim form (Time dynamic (Ecosim) > Output > Run Ecosim), select *Groups* from the drop-down *Target* menu on and then the adult pool. Using the fishing rate sketch pad, set up a fishing rate time series pattern where fishing is first stopped for a decade or so then ramped up over the remaining years to a very high value relative to your baseline rate from Ecopath.
ii. Open the *S/R plot* form, and select the same adult group (Time dynamic (Ecosim) > Output > S/R plot).
iii. Then run a series of scenarios. If the stock 'crashes' completely under heavy fishing, reshape the fishing rate to stop a few years after the crash, to check for a 'multiple equilibrium' outcome: i.e., for some models, and especially for top predators, there may be 'delayed depensation' effect where the predator fails to recover after heavy fishing, due to increases in species that it eats that are in turn competitors/predators on its juveniles - these species can cause 'recruitment failure'.