Gmail **Maia Sosa Kapur <maiarkapur@gmail.com>**

spatial equilibrium/ref point calcs in Synthesis

6 messages

Maia Sosa Kapur <kapurm@uw.edu> Tue, Jun 30, 2020 at 10:04 AM
To: Chantel Wetzel - NOAA Federal <Chantel.Wetzel@noaa.gov>, Ian Taylor - NOAA Federal <ian.taylor@noaa.gov>

Hey Chantel & Ian

Hope you both are doing as well as possible.

I'm leading a review paper for the CAPAM Next-Gen special issue on spatial reference points, and am wondering if you have any resources/insight to confirm how Synthesis computes equilibrium quantities for spatially-explicit models. My understanding is that the "right" way to do this involves getting the eigenvector of the input movement matrix and running the model for many years, but AEP nor I were positive if this is what is done in Synthesis. The suppl. material in the manual seems to apply to a single-area. Any pointers would be appreciated.
Thanks,
MK

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Ian Taylor - NOAA Federal <ian.taylor@noaa.gov> Tue, Jun 30, 2020 at 10:45 AM
To: Maia Sosa Kapur <kapurm@uw.edu>, Richard Methot - NOAA Federal <richard.methot@noaa.gov>
Cc: Chantel Wetzel - NOAA Federal <Chantel.Wetzel@noaa.gov>

Hi Maia,
Good question. I've included Rick on this reply as he should really confirm what I'm saying as I'm not sure on the details.

Looking at the source code (available here), I see that the "Do_Equil_Calc" function (search for "SS_Label_FUNCTION 30 Do_Equil_Calc") seems to be the place to look. I see that function includes application of the movement rates within a loop over seasons which is within a loop over ages. The loop over ages extends past the standard accumulator age to better approximate the plus group (e.g. comment "go to 3x nages to approximate the infinite tail, then add the infinite tail"). It appears that because the equilibrium movement, mortality, and biology elements are all available there is no need to extend the loop over years to reach an equilibrium.

However, I have heard Rick say that the reason local stock-recruit relationships aren't yet available (as opposed to the global relationship used throughout SS) is that calculating equilibrium conditions would be probelmatic, but he could explain that better.

Given that the movement rates can be age-specific and also specific to multiple growth patterns within the stock, I suspect that eigenvector calculations would not be simple, but haven't really thought about that approach.

Good luck with your review paper--I'm sure it will be a really valuable addition.
-Ian
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Chantel Wetzel - NOAA Federal <Chantel.Wetzel@noaa.gov> Tue, Jun 30, 2020 at 11:15 AM
To: Ian Taylor - NOAA Federal <ian.taylor@noaa.gov>
Cc: Maia Sosa Kapur <kapurm@uw.edu>, Richard Methot - NOAA Federal <richard.methot@noaa.gov>

As always, I think Ian provided a better answer that I could have and I don't have anything additional to say. I look forward to seeing your review paper. Hope you are doing well!

Chantel Wetzel, PhD

Pronouns: she/her (what does that mean?)

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Richard Methot - NOAA Federal <richard.methot@noaa.gov> Tue, Jun 30, 2020 at 11:57 AM
To: Chantel Wetzel - NOAA Federal <Chantel.Wetzel@noaa.gov>
Cc: Ian Taylor - NOAA Federal <ian.taylor@noaa.gov>, Maia Sosa Kapur <kapurm@uw.edu>

I will give you more later, but the short answer is that equil calcs is done on a per-recruit basis, so depends on the allocation of recruitment to areas to be already determined before it starts. But if there are local S-R curves, then the number of recruits in an area depends on the spawning biomass in that area. But spawning biomass in that area could depend on movement between areas and thus could depend on the level of fishing occurring in other areas. Andre, Mark M and I have discussed this and there is no analytical solution. I have an approximation in mind and hope to get it implemented, but it will be an approximation.

Richard D. Methot Jr. Ph.D.
NOAA Fisheries Senior Scientist for Stock Assessments
Mobile: 301-787-0241

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Maia Sosa Kapur <kapurm@uw.edu> Tue, Jun 30, 2020 at 3:27 PM
To: Richard Methot - NOAA Federal <richard.methot@noaa.gov>
Cc: Chantel Wetzel - NOAA Federal <Chantel.Wetzel@noaa.gov>, Ian Taylor - NOAA Federal <ian.taylor@noaa.gov>

Thank you both for these detailed responses -- that is a helpful pointer toward the source code.
Rick, it would be great to hear more about your approximation both for the purposes of this review and as we're in the situation of "local SR curves" for the transboundary sablefish model.
Best
MK

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Richard Methot - NOAA Federal <richard.methot@noaa.gov> Tue, Jun 30, 2020 at 4:10 PM
To: Maia Sosa Kapur <kapurm@uw.edu>
Cc: Chantel Wetzel - NOAA Federal <Chantel.Wetzel@noaa.gov>, Ian Taylor - NOAA Federal <ian.taylor@noaa.gov>

The solution I intend is the following:
1. fortunately, SS already calculates spawning biomass by area, so no need for change there.
2. I/O for the parameters by area is TBD

Here is what I wrote a few years ago on the topic:
5. Conceptual problem in equilibrium calcs if fish move between areas
Equil_Calc takes some total recruitment (Equ_Recr)
it distributes according to recr_dist,
then calculates equilibrium numbers at age taking into account F and movement between areas
if outputs a value for total SPR (spawners per recruit)
then SPR is input to Equ_Spawn_Recr_Fxn
to calculate the equilibrium total recruits and spawners from this SPR

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but if recruitment to an area depends on that areas SPB, then SPR needs to be area-specific
   but with movement between areas, the SPB in an area depends on the movement
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   so SPR cannot be calculated independently for each area if there is movement
   so equil_calc will need to output area-specific SPR; this seems feasible
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```
but it is still somewhat circular because the distribution of recruits to areas
   in equil_calc will depend on the SPB by area calculated by equil_calc
```

6. Need to reconcile the area-aspect of recr_dist with the R=F(SPB_area)
area-specific R0
global steepness
movement mixes B between areas
fishing reduces area-specific B
reduced area-specific B reduces E(area-specific R)

```
does global R=E(sum B)  equal  R = sum (E(Ba))  ??
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```
current approach:
   1.  Given some reference recruitment level - R
   2.  Call equil_calc
       a.  distribute R to areas according to recr_dist
       b.  loop areas within ages
       c.  for each age,/area calc SPB, Yield, Survivors
       d.  for each age mix survivors among areas according to movement specs
       e.  accumulate total SPB and Yield and return from equil_calc
   3.  calc SPB/R and Yield/R
   4.  call Equ_Spawn_Recr_Fxn to get B_equil and R_equil from SPB/R and SR parms
```

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Proposed two-stage iterative area-specific approach for equilibrium calcs:
   step A:
   1.  Given some reference recruitment level - R
   2.  Call equil_calc
       a.  distribute R to areas according to unfished recr_dist (which needs to be defined here)
       b.  loop areas within ages
       c.  for each age,/area calc SPB, Yield, Survivors
       d.  for each age mix survivors among areas according to movement specs
       e.  accumulate total and area-specific total SPB and Yield and return from equil_calc
   3.  calc area-specific SPB/R and Yield/R, using area-specific R
   4.  call Equ_Spawn_Recr_Fxn for each area to get B_equil and R_equil from SPB/R and SR parms
   5.  sum across areas to get adjusted total B_equil and R_equil
   6.  use ratio of B_equils among areas to calculate adjustment to recr_dist
   step B:
   7.  call equil_calc again, using the adjusted recr_dist
```

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