Review of **Calculating the Spawn Index for Pacific Herring (*Clupea pallasii*) in British Columbia, Canada** (DFO Technical Report) by M.H. Grinnell, J.F. Schweigert, M. Thompson, and J.S. Cleary.

The numbered comments below are my specific comments on the paper, addressed to complete paragraphs or to line numbers, written as I worked my way through the paper. However, the nature of this paper demonstrates that the complex procedure of estimating the herring spawn index deserves a much more "in depth" look than is provided here. All that I am able to do is to review what is presented. However, there is much more to review, including the appropriateness of the assumed statistical framework, the dated fixed relationships (e.g., Eq.3, Eq.6, Eq.9, Eq.10) applied as data without error, and the curious methodology used to expand the quadrat estimates to a spawn estimate. I am also very suspicious of the assumption that *EggsDSub* and *EggsDAlg* are independent within a quadrat and can be safely added without bias.

This paper would be improved if the introduction had a figure which showed the sequence of calculation for each of the main streams of the estimation procedure (surface spawn, *Macrocystis* and quadrat), showing each step. This information is already in the introduction as words, but a "flow" diagram would be an aid to the reader.

I question the decision to keep the equations "simple" by not showing subscripts and summation signs. The rationale provided for this ("*correspond with the R script which avoids subscripts*") is not sufficient because the fact that R does not use subscripts is irrelevant. The equations should be complete so that they are understandable to the reader. As it is, the context of the equations needs to be inferred from the surrounding text. Equations are a precise way to impart information which should be used!

My recommendation is that the paper be accepted with the following modifications:

- all equations spelled out in full, showing summations, means and subscripts;

- some ambiguities be clarified, particularly in how the word "*Width*" is used, which seems to be "distance from shore" as well as the left/right width of a transect. I suggest that a different word be used for one of these concepts;

- add a flow diagram showing the estimation sequence;

- add some discussion of what is an 'egg layer' and how the quantity is determined during the survey;

- rewrite the entire Section 4.4.2 (understory spawn surveys) which deals with the biased lead lines. It is (to me) unintelligible. I suggest that a well-laid out table showing the sequence of changes would help the description;

- provide text which puts Tables 1, 2 and 3 in some context: what is their purpose and how were they derived?

- clean up the descriptions of how the quadrat-level estimates are expanded into a spawn index (Paragraphs 7.1, 7.2 and 7.3). There are redundant variables and '*Width*' is potentially used incorrectly.

1.   Eq. 1: looks to me that you should be dividing by 1000 to convert from eggs/kg to eggs/tonne, not multiplying by 1000 (as I interpret the equation).

2.   Line 94: is the 'spawn number' unique within a year or between years? That is, is a spawning event in the same location in different years given the same number in each year? If not, is the location of the spawning event characterised by a latitude and longitude?

3.   Line 110: the explanation for *TransectWidth*=2m is confusing. Does that mean you apply an arbitrary 'width' of 2 m when the substrate is *Macrosystis*? Is the 'width' <>2m for other substrates?

4.   paragraph beginning with line 112: the first transect is '*200 m from one end*'. How is the 'end' determined? This is important because it affects the randomness of the design, given that it sets the first transect.

5.   line 117: '*Transects generally go from 20 m depth or the edge of the spawn*'. What happens if the spawn goes deeper than 20 m? is that ignored?

6.   line 118: having '*permanent transects*' makes this more of a 'fixed station' design rather than the claimed 'random design'. At best it is a bit of a hybrid design.

7.   line 124: are 'surface spawn survey' still active? or is this paragraph discussing the processing of historical surveys? some context would be helpful. the description of how this type of survey is handled does not make this part of the survey seem very quantitative or reproducible.

8.   lines 134-136: this paragraph defines '*TransectWidth*' as the distance to the right and left of the perpendicular transect line. however, when I read the definition in Lines 106-107, I got the impression that 'width' meant the distance from the shore to the end of the transect. Which is it? Using the word 'width' for two very different concepts is confusing. I suggest that 'width' be better explained when it is first introduced or else use a different variable name for one or the other.

9.   line 138: is there herring spawn on *Macrosystis* <1 m in height? if so, the index will not include this component.

10.   paragraph 4.3 (Understory spawn): the word 'dominant' is used twice in this paragraph, which is confusing: A) 'divers record the <u>dominant</u> (i.e., most heavily spawned) substrate type'; and B) 'divers identify the three dominant algae types that have spawn'. suggest using 'the three most abundant algal types' in the second sentence. Also, what is an 'egg layer'? This is a concept not identified as yet. suggest that it should be defined in the previous paragraph when it is first introduced.

11.   paragraph 4.4.1 (Surface Spawn Surveys): the procedure described for how the 'width' of the surface surveys is adjusted to avoid bias (assuming that 'width' means distance from shore) seems very ad-hoc. Obviously no one is going to change it now, but it is clear that a much better approach would be to treat the surface spawn series as having a different '*q*' than the dive surveys.

12.   line 184: the phrase '*behaviour of transect lines*' seems rather strange! surely transect lines are not behaving! what is meant by the '20 m spacing' (or segments)? earlier (in paragraph 4.3) it is stated that quadrats are spaced with a minimum of 2 m and maximum of 40 m. but there is no mention of the preferred spacing. Is this what is meant by the '20 m spacing'?

13.   line 190: does this mean that the measuring device used by the divers is biased by –5% (=1-19/20)? So where did the +15% bias come from? This needs more explanation.

14. paragraph 4.4.2 (understory spawn surveys): I commend the attempt to explain the +15% adjustment, but I don't understand it. The evaluation criterion should be: is the explanation sufficient for someone else to be able to make the same adjustment based on the description provided? I think not. At least I would not be able to do it. My suggestion is that you provide a table that looks something like this:

time interval	location	adjustment made
from yyyy1 to yyyy2		

    a. what I am looking for is the <u>exact</u> documentation of the details the adjustments: the period involved, the applicable spawning areas, and the size of the adjustment. The paragraph as presently written is impossible to decipher (at least, for me). It is written like a narrative: how things happened. What is needed is a description of how the adjustments are done.

    b. The last sentence of this paragraph states "*We have updated spawn widths in the database for the affected spawn surveys*". Does that mean you have changed the underlying data? That is not right. You should incorporate your adjustments into your code, but not alter the underlying records. Others who follow you may choose an alternate methodology to adjust the bias and that won't be possible if the data have been changed.

15. Eq. 2: is this equation at the level of a quadrat or a transect? seems like it applies to the quadrat, so presumably this is the proportions of 'the three most abundant algal types' in Paragraph 4.3? I suggest that the paragraph reflect this. You should be using sub-scripts and summation signs in your equations.

16. Eq. 3: the values in this equation look like parameters from a 2-parameter least-squares linear model. Although you cite Jake's paper, you might at least acknowledge what it is, mentioning whatever were the dependent and independent variables.

17. Eq. 4: 2 questions:

    a. what happens if there is no value for *WidthS*?

    b. why are you multiplying by 10^3? after dividing by 10^3 in Eq 1? I guess it is because the *EggDensT* is in eggs*10^3/m^2. However, you could put the *10^3 into Eq 4.

18. Table 1: what is this table? It is introduced with no explanation. What is '*intensity category*'? How does it relate to egg layers? Judging from the 5 adjustments made from lines 258 and 267, it looks like the data are presented in terms of 'intensity' and a number of egg layers is inferred from the 'intensity' estimate. Is that the case? if so, you need to document the source of the mean number of egg layers in Table 1. how many observations? cv? why the difference for the last two adjustments? what are 'historical averages'?

19. line 252: does this mean that surveys before 1951 are discarded?

20. paragraph 6.1 (Transect Level Calculations): is the equation for *AreaT*: *AreaT=WidthT*TransectWidth*? If so, that could be added.

21. paragraph 6.2 (Spawn Level Calculations):

    a. it is unclear why you would use *AreaTotS* in the denominator of Eq. 7 while you use *LengthMacroS*WidthMeanS* in the numerator of Eq. 8. Don't they estimate the same thing? At least it seems to me that they should. If that is the case, then the equations can be cleaned up. If not, then there should be an explanation.

    b. Eq. 6 is a worry. These parameters are estimated with error and there is obviously no background provided on their derivation. But the implication of using those parameters in this way is very troubling to me. At a minimum, the science that underlies these calculations is 30 years out of date and should be updated with any information since collected.

22. paragraph 7.1 (Quadrat Level Calculations): there are a number of problems with this section:

    a. Eq. 9 and Eq. 10: both rely on outdated analyses that, like Eq. 6, should be updated and reconsidered;

    b. the data collected at the quadrat level are described in paragraph 4.3 (Understory Spawn): what is unclear from the description is the independence of these data. I think that *EggsDSub* relates to the "dominant (i.e., most heavily spawned) substrate type" while *EggsDAlg* relates to 'the three most abundant algal types'. Are these observations independent? That is, is there an interaction between egg layers on the algae with the egg layers on the substrate (they might fall off, for instance)? Because independence is assumed when they are added together. In any case, the description provided in paragraph 4.3 should reflect this assumption.

    c. why is Eq 11 multiplied by *Width*? The quadrat already has an implicit area (m^2) component, so multiplying by the width isn't quite right computationally. I can see why the multiplication is needed, but I suggest it is more appropriate to multiply at the transect level.

23. paragraph 7.2 (Transect Level Calculations): as I said in 22.c, I think the equation for this step should be *EggDensWtMeanT*=mean(*EggsDSub* + *EggsDAlg*)*Width, because I think *Width* is set for the entire transect (or am I missing something?). *EggDensWtMeanT* should be eggs/m^2.

24. paragraph 7.3 (Spawn Level Calculations): I have difficulty with this section:

    a. you are summing *EggDensWtMeanT* to get *EggDensWtTotS*. Thinking like a trawl survey, I would take the <u>mean</u>(*EggDensWtMeanT*) and multiply it by *LengthAlgS*. That would be it. I don't think summing *EggDensWtMeanT* is necessarily wrong, but I don't understand the reasoning that causes you to divide the summed *EggDensWtTotS* by the *Width* and then multiply it <u>again</u> by the mean width. Essentially you are dividing and multiplying by the same number! Lot easier to skip those two steps! I suspect that the two widths might be different, but you have already introduced *Width* into the quadrat calculation as well. This part needs more explanation as to the nature of these '*Width*' variables. Subscripting would help here a lot.

    b. you have two estimates of egg density: *EggsDSub* and *EggsDAlg*, but only one value for length of the *Spawn*. Are you assuming that both egg density values are represented by the same length measurement? Is it conceivable that the length coverage would differ for the two density components.

    c.   what is the source of the scaling ratios in Table 3? they are not the ratios of the area, given that a 0.5 m^2 quadrat is 5% larger than a 0.25 m^2 quadrat while the 1 m^2 quadrat is 57% smaller!

25.   paragraph 9 (Spawn on Kelp):

    a.   *eggBrineProp* would be 0.88, not 0.87 (1/1.13=0.88496).

    b.   again, these are dated analyses and should be checked at a minimum.

26.   paragraph 10 (Sources of Uncertainty):

    a.   there is a lot more to the uncertainty of the spawn index than what is indicated in this section. You have fixed parameters in Eq. 3, Eq. 6, Eq. 9, Eq 10, all of which have associated error, but are used as data without error. As well, these are dated relationships which are 25-40 years old! Our understanding of these processes might have changed in the intervening years. One suggestion could be to incorporate the underlying data which inform these equations into the spawn index estimation procedure, thus acknowledging the underlying uncertainty.

    b.   Tables 1 and 2 also represent parameter estimates with associated error. I cannot interpret Table 3. I think it should be driven by the area ratios, but it looks wrong: how can a 1 m^2 quadrat cover less than a 0.25 m^2 quadrat while a 0.5 m^2 quadrat gets scaled up?

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