# General comments

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| appropriateness of the assumed statistical framework | MG I agree, but that is not the goal of this report, which is to document how the spawn index is calculated. I have added ‘reviewing the assumed statistical framework’ to a new section `Future research.’ |
| the dated fixed relationships (e.g., Eq.3, Eq.6, Eq.9, Eq.10) applied as data without error | MG I agree, but that is not the goal of this report, which is to document how the spawn index is calculated. I added the concern about using dated parameters and equations to ‘Future research; treating these relationships as data without error is already addressed in the section ‘Sources of uncertainty.’  JS Updating any or all of these relationships would require extensive directed research studies comparable to those conducted in the 1980s, unlikely to be funded given the relative importance of the herring fishery at this time. In large part this is because the original studies preserved the egg and algal samples using Gilsons solution which contains carcinogens that prevent its continuing use. Therefore, any new samples collected would represent a new data set not directly comparable to the existing data. |
| methodology used to expand the quadrat estimates to a spawn estimate | JS The methodology derives directly from the assumed statistical framework. The report describes that framework; future work could revisit the statistical framework. |
| suspicious of the assumption that EggsDSub and EggsDAlg are independent within a quadrat and can be safely added without bias | JS Not sure how one could resolve this, it is often the case that there are eggs on the algal substrate and not on the bottom substrate and vice versa so clearly independent. But when there are both in a quadrat in some cases there would be extensive egg deposition on both algae and bottom but in other cases there could be lots of eggs on either the algae or the bottom or fewer on either the algae or bottom so it depends; there is tremendous heterogeneity within a spawning bed.  MG I have added this possible issue to the ‘future research’ section. |
| 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. | MG Good suggestion; I added a ‘flow diagram’ to the introduction. |
| 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! | MG Good suggestion. I will update these, but I will need some help; this is not my forte.  JS It’s a bit unfortunate that the R script simply emulates the Access Basic code rather then developing a script based on the statistical framework. I think this approach would have made the presentation of equations with subscripts much clearer and more tractable. As it stands I find the equations very difficult to follow. |
| 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; | MG Good suggestion: I have changed ‘TransectWidth’ to ‘TransectSwath’.  JS I suggest retaining TransectWidth since it refers to the width of the egg bed and is integral to calculating the area. I think another term is needed for the swath of coverage in the Macrocystis beds that incorporate the counts of plants within 1 m on each side of the transect line. |
| add some discussion of what is an ‘egg layer’ and how the quantity is determined during the survey | MG Good suggestion. I added a definition and a figure.  JS Check the spawn survey manual for a definition, I think it differs for leafy and stringy algae. |
| 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; | JS I believe this section is accurate and correct as written. However, the last paragraph could be edited for clarity and a table laying out the changes could be helpful.  MG I don’t think a table is necessary: the short version is that all surveys/transects in all regions are affected by this issue, from 2003 to 2013. I have added this clarification to the report. |
| provide text which puts Tables 1, 2 and 3 in some context: what is their purpose and how were they derived? | JS Table 1 seems fine, Table 2 and 3 could be incorporated into the description of equation 10 if you add in subscripts as I did in some of the earlier publications. |
| 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. | JS I could spend some time on this and try and clarify.  MG I will add subscripts to the equations, which will help. Width is used correctly, and is explained below. |

# Specific comments

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| 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). | MG I’m sorry if this isn’t clear; I’m not sure how to improve it. The units for this equation/conversion work out: 200,000 eggs per kg \* 50% female \* 10^3 kg per t gives units of eggs per t. The 10^3 kg per t is just a conversion to go from kg to t (1000 kg in one t).  JS I think this is correct if you follow the calculation and cross out the units it does work out to 10^8 eggs/tonne. I think the reference to multiplying the eggs x10^3 is confusing. This should probably be removed from here and added as a footnote to the description of equation 10.  MG Done; moved to footnote for equation 3. |
| 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? | MG Good question; my description of a ‘unique spawn number’ was inaccurate. I re-wrote the last few sentences of this paragraph (lines 98 to 102: “We identify distinct spawns (both spatially and temporally) by the unique combination of year, location, and `spawn number.' A distinct spawn is typically a continuous stretch of shoreline with no detectable break in egg deposition. The spawn number is the finest scale at which we calculate the spawn index; distinct spawns are typically numbered 1, 2, ..., n where n is the number of spawns at a given location in a given year. Most spawns are characterized by longitude and latitude.” |
| 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? | MG I renamed the variable ‘TransectWidth’ to ‘TransectSwath’ to clear up confusion, and then I updated this sentence with a link to the Macrocystis section: “Note that transect swath, TransectSwath = 2m refers to the swath of substrate along Macrocystis transects (see subsection 4.2).” I think that it’s clear in the text that the other two sampling protocols don’t use TransectWidth (now TransectSwath): surface surveys use various techniques; and understory surveys use quadrats placed along transects.  JS As indicated earlier I think you should retain TransectWidth and maybe refer to TransectSwath in dealing with the Macro section. |
| 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. | MT/MG EOS spawn is determined by the absence of eggs. When eggs are located, we move in slightly (ie 200m) so we don’t start on sparse egg layers --- similar to why we move in a few meters along a dive transect and start our quadrats. The transects are also not set in “random design”. We have equal distance between transects. I added a sentence: “The end of the spawn is determined by the absence of eggs; the first transect is located in from one end (i.e., at the first permanent transect, or 200m if there are no permanent transects) to avoid surveying areas with patchy and sparse egg layers.” I also added a sentence to section 4.3 (Understory spawn): “Similar to how the first transect is moved in from one end of the spawn, the first quadrat is moved in from the edge of the spawn to the first 5m mark on the transect line to avoid surveying areas with patchy and sparse egg layers.”  JS Perhaps there has been some change in the sampling protocol but I would have expected that the dive team would start at the first fixed transect within the spawn bed beginning from one end of the bed. In that manner the decision of where to begin surveying is not biased by sampling where the density of eggs is known but rather within the overall area of egg deposition.  MG Correct Jake – I have updated this. |
| 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? | MT/MG/JS Not usually ignored, but is harder to survey. WCB diver protocols change past 20m (60’) as you have buddy dive, thus requiring another diver to enter the water. This burns up bottom time quickly and has an overall effect on the # of transects that can be completed in a day. I updated this sentence to “Transects generally go from the deep edge of the spawn towards shore until divers reach the nearshore edge of the spawn; the nearshore edge can be out of the water depending on the stage of the tide.” |
| 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. | MT Transects are fixed with the stations (quadrats) varying with spawn width annually.  I think what you also trying to say here is that we have mapped out a lot of the coast with “permanent” transects and if they do not exist, the before mentioned criteria are used to make transects in the field.  JS Its actually more of a systematic design but within a random universe since one never knows where the spawning will occur. The sampling universe is determined by where the egg deposition occurs but the sampling design that is overlaid on this is systematic which doesn’t bias the estimated mean eggs density although it does affect the variance estimates.  MG I’m not sure this is necessary, but I added a sentence to specify the design: “Thus, we describe our spawn surveys as having a systematic sampling 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. | MG This is described in the introduction, Line 41: “For example, surface spawn surveys were the only survey type prior to 1988, and they are still used extensively for minor spawns, remote spawns (i.e., outside stock assessment region boundaries; see below), as well as unusually early or late spawns.” |
| 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. | MG Good suggestion: I have changed ‘TransectWidth’ to ‘TransectSwath’.  JS I suggest retaining TransectWidth and using TransectSwath for the Macro section. |
| 9 | line 138: is there herring spawn on Macrosystis <1 m in height? if so, the index will not include this component. | MT/MG No. Spawn is on the mature fronds of macrocystis, and immature plants have limited fronds. Spawn is also usually higher up the plant and not into the stipes. I added two sentences to this effect: “Immature plants are excluded because Pacific Herring spawn on Macrocystis fronds, not stipes, and immature plants have limited fronds. In addition, spawn is typically higher up in Macrocystis plants.”  JS The plants <1 m are quite ‘slimy’ and eggs don’t adhere very well so very little if any eggs on them. |
| 10 | paragraph 4.3 (Understory spawn): the word ‘dominant’ is used twice in this paragraph, which is confusing: A) ‘divers record the dominant (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. | MG Good suggestion; I updated the text as suggested. |
| 10 | 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 | MG Good suggestion. I added definitions for eggs on the substrate, as well as eggs on flat and round algae.  JS Matt you should check the spawn survey manual I think there is a good definition there and it differs for the leafy and stringy vegetation types. |
| 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. | MG Your suggestion (re a different ‘q’ for surface and dive survey series) is good, and we do that in stock assessments. I think we should continue to omit the discussion on ‘q’ from this document because that is not the intent here.  JS Actually this is a legacy from when the stock assessment was based on an escapement model and an age structured model which were weighted equally and used through much of the 1990s. The escapement model required estimates of spawning biomass from both the surface survey period and recent dive surveys and although ad hoc it was the best of a couple of alternatives that were investigated to emulate the estimates from 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’? | MG Using ‘behaviour’ seems appropriate to me given that some transect lines change length when wet and over time. The Oxford dictionary defines behaviour as “the way in which a machine or natural phenomenon works or functions.” It seems like there is confusion between ‘20m segments’ vs. ‘quadrat spacing.’ These are two separate things: the first refers to a section of line which many may be joined to other sections to make a full transect; the second is the distance between quadrats along the transect line. I added a sentence to clarify what is meant by a ‘segment’: “Segments refer to individual sections of line that may be linked together to make a complete transect.”  JS The optimal sampling design determined from research studies in 1981 and 1983 indicated that 3 transects/km and 5 quadrat samples/transect should yield an estimate of egg density with a standard error of 0.25. The transect width is unknown to the diver when he enters the water but they know how much transect line has been put out so they have an idea of the width to shore once they encounter the beginning of the eggs and can estimate the likely spawn width and determine the spacing of the quadrats, typically 20 m spacing yields about 5 observations per transect. Very short transects will require more closely spaced quadrats. For very wide transects the max spacing is 40m. |
| 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: [table with columns ‘Time interval’, ‘Location’, and ‘Adjustment made’]. |  |
| 14a | what I am looking for is the exact 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. |  |
| 14b | 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. | MG Actually, that statement was incorrect. The original widths have been retained in the database. In addition, we also have ‘updated’ widths in the database. So, the underlying/original records have not 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 subscripts and summation signs in your equations. | MG This is at the transect level – surface surveys do not use quadrats (only understory surveys use quadrats).  JS This seems odd and may be function of the Access code that summarizes the data in this fashion. I would have thought it applies at the quadrat level but likely is generalizable to the transect, ie it is all additive. |
| 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. | MG Good suggestion. I added a brief model description: “Schweigert et al. (1997) developed a predictive model of surface egg density in thousands of eggs per square metre from egg layers using a linear regression model.” I added similar descriptions for the other predictive model equations (6, 9, and 10).  JS Equation 3 seems out of place here since it really only applies to the surface survey calculation and could be given better context and description there. |
| 17 | Eq. 4: 2 questions: |  |
| 17a | what happens if there is no value for WidthS? | MG We haven’t had this problem before (i.e., there is always a median region width or observed width as a last resort). However, we do have ‘incomplete’ spawn surveys in the database, which we omit from the spawn index calculations; these incomplete surveys may have missing WidthS values. Typically, spawns are labeled ‘incomplete’ and omitted from calculations if spawn is reported but not surveyed, or if spawn surveyors inadvertently omit some required data.  JS This applies more to data pre-1950. I believe there are relatively few spawns with missing width data in the main stock assessment regions in recent years. |
| 17b | why are you multiplying by 103? after dividing by 103 in Eq 1? I guess it is because the EggDensT is in eggs\*103/m2. However, you could put the \*103 into Eq 4. | MG Yes, we multiply by 103 because EggDensT is in units of thousands of eggs per m2. There are some redundant numbers here (in Eq. 4, 8, & 13 we multiply by 103 and then divide by ECF, which is 108), but I think this makes it more clear than skipping these steps. It also makes the spawn on kelp equation clear (Eq. 15). |
| 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’? | MG Good suggestion about providing an explanation for this table. I added a subsection ‘Spawn intensity categories’ to the end of the section ‘Sampling protocol,’ and moved the table here. Most of the table caption (along with some additional text) has been moved to this subsection to provide some background and introduce the table. |
| 19 | line 252: does this mean that surveys before 1951 are discarded? | MG Surveys prior to 1951 are not discarded, but they are not used in the stock assessment. I have added a sentence to make this clear: “Therefore, we do not include spawn data prior to 1951 in stock assessments.” |
| 20 | paragraph 6.1 (Transect Level Calculations): is the equation for AreaT: AreaT=WidthT\*TransectWidth? If so, that could be added. | MG Good suggestion; I have added another equation. |
| 21 | paragraph 6.2 (Spawn Level Calculations): |  |
| 21a | 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. | JS I believe the area in equation 7 refers just to the swath along the transect line where there has been a count of the plants and fronds. The are in equation 8 refers to the entire area of the Macro bed. |
| 21b | 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. | MG I agree, but that is not the goal of this report, which is to document how the spawn index is calculated. I added a new section ‘Future research’ and I have added the concern about using dated parameters and equations.  JS Eggs on giant kelp is a very complex and difficult sampling process. No new data have been collected since and would require a directed research study to update the information. Background is provided in the 1990 report. |
| 22 | paragraph 7.1 (Quadrat Level Calculations): there are a number of problems with this section: | JS I think the text and description can be cleaned up a bit. |
| 22a | Eq. 9 and Eq. 10: both rely on outdated analyses that, like Eq. 6, should be updated and reconsidered; | MG I have added this to the ‘Future research’ section. |
| 22b | 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. | JS I think there is some semantics here. The most abundant algal type and the dominant substrate are essentially the same. It is the substrate with the most eggs, be it rock, boulders, cobbles, etc. similar to the algae with the most eggs. Any eggs that fall off are not adhesive and would be carried away from the quadrat by current or wave action. |
| 22c | why is Eq 11 multiplied by Width? The quadrat already has an implicit area (m2) 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. | MG We multiply by ‘Width’ to calculate the ‘linear weighted egg density’ as is stated in the paper. The reason why is provided in the text: “We calculate the weighted mean egg density because spawn widths can vary greatly along their length; a weighted mean ensures that transects contribute proportionally to their area.”  JS Perhaps not clear from this equation but the statistical design is to calculate a mean egg density weighted by the transect width. At the quadrat level width should not be a consideration but should come into play at the transect and/or spawn 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/m2. | I will add subscripts to the equations to make these calculations clear. |
| 24 | paragraph 7.3 (Spawn Level Calculations): I have difficulty with this section: |  |
| 24a | you are summing EggDensWtMeanT to get EggDensWtTotS. Thinking like a trawl survey, I would take the mean(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 again 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. | I will add subscripts to the equations to make these calculations clear. |
| 24b | 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. | MT/MG Yes, we assume they’re represented by the same length measurement. I added a sentence to be explicit: “Thus, we assume that EggsDSub and EggsDAlg are represented by the same length measurement.”  JS Matt, correct me if I have this wrong but the two estimates of egg numbers are summed before the mean density for the transect is calculated. |
| 24c | what is the source of the scaling ratios in Table 3? they are not the ratios of the area, given that a 0.5 m2 quadrat is 5% larger than a 0.25 m2 quadrat while the 1 m2 quadrat is 57% smaller! | JS I think it needs to be clarified that the egg numbers were scaled up to 1 sq m for each quadrat size and then parameters estimated in the GLM with 0.25 sqm quadrat fixed at 1 and the others are scaled relative to that.  MG I have checked further, and it turns out that all quadrats used for the spawn index are 0.5m2. There are other sizes used for research (0.25 and 1m2), but they are not used for calculating the spawn index. Therefore I have removed the table, and updated the text and equation. |
| 25 | paragraph 9 (Spawn on Kelp): |  |
| 25a | eggBrineProp would be 0.88, not 0.87 (1/1.13=0.88496). | JS Paul is correct, it should be 0.88. |
| 25b | again, these are dated analyses and should be checked at a minimum. | MG I agree, and I have added this to the ‘Future research’ section. |
| 26 | paragraph 10 (Sources of Uncertainty): |  |
| 26a | 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. | MG Good suggestion. I added this concern to this section: “In addition, these prediction models are dated, and our understanding of these processes could have changed in the intervening years. Third, fixed parameters are used as data without error (e.g., Equation 3).” And I added this concern to a new section called ‘Future research’: “One approach to acknowledge the uncertainty in these prediction models is to incorporate the underlying data that informs these equations into the spawn index calculations.” |
| 26b | 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 m2 quadrat cover less than a 0.25 m2 quadrat while a 0.5 m2 quadrat gets scaled up? | JS The parameter estimates come out of a generalized linear model and have some error. The research data used to develop the model were collected over more than a decade and include some observations using both 0.25 and 1.00 sq m quadrats although these are a relatively small percentage of the 5000 plus quadrats that were sampled. I suspect there is no statistical difference between the observations from 0.25 and 0.5 sq m quadrats but apparently about half of the eggs are lost in sampling the larger quadrats.  MG I have checked further, and it turns out that all quadrats used for the spawn index are 0.5m2. There are other sizes used for research (0.25 and 1m2), but they are not used for calculating the spawn index. Therefore I have removed the table, and updated the text and equation. |