Review of EAP19-0502 Spencer et al.

General comments

This is a welcome contribution examining oyster responses to two climate-related stressors, warming and acidification. A major strength of the study is the ecologically realistic timing under which the oysters were exposed to the potentially stressful conditions. The investigation elegantly demonstrates carryover effects, but also that these vary by source population and environmental context –once again, generality in ecology is shown to be elusive, confounded by the messiness of spatial variation.

The conservation implications of this study are actually heartening: Olympia oyster reproduction seems to benefit, or at least not be negatively affected, under treatments mimicking potential future ocean conditions. The authors could more explicitly highlight this positive outcome. Combined with other recent studies (see below), this suggests that while *Crassostrea* may lose under climate change conditions, *Ostrea lurida* may be a winner, which has potential implications for the future of Pacific coast aquaculture as well as conservation.

For *Ecological Applications*, I would suggest that the study should be placed in a somewhat broader conceptual framework. The very start of the Introduction could begin with a few sentences about understanding population responses to climate change across generations or about the importance of realistic temporal exposure to climate-related stressors, before diving into marine bivalves. Likewise, the first sentence of the Abstract could open with a broader statement about the field of inquiry, to draw in readers from other systems. Finally, either the first or last paragraph of the Discussion could again zoom out to a broad level, discussing general implications of the work that would apply to any system (importance of realistic timing, of examining population variation, context-dependence, etc.) and citing non-bivalve papers.

The Introduction is generally well-written, but switches a bit between general bivalve information to information specifically relevant to the current study (Puget Sound conditions, Olympia oyster biology). A somewhat clearer organization might be helpful, for instance having a first short paragraph be general/conceptual, then following with a few paragraphs on marine bivalves facing changing ocean conditions, then following with a paragraph or two specific to Olympia oysters, and finishing with the specific goals and predictions of this study.

The Methods and Results are quite clear. In terms of making it an easier read for the non-specialist reader, I'd suggest moving details on exact make and model of equipment for aquaculture and measurements to the Supplement, though this is a stylistic preference and should be determined by the editor. For the section on gametogenesis, the rationale for the assessment needs to be clarified. It is not clear whether the evaluations pertain to individual fitness or population level reproductive output. Text is needed to explain why staging the gonads is a good indicator, and why the particular snapshots in time chosen are relevant predictors of reproduction. Likewise, in the Results, the significance of Figure 4 and 5 needs to be more clearly explained, in terms of indicators of fitness or population growth rate or whatever. In these complicated non-synchronous hermaphrodites, it seems that highest population level output might be achieved under conditions where more individuals function as females, as sperm is likely not limiting, at least in dense populations. Conversely, lowest population level output might occur under any conditions that lead to synchrony (all individuals functioning as males or all functioning as females).

So, it's a complex puzzle, to go back and forth between individual-level assessments and population-level consequences.

Olympia oyster citations

The community of researchers studying Olympia oysters is rather small, such that only a few papers a year are published. For this reason, it was surprising that a few highly relevant papers were not cited. The following papers should be cited, and moreover, their findings should be integrated with the results of the current study in the Discussion.

Barber, J. S., Dexter, J. E., Grossman, S. K., Greiner, C. M., & Mcardle, J. T. (2016). Low temperature brooding of Olympia oysters (Ostrea lurida) in northern Puget Sound. *Journal of shellfish research*, *35*(2), 351-358. This study reports on Oly brooding (indicating successful male and female function in population) at colder temperatures than typically reported; work done in similar area of Puget Sound as present MS.

Bible, J. M., Cheng, B. S., Chang, A. L., Ferner, M. C., Wasson, K., Zabin, C. J., ... & Grosholz, E. D. (2017). Timing of stressors alters interactive effects on a coastal foundation species. *Ecology*, *98*(9), 2468-2478. This study, like the present MS, examined effects of multiple climate-related stressors on Olys, and included consideration of timing of effects.

Cheng, B. S., Bible, J. M., Chang, A. L., Ferner, M. C., Wasson, K., Zabin, C. J., ... & Grosholz, E. D. (2015). Testing local and global stressor impacts on a coastal foundation species using an ecologically realistic framework. *Global change biology*, *21*(7), 2488-2499. Somewhat analogous study to present MS, testing two climate-related stressors to look for synergistic and lagged effects; like the present MS, this study found increased temperature was beneficial not harmful (in this case, to growth)

Moore, J. D., B. C. Marshman, R. Obernolte, and R. Abbott. 2016. Sexual development and symbionts of native Olympia oysters *Ostrea lurida* naturally settled on cultch deployed in San Francisco Bay, California. *California Department of Fish and Game*, 102:100-118. This study tracked gametogenesis over the course of a full year in an Oly population, with charts such as Fig 5 in the present study that showed how dynamic male vs. female allocation is over time, and how they can overlap. This paper can be hard to get a hold of, but is in the Dropbox of all known Oly references maintained by Kerstin Wasson of the Elkhorn Slough Reserve, which is open to anyone upon request.

Specific comments

Line 13: for a broad journal such as *Ecological Applications*, I'd suggest that the first sentence of the Abstract should be more general and conceptual, about the area of inquiry, not just Olympia oysters.

Line 19: towards the end of the abstract, it would seem worth highlighting that Olys may actually do better under projected climate change, or at least that for the scenarios tested here, they seem like they will not do worse

Line 36: "the focus" is misleading, as there are of course many focus areas for such research; rephrase to indicate that this is one area of interest, not the only one

Line 56: "are promising" is unclear – is this a compliment to the quality of the studies, or the conservation implications of the results?

Line 66: change to "only one study" (or delete the "to our knowledge")

Line 97: this statement isn't exactly true, as other oysters occur in Mexico

Line 98: remove apostrophe from 1900's

Line 120: does "this study" refer to the Hettinger in the previous sentence, or to your own study? If the latter, move this information to the following paragraph where you introduce your study.

Line 124: add a name to this unpublished observation (guessing it's from author Ryan Crim?)

Line 156, 168, 172, 175, etc: there are a lot of details about make and model of equipment used in the Methods that could be relegated to the Supplement. This is perhaps a call for the editor to make; it is a matter of taste whether this sort of detail is desirable in the main text or not.

Line 190 ff: it would be helpful to add some overview sentences about the rationale/approach for the assessment of reproduction. Since the same individuals were not tracked over time, and since individuals in a population are not synchronous (Moore et al. 2016) it seems impossible to tell if a needed "quiescent" period was absent, for instance. It also seems unclear how the particular snapshot in time for making the assessment was chosen, and why that time was particularly informative. Thus, you need to make a clearer case for why the results are representative or predictive of individual oyster fitness or overall oyster population output or whatever you had in mind.

Line 221: in my version, symbol here that presumably represented alpha came out as box (Mac/PC issues?)

Line 225 (and 237): instead of "April 11th", give full date

Line 227 & 756: what is spawning "volitionally"?

Line 232: "viviparous spermcaster" is a bit confusing, maybe just explain they release sperm but have internal fertilization and release larvae following a brooding period

Line 289 & 298: by "differences in sex", do you mean "differences in sex ratio"?

Line 310-314: clarify why # of larvae produced per day differed by temperature, but total larvae produced did not; does not seem to follow?

Line 325: those seem like very low female numbers compared to the entire number of oysters used? Especially since you indicate most oysters had active gonads of one sort or another?

Line 337ff: instead of chi the symbol shows up as a box in my version; conversion error when pdf was made by journal, presumably

Line 355: not clear why mortality should affect this measure? Explain.

Line 358: not clear why crashing populations would have greater sensitivity

Line 361: "leveraged" does not seem like right word here, "examined", maybe?

Line 374: hard to imagine sperm are limiting reproduction within hatchery conditions?

Line 380: "this study" is ambiguous: yours or the *Macoma* one?

Line 385: replace "things" with "factors" or some other word

Line 439: add “with” after “contrast”

Line 440: “they” doesn’t make sense here – maybe combine with previous sentence

Line 468: is “plasticity” the right word here?

Line 470-474: there is some jumping around between descriptors that apply to individuals vs. descriptors that apply to populations – stick to one level of organization throughout these recommendations

Line 485: odd use of exclamation mark

Table 1: indicate the years/months when measurements occurred, and define measurement units for chlorophyll

Tables 2-3: there is so much information here that it is hard to absorb. Perhaps it’d be possible to use color coding, e.g. conditional formatting in Excel to make the high values pop out, so the reader can quickly see which treatments yielded the highest levels for each indicator?

Fig 2: extremely clear and helpful overview!

Fig 3: suggest moving this to Supplement, as most readers are ecologists and won’t be able to make heads or tails of this. Also might be helpful to add some arrows, asterisks, etc. to point out key identifying features for some/all of the photos

Fig 6: font size is too small