**Suggested minor revisions to PhD thesis (Juliano Palacios)**

1. Need to be careful in some areas of thesis with some aspects of wording around ‘climate change’ effects. There are many instances where this occurs. A good example of this is Pg 6 – “Warming and less oxygenated water contributed to changes in sizes of marine fishes”. This statement was attributed to Oke et al. 2020 but it’s a large oversimplification of what they found in regards to declining sizes of various salmon species. They never studied oxygen levels and SST was not the main driver of the relationships though it played a role (SST is clearly a surrogate for other environmental changes occurring). Fish density, and upwelling indices were stronger predictors of size changes (and reduced age of maturation). The temperature changes in the north Pacific are in the order of a 1-1.5 C or so and if anything this small amount of warming might actually benefit fish growth if food was available but fish density is so high, that density dependence was one of the strongest drivers. The decline in oxygen associated with that level of warming probably has no impact at present. I suggest you also look at recent paper that explores these relationships further in terms of affecting salmon survival (Connors, B., Malick, M.J., Ruggerone, G.T., Rand, P., Adkison, M., Irvine, J.R., Campbell, R. Gorman, K. 2019. Climate and competition influence sockeye salmon population dynamics across the Northeast Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences 77: 943–949.)

**Response:** I have changed this specific sentence to: “Warming and less oxygenated waters have also *been related* to changes in size of marine fishes” and have included another reference to support my claim. He mentions “some areas of thesis” so it is hard to be objective in the changes. I’ve read through the thesis trying to identify such areas and did some re-wording.

That being said, I do not agree with this comment. The sentence precisely says “Warming and less oxygenated water *contributed* to changes in sizes of marine fishes” I do not imply warming, and oxygen are the main nor the only drivers of size change. As Scott says, Oke et al. does test environmental variables (e.g., water temperature) and finds a contribution in sie change for some species. In addition, the other reference in the sentence (Audzijonyte et al. 2020) directly tested SST vs fish size and found changes in body size.

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1. Need some more info in thesis on how diadromous species were dealt with and how many of these you examined. They contribute to major fisheries but they might be expected to show ‘different patterns of marine distributional shifts’ because they are also locked into natal freshwater rearing areas. Would we expect their shifts to follow the same rules as fully marine species ? Is this another type of limitation that needs some discussion?

**Response:** I have included the following sentence in the Synthesis and Conclusion Chapter under Limitations and uncertainties:

In total, I analyzed 938 marine species with different habitat preference and life history. Despite all of these species being marine, some of them are considered anadromus, that is, species like salmons Chinook (\*Oncorhynchus sp\*) that spawn in fresh water (e.g., rivers) but spend most of their adult life in the ocean. In these cases, the models I used captured the "oceanic" life stage of the species but not the freshwater component. A recent study looking at climate change impacts on Chinook salmon Chinook (\*Oncorhynchus tshawytscha\*) at all life stages found a relative resilience in freshwater stages but dramatic impacts in the marine stage [@Crozier:2021gd]. Thus, while impacts that these species will suffer in freshwater environments are beyond the scope of my thesis and thus, were not considered, my results do capture the life stage where most of the impacts are expected to happen and where it challenges transboundary management [@Crozier:2021gd;@Miller:2013iv; @Song:2017va].

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3) In Chapter 4, the GoMa case study highlited some issues around distributional shifts and re-allocations associated with species that are on the verge of commercial extinction. It raised in my mind two issues that I didn’t see discussed anywhere in the thesis but which have pretty big implications to the application and extension of your work so I feel some comments in this chapter and the conclusions are warranted. The TRAC status report shows that catch over past few years is miniscule relative to recent history (eg Yellowtail - 45 Mt compared to 7000 Mt in early 2000s and 20000 Mt in early 1970s.) Similar patterns for Cod. I’m sure this is the case in many other parts of your datasets. In recent years MSY/MCP (?) are goals which are not being met and these populations especially cod and yellowtail are at record low abundances; F pressure is minimal and getting lower each year as natural F increases each year. In the near future, the allocation issue may well be mute, as commercial extinction looms. The fact that we continue to target some stocks that are ‘endangered’ is problematic (most cod stocks are designated by COSEWIC as endangered in eastern Canada) – and not touched on in the discussion.

On Pg 58 you stated that “projected stock-share gain of yellowtail flounder and haddock by the US (Figure 4.5) follows a historical trend where in 2019, Canada’s stock-share decreased from 35% to 32% and 60% to 40% relative to 2010, respectively (Lake 2019).” Given these shifts have occurred in allocation already, what does that actually mean in an absolute sense (at present, and in the future) when there are virtually no fish around to harvest?

Have you given any thought to the bigger picture issue of how to factor into your analyses the fact that many current stocks are on verge of commercial extinction so allocation may no longer be an issue, or perhaps it fundamentally changes the way we need to think about allocations? Could this become another layer in models like you are doing, wherein even if populations are able to shift their distribution resulting from climate change, there may be no fish to reallocate or harvest? Big question - how does current or expected stock imperilment factor into projecting future species distributions?

**Response:** I have included the following sentence in the Discussion of Chapter 4:

Previous international action suggests that quota allocation should not only be centered in highly valuable fisheries (i.e., in terms of catch or economic value). For example, Atlantic mackerel (\*Scomber scombrus\*) represents a small proportion of the total catch of the EU, Norway, and the Faroe Islands (Denmark) who share the stock. Yet, they have all been in dispute with Iceland over quota allocation and rights since the stock shifted in 2017 reaching Icelandic waters [@Spijkers:2017ij, Chapter 2]. Similar, Peru has recently signed an agreement with Chile to manage the southern stock of Anchoveta (\*Engraulis ringens\*) which is substantially smaller than the northern Peruvian stock [@Cashion:2018cg; @UNDP:2016wp]. These examples suggest that a future change in shared proportion of even a "small" fishery, or fraction of, could still require management adaptations in order to reduce international conflict and sustain the stock. Naturally, no strategy to mitigate climate change impacts will be beneficial if a fishery is exploited to extinction, however, reformulation of fisheries management could actually offset many of the negative effects of climate change [@Gaines:2018sg]. Thus, the impacts and solutions presented here need to be align with sustainable fisheries management.

From Gordon:

[15:24](https://coru-group.slack.com/archives/D3FFK2VFE/p1614709448008000)

First, Scott was on about salmon yesterday, saying that because salmon always return to the fresh water habitat in which they were spawned, there should be no upset in cooperative management programs due to climate change – if I understood him correctly.            If I did understand the comment correctly, I urge you to ignore it. Cooperative management arrangements concerning salmon typically involve several stocks, not one. The Canada-US Pacific Salmon Treaty is an example. Climate change can have differential effects on sets of salmon stocks, leading to stress on cooperative management arrangements. In fact, Pacific salmon provides a case in point. A decadal climate regime shift had a very positive effect on the salmon stocks off Alaska and a very negative effect on such stocks off southern B.C. and Washington and Oregon. The aforementioned Treaty was signed in 1985. The decadal climate regime shift, which caught the players unawares, led to the Treaty seizing up in 1993. The breakdown in the Treaty lasted for six years.            Secondly, Scott referred to a fisheries piece of legislation in the 1990s, pertaining to Atlantic fisheries, which he said led to the turbot war. This was all about straddling stocks, which is irrelevant to the thesis. I advise you to ignore this comments as well.

[15:25](https://coru-group.slack.com/archives/D3FFK2VFE/p1614709513008200)

I should have added that Ellen's question about whether the shifts in the patterns of transboundary fishery resources movements could lead to boundary disputes can also be ignored. I assume that she is referring to EEZ boundaries.        Changing those boundaries is a very big operation. For example, at the end of the UN Third Conference on the Law of the Sea, there was a dispute between Canada and the US over the boundary between the US and Canadian Atlantic EEZs. To settle the dispute, the two had to go to the World Court.          At some future point, you and Juliano will want to get one or more articles from the dissertation. In so doing you will have to talk a bit about how to deal with the aforementioned shifting patterns. I could offer you both a few suggestions, if you think that they would be useful. The key words are side payments and side payment like arrangements.