# Dwarf Seahorse Status Review: ID 411

Peer Review Report

We solicited review of the Draft *Endangered Species Act Status Review Report: Dwarf Seahorse (Hippocampus zosterae)* from three potential reviewers. All three agreed to the review and provided comments. Reviewer comments are compiled below and are not in the order of the reviewer identification list below.

## I. Peer Reviewers (alphabetically)

Ms. Nicole Dunham
Fish Biologist, Florida Fish and Wildlife Research Institute
St. Petersburg, FL

Ms. Julia Lawson
PhD Candidate at University of California
Santa Barbara, CA

Dr. Heather Masonjones
Professor at the University of Tampa
Tampa, FL

## II. Peer Review Directive

- Please provide comments on the scientific information and data contained within the status review report.
- If you believe that justification is lacking or specific information was applied incorrectly in reaching specific conclusions, please specify.
- If there is any information missing from the report please provide the data and the associated citation.

## III. Summary of Peer Review Comments

Major comments are addressed in the bullets below. All non-substantive edits were incorporated within the document when and where appropriate and are not repeated here.

- Overall, I agree with the assessment and enjoyed the analytical process to come to the conclusion that they should not be listed at this time.

- Many of the personal communication references have since been published and so the actual citations should reflect the literature when possible.

*Response – Updated citations*

- Page 4. Masonjones et al 2010 reports maximum temperature up to 32ºC
*Response – Range modified to 14-32 ºC and citation added*

- Page 8. Table 1. Life History Parameters Used to Develop a Dwarf Seahorse Demographic Model.
    - There are no age data in Lourie et al. (2004). This information is incorrect.
    - The cited age at maturity of 3 months is actually from Strawn (1953), not Wilson and Vincent (2000) as cited. Also, 3 months is 0.25 years, not 0.3 years. Data from the 1950s seems a bit suspect (although I am unable to access the reference). Is there a more recent estimate?

  *Response – citation for age at maturity changed to Strawn 1953. While Carlson et al 2019 relied upon the value of 0.3 for age at maturity rather than 0.25, we believe this results in a conservative population estimate within the modeled population as it would suggest fewer reproductive cycles prior to death.*
  *Dwarf seahorse maximum age in the wild is estimated at 1 year by Strawn (1953; as cited in Vincent 1996) but is empirically demonstrated to be 2-3 years in aquaria (Abbott 2003). If the maximum age is less than the two years considered in Carlson et al. 2019, then there would be fewer reproductive cycles which would lead to an overestimate of lifetime reproductive contribution. However, the RAMAS model used in Carlson et al 2019 accounts for the variability in maximum age as there is higher mortality associated with older age classes. In the current model, less than 2% of the overall reproduction came from the Age-1 or Age-2 classes and nearly 99% of the stable age distribution is Age-0. Some clarifying language has been added to the text.*

- Page 9. Table 2. Population estimates of dwarf seahorse
    - I'm concerned about these estimates considering issues associated with the life history data noted in Table 1.
    - Additionally, without any context these population estimates are essentially meaningless. Are these large or small populations for dwarf seahorse? Is the fact that the species is rare or present in low abundances of concern? Or is it naturally found in low abundances in these areas?

  *Response – we acknowledge that there is variability in the distribution and abundance of dwarf seahorse throughout the species' range. Figure 3 shows much of this variability through time and space. The status review document as a whole is considering whether concern is warranted given the current population estimates for the species. We think the most concerning subpopulation is Indian River Lagoon where poor water quality conditions and HABs have led to dramatic declines in seagrass coverage and dwarf seahorse abundance. We evaluate this subpopulation in the "Significant Portion of the Range" analysis at the end of the document.*

    - Adding another column noting whether the population is "increasing", "decreasing" or "stable" would help provide context (or – if this isn't possible – a column noting the trend in seagrass habitat availability as a proxy for how the population might be doing). Otherwise this table of population estimates has no real value.

*Response –Text within the document as well as Figures 5 and 17 show the modeled populations through time to provide context of large or small sub-population size and sub-population trajectory. Further, Figure 3 provides the trend in dwarf seahorse abundance based on FIM data. We added text to the footer for Table 2 to refer the reader to the visual representation of the trends.*

- Is there a time scale associated with this table? Does this include data from all types of fishing gear or one specific collection method/survey method? Since these number seem to be an order of magnitude higher than expected were these compared to aerial seagrass surveys to calculate population by square area or density?

*Response – The abundance presented in Table 2 is the estimated subpopulation size for each area generated for the year 2016 from Carlson et al (2019). The modeled subpopulations were estimated taking into account conservative initial population sizes (based on 5% or 10% density quantiles) derived from empirical sampling as described in the text. Aerial extent of seagrass coverage was used in the calculation of subpopulation size as there is a clear link between seagrass coverage and dwarf seahorse abundance. Post-hoc comparisons of estimated population densities resulting from Carlson et al. (2019) relative to empirical sampling suggested the abundances, while high, are lower than that expected by extrapolating field-reported densities. Substantial additional documentation was added, especially in Section 10.3, to address these concerns.*

- Page 11. Figure 3.
  - Concern over the x-axis

  *Response – The x axis for each plot extends to 2016, though the labels for some are odd years instead of even depending on the beginning of each dataset. No changes made to axis.*

  - Which gear types used in the analysis?

  *Response – This figure is not an analysis but rather a plot of data provided by FWC. While originally this figure combined the results of trawl and small seine data, we have modified to plot the results of each gear type separately.*

- Page 19. Modelled dwarf seahorse abundance
  - These numbers seem greatly exaggerated even at 10%. Is there a time series associated with the model? It was my understanding that this model and the Leslie matrix were the current estimated population size. Correct? Even after reading through the Carlson et al. (2019) paper these calculations still seem a bit high for the current Florida seashore population.

  *Response – We believe the analysis by Carlson et al. (2019) represent a conservative estimate of Florida dwarf seahorse population abundance, due to conservative assumptions made regarding starting densities, density dependence, carrying capacity, and sex ratios. We are currently unaware of any empirical data or alternative population modeling suggesting these estimates are liberal. Masonjones et al 2019 calculated a population estimate of 64,125 dwarf seahorse in their 67.5 hectare sampling* *universe though acknowledged that this is an overestimate based on the patchy distribution of the species. Regardless, if this density were to be extrapolated over the known seagrass acreage of southwest Florida from Yarbro and Carlson 2016 (includes both Tampa Bay and Charlotte Harbor), the population in this area would exceed 55 million. Extrapolating this for the known area of seagrass in Florida would yield over 950 million dwarf seahorse. Like Masonjones et al, we don't believe this is appropriate or accurate but it provides some perspective that the estimates by Carlson et al. are reasonable. Substantial text was added to Section 10.3 to provide additional context for the abundance estimates emerging from the Carlson et al. (2019) modeling approach.*

- The 'conservative' mortality rate of 30% is actually not conservative. The basis for this estimate is from studies on cold tolerance done on much larger species of seahorse. The cold tolerance could be much higher, as numerous studies indicate that smaller fish are more likely to suffer mortality from cold water than larger fish.
- In Carlson *et al*. (2019) a reference to *H. erectus* was added to ameliorate this concern, stating that survival in this species was not affected when exposed to acute temperatures. A reviewer for that article took issue with the fact that the dwarf seahorse is small and therefore cannot be compared to the other species that the 30% mortality was taken from. As a result, adding *H. erectus* as comparison ($Ht_{max}$ of 19 cm vs. the dwarf seahorse $Ht_{max}$ of 2.5 cm) does not address this key concern.

*Response – unfortunately thermal tolerance studies are not available for dwarf seahorse so Carlson et al. (2019) relied upon those for other species of seahorses as surrogates. While these may not be ideal, they represent the best available data and are likely better surrogates than other small fish species. The last major cold event that affected Florida occurred in January 2010 and resulted in widespread fish mortality around the state (Adams et al. 2011); however, FWC data for most long-term surveys show no significant reductions in relative abundance following the 2010 "Florida Freeze" and several populations have increased following that 13 day event (Fig. 3 and page 46 of the Status Review). Similarly, USGS data presented in Figure 4 also show stable or increasing dwarf seahorse density between 2010-2011.*

- Where is the support for the 25% to 50% mortality rate associated with HABS? These numbers appear arbitrary. As with the assumptions surrounding acute cold exposure these HAB-associated mortality rates are noted to be 'conservative', yet they could easily be underestimates (mortality could be 100%).

*Response – without true estimates of mortality associated with HAB events, Carlson et al. (2019) assumed 100% mortality of dwarf seahorse in areas covered by a HAB, but assumed a HAB would cover only 25-50% of the available seagrass habitat within a given estuary. This is consistent with past observations that HABs generally do not cover entire estuaries/seagrass beds at fully toxic levels, and in the case of red tide, tend to occur in the coastal zone outside the bays where most dwarf seahorse are found (NOAA-HABSOS 2018). Added text and a figure in Section 8.1 to clarify.*

- Page 19 regarding the assumed 1:1 sex ratio

- Based on the Tampa Bay population studied from 2005-2009, overall with seasons and sites combined, the sex ratio of this population of *H. zosterae* was strongly female-biased, with a ratio of males to total adults collected of 0.418 (Rose et al. 2019). Sex ratio in seahorses is consistently female biased. Also see Masonjones and Rose, 2019 for a broad survey of sex ratios in seahorses.

*Response – Given the model in Carlson et al. (2019) was based on only males, if the sex ratio is skewed to females, that would suggest the overall population is greater than what was calculated from the Carlson et al. (2019) population sizes, and the estimates would be conservative. A sentence was added to the Status Review to reflect this.*

- Page 20. Fig. 5.
  - What is causing the spike in Tampa Bay for 2011 and 2015? Was the model run with all gears and projects combined?

  *Response – The peaks in 2011 and 2015 are not necessarily spikes but rather part of the increasing trend in abundance through time modeled by the analysis. They appear as spikes due to declines in 2012 and 2016 caused by HAB events (see Fig 3 in Carlson et al 2019). The model did not rely on FIM data from multiple gears. It was initialized with conservative (lower quantile) density estimates from the literature provided in Table 2 of Carlson et al. (2019) and forward-projected using life tables and a time series of environmental stressors based on empirical observations.*

  - The same for the CH region? Were zones D and E used in this estimate prior to 2005?

  *Response – See Figure 4 in Carlson et al. (2019); there were numerous red tide events causing the sawtooth pattern in population abundance. Again, the modeled population did not rely on FIM data but rather initial population sizes were modeled based on 10% quantile density data from the literature.*

  - Florida Bay: Is this a combined data set from FWC and the USGS?

  *Response – No, this is a projected (retrospective) population size in Florida Bay from a very conservative (10% quantile) starting density. USGS density data were only used in establishing an initial population size for use in the model. Results of the retrospective analysis were compared to FWC FIM data for Florida Bay to assess the accuracy of the model.*

  - IRL: Are you using the citizen science data from FIT for 2006-2008 for the model?

  *Response – No, this is a projected (retrospective) population size in Indian River Lagoon from a very conservative (5% quantile) starting density.*

- Page 22. Table 8. There are several very recent sightings records for dwarf seahorse on inaturalist.org (with pictures attached for identification). Dates range from 2016-2019.

  *Response – While these anecdotal reports support our conclusion that this species is present in Texas, in the absence of effort data, they don't convey any meaningful information on population abundance so they were not included.*

- Page 30. Table 11. Suggestion to modify title of table to “Change in seagrass coverage between each time period”
  *Response – made the decision to leave the title as is because the table provides areas of seagrass coverage by time period and changes between time periods are inferred by the reader, not explicitly provided in the table.*

- Page 55. Figure 17. What is accounting for the spike in the TB data in 2000?
  *Response –the spike in the red line is a reflection of the relative abundance data provided by FWC where there was a large number of captures during that year of sampling. The same spike can be seen in Fig 3 and could be a reflection of sampling some high-density areas, higher proportion of seagrass sampling sites, a particularly strong year-class, etc.*

- Page 56. Red List Assessment conducted for dwarf seahorse (Masonjones et al. 2017) supports this finding, and identified dwarf seahorses as Least Concern in terms of their threat status.
  *Response – Language was added to the Status Review with the Red List Assessment as a supporting citation*

- Page 58. Figure 18. Based on this model and the previous text, wouldn’t the population in dwarf seahorses eventually increase over time due to rising water temperatures?
  *Response – increasing water temperatures were not included in the model by Carlson et al. (2019). Increasing water temperatures associated with climate change could result in range expansion. However, they may also be associated with more frequent cold weather events, which may offset any range expansion with acute mortality. It’s difficult to evaluate this complex question as there is substantial uncertainty with how this would play out in the shallow seagrass environments throughout the Gulf of Mexico.*