Overall Review and Responses to Technical Questions to "Technical Documentation to Support Development of Minimum Flows and Levels (MFL) for Florida Bay"

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I. Overview:

As a large subtropical estuary, rich in unique wildlife, Florida Bay is arguably one of the most important estuaries in the United States. Accordingly, Florida Bay has been identified as a priority water body by the South Florida Water Management District (SFWMD) which manages a significant portion of the freshwater inflow from the adjacent landmass. Estuaries depend on freshwater inputs to maintain a salinity gradient whereby a wide variety of biota can flourish, from seagrass species at the primary producer level to fish and bird species at the higher trophic levels. Unfortunately, hyper-salinity in the central portion of Florida Bay has sometimes been in the range of 50–60 during dry years. The draft document we reviewed describes an approach for establishing Minimum Flows and Levels (MFL) for Florida Bay across the land-sea interface with the Everglades. In order to better protect Florida Bay from excessive hyper-salinity resulting from low inflow of freshwater, the MFL focuses on the Everglades-Florida Bay transition zone in the northeastern portion of the Bay (from the Taylor River through Little Madiera Bay to Eagle Key Basin). The overall management goal is the maintenance of enough freshwater inflow to the Florida Bay estuary to be able to sustain habitat for submersed aquatic vegetation (SAV) in both the transitional freshwater wetlands and adjacent estuarine areas.

After considerable review of resource impacts and modeling output, the staff of the SFWMD has identified *Ruppia maritima* as the key indicator species for the transition zone. The draft document makes the argument that if freshwater inflow is adequate to ensure continued survival of *Ruppia maritima* at the estuarine interface, it will also be adequate to maintain marine seagrass species downstream (including *Halodule wrightii and Thalassia testudinum*) in the northeastern portion of the Bay. Because seagrasses occur on nearly 87% of the bottom in Florida Bay (Fourqurean et al. 2002), and because of their demonstrated importance to the abundance, growth and survival of many finfish and shellfish (Heck et al. 2003), the selection or *Ruppia maritima* by the SFWMD as an indicator species appears to be an appropriate candidate for evaluating the impacts of alternative freshwater input scenarios to the Bay.

The scientific review panel concurred that the Northeastern portion of the Bay is indeed the most logical place to set the MFL since this is an area that is most highly influenced by freshwater runoff from the dominant source in the Southern Everglades (i.e. Taylor Slough) and it is also an ideal measurement location where there is adequate historical data enabling managers to gauge changes over time. Although the present

MFL is an important first step, it would be useful to expand the salinity/resource relationships described here in the future to be able to account for additional inflows to the Bay. The proposed minimum flow requirements may be adequate for survival of *Ruppia maritima*, but the environment needs to be monitored thereafter to ensure that this is indeed a good indicator species for the rest of the system from invertebrates through fish. Also, *Ruppia* is one of the more robust species in terms of salinity tolerance and it might be possible to eventually switch to a more sensitive species (e.g. *Utricularia spp*), once the system is more stabilized and more information is available on these species in the transition zone. Of course, there may be numerous other factors, such as increased nutrient loading, the presence of pollutants, invasive species, and hurricanes, which could potentially have adverse effects *on Ruppia maritima* and other SAV (and most likely other components of the ecosystem), so an ecosystem perspective should be maintained.

The panel members generally agreed that the treatment of the ecology of seagrasses is detailed and the modeling of plant growth and competition processes is state of the art. However, there are additional pieces of information and modeling which may be helpful in strengthening the conclusions of this report. Although seagrasses affect many physical and biogeochemical processes, it is their role as essential "nursery habitats" for the juveniles of many economically-important taxa that led to the large amount of funding for research on seagrasses in the past two decades (cf. Duarte 2002). That is, the factors determining the abundance of the economically important seagrass-associated animals, and not the seagasses themselves, are of greatest interest to most citizens. For this reason, in addition to emphasizing Florida Bay seagrass assemblages, another major focus of the SFWMD should be on these animals. Surprisingly, the treatment of how altered freshwater input might affect seagrass-associated animals, termed higher trophic levels (HTL) in the MFL draft document, is much less detailed and rigorous than that given the seagrasses, and relies primarily on correlative information. While overall conclusions would probably not change significantly, additional sampling, experiments and modeling efforts could bolster the HTL portion of the Report. This is an important issue that should be addressed in preparing the final Report and in determining future work carried out by the SFWMD (in conjunction with other groups in South Florida including Everglades National Park and the Audubon Society).

We view the setting of the MFL as an important management tool since it should ensure that low flows do not present unrecoverable stress on Florida Bay. As such, the MFL might be best viewed as a field scale experiment and the inflow goal of 105,000 acre ft per year may have to be altered depending on future ecosystem responses which should be carefully monitored by the SFWMD. The review team is in agreement that an adaptive management approach needs to be taken concerning the MFL and we also agree with the Recommendations for Future Work outlined by the staff (p. 145). A flexible management approach is especially important in estuaries where sea-level rise could not only change shoreline configurations, but also ecosystem dynamics over the next several decades. Although it is not possible to gauge the magnitude of change at present, seaward incursions will undoubtedly occur by the end of the present century and these will have an impact on salinity in the transition zone. If *Ruppia* is to be maintained where it now regularly occurs, the MFL most likely will have to be adjusted upwards.

II. We provide responses to the specific technical questions raised by the District.

General Questions:

1. Does the compiled information, including data modeling tools, and literature review, provide a scientific basis for the conclusions reached?

The overall approach for establishing the MFL goal for Florida Bay is scientifically sound. The District has done a thorough job reviewing a wealth of literature for this document and there are ample supporting materials from literature reviews as well as a suite of models to support the conclusions. The various models and other analyses are fairly well integrated and provide an extensive depiction of the northeastern Florida Bay ecosystem. However, the approach is complex and the MFL document could benefit from generalized flow charts showing both model structures and interrelationships among the various models and analyses used in the development of the MFL. Also the document would be easier to follow if Appendices/supporting documentation were referred to, where appropriate, in the text. Generally, conclusions in the MFL document were well supported by literature, data and/or modeling.

2. Does the analysis identify a relationship between salinity and associated changes or defined valued components and functions of the ecosystem?

The approach taken here looks explicitly at the relationship between salinity and submersed aquatic vegetation (SAV) species (*Ruppia maritima, Halodule wrightii, Thalassia testudinum*), with the assumption that many of the valued components and functions of the ecosystem are dependent on the integrity of these habitats. This is a valid assumption, as numerous studies have shown that SAV is important as food and shelter for the rest of the community, and that they also mediate sediment accumulation, nutrient cycling and other ecosystem processes in estuaries (Kemp et al. 1983). Although the MFL document does provide information regarding the requirements of floral components of the Florida Bay Estuary (*Halodule, Thalassia* and *Syringodium*), more effort needs to be made in the future to better cover the inter-relationships of habitat, salinity and other requirements of the Higher Trophic Levels (various fish and crustaceans in particular). The specifics of the *Ruppia* in the transition zone and the GAM analyses are evaluated in more detail below (in response to question 15).

An intriguing question concerns what changes might take place if *Ruppia* were to disappear from the transition zone during extended periods of drought and/or low freshwater input? For example, would *Halodule* colonize the area formerly occupied by *Ruppia*, and if so how quickly might this happen? If *Halodule* did colonize the former *Ruppia* habitat what would this mean for the animals usually associated with *Ruppia*? Would there be a net change in primary and secondary production or merely a minor shift in the species composition of the dominant plants and animals? Alternatively, might the former *Ruppia* bed be colonized by macroalgae, and if so what would this imply for associated animals? It would be useful to see some explicit predictions of alternative ecosystem-level scenarios that might occur after the loss of *Ruppia* and its associated habitat value under greatly elevated salinities. Plants and animals interact and there is a better need to integrate the faunal work on HTLs with the seagrass efforts to address these plant-animal interactions (see comments on higher trophic levels below in question 15).

3. Does the technical approach identify the duration of salinity variation and associated impacts to valued components and functions of the ecosystem?

The approach does not focus on salinity "variation" *per se*. Rather, it identifies the maximum salinities that have the potential to negatively affect *Ruppia* (and to a lesser extent seagrasses). The primary focus on SAV is justifiable based on the understanding that it provides much of the basic structure to ecological communities in shallow waters and as such is linked to valued ecosystem components (Stevenson 1988), as described in Q 2, above. However, more attention should be directed in the future at determining salinity relationships for HTL organisms using field, mesocosm, and/or modeling studies.

4. Does the analysis identify a frequency of salinity variation that would result in loss of valued functions of the ecosystem that would persist for multiple years?

The report does not identify salinity variation, but rather provides a rationale for choosing the target salinities that would be expected to negatively affect *Ruppia*. The argument is made that the same low flows that would affect *Ruppia* would also adversely affect seagrasses, such that protecting *Ruppia* in the transition zone would concurrently protect downstream areas as well. *Ruppia maritima* is a cosmopolitan species which appears to have different salinity tolerances for seed germination ranging from 15 to 30 to 40 over its geographic range from North Carolina to Florida and southward to Brazil (Koch and Seeliger 1988, Koch and Dawes 1991). Seed germination is especially critical in regrowth after a complete dieback of plants. More specifics of the *Ruppia* and seagrass relationships are evaluated in more detail below in #5.

5. Does the indicator approach used in the document (Ruppia maritima as an indicator of overall conditions of the ecosystem) identify the threshold hydrologic and environmental conditions capable of causing impacts that take more than two years to recover in the transition zone?

Although the MFL document provides a good theoretical basis for choosing *Ruppia* as an indicator, there is also a clear need for more research on this plant coupled with continued monitoring of SAV in Taylor Slough. The document suggests that 30-day average salinities > 30 during two consecutive years would be detrimental to *Ruppia*, and that recovery would take at least 2 years. These are reasonable starting points given the information compiled for the report, but in neither case is there enough information in hand to make these statements with utmost certainty based again on the plasticity of various ecotypes of *Ruppia maritima* which have been well documented for more than a quarter century by Verhoeven (1979).

The use of correlative data, along with some recent as yet unpublished experimental data on the effects of salinity on *Ruppia* in the transition zone, to define the effects of alternative freshwater input scenarios to the transition zone of Florida Bay was clearly and logically developed, even though there are a number of questions that have not been completely answered. Some of these were noted by the Report's authors. Given the paucity of published experiments on the effects of various physico-chemical factors on *R. maritima*, data gaps still exist and it would be desirable to identify them and initiate efforts to plug them. Studies that could fill these gaps include multi-factorial experiments to evaluate the single and interactive effects of varying salinity, nutrient loading and light levels on *R. maritima* survival and growth. Such experiments are important, since changes in salinity are likely to be accompanied by changes in nutrient regime and light levels. In addition, bioassays of the effects of co-variation in all these variables on seed production and seed banks would be valuable. Thus, the correlative approach taken to evaluate the effects of salinity should be supplemented by studies designed to clarify the role of important physico-chemical variables and how they may interact with salinity.

Generally, studies to date support the conclusion that seed germination is inhibited at salinities > 30, which is consistent with literature observations. This is reinforced by the observations of the Audubon monitoring program that *Ruppia* is virtually absent when 30-day average salinities exceed 30. However, the adult plants can withstand far higher salinities for longer periods of time, so it would be useful to continue monitoring plant response to salinity, and also to develop a better understanding of the conditions (and timing) necessary for reproductive success. Recovery after 2 years is suggested based on the Audubon observations and literature reports, but again it is critical to continue monitoring to document the time-frame for recovery from the current decline, and it would be useful to have more detail regarding the salinities and the time-frame for recovery associated with the observations of Montague et al. (1989).

6. *Does the indicator approach in the transition zone identify the threshold hydrologic and environmental conditions capable of causing impacts that take more than two years to recover in northeastern Florida Bay?*

Once the *Ruppia*/salinity relationships have been finalized (see Q 5 and Q 8), identifying the appropriate flow conditions to maintain these salinities becomes a matter of relating salinity to inflow (Q 13). The analysis of flows also supports the notion that maintaining salinities < 30 in the transition zone would prevent the northeastern portion of the Bay from becoming hypersaline (> 40), which would thus provide appropriate conditions for seagrasses (*Thalassia* and *Halodule*). Thus flourishing *Ruppia* in the transition area should provide a key indicator that the downstream areas of Florida Bay do not suffer from excessive hypersalinity.

Data sufficiency:

7. Do the water budget element including rainfall, Evapo-transpiration (E-T), surface water level and flow data) described in the report provide a basis upon which to identify relationships between freshwater inflow and salinity conditions in the bay?

The water budget is appropriate for identifying the relationships between inflow and salinity, but it is incumbent upon the District to revise the current document so that the budget is clearly and consistently described. The staff response to the questions we raised during our initial review (3/27/06) helps to clarify some of this. One outstanding issue has to do with the ET estimate used for this report. The staff response to Dr Alber's question indicates that the MFL base case ET estimate was used, yet the document refers to a different estimate (53% of total solar radiation).

8. Does the information support the report's conclusions regarding the relationship between salinity and the associated changes to defined valued components and functions of the ecosystem?

Salinity is often a controlling variable in estuaries, and the report provides relevant information describing the salinity response of many key components of both the transition zone and NE Florida Bay ecosystems. However, given the focus on *Ruppia* it would be useful to determine if it can be explicitly linked to other components of the ecosystem – for example, the District should compare *Ruppia* cover with Audubon data regarding the abundance of roseate spoonbills and other birds.

9. Are the literature survey, laboratory and field studies sufficient to determine relationships between salinity and the indicator species Ruppia?

Although *Ruppia* has been well studied in regard to salinity responses, there is quite a range of reported tolerance depending on location (Koch and Dawes 1991). In addition, as described in answer to (Q 5), additional analysis of *Ruppia* is warranted. Before the MFL is finalized, we would strongly recommend re-visiting the data used to compare salinity with *Ruppia* cover (Figs. 34 and 35 of the MFL document) to determine:

- whether a logistic fit would be better than a linear relationship
- whether a different salinity-averaging period improves these relationships

Along these lines, it might be appropriate to compare *Ruppia* cover with the salinity at the time the plant germinated, particularly given the difference in tolerance between the adult plants and germination conditions. Alternatively, the average growing season salinity, or possibly the maximum salinity the plant experienced might be useful to evaluate, as any of these might be more relevant than 30-day averages.

- whether the 2000-2001 period of low *Ruppia* cover did in fact correspond to average monthly salinities > 30 or if this represents a time when *Ruppia* cover diminished as a consequence of something other than salinity (i.e. a false positive). As part of this, we would recommend incorporating the figure that shows *Ruppia* cover over time (which was shown at the public meeting on 3/29/06) and presenting it alongside continuous salinity information (i.e. as opposed to the discrete samples that were used to generate the graph presented at the meeting).

All of this analysis, as well as continued monitoring, will help determine when the critical period might be for *Ruppia* response to salinity, as well as the time-frame for recovery.

10. Do the literature survey, laboratory and field studies support the proposal that Ruppia/salinity relationships is an indicator of valued components and functions of the Florida Bay ecosystem?

The information provided could be improved (see Q 5, Q 8, Q 9), but it does support the relationship between *Ruppia* and salinity. The report also makes the case that salinities/flows that are protective of *Ruppia* will be sufficient for downstream seagrasses, but it would be beneficial to strengthen this linkage (see Q 13). The document identifies the habitat value of *Ruppia* and other SAV in the transition zone as a data gap, and this should be a high priority for future work.

Modeling:

11. Are the hydrologic and ecological models used in this study appropriate for this application? Are these models sufficiently supported by monitoring and research data (e.g. for calibration and validation) such that they yield credible evaluations tools for this application?

There are numerous models used in this analysis: two hydrologic models, a seagrass model, and a GAM analysis of higher trophic levels. These are each considered further in the questions below, but the relationships between inflow and salinity in both the transition zone and the Bay itself are appropriate for this application.

One obvious omission in the modeling efforts involves *Ruppia.* Unfortunately there was no attempt in the MFL document to match the large and commendable effort devoted to modeling the response of *Halodule* and *Thalassia* to changing environmental conditions. Perhaps *Ruppia* could be the focus of subsequent modeling efforts, but the disparity between the allocation of effort devoted to *Ruppia* versus the other two species was puzzling to the review team. The need for a modeling effort on *Ruppia* was noted by the MFL authors themselves and could strengthen the credibility of this evaluation in future years.

12. Does the 33-year hindcasting method support reasonable scientific conclusions regarding the Bay's salinity under current dry conditions in the watershed?

This approach is reasonable. Both the multiple linear regression and FATHOM models performed well under current conditions, and hindcasting was a matter of using historic information regarding inflow and rainfall. When hindcasting, the assumption is made that the current conditions such as the relative amount of inflow through different streams and bay hydrology were stable throughout the period of interest. This is probably not the case, but it is also not likely to be as important in driving salinity patterns as total inflow. Also, (although there are data limitations) there may be some value in going further back in time for additional insight into system responses.

13. Are the hydrologic models sensitive to inflows of surface water such that confidence can be placed in the location, extent and duration of the resulting salinity predictions?

There are two hydrologic models here, both of which performed fairly well. The correlation analysis relates flow at USGS gages (and elevation in the Everglades) to salinity in the transition zone, and is a fairly good predictor of observed data. The FATHOM model is adequate in Little Madiera and Eagle Key basins, although it does better in some of the other basins. It is not entirely clear why the decision was made to work with the base case if some of the alternative estimates explored in the FATHOM report would have improved the model performance for the basins in question. If it is not a large difference, this needs to be stated and quantified. If it is a large difference, then the decision should be justified. It would also be instructive to include more information regarding the relationship between the predictions made by the two methods. The information Dr. Frank Marshall presented at the public meeting (3/29/06) suggested that there was fairly good agreement between the two methods, and that should be included in the report as a way to justify comparing predicted salinities in the transition zone with those in the Bay. In addition, it will be important to revisit these predictions in the context of CERP as other efforts (i.e. FBFKFS) move forward with improved modeling.

14. Does the hydrologic and SAV modeling in northeastern Florida Bay (for Halodule and Thalassia) support the linkage between salinity conditions in the transition zone and the impacts in northeastern Florida Bay?

The hydrologic model has been discussed above (Q 12, Q 13). The SAV model output suggests that *Halodule* declines when exposed to increased salinities, although the response varies from basin to basin (Fig. 46). This is difficult to infer from the literature, as both *Halodule* and *Thalassia* have broad salinity tolerances and field observations (Fig. 40) show virtually no relationship between shoot density and salinities up to 40. It would be useful to sort the data presented in Fig. 40 by basin and compare these with model predictions for those same areas (this appears to be a separate data set than that used for model calibration). This analysis is important to pursue as a way to understand the relative importance of salinity in determining SAV patterns. It may be that salinity is not the variable driving the differential response in these basins, but rather differences in the plants' response to light, sulfide concentrations, or other factors, and the model provides a way to help understand these interactions. As we understand it, however, the goal of the MFL is not necessarily to provide everything that the plants need to thrive but rather to ensure that they are not harmed by low flow conditions. The report would also benefit from a better description of model structure, much of which is now contained in Appendix I. As part of this, it would be useful to include a better description of how shading and competition were handled.

15. Does the upper trophic level modeling support the linkage between conditions in the transition zone and ecological impacts in northeastern Florida Bay?

Generally, there are three overarching issues relating to seagrasses and higher trophic levels (HTLs) and these have relevance to the modeling efforts. The first is the important role that epiphyte grazers play in controlling the abundance of algae on the leaves of seagrasses. Much work on the effects of nutrients on seagrasses has focused on nutrient loading and how this could stimulate algae to overgrow seagrasses, along with other variables such as light and salinity. Indeed, the conceptual Florida Bay model leans heavily toward a bottom-up view of seagrass meadows (Rudnick et al. 2004), as do the seagrass modeling efforts discussed above. However, a recent meta-analysis by Hughes et al. (2004) evaluated the relative effects of nutrients and grazers in controlling algal abundance on seagrass leaves. Hughes et al. (2004) concluded that both were important, but in studies that concurrently evaluated the relative importance of both factors, grazers explained more of the variance in algal biomass than did nutrients. Therefore, it would be useful to incorporate the effect of grazers in the future updates of the *Halodule* and *Thalassia* models.

The second is that many animals use multiple habitats at various times during their life. For example, organisms may shelter in seagrass beds but forage in adjacent unvegetated substrates, or they may move back and forth between seagrass and mangrove habitats. In fact, migration among adjacent habitats is a characteristic of the life history of several of the most common fishes in Florida Bay (e.g., gray snapper, cf. Nagelkerken et al. 2002 and references therein), and the issue of habitat connectivity is important, yet thus far uninvestigated in the present modeling efforts. The central issue here is that without all habitats available, many species will not thrive, and food webs may be structured very differently depending on the availability of multiple habitats to species with complex life cycles (Valentine and Heck 2005). This raises the question of whether changes in other habitats, such as mangrove swamps, for example, might negatively affect animal species thought to be characteristic of *Ruppia* beds, but who may also rely on habitats adjacent to *Ruppia* meadows. This possibility deserves consideration in future HTL assessments.

The third is the direct and indirect effects that harvesting of fishes and other large animals may have had on south Florida ecosystems. Many taxa of snappers, groupers and other families of fishes are heavily fished in south Florida (Bohnsack et al. 1994). It is difficult to know how current densities of targeted fishes relate to historical abundances, and whether ecosystems function in ways that are similar or very different than they did before extensive fishing pressures existed. But there is reason to believe that fishing may have produced large changes in trophic relationships and habitats in Florida Bay (Jackson et al. 2001) and this topic deserves more consideration in the MFL document. In addition, it could be relevant to changing levels of seagrass consumption if waterfowl, manatees, green turtles or other grazers (e.g., sea urchins) were to increase in abundance, as well as to cascading trophic effects that could affect the entire food web structure if abundance of of higher order consumers were to change.

In general, the treatment of higher trophic levels in the draft MFL document was much less fully developed than that of the seagrasses. The nearly complete reliance on correlational (GAMS) analysis is somewhat surprising given the long history of the concerns about higher trophic levels in Florida Bay. One often looks for correlations in data sets to help formulate hypotheses that are later tested by rigorously designed experiments. In the case of higher trophic levels of Florida Bay, it does not appear that analysis has advanced very far from searching for significant correlations between selected animal abundances, physico-chemical factors and estimates of seagrass abundance to process-related research. Unfortunately, after a large effort to calculate such correlations, their magnitude was often quite low, and only modest amounts of variance (low r^2 values) in the dependent variables (animal abundance) could be explained by the independent variables investigated. For example, models were considered to be "adequate" when r^2 was greater than or equal to 0.1 and p was less than or equal to 0.1. This means that 90% of the variance in the abundance of the Higher Trophic Level species being considered could remain unexplained by the model and still be considered "adequate" (along with a very high p-value of 0.1). In most cases the amount of variance explained was between 10 and 40%, and the most important independent variables in the throw trap data set were: Julian date, habitat, *Halodule* standing crop, depth and salinity, while for the trawl data the most important variables were: region, *Syringodium*, depth, salinity and *Thalassia* and *Halodule*. The fact that Julian date and region were the best predictors in the throw trap and trawl data, respectively, does not inspire confidence in the ability of the models to be of great use in predicting faunal responses to changing salinity regimes.

Unfortunately the Higher Trophic Level modeling did not include dissolved oxygen levels as an independent variable, an omission that is puzzling in such a shallow, warm and organically rich bank and basin system like FB. Perhaps more surprisingly, the HTL statistical modeling did not include an assessment of the effects of *Ruppia*, the indicator species chosen as the focus of the Report, on the HTL species chosen for study. Indeed, it does not appear that HTL species living in the *Ruppia* habitat were sampled by any of the HTL sampling programs. This suggests a lack of coordination between the HTL investigators and the other investigators whose work appears in the Report.

The need to improve the rigor and scope of the HTL studies in Florida Bay has been commented on previously (Boesch et al. 1997; Deegan et al. 1998; Hobbie et al. 2001). Issues noted herein have been discussed in the references cited above, and include: an incomplete assessment of the habitat value of individual seagrass species, as well as macroalgae, for the larger species of fishes and crustaceans; and a similarly incomplete assessment of how changes in the relative abundance of seagrasses could affect these species. The best way to address these questions is a combination of laboratory (mesocosms) and field experimentation and this was recommended previously (Boesch et al. 1997; Deegan et al. 1998). Additional factors deserving of consideration include: how variation in infaunal and epifaunal benthic taxa, the food of most fish and crustacean taxa considered by the HTL investigators, might influence their abundance; the previously mentioned effects of epiphytic grazing species of invertebrates and fishes; a more detailed consideration of the effects of harvesting on Higher Trophic Levels and the potential for cascading trophic effects; and further investigation of interactions between filter feeding sponges, water clarity and seagrass abundance and species composition.

The reliance on correlative approaches, which were not able to explain much of the variance in the abundance of the Higher Trophic Level species selected for study, and the absence of carefully designed and executed experiments, diminishes the strength of the conclusions that can be drawn and the confidence that can be placed in predictions about the effects of altered freshwater inputs. More effort should be made to use studies (even if unpublished) on the relationships between *Ruppia* and higher trophic levels, to fill critical data gaps noted here, would strengthen the Higher Trophic Level section of the MFL document significantly.

Conceptually, linking predictions of salinity and seagrass from the FATHOM and SAV models with upper trophic level response is an attractive idea. However, this should only be used in cases where these variables (salinity, seagrass cover) were found to be important predictors of upper trophic levels in the GAM analyses. In many of the cases considered here, salinity (or seagrasses) only accounted for a small proportion of the observed variability in upper trophic level biomass, which makes this approach less informative. Moreover, *Syringodium* and/or depth were often important variables in the GAM models, and these were not considered. Although there is evidence that salinity has an effect on all of these organisms, the GAM analyses indicate that it is not necessarily the controlling factor in their distribution (at least at the salinities associated with these sets of observations). Rather than work on predicting upper trophic level response to various scenarios, a more reasonable goal for the MFL analysis might be to determine what salinities would cause them harm, either directly via their physiological response or indirectly through loss of food and habitat, and then work to ensure that salinities do not reach these levels. Mesocosms are often ideal tools to approach these type of physio-ecological issues whereby critical feedback loops found in natural communities can be elucidated.

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