Independent peer review report of ‘Predicting the effects of low salinity exposure associated with the Mid-Barataria Sediment Diversion project on resident common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, LA.’

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Representing the Center of Independent Experts (CIE)

Contents

Executive Summary

1. The Mid-Barataria Sediment Diversion (MBSD) project is part of a plan to mitigate the long-term effects of land and marsh loss. This is designed to reconnect the flows from the Mississippi River into the northern portion of the Barataria Basin, and is expected to result in significant changes in this estuarine system. Resident bottlenose dolphins (*Tursiops truncatus*) are expected to experience increased exposure to low salinity water during the MBSD operations compared to projected conditions without the diversion.

2. NMFS developed a simulation approach to evaluate the probable effects of changes in salinity on the resident bottlenose dolphin stock. Information on the spatial distribution of dolphins, simulated dolphin movements, modelled exposure to low salinity, and an expert elicitation-based dose-response curve relating exposure to low salinity to survival, to estimate expected annual survival rates for the bottlenose dolphin population. This report represents a scientific peer-review of the document "*Garrison, LP, Litz, J, and Sinclair, C. 2020. Predicting the effects of low salinity associated with the MBSD project on resident common bottlenose dolphins (Tursiops truncatus) in Barataria Bay, LA. NOAA Technical Memorandum SEFSC-XXX, 85 pgs.*"

3. Overall, this is a well written report that describes the development and application of the modelling approaches; there is clearly an impressive amount of work that has gone into this. In general, the approaches that have been applied appear appropriate and robust, and the results are generally supported considering the available input data and statistical assumptions. Nevertheless, there are number of areas of the report that require some clarification, and I have made a series of recommendations with respect to specific statistical analyses.

4. A series of spatial Generalized Additive Models (GAMs) were constructed to provide an underlying density surface for the movement models; it is recommended that the authors investigate/account for potential variation in sighting rates with environmental covariates such as sea state in the GAM models, and investigate/account for potential residual autocorrelation in the GAM.

5. Given the inherent limitations associated with the salinity modelling, the approach to incorporating uncertainty and bias in Delft3D model predicted salinity values appears broadly appropriate, and the analysis accurately describes and quantifies the uncertainty available. However, a potentially important point in the salinity model calibration is that the stations should be representative of areas/habitats utilised by dolphins. A formal comparison of station locations with dolphin density is recommended.

6. The low salinity exposure model (LSEM) is adequately described and accounts for the various sources of uncertainty that have been considered. However, I would recommend investigating the sensitivity of the value of 5 km for the maximum displacement distance in the movement models.

7. For the most part, uncertainty has been well described and accounted for when drawing conclusions. However, it is recommended that two additional areas of potential uncertainty are investigated for potential inclusion into the model; (1) uncertainty surrounding the spatial GAM predictions of dolphin density, and (2) uncertainty in the maximum daily displacement for an individual dolphin.

8. There remain major uncertainties within the analysis, particularly with respect to (1) the influence of low salinity on individual survival, (2) the accuracy of the Deflt3d model to predict projected future scenarios, and (3) other factors (not considered here) that will likely impact bottlenose dolphin survival. Nevertheless, given that the available data and the analyses presented in the report, the conclusions that have been made appear generally appropriate.

Background

The Mid-Barataria Sediment Diversion (MBSD) project is part of the State of Louisiana's Coastal Master Plan to mitigate the long-term effects of land and marsh loss. The MBSD project is a multi-decade project that is designed to reconnect the flows of freshwater, sediment, and nutrients from the Mississippi River into the northern portion of the Barataria Basin on an annual basis. In the current planning phase, several possible maximum outflow volumes are being considered, with the preferred alternative (Applicant's Preferred Alternative) capping the maximum instantaneous inflow from the project at 75,000 cubic feet per second. The actual amount of freshwater outflow into the Basin would vary depending upon Mississippi River flow volumes.

While the MBSD project is projected to create new wetlands and reduce the net land loss over the 50-year project life, the annual influx of large volumes of freshwater is expected to result in significant changes in this estuarine system. In particular, there is a resident population of common bottlenose dolphins (*Tursiops truncatus*) which is expected to experience increased exposure to low salinity water on an annual basis during the MBSD operations compared to projected conditions without the diversion. Prior studies have demonstrated that exposure to low salinity water can have negative effects on bottlenose dolphin health and survivorship. Previous studies have also demonstrated that resident populations in estuarine systems maintain strong site-fidelity even in the presence of negative environmental changes or depletions in prey availability.

In response, NMFS developed a simulation approach to evaluate the probable effects of changes in salinity in Barataria Bay, LA associated with the Mid-Barataria Sediment Diversion (MBSD) project on the resident common bottlenose dolphin stock. Daily salinity surfaces from the Delft3D hydrodynamic model were used to assess the changes in the distribution of low salinity (<5 ppt) in the Bay and subsequent projected impacts on the bottlenose dolphin population. NMFS used information on the initial spatial distribution of dolphins, simulated dolphin movements, modelled exposure to low salinity, and an expert elicitation-based dose-response curve relating exposure to low salinity to survival to estimate expected annual survival rates for the bottlenose dolphin population. The analysis focusses exclusively on the survival impacts of low salinity exposure in a given year and does not consider other ecological or environmental effects or cumulative effects over time.

The outcome of this analysis, along with information on other potential impacts of the projects on bottlenose dolphins, are described in the document "*Predicting the effects of low salinity exposure associated with the Mid-Barataria Sediment Diversion project on resident common bottlenose dolphins (Tursiops truncatus) in Barataria Bay, LA.*" and will be used to inform an Environmental Impact Statement under the National Environmental Policy Act (NEPA) and the Natural Resource Damage Assessment (NRDA) Restoration Plan under the Oil Pollution Act (OPA) to determine the probable level of impact to bottlenose dolphins from the MBSD project under a range of possible diversion scenarios. This document provides a review of the scientific information used in the low salinity exposure model based on the specific Terms of Reference (TORs) referenced below.

Description of the Individual Reviewer's Role in the Review Activities

The Individual Reviewer's Role in the Review Activities is to conduct an impartial and independent peer-review following the PWS, OMB guidelines, and the TORs below. The reviewers shall have a working knowledge and recent experience in at least one of the following: (1) population modeling, (2) quantitative ecology, and/or (3) ecology, physiology, or population dynamics of bottlenose dolphins.

The reviewer will provide a scientific peer-review of the following document:

> Garrison, LP, Litz, J, and Sinclair, C. 2020. Predicting the effects of low salinity associated with the MBSD project on resident common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, LA. NOAA Technical Memorandum SEFSC-XXX, 85 pgs.

Terms of Reference

1. Are the statistical approaches applied in each section of the document appropriate to the problems addressed and are the results properly supported considering the available input data and statistical assumptions?

2. Is the approach to incorporating uncertainty in Delft3D model predicted salinity values (described in Section II) appropriate, and does the analysis accurately describe and quantify uncertainty where possible?

3. Does the low salinity exposure model (Section III) adequately and accurately describe and account for the various sources of uncertainty (e.g., uncertainty in

the Expert Elicitation dose-response model, abundance estimation, and dolphin movement model)? Are the key model inputs described and do they represent the best available data?

4. Have the sources of uncertainty and caveats in the analysis been adequately described? Is the treatment of the bias and uncertainty in the analysis adequate given the scope and scale of the project? Are there additional potential sources of uncertainty that can be quantified and should be incorporated into the model?

5. Are the conclusions presented appropriate and supported by the available models and data?

Summary of Findings

The reviewed report consists of three sections which describe (1) the results of a photo-identification study to provide an updated abundance estimate and an assessment of dolphin spatial distribution; (2) an approach to quantify known prediction biases in a hydrographic model (Delft3D); and (3) the development and application of a model to predict the impacts of low salinity exposure on bottlenose dolphin survival under various diversion scenarios. Overall, it is a very well written report and there is clearly an impressive amount of work that has gone into the development and application of the modelling approaches.

Terms of Reference 1:

Are the statistical approaches applied in each section of the document appropriate to the problems addressed and are the results properly supported considering the available input data and statistical assumptions?

In general, the statistical approaches that have been applied appear appropriate and robust, and the results are generally supported considering the available input data and statistical assumptions. Nevertheless, I have a number of queries relating to each of the inputs to the models, and have made a series of specific recommendations below.

Abundance Estimation

1. The abundance of dolphins was estimated using closed population capture-mark-recapture models. Overall, the field methods and analytical approach appear robust and appropriate for addressing the question. However, some of the model structure descriptions were confusing, e.g. "*(c) are assumed to be equal by vary across mark sessions*".

2. It is interesting to note that there were 835 individuals in the dataset from surveys conducted during 2010-2014, and there were 477 new animals sighted for the first time in 2019 (57%). This marked increase in numbers compared to previous years has implications for the overall prediction of risk and I think that this is worthy of more investigation/discussion – whether this is due to the expansion of the survey area to include bayous and contours of marsh habitat, increased survey effort, methodological differences compared to the previous years, or new animals sighted in areas previously surveyed. This is touched upon by the authors on page 10 and it is stated that "*the newly surveyed southeastern*

region is an area with generally lower densities of dolphins than the central region and areas around the passes…[and] *there was limited exchange of animals between the southeastern area and other portions of the Bay and very few of these animals had previously been sighted prior to this survey*". Although useful information, the potential reasons and implications of the marked increase could be expanded upon. I would recommend providing more details about these new animals; where they were sighted, what age class they were etc.

Spatial Distribution

1. The relative spatial distribution of bottlenose dolphins was modeled as a function of spatial location using a Generalized Additive Model. Sightings per unit effort (SPUE), calculated as 'the number of dolphins per 100 meters of on-effort trackline', was modeled as the response variable. The authors state that "*this is a metric of relative density assuming that detection probability and the searched strip width is consistent across all transect segments*". Although this all seems appropriate, something I expected to see in the modelling was a formal test of the potential influence of environmental variables that are traditionally known to influence sighting probability. In particular, surveys were carried out in sea states ≤ Beaufort Sea state (BSS) 4; I would expect that the sighting probability (and therefore SPUE) would be markedly different in sea states between 0 and 4. While this may not be an significant issue if the spatial distribution of different sea states was effectively random throughout the study area, it strikes me that the approach may bias the results to higher SPUE in regions with consistently lower sea states (and vice versa). I would recommend investigating variation in sighting rates with sea state prior to the modelling, or specifically testing sea state as a term in the GAM models.

2. The authors state that results of the spatial GAM "*indicated that all three smooth terms (East, North, and distance from Barataria pass) were statistically significant, and the model explained 14.6% of the residual deviance*". However, I would caution about interpreting these significance values as it is not clear how potential residual autocorrelation was tested for/incorporated into this model; from the information provided, it looks like it was not. The authors describe the importance of considering autocorrelation in later analyses, so it felt somewhat misplaced not to consider it here. The potential issues are that, as the data consisted of observations collected close together in space and time, consecutive

observations are likely to be correlated beyond the underlying processes included in the model, resulting in some residual auto-correlation which violates a key assumption of GAMs. It is recommended that the authors investigate this through inspection of acf plots. If residual autocorrelation is present, it may be worth considering using GAMs within a Generalized Estimating Equation (GEE) framework. These allow for time-series of data to be modelled whilst accounting for residual auto-correlation without explicitly modelling it (Pirotta et al. 2011). This requires data to be split into discrete 'panels', between which independence is assumed but within which the autocorrelation is accounted for through robust, sandwich-based estimates of variance (Pirotta et al. 2011).

3. At present, the spatial modelling of the distribution of dolphins is relatively rudimentary given the clear complexity of the study area topography. An important result from previous tagging studies showed that in the study area, dolphins generally moved close to shore; for example, the average maximum distance from shore for Gulf locations was 1.75 km (±0.98 km, range: 0.47–4.24 km) (Wells *et al.* 2017). While this may not be critical for the purposes of this modelling exercise (to provide an underlying surface for the movement models), a more robust approach would be to use the R package MRSea (Scott-Hayward *et al.* 2013). This allows for the inclusion of Complex Region Spatial Smoothers (CReSS) which consider geodesic distances around the coast. Importantly, this avoids problems with typical spatial smoothing algorithms that smooth with Euclidean distance, often across land barriers, and produce poor estimates of distributions in topographically complex areas (Scott-Hayward et al. 2014). The description of how the predicted spatial patterns were derived from the GAM outputs; does this represent a mean prediction? Further, it is stated that "*the resulting surface is masked to exclude areas where the coefficient of variation (standard error/mean) exceeded 0.4*" – it is important to consider the potential issue of autocorrelation described above if the standard errors around the predictions are being formally used to mask certain areas; there is a risk that the standard errors may have been underestimated if autocorrelation is present and unaccounted for.

Terms of Reference 2:

Is the approach to incorporating uncertainty in Delft3D model predicted salinity values (described in Section II) appropriate, and does the analysis accurately describe and quantify uncertainty where possible?

1. The Delft3D model was used to estimate salinity levels at each simulated dolphin location under each scenario. However, it is stated that "*if the Delft3D model consistently over- or under-estimates salinity, then the resulting prediction projection of future mortality rates will be similarly biased*". Therefore, an approach to account for retrospective prediction bias based upon the comparison of model predictions vs. station observations was carried out. This used a series of cluster analyses, mixed models with an autoregressive (AR) error structure, and bootstrapping to derive distributions of mean annual bias in salinity estimates. Overall, this appears to be a practical and robust approach to quantifying and accounting for uncertainty in the salinity estimates.

2. Importantly in this application, it is acknowledged that projected future scenarios include hydrographic conditions outside of the range of natural variability used to calibrate the Delft3d model, and therefore model performance is unknown under these conditions. This is clearly a major limitation of the modelling, and, although it is outwith my area of expertise, I felt that it would provide more confidence in the approach if there were details of previous examples where this model may have been used to successfully predict salinity values during extreme events (Oliveira *et al.* 2019).

3. An important point in the salinity model calibration is that the stations are broadly representative of areas/habitats utilised by dolphins. In other words, are the bias corrections relevant to areas that are used by dolphins? Although it appears from Figure II.1 that most of the stations are close to shore, which may be encouraging given the coastal nature of the dolphins, I would recommend carrying out a formal comparison of station locations with dolphin density – i.e., are stations predominantly in areas of high or low dolphin density.

Terms of Reference 3:

Does the low salinity exposure model (Section III) adequately and accurately describe and account for the various sources of uncertainty (e.g., uncertainty in the Expert Elicitation *dose-response model, abundance estimation, and dolphin movement model)? Are the key model inputs described and do they represent the best available data?*

1. The low salinity exposure model (LSEM) was developed to predict the impacts of exposure to low salinity on the survivorship of bottlenose dolphins in the bay under various diversion scenarios. Information on the spatial distribution of dolphins, simulated dolphin movements, estimated exposure to low salinity, and an expert elicitation-based dose-response curve relating exposure to low salinity to survival were used to estimate expected annual survival rates for dolphins. Several sources of uncertainty are also incorporated into the predictions. The model outputs suggest that increasing freshwater input into Barataria Bay will result in substantial declines in bottlenose dolphin survival rates; this is predicted to result in substantial declines in bottlenose dolphin population size over the short-term. Overall, this appears to be a well-conceived and appropriate approach to addressing the question. However, I have a series of specific recommendations for each of the model inputs described below.

Spatial distribution of dolphins

2. The key model inputs are generally well described and appear to represent the best available data. However, I had a number of queries and suggestions regarding the spatial modelling described in the responses to TOR 1.

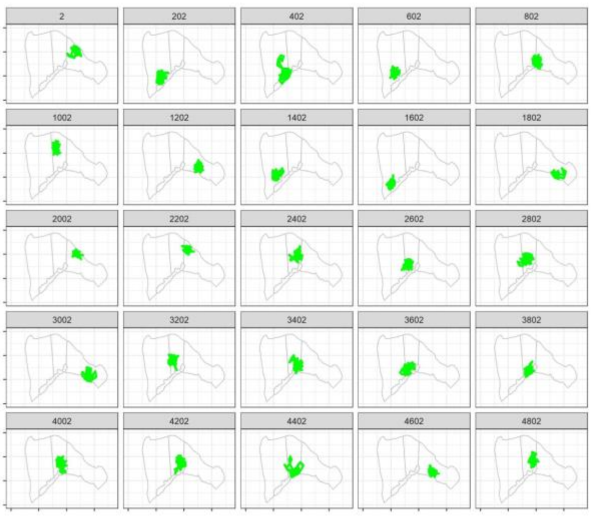
Simulated dolphin movements

3. The key model inputs for the individual dolphin movement model are generally well described and appear to represent the best available data. In particular, the model was based on the results of a previous study with an impressive sample size of dolphins tagged with satellite tags (Wells *et al.* 2017).

4. The movement model was relatively rudimentary and consisted of simulated dolphins carrying out a constrained random walk at a daily time step. Importantly, the maximum daily displacement for an individual was set at 5km. Although it stated that "*this is consistent with tag telemetry studies that demonstrated that bottlenose dolphins had relatively restricted home ranges within Barataria Bay and tended to remain within strata (Wells et al. 2017)*", to my knowledge, daily displacement values were not reported by Wells *et al.* (2017). The closest range estimates I was able to locate in the results from the

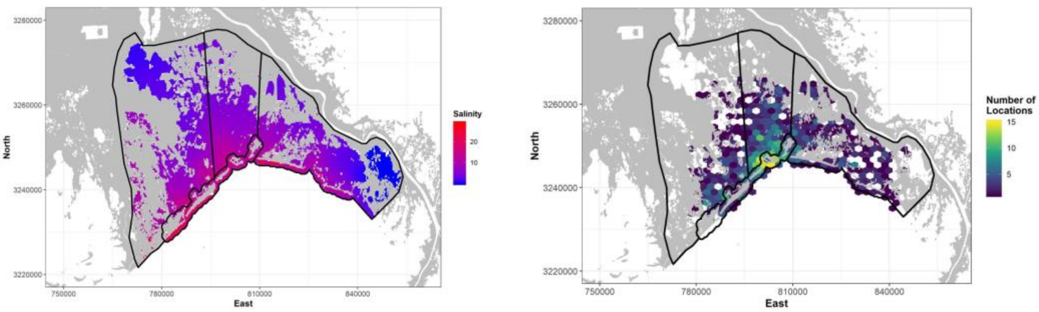
tagging showed that the mean 50% Utilisation Distribution of dolphins ranged between 7.9 and 11.2 km^2 (Wells *et al.* 2017). The description of the process of modelling movement is somewhat confusing: "*The destination cell was selected randomly from this neighborhood, with the probability selection weighted by 1/distance2 where the distance is that from the initial starting location. Because of the inverse-distance2 weighting, there was a much greater likelihood of selecting cells close to the starting location as opposed to those further away. This approach effectively constrained the movement of simulated individuals to stay in relatively close proximity to the initial starting location*". In theory, this seems to make sense – weighting the choice of cell to ensure that the simulated dolphins do not "stray" too far from the initial location. However, I would recommend clarifying why the value of 5 was chosen and the sensitivity behind its choice – perhaps a worked example would be helpful.

5. Some example movement histories of simulated dolphins have been provided in Figure III.5 (below) and it is stated that "*relatively small home ranges of simulated animals within the Bay that were generally restricted to within 5-10 km of their original starting point*". This is useful and appears to support the choice of movement parameters; however, I would also recommend presenting the final distribution of home ranges and/or mean/max displacement distances for the simulated dolphins across the year – this would allow the reviewer to better assess whether the simulated displacements were broadly representative of those observed in the tagging data (Wells *et al.* 2017). In addition, see comment related to uncertainty in the response to TOR 4.



6. Similarly, there is an implicit assumption that the tracks of the simulated dolphins are representative of real dolphin movements. While this may be a reasonable assumption to make, a potentially useful 'sense check' of the dolphin movement model would be to calculate low salinity exposures based on the real tracks of dolphins (if these are available) to ensure that they fall within the bounds of the simulated dolphin exposures. This should provide a degree of confidence that the simulated dolphin tracks, and subsequent exposure estimates are representative of those that will be experienced by real dolphins.

7. It is stated that "*areas outside of the valid extrapolation of this density grid were assigned a sampling probability of zero*." It is not clear what the valid extrapolation areas are, but I assumed that this is consistent with the exclusion of areas where the coefficient of variation (standard error/mean) exceeded 0.4. If this is the case, it is important to consider the potential issues of autocorrelation in relation to standard error estimates described in the response to TOR 1. Further, by taking this approach it seems like there is a risk that those areas which may be higher risk in terms of low salinity (towards the extreme northwest and east of the study area – figures below) may be non-/under-represented in the salinity exposure histories, thus under-estimating overall risk.



Expert elicitation-based dose-response curve

8. The influence of low salinity exposure is clearly a major uncertainty in the process; as such, the probability distributions derived during the expert elicitation (EE) process are a key component of the model. As described, this was designed to estimate changes in survival as a result of a range of difference low salinity scenarios. It is stated that "*the average BSE bottlenose dolphin in the population*" was considered. This seems unnecessarily vague, particularly when

it is highlighted that "*some weaker animals succumb early (younger age classes, very old, 'sick' animals etc)*". Given the differences in relative importance of different of age classes in population dynamics, and the likely differences in sensitivity of different age classes, I expected to see some attempt at deriving age-class specific probability distributions. This may not have been possible or deemed unfeasible by the expert panel; if this was the case, it would be worthwhile adding the reasoning behind the use of a single '*average dolphin*' probability distribution to the text, and a discussion of the potential implications of this.

9. Similarly, I was surprised that the EE process did not consider the influence of the scenarios on fecundity or fertility. For example, how many days of low salinity exposure could an individual mature female tolerate before fertility was affected. Previous studies using expert elicitation to estimate the influence of exposure of a stressor on marine mammals have considered potential impacts on both survival *and* fertility (e.g. King *et al.* 2015). As above, there may be valid reasons why this was not considered but it should be made explicit in the text.

Estimated exposure to low salinity

10. The LSEM was based on the inputs covered above (the spatial distribution of dolphins, simulated dolphin movements, estimated exposure to low salinity, and an EE derived dose-response curve) and was used to predict the impacts of exposure to low salinity on the survivorship of bottlenose dolphins in the bay under various diversion scenarios. In general, the inputs are well described, and they appear to represent the best available data (but see specific comments in relation to each input above).

Terms of Reference 4:

Have the sources of uncertainty and caveats in the analysis been adequately described? Is the treatment of the bias and uncertainty in the analysis adequate given the scope and scale of the project? Are there additional potential sources of uncertainty that can be quantified and should be incorporated into the model?

1. There are generally a number of uncertainties associated with a risk modelling exercise such as this and, as a consequence, a series of broad assumptions have to be made. It is encouraging to see that, for the most part, these have been well

described and accounted for when drawing conclusions. Although there are a number of areas where the uncertainty is clearly substantial, it is difficult to see how this could be reduced without significant targeted new research.

2. Clearly, the two major sources of uncertainty in the modeling exercise are links between low salinity exposure and individual survival (currently parameterized using EE), and uncertainty surrounding future hydrographic conditions. From this perspective, I would recommend that the authors consider carrying out a sensitivity analysis (Cariboni *et al.* 2007) to establish the relative importance of each of the input factors involved in the model.

3. An area where there is clear uncertainty but where this does not seem to have been propagated through to the LSEM is the predicted spatial distribution of dolphins. Although the methodological description is a little unclear, it is assumed that the predicted relative density (SPUE) projected over the spatial grid is based on a single mean prediction. There will be uncertainty surrounding these predictions which it seems could potentially be used to vary starting positions of simulated dolphins.

4. Similarly, at present the simulated dolphin movement model appear to be based on a single (5km) maximum daily displacement for an individual. As described above, it is unclear where this is derived from, but it is likely to vary between individuals. Information from Table 4 in Wells *et al.* (2017) (below) could potentially be used to vary the movement parameters for simulated dolphins and propagate additional uncertainty through to the salinity exposure estimates.

Table 4 in Wells *et al.* (2017)

Dolphin: FB	Sex	No. LC2+ LC3 locations	95% UD (km^2)	50% UD (km^2)	Maximum distance between locations (km)	% sightings within 95% UD	Maximum distance of sightings outside 95% UD (km)
2011 deployments							
Y01	F	289	46	9	18.8	79.0	2.3
Y03	F	70	12	4	15.5	25.0	1.7
Y00	M	131	35	8	22.4	70.3	3.4
Y02	M	85	71	10	20.8	16.7	1.8
Y07	F	196	44	8	32.5	64.7	2.9
Y09	F	67	7	2	9.4	80.0	0.7
Y11	F	62	20	4	15.2	77.8	0.9
Y04	M	102	45	15	16.4	43.8	1.5
Y13	F	279	56	17	23.6	69.2	2.4
Y15	F	19	20	6	15.8	8.0	2.5
Y17	F	222	15	3	10.7	78.6	0.3
Y08	M	67	24	4	27.5	50.0	1.4
Y10	M	155	85	21	26.8	40.0	2.4
Y19	F	24	1	0	7.4	14.3	9.7
Y12	M	56	23	7	14.0	50.0	1.1
Y14	M	266	72	16	27.2	21.4	7.8
Y25	F	201	40	13	20.2	25.0	0.9
Y27	F	267	91	21	35.7	50.0	0.0
Y16	M	76	4	1	12.2	4.3	2.6
Y33	F	164	34	7	22.0	33.3	0.2
Y18	M	312	86	18	29.9	59.3	0.5
Y20	M	188	130	25	36.7	44.8	1.3
Y22	M	162	64	8	21.2	60.9	3.0
Y37	F	301	40	11	22.0	0.0	2.5
Y39	F	143	9	3	17.1	36.0	0.9
2013 deployments							
Y38	M	399	38	8	18.5	66.7	0.0
Y40	M	311	49	9	31.7	0.0	0.0
Y42	M	246	66	10	27.3	0.0	0.5
Y44	M	239	86	15	31.5	0.0	0.8
Y46	M	177	18	4	14.7	77.8	1.8
Y65	F	244	14	3	14.6	66.7	0.1
Y67	F	182	9	2	6.8	100.0	0.0
Y69	F	176	33	7	17.9	85.7	0.3
2014 deployments							
Y71	F	68	15	4	16.3	0.0	5.1
Y75	F	122	44	10	17.2	47.8	0.7
Y81	F	67	6	1	11.7	81.8	0.1
Y83	F	40	8	3	12.6	70.0	4.6
Y85	F	33	48	11	32.4	78.6	1.3
Y91	F	173	38	8	22.8	81.8	13.7
Y97	F	67	22	7	18.1	22.2	1.6
Y99	F	86	29	4	26.2	73.7	0.2
YA1	F	170	103	19	39.1	33.3	0.1
YA3	F	146	111	23	37.3	16.7	3.1
YA5	F	42	16	3	20.9	25.0	0.8

Terms of Reference 5:

Are the conclusions presented appropriate and supported by the available models and data?

1. The outputs of the LSEM represent a series of dolphin survival estimates under each scenario, and for different sub-regions of the study area and cycles (decades). The results suggest that survival rate decreased under each alternative and the main conclusions are that:

    a. Relative to the 'No Action Alternative', the model projects that the mean population survival rate will decline by an estimated 34% (95% CL: 15.3%-62.7%) in any given year in the first decade under the 'Applicant's Preferred Alternative'.

    b. The greatest impacts would be on dolphins inhabiting the central and western portions of the Bay.

c. The projected reductions in survival would likely result in substantial declines in bottlenose dolphin population size over the short-term.

2. It is acknowledged by the authors that there remain major uncertainties with the analysis, and that other factors, not included in the modelling, will likely impact bottlenose dolphin survival. Nevertheless, given the available data and the analyses presented in the report, these conclusions generally appear appropriate and are supported by the available models and data.

Conclusions and recommendations in accordance with the TORs.

I appreciate the enormous amount of work that has clearly gone into the development of this model; it is an impressive undertaking. There are generally a number of uncertainties associated with a predictive modelling exercise such as this and, as a consequence, a series of broad assumptions have to be made. It is encouraging to see that here, for the most part, these have been well described and have been considered when drawing conclusions. With respect to each of the specific Terms of Reference, I have a number of queries and have made a series of recommendations.

In general, the statistical approaches that have been applied appear appropriate and robust, and the results are generally supported considering the available input data and statistical assumptions. Nevertheless, it is recommended that the authors (1) investigate/account for potential variation in sighting rates with sea state or specifically test sea state as a covariate in the spatial GAM models, and (2) investigate/account for potential residual autocorrelation in the spatial GAM.

Given the inherent limitations associated with the salinity modelling, the approach to incorporating uncertainty and bias in Delft3D model predicted salinity values appears broadly appropriate, and the analysis accurately describes and quantifies the uncertainty available. However, an important point in the salinity model calibration is that the stations should be broadly representative of areas/habitats utilised by dolphins. I would recommend carrying out a formal comparison of station locations with dolphin density.

The low salinity exposure model (LSEM) is adequately described and accounts for the various sources of uncertainty that have been considered. However, I would recommend clarifying why the value of 5 km was chosen for the maximum displacement distance and/or investigating the sensitivity behind its choice.

For the most part, uncertainty has been well described and accounted for when drawing conclusions. Although there are clearly a number of areas where the uncertainty is clearly substantial, it is difficult to see how this could be reduced without significant targeted new research. However, I would recommend that the authors consider carrying out a sensitivity analysis to establish the relative importance of each the input factors involved in the model. Further, it is recommended that two additional areas of potential uncertainty are investigated for potential inclusion into the model; these include uncertainty surrounding the spatial GAM predictions of dolphin density and uncertainty in the maximum daily displacement for an individual (currently set at 5km).

There remain major uncertainties within the analysis, particularly with respect to (1) the influence of low salinity on individual survival, (2) the accuracy of the Deflt3d model to predict projected future scenarios, and (3) other factors, not considered here, that will likely impact bottlenose dolphin survival. Nevertheless, given that the available data and the analyses presented in the report, the overall conclusions appear appropriate.

References

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Appendix 1: Bibliography of materials provided for review

Booth, C. Summary of an Expert Elicitation on the Effects of Exposure to Low Salinity in Estuarine Bottlenose Dolphins. Presentation.3

Booth, C. Debrief of an Expert Elicitation on the Effects of Exposure to Low Salinity in Estuarine Bottlenose Dolphins.

McDonald, T. L., F. E. Hornsby, T. R. Speakman, E. S. Zolman and others. (2017). Survival, density, and abundance of common bottlenose dolphins in Barataria Bay (USA) following the Deepwater Horizon oil spill. Endang Species Res 33:193-209. https://doi.org/10.3354/esr00806

Sadid, K., Messina, F., Hoonshin, J., Yuill, B, Meselehe, E. (2018). Basinwide Model Version 3: Basinwide model for mid-Breton Sediment Diversion Modeling. The Water Institute of the Gulf. Prepared for and funded by the Coastal Protection and Restoration Authority under TO51. Baton Rouge, LA.

Schwacke LH, Thomas L, Wells RS, McFee WE and others. (2017). Quantifying injury to common bottlenose dolphins from the Deepwater Horizon oil spill using an age-, sex- and class-structured population model. Endang Species Res 33:265- 279. https://doi.org/10.3354/esr00777

Wells, R. S., L. H. Schwacke, T. K. Rowles, and others. (2017). Ranging patterns of common bottlenose dolphins Tursiops truncatus in Barataria Bay, Louisiana, following the Deepwater Horizon oil spill. Endang Species Res 33:159-180. https://doi.org/10.3354/esr00732

Appendix 2: CIE Performance Work Statement

Performance Work Statement (PWS)
National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Center for Independent Experts (CIE) Program

External Independent Peer Review

Predicting the effects of low salinity exposure associated with the Mid-Barataria Sediment Diversion project on resident common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, LA.

Background

The National Marine Fisheries Service (NMFS) is mandated by multiple statutes to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science and without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards.

(http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf).

Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

The Mid-Barataria Sediment Diversion (MBSD) project is part of the State of Louisiana's Coastal Master Plan to mitigate the long-term effects of land and marsh loss. The MBSD project is a multi-decade project that is designed to reconnect the flows of freshwater, sediment, and nutrients from the Mississippi River into the northern portion of the Barataria Basin on an annual basis. In the current planning phase, several possible maximum outflow volumes are being considered, with the preferred alternative (Applicant's Preferred Alternative) capping the maximum instantaneous inflow from the project at 75,000 cubic feet per second. The actual amount of freshwater outflow into the Basin would vary depending upon Mississippi River flow volumes.

While the MBSD project is projected to create new wetlands and reduce the net land loss over the 50-year project life, the annual influx of large volumes of freshwater is expected to result in significant changes in this estuarine system. In particular, there is a resident population of common bottlenose dolphins (*Tursiops truncatus*) which is expected to experience increased exposure to low salinity water on an annual basis during the MBSD operations compared to projected conditions without the diversion. Prior studies have demonstrated that exposure to low salinity water can have negative effects on bottlenose dolphin health and survivorship. Previous studies have also demonstrated that resident populations in estuarine systems maintain strong site-fidelity even in the presence of negative environmental changes or depletions in prey availability.

In this analysis, NMFS developed a simulation approach to evaluate the probable effects of changes in salinity in Barataria Bay, LA associated with the Mid-Barataria Sediment Diversion (MBSD) project on the resident common bottlenose dolphin stock. Daily salinity surfaces from the Delft3D hydrodynamic model were used to assess the changes in the distribution of low salinity (<5 ppt) in the Bay and subsequent projected impacts on the bottlenose dolphin population. We used information on the initial spatial distribution of dolphins, simulated dolphin movements, modelled exposure to low salinity, and an expert elicitation-based dose-response curve relating exposure to low salinity to survival to estimate expected annual survival rates for the bottlenose dolphin population. This analysis focusses exclusively on the survival impacts of low salinity exposure in a given year and does not consider other ecological or environmental effects or cumulative effects over time.

The outcome of this analysis, along with information on other potential impacts of the projects on bottlenose dolphins, will be used to inform an Environmental Impact Statement under the National Environmental Policy Act (NEPA) and the Natural Resource Damage Assessment (NRDA) Restoration Plan under the Oil Pollution Act (OPA) to determine the probable level of impact to bottlenose dolphins from the MBSD project under a range of possible diversion scenarios.

Given the importance and magnitude of the MBSD project, it is important that the science used to predict potential impacts on survival rates in this marine mammal population represents the best available science. Therefore, the CIE reviewers will conduct a peer review of the scientific information in the low salinity exposure model based on the Terms of Reference (TORs) referenced below. Given the public interest, it will be important for NMFS to have a transparent and independent review process of the model used in this assessment.

The specified format and contents of the individual peer review reports are found in **Annex 1**. The Terms of Reference (TORs) of the peer review are listed in **Annex 2**.

Requirements

NMFS requires three (3) reviewers to conduct an impartial and independent peer-review following the PWS, OMB guidelines, and the TORs below. The reviewers shall have a working knowledge and recent experience in at least one of the following: (1) population modeling, (2) quantitative ecology, and/or (3) ecology, physiology, or population dynamics of bottlenose dolphins.

Tasks for Reviewers

1) <u>Review the following background materials and reports before the review</u>:

Booth, C. Summary of an Expert Elicitation on the Effects of Exposure to Low Salinity in Estuarine Bottlenose Dolphins. Presentation.

McDonald, T. L., F. E. Hornsby, T. R. Speakman, E. S. Zolman and others. 2017. Survival, density, and abundance of common bottlenose dolphins in Barataria

Bay (USA) following the *Deepwater Horizon* oil spill. Endang Species Res 33:193-209. https://doi.org/10.3354/esr00806

Sadid, K., Messina, F., Hoonshin, J., Yuill, B, Meselehe, E. 2018. Basinwide Model Version 3: Basinwide model for mid-Breton Sediment Diversion Modeling. The Water Institute of the Gulf. Prepared for and funded by the Coastal Protection and Restoration Authority under TO51. Baton Rouge, LA.

Schwacke LH, Thomas L, Wells RS, McFee WE and others (2017) Quantifying injury to common bottlenose dolphins from the *Deepwater Horizon* oil spill using an age-, sex- and class-structured population model. Endang Species Res 33:265-279. https://doi.org/10.3354/esr00777

Wells, R. S., L. H. Schwacke, T. K. Rowles, and others. 2017. Ranging patterns of common bottlenose dolphins *Tursiops truncatus* in Barataria Bay, Louisiana, following the *Deepwater Horizon* oil spill. Endang Species Res 33:159-180. https://doi.org/10.3354/esr00732

2) Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the PWS and TORs, and shall not serve in any other role unless specified herein. Modifications to the PWS and TORs cannot be made during the peer review, and any PWS or TORs modifications prior to the peer review shall be approved by the NMFS Project Contact.

3) Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent report consistent with the PWS. Each CIE reviewer shall complete the independent peer review in the required format and content as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review addressing each TOR as described in **Annex 2**.

4) Deliver their reports to the Government according to the specified milestones dates.

Place of Performance

Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Period of Performance

The period of performance shall be from the time of award through September 2020. The CIE reviewers' duties shall not exceed 10 days to complete all required tasks.

Schedule of Milestones and Deliverables

The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Schedule	Milestones and Deliverables
Within two weeks of award	Contractor selects and confirms reviewers
No later than two weeks before the review	Contractor provides the pre-review documents to the reviewers
August 2020	Each reviewer conducts an independent peer review as a desk review
Within two weeks after review	Contractor receives draft reports
Within two weeks of receiving draft reports	Contractor submits final reports to the Government

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards:
(1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

Since this is a desk review travel is neither required nor authorized for this contract.

Restricted or Limited Use of Data

The contractors may be required to sign and adhere to a non-disclosure agreement.

Project Contact

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Annex 1: Peer Review Report Requirements

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether or not the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the TORs.

3. The reviewer report shall include the following appendices:
    a. Appendix 1: Bibliography of materials provided for review
    b. Appendix 2: A copy of the CIE Performance Work Statement

Annex 2: Terms of Reference for the Peer Review

The reviewers will provide a scientific peer-review of the following document:

Garrison, LP, Litz, J, and Sinclair, C. 2020. Predicting the effects of low salinity associated with the MBSD project on resident common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, LA. NOAA Technical Memorandum SEFSC-XXX, 85 pgs.

The reviewers will provide input on the following questions:

1. Are the statistical approaches applied in each section of the document appropriate to the problems addressed and are the results properly supported considering the available input data and statistical assumptions?

2. Is the approach to incorporating uncertainty in Delft3D model predicted salinity values (described in Section II) appropriate, and does the analysis accurately describe and quantify uncertainty where possible?

3. Does the low salinity exposure model (Section III) adequately and accurately describe and account for the various sources of uncertainty (e.g., uncertainty in the Expert Elicitation dose-response model, abundance estimation, and dolphin movement model)? Are the key model inputs described and do they represent the best available data?

4. Have the sources of uncertainty and caveats in the analysis been adequately described? Is the treatment of the bias and uncertainty in the analysis adequate given the scope and scale of the project? Are there additional potential sources of uncertainty that can be quantified and should be incorporated into the model?

5. Are the conclusions presented appropriate and supported by the available models and data?