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SECTION 1.0 INTRODUCTION AND PURPOSE

The Newark City Council approved the Newark Areas 3 and 4 Specific Plan in 2015, following the City's certification of a Recirculated Environmental Impact Report (REIR) under the California Environmental Quality Act (CEQA), California Public Resources Code Section 21000 et seq. That certification act is final and the REIR is beyond any legal challenge and is presumed adequate as a matter of law. The City previously approved various land use entitlements for the development of Area 3 under the Specific Plan in 2016 based on the REIR. The City is now considering further implementation of the Specific Plan, including a proposed vesting tentative subdivision map and related development applications with regard to Area 4 of the Specific Plan – referred to as the Sanctuary West Residential Project.

Once an EIR has been certified as to a project or program, such as the 2015 Specific Plan REIR, CEQA generally provides (Public Resources Code Section 21166, and CEQA Guidelines Section 15162) that the circumstances requiring or allowing further CEQA review, or calling for supplemental or subsequent environmental reviews, are limited to specific situations involving substantial changes in the proposed project; or the circumstances under which the project is being undertaken; or new, previously unknowable, information of substantial importance which shows a need for new detailed investigation or analysis. When the conditions calling for supplemental or subsequent environmental review are not present, the agency can prepare an Addendum to the EIR.

Additionally, pursuant to CEQA Guidelines Section 15168, an agency can approve an activity as being within the scope of the project covered by a program EIR and no new environmental document is required provided that the triggers for subsequent environmental review are not met. In making the determination that a later activity is within the scope of a program EIR, the agency should consider consistency of the later activity with the type of allowed land use, overall planned density and building intensity, geographic area analyzed for environmental impacts, and covered infrastructure as described in the program EIR.

Separately but similarly, Section 65457 of the California Government Code provides that residential development projects, including a subdivision, that implement and are consistent with a specific plan for which a lead agency certified an EIR are exempt from further CEQA review, unless an event as specified in Public Resources Code Section 21166 has occurred after adoption of the specific plan.

The information and analysis presented in the September 2019 checklist demonstrate that no further environmental review is called for as to the proposed Sanctuary West Residential Project, because the Project is within the scope of the program Specific Plan REIR certified in 2015, and because none of the events specified in Public Resources Code Section 21166, or CEQA Guidelines Section 15162 have occurred since the certification of the REIR.

SECTION 2.0 VOLUNTARY PUBLICATION OF COMPLIANCE CHECKLIST

Circulation of the Compliance Checklist is not required by CEQA; nor are formal responses required to any comments received in response to the Checklist. The City of Newark elected to post the checklist for informational purposes for a 20-day period (September 11 through October 1, 2019); however, this posting period is not a comment period. The Checklist is still available for public review and will be considered by the City's decision makers when they consider the Vesting Tentative Map, Conditional Use Permit, and Planned Unit Development Permit. The City undertook the following actions to inform the public of the availability of the Compliance Checklist:

- A Notice of Draft Compliance Checklist was published on the City's website (http://www.newark.org/home/showdocument?id=5265);
- Copies of the Compliance Checklist were made available on the City's website (http://www.newark.org/home/showdocument?id=5267); and
- Email notification of the availability of the Compliance Checklist was sent to members of the Citizens' Committee to Complete the Refuge.

SECTION 3.0 RESPONSES TO CHECKLIST LETTERS

Although not required by CEQA, this document includes written responses to letters received by the City of Newark between October 21 and October 22, 2019. Letters received by the City of Newark prior to October 21, 2019 were addressed in the October 22, 2019 Planning Commission Staff Report.

Letters are organized under headings containing the source of the letter and its date. The specific comments from each of the letters and/or emails are presented with each response to that specific comment directly following. Copies of the letters and emails received by the City of Newark are included in their entirety in Appendix A of this document. Letters received on the Compliance Checklist are listed below.

Comment Letter/Verbal Comments **Page of Response**

REGIONAL AND LOCAL AGENCIES

A. Alameda County Water District (letter dated October 22, 2019)

Comment A.1: Stevenson Boulevard Extension and Other Identified Bridges (Section 3.2.1): As required by ACWD Ordinance No. 2010-01, drilling permits are required prior to the start of any subsurface drilling activities for wells, exploratory holes, and other excavations (i.e. installation of support piers, piles, or caissons, etc.). The installation of support piles and piers are frequently installed similar to wells and exploratory holes and may intersect an aquifer or may impact the integrity of any aquitard located directly above an aquifer. If the annular space between the excavation or borehole wall and the support pier or pile is not properly sealed, it can act as a vertical conduit and may create preferential pathways that allow pollutants to rapidly infiltrate the subsurface and impact groundwater. Conversely, specific aquifers within the Niles Cone (managed by ACWD) are under artesian conditions and the installation of a pile without a proper seal (such as a H or cast-in-steel piles) into such an aquifer may create a preferential pathway for groundwater to flow artesian which could result in a significant loss of groundwater supplies.

Based on information in the Draft Compliance Checklist, some work has been done regarding possible soil improvements for the project, as demonstrated by proposed pile design and other soil improvements identified in the Draft Compliance Checklist. As stated in ACWD's previous letters and as specified in MM GE0-1.1 "The project geotechnical engineer shall coordinate with ACWD prior to beginning any soil improvement measures to ensure impacts on groundwater resources are minimized." To date, no such coordination with ACWD has taken place. For this reason, ACWD requests the Draft Compliance Checklist specify that Project proponents coordinate soil improvement measures with ACWD.

> **Response A.1:** This comment is noted. Coordination with ACWD regarding soil improvement measures will be included as a condition of approval for the Project.

Comment A.2: ACWD records indicate the existence of at least four (4) water wells located within the Project area. Any abandoned wells located within the Project area must be properly destroyed in compliance with ACWD Ordinance No. 2010-01 prior to grading and/or construction activities. The language specifically related to abandoned wells has been deleted in the Draft Compliance Checklist by strike out (page 79). ACWD requests that the strike out be removed and requests that Project proponents coordinate with ACWD so that: a) ACWD can assist in identifying abandoned wells, and b) any wells identified or discovered during construction are properly destroyed in accordance to ACWD Ordinance No. 2010-01.

> **Response A.2:** This comment is noted. A condition of Project approval will be that Project proponents coordinate with ACWD so that: a) ACWD can assist in identifying abandoned wells, and b) any wells identified or discovered during construction are properly destroyed in accordance with ACWD Ordinance No. 2010-01. The text of the Compliance Checklist has been modified in Section 4.0, in response to this comment.

Comment A.3: There are also four (4) ACWD monitoring wells, 5S/ 1W-08P004, 5S/1W-l 7C003, 5S/1W-17C004 and 5S/ 1W-17G001 located in the vicinity of the Project area. The information collected from the monitoring wells is used in the management of the Niles Cone Groundwater Basin underlying the region. Therefore, as previously stated in ACWD's other letters, access must be maintained to ACWD's facilities including a provision that the well must be protected against being buried and/or damage during construction activities.

> **Response A.3:** The comment is noted. As a condition of Project approval, ACWD access to monitoring wells within Area 4 shall be maintained, including a provision that the well(s) must be protected against being buried and/or damage during construction activities.

Comment A.4: ACWD is currently reviewing its recycled water system master plans and as such, requirements and locations for recycled water service previously identified for the subject development may change. With that, ACWD requests the following changes to the document be considered:

The first sentence should be revised to read "The ACWD has jurisdiction of overall public water mains, appurtenances and laterals through the individual water meter or device." The second sentence should be deleted as the City of Newark does not have jurisdiction over the public water system.

The first sentence of the second paragraph should be revised to "Area 4 potable water needs will be met by an extension of the existing main within Stevenson Boulevard as well as a minimum of one additional connection from existing mains in either Mowry Avenue or Cherry Street (via the new potable water system installed in Area 3 or a direct connection(s) from the main(s) within Mowry Avenue and/or Cherry Street)."

Revise the first sentence of the third paragraph to state "Reclaimed water is not available at this time, but the proposed development may include provisions (installation of purple piping onsite) for use of reclaimed water when it becomes available."

The third bullet under "For Landscape Development Within Area 4 (page 22):" should be revised to state "May include installation of a separate, non-potable distribution system (i.e. "purple pipe") for the non-residential landscape needs. The on-site system may also include non-potable distribution mains extending to areas where recycled water could be used."

> **Response A.4:** The comment is noted. The text of the Compliance Checklist has been modified in Section 4.0 to reflect these clarifications to water system jurisdiction, water mains, and lines.

Comment A.5: The following ACWD contacts are provided so that the City of Newark staff can coordinate with ACWD as needed during the Project:

- Michelle Myers, Groundwater Resources Manager, at (510) 668-4454 or by email at michelle.myers@acwd.com, for coordination regarding ACWD's groundwater resources.

- Kit Soo, Well Ordinance Supervisor, at (510) 668-4455 or by email at kit.soo@acwd.com, for coordination regarding groundwater wells and drilling permits.
- Juniet Rotter, Development Services Manager, at (510) 668-4472 or by email at juniet.rotter@acwd.com, for coordination regarding public water systems and water service.

Response A.5: This comment is noted. The comment does not raise issues regarding the CEQA analysis. No further response is necessary.

ORGANIZATIONS, BUSINESSES, AND INDIVIDUALS

B. Law Offices of Stuart M. Flashman (letter dated October 21, 2019)

Comment B.1: I am writing on behalf of my client, the Citizens' Committee to Complete the Refuge ("Committee") to comment on the above-referenced project ("Project") and its public hearing before the Newark Planning Commission currently scheduled for October 22nd. This letter follows up on a September 27, 2019 letter submitted on behalf of the Committee by Mr. Richard Grassetti, environmental consultant, detailing procedural and substantive inadequacies in the environmental review of the Project. Those inadequacies must be corrected before the City can consider approving the Project. It also follows up on an October 1, 2019 letter submitted to the City by Mr. Xavier Fernandez of the San Francisco Bay Regional Water Quality Control Board ("Regional Board") and an email sent to the City by Kim Squires of the U.S. Fish and Wildlife Service ("Service") on September 26, 2019. Both of the latter identified specific substantive deficiencies in the City's environmental review of the Project.

The City is proceeding under the assumption that the prior Recirculated EIR for the Newark Areas 3 and 4 Specific Plan Project, along with the preceding EIR for that project, adequately addressed the potential water quality, hydrology, and biological impacts of the Project, and therefore no further environmental review is necessary. (Draft Compliance Checklist for Project, dated September 2019.) That assumption is incorrect and invalid.

There have been both changes to the Project and to the circumstances surrounding the Project as well as the release of new, previously unavailable, information related to the Project and its potential environmental impacts. All of these present the City with substantial evidence indicating that the Project will have new site- specific significant impacts and/or significantly increased impacts that were not analyzed or addressed in the prior EIR or the prior Recirculated EIR for the Newark Areas 3 and 4 Specific Plan Project. Consequently, the environmental review must be reopened and supplemented before the City can proceed to consider approving the Project.

Response B.1: Pursuant to CEQA Guidelines Section 15168(c)(4) and Government Code Section 65457, the Compliance Checklist concluded that (a) the proposed Project is a later activity within the scope of the Areas 3 and 4 Specific Plan covered in the 2015 REIR; (b) none of the events listed in Public Resources Code Section 21166 and CEQA Guidelines Section 15162 have occurred; and (c) the proposed Project would not result in any new or substantially more significant environmental impacts from changes to the Project or changes in circumstances beyond those previously evaluated and disclosed in the REIR.

Although not required by CEQA, responses have been provided to all written comments received by the City to date. The comments received do not provide new information of substantial importance identifying that the proposed Project would result in a new impact that was not previously identified in the REIR, nor an impact of substantially greater severity than was previously identified in the REIR. Therefore, no further environmental review is required.

Comment B.2: As noted in the letter from the Regional Board, both the prior programmatic EIR and the Recirculated EIR relied upon a 2007 U.S. Army Corps of Engineers ("Corps") wetlands delineation. By its own standards, that delineation's validity expired in 2012. Consequently, even if there had been no changed circumstances, the 2007 delineation should not have been relied upon in the current project-level environmental review.

However, making matters worse, there have been changed local circumstances since 2007, and indeed, since 2015, when the Recirculated EIR was certified.

For one thing, the Project itself has become far more clearly defined than it was when the environmental review of the specific plan was completed. While the specific plan only identified general area and general conceptual plans for the development on the site, the approvals currently before the City include very detailed plans identifying exactly what would be built and where it would be built. Specifically, those plans depend heavily on the 2007 wetlands delineation to identify areas that are NOT wetlands, and the project is designed to build exclusively on the non-wetlands areas. While this may be beneficial in reducing impacts to wetlands, and certainly seeks to aid the project in avoiding having to deal with a Section 7 consultation with the Service, it makes it crucial that the wetlands delineation be absolutely accurate.

In addition, while the effect of global climate change in causing a rise in sea levels was known in 2007 (and in 2009 when the Biological Resources Report for the program level EIR was prepared), recent research shows that the rate of sea level rise due to global climate change, and specifically due to glacial melting and increase in sea water temperatures, had previously been significantly underestimated. This makes it all the more important that a new wetlands delineation be done. During the time period since 2007, the sea levels in the areas west of the Project have almost certainly risen, and just as certainly have risen more than would have been expected or predicted at the time when the program EIR, or even the recirculated EIR, was prepared and certified. Because sea levels and tides are extremely local, the effects of sea level rise at this project site were not, and could not have been analyzed in the prior EIRs, and certainly not the new information showing an increased rate of sea level rise.

The supplemental biological report done in support of the checklist claims to have confirmed the continued reliability of the 2007 delineation through three "reconnaissance-level site visits" between July and December 2018. The Committee has contacted the Corps and was informed that there is no record of the 2007 jurisdictional delineation being recertified. As the letter from the Regional Board notes, the information contained in the supplemental environmental report is insufficient to allow anyone to confirm that the 2007 delineation remains valid and accurate. The mere say-so of the consultants that nothing has changed, without supporting factual evidence and data, does not constitute substantial evidence and is insufficient to validate the consultants' conclusion.

Especially given how close the boundaries of the residential areas, and the associated extensive fill, come to the boundaries of the wetlands areas, as determined by the 2007 delineation, and the importance of those wetlands areas to several federally protected species, absolute accuracy in the delineation is essential. Unless it can be confirmed that the 2007 wetlands delineation remains accurate and valid, it appears quite likely that violations of the Endangered Species Act via the take of protected species or their habitat, as well as potential violations of § 404 of the Clean Water Act,

will occur during construction. Those would be significant impacts, and could also result in the City, as well as all those involved in the construction, being subject to federal criminal liability. At the very least, the data collected by the biological consultants needs to be fully reviewed by Corps staff, who can determine whether, based on that data, the 2007 delineation can be recertified or not.

Response B.2: The City first notes that the REIR disclosed that the Specific Plan would result in the fill of up to 86 acres of federally and state protected wetlands in Area 4 and discusses a range of environmental impacts that could occur from 86 acres of fill. By significantly reducing the size of the Project from 874 units to 469 units, the implementation of the Specific Plan proposes zero acres of fill of federally and state protected wetlands. Despite the avoidance of any fill of wetlands compared to the Project as described in the REIR, the commenter avers that the proposed fill of zero acres of wetlands would have more significant or new environmental impacts on wetlands than were disclosed in the 2015 REIR disclosing 86 acres of wetland fill. The City finds this claim illogical. Commenter also appears to believe that the only way for the City to validly conclude that the implementation of the Specific Plan would in fact avoid impacts to wetlands is to require the applicant to produce a recent Corps verification of a wetlands delineation. CEQA contains no such requirement.

In 2007, the U.S. Army Corps of Engineers (Corps) issued a jurisdictional determination which determined the location and extent of "waters of the United States" (including wetlands) present on Area 4. That jurisdictional determination was based on extensive site monitoring and wetland delineation mapping conducted by H.T. Harvey & Associates (HTH) in 2005 and 2006. In 2012, HTH requested that the Corps re-verify its jurisdictional determination. On July 23, 2013, Katerina Galacatos of the Corps visited the site with then-HTH principal-in-charge Dr. Patrick Boursier. The purpose of the visit was to examine existing conditions and determine what would be needed to re-verify the jurisdictional determination. The site visit and the resulting outcome were documented in a Corps Memorandum For Record dated February 19, 2014 (copy attached as Appendix B). In it, the Corps documented that no substantial changes to the Project site had occurred since the 2007 verification. The Corps did note that there were some areas of vegetation shifts "reflecting the drier conditions of the past few years," (i.e., fewer wetlands), but concluded that the wetland delineation mapping from 2007 should remain unchanged as it was based on monitoring and mapping conducted during a period of time with more normal precipitation.

As described in the Compliance Checklist and Appendix B thereto, between mid-2018 and mid-2019 HTH updated its previous analyses of biological resources (including wetlands) and potential impacts to such resources from the proposed Project. HTH has a long history studying Area 4, and its qualified wetland biologists visited the site multiple times to inspect the wetlands. These site visits include multiple times prior to 2007 and after 2007, including several times between the 2013 Corps re-verification visit and the HTH reconnaissance surveys conducted in mid- and late 2018 to document existing conditions for the purposes of the Compliance Checklist. These wetland biologist visits included two visits by Dr. Patrick Boursier

in 2016 to assess the extent of wetlands as part of preparing a draft Nationwide Permit application for submittal to the Corps, and a visit by Kelly Hardwicke and Dr. Boursier in 2017 with the Corps and U.S. EPA to inspect the site and areas of illegal dumping committed by a third party (who was subsequently prosecuted and convicted). They concluded that recovery from the drought had allowed areas that were drier in 2013 to recover to normal circumstances consistent with the 2007 mapping. In HTH's expert opinion, with the possible exception of some areas (outside of the Project footprint) that may now be technically uplands due to illegal filling, regular and ongoing site management has maintained the 2007 distribution and location of wetlands in Area 4, and the 2007 mapping remains accurate.

The 2014 Corps Memorandum concluded that the 2007 jurisdictional determination should be re-verified, but CEQA does not require a verified delineation and HTH has confirmed that between 2014 and 2019, no substantial changes to the wetland boundaries occurred. The City finds it does not need a reissued stamped map because the determination by the Corps in 2014 that the 2007 wetland mapping remained valid is clearly documented. There is substantial evidence to conclude that sea-level rise as well as other occurrences have not affected the distribution of wetlands on the site, and especially have not affected the wetland boundaries near the proposed development, including but not limited to the following:

- The site has been farmed consistently for many decades. It is managed to maintain farmable conditions by preventing tidal inflow, and by removing surface runoff via a pump that discharges to Mowry Slough (as noted in the Corps Memorandum). Wetlands in the vicinity of the proposed development are seasonal wetlands driven by surface water that perches over the restrictive plow layer (Ap) in the heavy clay soils, and thus would not be affected by sea level rise.
- HTH has a long history studying this site using qualified wetland biologists who have visited the site multiple times to inspect wetlands. As noted above, these site visits include multiple times prior to 2007 and after 2007, including several times between the 2013 Corps verification visit and the reconnaissance surveys in 2018 to document existing conditions for the purposes of the Compliance Checklist.
- The 2014 Corps Memorandum concluded that no substantial changes to the Project site had occurred since 2007.

Finally, even if the City needed a Corps verification to determine the extent of wetlands impact (which it does not), an allegation that the Corps' 2007 verification expired in 2012 could have been raised in 2015 when the City certified the REIR. The information is therefore not "new," and cannot be the basis for a claim that supplemental environmental review is required.

Comment B.3: In addition to its effects on wetlands delineation, the recent re-evaluation of the expected rate of sea level rise creates other new and significantly increased impacts, especially with

the Project's design placing much of the residential development in close proximity to low-lying wetlands areas.

While the plans for the Project include adding extensive fill (5 to 16 feet) in the developed areas to reduce the risk of flooding, consistent with recommendations in the 2015 Recirculated DEIR, the plans do not appear to take into account recent revisions to the expected rate of sea level rise.

Response B.3: CEQA does not require an analysis of the impacts of the environment on the project, only the impacts of the project on the environment. Nevertheless, the REIR and Compliance Checklist examined the impacts of sea-level rise on the Project.

In April 2017, a working group of the Ocean Protection Council Science Advisory Team (OPC-SAT), supported and convened by the California Ocean Science Trust, published Rising Seas in California: An Update on Sea-Level Rise Science to "provide guidance to state agencies for incorporating sea-level rise projections into planning, design, permitting, construction, investment, and other decisions."[1] A 2018 update, titled State of California Sea-Level Rise Guidance, was adopted by the OPC in March 2018.[2] These documents provide the best available science to support planning for sea level rise in California and is a suitable foundation for land use and project planning. OPC-SAT anticipates updating their guidance document at a minimum of every five years based on advances in climate change science and the release of relevant, peer-reviewed studies. The sea-level rise projections included in the Compliance Checklist were excerpted directly from the OPC-SAT document.

The Project proposes to place housing on building pads elevated to a minimum of 15 feet NAVD. For context, this is 3.7 feet above the one-percent (100-year) storm surge elevation of 11.3 feet NAVD at Mowry Slough, established by FEMA in 2016; therefore, the Project would provide 3.7 feet of sea-level rise resilience above the 100-year tide elevation. Based on the OPC-SAT projections, there is a 50 percent chance that this resilience will be gone in 2140 (assuming the more conservative, high emissions scenario). Based on the "likely" range of sea level rise, there is a 33 percent chance that this resilience will be gone in 21110. Based on the "risk averse" range of sea level rise, there is a less than 0.5 percent change this resilience will be gone in 2070. The REIR established 50 years as the Project life for planning.

Comment B.4: Nor do the supplemental reports on geotechnical and hydrological aspects of the project appear to consider the increase in groundwater levels and associated increased risk of

[1] California Ocean Protection Council Science Advisory Team. *Rising Seas in California: An Update on Sea-Level Rise Science*. April 2017. Available at: http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf.

[2] California Ocean Protection Council Science Advisory Team. *State of California Sea-Level Rise Guidance*. March 2018. Available at: http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf.

liquefaction that will be associated with the increased rate of predicted sea level rise. These will all be affected by the rate of sea level rise, and all need to be re-evaluated to determine whether, with the increased rate of sea level rise, additional mitigation is needed.

Response B.4: CEQA does not require an analysis of the impacts of the environment on the project. Nevertheless, the REIR and Compliance Checklist examined sea-level rise, and also included geotechnical and hydrologic analyses.

Area 4 has relatively shallow depths to groundwater, and some exposed groundwater table, due to low ground elevations and the site's proximity to San Francisco Bay. The site overlies four aquifers in the Niles Cone Groundwater Basin: Newark, Centerville, Fremont, and Deep. An Aquifer Reclamation Program (ARP) well is located within the Specific Plan area. ARP wells remove saline water from degraded portions of aquifers.

As the mean sea level rises, the flow of brackish water into the Newark Aquifer would generally increase. Absent changes in freshwater recharge from the east (which might or might not occur with climate change), to maintain the same freshwater/salt water interface location and similar groundwater levels, the ARP wells would need to pump at higher rates. There is no indication that existing pumping systems could not accommodate higher gradients and maintain current groundwater levels within Area 4.

Because the shallow water-bearing zone underlying the site is disconnected hydraulically from the four aquifers by a layer of impermeable soil, sea level rise and the resulting higher pumping rate in the shallow water-bearing zone would not result in any changes to the four deeper aquifers.

As discussed in the REIR and Compliance Checklist, the Project would not affect groundwater levels or the intrusion of sea water from rising tides.

Soil susceptible to liquefaction generally display the following characteristics:

- Loose to medium stiff consistency
- Cohesionless (sandy or gravelly) or low plasticity (lean clay and silt)
- Saturated (below ground water table)

The Preliminary Geotechnical Exploration included in the Compliance Checklist identified historical high groundwater to be approximately five feet below the ground surface. Soil above the groundwater level generally consists of stiff to very stiff, moderate to high plasticity clay. Due to the stiffness and high plasticity characteristic of the soil, the near surface clayey soil is not considered liquefiable even if the groundwater were to rise due to sea level rise. New fill placed to raise site grades would consist of compacted engineering fill; thus, it is not considered liquefiable

even if groundwater rises with sea level rise. Therefore, potential sea level rise would not result in an increased risk of liquefaction at the site.

Comment B.5: The supplemental hydrology report does note that groundwater quality at the one measured well in Newark (site well #2) showed a dramatic drop in TDS and chloride between 2006 and 2017. The report provides no explanation for this drop, but it may reflect the rising groundwater levels due to sea level rise and the consequent backing up and rising of the fresh water groundwater underneath the site, resulting in greater apparent dilution of salinity in the groundwater underlying the site. Of course, without doing detailed analysis of groundwater flows, and the soil's permeability to groundwater, it is impossible to do a detailed interpretation of the significance to the marked changes in groundwater water quality. By the same token, however, these changes indicate that groundwater conditions are anything but static, and seismic stability and risk of liquefaction can likewise not be assumed to be unchanged from those analyzed and mitigated in the 2015 Recirculated EIR.

Response B.5: As discussed in the REIR and Compliance Checklist, the Project would not affect groundwater quality, with or without the intrusion of sea water from rising tides.

There are a number of reasons measured local groundwater quality at Site Well No. 2 may have improved between 2006 and 2017, including the effectiveness of Aquifer Storage and Recovery (ASR) wells and South Bay salt pond restoration. Sea level rise between 2006 and 2017, however, does not appear to be one of those reasons. According to National Oceanographic and Atmospheric Administration (NOAA) measurements,[3] the San Francisco Bay tides increased by 23.5 millimeters, or approximately one inch, between 2006 and 2017. By itself, this increase in tide level would have no impact on groundwater hydrology in the shallow water-bearing zone under Area 4, or the deeper water-bearing aquifers.

Comment B.6: The supplemental geotechnical report recommends that a post-approval design-level geotechnical study be done "to characterize and mitigate potential liquefaction- induced settlement and lateral deformation." This is a tacit admission that the potential risk of liquefaction has not been adequately studied and mitigated. In particular, it assumes that the study will be able to adequately mitigate any risk of liquefaction found during the study. Yet no evidence is presented to support that assumption. Mitigation of potential impacts cannot depend on post-approval studies, especially when those studies come out of a checklist that has not been subject of the rigorous comment and response process of an EIR. Consequently, due to the changes in groundwater and the change in the expected rate of sea level rise, additional analysis of seismic impacts through a supplemental EIR is needed.

Response B.6: Responses concerning the allegations of the impacts of sea-level rise are set forth above. The Preliminary Geotechnical Exploration included in the

[3] https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=9414290

Compliance Checklist adopted a conservative approach when evaluating liquefaction risk at the Project site. Liquefaction risk is, like sea-level rise, an impact of the environment on the project, rather than the project on the environment. Nonetheless, as discussed in the Preliminary Geotechnical Exploration, potential total liquefaction-induced settlements of up to 5.2 inches are anticipated at the Project site. Additional explorations will be advanced at the site during design-level studies, and the supplemental subsurface data will be used to refine the liquefaction analysis.

Liquefaction is a common geotechnical hazard around the Bay Area. Many residential developments and infrastructure have been successfully constructed in mapped liquefaction zones when geotechnical recommendations are incorporated in the design to mitigate liquefaction. REIR mitigation measures MM GEO-1.1 and MM GEO-2.1 are commonly used around the Bay Area to reduce liquefaction-induced settlement when necessary. The potential risk of liquefaction at the site has been adequately studied for the purposes of evaluating the hazard and developing the mitigation approaches.

Comment B.7: Another concern that is heightened by the increased rate of sea level rise is impacts related to the tracks used by the Capitol Corridor Amtrak train, which currently travels along tracks immediately adjacent to the Project. The prior EIRs had identified noise and vibration from passing trains as causing a potentially significant impact, and proposed placing sound walls between the tracks and the Project.

In 2014, the Capital Corridor Joint Powers Authority ("JPA") conducted a study of the effects of sea level rise on the Capitol Corridor route. As a result of that study, the JPA plans to elevate and triple track the rail line through Newark. The Alviso Adaptation Study is using California Sea Level Rise Curve 3 for evaluating alternative designs for the Capitol Corridor rail line. This design standard requires elevating the Capital Corridor Line to an elevation of 13.4 feet for sea level rise and Storm Surge plus 2 feet for wave run up for a total of 15.4 feet. This critical infrastructure project has implications for the Area 4 Project.

Raising the Capitol Corridor tracks will, among other things, require redesign of the Stevenson Overpass, as there is a minimum clearance requirement over the rail tracks. It would be best to take that into account now, before the Project is approved, as significant additional costs are likely to be involved.

As noted, the EIR proposed to mitigate noise and vibration impacts from passing trains by placing a sound wall between the tracks and the project. If both the tracks and the housing are to be raised by 10-15 feet, the sound wall would likewise need to be raised by at least an equal amount. This raises questions about the stability of the sound wall, especially in an area subject to soil liquefaction. The supplemental EIR should address whether modification of the previously proposed mitigation is needed.

In addition, the California Rail Plan calls for increasing the frequency of service of Capital Corridor trains, as well as potentially widening or moving the right-of-way. The supplemental EIR needs to take into account how this now reasonably foreseeable future project will affect this Project,

especially because one of the main alternative alignments would run the train tracks right through the middle of the Project.

Response B.7: The 2014 Capitol Corridor JPA Sea Level Rise Vulnerability Assessment noted in the comment is a regional-scale study "intended to help CCJPA staff in planning for future impacts….due to climate change." None of the six identified focus areas in the study included the Area 4 Project site. The assessment does not represent a project, and is only the first step in a possible regional adaptation strategy. Further, the assessment identified general vulnerabilities, but did not include specific recommendations for future improvements, such as those noted in the comment.

The 2018 California State Rail Plan "establishes a statewide vision" for general rail service improvements, and does not represent a project. The plan does not discuss improvements specific to the Project site.

The Alviso Wetland Railroad Adaptation Alternatives Study is ongoing. The study area is limited to Santa Clara County and does not include the Project site. For these reasons, these three studies do not create any requirements for or establish any restrictions on private landowners or local governments.

The design of the Stevenson Boulevard extension was originally contemplated in the Specific Plan as converting an existing at-grade crossing to a separated grade overcrossing for public safety needs. The Newark Area 4 Project's overpass design has been shared with UPRR, and UPRR has not requested a redesign to accommodate any preliminary planning studies. The overpass design is proposed to meet UPRR's current design guidelines of a 23-foot, 4-inch clearance between the top of the rail and the overpass. Furthermore, UPRR's design guidelines require the bridge structural supports to be located outside of UPRR's right of way, allowing for future track expansion and for their access road.

Because the raising of the tracks is contemplated in a preliminary study, the impacts of such actions would be examined at the time the JPA study progresses and requires coordination with the surrounding jurisdictions and stakeholders. As the JPA study progresses, noise levels would be analyzed to determine the feasibility of the proposed alternatives in the JPA study. The outcome of the JPA study is speculative at this time and does not fall within the scope of the current Project.

Similarly, any future changes to the existing 100-foot UPRR right of way would require feasibility analysis and coordination with the adjacent landowners. Currently, UPRR has a provision to maintain space for future track expansion within their own right of way. A future alignment crossing through the Area 4 site could potentially have significant environmental impacts, which would be evaluated at the appropriate stage in the study process. These future studies do not fall within the scope of the current Project, which has already evaluated environmental impacts and adopted mitigation measures in the certified REIR.

Comment B.8: A just-released report from the Federal Reserve Bank of San Francisco entitled Flood Risk and Structural Adaptation of Markets: An Outline for Action discusses some of the consequences of sea level rise in the Bay Area as it relates to real estate development and its financing. The report finds that properties that may be affected by sea level rise have their property value decrease as the likelihood of flooding increases. Thus, as sea levels continue to rise, home values drop, such that long before the properties are literally under water, they are financially "under water" – that is, their mortgage balances exceed the property values.

As the Great Recession of 2007-2008 demonstrated, under those circumstances, many homeowners, rather than continue to pay down a mortgage on the property at a loss, will default on their loan and allow the mortgage to be foreclosed. As a result, banks would be left with many properties – or, in the case of a project such as this, entire subdivisions – of vacant and unsellable homes. The end result would be blight on a massive scale. While the loss of financial value is an economic impact. The resulting blight is a secondary physical environmental impact. With the increase in the expected rate of sea level rise, such blight is a very real potential long-term impact from this property's development as proposed. Since this site-specific impact was not addressed in the prior EIRs, it should be addressed in a supplemental EIR prior to the City making any decision on approving this project.

That same article also notes that continuing to allow development in vulnerable areas such as this can have impacts beyond the specific development. If the City is required to spend public funds attempting to protect the public infrastructure installed along with this development, it will draw funds away from other needed infrastructure maintenance and improvement projects, resulting in a city-wide deterioration of infrastructure, such as happened, for example, in Detroit. Again, this issue involves not only economic impacts, but secondary physical environmental impacts, and needs to be examined in the supplemental EIR.

> **Response B.8:** The Compliance Checklist includes an updated analysis of hydrology and the Project's resilience to sea level rise. Refer to previous Responses C.7 and C.8 to the letter dated October 1, 2019 from the San Francisco Bay Regional Water Quality Control Board. As noted in the REIR and Compliance Checklist, the Project would abide by the City's Municipal Code Flood Ordinance, and the Project would provide sufficient freeboard from 100-year flood events under low, intermediate, and high sea level rise projections. There is no evidence provided in the comment that the Project would result in city-wide deterioration of infrastructure, and any evaluation of such a scenario would be entirely speculative.

Comment B.9: The EIR (and Recirculated EIR) for the Areas 3 and 4 Specific Plan proposed general mitigation for impacts to the salt marsh harvest mouse ("SMHM"). It noted that since the location and extent of development in Area 4 were not yet available, the mitigation might need to be revisited and revised. The checklist asserts that the mitigation proposed in the EIR and Recirculated EIR remains valid and adequately mitigates potential impacts on salt marsh harvest mouse habitat. This assertion is incorrect.

As noted in the letter from the Regional Board, new information has become available since the certification of the Recirculated EIR. That information4 indicates that areas outside of "traditional" habitat also support the species (e.g., diked seasonal saline, fresh water, and brackish marsh areas, as well as potentially adjoining upland areas). The analysis of SMHM habitat areas and project impacts on these areas needs to be revisited and reevaluated in a supplemental EIR based on this new information, which indicates that the SMHM may occupy a considerably wider area than has been assumed, and therefore may require additional habitat area.

In addition, the prior EIRs noted that, with sea level rise, additional habitat for the SMHM will be needed as in some current areas the water level may become too high to serve as SMHM habitat. The prior EIRs noted that because the area contained a mixture of wetland and upland areas, some low-lying upland areas could be recruited as wetlands and replace lost SMHM habitat. Therefore specific mitigation for lost habitat due to sea level rise was not needed.

The current project plans, however, involve blocking expansion of the wetlands areas due to the development project and the raised height and fill for the housing sites. The new detailed plans foreclose the ability to recruit most upland area in Area 4 into new wetlands as sea levels rise over time. As a result, it appears that the Project will negatively impact the SMHM and its habitat in ways that are site-specific and could not have been addressed in the prior EIRs. These adverse impacts must be studied, addressed, and, if possible, mitigated in a supplemental EIR.

Response B.9: This commenter and others have suggested that research results issued after certification of the REIR, including the 2019 dissertation by Katherine Smith, entitled *Ecology and Conservation of the Salt Marsh Harvest Mouse in the Modern San Francisco Estuary*, represents new information regarding the biology and habitat use of the salt marsh harvest mouse (SMHM) that was not known or considered in the 2015 REIR and that would modify the assessment of impacts to the SMHM in the 2015 REIR and therefore in the Compliance Checklist. For example, commenters have suggested that because Ms. Smith found the SMHM to occur in habitats other than tidal salt marsh, H. T. Harvey's assessment of the distribution of the species on the Sanctuary West Project site was inadequate because it did not include some non-salt marsh habitats where the species could potentially occur.

The City disagrees with the suggestion that the findings of post-REIR research would change how SMHM habitat was mapped, and how impacts and mitigation requirements were assessed, for the Sanctuary West Project. Although the discussion of the distribution of the SMHM on the Project site in HTH's 2019 Biological Resources Technical Report focuses on pickleweed-dominated salt marsh, HTH appropriately mapped all areas that should be considered potential SMHM habitat, even taking Ms. Smith's dissertation findings into consideration, for several reasons:

(a) All of the potential SMHM habitat mapped on the Project site was diked/non-tidal marsh; none was tidal. SMHM have long been known to occur in diked marshes, as noted in Ms. Smith's dissertation. That dissertation suggests that the value of diked marsh to SMHM may be greater than was previously known, but HTH did not exclude any areas as potential SMHM habitat because they were

diked, nor did HTH's impact assessment or the REIR mitigation requirements discount the value of potential SMHM habitat on the Project site because it was diked rather than tidal. Therefore, nothing in the 2015 REIR or the 2019 Compliance Checklist is inconsistent with Ms. Smith's findings that diked marsh can provide high-quality habitat for the SMHM.

(b) HTH's mapping of potential SMHM habitat, in Figure 6 of the 2019 Biological Resources Technical Report and Figure 4.4-1 of the Compliance Checklist, included considerable areas that were mapped as "brackish marsh", "seasonal wetland", or "ag field/seasonal wetland – saline to brackish", in addition to areas mapped as "diked salt marsh." Appendix A to this Response to Comments document shows the areas that were considered to represent potential SMHM habitat, overlain on the habitat mapping performed for the Project. This figure shows that HTH did not restrict its designation of potential SMHM habitat only to salt marsh. Therefore, nothing in the 2015 REIR or the 2019 Compliance Checklist is inconsistent with Ms. Smith's findings that brackish habitats supporting vegetation other than pickleweed can provide high-quality habitat for the SMHM.

(c) The commenter noted that SMHM can occur in upland habitat adjoining suitable wetland habitat for SMHM. The ability of SMHM to occur in upland transitional habitat has long been known, and Ms. Smith's documentation of upland habitat use by the SMHM is not new information. The text of the 2019 Biological Resources Technical Report mentions that there is some potential for SMHM to occur "in narrow strips of well-vegetated agricultural habitats and ruderal areas" adjacent to suitable marsh habitat for the SMHM. Appendix A indicates that a few areas that were mapped as "upland agricultural" and "ruderal herbaceous field" habitats were included in the mapping of potential SMHM habitat. Therefore, Ms. Smith's findings of SMHM use of certain upland habitats adjoining wetland habitats do not change the mapping of SMHM habitat for the Project.

It is important to note that the mapping of potential SMHM habitat on the Project site was not based solely on whether areas were tidal vs. non-tidal, saline vs. brackish/fresh, or wetland vs. upland. HTH's mapping of habitat as potential SMHM habitat was based primarily on which areas had been and are regularly disked and cultivated vs. those areas that had been left relatively undisturbed. The vast majority of the Project site has been subject to regular disking, multiple times per year, and agricultural cultivation for decades. Those heavily and regularly disturbed areas do not provide suitable SMHM habitat, and there is no "new" information to suggest otherwise. When mapping the distribution of potential SMHM habitat on the site, HTH first looked at the areas that were subject to regular disking and excluded those as potential SMHM habitat, as they do not provide suitable cover for the species. In the area east of the diked salt marsh at the former Pintail Duck Club, for example, the boundary of potential SMHM habitat was determined by the boundary between the disked and

cultivated fields and the areas (which included a variety of habitat types, including some upland habitat) that were not disked and cultivated. Areas that were not disked and cultivated, and that were contiguous with the extensive marsh/seasonal wetland habitat around the former duck club, were identified as potential SMHM habitat. A few additional areas were also identified as potential SMHM habitat, including a ditch along the north side of the agricultural road running east-west in the central portion of Area 4; the ditch that follows the southeastern border of Area 4; a remnant slough leading northeastward from the pump in the southern part of Area 4; and isolated, limited areas of seasonal wetlands in the east-central part of Area 4. Although these very narrow, and somewhat isolated, strips of vegetation provide relatively low-quality habitat (e.g., it is possible that they may be unoccupied by SMHM due to their very narrow nature and proximity to disturbance by disking and cultivation), these were nevertheless identified in HTH's mapping as potential SMHM habitat. Areas that were both undisked and were not identified as potential SMHM habitat included ruderal and scrub habitat that was dominated by those plants, and/or contained habitat structure, that is not characteristic of suitable SMHM habitat.

The City also disagrees with the suggestion that additional mitigation is necessary for lost opportunity for SMHM habitat migration with sea level rise. Under CEQA, it is appropriate to assess impacts relative to baseline conditions, and the baseline condition of the majority of the Project footprint includes regular disking and cultivation that precludes suitability for SMHM. CEQA does not impose on the Project an obligation to mitigate for loss of migration opportunities due to a global phenomenon such as sea-level rise. In addition, there is extensive area within Area 4 that is both outside the Project footprint and that is currently unsuitable for SMHM due to regular disking and cultivation. It is not incumbent upon this Project to enhance such areas for use by SMHM (beyond the mitigation requirements in Mitigation Measure BIO-8.4).

Comment B.10: When the program EIR was certified, details were not available regarding either the location of the constructed development within the sub areas or the scope of the proposed residential development. At this point, plans have been released showing that while the Project does not propose extensive intentional wetlands fill in conjunction with the project, it proposes adding fill up to the very edge of wetlands areas, with 3:1 or 2:1 slopes at the transition between fill and wetlands, information that was not provided in the EIR or REIR. With that kind of slope, there is no room for error. Indeed, it can be predicted that there will be erosion of some of the fill soil, or potential slumping of material, which will be carried into the wetlands area. Not only will this result in fill of the wetlands area, thus requiring a permit from the Corps and the Regional Board; it will also potentially carry pollutants from the fill dirt into the wetlands. Neither of these results were predicted or analyzed in the program EIR, yet they could result in significant impacts in terms of loss of wetlands due to fill and detrimental water quality impacts in the wetlands that could adversely affect RARE and WILD beneficial uses of the wetlands areas. These potentially significant impacts should also be analyzed through a supplemental EIR.

Response B.10: The City is entitled to assume that fill slopes would be designed to be stable, and would be rocked to prevent erosion of fill material. The Project must also comply with the Statewide Construction General Permit and the NPDES Municipal Regional Stormwater Permit to control both construction and post-construction releases of materials (such as stormwater that could carry fill-based sediment) off of the site. The toe of fill slope is typically set a few feet back from the wetland boundary, ensuring there is adequate space in the event the toe of slope shifts. In a few areas, the toe of slope comes within a couple feet of the wetland boundary. In these cases, the contractor may use form boards to help ensure the fill placement of the slope does not slump into the wetland areas. The wetland areas would be staked and clearly marked in the field to ensure all construction personnel are aware of the boundaries. Erosion control measures such as silt fencing and fiber rolls would be used during the construction process to ensure the wetland boundary is respected, much like a property boundary. The finished grade fill slope would consist of planting and include a landscape design that allows slope stability and limits soil and sediment transport into the wetland area. The Project would not fill any wetlands, either directly or indirectly through surface runoff and erosion. The commenter has not presented any new significant information requiring supplemental environmental review.

Comment B.11: The Response to comments on the checklist asserts that, as mitigation for the potential erosion of the added fill along the western Project border, where the Project abuts wetlands, the slopes will be "armored" with riprap. While riprap may help prevent erosion, it is also well known for harboring rodents (e.g., mice, rats), which would be predators and/or competitors of the SMHM living in the adjoining wetlands. This potentially significant secondary impact needs to be addressed in the supplemental EIR.

Response B.11: An increase in species such as house mice and non-native rats as a result of the Project was explicitly discussed in the impact assessment for SMHM in the REIR.

Comment B.12: In addition, Appendix E of the Checklist identifies another potentially significant secondary impact that should be analyzed in a supplemental EIR:

> If slope instability conditions, such as a "mud wave", are identified in the additional design-level geotechnical exploration, the required design-level geotechnical exploration would ensure that appropriate design details, such as properly placed retaining walls or staging of fill placement, will be provided to prevent a potential "mud wave" from forming at the toe of the fill slope.

Analysis of potential impacts such as "mud waves" should not be put off to post- approval studies when it is not self-evident that successful mitigation is possible. Their potential for forming, and appropriate mitigation (if feasible), should be discussed pre- approval in the supplemental EIR.

Response B.12: The design-level geotechnical report conducted pursuant to REIR mitigation measure MM GEO-3.1 will include a slope stability analysis to

further evaluate the risk of slope deformation and instability along the perimeter slopes of the Project during grading, surcharge program and post-construction static and seismic conditions.

Mud waves can develop as a result of slope instability when fill is placed too rapidly and steeply along bay margins. Numerous residential developments have been constructed around the Bayfront of the San Francisco Bay, and the ways to prevent mud wave are well understood by the geotechnical community and specifically ENGEO.

Pursuant to REIR mitigation measure MM GEO-3.1, the Project applicant engaged ENGEO to undertake a site-specific investigation resulting in the Preliminary Geotechnical Report, which states graded slopes up to six feet may be constructed at an inclination of 2:1 (horizontal:vertical), and recommends measures for reinforcement as anticipated by the REIR, including geogrid reinforcement. If slope instability conditions, such as risk of a "mud wave", are identified in the additional design-level geotechnical exploration, the required design-level geotechnical exploration would include development of appropriate design details, such as properly placed retaining walls or staging of fill placement, to prevent a potential "mud wave" from forming at the toe of the fill slope. It is speculative to assume that the Project sponsor and its engineers would be unable to design the slopes near wetlands to withstand a mud wave and to require the City to prepare a supplemental EIR to study this unlikely possibility.

Comment B.13: As the Regional Board's letter points out, the location and distribution of the residential areas as proposed in the Project results in a much larger interface between residential and wetlands areas than was evaluated in the EIR or Recirculated EIR. While the prior EIRs attempted to evaluate and mitigate secondary impacts resulting from this proximity, the much larger scope of that interface in the Project will greatly increase the potential for such secondary impacts (e.g., predation on wildlife, including listed species, by household pets, spread of human-associated pests such as house mice and rats into the wetlands areas, and increased predation by human-associated wildlife (e.g., raccoons, skunks, opossums).

While the EIR proposed various mitigation measures to attempt to reduce these secondary impacts, the increase in the size of the interface area and the close proximity of the housing in the Project to the sensitive wetlands, and the resultant increase in the significance of secondary impacts requires reevaluation of the efficacy and effectiveness of the proposed mitigation measures (e.g., by study of their effectiveness as applied in other similar projects.) Unless they can be shown to be highly effective, the indirect impacts should be disclosed as significant and unavoidable, and alternatives that would reduce the secondary impacts (e.g., by concentrating the development in smaller areas or areas more removed from the wetlands areas) should be considered.

Response B.13: Indirect impacts to wetlands and water quality were thoroughly analyzed in the 2015 REIR, and the REIR prescribed mitigation measures that require the Project stormwater design to take into account local watersheds to ensure continued discharge of contributing hydrology as treated stormwater into the

surface water-based wetlands (see MM BIO-1.2 and MM HYD-1.1 through 1.4). Invasive weeds that could affect the undeveloped areas would be controlled and minimized via a site-specific invasive species control plan (MM BIO-11.1). MM BIO-1.2 goes beyond typical Municipal Regional Permit (MRP) requirements for stormwater design that is required by the Regional Boards to ensure continued hydrological inputs. Invasive species control plans are current industry standards for preventing the introduction and spread of weed species. An increase in non-native and nuisance species as a result of the Project was explicitly discussed in the REIR. For example, MM BIO-4.7 requires the preparation of a predator management program, which will address impacts of predation on sensitive species. The direct impacts to 86 acres of direct wetland fill are much greater than the alleged indirect impacts of avoiding any acres of wetland fill.

Comment B.14: Another potential secondary effect of placing so much development that close to wetlands is that it would increase the need for far more intensive efforts at mosquito control. Wetlands areas are known to breed a variety of mosquito species, including species that attack humans and can be anything from a nuisance to a public health risk. The more residential development that occurs in close proximity to wetlands, the stronger will be the pressure to reduce mosquito populations by any means necessary.

While the Alameda County Mosquito Abatement District, which would be responsible for mosquito control, relies primarily on biorational pest control, particularly the use of bacillus thuringiensis israelensis (Bti) pellets, it also uses mosquito fish, which are strongly discouraged from use in wildlife areas. In extreme cases (e.g., spread of West Nile Disease or related viruses), the Abatement District has had to resort to aerial spraying of adulticide insecticides. These can have significant adverse effects on wildlife, especially fish and migratory birds that rely on insect populations as in their diet. The potential for such adverse effects must be considered as another potentially significant indirect impact from placing the residential development in such close proximity to wetlands areas, especially ones with listed species.

Response B.14: The vast majority of wetlands on the Project site are saturated near the surface but do not pond water, and therefore do not provide suitable mosquito breeding habitat. Mitigation Measure BIO-2.4 of the REIR describes how perennial ponding within existing seasonal wetlands, which would increase mosquito breeding habitat if it were to occur, would be avoided. Therefore, relative to baseline conditions, the Project would not result in an increase in the extent or suitability of mosquito breeding habitat, and there is no basis to speculate that the Mosquito Abatement District would be required to engage in additional abatement techniques that would rise to the level of a new significant environmental impact.

Comment B.15: Because of the changes to the Project and to circumstances surrounding the Project and new information affecting the Project's potential impacts, all of which are specific to the Project site and hence could not be addressed in the EIRs for the specific plan, the use of the checklist form is improper, as is its conclusion that no additional or increased impacts results from the Project that were not studied in the specific plan EIRs.

A supplemental EIR is required to address the new/significantly increased Project impacts. Only after that supplemental EIR has been prepared, circulated for public and agency comments, and the resulting comments responded to may the City consider whether to approve this project.

Response B.15: The changes to the Project have resulted in avoidance or reduction of impacts, or similar impacts compared to impacts identified in the certified 2015 REIR. No new significant impacts or impacts of substantially greater severity have been identified to result from the proposed Project. New information of substantial importance did not show that the Project would have new or substantially more severe impacts than previously discussed in the REIR or that new mitigation measures or alternatives not discussed in the REIR would substantially reduce a significant effect and the Project applicant declined to adopt such alternatives or measures. The comments received do not provide new information of substantial importance identifying that the proposed Project would result in a new impact that was not previously identified in the REIR, nor an impact of substantially greater severity than was previously identified in the REIR. Therefore, the conditions described in Public Resources Code Section 21166 and CEQA Guidelines Section 15162 have not been met and no further environmental review is required.

C. Citizens Committee to Complete the Refuge (letter dated October 21, 2019)

Comment C.1: These comments are submitted by Citizens' Committee to Complete the Refuge (CCCR) regarding the Sanctuary West Residential Area Project for the public hearing before the Newark Planning Commission scheduled for October 22nd. It is most unfortunate that the public hearing has been scheduled for this date as it is the same day as the State of the Estuary Conference.

We respectfully request that this letter be provided to the members of the Planning Commission. This letter follows up on a September 27, 2019 letter submitted on behalf of CCCR by Mr. Richard Grassetti, environmental consultant, a September 30, 2019 memorandum prepared by Geoffrey Hornek, environmental air quality consultant and a letter dated October 21, 2019 submitted by our attorney Stuart M. Flashman. These letters and memorandum detailed procedural and substantive inadequacies in the environmental review of the Project. The identified inadequacies must be corrected before the City can consider approving the project, specifically, a supplemental environmental impact report (EIR) should be circulated for agency and public review and comment.

Additionally, according to the recently circulated October 22nd Planning Commission packet an October 1, 2019 letter submitted to the City by Mr. Xavier Fernandez of the San Francisco Bay Regional Water Quality Control Board (RWQCB), an email sent to the City by Kim Squires of the U.S. Fish and Wildlife Service (USFWS) on September 26, 2019, and a letter submitted by the U.S. Fish and Wildlife Service, Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) identified specific substantive concerns with the City's environmental review of the Project.

The letters submitted by Richard Grassetti and Stuart Flashman describe why a supplemental EIR must be circulated. In this letter we attempt to identify issues that should be analyzed within a supplemental EIR, though due to the limited amount of time we have had to review the response to comments and information that has not been provided in the Checklist/Addendum (Checklist) and its

appendices, this list may be incomplete. Reference materials to support the substantive concerns we have identified will be supplied as soon as possible by separate communication.

> **Response C.1:** The City has received and responded to all the letters mentioned by the commenter. As stated in those responses, the comments received do not provide new information of substantial importance identifying that the proposed Project would result in a new impact that was not previously identified in the REIR, nor an impact of substantially greater severity than was previously identified in the REIR.
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> Pursuant to CEQA Guidelines Section 15168(c)(4) and Government Code Section 65457, the City prepared a Compliance Checklist, which concluded that (a) the proposed Project is consistent with the Areas 3 and 4 Specific Plan; (b) none of the events listed in Public Resources Code Section 21166 and CEQA Guidelines Section 15162 have occurred; and (c) the proposed Project would not result in any new or substantially more significant environmental impacts from changes to the Project or changes in circumstances beyond those previously evaluated and disclosed in the REIR. The comment letters mentioned by the commenter did not present evidence that would require a change in the Compliance Checklist's conclusions.

Comment C.2: The staff response to comments submitted by the RWQCB (provided in the Planning Commission packet) asserts that reverification of waters of the U.S. (and therefore, according to the staff response, waters of the State) occurred in 2014. CCCR subsequently contacted the San Francisco Regulatory Division of the U.S. Army Corps of Engineers (Corps) and was informed that there is no record of a letter re-verifying the 2007 jurisdictional delineation.

We request that documentation regarding reverification of the 2007 jurisdictional delineation be provided.

> **Response C.2:** Issues regarding the location of the waters of the U.S. are addressed in Response B.2 above. In addition, a copy of the 2014 Corps Memorandum regarding the Project site is included as Appendix B to this document.

Comment C.3: The Checklist asserts that no direct fill will occur in wetlands. This is difficult to ascertain based upon the figures provided in the Checklist. Figure 3.2-6 Pedestrian and Bicycle Circulation identifies at least some of the wetland boundaries, but there are so many lines on this figure that it is not always easy to determine exactly where the wetland boundary is. Based upon the limitations of the maps provided it appears the proposed development is extremely close to the wetlands boundary in a number of locations throughout the proposed development. In the area of the Stevenson Blvd. overcrossing, the alignment of the graded fill is oddly configured in several locations, presumably to avoid wetlands.

The information regarding the location of the development within Sub Areas B and C was not provided in the EIR/REIR, nor were any details included regarding how the Stevenson Blvd. overcrossing would be constructed. Preliminary grading plans or even conceptual grading plans have not been provided in the Checklist or the appendices.

Given that the project is claiming there will be no indirect fill in wetlands, a greater level of detail should be provided regarding the proximity of the proposed facilities to wetlands boundaries. Without this information how can the public and regulators confirm impacts will not occur to waters of the U.S.? To add to the lack of clarity, Figure 3.2-7 suggests that the sidewalk along S Drive overlays an area identified as wetlands and that the pedestrian-bicycle path and biotreatment area near Parcel I are extremely close to, if not within the wetland boundaries.

Response C.3: HTH reviewed Project plans in detail as part of preparing its 2019 Biological Resources Report, which was included as an appendix to the Compliance Checklist. The Project team is fully aware of the wetland mapping and the applicant's firm commitment to not filling any wetlands.

Comment C.4: The 2014 REIR states, "…At the time project-specific applications are proposed for residential development in Area 4, the detailed plans will be subject to tiered environmental review, in conformance with CEQA Section 21094, including more detailed evaluation of wetland impacts and identification of mitigation measures." That detailed evaluation is not evident in the information provided in the Checklist.

As an example, the Checklist provides a plan view of the Stevenson Blvd. overcrossing (Figure 3.2-4) that depicts what appear to be vertical walls holding back the fill embankment of the overcrossing approach. These walls appear to be directly adjacent to and almost touching the existing wetland areas. What type of retaining wall construction will be employed? Will excavation immediately adjacent to wetland areas occur? How will temporary impacts to wetlands be avoided? Will excavation immediately adjacent to wetland areas occur? How will temporary impacts to wetlands be avoided the construction process in areas of such vertical fills? The proximity of the wetlands to the Stevenson Blvd. overpass provides limited area to access the site with the construction equipment necessary to build the structure. How will permanent and temporary fill in these wetlands be avoided? None of the mitigation measures provided in the REIR appear adequate to address the concern of fill materials being introduced to the adjacent wetlands at this location.

Response C.4: As discussed in Section 1.0 of this document, the Newark Areas 3 and 4 Specific Plan was certified in 2015. The Compliance Checklist was prepared pursuant to CEQA Guidelines Section 15168(c)(4) and Government Code Section 65457, and documents that the Project is within the scope of the REIR. Additionally, the Checklist serves as an Addendum pursuant to CEQA Guidelines Section 15164 by documenting that the Project would not result in any new or substantially more severe impacts than those previously identified in the REIR. It will be attached to the REIR for consideration by the decision makers. The Project is exempt from further CEQA review.

The reference to detailed plans in the REIR was to the proposed subdivision map, which provides more information about the location of lots and infrastructure than provided in the REIR. Regarding wetlands, the REIR studied the impacts of filling 86 acres of wetlands. At this time, it is not anticipated that the Project would require wetland fill. In addition, the Project would incorporate Best Management Practices as

required by mitigation measure MM BIO-12.1, which would prevent fill from inadvertently entering wetland areas.

The retaining wall limits shown at this time are preliminary and can be further examined during the construction phase to determine the exact limits. As this Project proposes to not enter the delineated wetland area, the retaining wall footing would be designed with the restriction that the construction of the wall would not encroach into these sensitive areas. A majority of the retaining walls maintain a setback of more than a couple feet to allow construction accessibility. In the few constricted areas where the retaining wall is a couple feet from the wetland, the height of the retaining wall can be increased to shift the wall further away from the wetland area. At this time, the limits of the slope (included on Figure 3.2-4 of the Compliance Checklist) are shown to limit the height of the retaining wall, but the height can be increased during the final design if needed to create additional working space for wall construction. The exact extents and height of the wall would be dependent on the type of wall selected by the Project structural engineer during the construction document phase. The wetland areas would be staked and clearly marked in the field to ensure all construction personnel are aware of and respect the boundaries.

Comment C.5: The City must identify and evaluate the impacts of the proposed development on the salt marsh harvest mouse (SMHM), in particular, the removal of suitable upland escape habitat should be analyzed. The Checklist response to comments states:

> "Response C.4: The commenter is incorrect in stating that the non-developed area would consist almost entirely of wetlands and other waters, and that the only high water refugia would consist of steep-sided perimeter levees and created transition zones. The portions of Area 4 that would not be developed or altered by the Project do contain a mosaic of uplands and wetlands."

Nothing is provided in the EIR/REIR or the Checklist and its appendices to verify suitable upland habitat will remain if the site is developed as proposed. In fact, previous descriptions provided in the EIR/REIR would suggest that uplands that provide the most suitable escape habitat for the SMHM will be consumed by the proposed development.

What are the elevations of the uplands that would not be impacted by the proposed project? The environmental review of the proposed project should include a base map of existing ground elevations and we request a copy be provided.

Response C.5: This comment appears to be predicated on the assumption that upland escape habitat for the SMHM would be impacted by the Project. However, that is not the case. CEQA requires that impacts be analyzed relative to the baseline conditions, and under those conditions, the vast majority of the Project footprint, as well as vast portions of Area 4 that are outside the Project footprint, are disked and cultivated annually and therefore do not provide SMHM habitat. The Project would therefore not remove any habitat that provides suitable upland escape habitat for the SMHM under existing/baseline conditions.

Comment C.6: The EIR/REIR described the elevations of the land as tending to be relatively flat and appearing "to slope gently towards the southwest." The elevations in Area 4 "generally range from approximately elevation 0 to 10 feet." The Checklist response to comments suggests that other than the areas proposed for development, the remaining uplands may not differ greatly from the areas depicted as wetlands, for this reason we question the ability of the remaining uplands to provide escape habitat for the SMHM in instances of flooding.

Figure 4.4-1 of the Checklist depicts the habitat for selected special-status species. Potential salt marsh harvest mouse habitat is identified as being immediately adjacent to the levees of the Alameda County Flood Control and Water Conservation District (ACFCWCD) Line D to the north and Residential Area C of the proposed development. If in fact SMHM are concentrated in the area depicted on Figure 4.4-1, then the only remaining viable upland escape habitat areas are the flood control levees and the development footprint. Needless to say, neither of these is acceptable, as they are not really habitat areas and would expose SMHM to predation and other hazards and risks (e.g., into the path of bicycles or pedestrians or being run over by vehicles). The proposed development would therefore have significant adverse impacts on the sustainability and continued survival of the federally listed endangered salt marsh harvest mouse within Area 4.

> **Response C.6:** As noted in Response C.5 above, the vast majority of the Project footprint, as well as vast portions of Area 4 that are outside the Project footprint, are disked and cultivated annually and therefore do not provide SMHM habitat. The areas that would be developed by the Project do not currently provide suitable upland escape habitat for the SMHM, and no such habitat would be impacted by the Project.
>
> After Project development, if/when SMHM need to find refugia from flood events, they would rely on whatever refugia they currently use. Those refugia may include vegetation at higher elevations along Line D or the Mowry Slough levee. In addition, SMHM may also be able to find refuge in taller vegetation within their existing habitat. For example, Ms. Smith's dissertation (see Response B.7) states that while some previous studies concluded that SMHM move out of tidal wetlands into upland areas or levees to escape rising waters, other studies concluded that SMHM remain in tall, dense vegetation over the rising water, and "Recent work using radiotransmitters demonstrated that mice remain in tall vegetation (e.g., bulrushes) throughout the cycle of tidal inundation when such vegetation is available."

Comment C.7: Additionally, the Checklist response to comments states the area is disced regularly and that these areas may continue to be disced after the project is constructed raising the substantive concern that implementation of the project will result in the extirpation of the SMHM from this site, in violation of both state and feral endangered species acts. This would be a significant and adverse impact to a federally listed species.

> **Response C.7:** CEQA requires that impacts be analyzed relative to baseline conditions. Under baseline conditions, large portions of Area 4 are disked and cultivated annually. The continuation of existing disking and cultivation activities would not be an impact under CEQA because it would not change existing conditions

without the Project. The areas that are regularly disked and cultivated do not provide suitable SMHM habitat because of this regular disturbance.

Comment C.8: While we certainly support the concept of parks and open space for Newark residents, we are extremely concerned by the proximity of the recreational facilities to wetlands and wildlife habitat. The locations of the parks within the development envelopes of Area 4 were not previously identified. The pedestrian-bicycle path that winds through the development as well as the parks themselves are all located immediately adjacent to areas identified as wetlands. Cross sections should be provided to illustrate the relationship between these recreational features and the wetlands/wildlife habitat areas.

The biological mitigation measures identified in the EIR/REIR are inadequate to protect wildlife at these recreational interfaces with wetlands. Issues that would result from the proposed locations of the recreational facilities, include without limitation noise, pets and nuisance species. These have not adequately addressed by the previously proposed mitigation measures, given the close proximity of the proposed parks and pedestrian/bicycle path to wetlands and wildlife habitat. Additional mitigation measures, such a fencing or other barriers to prevent trespass into wetlands areas (while using landscaping etc. to allow use of the areas as flooding escape habitat for the SMHM) from the trails, closure of these areas during and immediately after flooding events, tamper-proof refuse disposal bins (to avoid attracting raccoons, opossums, and other potential predators), and restrictions on pet access/use must be included, including adequate enforcement mechanisms. Biological Mitigation Measure Bio-4.7 restricts off-leash dogs in "conservation areas." Are the wetlands considered "conservation areas?" If not, how will wildlife be protected in areas adjacent to the trails?

Response C.8: Impacts of recreation and other human activities, and impacts of domestic and nuisance animals, on sensitive wildlife and habitat areas were discussed in the 2015 REIR and the Compliance Checklist in the context of impacts to certain potentially breeding special-status wildlife species and their habitats, impacts to burrowing owls, impacts to the SMHM and salt marsh wandering shrew, impacts to sensitive habitat and species from recreational disturbance, and indirect impacts on waterbird use of wetlands. As discussed in the 2015 REIR and the Compliance Checklist, these impacts would be reduced to less-than-significant levels through implementation of mitigation measures MM BIO-4.4 and MM BIO-4.5 (requiring compensatory mitigation for impacts to burrowing owls and their habitat), MM BIO-4.6 (requiring placement of signage prohibiting the public from entering on-site burrowing owl conservation areas), MM BIO-4.7 (requiring preparation of a predator management program to reduce the effects of domestic and nuisance animals), MM BIO-8.4 (requiring compensatory habitat mitigation for potential SMHM and salt marsh wandering shrew habitat that is within 100 feet of residential development), and MM BIO-10.1 (requiring compensatory mitigation for indirect impacts of human activities on birds using wetlands in the former Pintail Duck Club). No additional significant impacts, nor any impacts of substantially greater magnitude, would result from the avoidance of direct wetland impacts and the resulting increase in interface between developed areas and conserved wetlands.

Comment C.9: The majority of the Geology mitigation measures in the EIR/REIR targeted issues relating to settlement of the fill material arid in particular how to reduce settlement associated with the placement of fill material and building loads, how to reduce differential settlement across the site, containment of fill during the construction of the development pads and prevention of erosion. The only mitigation measure pertaining to containment of fill during or after construction provided in the EIR/REIR is Biological Mitigation Measure 12.1:

> "Standard erosion control and slope stabilization measures will be required for work performed in any area where erosion could lead to sedimentation of a waterbody. For example, silt fencing will be installed just outside the limits of grading and construction in any areas where such activities will occur upslope from, and within 50 feet of, any wetland, aquatic, or marsh habitat. This fencing shall be inspected and maintained regularly throughout the duration of construction."

Appendix E of the Checklist - "Preliminary Geotechnical Exploration" provides a one paragraph discussion of slope stability:

> "The design level geotechnical report conducted pursuant to REIR mitigation measure GE0-3.1 will include a study to evaluate the risk of slope deformation and instability along the perimeter slopes of the project during grading, surcharge program and post-construction static and seismic conditions. Pursuant to REIR mitigation measure GE0-3.1, the Project applicant engaged ENGEO to undertake a site-specific investigation resulting in the Preliminary Geotechnical Report, which states graded slopes up to 6 feet may be constructed at an inclination of 2:1 (horizontal:vertical) and recommends measures for reinforcement as anticipated by the REIR, including a geogrid. If slope instability conditions, such as a "mud wave," are identified in the additional design-level geotechnical exploration, the required design-level geotechnical exploration would ensure that appropriate design details, such as properly placed retaining walls or staging of fill placement, will be provided to prevent a potential "mud wave" from forming at the toe of the fill slope."

The EIR/REIR did not discuss the slope of the fill pads and there was no previous mention of the use of geogrid to stabilize 2:1 slopes. Given the very close proximity of the developed area to the adjacent wetlands and substantive concerns that fill will occur in wetlands, contrary to what is stated in the project description, the issue of slope stability requires additional analysis. The discussion in the appendix of the Checklist of potential "mud waves" forming at the toe of the fill slope is new information that was not previously identified in the EIR or REIR nor was any analysis provided or mitigation measures identified to ensure such significant and adverse impacts would be prevented. This issue has been identified in the Preliminary Geotechnical Exploration but never properly analyzed under CEQA.

> **Response C.9:** Refer to Response B.12 above. A design-level geotechnical report will be prepared pursuant to REIR mitigation measure MM GEO-3.1, including a slope stability analysis to evaluate the risk of slope deformation and instability along the perimeter slopes of the Project during grading, surcharge program and post-construction static and seismic conditions. If slope instability conditions, such as risk of a “mud wave,” are identified in the additional design-level geotechnical

exploration, the required design-level geotechnical exploration would include development of appropriate design details, such as properly placed retaining walls or staging of fill placement, to prevent a potential "mud wave" from forming at the toe of the fill slope.

Comment C.10: Geology Mitigation Measure 5.1 states:

> "Construction-level evaluation of undocumented fills shall be undertaken as necessary as part of the lot-specific geotechnical evaluation. The undocumented fills shall be over-excavated and recompacted or removed and replaced with engineered fill material as required to stabilize each lot in accordance with standard engineering practice, prior to site development. The Director of Public Works shall review and approve the specified approach for all undocumented fill area prior to issuance of grading permits."

The FREIR acknowledged that illegal fill was placed in Area 4 in September 2014:

> "It should be noted that on September 8, 2014, a representative of the property owner discovered that a construction firm had been illegally dumping on Newark Area 4. The representative immediately called the Newark Police Department who arrived on site several minutes later. H. T. Harvey & Associates were asked to visit the property the next morning, September 9, 2014, for the purpose of documenting the extent of dumping. H.J. Harvey & Associates personnel drove and hiked the perimeter of the fill areas which were obvious due to the significantly different soil color and composition of the fill material which included roots, small pieces of concrete, rocks and gravel in contrast to the native soils on the property. It is estimated that the fill area comprises 22.08 acres, consisting of 1.33 acres of aquatic habitat, 11.85 acres of wetlands, and 8.9 acres of upland habitat. The City considers this activity to be outside the scope of the project and the result of illegal unauthorized dumping. The resolution of this incident is the subject of an on-going investigation by the regulatory agencies including USEPA, the Corps, and the Alameda County District Attorney's Office. The presence of this unauthorized fill does not change the project's impacts or any of the conclusions in this REIR."

It is pertinent to the construction of the proposed project that the City/Landowner disclose how this illegal fill will be dealt with. How will the illegal fill's composition be evaluated to ensure it will not, through spreading or erosion, result in contamination of the sensitive wetlands areas or underlying groundwater? If contamination is found, requiring removal of the illegal fill, how will the excavation be done to avoid spreading the contamination, and how will the contaminated material be disposed of? These questions raise issues about potentially significant impacts that must be answered adequately before project approval is considered. Will the illegal fill be "over-excavated and recompacted or removed and replaced?" Will these actions take place in the 8.9 acres of upland habitat as it appears to be in an area proposed for development or in close proximity and how would impacts to adjacent wetlands be avoided? Will the illegal fill be removed from the wetlands areas or left in place? This is a change in the circumstances of the site since the certification of the EIR and REIR and should be identified and discussed in a supplemental EIR (resolution of the illegal activity was unknown at the time of REIR certification).

Response C.10: As acknowledged in the REIR, the City considers the illegal fill activity outside the scope of the Project. The illegal fill activity is the subject of investigation by regulatory agencies. In 2014, the illegal fill was found to impact only one acre within the proposed development area. As a result of 2018 sampling, the illegal fill was found to be below Regional Screening Levels (RSLs) and 2018 Department of Toxic Substances Control (DTSC) Human and Ecological Risk Office (HERO) modified screening levels (SLs) for residential soil. All six samples were reported as non-detect for TPHg, VOCs, SVOCs, chlorinated herbicides, and PCBs. Detections of all other compounds were reported below both U.S. EPA RSLs and DTSC SLs. Accordingly, the illegal fill did not result in a change in circumstances that would cause the Project to create new or substantially more significant impacts to the environment. As discussed in the REIR and Compliance Checklist, the Project would require engineered fill, which would be placed in accordance with the City's standards and comply with the geotechnical report, and would be kept out of wetland areas as discussed in Response C.4 above.

Comment C.11: What provisions are being made to prevent this project from being primarily accessed by single occupancy vehicles, with the resulting increase in vehicle miles traveled and GHG production? What provisions are being made to encourage use of renewable energy sources by the project (e.g., rooftop solar, windmill placement, placement of electric vehicle charging stations at individual homes and public spaces in the project)? How will the project provide good access to public transit and provide incentives for the use of public transit and alternative transportation modes? Again, all these questions need to be reconsidered now that a specific project has been proposed. The generic, program-level discussions in the prior EIRs need to be supplemented in a supplemental EIR.

Response C.11: The Project area is served by existing bike lanes on Cherry Street-Boyce Road and Stevenson Boulevard, and by existing Alameda County Transit bus routes. The Project would construct sidewalks along public and private streets and a combined EVA roadway and multi-use trail along the UPRR tracks. The Project would be consistent with General Plan policies concerning bicycles and pedestrians, and would not result in a new or substantially more significant transportation impact than previously identified in the REIR.

Project green building features would include photovoltaic panels on the roof of each home and electric vehicle charging stations in each garage. The Project would be built to the California Green Building Code (CALGreen) and Title 24, Part 6 requirements in effect at the time of construction. Since studied in the REIR, the Project has been reduced in size and building codes have become more stringent, resulting in the Project's GHG emissions being less than anticipated in the REIR.

The Compliance Checklist concluded that no further environmental review is called for, because the Project is within the scope of the Specific Plan REIR certified in 2015, and because none of the events specified in Public Resources Code Section 21166 or CEQA Guidelines Section 15162 have occurred since certification of the REIR.

Comment C.12: Has consideration been given to how fire trucks and other emergency response vehicles will navigate the narrow streets and sharp turns on project roadways? Should there be parking restrictions to ensure access to emergency vehicles? What plans have been made for EVA passages if evacuation should prove necessary (e.g., earthquake, tsunami, or major fire)? What assurance will there be that such EVAs will remain usable after such an event? None of these questions could be answered in the prior EIRs, as there were no plans for how and where this project would be placed. They must be addressed adequately before approval is considered.

Response C.12: The City's Tentative Map approval process includes a review and comment period by the Newark Deputy Fire Marshal.[4] The proposed Project plans have been shared with the Newark Deputy Fire Marshal, who reviewed the proposed fire access and provided comments that have been incorporated into the Project design. The Alameda County Fire Department provided conditions of approval for the Project, which are included in the draft resolutions.

Turning movements utilizing the Alameda County-approved fire truck is included within the Tentative Map documents. The roadway section accounts for a 20-foot-wide travel way and eight-foot parking stalls, for a total of 36 feet curb to curb. The 20-foot-wide unobstructed travel way is consistent with California Fire Code Appendix D.

In the event of an emergency, two points of access are provided on the site to allow for evacuation. The fire access roads are proposed to be consistent with state guidelines outlined in the California Fire Code. The levees and salt ponds between the Bay and Project site would minimize waves generated by a seiche. The Project site is not located within an ABAG Resilience Program tsunami evacuation area. The Project site is not considered to be subject to significant risk from seiche or tsunami.

Comment C.13: The 2018 California Rail Plan calls for triple tracking the UPRR line through Newark. The Alvisio Wetland Railroad Adaptation Alternatives Study evaluates a range of alternatives for raising and triple tracking the rail line from Santa Clara to Newark. The rail line is proposed to be raised above the combined projections for sea level rise, storm surge and wave run up which are all conditions anticipated to impact this section of the Capitol Corridor line.

Over the past year and a half, consultants for the Capitol Corridor have been meeting with local environmental groups to discuss the long-term plans for running passenger rail service every half hour during peak commute times and at least bi-hourly rail service in non-peak times. The plans call for triple tracking the rail lines from Newark to Santa Clara. Currently the UPRR tracks extend from the rail switching yard just north of Mowry Avenue as triple tracks and diminish to double tracks down to a single track at Stevenson Blvd. The expansion of the line to triple tracks will allow for

[4] The Alameda County Fire Department is under contract with the Newark Deputy Fire Marshal to provide fire protection services in the City.

more frequent commuter rail service and expanded freight service directly adjacent to the proposed Area 4 development.

At this time potential alignments are very conceptual, with one proposed alignment cutting through a portion of Area 4 and three others following the existing rail alignment. There has been discussion to raise the rail embankment upon which the rail lines are constructed to elevate the tracks above the combined projected impacts of sea level rise, storm surge and wave run up to provide resilience for rail operations. Raising the tracks also has the potential to impact the horizontal width of the existing rail right-of-way (ROW).

These proposed rail service changes raises the question of whether the proposed height of the Stevenson Blvd. overcrossing will be sufficient to accommodate any increase in the elevation of the rail embankment. Raising the rail lines could necessitate a taller overcrossing to provide the required vertical clearance necessary for train passage. A taller bridge has the potential to change the footprint of the structure, which could in turn impact Area 4 wetlands that are located in close proximity to the overpass alignment. It also raises the question of whether there will be adequate room within the existing ROW or whether the ROW will need to be expanded to accommodate raising the rail line. If the rail lines are to be raised for sea level rise and flood resilience, will the proposed residential project be able to avoid filling wetlands?

Response C.13: The 2018 California State Rail Plan "establishes a statewide vision" for general rail service improvements, and does not represent a project. As noted in the comment, "at this time potential alignments are very conceptual." The plan does not discuss improvements specific to the Project site. The State Rail Plan does not create any requirements for or establish any restrictions on private landowners or local governments.

UPRR currently has a 100-foot-wide right of way adjacent to the proposed development. The Project overpass design follows UPRR's design guidelines, which require that bridge structural supports be located outside of UPRR's right of way. While triple tracking is not a reasonably foreseeable project, the bridge design allows for future track expansion to three tracks and for their access road. As discussed under Response B.7, the overpass design has been shared with UPRR, and at this time, they have not required a deviation from the vertical clearance requirement of 23 feet, 4 inches from top of rail to the overpass structure. The overpass structure is proposed to reside within the City's right of way and outside of any wetland areas. The Compliance Checklist properly analyzed the impacts of the Project as proposed.

As Capitol Corridor explores future changes to their right of way, the feasibility of acquiring such right of way would be examined. Any shifting of the right of way would require discussions and coordination with the adjacent landowners and the City. If the Capitol Corridor determined to explore track through Area 4 or a change to the overpass after it is constructed, then because a future alignment crossing through the Area 4 site or new overpass could potentially have significant environmental impacts, the Capitol Corridor would need to prepare CEQA review. The Project does not propose expansion of rail service or overpass footings in the

areas suggested by the commenter, and those projects are not reasonably foreseeable at this time.

Comment C.14: The proposed increase in passage and freight service resulting from the triple tracking and the potential to elevate the tracks could not have been anticipated when the original noise analysis conducted for the EIR in 2009. No changes were made to the noise analysis presented in the 2015 FREIR. The 2015 FREIR Section 3.4.2.2 states that:

> "Noise barriers could be constructed to reduce noise levels in the yards of homes adjacent to the UPRR. Preliminary barrier calculations indicate that a soundwall eight (8) feet high would be required at the residential property line to reduce noise levels in the rear yards to "normally acceptable" levels (at or below 60 dBA Ldn). Table 3.4-3 summarizes the future exterior noise levels of homes adjacent to the UPRR assuming various barrier heights."

Will the noise mitigation measures proposed for the residential development, such as construction of sound walls, remain effective with increased rail services and potentially raised rail tracks? While the use of horns may be avoided at the Stevenson Blvd crossing due to the construction of the overcrossing, horns will still be necessary at the Mowry Avenue at grade crossing.

Response C.14: A Noise and Vibration Assessment Update was prepared as part of the Compliance Checklist for the current Project, and concluded that the Project would have no new or substantially increased noise or vibration impacts compared to those identified in the REIR.

The Project would construct sound barriers either at the UPRR right of way or at the residential property line of homes adjacent to the UPRR. The elevation of the UPRR right of way is approximately 5.5 feet below the proposed residential building pad elevation. If the barriers are constructed at the residential property lines, they would be approximately eight feet high; if constructed at the UPRR right of way, they would be approximately 14 feet high. With the proposed sound barriers, the Project would be consistent with the City's General Plan noise acceptability criteria.

The proposed sound barriers serve to attenuate noise levels from train passbys and allow the proposed residences to meet the City's exterior noise compatibility guideline level of 60 dBA L_{dn}. The Project does not propose to increase train frequency or elevate railroad tracks, and no such projects are reasonably foreseeable. Any future projects proposing those actions would be required to evaluate noise impacts and mitigate as necessary.

Comment C.15: A huge public safety concern is the at-grade crossing at Mowry Avenue. The project proposes to construct a locked and gated emergency vehicle access (EVA)/multi-use trail from the edge of the Area 4 development, across the Alameda County Flood Control and Water Conservation District (ACFDWCD) channel and exiting at Mowry Avenue to serve as the only EVA route. How will emergency vehicles enter Area 4 when the EVA is congested with the vehicular traffic of up to 469 housing units fleeing the area? With increased rail traffic and the immediate adjacency of the rail switching yard what happens in the event of an emergency if a train is stuck at

the crossing, a very common occurrence in Newark? Of greater concern is the fact that the proposed EVA will also serve as a continuation of a bicycle and pedestrian path. It is highly concerning from a public safety perspective to have increased frequency of train traffic and an at-grade crossing that children might use to access the recreational facilities at the Silliman Center. The California Public Utilities Commission (CPUC) in their January 26, 2010 comment letter recommended a grade separated pedestrian and bicycle crossing in this location. Have the potential circulation and safety risks associated with the Mowry Avenue EVA/multi-use trail received adequate review given the changed circumstance resulting from the 2018 California Rail Plan and 2019 Capitol Corridor Alviso Wetland Railroad Adaptation Alternatives Study?

Response C.15: The proposed emergency vehicle and pedestrian access to Mowry Avenue is consistent with access in the Specific Plan; therefore, these conditions were known at the time of the 2015 REIR certification and the comment does not raise new information.

In the unlikely event of an evacuation in Area 4 when both lanes of Stevenson Boulevard are blocked, the proposed EVA is 20 feet wide, which would allow for inbound emergency vehicles and outbound passenger vehicles to pass each other. Firetrucks are typically eight feet wide, and passenger vehicles are between six and eight feet wide. The situation described in the comment where Area 4 requires evacuation, both lanes are Stevenson Boulevard are blocked, and a train is blocking the crossing and cannot be moved is an extremely improbable event that is highly speculative. In such an improbable situation, residents would need to evacuate Area 4 on foot, scooter, motorcycle, or bicycle, or, if dispatched, emergency helicopters.

Currently, the Mowry Avenue crossing has both flashing lights and gates that signal to bicyclists and pedestrians when a train is approaching. There are at-grade crossings throughout the Bay Area and United States, and gates and flashing lights are considered effective means of traffic and pedestrian control. It is reasonable to assume that future residents would follow the law and not attempt to cross the tracks when the gates are down and the lights are flashing. Under existing conditions, crossings in the vicinity of Area 4 are limited to an estimated 32 trains per day;[5] therefore, there would be relatively few conflicts between trains and pedestrians. Increases in rail activity are not proposed by the Project, and do not represent a reasonably foreseeable project. For comparison purposes, at a typical intersection in the vicinity of a large school, there are routinely hundreds of pedestrians per hour conflicting with hundreds of vehicles on adjacent streets. Therefore, the proposed at-grade crossing would not result in any unusual safety hazards.

Comment C.16: Has any coordination occurred between the City/landowner and Union Pacific Railroad or with the Capitol Corridor? The 2018 California Rail Plan and the consequences it may

[5] U.S. Department of Transportation, Federal Railroad Administration. "U.S. DOT Crossing Inventory Form Number 749950S." May 2, 2019.

have for project design and public safety measures are issues that should be further analyzed and mitigated. It is incumbent upon Newark to evaluate the needs of this critical regional rail infrastructure project relative to any and all discretionary development approvals.

Response C.16: Refer to Response C.13 above. The property owner has engaged with UPRR's Public Projects department regarding the construction of the Stevenson Boulevard Overpass and the overall Project scope. Consistent with UPRR's design guidelines, the overpass is proposed to maintain a vertical clearance of 23 feet, 4 inches from top of rail to the overpass structure. UPRR has not requested that any additional revisions be made to the Project design to accommodate any preliminary planning studies. The feasibility and environmental impacts from implementation of the vision outlined in the 2018 California Rail Plan would be examined by the lead agency for that rail project if a project is ever proposed. Such a future rail project is too speculative at this point in time to be considered in the cumulative analysis for this Project.

Comment C.17: We have identified some of the many issues that were not and could not have been analyzed in the EIR/REIR since project details and scientific information were not available at the time those documents were produced. We have raised substantive issues that require additional environmental review in a supplement EIR.

Response C.17: Responses have been provided to all written comments received by the City to date. The comments received do not provide new information of substantial importance identifying that the proposed Project would result in a new impact that was not previously identified in the REIR, nor an impact of substantially greater severity than was previously identified in the REIR. Therefore, the conditions described in Public Resources Code 21166 and CEQA Guidelines Section 15162 have not been met, and no further environmental review is required.

We will provide additional materials in advance of the public hearing before the City Council. We ask that we be informed of any additional opportunities to provide public comment and that a map depicting the ground level elevations of Area 4 be provided.

Response C.17: This comment is noted. The comment does not raise issues regarding the CEQA analysis.

D. Environmental Coalition (letter dated October 22, 2019)

Comment D.1: We are writing jointly on behalf of the environmental organizations signed below to respectfully urge the Planning Commission to recommend that the CEQA Compliance Checklist be rejected for the Sanctuary West Residential Project, including the Vesting Tentative Map, Conditional Use Permit, and Planned Unit Development for construction of a 469-unit residential subdivision in Newark's shoreline "Area 4."

We join state and federal resource agencies (see attached letters from SF RWQCB and US F&WS) in requesting the completion and circulation of a Supplemental EIR for this project before consideration

for approval by the Newark Planning Commission and City Council. The proposed use of the CEQA Compliance Checklist is wholly inadequate and inappropriate for a project of such magnitude with significant and far-reaching impacts on the environment.

Response D.1: Responses have been provided to all written comments received by the City to date. The comments received do not provide new information of substantial importance identifying that the proposed Project would result in a new impact that was not previously identified in the REIR, nor an impact of substantially greater severity than was previously identified in the REIR. Therefore, no further environmental review is required.

Pursuant to CEQA Guidelines Section 15168(c)(4) and Government Code Section 65457, the City prepared the Compliance Checklist, which concluded that (a) the proposed Project is consistent with the Areas 3 and 4 Specific Plan; (b) none of the events listed in Public Resources Code Section 21166 and CEQA Guidelines Section 15162 have occurred; and (c) the proposed Project would not result in any new or substantially more significant environmental impacts from changes to the Project or changes in circumstances beyond those previously evaluated and disclosed in the REIR. The comment letters mentioned by the commenter did not present evidence that would require a change in the Compliance Checklist's conclusions.

Comment D.2: Many of our organizations have long been on record in expressing our deep concern and opposition to development within Area 4. As a mosaic of undeveloped diked wetlands and low-lying uplands, supporting nearly a dozen special-status species, including the endangered Salt Marsh Harvest Mouse, and susceptible to flooding and sea level rise, the 559-acre Area 4 is an inappropriate place for development - and a critical natural resource worth protecting and restoring. We urge the City of Newark to follow the consistent and overwhelming recommendations of the region's scientific community in pursuing the long-term protection and restoration of this critical open space area, and promoting its eventual inclusion in the Don Edwards SF Bay National Wildlife Refuge, as authorized by the U.S. Congress.

Reports and recommendations from the regional scientific community and resource managers are unanimous in their agreement on the ecological value of Area 4:

- The Baylands Ecosystem Habitat Goals Project (Updated in 2015) - The scientific roadmap for the restoration of the Bay shoreline, identifies Area 4 as being uniquely situated for the restoration of both tidal marsh and adjacent upland transition zones, two habitats critical to the health of the Bay. (Baylands Ecosystem Goals 2015 Update, Section Q: Mowry Slough Area, p.211-214)
- U.S. Fish and Wildlife Service Recovery Plan for Tidal Marsh Ecosystems in Northern and Central California (2013) - A plan delineating actions to recover special-status species throughout tidal marsh ecosystems identifies Area 4 as within the recovery unit, and as a priority site for ecotone restoration. (Figure III-23. Segment Q, p. 275)
- San Francisco Bay Shoreline Adaptation Atlas (2019) - A joint project of the San Francisco Estuary Institute and SPUR, provides recommendations for nature-based climate adaptation

solutions around the San Francisco Bay shoreline. It describes the Area 4 area as "a rare buffer between the Bay and developed communities" where restoration opportunities have the ability to "increase the climate resilience of both ecosystems and developed communities." (Section 21 - Mowry)

- The U.S. Fish and Wildlife Service, Don Edwards SF Bay National Wildlife Refuge Comprehensive Conservation Plan (2012) - Guiding management of the Refuge for the next 15 years, the plan notes that "the Refuge is particularly interested in acquiring unprotected high marsh, ecotonal, and upland habitats that will benefit migratory birds that are Refuge trust species… [and] acquiring those lands within the approved acquisition boundary that can address climate change efforts." (p. 191.) Development of Area 4 would conflict with the CCP's goal to "conserve, restore, enhance, create and acquire habitats to support the diversity and abundance of migratory birds and other native flora and fauna that depend on Refuge lands." (p. 180.) In fact, Area 4 is one of the largest remaining sites within the Refuge's acquisition boundary that can meet these specific needs.
- Bay Conservation and Development Commission's San Francisco Bay Plan (Amended 2011) - Guiding the future conservation and development of San Francisco Bay, the Bay Plan's Climate Change Policies, unanimously approved in 2011, included Policy #4, describing sites like Area 4 deserving special consideration for protection: "To address the regional adverse impacts of climate change, undeveloped areas that are both vulnerable to future flooding and currently sustain significant habitats or species, or possess conditions that make the areas especially suitable for ecosystem enhancement, should be given special consideration for preservation and habitat enhancement and should be encouraged to be used for those purposes."

Additional comments from regulatory and resource agencies:

- The San Francisco Bay Regional Water Quality Control Board has stated that "large expanses of undeveloped uplands immediately adjacent to tidal sloughs are extremely rare in the south and central San Francisco Bay" and that "Area 4 represents a rare opportunity to … provide an area for tidal marsh species to move up slope in response to sea level rise" (San Francisco Bay Regional Water Quality Control Board letter to City of Newark in response to Areas 3 and 4 Specific Plan FEIR, June 23, 2010, p.2)
- The U.S. Fish and Wildlife Service has been consistent in stating their interest in protecting and acquiring Area 4 for the Don Edwards SF Bay National Wildlife Refuge, emphasizing that, "the proposed development of Area 4 will only add to the cumulative loss of tidal wetlands in San Francisco Bay and endangered species that are dependent on that habitat," and "Area 4 would be an extremely valuable addition to the Refuge as it could provide valuable ecotonal habitat transitioning from restored wetlands to upland areas" (US Fish and Wildlife Service letter to City of Newark in response to the General Plan DEIR, Sept. 19, 2013)

In short, the science is clear that if we are to achieve our region's goals of protecting and restoring biodiversity, combating climate change, and advancing climate resilience to protect our communities from the impacts of sea level rise, the preservation and restoration of Area 4 is critical.

As an undeveloped shoreline area at risk of flooding and sea level rise, containing significant wildlife habitat and considerable restoration potential, this project is the epitome of the type of development that should not move forward. With Alameda County already facing $15 billion in infrastructure and property at risk from sea level rise ("The impacts of Sea Level Rise on the San Francisco Bay, Pacific Institute, July 2012) - the 2nd most of any county in the state - and global wildlife species facing rapid declines, we all need to work together to quickly increase the resilience and adaptability of our communities and environment - not make these problems worse, as this development proposal would do.

We urge the Planning Commission to please consider our comments and those of the resource agencies, and move away from this destructive development path. We also request that we be kept informed of any future public meetings regarding this project and opportunities to provide public comments.

> **Response D.2:** The comment is noted. In 2015, the City of Newark certified the Newark Areas 3 and 4 Specific Plan REIR, approved the Areas 3 and 4 Specific Plan and additional land use entitlements, and entered into a Development Agreement for the Specific Plan development. The Compliance Checklist serves to document that the Project is consistent with the adopted Specific Plan, is within the scope of the REIR pursuant to CEQA Guidelines Section 15168, and is exempt from further CEQA review under Government Code Section 65457. The reports and recommendations noted in the comment either predate the certified REIR and/or do not create any requirements for or establish any restrictions on private landowners or local governments.

E. Jana Sokale (letter received October 22, 2019)

Comment E.1: In 1959, the Army Corps of Engineers developed a map that would forever change the course of our region. Later entitled, "Bay or River" the map showed an image of what San Francisco Bay would look like if current development trends continued. At the time, the Bay was abused in almost every imaginable way: wetlands were turned into trash dumps, raw sewage was dumped directly into its waters, and nearly every city along the Bay had plans to fill in and develop its portion of the shoreline. By 2020, the Army Corps predicted that if current development trends continued, the Bay would be nothing more than a shipping channel.

This map sparked grassroots movements to save the bay and create the first urban national wildlife refuge. Through congressional actions and state regulations, we have largely stopped the filling of our Bay, and have instead restored tens of thousands of acres of wetlands, built dozens of parks, cleaned our waters, and reconnected millions of people with the incredible San Francisco Bay estuary we call home.

Yet, here in Newark, it is as if these past 60 years of progress never happened. For decades, developers and city leaders have worked together to advance plans to fill in Newark's Bay shoreline – specifically the area around the former Pintail and Whistling Wings Duck Clubs, now called "Area 4." Despite pushback from almost every major environmental group and concern from numerous regulatory agencies, the city has continued to move forward with their plan to truck in 1.67 million

cubic yards of fill (more than 100,000 dump trucks of fill to bury the shoreline) and build nearly 500 single-family houses in Area 4. It will all come to a head when the Newark Planning Commission will vote to approve the plan.

The real question is, "why?" As cities across the region are restoring their sections of the Bay – why should we in Newark be turning our back on the Bay, paving over wildlife habitat, and treating our shoreline like "quick land" for developers to make billions by building million-dollar houses?

We have another vision. Rather than paving over our Bay shoreline, let's embrace it. Let's protect our shoreline and restore it. "Area 4," which is currently an undeveloped mosaic of wetlands, ponds and upland habitat, has been prioritized by the scientific community for protection, and is already included within the expansion boundaries of the Don Edwards SF Bay National Wildlife Refuge. If restored, Area 4 can help provide flood protection for our community in the face of sea level rise, provide critical habitat for wildlife, and equally importantly, offer an opportunity to reconnect Newark residents to our Bay shoreline for the first time in decades.

We urge the Planning Commission to oppose plans to develop "Area 4;" instead, reset our city on a path of protecting our shoreline, rather than paving it over. Newark residents – and our Bay – deserve nothing less.

> **Response E.1:** The comment is noted. The comment does not raise issues regarding the CEQA analysis.

F. Carin High (letter dated October 22, 2019)

Comment F.1: I have spent yesterday and today listening to presentations by regulators, resource agencies, scientific and academic experts all focused on the San Francisco Bay estuary, from the delta to south and our end of the Bay. And this collective group, from divergent backgrounds, ethnicities and priorities could agree on a few things – sea level rise is proceeding at a rate we all hoped we would never have to consider and with that reality, there are hard choices we will have to make as a society. Many of the discussions centered on how we protect our communities and the incredible natural and societal benefits that the Bay provides to each of us.

Tidal marshes were a large focus of this conference because we have suffered devastating losses of that habitat – up to 90% by some accounts, and this in turn has had real world consequences for the health of the Bay, the natural communities it supports and for our own communities.

Tidal marshes are crucial to protect the biodiversity of the Bay – think fisheries, shellfish, aquatic mammals, birds and of course endangered species – species largely imperiled because we have consumed the habitat that supports them.

Tidal marshes are also important to those for whom wildlife is not a priority, because tidal marshes support improved water quality, can fix carbon, can reduce flood risk and thus are a hedge against sea level rise.

You might be wondering why I am bothering to mention this. Here's the reason – every major scientific publication dealing with this question of how we restore tidal marshes has identified Area 4 as one of the very few remaining locations in the South Bay proper where this opportunity still remains. If you look around the edges of the South Bay, we have for the most part built right up to the edges of the Bay or the salt ponds and while restoration of salt ponds is occurring in the South Bay we are racing against time, hoping we will have enough sediment for tidal marshes to be restored. There is no such problem with Area 4 and if this community wants the benefits that tidal marshes provide, it is one of the few options that has not been paved over.

Response F.1: The proposed development area does not include tidal marshes. All of the marsh in Area 4 on the southeast side of Line D is diked marsh with no tidal influence; therefore, the Project would not reduce tidal marshes.

Comment F.2: I understand the City wants and needs to build homes. I understand that the landowners want to make money, possibly a lot of money, that's a realistic business perspective.

However, you have only to look at this site, its location on the landscape, the elevations of the site, the distance to public transit and the fact that to go about their daily lives, the majority of people who would populate this development would choose to get in their cars and drive to the store, to school, to work, etc. to know this isn't the right place for development.

Response F.2: The Newark Areas 3 and 4 Specific Plan REIR was certified in 2015, and the City approved the Areas 3 and 4 Specific Plan, a Development Agreement between the City and the applicant, and other discretionary actions in furtherance of the Specific Plan. The REIR certification action is final. The current Project implements the Specific Plan in Area 4. As part of the Compliance Checklist, a Level of Service Update was prepared for the current Project, and concluded that the Project would have no new or substantially increased transportation impacts compared to those identified in the REIR. In addition, the Compliance Checklist confirms that the Project would have no new or substantially increased impacts related to GHG emissions compared to those identified in the REIR.

Comment F.3: Then there's the issue I began with, sea level rise. Rates of sea level rise are increasing faster than once expected/predicted, and those outrageous elevations that we feared but secretly hoped would never come to be, are now becoming mainstream and rather conservative estimates. If the Western Antarctic ice continues unabated, all bets are off. Building on elevated building pads may buy you several decades, I would like to be wrong, but I would be surprised if flooding doesn't become an issue by 2050.

Response F.3: The Compliance Checklist, like the 2015 REIR, included a Hydrology and Water Quality Report analyzing effects of climate change and sea level rise. The Water Quality and Hydrology Section Update (March 2019) was prepared by Schaaf & Wheeler Consulting Civil Engineers pursuant to 2018 California Ocean Protection and Council Science Advisory Team (OPC-SAT) guidance for selection of appropriate sea level rise projections.

The OPC-SAT guidelines indicate probabilities of projected sea level rise for various emissions scenarios. For the high emissions scenario (RCP 8.5), there is 99.5 percent certainty ("high risk aversion") that the Project would be resilient to the one-percent storm surge through 2070, which is the established 50-year Project life. Using the "low risk aversion" but high emissions projections, the Project would be resilient to the one-percent storm surge through end of century (2100). Based on the OPC-SAT projections, the Project is expected (as likely as not) to be resilient to the one-percent storm surge through 2140 under a high emissions scenario.

Comment F.4: Mr. Richard Grassetti and Attorney Stuart Flashman have submitted comments on behalf of the Citizens' Committee to Complete the Refuge documenting the reasons that the City must prepare a Supplemental EIR for the proposed Sanctuary West Residential Project.

There is in fact, new information of substantial environmental significance that has been released since the certification of the 2015 REIR and details provided about the project in the Checklist/Addendum that have raised issues that were not adequately analyzed or mitigated at the previous programmatic level of environmental review.

As an example, there is the issue of increased passenger rail service on the UPRR tracks, the expansion and potential raising of the rail berm. These are new issues that were not known at the time the REIR was certified and they are pertinent to the proposed project. We have outlined some of these issues in the letter we submitted late last night. One issue of great concern is public safety for the residents of the proposed development, another is the danger posed by terminating a pedestrian-bicycle path at the at grade railroad crossing at Mowry Avenue, especially when you consider the plan for increased passenger rail service, and the potential that children might be using this path to get to the Silliman Center.

Response F.4: Potential future rail projects are discussed under Responses B.7, C.13, and C.14 above. Existing regional and state studies, such as the 2014 Capitol Corridor JPA Sea Level Rise Vulnerability Assessment and 2018 California State Rail Plan, do not represent projects and do not create any requirements for or establish any restrictions on private landowners or local governments. The lead agency for any future rail projects proposing UPRR expansion or raising rail berms would be required to prepare the appropriate environmental review for the rail project. At this time, such a project is not reasonably foreseeable.

As discussed in Response C.15, the Mowry Avenue crossing currently has both flashing lights and gates that signal to vehicles, as well as bicyclists and pedestrians, when a train is approaching. Gates and flashing lights are considered effective means of traffic and pedestrian control at rail crossings in the vicinity of Area 4. The proposed at-grade crossing would not create a new or substantially more significant safety hazard compared with those disclosed in the REIR.

Comment F.5: Stabilization of the fill slopes was another issue for which mitigation measures were not proposed in the previous environmental review documents – particularly the potential for the formation of "mud waves" at the toe of the fill slopes.

Response F.5: Refer to Response B.12 above. A design-level geotechnical report will be prepared pursuant to REIR mitigation measure MM GEO-3.1, including a slope stability analysis to evaluate the risk of slope deformation and instability along the perimeter slopes of the Project during grading, surcharge program and post-construction static and seismic conditions. If slope instability conditions, such as risk of a "mud wave", are identified in the additional design-level geotechnical exploration, the required design-level geotechnical exploration would include development of appropriate design details, such as properly placed retaining walls or staging of fill placement, to prevent a potential "mud wave" from forming at the toe of the fill slope.

Comment F.6: The jurisdictional delineation of wetlands was last verified by the Corps in 2007. This has been confirmed by a phone call to the Regulatory Division of the San Francisco District.

Response F.6: Refer to Response B.2 above. In 2014, the Corps determined that the 2007 mapping remained valid, as documented in Appendix B.

Comment F.7: There are other issues identified in the letters that have been submitted, and I am sure more will be revealed before the City Council meeting.

I want to leave you with one last piece of information regarding the endangered salt marsh harvest mouse. A presentation of the most recent research concerning the behavior, feeding, movements, etc. of the endangered species was the last presentation I was able to attend today. What I learned confirmed all the issues that were raised in the letter we submitted as well as the letters of the Regional Water Quality Control Board and the U.S. Fish and Wildlife Service. The mouse can forage in pickleweed habitat up to uplands habitat, with some mice having very restricted ranges to others that have moved several hundred meters throughout the marsh. Some mice routinely foraged between the pickleweed habitat and uplands habitat. The biggest concern with the proposed project from a biological resource perspective is that the development will consume all the "higher" upland habitat thereby dooming the salt marsh harvest mouse on this site if flooding becomes the norm for the wetlands areas.

Response F.7: Refer to Response B.9, which addresses recent information regarding SMHM habitat use, and Response C.6, which discusses why the Project would not impact refugial habitat for the SMHM relative to baseline conditions, in which the Project footprint and much adjacent area is disked and cultivated annually. Also, the site is not subject to unrestricted tidal flooding due to active hydrological management, and large transitional, seasonal wetland areas driven by collected surface water would remain undeveloped under the proposed Project.

Comment F.8: The proposed project represents the opposite of the solutions to sea level rise that were proposed during the many presentations of the past two days from a natural resource and societal perspective.

Response F.8: CEQA does not require an analysis of the environment on the project. Nevertheless, the REIR and Compliance Checklist examined sea-level rise. The comment does not raise issues regarding the CEQA analysis.

Comment F.9: I urge the Planning Commission to recommend compliance with the requirements of CEQA by requiring a supplemental EIR to be circulated to identify, analyze and mitigate the negative impacts of the proposed project on the environment and future residents.

Response F.9: The Newark Areas 3 and 4 Specific Plan REIR was certified in 2015, and that certification action is final. The Project is exempt from further CEQA review under Government Code Section 65457. Public circulation of the Compliance Checklist is not required; the Compliance Checklist will be attached to the REIR, pursuant to CEQA Guidelines Section 15164(c). The Checklist also serves to document that the Project is within the scope of the REIR pursuant to CEQA Guidelines Section 15168.

SECTION 4.0 TEXT REVISIONS TO COMPLIANCE CHECKLIST

This section contains revisions to the text of the Compliance Checklist for the Area 4 – Sanctuary West Residential Project, dated September 2019. Revised or new language is underlined. All deletions are shown with a ~~line through the text~~.

The following text revisions are minor clarifications regarding the jurisdiction of water infrastructure, the water mains and lines serving the Project site. This information does not change any of the analysis in the Compliance Checklist or result in any new impacts or substantial increase in severity of any identified impacts.

Page and Section	Text Revisions
Page 20; Section 3.2.5.1, Water Service	Water service in the City of Newark is provided by the Alameda County Water District (ACWD). The ACWD has jurisdiction of overall public water mains, appurtenances, and laterals through the individual water meter or device. ~~all water service laterals from their mains to the individual water meters. The City of Newark has jurisdiction over all water piping from the meter to all fixtures connected to water lines.~~ Area 4 residential potable water needs would be met by an extension of the existing main within Stevenson Boulevard as well as a minimum of one additional connection from existing mains in either Mowry Avenue or Cherry Street (via the new potable water system installed in Area 3 or a direct connection(s) from the main(s) within Mowry Avenue and/or Cherry Street).~~via service from an existing 12-inch main in Alameda County Flood Control & Water Conservation District easement at the north end of the project site and a 12-inch main in Stevenson Boulevard.~~ Both would serve as a connection point to a new public water distribution system within the residential streets proposed in Area 4. This proposed distribution system would consist of 8-inch and 12-inch diameter pipes, which would be sufficient to serve both residential and fire service needs. Reclaimed water is not available at this time, but the proposed development may include~~s~~ provisions (installation of purple piping onsite) for use of reclaimed water when it becomes available.
Page 22; Section 3.2.5.1, Water Service, Water Conservation Standards, for landscape development within Area 4, third bullet	• May include installation of ~~Install~~ a separate, non-potable distribution system (i.e., "purple pipe") for the non-residential landscape needs. The on-site system may ~~will~~ also include non-potable distribution mains extending to areas where recycled water could be used.

Page and Section	Text Revisions
Page 79, MM HAZ-3.1, seventh bullet	• ~~Soil quality adjacent to on-site wells shall also be analyzed for spilled chemicals including pesticides. The results shall be provided to the City and appropriate regulatory oversight to determine the appropriate remediation, if necessary.~~ Prior to issuance of a grading permit, the project proponent(s) and ACWD shall identify all abandoned wells within the project boundary. Any wells identified or discovered during construction shall be appropriately destroyed in accordance with ACWD specifications and local standards prior to issuance of a grading permit.

Appendix A: Salt Marsh Harvest Mouse Habitat/Habitat Types Overlay

N:\Projects\2596-05\17\Reports\Bio Res Tech\Fig A SMHM and Habitats.mxd

H. T. HARVEY & ASSOCIATES
Ecological Consultants

Figure A. Salt Marsh Harvest Mouse Habitat/Habitat Types Overlay
Newark Area 4 Biological Resources Technical Report (2596-15)
October 2019

Appendix B: 2014 U.S. Army Corps of Engineers Verification Memorandum

Memorandum for Record, JD Reverification
Newark Area 3 and 4, File Number 400075S
February 19, 2014

U.S. Army Corps of Engineers, San Francisco District

MEMORANDUM FOR RECORD

FILE NUMBER: 400075S

PROJECT: Newark Area 3 and 4

DATE: February 19, 2014

SUBJECT: JD re-verification

On July 23, 2013, I met with Pat Boursier to conduct a site visit for the re-verification of the 2007 jurisdictional determination for the site. The project site has been extensively studied by H.T. Harvey and Associates in regard to wetland hydrology and ground water monitoring and Dan Martel, the District's previous wetland specialist had conducted a site visit for the 2007 verification (See September 19, 2007 site report by Dan Martel). No substantial changes to the project site have occurred on the site since the 2007 verification. However, we did note that there were some areas of vegetation shifts reflecting the drier conditions of the past few years. The wetland delineation should remain the same as the 2007 mapping since wetland areas were monitored and mapped during a period of time with more normal precipitation (e.g. 2005-2006, 91% of average annual total precipitation). The project site is comprised of large parcels that have with the exception of the auto dismantler business (in the northwestern portion of the project site) been in agricultural activity for many years.

Mapping of Historic Bay Margin: The map has been revised to include the mapping of the historic bay margin for the compliance with the San Francisco Regional Conditions for Nationwide Permits. The historic bay margin is defined as the areas below the 5' contour line (NGVD) as per the 1971 Nichols and Wright map. However, this 5' contour line differs from the t-sheet mapping of the bay margin. Pat Boursier of H.T. Harvey and I discussed the

difference between these two maps and agreed to map the historic bay margin as depicted on the 1971 Nichols and Wright map.

Historic Section 10 Jurisdiction pursuant to the Rivers and Harbor Act: The western portion of the project site is diked bay lands (situated within the historic bay margin) and contains historic Section 10 jurisdiction in the form of double-sided slough channels (see attached Figure 1). There is one remnant slough that still exists in the southwestern corner of the property near the pump. Most of the historic Section 10 double-sided sloughs are no longer visible in aerial photography probably due to ground alterations from the construction of the duck ponds and farming. However, a 1948 aerial of the project site shows the historic tidal sloughs plus additional man-made channels most probably constructed to aid in dewatering the site (Figure 2). There are some channels that appear to have been man-made, probably to dewater the site. However, the fact that the site has never been developed in roads/buildings is sufficient for us to conclude that area encompassed by the historic double sided sloughs have never been above MHW and therefore still jurisdictional pursuant to Section 10 of the Rivers and Harbor Act. These double sided sloughs flowed into Mowry Slough, also navigable water of the U.S. that is a tributary to the San Francisco Bay (see Approved Jurisdictional Determination Form, Section II.A).

Jurisdictional waters of the U.S. pursuant to Section 404 of the Clean Water Act: The eastern portion of the project site is situated along the northern boundary of Newark and Fremont Cities (between Addition Road and Stevenson Boulevard and south of Boyce Road). This 77 acre site has been heavily farmed and is comprised of uplands except for a small strip of wetlands that have formed on southern edge due to landscaping irrigation. This wetland area is less than an acre in size and is not considered jurisdictional since ceasing of irrigation would most likely cause the disappearance of the wetlands (see Approved Jurisdictional Determination Form, Section II.B.2).

The two stormwater detention basins constructed to the east of the auto dismantler property are the are not considered jurisdictional because they were are isolated wetland areas (see Approved

Jurisdictional Determination Form, Section II.B.1.a, Isolated waters, including isolated wetlands).

Portion of the large southwestern project site have been further manipulated in the past for the construction of duck ponds. Large portions of the site are mapped as other waters due to long periods of deep inundation that limits the establishment of vegetation. Wetland areas have less surface ponding allowing for the establishment of wetland vegetation. Surface water in the project site is discharged through a pump located on the southwestern corner of the project site directly into Mowry Slough. This pumping is probably the only means by which this large western portion of the project site can be farmed and also establishes a hydrologic connection between the other waters and wetlands and Mowry Slough, a navigable tributary to the San Francisco Bay. The wetlands and other waters on the project site are abutting Mowry Slough (see Approved Jurisdictional Determination Form, Section II.B.1a., wetlands adjacent to TNWs, relatively permanent waters that flow directly or indirectly into TNW, impoundments of jurisdictional waters and Section III, A.2).

Impoundment

The Corps should proceed with re-verifying the jurisdictional delineation for the project site annotating the label to clarifying the following: a) wetland vegetation supported by artificial hydrology is non-jurisdictional pursuant to Section 404 of the Clean Water Act; b) non-jurisdictional, isolated wetlands that are storm water detention basins; c) historic double-sided sloughs are jurisdictional pursuant to Section 10 of the Rivers and Harbor Act; and d) wetlands and other waters are jurisdictional pursuant to Section 404 of the Clean Water Act.

_____ _____

Katerina Galacatos Date

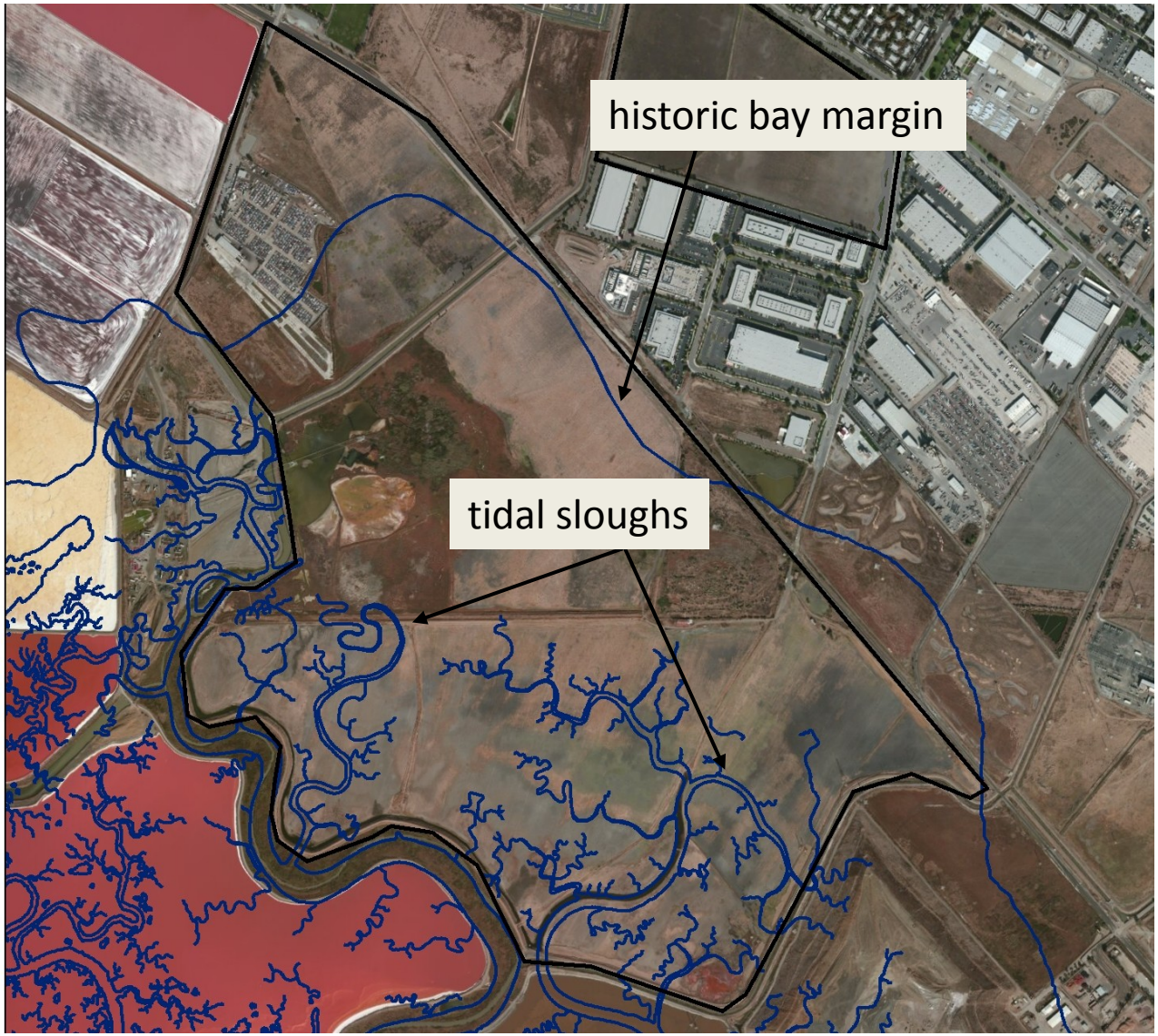

Figure 1. Overlay of current aerial photograph of southwestern portion of project site t-sheet showing historic sloughs.

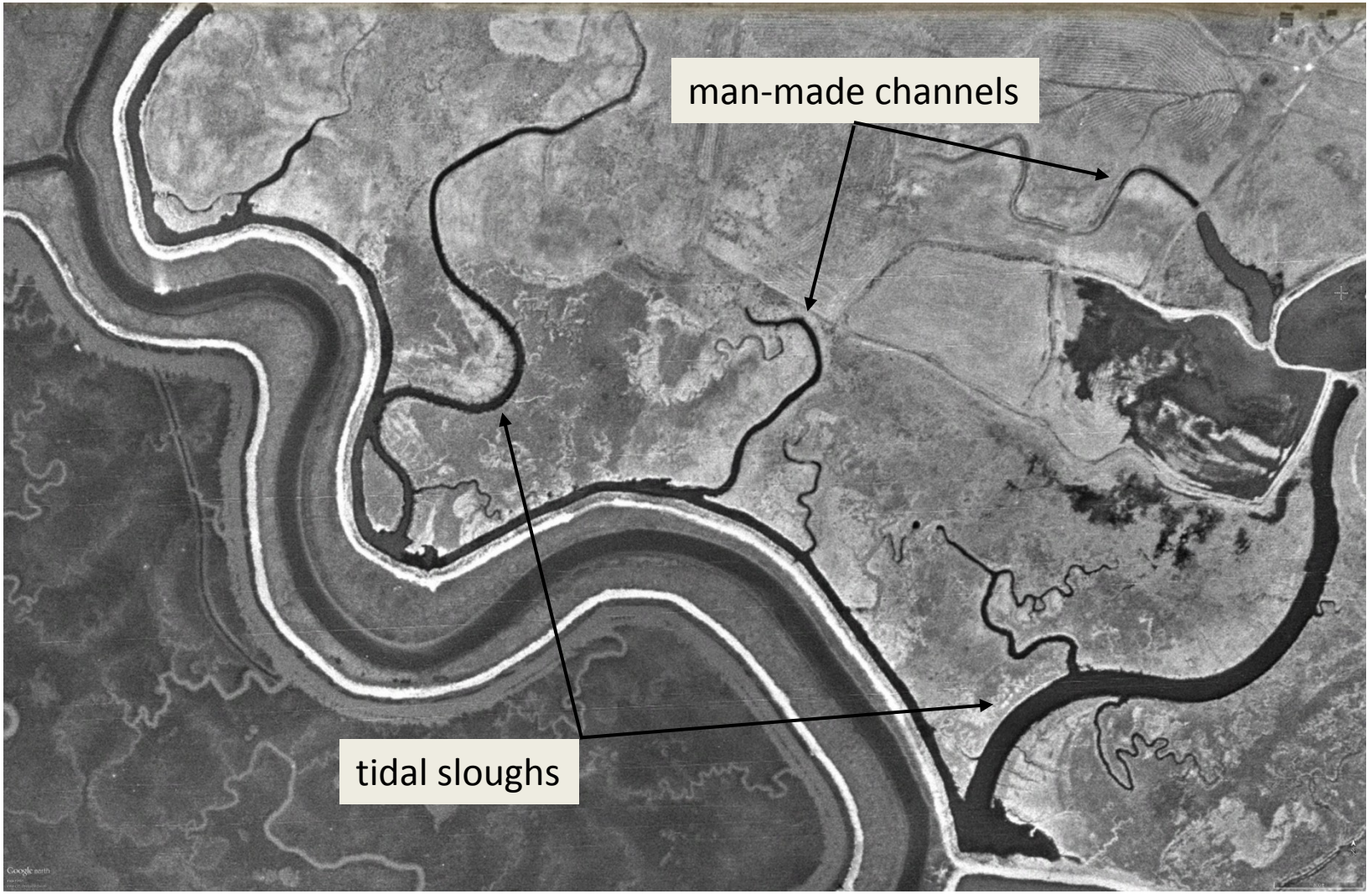

Figure 2. 1948 aerial photograph of southwestern portion of project site with historic sloughs still visible behind constructed dikes and most likely, man-made channels.

Appendix C: Compliance Checklist Comment Letters

ALAMEDA COUNTY WATER DISTRICT

43885 SOUTH GRIMMER BOULEVARD • FREMONT, CALIFORNIA 94538
(510) 668-4200 • FAX (510) 770-1793 • www.acwd.org

October 22, 2019

Sofia Mangalam, Senior Planner
City of Newark Planning Department
37101 Newark Blvd.
Newark, CA 94560

Dear Ms. Mangalam:

Subject: Draft Compliance Checklist for the Area 4 – Sanctuary West Residential Project

The Alameda County Water District (ACWD) wishes to thank you for the opportunity to comment on the Draft Compliance Checklist for the Area 4 – Sanctuary West Residential Project (Project). ACWD previously reviewed and provided comments to the City of Newark that are generally still applicable to the Newark Areas 3 and 4 Specific Plan (State Clearinghouse No. 2007052065), in correspondence as follows: June 8, 2007, Notice of Preparation of an Environmental Impact Report for Newark Area 3 & 4 Specific Plan; January 15, 2010, Draft Environmental Impact Report for Newark Areas 3 and 4 Specific Plan Project; and September 19, 2014, Draft Recirculated Environmental Impact Report for Newark Areas 3 and 4 Specific Plan Project.

ACWD staff has reviewed the Draft Compliance Checklist and offers the following comments for your consideration:

1. Stevenson Boulevard Extension and Other Identified Bridges (Section 3.2.1): As required by ACWD Ordinance No. 2010-01, drilling permits are required prior to the start of any subsurface drilling activities for wells, exploratory holes, and other excavations (i.e. installation of support piers, piles, or caissons, etc.). The installation of support piles and piers are frequently installed similar to wells and exploratory holes and may intersect an aquifer or may impact the integrity of any aquitard located directly above an aquifer. If the annular space between the excavation or borehole wall and the support pier or pile is not properly sealed, it can act as a vertical conduit and may create preferential pathways that allow pollutants to rapidly infiltrate the subsurface and impact groundwater. Conversely, specific aquifers within the Niles Cone (managed by ACWD) are under artesian conditions and the installation of a pile without a proper seal (such as a H or cast-in-steel piles) into such an aquifer may create a preferential pathway for groundwater to flow artesian which could result in a significant loss of groundwater supplies.

Based on information in the Draft Compliance Checklist, some work has been done regarding possible soil improvements for the project, as demonstrated by proposed pile design and other soil improvements identified in the Draft Compliance Checklist. As stated in ACWD's previous letters and as specified in MM GEO-1.1 "The project geotechnical engineer shall coordinate with ACWD prior to beginning any soil improvement measures to ensure impacts on groundwater resources are minimized." To date, no such coordination with ACWD has taken place. For this reason, ACWD requests the Draft Compliance Checklist specify that Project proponents coordinate soil improvement measures with ACWD.

2. Groundwater Protection:

   a. ACWD records indicate the existence of at least four (4) water wells located within the Project area. Any abandoned wells located within the Project area must be properly destroyed in compliance with ACWD Ordinance No. 2010-01 prior to grading and/or construction activities. The language specifically related to abandoned wells has been deleted in the Draft Compliance Checklist by strike out (page 79). ACWD requests that the strike out be removed and requests that Project proponents coordinate with ACWD so that: a) ACWD can assist in identifying abandoned wells, and b) any wells identified or discovered during construction are properly destroyed in accordance to ACWD Ordinance No. 2010-01.

   b. There are also four (4) ACWD monitoring wells, 5S/1W-08P004, 5S/1W-17C003, 5S/1W-17C004 and 5S/1W-17G001 located in the vicinity of the Project area. The information collected from the monitoring wells is used in the management of the Niles Cone Groundwater Basin underlying the region. Therefore, as previously stated in ACWD's other letters, access must be maintained to ACWD's facilities including a provision that the well must be protected against being buried and/or damage during construction activities.

3. Water Service (Section 3.2.5.1): ACWD is currently reviewing its recycled water system master plans and as such, requirements and locations for recycled water service previously identified for the subject development may change. With that, ACWD requests the following changes to the document be considered:

   The first sentence should be revised to read "The ACWD has jurisdiction of overall public water mains, appurtenances and laterals through the individual water meter or device." The second sentence should be deleted as the City of Newark does not have jurisdiction over the public water system.

   The first sentence of the second paragraph should be revised to "Area 4 potable water needs will be met by an extension of the existing main within Stevenson Boulevard as well as a minimum of one additional connection from existing mains in either Mowry Avenue or Cherry Street (via the new potable water system installed in Area 3 or a direct connection(s) from the main(s) within Mowry Avenue and/or Cherry Street)."

Revise the first sentence of the third paragraph to state "Reclaimed water is not available at this time, but the proposed development *may* include provisions (installation of purple piping onsite) for use of reclaimed water when it becomes available."

The third bullet under "For Landscape Development Within Area 4 (page 22):" should be revised to state "*May* include installation of a separate, non-potable distribution system (i.e. "purple pipe") for the non-residential landscape needs. The on-site system may also include non-potable distribution mains extending to areas where recycled water could be used."

4. ACWD Contacts: The following ACWD contacts are provided so that the City of Newark staff can coordinate with ACWD as needed during the Project:

   - Michelle Myers, Groundwater Resources Manager, at (510) 668-4454 or by email at michelle.myers@acwd.com, for coordination regarding ACWD's groundwater resources.

   - Kit Soo, Well Ordinance Supervisor, at (510) 668-4455 or by email at kit.soo@acwd.com, for coordination regarding groundwater wells and drilling permits.

   - Juniet Rotter, Development Services Manager, at (510) 668-4472 or by email at juniet.rotter@acwd.com, for coordination regarding public water systems and water service.

Thank you again for the opportunity to comment on the Draft Compliance Checklist for the Area 4 – Sanctuary West Residential Project.

Sincerely,

Robert Shaver
General Manager

jr/mh
By E-mail
cc: Ed Stevenson, ACWD
Laura Hidas, ACWD
Michelle Myers, ACWD
Kit Soo, ACWD
Juni Rotter, ACWD

Law Offices of
Stuart M. Flashman
5626 Ocean View Drive
Oakland, CA 94618-1533
(510) 652-5373 (voice & FAX)
e-mail: stu@stuflash.com

Delivery via email to Sophia.mangalam@newark.org

October 21, 2019

Ms. Sophia Mangalam, Senior Planner
Planning Department
City of Newark
37101 Newark Blvd.
Newark, CA 94560

Re: Sanctuary West Residential Area Project (E-19-4)

Dear Ms. Mangalam:

I am writing on behalf of my client, the Citizens' Committee to Complete the Refuge ("Committee") to comment on the above-referenced project ("Project") and its public hearing before the Newark Planning Commission currently scheduled for October 22nd. This letter follows up on a September 27, 2019 letter submitted on behalf of the Committee by Mr. Richard Grassetti, environmental consultant, detailing procedural and substantive inadequacies in the environmental review of the Project. Those inadequacies must be corrected before the City can consider approving the Project. It also follows up on an October 1, 2019 letter submitted to the City by Mr. Xavier Fernandez of the San Francisco Bay Regional Water Quality Control Board ("Regional Board") and an email sent to the City by Kim Squires of the U.S. Fish and Wildlife Service ("Service") on September 26, 2019. Both of the latter identified specific substantive deficiencies in the City's environmental review of the Project.

The City is proceeding under the assumption that the prior Recirculated EIR for the Newark Areas 3 and 4 Specific Plan Project, along with the preceding EIR for that project, adequately addressed the potential water quality, hydrology, and biological impacts of the Project, and therefore no further environmental review is necessary. (Draft Compliance Checklist for Project, dated September 2019.) That assumption is incorrect and invalid.

There have been both changes to the Project and to the circumstances surrounding the Project as well as the release of new, previously unavailable, information related to the Project and its potential environmental impacts. All of these present the City with substantial evidence indicating that the Project will have new site-specific significant impacts and/or significantly increased impacts that were not analyzed or addressed in the prior EIR or the prior Recirculated EIR for the Newark Areas 3 and 4 Specific Plan Project. Consequently, the environmental review must be reopened and supplemented before the City can proceed to consider approving the Project.

OUTDATED WETLANDS DELINEATION

As noted in the letter from the Regional Board, both the prior programmatic EIR and the Recirculated EIR relied upon a 2007 U.S. Army Corps of Engineers ("Corps") wetlands delineation. By its own standards, that delineation's validity expired in 2012. Consequently, even if there had been no changed circumstances, the 2007 delineation should not have been relied upon in the current project-level environmental review.

However, making matters worse, there *have* been changed local circumstances since 2007, and indeed, since 2015, when the Recirculated EIR was certified.

For one thing, the Project itself has become far more clearly defined than it was when the environmental review of the specific plan was completed. While the specific plan only identified general area and general conceptual plans for the development on the site, the approvals currently before the City include very detailed plans identifying exactly what would be built and where it would be built. Specifically, those plans depend heavily on the 2007 wetlands delineation to identify areas that are NOT wetlands, and the project is designed to build exclusively on the non-wetlands areas. While this may be beneficial in reducing impacts to wetlands, and certainly seeks to aid the project in avoiding having to deal with a Section 7 consultation with the Service, it makes it crucial that the wetlands delineation be absolutely accurate.

In addition, while the effect of global climate change in causing a rise in sea levels was known in 2007 (and in 2009 when the Biological Resources Report for the program level EIR was prepared), recent research shows that the rate of sea level rise due to global climate change, and specifically due to glacial melting and increase in sea water temperatures, had previously been significantly underestimated.[1] This makes it all the more important that a new wetlands delineation be done. During the time period since 2007, the sea levels in the areas west of the Project have almost certainly risen, and just as certainly have risen more than would have been expected or predicted at the time when the program EIR, or even the recirculated EIR, was prepared and certified. Because sea levels and tides are extremely local, the effects of sea level rise at this project site were not, and could not have been analyzed in the prior EIRs, and certainly not the new information showing an increased rate of sea level rise.

The supplemental biological report done in support of the checklist claims to have confirmed the continued reliability of the 2007 delineation through three "reconnaissance-level site visits" between July and December 2018. The Committee has contacted the Corps and was informed that there is no record of the 2007 jurisdictional delineation being recertified. As the letter from the Regional Board notes, the information contained in the supplemental environmental report is insufficient to allow anyone to confirm that the 2007 delineation remains valid and accurate. The mere say-so of the consultants that nothing has changed, without supporting factual evidence and data, does not constitute substantial evidence and is insufficient to validate the consultants' conclusion.

Especially given how close the boundaries of the residential areas, and the associated extensive fill, come to the boundaries of the wetlands areas, as determined by the 2007 delineation, and the importance of those wetlands areas to several federally protected species, absolute accuracy in the delineation is essential. Unless it can be confirmed that the 2007 wetlands delineation remains accurate and valid, it appears quite likely that violations of the Endangered Species Act via the take of protected species or their habitat, as well as potential violations of § 404 of the Clean Water Act, will occur during construction. Those would be significant impacts, and could also result in the City, as well as all those involved in the construction, being subject to federal criminal liability. At the very least, the data collected by the biological consultants needs

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[1] See, e.g., *Global and Regional Sea Level Rise Scenarios for the United States* [hyperlink] (PDF) (Report) (NOAA Technical Report NOS CO-OPS 083 ed.). National Oceanic and Atmospheric Administration. January 2017. p. vi. Retrieved 24 August 2018. ["The projections and results presented in several peer-reviewed publications provide evidence to support a physically plausible GMSL rise in the range of 2.0 meters (m) to 2.7 m, and recent results regarding Antarctic ice-sheet instability indicate that such outcomes may be more likely than previously thought."]

to be fully reviewed by Corps staff, who can determine whether, based on that data, the 2007 delineation can be recertified or not.

OTHER DIRECT AND INDIRECT IMPACTS FROM THE INCREASED RISKS DUE TO SEA LEVEL RISE.

In addition to its effects on wetlands delineation, the recent re-evaluation of the expected rate of sea level rise creates other new and significantly increased impacts, especially with the Project's design placing much of the residential development in close proximity to low-lying wetlands areas.

While the plans for the Project include adding extensive fill (5 to 16 feet) in the developed areas to reduce the risk of flooding, consistent with recommendations in the 2015 Recirculated DEIR, the plans do not appear to take into account recent revisions to the expected rate of sea level rise. Nor do the supplemental reports on geotechnical and hydrological aspects of the project appear to consider the increase in groundwater levels and associated increased risk of liquefaction that will be associated with the increased rate of predicted sea level rise. These will all be affected by the rate of sea level rise, and all need to be re-evaluated to determine whether, with the increased rate of sea level rise, additional mitigation is needed.

The supplemental hydrology report does note that groundwater quality at the one measured well in Newark (site well #2) showed a dramatic drop in TDS and chloride between 2006 and 2017. The report provides no explanation for this drop, but it may reflect the rising groundwater levels due to sea level rise and the consequent backing up and rising of the fresh water groundwater underneath the site, resulting in greater apparent dilution of salinity in the groundwater underlying the site.[2] Of course, without doing detailed analysis of groundwater flows, and the soil's permeability to groundwater, it is impossible to do a detailed interpretation of the significance to the marked changes in groundwater water quality. By the same token, however, these changes indicate that groundwater conditions are anything but static, and seismic stability and risk of liquefaction can likewise not be assumed to be unchanged from those analyzed and mitigated in the 2015 Recirculated EIR.

The supplemental geotechnical report recommends that a post-approval design-level geotechnical study be done "to characterize and mitigate potential liquefaction-induced settlement and lateral deformation." This is a tacit admission that the potential risk of liquefaction has not been adequately studied and mitigated. In particular, it assumes that the study will be able to adequately mitigate any risk of liquefaction found during the study. Yet no evidence is presented to support that assumption. Mitigation of potential impacts cannot depend on post-approval studies, especially when those studies come out of a checklist that has not been subject of the rigorous comment and response process of an EIR. Consequently, due to the changes in groundwater and the change in the expected rate of sea level rise, additional analysis of seismic impacts through a supplemental EIR is needed.

Another concern that is heightened by the increased rate of sea level rise is impacts related to the tracks used by the Capitol Corridor Amtrak train, which currently travels along tracks immediately adjacent to the Project. The prior EIRs had identified noise and vibration from passing trains as causing a potentially significant impact, and proposed placing sound walls between the tracks and the Project.

In 2014, the Capital Corridor Joint Powers Authority ("JPA") conducted a study of the effects of sea level rise on the Capitol Corridor route. As a result of that study, the JPA plans to elevate and triple track the rail line through Newark. The Alviso Adaptation

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[2] Fresh water is less dense than salt water, and hence will "float" on top of salt water when both are present but not mixed – as would be the case in groundwater.

Study is using California Sea Level Rise Curve 3 for evaluating alternative designs for the Capitol Corridor rail line. This design standard requires elevating the Capital Corridor Line to an elevation of 13.4 feet for sea level rise and Storm Surge plus 2 feet for wave run up for a total of 15.4 feet. This critical infrastructure project has implications for the Area 4 Project.

Raising the Capitol Corridor tracks will, among other things, require redesign of the Stevenson Overpass, as there is a minimum clearance requirement over the rail tracks. It would be best to take that into account now, before the Project is approved, as significant additional costs are likely to be involved.

As noted, the EIR proposed to mitigate noise and vibration impacts from passing trains by placing a sound wall between the tracks and the project. If both the tracks and the housing are to be raised by 10-15 feet, the sound wall would likewise need to be raised by at least an equal amount. This raises questions about the stability of the sound wall, especially in an area subject to soil liquefaction. The supplemental EIR should address whether modification of the previously proposed mitigation is needed.

In addition, the California Rail Plan calls for increasing the frequency of service of Capital Corridor trains, as well as potentially widening or moving the right-of-way. The supplemental EIR needs to take into account how this now reasonably foreseeable future project will affect this Project, especially because one of the main alternative alignments would run the train tracks right through the middle of the Project.[3] (Shown in blue on the attached diagram.)

A just-released report from the Federal Reserve Bank of San Francisco entitled *Flood Risk and Structural Adaptation of Markets: An Outline for Action* (also available as pdf at https://www.frbsf.org/community-development/files/02_Berman.pdf) discusses some of the consequences of sea level rise in the Bay Area as it relates to real estate development and its financing. The report finds that properties that may be affected by sea level rise have their property value decrease as the likelihood of flooding increases. Thus, as sea levels continue to rise, home values drop, such that long before the properties are literally under water, they are financially "under water" – that is, their mortgage balances exceed the property values.

As the Great Recession of 2007-2008 demonstrated, under those circumstances, many homeowners, rather than continue to pay down a mortgage on the property at a loss, will default on their loan and allow the mortgage to be foreclosed. As a result, banks would be left with many properties – or, in the case of a project such as this, entire subdivisions – of vacant and unsellable homes. The end result would be blight on a massive scale. While the loss of financial value is an economic impact. the resulting blight is a secondary physical environmental impact. With the increase in the expected rate of sea level rise, such blight is a very real potential long-term impact from this property's development as proposed. Since this site-specific impact was not addressed in the prior EIRs, it should be addressed in a supplemental EIR prior to the City making any decision on approving this project.

That same article also notes that continuing to allow development in vulnerable areas such as this can have impacts beyond the specific development. If the City is required to spend public funds attempting to protect the public infrastructure installed along with this development, it will draw funds away from other needed infrastructure maintenance and improvement projects, resulting in a city-wide deterioration of infrastructure, such as happened, for example, in Detroit. Again, this issue involves not only economic impacts, but secondary physical environmental impacts, and needs to be examined in the supplemental EIR.

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[3] As a common carrier, the Capitol Corridor JPA can assert eminent domain to take any land needed for its new right of way.

DETERMINATION AND MITIGATION OF HABITAT IMPACTS FOR THE SALT MARSH HARVEST MOUSE.

The EIR (and Recirculated EIR) for the Areas 3 and 4 Specific Plan proposed general mitigation for impacts to the salt marsh harvest mouse ("SMHM"). It noted that since the location and extent of development in Area 4 were not yet available, the mitigation might need to be revisited and revised. The checklist asserts that the mitigation proposed in the EIR and Recirculated EIR remains valid and adequately mitigates potential impacts on salt marsh harvest mouse habitat. This assertion is incorrect.

As noted in the letter from the Regional Board, new information has become available since the certification of the Recirculated EIR. That information[4] indicates that areas outside of "traditional" habitat also support the species (e.g., diked seasonal saline, fresh water, and brackish marsh areas, as well as potentially adjoining upland areas). The analysis of SMHM habitat areas and project impacts on these areas needs to be revisited and reevaluated in a supplemental EIR based on this new information, which indicates that the SMHM may occupy a considerably wider area than has been assumed, and therefore may require additional habitat area.

In addition, the prior EIRs noted that, with sea level rise, additional habitat for the SMHM will be needed as in some current areas the water level may become too high to serve as SMHM habitat. The prior EIRs noted that because the area contained a mixture of wetland and upland areas, some low-lying upland areas could be recruited as wetlands and replace lost SMHM habitat. Therefore specific mitigation for lost habitat due to sea level rise was not needed.

The current project plans, however, involve blocking expansion of the wetlands areas due to the development project and the raised height and fill for the housing sites. The new detailed plans foreclose the ability to recruit most upland area in Area 4 into new wetlands as sea levels rise over time. As a result, it appears that the Project will negatively impact the SMHM and its habitat in ways that are site-specific and could not have been addressed in the prior EIRs. These adverse impacts must be studied, addressed, and, if possible, mitigated in a supplemental EIR.

NEWLY AVAILABLE DETAILS ON THE PROJECT REQUIRE REEVALUATION OF THE POTENTIAL INADVERTENT FILL OF WETLANDS AND WATER QUALITY IMPACTS FROM EROSION.

When the program EIR was certified, details were not available regarding either the location of the constructed development within the sub areas or the scope of the proposed residential development. At this point, plans have been released showing that while the Project does not propose extensive intentional wetlands fill in conjunction with the project, it proposes adding fill up to the very edge of wetlands areas, with 3:1 or 2:1 slopes at the transition between fill and wetlands, information that was not provided in the EIR or REIR. With that kind of slope, there is no room for error. Indeed, it can be

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[4] See references provided in the Regional Board letter. See also, e.g., *Effects of Natural and Anthropogenic Change on Habitat Use and Movement of Endangered Salt Marsh Harvest Mice* K.R. Smith et al., https://doi.org/10.1371/journal.pone.0108739; *Toward Salt Marsh Harvest Mouse Recovery: A Review*, K.R. Smith et al., https://escholarship.org/uc/item/2w06369x ; *Ecology and Conservation of the Salt March Harvest Mouse in the Modern San Francisco Estuary*, K.R. Smith (2019, U.C. David doctoral dissertation) [copy attached].

predicted that there will be erosion of some of the fill soil, or potential slumping of material, which will be carried into the wetlands area. Not only will this result in fill of the wetlands area, thus requiring a permit from the Corps and the Regional Board; it will also potentially carry pollutants from the fill dirt into the wetlands. Neither of these results were predicted or analyzed in the program EIR, yet they could result in significant impacts in terms of loss of wetlands due to fill and detrimental water quality impacts in the wetlands that could adversely affect RARE and WILD beneficial uses of the wetlands areas. These potentially significant impacts should also be analyzed through a supplemental EIR.

The Response to comments on the checklist asserts that, as mitigation for the potential erosion of the added fill along the western Project border, where the Project abuts wetlands, the slopes will be "armored" with riprap. (See, Responses to Comments at p. 19 [response to comment C.5].) While riprap may help prevent erosion, it is also well known for harboring rodents (e.g., mice, rats), which would be predators and/or competitors of the SMHM living in the adjoining wetlands. This potentially significant secondary impact needs to be addressed in the supplemental EIR.

In addition, Appendix E of the Checklist identifies another potentially significant secondary impact that should be analyzed in a supplemental EIR:

> If slope instability conditions, such as a "mud wave", are identified in the additional design-level geotechnical exploration, the required design-level geotechnical exploration would ensure that appropriate design details, such as properly placed retaining walls or staging of fill placement, will be provided to prevent a potential "mud wave" from forming at the toe of the fill slope.

Analysis of potential impacts such as "mud waves" should not be put off to post-approval studies when it is not self-evident that successful mitigation is possible. Their potential for forming, and appropriate mitigation (if feasible), should be discussed *pre-approval* in the supplemental EIR.

THE PROXIMITY OF RESIDENTIAL DEVELOPMENT TO WETLANDS AREAS INCREASES THE POTENTIAL FOR INDIRECT IMPACTS ON THE WETLANDS.

As the Regional Board's letter points out, the location and distribution of the residential areas as proposed in the Project results in a much larger interface between residential and wetlands areas than was evaluated in the EIR or Recirculated EIR. While the prior EIRs attempted to evaluate and mitigate secondary impacts resulting from this proximity, the much larger scope of that interface in the Project will greatly increase the potential for such secondary impacts (e.g., predation on wildlife, including listed species, by household pets, spread of human-associated pests such as house mice and rats into the wetlands areas, and increased predation by human-associated wildlife (e.g., raccoons, skunks, opossums).

While the EIR proposed various mitigation measures to attempt to reduce these secondary impacts, the increase in the size of the interface area and the close proximity of the housing in the Project to the sensitive wetlands, and the resultant increase in the significance of secondary impacts requires reevaluation of the efficacy and effectiveness of the proposed mitigation measures (e.g., by study of their effectiveness as applied in other similar projects.) Unless they can be shown to be highly effective, the indirect impacts should be disclosed as significant and unavoidable, and alternatives that would reduce the secondary impacts (e.g., by concentrating the development in smaller areas or areas more removed from the wetlands areas) should be considered.

Another potential secondary effect of placing so much development that close to wetlands is that it would increase the need for far more intensive efforts at mosquito control. Wetlands areas are known to breed a variety of mosquito species, including species that attack humans and can be anything from a nuisance to a public health risk. The more residential development that occurs in close proximity to wetlands, the stronger will be the pressure to reduce mosquito populations by any means necessary.

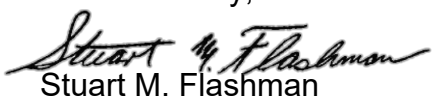
While the Alameda County Mosquito Abatement District, which would be responsible for mosquito control, relies primarily on biorational pest control, particularly the use of bacillus thuringiensis israelensis (Bti) pellets, it also uses mosquito fish, which are strongly discouraged from use in wildlife areas. In extreme cases (e.g., spread of West Nile Disease or related viruses), the Abatement District has had to resort to aerial spraying of adulticide insecticides. These can have significant adverse effects on wildlife, especially fish and migratory birds that rely on insect populations as in their diet. The potential for such adverse effects must be considered as another potentially significant indirect impact from placing the residential development in such close proximity to wetlands areas, especially ones with listed species.

CONCLUSION

Because of the changes to the Project and to circumstances surrounding the Project and new information affecting the Project's potential impacts, all of which are specific to the Project site and hence could not be addressed in the EIRs for the specific plan, the use of the checklist form is improper, as is its conclusion that no additional or increased impacts results from the Project that were not studied in the specific plan EIRs.

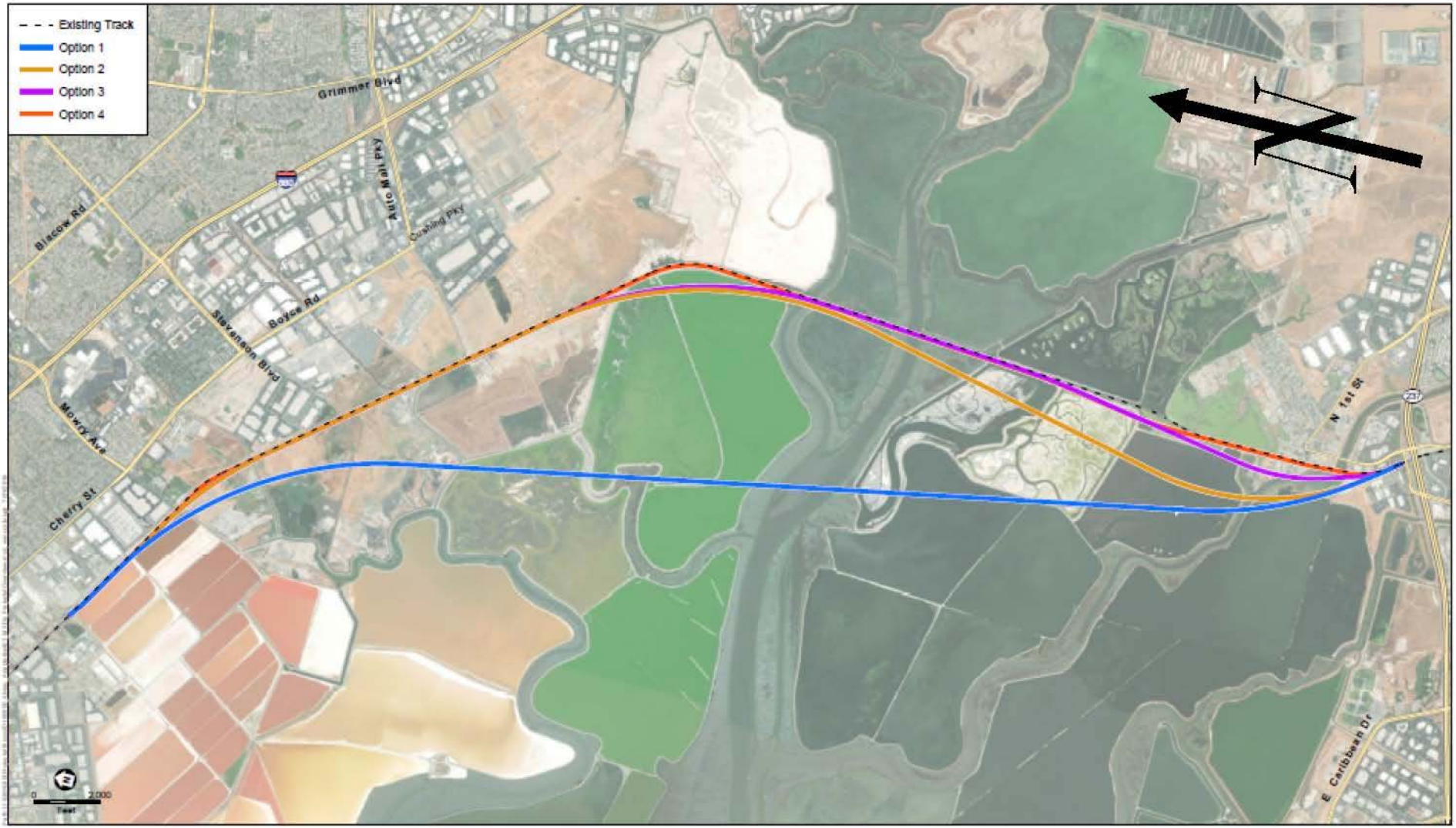
A supplemental EIR is required to address the new/significantly increased Project impacts. Only after that supplemental EIR has been prepared, circulated for public and agency comments, and the resulting comments responded to may the City consider whether to approve this project.

Most sincerely,



Stuart M. Flashman

Study Area Overview



Ecology and Conservation of the Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

By

KATHERINE ROSE SMITH

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Ecology

in the

OFFICE OF GRADUATE STUDIES

of the

UNIVESRITY OF CALIFORNIA

DAVIS

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2019

ACKNOWLEDGMENTS

Completing this dissertation has been one of the most challenging and rewarding experiences of my life. It has been an honor to be part of the graduate group in Ecology and the Wildlife, Fish, and Conservation Biology Department at UC Davis.

First of all I must thank my many collaborators. Your willingness to get up and chase mice with me for hundreds of hours over the past six years has made this dissertation possible. For the midnight forays into the marsh, the bumps and bruises along the way, and dozens of Bab's cinnamon rolls, I thank you. You support has been indispensable, and I couldn't have asked for a better family to share this experience with. From the bottom of my heart, thank you Laureen Barthman-Thompson, Sarah Estrella, Melissa Riley, Sadie Trombley, Caitlin Roddy, Orlando Rocha, Candace Rose, Susan Fresquez, and Mike Harris. Everyone from the California Department of Fish and Wildlife Grizzly Island Wildlife Area, California Department of Water Resources Suisun Marsh Group, California Waterfowl Association, and Suisun Resource Conservation District who supported this work deserve sincere thanks and a lot of credit for supporting the work presented in this dissertation. Laureen and Sarah you have been such amazing mentors, I wish we could work together forever. Melissa, you made work feel like play, even measuring plants was fun when we were out in the marsh together.

I would also like to thank my adviser Dr. Douglas Kelt, and other committee members, Dr. Dirk Van Vuren and Dr. John Eadie. Doug is an incredible mentor, and his writing and editing skills were essential for molding my initially convoluted and, at times, incomprehensible explanations of my analyses into a presentation that can convey the important management messages we set out to present. Having him on the salt marsh harvest mouse team will contribute greatly to conservation of the species in the future.

Thanks for supporting me for all these years, Doug! Dirk is one of the most positive people I have ever know, and I could always count on him to lift my spirits when I was feeling frustrated or down. He also has a great way of distilling complex concepts into digestible summaries. Thanks for always being there Dirk! John was a crucial part of the team, providing the waterfowl perspectives that were essential for this research. His insights have helped to keep my publications on track when I get my head caught in the mice. Keep up the great work in the marsh, John!

Over 100 different UC Davis undergraduates volunteered on the project in one way or another. They provided indispensable assistance that made a project of this magnitude possible. It has been great to see students work their way from volunteers, to student employees, to professionals, and in some cases, graduate student studying salt marsh harvest mice themselves. I am so grateful for each and every hour you all spent working on the project, whether you were radio tracking salt marsh harvest mice, tagging house mice, watching hours of video of mice eating, or entering hundreds of numbers in spreadsheets. Your assistance was more helpful than you can ever know, and I hope that you got some valuable experience out of the effort.

I am grateful to the Ecology Graduate Group, one of the most wonderful groups of people I have had the pleasure of knowing. You are all an inspiration, and it has been so cool to see everyone's research grow over the years. I must especially thank my princess unicorning, gladiating, ghost busting, Mad Maxin', Power Ranging, St. Patty's Day crew. Rachel, Allison, Denise, Missy and Jackie, you are all intelligent, talented, angels, and your friendships have made this grueling process all worth it.

Finally, I send my thanks and love to my family and friends. You listened to me vent over the years, without complaining that I smelled like mouse pee. You supported me in so many ways, I definitely would not have made it through this process without you. I must especially thank my partner Chris, who was my biggest cheerleader, and my backup. Thanks for putting up with me when I was grumpy from devilish R code, or lack of sleep, or leaky waders. And thanks for never hesitating to do anything I asked for in terms of support. I couldn't ask for a better partner in all of this.

Finally, I dedicate this dissertation to my mother, Rose. You have always been an inspiration to me, and that is still true today. Your kind heart, creativity, and unstoppable drive has made you one of the greatest mentors of my life. I love you.

ABSTRACT

The salt marsh harvest mouse (*Reithrodontomys raviventris*, SMHM) is an endangered rodent, endemic to the marshes of the San Francisco Bay Estuary (SFE), and comprises two subspecies, the northern (*R. r. halicoetes*) and the southern (*R. r. raviventris*). The northern subspecies is found in the brackish to saline marshes of San Pablo and Suisun Bays at relatively high numbers, while the southern subspecies occurs in the salt marshes of central and South San Francisco Bay where populations are much smaller. The SMHM is adapted to its marsh habitat, but reliance on the marshes of the SFE has made this species vulnerable, as 90% of tidal marshes in the SFE have been lost to filling and diking. The Suisun Marsh represents about 10% of the remaining wetland habitat in California, but is primarily made up of wetlands managed for waterfowl, which have been considered inferior habitat for SMHM when compared to natural tidal wetlands. Nonetheless, large populations of SMHM occur on managed wetlands, and I sought to investigate the relative value of these two wetland types for SMHM through investigations of demography and populations (utilizing capture-mark-recapture [CMR] methods), diet preferences (utilizing a cafeteria trial), and habitat use (utilizing trapping and radiotelemetry). Results of CMR analyses of trapping data revealed that wetland type alone did not have a significant effect on important demographic parameters for SMHM, or on abundance estimates, indicating that both wetland types support SMHM equally well. Results of the cafeteria trial revealed that, contrary to popular belief, pickleweed (*Salicornia* spp.) may not be the top preferred food choice of SMHM, as they spent significantly more time in the trials eating plants that are non-native and are grown extensively in managed wetlands as food for ducks. Finally, analysis of CMR and telemetry data revealed that SMHM utilize many microhabitats within both wetland types, and that home range size does not differ between wetland type.

Overall, the results of these projects indicate that managed wetlands provide substantial habitat value for SMHM, potentially equal to that of their natural tidal wetland habitat.

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INTRODUCTION

Coastal wetlands and the species they support are imperiled worldwide. A recent meta-analysis of 189 reports indicates that over 50% – and up to 87% – of global wetlands have been lost to anthropogenic activities (Davidson 2014). Losses in the San Francisco Estuary (SFE) have been even more extreme, and it is estimated that <10% of historical tidal wetlands remain (Goals Project 2015). However, this loss has not been homogeneous throughout the SFE. While salt ponds provide habitat for only a very select group of wildlife (e.g., shorebirds and waterfowl, Warnock et al. 2002), wetlands managed for waterfowl habitat support much of the remaining wildlife community, including the salt marsh harvest mouse (*Reithrodontomys raviventris;* SMHM hereafter) (Sustaita et al. 2011; Smith et al. 2014).

The SMHM is endemic to the SFE and is the only mammal species (and one of only 5 terrestrial vertebrates) known to be fully restricted to coastal marshes (Greenberg 2006). It two subspecies, the northern *R. r. halicoetes* and the southern *R. r. raviventris*. Originally described as distinct species (Dixon 1908, 1909), these were subsequently shown to be conspecific on both morphological (Howell 1914) and genetic grounds (Statham et al. 2016). The northern subspecies is found in the brackish to saline marshes of San Pablo and Suisun Bays at relatively high numbers (e.g., 18-181 mice/ha; Bias 2006; Sustaita et al. 2011), while the southern subspecies occurs in the salt marshes of central and South San Francisco Bay (South Bay hereafter), where populations are much smaller (e.g., <1-3.6 mice/ha; Padgett-Flohr 1999; Kingma 2003; Basson 2009).

The SMHM is highly adapted to its marsh habitat (Fisler 1965), and exhibits numerous morphological and physiological adaptations for life in this challenging environment (Fisler 1965). SMHM can subsist on salt water, they climb well in emergent vegetation, and they swim

well compared to their upland counterparts (Fisler 1965). This apparent specialization for tidal wetlands, along with a legacy of research with a regional focus, led managers and researchers to conclude that SMHM are dependent on tidal wetlands dominated by pickleweed (*Salicornia* spp.) and, by inference, that management of wetlands in a non-tidal state would be harmful to the species (Shellhammer et al. 1982). However, reliance on the disappearing marshes of the SFE has made this species vulnerable. Amplifying the impact wetland loss in the SFE is the increasing fragmentation of remaining SMHM habitat (Fisler 1961). These factors led the United States Fish and Wildlife Service (USFWS) to list the SMHM as endangered (Federal Register 1970), followed soon thereafter by the State of California. Since being listed, SMHM management and recovery has been addressed in two Recovery Plans (USFWS 1984, 2013) and at least nine other restoration and management plans for the SFE. Most of these documents emphasize the importance of habitat protection, enhancement, acquisition, and restoration as the primary strategies for SMHM recovery. Despite the large number of threats to SMHM, and its incorporation into these many plans, general knowledge of the species remains limited, and significant knowledge gaps hinder conservation efforts. Additionally, research foci have changed little throughout the years, resulting in some aspects of SMHM conservation being addressed extensively in the literature (e.g., habitat use – Johnson and Shellhammer 1988, Bias and Morrison 2006, Sustaita et al. 2011), while others have remained largely unexplored (e.g., effects of environmental contamination, but see Clark et al. 1992).

Despite the belief that SMHM are dependent on tidal marshes, surveys in managed wetlands have confirmed that these habitats support substantial SMHM populations (Shellhammer et al. 2010; Sustaita et al. 2011). However, with almost no data regarding the demographic value of tidal and managed wetlands, managers have been unable to properly evaluate the importance of

managed wetlands. Understanding which habitat features favor native species, and disfavor non-native species, is critical for the recovery of species facing severe habitat loss, such as SMHM, and has been addressed in the recovery plan for this species (USFWS 2013).

For my dissertation I sought to further understand the state of knowledge regarding SMHM, and to investigate the relative value of tidal and managed wetlands through a holistic lens. To accomplish this, I convened a panel of experts to perform an extensive review of SMHM, and performed three large-scale field efforts.

Chapter 1 is an effort to succinctly review the entirety of the published literature addressing SMHM in which we distill current understanding of the biology and management of the SMHM. We begin by outlining the current state of knowledge, and highlight research gaps with respect to habitat requirements and distribution, taxonomic status and genetic structure, physiology, reproduction and demographics, population dynamics, and behavior and community interactions. We then present an overview of threats to the species, both historic and emerging.

Chapter 2 is a companion document to Chapter 1 in which we present what we believe are the most pressing data gaps and research needs to facilitate the recovery of SMHM throughout its range. These needs are distilled into seven topics: potential effects of climate change and associated sea level rise, range-wide population demographics and dynamics, range-wide genetics, response to habitat restoration, environmental contamination, community context in current and future management, and improved collaboration and meta-analyses. For each of these seven topics we present the most important research priorities, and link them to any associated recovery actions from the 2013 Recovery Plan (USFWS 2013).

In Chapter 3, I investigated the potential diet preferences of SMHM. Resource agencies have long managed SMHM under the assumption that pickleweed is the species preferred and most

important food source, primarily based on the fact that SMHM are commonly trapped in pickleweed-dominated habitats (USFWS 2010). However, the importance of pickleweed as a food source for SMHM has never been directly investigated. In contrast, the diets of waterfowl in Suisun have been better characterized, and biologists and wetland managers have developed methods of managing disturbance, hydrology, and water and soil salinity to encourage the growth of important waterfowl food types in managed wetlands (Ackerman et al. 2014). In this study, I performed cafeteria trials on SMHM in the Suisun Marsh to identify important food sources for SMHM and to evaluate the overlap with waterfowl food sources. I addressed the following questions: (1) What plant and invertebrate species in the Suisun Marsh do SMHM prefer to consume, and are native species more strongly preferred? (2) Do the diet preferences of SMHM overlap with those of waterfowl within the Suisun Marsh?

Finally, in Chapter 4, we investigated the relative impact of wetland type on the demography of rodent species in the Suisun Marsh, with a focus on the three most abundant species: the SMHM, a sympatric native congener (the western harvest mouse, *R. megalotis*), and a sympatric non-native (the house mouse, *Mus musculus*). We addressed three specific objectives. First, do tidal and managed wetlands differ in their demographic value (e.g., survival, fecundity, population growth rate) for these rodents? Our second objective follows directly from the first; we ask if abundances of these three species differ in tidal and managed wetlands. Finally, we sought to determine whether a series of microhabitat and other environmental characteristics (e.g., high plant species and structural diversity, average temperatures and rainfall) influenced estimated abundance of small mammals.

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CHAPTER 1 - Towards Salt Marsh Harvest Mouse Recovery: a review

Note: This chapter has been published in the *San Francisco Estuary and Watershed Science* and should be cited as follows:

Smith KR, Riley MK, Barthman-Thompson L, Woo I, Statham MJ, Estrella S, Kelt DA. 2018. Towards Salt Marsh Harvest Mouse Recovery: a review. San Francisco Estuary and Watershed Science. 16(2).

INTRODUCTION

The salt marsh harvest mouse (SMHM, *Reithrodontomys raviventris* – Figure 1-1) is the only mammal species (and one of only 5 terrestrial vertebrates) known to be fully restricted to coastal marshes (see Figure 1-2; Greenberg 2006). The SMHM is endemic to the San Francisco Estuary (SFE; Figure 1-3), California (Fisler 1965), and comprises two subspecies, the northern *R. r. halicoetes* and the southern *R. r. raviventris*. Originally described as distinct species (Dixon 1908, 1909), these were subsequently shown to be conspecific on both morphological (Howell 1914) and genetic grounds (Statham et al. 2016). The northern subspecies is found in the brackish to saline marshes of San Pablo and Suisun Bays at relatively high numbers (e.g., 18-181 mice/ha; Bias 2006; Sustaita et al. 2011), while the southern subspecies occurs in the salt marshes of central and South San Francisco Bay (South Bay hereafter), where populations are much smaller (e.g., <1-3.6 mice/ha; Padgett-Flohr 1999; Kingma 2003; Basson 2009).

The SMHM is highly adapted to its marsh habitat (Fisler 1965), but reliance on the marshes of the SFE has made this species vulnerable. Since the mid-1800's, over 90% of tidal marshes in the SFE have been lost to filling and diking (Williams and Faber 2001). Amplifying the impact of this spatial constraint is the increasing fragmentation of remaining SMHM habitat (Fisler 1961). These factors led the United States Fish and Wildlife Service (USFWS) to list the SMHM

as endangered (Federal Register 1970), followed soon thereafter by the State of California (see Table 1-1; CCR 1971). Since being listed, SMHM management and recovery has been addressed in two Recovery Plans (USFWS 1984, 2013) and at least nine other restoration and management plans for the SFE (see Appendix A). Most of these documents emphasize the importance of habitat protection, enhancement, acquisition, and restoration as the primary strategies for SMHM recovery (see Appendix A for further detail). Despite the large number of threats to SMHM, and its incorporation into these many plans, general knowledge of the species remains limited, and significant knowledge gaps hinder conservation efforts. Additionally, research foci have changed little throughout the years, resulting in some aspects of SMHM conservation being addressed extensively in the literature (e.g., habitat use – Johnson and Shellhammer 1988, Bias and Morrison 2006, Sustaita et al. 2011), while others have remained largely unexplored (e.g., effects of environmental contamination, but see Clark et al. 1992).

In this contribution we distill current understanding of the biology and management of the SMHM. We begin by outlining the current state of knowledge, and highlight research gaps with respect to habitat requirements and distribution, taxonomic status and genetic structure, physiology, reproduction and demographics, population dynamics, and behavior and community interactions. We then present an overview of threats to the species, both historic and emerging. The primary recovery strategies for SMHM are habitat acquisition, enhancement, and protection (USFWS 2013). Via recovery and other planning efforts, managers are creating a habitat reservoir for SMHM intended to be functional now and into a future where sea level rise is projected to inundate many U.S. Pacific coastal wetlands, leading to substantial habitat loss (Thorne et al. 2018).

HABITAT & DISTRIBUTION

The Gold Rush during the mid to late 19th century led not only to increased settlement throughout the SFE as San Francisco became a major port city, but also to ecological changes to the estuary through practices such as hydraulic mining and agriculture (Arnold 1996, Moyle et al. 2014). Consequently, by the time the SMHM was described (Dixon 1908, 1909), significant changes to its habitat had already occurred (USFWS 2010), and it is important to note that SMHM currently occur in both "natural" (e.g., subject to tidal fluctuations) and managed (e.g., altered by land reclamation and subject to water level manipulations) wetlands. The latter compose a large proportion of remaining wetlands in the SFE. The earliest description of the species lists the geographic distribution simply as "restricted to the salt marshes of the San Francisco Bay" (Dixon 1908:197), and for many decades managers generally settled on a simplified definition of SMHM habitat as tidal marshes dominated by pickleweed (*Salicornia pacifica*). Consequently, the historical range of the SMHM has largely been inferred from maps of historic distribution of habitat types throughout the SFE, and while habitat associations have been examined extensively, the only major study of modern SMHM distribution was restricted to the Suisun Marsh (USFWS 1981).

Habitat Requirements

Understanding of SMHM habitat use is continuously evolving, and will likely continue to do so, especially if relationships between salinity, inundation, and vegetation change. The combined effect of increased inundation and salinity, as projected under most climate scenarios, can reduce plant height and structure of the salt marsh dominant pickleweed (Woo and Takekawa 2012), compromise the competitive ability of stress-sensitive plant species and communities (Schile et al. 2017), and lead to shifts in plant communities where salt tolerant plants replace salt intolerant

plants at low elevations (Watson and Byrne 2010). Earlier research found that shorter vegetation and more extreme tidal ranges of marshes in the South Bay may make these less suitable for SMHM (Schaub 1971, Cummings 1975, Gilroy and Shellhammer 1980; Figure 1-4). The use of non-tidal wetland habitat types (e.g., levee berms) was also investigated early (Rice 1974), and by the 1980's it was well accepted that tidal saline wetlands with tall, dense pickleweed mixed with other halophytic species (especially fat hen (*Atriplex prostrata*) and alkali heath (*Frankenia salina*)) were optimal for SMHM (Zetterquist 1977, Gilroy and Shellhammer 1980, Shellhammer et al. 1982, Takekawa et al. 2001).

On the other hand, early trapping efforts failed to find mice in brackish wetlands, even with high-density pickleweed cover (e.g., Figure 1-5a). Therefore, it was concluded that management of diked wetlands for waterfowl (e.g., as standing ponds during the hunting season) and vegetation management that included, but did not promote, dominance of pickleweed, would lead to the extirpation of SMHM (Shellhammer et al. 1982). However, when researchers began capturing SMHM outside of pickleweed stands in the mid-1980s, the habitat was still classified as "marginal" (Botti et al. 1986, Shellhammer et al. 1988), presumably reflecting an unrecognized bias from earlier understanding of favored habitat.

Habitat associations for SMHM vary both temporally and spatially. Captures of SMHM have been correlated with a range of tall to short and saline to less saline pickleweed (Shellhammer et al. 1982, 1988, Kingma 2003, Padgett-Flohr and Isakson 2003), while in some cases there was no association at all (Basson 2009). Similarly, SMHM captures have been correlated with both high and mid-level water salinities (Zetterquist 1977, Shellhammer et al. 1982, Kingma 2003, Padgett-Flohr and Isakson 2003). To an unknown extent, these contradictory associations could be attributed to differences between the subspecies, inaccurate species identification, local

population dynamics, local competition, or short timeframe, highlighting the need for coordinated efforts and replication throughout the range as well as for long-term datasets. Regardless, they indicate that the habitat metrics that characterize "good" SMHM habitat are likely too complex to simplify to one or two parameters (e.g., pickleweed height, water salinity).

Recent trapping efforts have detected SMHM in significant numbers in brackish marshes and in marshes dominated by plants other than pickleweed, such as alkali bulrush (*Bolboschoenus maritimus*; Shellhammer et al. 2010) and tri-corner bulrush (*Schoenoplectus americanus*; Sustaita et al. 2011). As a result, managed wetlands are recognized as important habitat for the persistence of this species (Sustaita et al. 2011, Shellhammer 2012; Figure 1-2b, 1-6a). However, as there has been very little research addressing the *relative* value of wetland types for SMHM, tidal habitat remains regarded as superior to managed wetland habitat (USFWS 2013).

Current Distribution

As SMHM is no longer thought to be restricted to pristine tidal marshes, delineating current distribution and estimating total acreage has become complex and challenging, and no range-wide census or distribution study of the SMHM has been conducted. Consequently, SMHM habitat is usually described in terms of how much tidal marsh area has been lost, rather than how much remains (e.g., Shellhammer et al. 1982, 2010; Bias and Morrison 1999). Estimates of habitat loss range from 70% to over 90%, but while some of this has been permanently lost through development, an unknown portion has been altered to a different habitat type that may also support SMHM (Goals Project 1999).

The northern SMHM subspecies is believed to occur throughout San Pablo Bay and the interior portions of the SFE (e.g., Suisun Marsh and Contra Costa shoreline; USFWS 2013; Figure 1-2), whereas the southern subspecies occurs throughout the South Bay and North to the Marin

Headlands near Point Richmond. However, no empirical investigation has been made regarding the subspecific status of populations near the presumed taxonomic border, either on the east or west sides of the central San Francisco Bay (USFWS 2013). Three major areas of the SFE that can be considered strongholds for the SMHM are the marshes of the South Bay, the marshes of north San Pablo Bay, and the Suisun Marsh. These three areas differ greatly in past land use and management, current state, and ownership, and these differences translate to differing suitability for supporting SMHM and priority actions for SMHM recovery.

South Bay

Marshes in the South Bay are the most highly altered of the remaining wetland habitat throughout the SFE (SFEI 1998). South Bay marshes currently consist of ~2,000 ha of managed wetlands (all diked and managed marshes, SFEI 1998) and ~3,900 ha of tidal wetlands (all high-, mid- and low-elevation and muted tidal marshes; SFEI 1998; Figure 1-3). The 2013 Recovery Plan calls for a total of ~2,500 ha of *protected* SMHM habitat in the South and Central Bay (USFWS 2013). Beginning in 1860, large tracts of the South Bay were diked for salt production, and by the 1930's almost half of the tidal marshes had been converted through land reclamation, rendering a large proportion of potential SMHM habitat in the South Bay unsuitable (Goals Project 1999). The remaining marshes in this region have the highest salinity of the three SFE regions. These marshes are narrow and fragmented (Figure 1-4), the vegetation is dominated by relatively short pickleweed and cordgrass (*Spartina* spp.; Figure 1-4), and land ownership is split primarily among state agencies and federal agencies (Goals Project 1999). Large scale habitat restoration is possible by the acquisition of over 15,100 acres of former commercial salt evaporation ponds, which will be adaptively managed, enhanced, and restored. The South Bay is highly urbanized, and aside from the South Bay Salt Pond Restoration Project, a large scale,

multiphase restoration program totaling 6100+ ha (SBSPRP, http://www.southbayrestoration.org), virtually all wetland habitat is bounded by steep levees adjacent to development, and therefore is highly vulnerable to sea-level rise because there are very limited opportunities for marshes to migrate upland (Thorne et al. 2018). While modeling suggests that significant accretion rates may partially offset sea level rise (Takekawa et al. 2013), accretion is unlikely to fully compensate for habitat loss. Combined, these studies suggest that, there is less potential SMHM habitat in the South Bay than other areas of the SFE.

At the California Department of Fish and Wildlife (CDFW) Eden Landing Ecological Reserve restoration site (part of the SBSPRP), initial surveys indicate that restored areas support some SMHM (Statham et al. 2016). Recovering SMHM in the South Bay will require wetland conservation and preservation along with significant habitat restoration, enhancement of existing habitat, or protection of habitat from sea level rise, to provide habitat acreage and connectivity (USFWS 2013). If marshes are unable to accrete to compensate for sea level rise (contra Takekawa et al. 2013), then managers may need to consider novel options such as sediment augmentation to increase marsh resiliency, or managing marshes as partially or fully diked, muted tidal systems.

San Pablo Bay

Because of inflow from the Sacramento and San Joaquin rivers, San Pablo Bay is less saline than the South Bay, and while about one fifth of San Pablo Bay marshes were utilized historically for commercial salt production, the primary use was agriculture, especially grazing (Goals Project 1999). Diking for agriculture ceased in the 1930's, but a large proportion of land San Pablo Bay remains under cultivation still (Goals Project 1999). The marshes of San Pablo Bay currently consist of ~3,200 ha of managed wetlands and ~6,500 ha of tidal wetlands (SFEI 1998; Figure 1-

3); the 2013 Recovery Plan calls for a total of ~1,800 ha of *protected* SMHM habitat in San Pablo Bay (USFWS 2013). The marshes here are deep (shore to inland margin; Figure 1-5a), dominated by short pickleweed (Figure 1-5b), and provide a significant amount of upland habitat for marsh expansion with sea level rise (Goals Project 1999). As in the South Bay, large, multiphase restoration projects have occurred and are underway, including the Cullinan Ranch Restoration Project in the San Pablo Bay National Wildlife Refuge (620+ ha, https://www.epa.gov/sfbay-delta/cullinan-ranch-tidal-marsh-restoration-project), and the former salt evaporation ponds in the CDFW Napa-Sonoma Marshes Wildlife Area Restoration (5600+ ha, https://www.wildlife.ca.gov/Lands/Planning/Napa-Sonoma-Marshes-WA). As noted above, SMHM population densities in the San Pablo Bay are much higher than those in the South Bay (USFWS 2013). Therefore, protection of existing habitat, along with a moderate amount of habitat restoration and enhancement of tidal marsh and upland transition zones, has the opportunity to greatly increase the probability of recovery of SMHM in San Pablo Bay.

Suisun Marsh

Situated directly between the Sacramento-San Joaquin Delta and San Pablo Bay, the Suisun Marsh is brackish, with salinities lower than other parts of the SFE. Beginning in 1859 the Suisun Marsh was used primarily by market hunters who supplied ducks to the massive influx of migrants flooding to San Francisco during the Gold Rush (Arnold 1996, Moyle et al. 2014). Reclamation began in earnest on Grizzly Island in the late 1870's and 1880's for dairy grazing and agriculture (Arnold 1996). Grazing gave way to agriculture in the early 1900's, but by the 1920's increased salinity and subsidence in the eastern marsh led to the abandonment of farming and the formation of private duck hunting clubs (Goals Project 1999). In 1974 The Suisun Marsh Preservation Act was enacted; this Act protected the marsh from urban development, established

water quality standards, and specifically lead to additional efforts including other plans and acts (most notably the Suisun Marsh Habitat Management, Preservation, and Restoration Plan; USDOI et al. 2013) to protect the marsh from development (Arnold 1996). The Suisun Marsh currently consists of ~20,000 ha of managed wetlands and ~5,500 ha of tidal wetlands (SFEI 1998; Figure 1-3); the 2013 Recovery Plan requires a total of ~1,800 ha of *protected* SMHM habitat in the Suisun Marsh (USFWS 2013). Duck hunting remains the primary land use in the Suisun Marsh, and more than half of the land is owned by private duck clubs (USFWS 2013). Unlike salt production, waterfowl management can provide suitable habitat for SMHM; thus, duck clubs have resulted in protection of significant tracts of habitat in the Suisun Marsh (Sustaita et al. 2011, Smith et al. 2014). However, the multitude of landowners in Suisun (150+) makes acquisition of large tracts of land difficult, and planned restoration here has largely been opportunistic (e.g., Montezuma Wetlands Project, 690+ ha, http://www.sfei.org/projects/montezuma-technical-review-team; Tule Red Restoration Project, 140+ ha, http://www.sfcwa.org/2013/03/27/tule-red-restoration-project; Hill Slough Wildlife Area Restoration Project, 340+ ha, http://www.dfg.ca.gov/ERP/erp_proj_hill_slough.asp).

Marshes in this region are deep (Figure 1-6a), with tall pickleweed intermixed with a variety of other halophytic plants such as bulrushes (*Bolboschoenus* spp. and *Schoenoplectus* spp.), fat hen, Baltic rush (*Juncus balticus*), and alkali heath (Goals Project 1999; Figure 1-6b). Suisun Marsh has some of the largest remaining tracts of SMHM habitat, and it supports large populations of SMHM (Sustaita et al. 2011). Continued protection and maintenance of habitat in the Suisun Marsh should increase the likelihood of recovery of SMHM there, although much suitable habitat exists behind levees that may be vulnerable to sea level rise, earthquakes (Mount and Twiss 2005, Goals Project 2015), and shifts in vegetation (from brackish- to saline-associated

species) as a result of water diversions in the Sacramento-San Joaquin Delta (Mall 1969), which are likely to worsen if additional water is diverted. Consequently, ongoing and potentially intensive habitat management may be more vital here than in other parts of the SFE.

TAXONOMY & GENETICS

The SMHM was originally thought to have descended from the western harvest mouse (WHM, *R. megalotis* – Hooper 1944, Fisler 1961), reflecting both their morphological similarity (Figure 1-7) and the geographic distribution of these taxa. The WHM ranges over much of the western United States, completely encompassing the range of the SMHM. However, these two species are unable to produce viable offspring (Fisler 1965), and they have different chromosomal complements (2n = 38 and 44, FN = 72 and 84, for SMHM and WHM, respectively; Shellhammer 1967), suggesting more distant relatedness. Further work including additional *Reithrodontomys* species and analyzing both karyotypes (Hood et al. 1984), allozymes (Nelson et al. 1984), and maternally inherited mitochondrial DNA (mtDNA) sequence data (Bell et al 2001, Statham et al. 2016) clarified that the closest relative was the plains harvest mouse (PHM, *R. montanus*), which occurs in the Great Plains and northern Chihuahuan Desert. The two species likely diverged over 3 million years ago (Bell et al 2001; Statham et al. 2016), while the modern SFE is less than 10,000 years old (Goman et al 2008).

One of the most basic needs for monitoring and conservation of any endangered species is correct field identification. Difficulty distinguishing SMHM from WHM (Figure 1-7) undermines ongoing monitoring and research efforts. Brown (2003) identified mice from the Suisun Marsh with mtDNA, and developed dichotomous keys to differentiate SMHM and WHM based on external characters. Comprehensive extensions of Brown's (2003) work have resulted in more refined statistical models to utilize the most important characteristics for differentiating

between species (Sustaita et al. 2018). Although promising, these models remain limited to the northern subspecies, and even there they are unable to classify young and small harvest mice. In the South Bay, genetic analyses determined that current methods were insufficient to correctly identify SMHM (Statham et al. 2016). Recent work has begun to more rigorously investigate the utility of traditional measurements, and to consider additional morphological characteristics for differentiating these species.

Given the unique regional challenges, it may be constructive to consider the conservation status and needs of the two subspecies separately. Shellhammer (1967:549) argued that karyotypes of the two subspecies were sufficiently distinct "to suggest that the two are in the terminal stages of speciation." This is broadly consistent with recent genetic analyses (nuclear and mtDNA) that identified deep genetic subdivision within the SMHM (Statham et al. 2016; Figure 1-8). Importantly, no assessment has been made of potential intergradation or reproductive isolation between the two subspecies, as most habitat along the border of these taxa has been greatly altered. In addition to the taxonomic implications, ongoing genetic work has begun to explore genetic diversity and connectivity among populations throughout the SFE, as well as potential metapopulation dynamics and demographic isolation of SMHM. Thus far, limited sampling indicates that northern (San Pablo Bay, Suisun Marsh) populations have greater genetic diversity than southern populations (likely reflecting the greater range and population size of the former), but that both subspecies possess endemic mtDNA haplotypes and nuclear alleles (Statham et al. 2016). Very recent analyses extend this work using immunogenetic data and show higher diversity in both the northern subspecies and in Suisun Marsh while the southern subspecies (San Francisco Bay) has a reduced ability to respond to selection (Ennis 2018; Ennis and Cohen 2018).

PHYSIOLOGY

Both Fisler (1963) and Haines (1964) studied the exceptional ability of SMHM to consume and survive on salt water. Physiological adaptations (e.g., increased kidney function) appear to be more strongly developed in the northern subspecies than in either the southern subspecies or the WHM (Fisler 1963). Both subspecies of SMHM lost weight when drinking only seawater at 0.57M (~33-35‰ NaCl), but whereas the northern subspecies survived an average of just over 200 days (and some individuals survived over a year), the southern subspecies survived an average of only 12 days (maximum of 48 days; Fisler 1963). The northern SMHM can survive on even more saline water (700mN, ~40‰ NaCl) without loss of body mass and with only modest changes to blood plasma ("urea was slightly elevated"; Haines 1964:271). It is important to note that these studies were completed before the development of many of the modern tools used for differentiating SMHM subspecies, and are best interpreted with some caution. Nonetheless, the ability to consume water far too saline for most terrestrial mammals confers upon both SMHM subspecies a competitive advantage in coastal marshes.

REPRODUCTION & DEMOGRAPHICS

Understanding reproduction and demographics is fundamental to population ecology and management, and has implications for conservation efforts. Almost five decades after SMHM was listed, assessments of demographics, distribution, and density throughout the SFE remain critical data gaps (USFWS 2013). Although SMHM monitoring occurs annually for many sites, surveys are rarely coordinated or standardized (e.g., methodology), and they lack both clearly defined (and shared) goals and a shared data repository, which in some cases has resulted in redundant research and monitoring efforts. Further, due to limited resources, most monitoring is temporally limited to a single 3-5 day sampling session and considers SMHM in isolation

relative to the broader ecosystem in which it occurs. Furthermore, monitoring reports are rarely published, limiting the ability of researchers or managers to capitalize on these numerous, but disparate, data sets. Similarly, no large-scale, long-term studies have been undertaken to address any key facets of SMHM demographics (e.g., fecundity, age and sex ratios, survival, and density; but see Sustaita et al. 2011). One brief effort (Basson 2009) underscores challenges associated with studying small, mobile species such as SMHM, with exceedingly low estimated survival and highly variable monthly population growth rate (see below). Understanding the drivers of SMHM populations and the mechanisms behind population declines or colonization in restored habitats could help guide conservation and management actions.

The reproductive biology of wild SMHM was identified as a research need in the 1984 Recovery Plan, and remains understudied (USFWS 1984, 2013). Captive females may produce multiple litters throughout the year, and while early field studies suggested that they reproduce only once per year in the wild (Fisler 1961), females of the northern subspecies may reproduce at least three times per year (Sustaita et al. 2011). Whereas reproductive males can be found year-round, reproductive females were mostly detected between March (southern subspecies) or May (northern subspecies) and November (Fisler 1965), although Geissel et al. (1988) posited that in years with high vole (*Microtus californicus*) numbers, SMHM breeding may be delayed into late spring. Reproduction for the southern subspecies appears to peak in March and April (Wondolleck et al. 1976). Based on embryo counts *in utero* and litters born in captivity, Fisler (1965) concluded that the northern subspecies can produce just over four young per litter, while the southern subspecies averages just under four. Furthermore, different wetland types appear to differ in reproductive value for SMHM (e.g., they vary in the proportion of juveniles and reproductive females; Sustaita et al. 2011). Recent observations on radiocollared SMHM indicate

that males may play a role in parental care, a behavior which could have important effects on population growth rates (Trombley and Smith, 2017).

Sex ratios appear to range from male-biased (Fisler 1971, Basson 2009) to even (Wondolleck et al. 1976), with no consistent pattern. Captive populations present a 1:1 ratio in newborn litters, whereas live-trapping efforts have yielded female-dominated captures both of the youngest and oldest wild mice (Fisler 1971). Adults comprise the majority of the population (Wondolleck et al. 1976), but juveniles comprised about one third of the population in the Suisun Marsh, and the proportion of juveniles increased with population density, presumably reflecting seasonal recruitment (Sustaita et al. 2011). Fisler (1971) found that captive SMHM may live for 31 months, although most wild mice likely live for no more than 8 months (maximum likely 12 months).

POPULATION DYNAMICS

Although anthropogenic activities continue to fragment available SMHM habitat in some parts of its range, it is important to recognize that habitat occupied by SMHM is naturally fragmented, and the species likely persisted historically as a series of metapopulations distributed around the SFE. Individual SMHM populations were historically separated by large-scale barriers (e.g., the San Francisco Bay, the Golden Gate, the Carquinez Strait) as well as barriers to localized movements (e.g., sloughs bisecting wetlands). Urbanization and habitat conversion have generally increased patch isolation and decreased suitability for SMHM. Additionally, much of the species' range includes habitat owned by diverse landowners who practice varied habitat enhancement and management techniques (USDOI 2013), few with the primary goal of maintaining SMHM habitat, which may provide different values to SMHM. These factors have the potential to create demographic sinks, habitat patches where SMHM populations appear to be

self-sustaining, but persist only due to immigration from nearby source populations (McDonald and Greenberg 2006). Encouragingly though, Sustaita at al. (2011) found higher densities of SMHM in managed wetlands (which have traditionally been regarded as inferior habitat sinks) than in tidal wetlands of Suisun Marsh.

Despite the fact that many recovery actions for the SMHM recommend that habitat patches created via restoration or enhancement activities be situated within dispersal distance of source populations, very little is known of the dispersal and colonization capabilities of SMHM (USFWS 2010, 2013). Many potential habitat patches for SMHM are isolated (often as literal islands surrounded by water) and may not be readily accessible, precluding timely recolonization following local extirpation or restoration of previously unsuitable habitat. Whereas some managers (USFWS 2010) have made inferences about colonization based on differential habitat use (Geissel et al. 1988, Bias and Morrison 1999), our review found no research that directly addressed the level of habitat connectivity needed for dispersal and colonization by SMHM. In the sole published study assessing SMHM survival and population growth (spanning just three months, May to August 2008), Basson (2009) reported an apparent monthly survival rate of 0.13 and monthly population growth rates (λ) of 4.4 (May to June), 0.79 (June to July), and 0.75 (July to August) at one 10-ha site.

BEHAVIOR & COMMUNITY DYNAMICS

Understanding the behavior of small mammals in natural conditions is challenging, and SMHM behavior is no exception. It is likely this challenge that has led to the veritable paucity of research and limited emphasis of this theme by both researchers and managers. Our review found that neither the direct nor indirect interactions of SMHM with potential competitors, predators, parasites, nor other animals have been explicitly investigated; the few published observations are

anecdotal or based largely on inference. Whereas direct interactions are easy to envision (e.g., direct predation), indirect interactions such as apparent competition, trophic cascades, and competitor- or predator-mediated habitat selection are less obvious but no less important to understanding the role of SMHM within ecological communities, and therefore also to informing land and resource managers. The same is generally true of most aspects of SMHM interactions with their habitat, such as feeding ecology. During the majority of annual SMHM surveys that occur, few observations are recorded on other species, including other captured small mammals, with little associated vegetation data to quantitatively describe the habitat.

Interactions with other Animals

Interactions between SMHM and sympatric rodents have been documented both in the laboratory (Catlett and Shellhammer 1962, Fisler 1965) and opportunistically in the field (Catlett and Shellhammer 1962, Geissel et al. 1988, Bias and Morrison 1999, McDonald and Greenberg 2006, Sustaita et al. 2011). However, no studies have targeted this research area with a specific management question. SMHM coexist harmoniously with house mice (*Mus musculus*) in the laboratory (Catlett and Shellhammer 1962), but in the wild these species evidently partition habitat, with house mice associated with more fragmented habitat patches (Bias and Morrison 2006). Geissel et al. (1988) suggest that SMHM acts as a fugitive species (using poorer quality pickleweed) when voles are abundant, but may be competitively superior in areas of high salinity, while Bias and Morrison (2006) reported evidence of niche partitioning, with voles preferring taller pickleweed than SMHM. These observations suggest that rising sea levels may indirectly alter competitive dynamics by altering vegetation assemblages or by increased competition for limited resources (e.g., food or high tide refugia).

Understanding the effects of predation on SMHM was identified as a key priority in the 1984

Recovery Plan (USFWS 1984), and the updated plan (USFWS 2013) recognized that predation pressure may be elevated by anthropogenic changes to habitat, such as landfills subsidizing predators, or public trails and levees increasing access to interior habitat. Predation risk is also likely to increase as sea level rise causes more extreme flooding in tidal wetlands that can force SMHM onto uplands where they are more vulnerable (USFWS 2010). Surprisingly, virtually no research has assessed predation on SMHM. The only data we are aware of come from analysis of short-eared owl (*Asio flammeus*) pellets (Johnston 1956). Although cranial material was reported from <10% of pellets analyzed, skulls of SMHM and WHM are indistinguishable, rendering any conclusions regarding predation on SMHM somewhat equivocal.

The presence or effects of parasites on SMHM has also received almost no attention. The only published study of ectoparasites identified one species of flea, *Orchopeas leucopus*, on SMHM in the Suisun Marsh (Clark et al. 2006). This flea species is widespread throughout the United States and Canada where it is found on rodent hosts from many different genera (especially *Peromyscus*; Lewis 2000). Work on endoparasites is similarly limited; Forrester (1971) found a strain of the nematode *Heligmosomoides polygyrus* in one of 24 wild-caught SMHM in San Pablo Bay, but determined they were not susceptible to two other strains of the same nematode in the lab. High parasitic loads may cause increased mortality due to physical stress or disease transmission (Clark et al. 2006). Whether parasite loads are particularly high in SMHM is not clear, although many researchers report observing fleas, ticks, and mites on SMHM and other species during annual monitoring (K. Smith, unpublished data, see "Notes"). Stressed individuals are more susceptible to disease (Lafferty and Holt 2003), but the impacts of disease, as well as the compounding effects of potential contaminants and environmental stressors associated with climate change (e.g., prolonged drought resulting in changes in vegetation types

and wetland habitat loss via sea-level rise), on SMHM populations is completely unknown.

In addition to the negative impacts of interactions discussed thus far, SMHM may play other roles in wetland communities. Waterfowl in the Suisun Marsh exhibit higher nest success where small mammals (primarily SMHM) are more abundant (Ackerman 2002). Understanding whether the SMHM may similarly receive a reciprocal benefit by the presence or actions of other species could better inform management efforts. For example, large populations of other rodents or nesting waterfowl may alleviate predation pressure on SMHM; alternatively, they may elevate competitive pressures or attract predators, leading to elevated risk to SMHM.

Interactions with their Habitat

Substantial effort has gone into characterizing habitats where SMHM are captured, but little research has addressed how the species actually interacts with its habitat. One aspect of SMHM behavior that has been investigated is the use of refugia during high tides, a research need identified in the 2013 Recovery Plan (USFWS 2013). Since SMHM often reside in the intertidal zone, they may require refuge during high tides. Some early studies concluded, based on trapping data or visual observations, that animals move out of tidal wetlands and into upland areas or onto levees to escape rising waters (Johnston 1957, Hadaway and Newman 1971); others concluded that SMHM remain in tall, dense vegetation over water, where they can easily move about in the dense thatch layer (Fisler 1965, Hulst et al. 2001). Recent work using radiotransmitters demonstrated that mice remain in tall vegetation (e.g., bulrushes) throughout the cycle of tidal inundation when such vegetation is available (Smith et al. 2014). Unfortunately, this study was restricted to adult male SMHM in the Suisun Marsh, and further work is needed to confirm the generality of these observations (e.g., in other parts of the range) and extend this to other subpopulations (females, younger animals).

Feeding ecology and the effects of salinity on diet were identified early as important research needs, but no comprehensive assessments have been conducted (USFWS 1984, Shellhammer 2012). Stomach contents of wild-caught animals indicate that SMHM consume more stem and leaf matter than WHM, and that the diet of WHM is relatively constant throughout the year while that of SMHM appears to vary seasonally (Fisler 1965). When presented with two halophytic plant species (pickleweed and salt grass (*Distichlis spicata*)), captive WHM refused to eat either plant, to the point of starvation, whereas SMHM readily consume seeds, leaves, and stems of both species (Fisler 1965). Finally, when presented with insect prey, WHM ate the soft parts of the bodies while SMHM showed no apparent interest (Fisler 1965). Beyond these limited observations essentially nothing is known of SMHM diet in the wild, and diet is not addressed in depth in the 2013 Recovery Plan or status review, although it is presumed to be dominated by pickleweed (USFWS 2010, 2013). Impacts associated with climate change such as sea level rise and increased salinity, could alter vegetative assemblages throughout the range of the species (Watson and Byrne 2012, Schile et al. 2017) and result in substantial habitat loss (Thorne et al. 2018). Without a baseline understanding of SMHM diet, managers lack information needed to protect habitat that provides a rich food base, or to design habitat enhancements and restorations resilient to these sorts of impacts, in terms of food production.

THREATS

Threats identified in both Recovery Plans addressing SMHM all pertain to loss or degradation of habitat, and few are new to the system (USFWS 1984, 2013). Takekawa et al. (2006) also highlighted habitat loss and deterioration, but emphasized the importance of biotic interactions (including competition, predation, invasive species, disease) as potential threats to tidal marsh vertebrates in the SFE. Ensuring the persistence of the SMHM requires understanding and

assessing the causes of these threats and the interactions among them as well as taking actions to ameliorate the most pressing ones.

The impact of habitat loss in the SFE is extensive and virtually every hectare of historical SMHM habitat has been altered, either through direct action such as wetland filling or salt production or indirectly through shifts in vegetation due to water diversions (which change water availability, salinity, and sedimentation) and introduction of invasive plants (Kimmerer 2002, Takekawa et al. 2006, Goman et al. 2008). Remaining habitat patches are fewer, smaller, and degraded when compared to prehistorical patches (Takekawa et al. 2006), likely leading both to direct reduction in the number and size, and an increase in the fragmentation of SMHM populations. Small, fragmented populations are more prone to deleterious genetic effects and extinction, and small mammals may be especially susceptible due to relatively low mobility in the face of what may be minor geographic barriers for large or volant animals (Soulé et al. 1992, Lowe et al. 2017).

Management of wetlands for extractive use has been considered a threat to SMHM (Shellhammer 2012). However, it is important to note that Native Americans were present in the area, performing habitat management for resource extraction for thousands of years (ca. 10,000-15,000 years ago; Lewis 1993, Erlandson et al. 2007) before the modern SFE and its associated marshes formed (ca. 6,000 years ago; Goman et al 2008). Today, many remaining wetlands are managed moderately to intensely, and the effects of habitat management on SMHM are poorly understood. In the Suisun Marsh, for example, most marshes are diked, and many of these are managed to regulate hydrology, salinity, and vegetation to provide habitat for resident and migrating waterfowl (which provides habitat for other wildlife as well). Hence, marshes of the SFE have been under anthropogenic influence since their initial development, and the SMHM,

while much older than the marshes themselves (see Taxonomy & Genetics), has likely never existed in modern marshes of the SFE without human influence.

A number of invasive species likely impact the SMHM. Terrestrial vertebrates, such as feral cats (*Felis catus*) and house mice, affect the species through predation and competition, respectively. Invasive plants are a large concern (USFWS 2013); species such as smooth cordgrass (*Spartina alterniflora*), common reed (*Phragmites australis*), and perennial pepperweed (*Lepidium latifolium*) alter habitat structure and may displace native flora and fauna (Takekawa et al. 2006, Estrella and Kneitel 2011, Wigginton et al. 2014). Aquatic invasive plants can alter flows and displace native species in the SFE, which affects SMHM habitat (Moyle et al. 2010).

The effect of environmental contamination such as heavy metals, organochlorines, PCBs, or oil spills on SMHM (USFWS 2013) is an important research gap. Clark et al. (1992) tested house mice, deer mice (*P. maniculatus*), and California voles throughout the SFE for a number of contaminants. Although SMHM were not tested, this species was absent from all areas where house mouse livers contained elevated (>0.19 µg/g dry weight) mercury and PCB concentrations (0.06 µg/g wet weight). Because SMHM occur in habitats that are bordered in most parts of its range by dense urban and suburban habitats on one side, and busy maritime shipping routes on the other, they are subject to a steady barrage of environmental contamination (Phillips 1987, Clark et al. 1992; Figure 1-9) such as petroleum products, pesticides, and detergents that may negatively impact SMHM (USFWS 2010). Beyond the threat of chronic environmental contamination, SMHM may be at risk from catastrophic chemical disturbance, such as oil spills from refineries, pipelines, or ships, which could rapidly impact a large proportion of remaining SMHM populations (USFWS 1984); to our knowledge, no contingency plans exist to protect SMHM from this risk.

Climate change and associated sea-level rise and salt water intrusion in the Delta may be the greatest threat to tidal marshes and SMHM persistence in the future (USFWS 2010, Thorne et al. 2012). Where marshes lack area to migrate upland, and either enough time and sediment input for accretion in response to rising sea level, studies project a net loss of SMHM habitat as some areas of mid- and high-marsh become low- or mid-marsh, and some low-marsh converts to mud flat (Takekawa et al. 2006, 2013, Thorne et al. 2012). Projections using a modest estimate of 1.24 m sea level rise indicate the loss of most low- and mid-marsh areas by 2050 and the loss of almost 100% of low-marsh areas by 2100 (Takekawa et al. 2013). More recent analyses project sea level rise to exceed 1.66-2 m (Oppenheimer and Alley 2016), indicating that losses may be much more severe than previously estimated (Thorne et al. 2018). Using predictions of sea level rise combined with wetland-specific accretion rates, Thorne et al. (2018) calculated that in California, 59% of coastal marshes will be lost if space is available for upland migration, while 99% will be lost if such space is not available. Seawater intrusion into brackish areas and decreased outflow will also alter vegetation structure and assemblages (Woo and Takekawa 2012). In addition, the multiple effects of climate change such as increased temperatures, reduced snowpack, more frequent and extreme weather events (prolonged drought, extreme storms, and king tides) in combination with sea-level rise impacts on salt water intrusion further into the estuary could have cascading impacts on the whole ecological system (Dettinger et al. 2016). While projections of changes in precipitation have high uncertainty, it is likely that storms will be more extreme and more frequent (Cloern et al. 2011, Dettinger et al. 2016). This extreme and unpredictable weather may further stress SMHM through processes such as exposure to extreme temperatures and precipitation events which can reduce adult and pup survival (e.g., by soaking or inundating nests), or reduced food availability as a result of prolonged drought

(USFWS 2013).

CONCLUSIONS

The USFWS (2010:27) has determined that SMHM continues to be in need of protection throughout its range from historical threats as well as climate change which "likely imperils the salt marsh harvest mouse and the resources necessary for its survival." Habitat threats, research needs (see Smith et al. 2018), funding support, and management approaches to restoration or enhancement opportunities can vary by project, region, and stakeholder needs. Regular communication and coordination between managers and researchers can help target research needs in support of management actions and lead to innovative approaches (Smith et al. 2018).

Our review indicates that substantial data gaps exist, and that conservation and restoration planning processes could consider experimental approaches within restoration designs to address these deficiencies and, in turn, maximize wildlife functions (for SMHM and other tidal marsh inhabitants) via adaptive strategies to confront sea level rise and other climate change-related threats. Science-based decision-making and addressing uncertainties through adaptive learning can make restoration and conservation efforts more effective (Zedler 2017). Indeed, innovative approaches and experiments can incorporate wildlife needs within restoration designs for sea level rise adaptation (Parker and Boyer 2017). Close coordination and sustained efforts can facilitate more nimble responses to uncertainties and emerging threats. Strategies based on a keen understanding of the species ecology, life history traits, and habitat are likely to be more effective, suggesting that continued investment in basic and applied SMHM ecology to collect baseline and longterm data is beneficial. This summary of the current knowledge and complexities related to the species and ongoing management efforts informs the identification of data gaps and development of research priorities (see Smith et al. 2018) within a coordinated

approach to support science-based decision-making for the recovery of SMHM.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the years of research contributed by salt marsh harvest mouse researchers and managers over the past 5 decades. Without their dedication and hard work an effort such as this would not have been possible. We would like especially to acknowledge Dr. Howard Shellhammer whose tireless efforts built the foundation on which our understanding of the salt marsh harvest mouse is based, and who was instrumental in securing protections for the species. We would like to acknowledge the Salt Marsh Harvest Mouse Workgroup for providing input on the mouse research needs and their encouragement to complete this work. We also wish to thank two anonymous reviewers and Colin Grant for thoughtful input on the manuscript, as well as the staff at San Francisco Estuary and Watershed Science who supported this effort. During preparation of this manuscript K. Smith was supported by the Delta Stewardship Council Delta Science Program under Grant No. F12AC00887. The contents of this material do not necessarily reflect the views and policies of the Delta Stewardship Council. The California Department of Water Resources Suisun Marsh Program has generously supported M. Riley, L. Barthman-Thompson, and S. Estrella and has funded a great deal of recent salt marsh harvest mouse research. USGS Ecosystem Mission Area provided support for I. Woo. D. Kelt was supported by the UC Davis Department of Wildlife Fish and Conservation Biology and the USDA National Institute of Food and Agriculture (Hatch project CA-D-WFB-6126-H).

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Table 1-1. A brief summary of major recovery actions required by the 1984 and 2013 recovery plans addressing the salt marsh harvest mouse.

Salt Marsh Harvest Mouse Recovery Plans	
1984[1]	**2013[2]**
Research and Management Recommendations	
Protect select existing marshes, especially those that will create large, well connected habitat patches.	Protect existing, historic, and restorable tidal wetlands.
Restore diked wetlands to create pickleweed-dominated tidal marshes.	Manage, restore, and monitor tidal wetlands.
Restore upland and transition zone habitats to create high tide refugia and to accommodate sea level rise.	Conduct range-wide species surveys and monitoring.
Perform biological research on anthropogenic actions that may affect water salinity, marsh floristics, and habitat suitability. Perform studies on the effects of sea level rise, reduced sediment input, marsh erosion, and marsh accretion.	Conduct research necessary for conservation and recovery such as demographic analyses or techniques for habitat management and restoration.
Perform ongoing habitat management.	Improve coordination, participation, and outreach.
Recovery Criteria	
Down-list to Threatened Status	
Secure and manage 3,900 ha of occupied, publicly owned essential habitat.	Protect ~2,500 ha of habitat around the Central and south San Francisco Bay.
Secure and manage 3,200 ha of occupied, privately owned essential habitat and/or 7,000 ha of tidal and diked baylands.	Protect ~1,800 ha of habitat around San Pablo Bay.
	Protect ~1,800 ha of habitat around Suisun Bay.
	Achieve 3-5% catch per unit effort during annual population surveys in a defined proportion of designated viable habitat areas.
	Reduce and control invasive plants.
Down-list to Fully Recovered	
Achieve the above and restore or enhance ~3,000 ha of essential habitat and complete restoration efforts on the San Francisco National Wildlife Refuge.	Implement the Suisun Marsh Habitat Management, Preservation, and Restoration Plan and the South Bay Pond Restoration Plan; develop oil spill response plans.
	Preserve or create enough high marsh and upland habitat to accommodate sea level rise while meeting acreage criteria.

[1] (USFWS 1984) [2] (USFWS 2013)

Figure 1-1. A northern salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes*).

Figure 1-2. (a) A tidal wetland dominated by pickleweed. This habitat type was long considered necessary for persistence of salt marsh harvest mice. (b) A diked managed wetland, with a variety of vegetation types present. This habitat type was once thought to be detrimental to salt marsh harvest mice, but is now known to support healthy populations of salt marsh harvest mice.

Figure 1-3. The San Francisco Bay Estuary with tidal wetlands highlighted in purple, diked and managed wetlands highlighted in orange, and the historical extent of tidal wetlands indicated by the solid while line. The dashed white line indicates the best current estimate of the division between the northern and southern subspecies of SMHM. Data sources: ESRI, DigitalGlobe [accessed 2017 Feb 01]; CWMW, EcoAtlas [accessed 2017 Feb 01].

Figure 1-4. (a) A marsh on the San Leandro Shoreline exemplifies some characteristics of most South Bay marshes: the narrow distance from the marsh edge on the far top right to the hard edge on the top left, in this case a housing development; close proximity to industrial development, in this case a water treatment plant visible in the distance on the top middle right. (b) Vegetation in the saline South Bay marshes is typified by short pickleweed and medium height, non-thatch forming plants such as cordgrass, with little structural complexity

Figure 1-5. (a) A marsh on San Pablo Bay near the Napa River. Visible in the distance are the hills of southern Napa and Sonoma counties. Virtually no significant development exists between the San Pablo Bay and the hills. (b) Vegetation in the brackish marshes of the San Pablo Bay are typified by vast expanses of short pickleweed mixed with a low diversity of other halophytes providing a moderate amount of structural complexity

Figure 1-6. (a) A managed wetland in the Suisun Marsh. Visible in the distance are the Potrero Hills. Development from the outer marsh edge to the hills is restricted to sparsely distributed duck hunting clubs. (b) Due to relatively low salinity vegetation in the Suisun Marsh is highly diverse ranging from herbaceous ground cover to bulrushes that can reach greater than 3 meters in height. The tidal marsh pictured here has tall pickleweed mixed with alkali heath (*Frankenia salina*) and dodder (*Cuscuta salina*) in the background, tall tricorner bulrush (*Schoenoplectus americanus*) mixed with cattail (*Typha* spp.) and herbaceous flowers in the midground, and very tall bulrush (*Schoenoplectus* spp.) and reeds (*Phragmites australis*) on the slough edge in the foreground

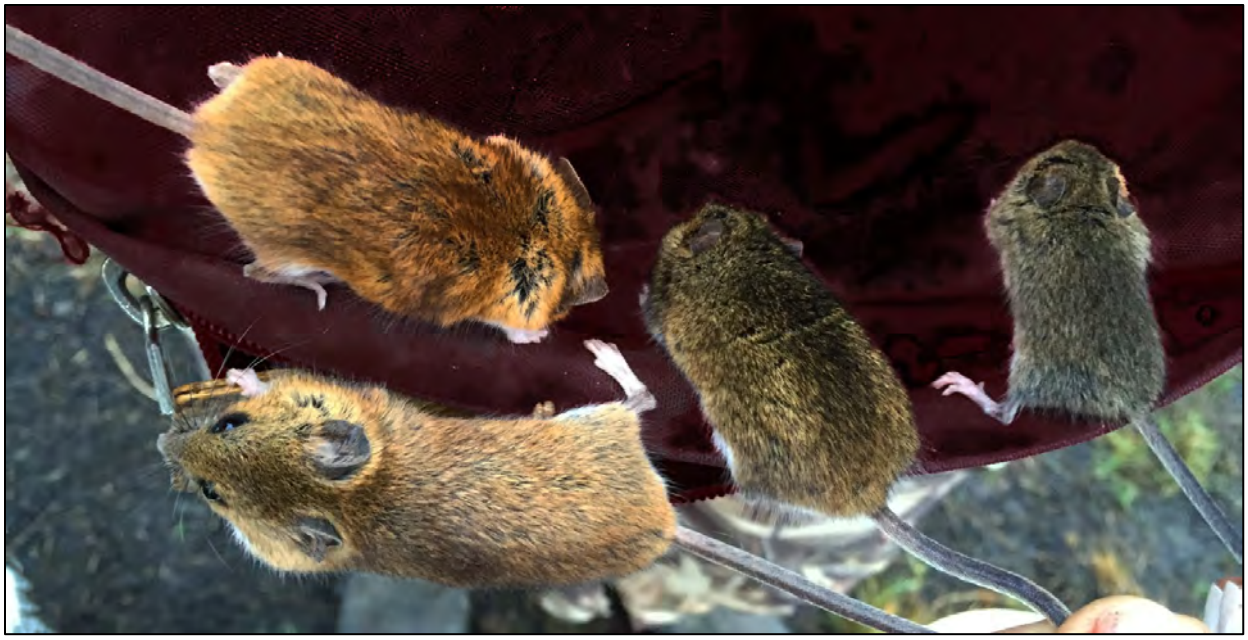

Figure 1-7. Due to high variation in color and significant overlap in morphology, salt marsh harvest mice (3 left) and western harvest mice(right) can be difficult to distinguish in the field.

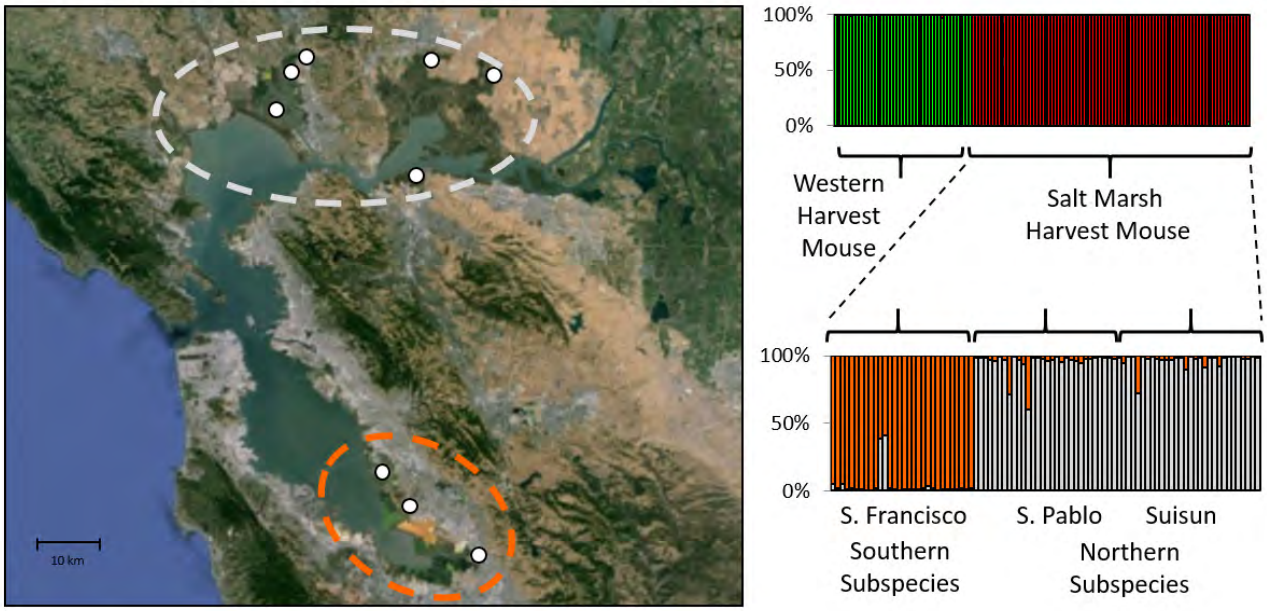

Figure 1-8. Genetic analyses support the separation of SMHM and WHM, as well as the northern and southern SMHM subspecies (Statham et al. 2016). Harvest mice were sampled from three sites in each of three bays (white circles), but further sampling is needed to understand relationships of intervening populations, as well as to confirm the spatial extent of each subspecies.

Figure 1-9 Many marshes in the San Francisco Estuary, such as the marshes of Suisun Bay pictured here, occur in close proximity to sources of chronic contamination and sources of potential acute catastrophic contamination. Labels: (a) Suisun Bay Reserve Fleet, (b) Goodyear Slough marshes which support some of the highest recorded densities of SMHM, (c) Industrial complex, (d) Point Edith Wildlife Area, (e) Petroleum tanker, (f) Southern Pacific Railroad, (g) Tesoro Golden Eagle Refinery, (h) Shell Martinez Refinery, (i) Benicia–Martinez vehicle and rail bridges, (j) Cargo docks, (k) Imported vehicle cargo storage, (l) Valero Benicia Refinery, (m) Highway 680, and (n) Highway 780.

APPENDIX A - SELECTED RECOVERY PLAN DETAILS

The 1984 SMHM Recovery Plan (USFWS 1984) identified a number of reasons for decline of SMHM. All of these related to habitat degradation, including direct habitat loss and fragmentation of remaining marshes, loss of higher-elevation marshes by backfilling, land subsidence (due to groundwater pumping), and vegetation changes (often associated with subsidence or diking and associated flow changes). The plan stated that preserving both subspecies would require protection and enhancement of existing marshes, restoration of degraded marshes, and research on habitat requirements and population trends. It required several general actions including the extensive development of habitat management plans for enhancement, preservation, and creation of marshes; restoration of upland refugia that can be important during high tides; and studies of the effects of various threats to SMHM habitat, including contaminants, flood control, and waterfowl management (see Table 1-1; USFWS 1984). The plan also stated that ongoing management would be needed on all SMHM marshes, recognized the emerging threat of sea level rise, and recommended investigating the effects that this could have on SMHM habitat. The plan speculated that, at the time it was written, available habitat for protection and restoration was sufficiently limited to preclude any future delisting of the southern subspecies of SMHM.

The updated plan (USFWS 2013) proposed an ecosystem approach, incorporating recommendations for multiple threatened species including the Ridgway's rail (*Rallus obsoletus*), soft bird's beak (*Cordylanthus mollis* ssp. *mollis*), and the Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*). It expanded on threats identified in the original 1984 Recovery Plan and classified them under three main headings: habitat loss, predation, and contaminants. This plan mandated further monitoring as well as investigations of genetics, interspecific

interactions, vegetation associations, and demographics to inform SMHM recovery (see Table 1-1; USFWS 2013). Both plans defined requirements for down-listing SMHM to threatened status and delisting to recovered status, including minimum acreage of land and target population sizes (see Table 1-1).

In addition to these US Fish and Wildlife Service Recovery Plans, the SMHM is featured in a number of other restoration and management plans throughout the SFE, including:

- Suisun Marsh Protection Plan (BCDC 1976)
- San Francisco Bay National Wildlife Refuge Predator Management Plan and Final Environmental Assessment (Foerster and Takekawa 1991)
- Baylands Ecosystem Habitat Goals Report (Goals Project 1999) and update The Baylands and Climate Change: What We Can Do? Baylands Ecosystem Habitat Goals Science Update (Goals Project 2015)
- Restoring the Estuary: Implementation Strategy of the San Francisco Bay Joint Venture (Steere and Schaefer 2001)
- Design Guidelines for Tidal Wetland Restoration in San Francisco Bay (Philip Williams & Associates, Ltd and Faber 2004)
- San Francisco Bay Plan (BCDC 2008)
- DWR and DFG Fish Restoration Program Agreement (CDWR and CDFW 2010)
- Bay Delta Conservation Plan (BDCP 2013)
- Suisun Marsh Habitat Management, Preservation, and Restoration Plan (USDOI et al. 2013)

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CHAPTER 2 - Towards Salt Marsh Harvest Mouse Recovery: research priorities

Note: This chapter has been published in the *San Francisco Estuary and Watershed Science* and should be cited as follows:

Smith KR, Riley MK, Barthman-Thompson L, Statham MJ, Estrella S, Kelt DA. 2018. Towards Salt Marsh Harvest Mouse Recovery: research priorities. San Francisco Estuary and Watershed Science. 16(2).

The State and Federally endangered salt marsh harvest mouse (SMHM, *Reithrodontomys raviventris*) is endemic to wetlands within the San Francisco Estuary (SFE) in California. The biology of SMMH is summarized by Smith et al. 2018; here we present what we believe are the most pressing data gaps and research needs, including associated recovery actions from the 2013 Recovery Plan (USFWS 2013), to facilitate the recovery of SMHM throughout its range. To the degree that resources allow, we strongly urge that all of the following research recommendations be implemented throughout the species range, in key habitat types, and with replication.

1. Potential effects of climate change and associated sea level rise**.** *Understanding this threat and how it will affect recovery measures (e.g., tidal restoration) should be, at the least, an ancillary component underlying all research moving forward.*

   Priority needs:

   a. When possible, research projects should be designed to explicitly investigate how the threat of climate change intersects with other threats, and how it affects SMHM biology. Climate change should be a consideration in all recommendations below.

i. <u>*Recovery Action 4.4.7*</u> *Study the effects of global climate change and resulting sea level rise on tidal marsh ecosystems. (page 325)*

2. Range-wide population demographics and dynamics. *Lack of population and demographic data for SMHM hinder efforts to identify areas of conservation concern or to understand how natural or anthropogenic changes (including habitat loss and restoration) affect population health.*

Additional long-term and comprehensive demographic studies on the SMHM are needed. Strategically allocating these in key habitats (e.g., managed, tidal, and restored wetlands) would facilitate prioritization of habitat for acquisition and enhancement. Researchers should collaborate to determine densities, carrying capacities, and population viabilities for various habitat types over both short (ca. 5 years) and longer (ca. 50 years) time periods (USFWS 2010). Such data are essential for population viability analyses (suggested by USFWS 2013), and crucial for conservation planning in light of the large shifts in habitat anticipated due to climate change and sea level rise (Takekawa et al. 2013; Thorne et al. 2018).

Understanding metapopulation dynamics should help to identify characteristics of habitats that serve as demographic sources and sinks, allowing managers to prioritize the former in regional planning. Data on dispersal and colonization are important criteria in site selection for enhancement activities and predicting the potential for populations to populate uninhabited patches (e.g., newly created wetlands) or whether assisted colonization will be necessary.

<u>Priority needs</u>:

a. Determine the realized geographic range of the species (and both subspecies) through comprehensive censuses.

b. Obtain population estimates of SMHM.

   i. <u>Recovery Action 3.1.2.6</u> *Monitor for salt marsh harvest mouse (page 313).*

c. Characterize key demographic parameters (survival, reproductive rate, net population growth rate), prioritizing vulnerable populations (e.g., South Bay) when resources are limited.

   i. <u>Recovery Action 4.2.7.1</u> *Conduct a population viability analysis to determine desirable population sizes for long-term persistence of extant South Bay SMHM populations (page 321).*

d. Characterize demographic relationships among populations (frequency and distance of dispersal, nature of dispersal barriers, and potential for source-sink dynamics).

   i. <u>Recovery Action 3.2.1</u> *Conduct surveys in suitable habitat for new and relict populations of SMHM (page 316).*

3. Range-wide genetics. *Further characterize genetic structure of SMHM throughout the SFE, but in particular in the South Bay where populations are smallest and habitat is most at risk. Losing even very small populations could mean losing unique and rare genetic lineages permanently.*

Understanding SMHM population genetics is critical to both long-term management and to prioritization of areas for conservation action (Goals Project 1999, USFWS 2013). Trapping and genetic sampling throughout the potential range of the species would allow validation of species occurrence, especially in isolated and peripheral habitat patches.

Such work is essential to delineate the geographic extent of the subspecies, identify distinct populations, and improve understanding of how genetic diversity may influence the effectiveness of conservation measures such as tidal restoration.

Priority needs:

a) Genetic delineation of subspecies boundaries.

   i. *Recovery Action 4.3.4 Conduct research to resolve taxonomic uncertainties regarding SMHM (page 323).*

b) Genetic characterization of relationships among populations, effectively using genetic markers to document demographic parameters such as extent of dispersal, barriers to dispersal, source-sink dynamics, and metapopulation structure (Peery et al. 2008).

   i. *Recovery Action 4.3.1 Conduct a SMHM population genetic analysis (page 323).*

4. Response to habitat restoration. *Virtually no data exist on the effects of restoration activities (e.g., levee removal and subsequent flooding) or the secondary effects of habitat alteration (e.g., development of tidal wetlands). A better understanding of SMMH habitat requirements and dispersal dynamics is vital to acquiring and enhancing suitable habitat in the future.*

We suggest managers thoroughly investigate habitat preference and use by SMHM in restored wetlands, even if pre-restoration data are lacking.

Priority needs:

a) Characterize the direct impacts (e.g., altered survival or reproductive success) of restoration activities such as use of heavy equipment in currently occupied habitat, to minimize negative effects on SMHM during active restoration.

b) Characterize the secondary effects of large-scale shifts in habitat following restoration activities (e.g., changes in SMHM population densities).

    i. <u>*Recovery Action 4.4.1*</u> *Conduct studies on the efficacy of various habitat restoration techniques for SMHM (page 324).*

c) Determine factors that may influence the colonization of newly created, potentially isolated, habitat patches (e.g., typical dispersal distance, minimum viable patch size).

    i. <u>*Recovery Action 4.4.5*</u> *Study the time lag between habitat restoration and recolonization by SMHM (page 325).*

5. Environmental contamination. *The risk of SMHM population failure due to chemical contamination, either chronic (e.g., methylmercury) or acute (e.g., oil spill), calls for a comprehensive assessment (USFWS 2013).*

   Clark et al. (1992) recommended laboratory feeding trials to assess toxicity of common toxic agents, and regular monitoring of common small mammals to assess contaminant concentrations (and whether SMHM disappear where concentrations increase). We suggest at a minimum, researchers should collect hair samples during routine monitoring for contaminant testing, even if funds for performing the tests are not yet available.

   <u>Priority needs</u>:

   a. Characterize the population level effects of chronic contamination on SMHM and their habitat.

i. *Recovery Action 4.5.2.5 Establish a list of "biosentinal" species to use as surrogates for SMHM, and establish "acceptable" and "not acceptable" contaminant levels in these species… (page 326).*

b. Assess the risk of acute catastrophes; develop contingency plans for SMHM populations potentially threatened by such catastrophes.

i. *Recovery Action 2.1.5.3 Develop and implement site-specific oil spill prevention and response plans for lands supporting known populations of SMHM (page 293)*

6. Community context in current and future management. *SMHM surveys generally consider the species in relative isolation, thereby failing to understand how SMHM vary with community composition. We encourage a systems approach to SMHM surveys, documenting co-occurring species, parasites, and predators, to monitor changes in potentially harmful interspecific interactions in the future.*

The importance of broader community dynamics (e.g., predation, competition, parasitism, etc.) should be given elevated priority in future efforts. Whereas the Recovery Plan (USFWS 2013:254) recommends understanding conditions where competition has "significant adverse effects" on SMHM populations, most SMHM researchers do not individually mark most other rodent species (e.g., voles, house mice). We contend that the need to understand the role of competitive dynamics on SMHM comprises a call for data on other rodents captured during routine monitoring activities.

Lacking baseline knowledge of predation pressure on SMHM, it will be difficult to interpret and respond to changes in predation through processes like sea level rise and tidal restoration (e.g., altering the availability and configuration of habitat) or urban

encroachment (influencing the composition of the predator fauna). The application of "molecular scatology" (see Symondson and Harwood 2014) would be optimal, but this assumes molecular barcodes are available for the forage species of interest. As an alternative we suggest researchers who perform routine monitoring should include standardized observations of predators and predator sign in relation to habitat type and configuration. These data may be most useful to managers designing tidal restorations, especially near urban environments where human associated predators such as cats (*Felis catus*) are common.

We recommend researchers be vigilant for indications of harmful disease outbreak and identify and implement research needs should they arise, especially near urban areas where SMHM are more exposed to sources of disease such as domestic pets and sewage.

Priority needs:

a) Characterize small mammal assemblages thoroughly, individually marking all captured animals and record comprehensive data about community composition during survey activities.

    i. *Recovery Action 4.5.1.1 Determine the effects of non-native species on tidal marsh ecosystems. Conduct studies to determine the direct and indirect effects of invasive species… (page 326).*

b) Characterize key interspecific interactions; we recommend field efforts be structured to quantify the impact of predation, competition, and parasites on SMHM population size and health.

    i. *Recovery Action 4.2.7.4 Study the nature and strength of predation on SMHM (page 322).*

ii. Recovery Action 4.5.4.3 *Conduct other research on SMHM predator/prey and parasite/host relationships (page 328).*

c) Quantify how habitat use by SMHM changes in response to changes in the community (e.g., in likely competitors or predators).

i. Recovery Action 4.2.7.2 *Investigate the use of suboptimal habitats by SMHM to cope with interspecific competition (page 322).*

d) Integrate habitat-based observations of community structure to projected habitat shifts to help managers incorporate predicted assemblage structure in long-term planning.

i. Recovery Action 4.2.7.2 *The role of bulrush (*Schoenoplectus *spp.) and cattail (*Typha *spp.) in SMHM biology needs to be more thoroughly examined in the South Bay, especially when such areas are lightly flooded by tides (page 322).*

ii. Recovery Action 4.2.7.3 *Study the impact of* Spartina alterniflora *and its hybrids, and* Lepidium latifolium *on SMHM (page 322).*

7. Improved Collaboration and Meta-Analyses. *Collaboration and integration of parallel datasets across multiple sites with the ultimate objective of strengthening quantitative estimates of key parameters while better understanding how local context influences SMHM biology is essential.*

The pursuit of meta-analyses across replicate sites is a critical need (e.g., Beston 2011, Koricheva et al. 2013). Current regulations mandate similar sampling efforts at a number of sites throughout the SFE, and the 2013 Recovery Plan recommends a research coordinator to maximize the impact of potential collaborations (USFWS 2013). Related to

this is the need for standardized field methods, which have limited earlier efforts by members of the Salt Marsh Harvest Mouse Working Group to pursue integrative analyses. Such coordinated efforts would support all of the recovery actions listed above, as well as the following:

i. <u>Recovery Action 2.1.1</u> *Coordinate with existing agencies to develop and implement mechanisms for coordinated, long-term management of SMHM and their habitat (page 290).*

ii. <u>Recovery Action 2.1.3.2</u> *Develop and implement standardized SMHM monitoring techniques to evaluate ecosystem function and response, species response, and threat response to interim management activities (page 291).*

iii. <u>Recovery Action 3.3</u> *Periodically review and improve methods of SMHM monitoring (page 316)*

iv. <u>Recovery Action 3.5</u> *Periodically review progress toward SMHM recovery and long-term conservation of species of concern, and identify warranted changes in status (delisting, uplisting, or downlisting) (page 317).*

v. <u>Recovery Action 4.1</u> *Designate a research coordinator to coordinate all tidal marsh research sponsored or overseen by U.S. Fish and Wildlife Service (page 317).*

The SMHM continues to be in need of protection from both historic and contemporary threats. Management and conservation of SMHM in the face of emerging threats (e.g., climate change and associated sea level rise, which "likely imperils [SMHM] and the resources necessary for its survival", USFWS 2010:27), will require continued investment in basic and applied research to

help managers detect responses to large-scale restoration and climate change, and implement necessary management actions. We encourage researchers to consider climate change when designing field efforts, thereby providing further insight to how SMHM may be affected.

Though coordination has been improved recently through an ad-hoc inter-agency SMHM Working Group, we believe the greatest impediments to conservation of the SMHM are the lack of dedicated personnel and funding. To this end we propose creation of an independent program coordinator to prioritize and facilitate centralized and sustained research funding towards commonly agreed-upon objectives among researchers and management agencies in support of complementary and management-driven research, standardization of methods, and integration of collaborative efforts. This position, likely funded jointly by key regulatory agencies, would require programmatic autonomy and should interface closely with the SMHM Working Group. The research needs highlighted here provide a foundation from which such efforts can be developed. Our intent has been to identify key threats and associated research and management needs that will improve the chances of SMHM recovery throughout its range. We encourage researchers and managers to revisit such an effort regularly, with 5- to 10-year updates to ensure applied research remains appropriately targeted at priority research needs.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the years of research contributed by salt marsh harvest mouse researchers and managers over the past 5 decades. Without their dedication and hard work an effort such as this would not have been possible. We would like especially to acknowledge Dr. Howard Shellhammer whose tireless efforts built the foundation on which our understanding of the salt marsh harvest mouse is based, and who was instrumental in securing protections for the species. We would like to acknowledge the Salt Marsh Harvest Mouse Workgroup for

providing input on the mouse research needs and their encouragement to complete this work. We also wish to thank two anonymous reviewers, Colin Grant, and Isa Woo for thoughtful input on the manuscript, as well as the staff at San Francisco Estuary and Watershed Science who supported this effort. During preparation of this manuscript K. Smith was supported by the Delta Stewardship Council Delta Science Program under Grant No. F12AC00887. The contents of this material do not necessarily reflect the views and policies of the Delta Stewardship Council. The California Department of Water Resources Suisun Marsh Program has generously supported M. Riley, L. Barthman-Thompson, and S. Estrella and has funded a great deal of recent salt marsh harvest mouse research. D. Kelt was supported by the UC Davis Department of Wildlife Fish and Conservation

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CHAPTER 3 - The importance of non-native plants and waterfowl management in the seasonally flexible diet of the salt marsh harvest mouse

*The salt marsh harvest mouse (*Reithrodontomys raviventris*) is an endangered species, endemic to the marshes of the San Francisco Bay. This species is believed to feed primarily on pickleweed (*Salicornia pacifica*), although its diet is poorly understood, and a large proportion of remaining salt marsh harvest mouse habitat is managed for non-pickleweed vegetation to provide waterfowl habitat. Using two sets of cafeteria trials, I tested food preferences of the salt marsh harvest mouse when offered a variety of plants and invertebrates from the Suisun Marsh. In both trial types, salt marsh harvest mice showed strong preferences for food types commonly grown for waterfowl, and also for non-native plants; in contrast, pickleweed rarely ranked highest. These results suggest that salt marsh harvest mice have a much more flexible diet than previously believed, and that waterfowl management in areas like the Suisun Marsh provides abundant food for waterfowl and salt marsh harvest mice alike. Salt marsh harvest mice may be exemplars of reconciliation ecology, where active management, even promoting non-native species, may be essential elements of an enlightened conservation strategy.*

INTRODUCTION

The San Francisco Estuary (SFE, Fig. 3-1) is extremely valuable biologically, but it also is one of the most threatened estuaries in the world. Twenty of the 500 or so animal species found there are endangered (Goals Project 1999), and less than 20% of historic tidal marsh remains (Goals Project 2015). The SFE also is one of the most highly invaded ecosystems in the world (Cohen and Carlton 1998). In addition to these ecological concerns, protecting this ecosystem has tremendous economic value. The economy of the greater San Francisco Bay Area (ca. $535 billion in 2010) is the 19th largest in the world (BACEI 2012). Recreational activities associated with wetlands in the San Francisco Bay engage tens of thousands of outdoor enthusiasts and

bring in more than a billion dollars in local revenue annually (Goals Project 1999). However, these recreational activities have contributed to the introduction of non-native species and genotypes into the SFE, which have had diverse impacts on the ecological and cultural value of these wetlands (Lampert et al. 2014, Moyle et al. 2014). Whereas many introductions have been harmful to the ecosystem (Cohen and Carlton 1998), a limited number have provided cultural and economic benefits; for example, intentionally introduced striped bass (*Morone saxatilis*) support a lucrative recreational fishery (up to $45 million per year in the late 20th century; Cohen and Carlton 1998). Some introductions have even benefitted native, endangered species. As one example, non-native cordgrasses (*Spartina* spp.), intentionally introduced to the SFE, hybridize with native species and produce larger patches of vegetation than the pure native taxon (Zedler and Kercher 2004). Endangered Ridgway's rail (*Rallus obsoletus*) heavily colonize hybrid patches and populations increase; when managers remove hybrid patches, rail populations decrease (Lampert et al. 2014). As a result of dynamics such as these, the SFE has become a model system for managing and studying complex interactions between introduced and endangered native species (Lampert et al. 2014).

One SFE endemic that is affected by introduced species is the salt marsh harvest mouse (*Reithrodontomys raviventris*; SMHM hereafter; Fig. 3-2a; USFWS 2010). The SMHM was listed as endangered by the federal government in 1970 and by the State of California in 1971, primarily due to habitat loss (USFWS1984). The SMHM is a marsh obligate that is highly adapted for life stressful tidal environments (Fisler 1965, Shellhammer et al. 2010, Smith et al. 2014). In fact, the SMHM is the only mammal species worldwide that is entirely restricted to coastal marshes (Greenberg and Maldonado 2006). For many decades, the SMHM has been managed as a relatively strict habitat specialist, relying heavily on tidal wetlands dominated by

pickleweed (*Salicornia pacifica*; Fig. 3-2b; Fisler 1961, Shellhammer et al. 1982). Consequently, the effects of invasive species, especially plants, have been a conservation concern for SMHM for decades (USFWS 1984;2013). The belief that SMHM require tidal wetland habitat dominated by pickleweed has persisted (USFWS 2013), despite the fact that researchers have recently reported that SMHM readily use managed and other non-tidal wetland types throughout the species range (Fig. 3-2c; Shellhammer et al. 2010, Sustaita et al. 2011, Smith et al. 2014).

Alternative habitat use of SMHM has been especially well studied in the Suisun Marsh (Fig. 3-1; Sustaita et al. 2011, Smith et al. 2014), which lies in the eastern SFE, composes a large proportion of remaining SMHM habitat, and supports some of the largest remaining populations of the northern subspecies, *R. r. raviventris*. Suisun Marsh is maintained primarily as non-tidal wetlands (Sustaita et al. 2011), with tens of thousands of hectares managed by over 150 private waterfowl hunting clubs, the California Department of Fish and Wildlife, and others to provide food and habitat for resident and migratory waterfowl and shorebirds. Managers here promote growth of many non-native plant species, and favor vegetation assemblages that differ from those found in the historic tidal wetlands in the SFE, a practice that provides both vital wildlife habitat and cultural and economic value through waterfowl hunting.

Resource agencies have long managed SMHM under the assumption that pickleweed is the species preferred and most important food source, primarily based on the fact that SMHM are commonly trapped in pickleweed-dominated habitats (USFWS2010). However, the importance of pickleweed as a food source for SMHM has never been directly investigated. Fisler (1965), making opportunistic observations, found that SMHM gut contents were dominated by plant fibers, but included few seed coats and insect remains. During dry months stomach contents were brown and black, while during the wet months, when young grass was available, stomach

contents were bright green. Fisler (1965) also reported that SMHM did not eat insects when these were offered in a laboratory setting. Unfortunately, there have been no studies directly investigating the diet or feeding ecology of SMHM in any capacity in the five decades since Fisler made these observations, although several other species in the genus *Reithrodontomys* have been reported to have flexible, omnivorous diets (Kincaid and Cameron 1982, Sealander and Heidt 1990, Clark et al. 2005). As a result, biologists and managers are unable to provide guidance to landowners on how to "grow mouse food," and this has raised concerns that wetlands managed for waterfowl might not provide adequate food to sustain SMHM populations. However, researchers recently postulated that higher densities of SMHM in wetlands with a diverse mix of halophytic vegetation (as are commonly found in Suisun Marsh), than wetlands dominated by pickleweed may be attributed to a diversity of food resources and indicate a flexible diet (Sustaita et al. 2011).

In contrast, the diets of waterfowl in Suisun have been better characterized, and biologists and wetland managers have developed methods of managing disturbance, hydrology, and water and soil salinity to encourage the growth of important waterfowl food types in managed wetlands (Ackerman et al. 2014). Studies suggesting that large populations of rodents in the Suisun Marsh are correlated with higher nest success of waterfowl (Ackerman 2002), presumably by providing an alternative prey resource that relieves predation pressure on nests, raise the possibility that promoting SMHM populations may provide benefits to waterfowl managers as well. Hence, identifying preferred food types of SMHM, as well as overlaps in waterfowl and SMHM diet, may lead to management recommendations that will provide a win-win strategy for multispecies management.

In this study, I performed cafeteria trials on SMHM in the Suisun Marsh to identify important

food sources for SMHM and to evaluate the overlap with waterfowl food sources. I addressed the following questions: (1) What plant and invertebrate species in the Suisun Marsh do SMHM prefer to consume, and are native species more strongly preferred? (2) Do the diet preferences of SMHM overlap with those of waterfowl within the Suisun Marsh?

METHODS

Live Trapping

This research was conducted on three blocks (each consisting of a trapping grid in a tidal wetland, and a trapping grid in an adjacent [<1 km] managed wetland) within the Suisun Marsh in Solano County, California (Fig. 3-1). Denverton Property is owned and managed by the California Waterfowl Association, and Goodyear Slough and Joice Island are units of the Grizzly Island Wildlife Area, owned and managed by the California Department of Fish and Wildlife. I performed the cafeteria trials once per season in each block, from fall (September) 2013 through summer (August) 2016 (hence, each of 4 seasons over 3 years). I also measured vegetation metrics, including percent cover of individual plant species, at each trap location within all grids on the same seasonal basis, and used trap location level metrics to calculate grid level vegetation metrics. Tidal grids received natural tidal inundation, while managed trapping grids were subject to a variety of land management practices for waterfowl hunting (e.g., flooding, mowing, discing). Trapping grids were large (1 ha, 60 traps [6x10] at 15 m spacing) and spanned a variety of plant assemblages in both wetland types. As part of a larger ecological study, I performed regular censuses at each block over three nights on a monthly (project year 1) or bimonthly (project years 2 & 3) basis. During regular censuses I set traps shortly before sunset and checked them at sunrise (Smith 2018); on nights that I performed the diet study I began checking traps several hours after they were deployed to obtain mice for cafeteria trials, which were conducted

on site during the nocturnal active period of SMHM. I used up to eight individual mice per wetland type per night (depending on capture success) and endeavored to balance sexes.

Cafeteria Trial

Mice were fasted for two hours before trials. After fasting, one mouse was placed in each of up to eight feeding arenas constructed from five-gallon buckets. Each bucket contained seven glass containers (tea light candle holders) filled (by volume) with different food types (see below) arranged in a circle; for insulation I placed a handful of cotton batting at the center of the arena (Fig. 3-3a). Each bucket was covered with a lid that was fitted with a Swann Home Security DVR system (Swann SWDVR-16150H; Fig. 3-3b), and all activities were recorded for two hours. Mice were then removed and returned to their point of capture. I tested up to eight mice simultaneously, and the logistics of checking traps in a timely manner dictated that these all came from one randomly selected trapping grid (e.g., either tidal or managed wetland). While the first round of mice was being recorded I collected up to eight more mice from the other wetland type. These animals were tested immediately after the first trial was completed. I ran only two sets of trials in a given night.

Salt marsh harvest mice were presented with one of two menus, labeled Set and Seasonal. The Set menu was developed in consultation with a representative from the California Waterfowl Association and included four plant species (food types) known to be eaten commonly by waterfowl in the Suisun Marsh (waterfowl foods: alkali bulrush (*Bolboschoenus maritimus*), fat-hen (*Atriplex prostrata*), rabbitsfoot grass (*Polypogon monspeliensis*), and watergrass (*Echinochloa crus-galli*)), and three plant species that are strongly associated with SMHM captures during live trapping in Suisun Marsh (mouse foods: pickleweed, saltgrass (*Distichlis spicata*), and tricorner bulrush; Fig. 3-3 box c). The Set menu consisted of the dehydrated seed-

containing portions of the plants (e.g., seed heads, dried succulent stems) collected from all study blocks and combined by food type.

Two limitations of the Set menu should be noted. First, I collected seeds at peak ripeness, dried them, and offered them throughout all three years of the study. Thus, during all seasons, SMHM were offered ripe seeds, and ripe seeds of all species were not available each season in each habitat. Second, watergrass was not naturally available throughout the duration of the study because of an extended drought. To compensate to some extent for these constraints, and to test seasonally relevant foods, I developed the Seasonal menu.

The Seasonal menu consisted of the seven most abundant plant or invertebrate species at each wetland during the focal season (based on vegetation metrics recorded as part of the live-trapping study). Consequently, the Seasonal menu varied somewhat across wetlands and seasons. The food types offered in the seasonal menu included seeds, leaves and blades, flowers, fruits, roots in various stages of development, and invertebrates.

Videos were coded and analyzed by trained technicians, who recorded the duration of time a mouse smelled, physically inspected without eating, or ate any of the food types. I then spot-checked the data, verifying each of the three longest feeding events (uninterrupted period feeding on one food type) and resolving instances in which video technicians were unsure about the behavior or food type.

If an individual mouse did not investigate (smell, inspect, or eat) at least three different food types during a trial, or spend at least 30 seconds eating (suggesting that it was not hungry) during the trial, or if technical malfunctions led to missing videos or portions of videos, that trial was omitted from analysis (this included 39 individual trials from the Set menu analyses and 31 individual trials from the Seasonal menu analyses). Seven individual mice were offered the Set

menu over multiple seasons and for each individual I retained only the trial from the more underrepresented season overall to help balance sample sizes. In preparation for analysis, I summed the total time each mouse spent eating each food type during a given trial.

Despite fasting for two hours before the cafeteria trials, there were substantial differences in the apparent hunger levels of individual mice when exposed to foods in the Set menu; some individuals spent more than an hour eating (max. 73 minutes) while others did not eat at all during their trial. I presume that these differences indicate variation in baseline metabolic needs over which I had no control, but this variation should add "noise" to the data and not bias results in any direction. Nonetheless, to account for this I also transformed the total time each individual spent eating each food type during Set menu trials into a proportion of total time spent eating overall (all food types) during their trial.

Data Analysis

Set and Seasonal Menus

Because my data included a large number of zero values (for animals that spent no time eating a given food type) it proved impossible to transform these for parametric analyses. Consequently, to determine overall effects on the amount of time SMHM spent eating I performed a semiparametric repeated measures multivariate analysis of variance (MANOVA; function RM in package MANOVA.RM in program R; R Core Team 2013, Friedrich et al. 2017b). This package allows for a permutational approach (Friedrich et al. 2017a), and provides a Wald-type statistic which is interpreted as a traditional F-statistic. For my analysis I ran 10,000 iterations on the total time each mouse spent eating. Main effects included food type, wetland type, season, block, percent cover of food type within trapping grid, project year, and sex. Additionally, to evaluate whether food preferences varied across main effects, I included the interaction of food type with

all other factors. However, due to constraints of the analysis (insufficient factor level combinations), the model could not accommodate all main effects. Because preliminary analyses indicated that block, percent cover of food type, and sex had non-significant effects on time spent eating and food type choice in the Set menu, these were omitted from subsequent analysis. Hence, the final model was Time ~ Wetland Type * Season * Project Year * Food Type (e.g., testing all main effects and all 2-, 3-, and 4-way interactions), where food type was the repeated measure and individual mice were the subjects. As noted above, I performed the same analysis with proportion of time spent eating the various food types to account for different hunger levels. Results for the time and proportion data sets were qualitatively similar, so I report only the time data. Because these analyses are not parametric, traditional post-hoc tests (e.g., Scheffé, Tukey, etc.) are not available. Consequently, I made post-hoc comparisons using 95% confidence intervals (CI) provided by the repeated measures MANOVA. In most instances, CI did not overlap, making interpretations straightforward. In cases where CI did overlap even when analyses indicate that the respective data differ, I identify significantly different entities by evaluating overlap of CI with the means of other groups (e.g., if the mean of both members of any pair lie outside the confidence limits of the other pair).

As noted above, Seasonal menus were developed to compensate for limitations with the Set menu. These also presented analytical constraints, however, because menus varied from site to site, season to season, etc. As such, food types are not balanced across sites, seasons, or years, precluding a MANOVA-style analysis. Instead, I calculated the total time each mouse spent eating each food type during its trial, pooled all individuals by season and wetland type (e.g., across sites and years; hence, 4 seasons x 2 wetland types = 8 sets of data) and calculated the mean time spent eating the food types offered. I also applied a linear model (function lm in

package stats in program R; R Core Team 2013) to test for a correlation between the mean time spent eating each of the food types offered during a session (trial corresponding to one wetland type within a site, season, and year) and the only correlate for which sufficient data exist, the percent cover of the food type at the wetland during that session (Time Spent Eating Food Type ~ Percent Cover of Food Type corresponding to that Wetland Type at that Site within that Season and Year). I developed separate models for each season and wetland type combination, and because these 8 analyses are not entirely independent, any significant results should be interpreted cautiously, and we provide Bonferroni-adjusted critical values for comparison (assuming replicate tests within seasons may not be fully independent, $p_{crit(adj)} = 0.05/2 = 0.025$). More conservative adjustments could be made (e.g., $p_{crit(adj)} = 0.05/8 = 0.00625$) but this would not influence interpretation (see results below).

Comparing Diets of SMHM and Waterfowl

To determine if waterfowl management promotes food types favored by SMHM, I calculated what proportion of the top one, two, and three most favored foods (per individual) in the Set menu were waterfowl foods (as defined above; alkali bulrush, fat-hen, rabbitsfoot grass, and watergrass) versus mouse foods (pickleweed, saltgrass, and tricorner bulrush). For example, if two of the top three foods an individual mouse spent the most time eating were duck foods, then 66.66% of its top choices were duck foods. I then calculated the mean proportions of the top one, two, and three most favored foods, across all Set menu trials, that were waterfowl foods. For further comparison I extracted data on waterfowl diet preferences from Mall (1969) and Burns (2003), who presented four metrics of diet. These include a use index (a function of frequency of occurrence in diet and percent volume in diet), a selection index (a function of use and relative abundance of plants), percent occurrence in individuals, and percent dry esophageal content. To

determine if SMHM and waterfowl in Suisun have similar patterns of preference, I compared the ranking of the Set menu food items with the rankings of the top food types in the waterfowl diet studies with a Kendall rank correlation (function cor.test in package stats in program R; R Core Team 2013).

RESULTS

Set and Seasonal Menus

I presented the Set menu on 59 occasions (managed wetlands, n=32; tidal wetlands, n=27). This included a total of 293 SMHM that were offered the Set menu 303 times, yielding just under 12,000 smelling, investigating, and feeding events. Food type, wetland type, and season significantly influenced the total time individual SMHM spent eating (Table 3-1). Moreover, three pairwise interactions and one 3-way interaction, all involving food type, were significant (Table 3-1, Fig. 3-4). Overall, SMHM food preferences declined in the following order (Table 3-2, Fig. 3-5): rabbitsfoot grass^{a} > fat-hen^{b} > pickleweed^{c} > watergrass^{cd} > alkali bulrush^{d} > tricorner bulrush^{e} > saltgrass^{e} (different superscripts denote significant differences). Mice in managed wetlands spent significantly more time eating than mice in tidal wetlands (308.20 [CI, 272.04, 344.36] sec., n=155 versus 232.91 [198.77, 267.05] sec., n=102; Table 3-1). However, this pattern appears to be entirely attributable to the time spent eating rabbitsfoot grass in managed wetlands (Fig. 3-5); if rabbitsfoot grass is omitted there is no significant difference in time spent eating between wetland types (206.68, [178.66, 234.69] sec. in managed versus 216.46, [181.37, 251.55] sec. in tidal wetlands). Based on CI overlap with mean values, SMHM spent more time eating in the fall (345.83 [269.96, 421.71] sec., n=50) than in the spring (265.22 [224.78, 305.67] sec., n=78) and summer (230.43 [178.06, 282.80], n=59), and more time in winter (285.05 [240.28, 329.82] sec., n=70) than summer. As expected, project year did not

significantly affect the mean time spent eating per food. However, all pairwise interactions with food type were highly significant, indicating that food type preferences differed between wetland types, across seasons, and across project years. Hence, as noted above, SMHM spent significantly more time eating rabbitsfoot grass in managed than in tidal wetlands (917.34 [757.51, 1077.166] sec. versus 331.59 [218.67, 444.50] sec. respectively; Fig. 3-4a), although no other food types elicited responses across wetland type. SMHM demonstrated interannual variation in consumption of two food types, spending significantly more time eating pickleweed in the second than the first year of the project (360.19 [291.26, 429.11] sec. and 187.02 [139.64, 234.41] respectively), while the time spent eating during the third year was intermediate, but much closer to the second year time than the first (336.04 [224.06, 448.02], Fig. 3-4b). Mean time eating tricorner bulrush decreased steadily throughout the study, from year one (44.39 [22.57, 66.22] sec.) to year two (26.53 [3.87, 49.27] sec.), and year three (7.78 [3.11, 12.45] sec.), with the first year being significantly higher than the last; (Fig. 3-4b). Finally, SMHM exhibited seasonal preferences for only two food types. They spent significantly more time eating watergrass in the fall (549.04 [297.07, 801.00] sec., n=50) than either spring (184.51 [115.45, 253.58] sec., n=78) or winter (153.50 [90.82, 216.18] sec., n=70), but not summer (230.81 [127.12, 334.51] sec., n=59; Fig. 3-4c), and more time eating pickleweed in the winter (423.29 [303.71, 542.86] sec., n=70) than spring (255.77 [206.64, 304.90] sec., n=78) or summer (158.20 [97.22, 219.19] sec., n=59), but not fall (340.70 [262.21, 419.19] sec., n=50; Fig. 3-4c).

A total of 251 SMHM were offered the Seasonal menu on 45 occasions (managed wetlands, n=25; tidal wetlands, n=20), and just over 12,000 smelling, investigating, and feeding events were recorded. As noted in Methods, the seasonal menu varied annually, seasonally, and by wetland type; overall, it included a total of 39 different plants and invertebrates, all of which

were eaten by SMHM during at least one occasion. Pickleweed was the only food type that occurred in every seasonal menu (e.g., 25 managed, 20 tidal). The next most common types were fat-hen (19 managed, 9 tidal), common reed (*Phragmites australis*, 19 managed, 4 tidal), saltgrass (13 managed, 7 tidal), and hardstem bulrush (*S. acutus*, 8 managed, 9 tidal) and pepperweed (*Lepidium latifolia*, 7 managed, 10 tidal). In managed wetlands, food types that were highly ranked in relative preference (e.g., top five species) during at least two seasons included the three top food types from the Set menu (rabbitsfoot grass, fat-hen and pickleweed), as well as annual grasses, prickly lettuce (*Lactuca seriola*), and saltgrass (Table 3-3a), the latter of which ranked lowest in the Set menu (Table 3-2). In tidal wetlands, food types that were highly ranked in two or more seasons included two of the top three food types from the Set menu (fat-hen and pickleweed), as well as cattail (*Typha* spp.), Baltic rush (*Juncus balticus*), and marsh arrowgrass (*Triglochin maritima*).

Finally, most of the 8 linear models (4 seasons x 2 wetland types) I evaluated yielded very poor correlations between time spent eating Seasonal menu food types and their associated seasonal percent covers in each wetland type (all $p \geq 0.25$, all $R^2_{adj} \leq 0.088$). The only exceptions to this were managed wetlands during winter ($F(1,62)=4.20$, $p=0.045$; $R^2_{adj}=0.048$) and tidal wetlands during spring ($F(1,35)=4.45$, $p=0.042$; $R^2_{adj}=0.088$). However, neither of these results are significant when using even the most liberal Bonferroni-adjusted critical value ($p_{crit(adj)} = 0.025$).

Comparing Diets of SMHM and Waterfowl

A very high proportion of individual SMHM in the Set menu spent most of their time eating waterfowl foods (e.g., fat-hen, rabbitsfoot grass, watergrass, alkali bulrush). Indeed, almost 90% of mice in managed wetlands and over 80% of individuals in tidal wetlands ranked a waterfowl food highest (managed wetlands, 88.39±2.58%, n=155; tidal wetlands, 81.37±3.87%, n=102).

When I included the top two and top three ranked foods, the percentages remained high (77.42±2.16% and 70.54±1.52% for the top two and three in managed wetlands, respectively, and 70.59±2.64% and 63.07±1.85% for the top two and three in tidal wetlands, respectively). These patterns of preference suggest that there may be common preferences between SMHM and waterfowl.

Mall (1969) and Burns (2003) studied waterfowl diet in Suisun Marsh. Mall (1969) conducted a comprehensive multi-species, multi-year study of waterfowl food use and selection, and ranked alkali bulrush and fat-hen high for both use and selection, pickleweed and annual grasses (including rabbitsfoot grass) high for use but low for selection, and saltgrass and tricorner bulrush low for both use and selection (see the supplement for details [appendix A]). Burns (2003) studied the diet of pintails and mallards across two overwintering seasons, and reported that alkali bulrush and watergrass were highly ranked both by percent aggregate dry matter esophageal content and by the proportion of individuals with these foods in esophageal samples. Fat-hen and pickleweed were ranked low by the same measures, but still ranked in the top six most common food types. Unlike Mall (1969), Burns (2003) did not record rabbitsfoot grass in the diet of ducks in Suisun Marsh, although this ranked second among pintail in a different study area (the Sacramento-San Joaquin Delta; see the supplement for details [appendix A]).

Integrating the Set menu (Fig. 3-5) with these two waterfowl studies (Fig. 3-6), both SMHM and waterfowl ranked fat-hen, pickleweed, rabbitsfoot grass, and watergrass high, whereas they ranked both saltgrass and tricorner bulrush low. In contrast, alkali bulrush was the top choice in both waterfowl studies but ranked relatively low in the Set menu (but notably higher than saltgrass and tricorner bulrush; Fig. 3-5, Table 3-2). Despite these qualitative similarities, a rank correlation revealed that none of the pairwise comparisons – including a comparison of the two

waterfowl diet studies – were significantly correlated (all tau ≤ 0.43, and all p ≥ 0.23).

DISCUSSION

My cafeteria trials were designed to characterize the seasonal diet preferences of SMHM, test SMHM preferences for native plants versus non-native, and to determine if SMHM and waterfowl have similar diet preferences. Across the Set and Seasonal menu SMHM consumed a total of 39 different plants and animals but showed strong preferences (e.g., >10% of their time eating) for only about half of the food types. When offered the Set menu, SMHM spent the greatest amount of time eating non-native plants (rabbitsfoot grass and fat-hen). Further, even though the majority of foods in the Seasonal menu were native food types (>85%), close to one-third of the highest ranked food types were non-native food types. I conclude that SMHM have a flexible diet, and that there is no apparent preference for native plants over non-natives; on the contrary, there is some indication that they preferentially forage on non-native foods. Salt marsh harvest mice also showed strong preferences for waterfowl favored foods (Fig. 3-6, Tables 3-2, 3-3). A waterfowl food ranked highest in both managed (rabbitsfoot grass) and tidal wetlands (fat-hen) in the Set menu. In contrast, pickleweed (the commonly assumed most preferred food) ranked only third in the Set menu overall (Table 3-2) and was highly selected only about half of the time in the Seasonal menu (Table 3-3).

Salt marsh harvest mice in my cafeteria trials consumed 39 different foods, including beetles and amphipods (contra Fisler 1965). Further, during field efforts I have seen SMHM eating insects and consuming a wide variety of plant species (K. Smith, pers. obs.). Of the 23 species of harvest mice currently described in the genus *Reithrodontomys*, the diets of only seven have been described in any detail in the published literature. The eastern harvest mouse (*R. humulis*; Sealander and Heidt 1990), fulvous harvest mouse (*R. fulvescens*; Kincaid and Cameron 1982),

western harvest mouse (Webster and Jones 1982), and plains harvest mouse (*R. montanus*; Clark et al. 2005), the closest relative of SMHM, have all been reported to have omnivorous, seasonally flexible diets, similar to SMHM. The eastern, plains, and western harvest mouse diets consist predominantly of seeds (primarily from grasses), invertebrates, and to a smaller degree, green plant matter. Further, western harvest mice in Oregon shrublands (Frank et al. 2009), and Mexican harvest mice (*R. mexicanus*) in a Panamanian cloud forest (Mangan and Adler 2000), have been shown to consume mycorrhizal fungi. Sumichrast's harvest mouse (*R. sumichrasti*) has even been shown to tolerate consumption of toxic insects, preferentially consuming the least toxic parts of the organism (Glendinning 2007).

The diet of the fulvous harvest mouse further illustrates the flexibility of *Reithrodontomys*. This species spans both temperate and tropical regions, and diets vary regionally. Stomach contents of the fulvous harvest mouse in the Wichita Mountains of Oklahoma consisted of about 40% plant matter and 60% animal. Plants were primarily grasses and animal matter included grasshoppers, beetles, moths, cockroaches, and roundworms (Stancampiano and Caire 1995) . In contrast, in tropical Mexico this species ate dicot leaves, stems, fruit, seeds, monocots, and insects (Vazquez et al. 2004).

Additionally, rodent species of other genera that occur in coastal marshes exhibit flexible diet habits. Rice rats (*Oryzomys palustris*) in Texas marshes may forage in uplands when food availability is low in wetlands, or to supplement their diet when nutrient demands are high, such as during reproduction (Kruchek 2004). This species also eats a wide variety of plants, invertebrates and vertebrates in Georgia marshes (Sharp 1967). The diet of California voles (*Microtus californicus*) in the SFE is composed primarily of grass leaves and stems (~88%) and forb leaves (9.3%) during the wet season, and primarily of grass heads (72.6%) and forb leaves

(15.4%) during the dry season (Batzli and Pitelka 1971). Further, these preferences held even when individuals originally from the SFE were bred several generations in captivity (Gill 1977). The results of this diet study have important implications for SMHM conservation and management. Two points stand out in particular. First, the general classification of non-native plants as a threat to SMHM may warrant reevaluation; some non-native plant species provide substantial food value for SMHM while having overall negative effects on habitat structure. Indeed, some of the non-native plants that were strongly selected in cafeteria trials, such as perennial pepperweed (which ranked relatively high during some seasons in the Seasonal menu, Table 3-3), are considered to pose potential conservation threats to SMHM (USFWS 2013). Further work on the diet of SMHM under natural conditions is needed in light of these observations, as invasive plants may be important food sources in the modern marshes of the SFE. The second major implication of this study is that waterfowl management, which has at times been considered harmful to SMHM (Shellhammer 1982), actually promotes the production of plants that SMHM readily consume. This suggests that holistic management for both waterfowl and SMHM is not only feasible but may be readily accomplished. Waterfowl management also reintroduces successional processes that have been arrested by various habitat management practices throughout the state (i.e., regulating reservoir releases and normalizing Delta outflows). While unmanaged tidal wetlands frequently are characterized by large monotypic vegetation stands (Goals Project 1999), management at waterfowl clubs encourages a more diverse plant community, which may provide a more stable food supply throughout the year (Sustaita et al. 2011). The importance of this temporally diverse food base has likely been underestimated due to the very strong association between SMHM and pickleweed.

Finally, this study, along with other recent work (Sustaita et al. 2011, Smith et al. 2014,

Trombley and Smith 2017), supports an emerging consensus that SMHM are much more flexible in their habitat use (and diet) than previously believed. This suggests that a reconciliation approach (Rosenzweig 2003, Moyle et al. 2014) to SMHM recovery may be preferable; it may be appropriate to relax some conservation actions, such as tidal restoration, that target historical habitat characteristics (i.e., tidal wetlands dominated by pickleweed) while still achieving conservation objectives for SMHM, increasing efficiency of habitat management, and conserving resources. It also contributes to the growing body of research in the SFE that illustrates the complex interactions between introduced species and endangered native species. Instead of fighting invasive plants in wetlands, we may be able to use some of them to our advantage. For example, keeping levees clear of weedy, invasive species is extremely difficult, but seeding levees with rabbitsfoot grass could improve the habitat for SMHM with minimal management effort. This study also illustrates an unrecognized positive influence that waterfowl management may have on SMHM (e.g., providing food), and that by encouraging the growth of rabbitsfoot grass, fat-hen, pickleweed, watergrass, and alkali bulrush on their properties, managers can support both waterfowl and endangered SMHM. Climate change and sea level rise are projected to lead to large-scale shifts in vegetation communities in the SFE (Takekawa et al. 2013). The flexible diet of SMHM and their ability to utilize non-native plants as food when available suggests that they may be resilient to these changes (Cudworth and Koprowski 2013, Juškaitis and Baltrūnaitė 2013), and illustrate that even habitats that have long been considered marginal for SMHM (e.g., weedy levees, grass dominated uplands) may provide a valuable food base.

ACKNOWLEDGEMENTS

For invaluable field assistance I thank L. Barthman-Thompson, S. Estrella, M. Riley, S. Trombley, S. Fresquez, C. Roddy, M. Smith and dozens of undergraduate volunteers from the Department of Wildlife, Fish and Conservation Biology at UC Davis. For the hours spent watching mice eat I thank C. Rose, E. Edgerton, and numerous volunteers. For insights in analyses and writing I thank D. Kelt and D. Sustaitia. This work was supported financially by the Delta Science Council, UC Davis Graduate Studies, a Howard Research Award, and a Jastro Research Fellowship, with further financial and logistical support provided by the Suisun Marsh and Grizzly Island Units of the California Department of Fish and Wildlife, the Suisun Marsh Program at the California Department of Water Resources, and R. Eddings and the California Waterfowl Association.

The research reported here was conducted under an approved IACUC protocol from UC Davis (19323) and a Memorandum of Understanding between the California Department of Fish and Wildlife and the United States Fish and Wildlife Service for handing of endangered species, with direct involvement and supervision by the California Department of Fish and Wildlife. All procedures were consistent with the guidelines for the use of wild mammals in research from both ASAB/ABS and the American Society of Mammalogists.

During data collection and preparation of this manuscript K. Smith was supported by the Delta Stewardship Council Delta Science Program under Grant No. F12AC00887. The contents of this material do not necessarily reflect the views and policies of the Delta Stewardship Council.

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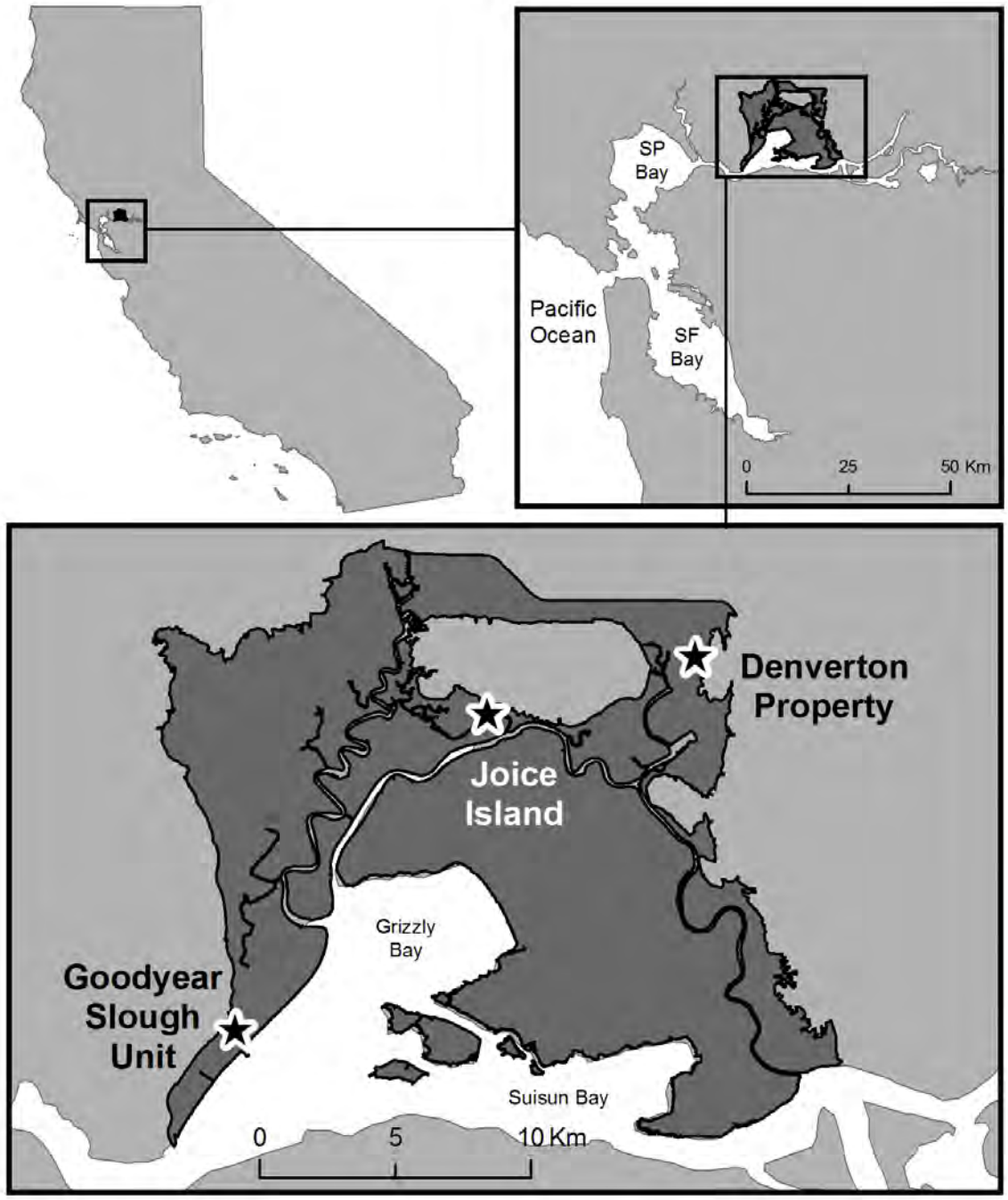

Fig. 3-1. The state of California with the San Francisco Estuary enlarged in the upper inset, and the Suisun Marsh enlarged in the lower inset. Study blocks are marked by stars and labeled.

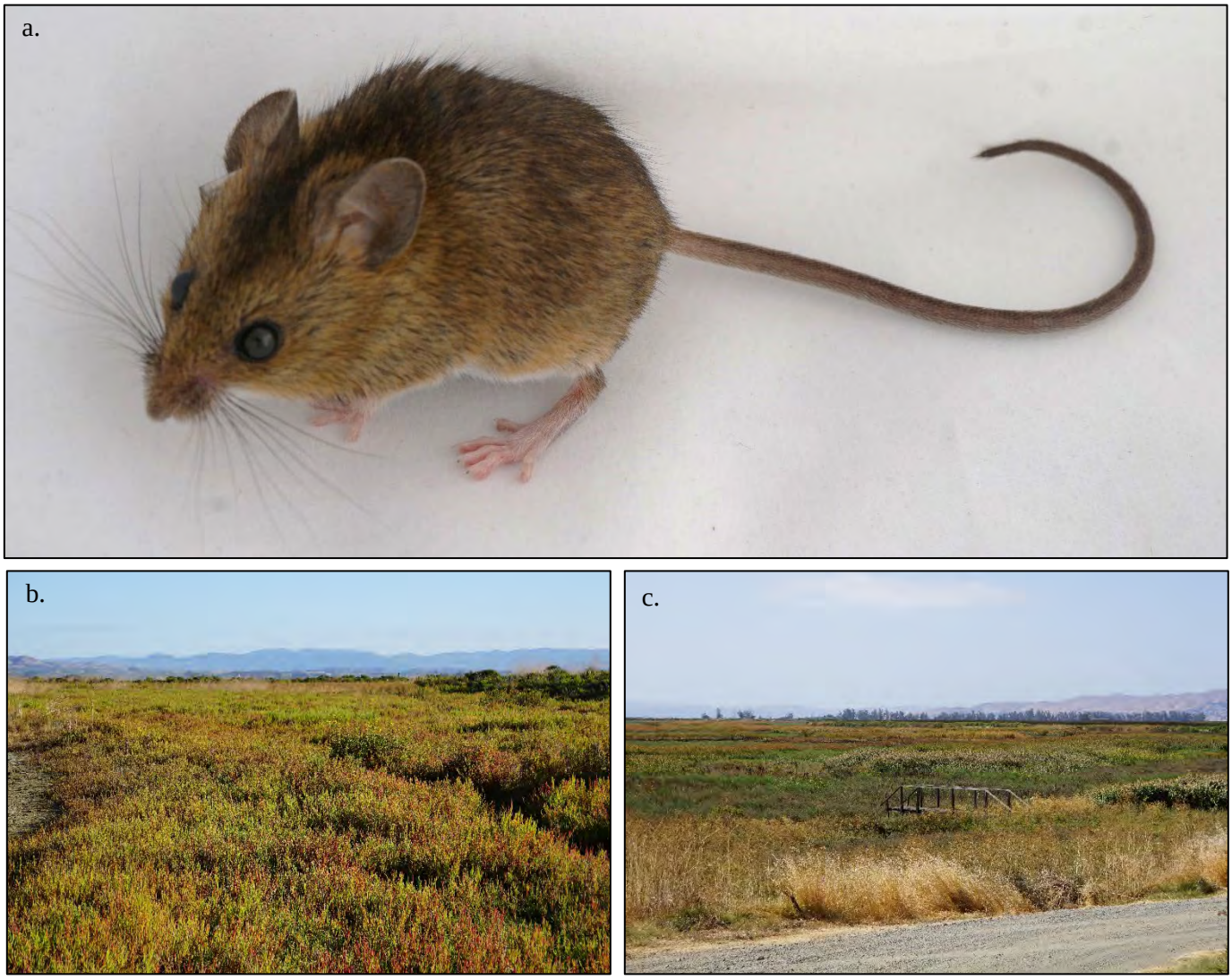

Fig. 3-2. (a) A salt marsh harvest mouse (*Reithrodontomys raviventris*). (b) A tidal wetland dominated by pickleweed. This habitat type was long considered necessary for persistence of salt marsh harvest mice. **c**. A diked managed wetland, with a variety of vegetation types present. This habitat type was once thought to be detrimental to salt marsh harvest mice, but is now know to support healthy populations of this species.

Fig. 3-3. (a) A salt marsh harvest mouse (*Reithrodontomys raviventris*) inside the feeding arena provisioned with a sample Seasonal menu. (b) Swann home security cameras were fitted into holes in the top of the bucket lids to video record feeding behaviors while keeping mice sheltered. (box c) The plants of the set menu. From left to right: rabbitsfoot grass, fat-hen, pickleweed, watergrass, alkali bulrush, tricorner bulrush, and salt grass.

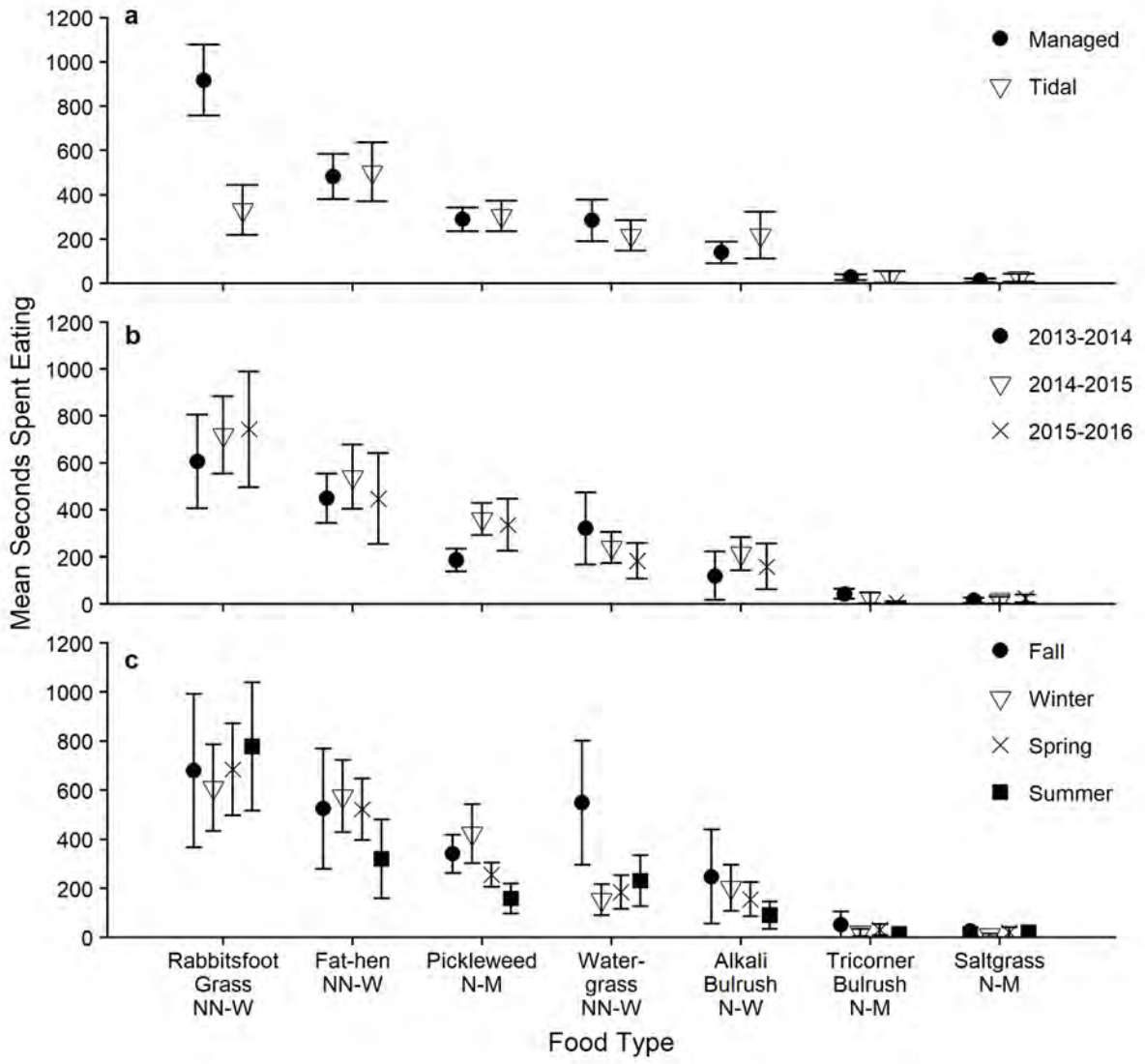

Fig. 3-4. Plots for interactions between the main effects in the Set menu. (a) Food and wetland type. (b) Food and project year. (c) Food and season. Foods that are non-native and associated with waterfowl are marked by NN-W. Foods that are native and associated with waterfowl are marked by N-W. All foods that were chosen as mouse foods are native and are marked by N-M.

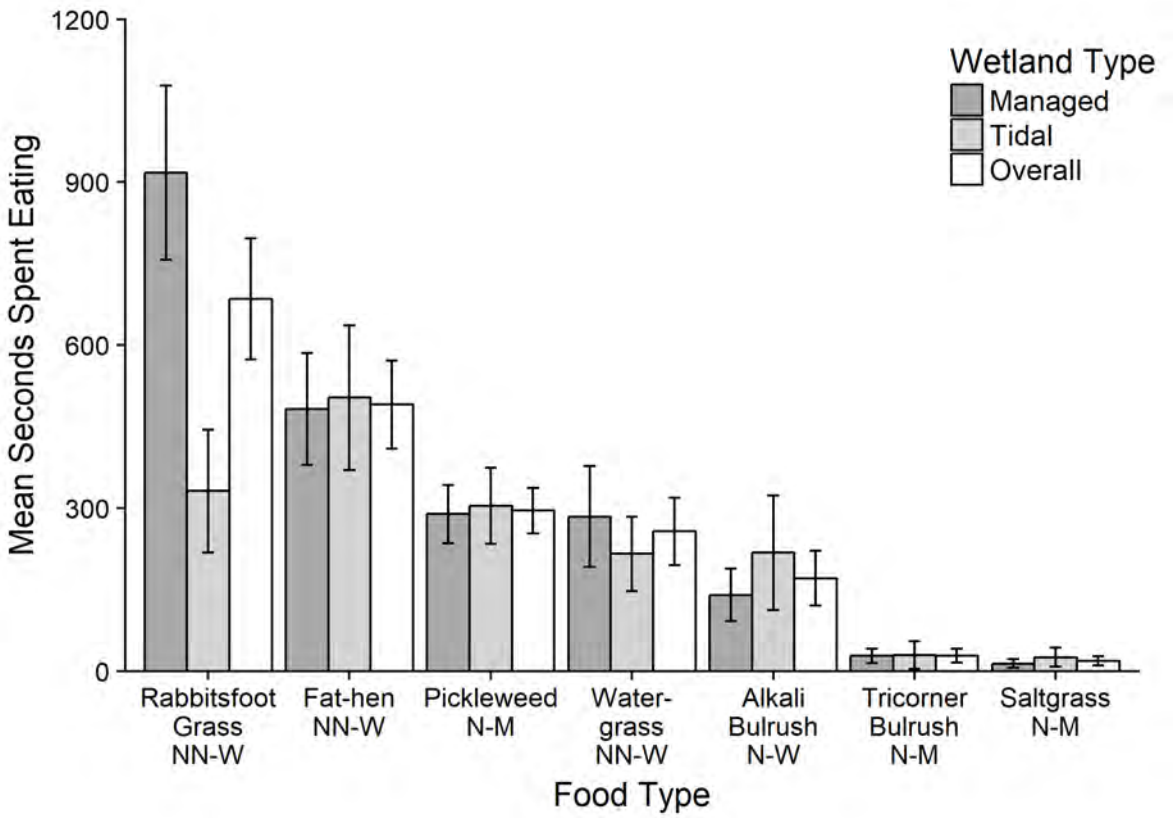

Fig. 3-5 Mean proportion of time spent eating Set menu foods by wetland type and for the overall means (combined managed and tidal values). Foods that are non-native and associated with waterfowl are indicated by NN-W. Foods that are native and associated with waterfowl are indicated by N-W. All foods selected as mouse foods are native and are indicated by N-M.

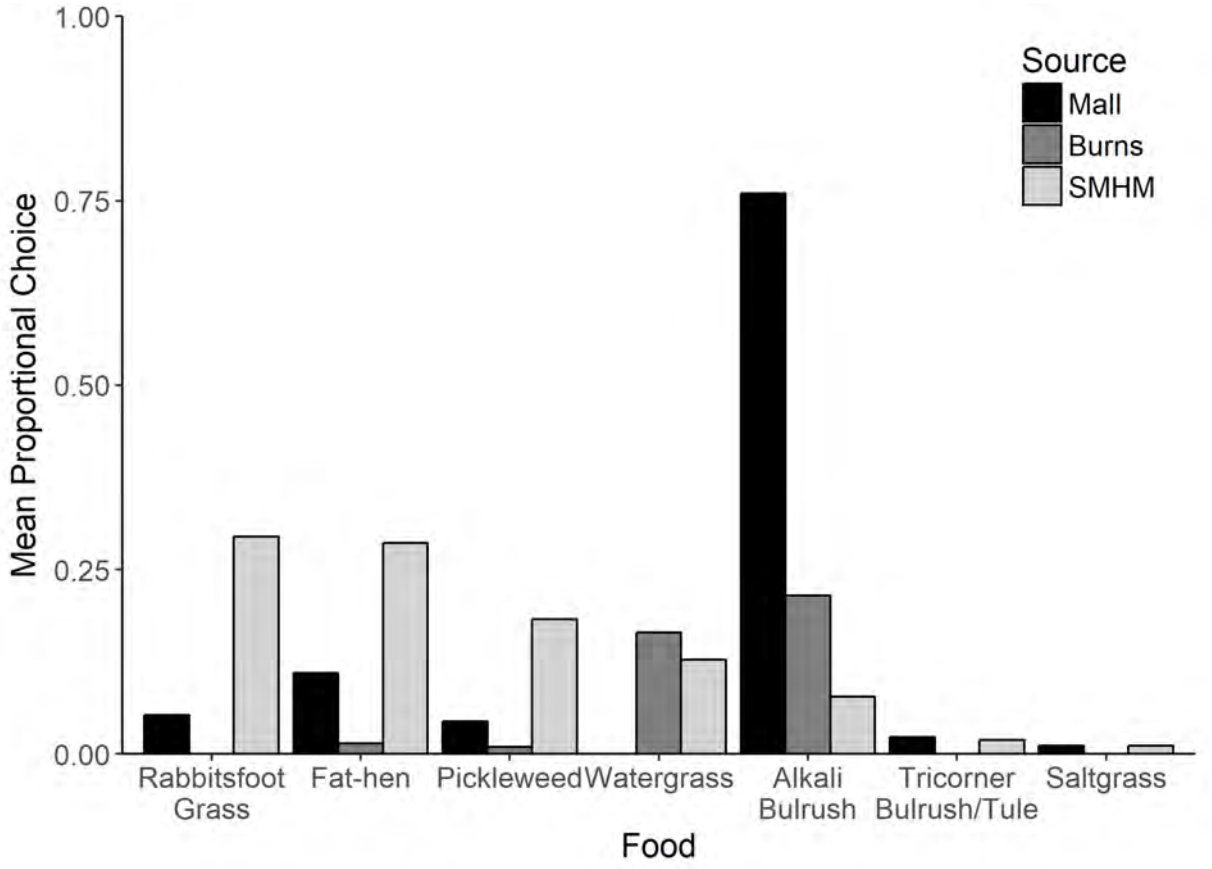

Fig. 3-6. Proportional preferences of waterfowl from Mall (1969) and Burns (2003) compared with those of SMHM in the Set menu. Bulrushes of the genus Schoenoplectus (tricorner bulrush and hardstem bulrush/tule) are combined.

Table 3-1. Test statistics, including the Wald-type statistic (WTS), for the repeated measures MANOVA for the Set menu. Factors that are significant after resampling are indicated in bold. P-values of ≤ 0.05 are indicated with one asterisk, of ≤ 0.01 with two, and ≤ 0.001 with three.

	WTS	df	p-value	Resampled p-value
Food Type	**370.51**	**6**	**<0.001*** **	**<0.001*** **
Wetland Type	**13.10**	**1**	**<0.001*** **	**<0.001*** **
Season	**13.67**	**3**	**0.003****	**0.022***
Project Year	4.42	2	0.298	0.331
Wetland Type x Food Type	**45.18**	**6**	**<0.001*** **	**<0.001*** **
Season Type x Food Type	**71.59**	**18**	**<0.001*** **	**0.006****
Project Year x Food Type	**50.02**	**12**	**<0.001*** **	**0.002****
Wetland Type x Season	2.42	3	0.595	0.639
Wetland Type x Project Year	1.91	2	0.385	0.409
Season x Project Year	16.12	6	0.013*	0.061
Wetland Type x Season x Food Type	33.84	18	0.013*	0.162
Wetland Type x Project Year x Food Type	11.55	12	0.482	0.675
Season x Project Year x Food Type	**141.13**	**36**	**<0.001*** **	**0.020***
Wetland Type x Season x Project Year	10.33	6	0.111	0.206
Wetland Type x Season x Project Year x Food Type	70.02	36	0.001**	0.299

Table 3-2. Mean time in seconds spent eating foods in the Set menu with 95% lower confidence intervals (LCI) and upper confidence intervals (UCI). Overall preferences are indicated by superscripted letters in the "mean" column; foods with different letters received significantly different levels of attention from mice.

	Overall				Managed Wetlands				Tidal Wetlands			
a.	**n**	**Mean**	**LCI**	**UCI**	**n**	**Mean**	**LCI**	**UCI**	**n**	**Mean**	**LCI**	**UCI**
Rabbitsfoot grass	257	684.86[a]	573.40	796.31	155	917.34[a]	757.51	1077.17	102	331.59[a]	218.67	444.50
Fat-hen	257	490.87[b]	409.96	571.76	155	482.54[b]	379.78	585.29	102	503.53[a]	370.41	636.65
Pickleweed	257	295.52[c]	253.18	337.86	155	289.50[c]	235.87	343.122	102	304.68[a]	234.72	374.63
Watergrass	257	257.61[cd]	195.62	319.61	155	284.79[c]	191.96	377.622	102	218.18[a]	148.03	284.59
Alkali bulrush	257	171.38[d]	120.53	222.23	155	140.58[d]	91.884	189.277	102	216.31[a]	112.95	323.41
Tricorner bulrush	257	29.07[e]	16.16	41.97	155	28.40[e]	15.029	41.7706	102	30.08[b]	4.37	55.78
Saltgrass	257	18.92[e]	10.51	27.34	155	14.26[e]	6.2112	22.305	102	26.01[b]	8.57	43.45

Table 3-3. Mean proportion of time spent eating foods in the Seasonal menu in the fall in managed wetlands (a) and tidal wetlands (b), winter in managed wetlands (c) and tidal wetlands (d), spring in managed wetlands (e) and tidal wetlands (f), and summer in managed wetlands (g) and tidal wetlands (h). Pickleweed, presumed to be the preferred food of salt marsh harvest mice, is highlighted. Superscripts indicate non-native plants (1) or plants with some non-native varieties or genotypes present (2).

(a)

Fall - Managed Wetlands				
	N	**Mean**	**LCI**	**UCI**
Pickleweed	14	684.07	355.25	1012.89
Fat-hen[1]	14	430.5	173.84	687.16
Rabbitsfoot grass[1]	5	190	-40.55	420.55
Saltgrass	12	85.92	-11.96	183.8
Unknown	1	30	NA	NA
Common reed[2]	13	27.69	9.73	45.65
Dock spp.	1	23	NA	NA
Coyote brush	5	17.6	-14.3	49.51
California rose	7	6.43	-1.93	14.78
Coastal gumweed	1	0	NA	NA
Brass buttons[1]	4	0	0	0

(b)

Fall - Tidal Wetlands				
	N	**Mean**	**LCI**	**UCI**
Fat-hen[1]	17	595.83	300.47	891.18
Pickleweed	22	595.05	178.02	1012.07
Cattail[2]	18	457.9	35.33	880.47
Baltic rush	5	138.4	-139.89	416.69
Hardstem bulrush	13	126.46	-36.29	289.22
Coyote brush	6	52	-30.91	134.91
Coastal gumweed	7	37.43	-44.04	118.91
Saltgrass	10	35.9	-14.45	86.25
California aster	5	32	-9.99	73.99
Unknown	3	25	-63.21	113.21
Salt marsh fleabane	8	21.13	-12.78	55.03
Common yarrow	6	16.17	-12.13	44.47
Common reed[2]	1	11.01	NA	NA
Salt marsh baccharis	6	7.34	-11.52	26.19
Tricorner bulrush	7	6.86	-7.17	20.89
Alkali heath	10	6.1	0.33	11.87
Perennial pepperweed[1]	3	3	-9.91	15.91
Alkali bulrush	1	0	NA	NA

(c)

Winter - Managed Wetlands				
	N	**Mean**	**LCI**	**UCI**
Pickleweed	30	357.7	201.33	514.08
Rabbitsfoot grass[1]	13	316.62	-60.2	693.43
Fat-hen[1]	19	257.95	52.57	463.33
Annual grass – young[1]	12	140.01	-24.04	304.05
Unknown	7	50.57	-46.93	148.07
California rose	6	48.33	-64.98	161.64
Brass buttons[1]	4	46.25	-38.79	131.29
Saltgrass	10	35.5	-10.9	81.9
Lamb's quarters[1]	5	30.8	-25.33	86.93
Cattail[2]	6	21.17	-7.21	49.55
Perennial pepperweed[1]	11	16.82	2.37	31.27
Common reed[2]	25	13.04	0.74	25.35
Dock spp.	11	12.91	-1.41	27.23
Alkali bulrush	6	11.83	-10.64	34.31
Fennel[1]	5	9	-15.3	33.3
Coyote brush	6	6	-3.84	15.85
Alkali heath	5	0	0	0

(d)

Winter - Tidal Wetlands				
	N	**Mean**	**LCI**	**UCI**
Fat-hen[1]	8	1128.1	588.33	1667.92
Cattail[2]	16	283.32	71.3	495.33
Baltic rush	10	274.7	-220.84	770.24
Pickleweed	19	159.37	77.86	240.89
Alkali heath	8	112.25	-32.15	256.65
Tricorner bulrush	3	75.33	-54.63	205.3
Coastal gumweed	15	72.54	0.97	144.1
Saltgrass	18	63	-7.44	133.44
Salt marsh fleabane	10	52.2	-61.19	165.59
Invertebrates	1	49	NA	NA
Common reed[2]	1	39	NA	NA
California aster	8	33.13	-4.35	70.61
Perennial pepperweed[1]	9	22.33	-1.48	46.15
Unknown	3	21.33	3.89	38.78
Fleshy jaumea	2	14	-163.89	191.89

(e)

Spring - Managed Wetlands				
	N	**Mean**	**LCI**	**UCI**
Prickly lettuce[1]	3	716.67	-678.9	2112.21
Rabbitsfoot grass[1]	21	602.76	245.78	959.75
Annual grass	5	490.8	133.48	848.12
Alkali bulrush	3	473.67	-1530	2477.28
Saltgrass	22	337.68	190.09	485.28
Fat-hen[1]	19	127.11	18.15	236.07
Baltic rush	7	125.57	-90.24	341.38
Hardstem bulrush	23	120.7	43.31	198.09
Brass buttons[1]	26	120.08	35.65	204.51
Common reed[2]	6	69.5	-48.79	187.8
Unknown	5	68.2	-8.99	145.39
Dock spp.	16	22.32	4.09	40.54
Pickleweed	28	21.22	9.76	32.67
Perennial pepperweed[1]	12	7.42	-1.5	16.34
Fennel[1]	4	7	-15.28	29.28

(f)

Spring - Tidal Wetlands				
	N	**Mean**	**LCI**	**UCI**
Unknown	1	285	NA	NA
Marsh arrowgrass	17	269.88	83.73	456.03
Tricorner bulrush	10	263.4	-20.21	547.01
Baltic rush	15	222.47	135.24	309.69
Invertebrates	8	29.25	5.48	53.02
Pickleweed	15	26.8	5.51	48.1
Western goldenrod	2	23.5	-275.1	322.11
Birdsfoot trefoil[1]	7	15.29	-6.68	37.26
Hardstem bulrush	13	14.39	4.1	24.67
Cattail[2]	6	14.17	-12.32	40.66
Perennial pepperweed[1]	14	13.5	-3.74	30.74
Saltgrass	4	10.25	-13	33.51
Alkali heath	5	3.4	-6.04	12.84

(g)

Summer - Managed Wetlands				
	N	**Mean**	**LCI**	**UCI**
Hardstem bulrush	2	1182.5	-317.2	2682.17
Knotweed[2]	8	1111.6	316.73	1906.52
Rabbitsfoot grass[1]	32	1053.1	670.67	1435.46
Prickly lettuce[1]	7	453.15	68.72	837.58
Dock spp.	5	244.4	-73.82	562.62
Sea purslane	25	217.8	117.74	317.86
Coastal gumweed	11	211	-168.3	590.28
Common reed[2]	29	187.52	88.37	286.67
Alkali bulrush	20	182.85	-56.6	422.3
Unknown	8	109.37	43.16	175.59
Pickleweed	35	92.23	34.54	149.92
Saltgrass	14	81.07	-62.41	224.56
Alkali Russian thistle[1]	4	54.75	-70.12	179.62
Fat-hen[1]	29	51.59	19.92	83.26
Perennial pepperweed[1]	11	39.55	-17.41	96.5
Brass buttons[1]	6	25	-20.83	70.83
California rose	2	4.5	-52.68	61.68
Bristly oxtongue	1	0	NA	NA

(h.)

Summer - Tidal Wetlands				
	N	**Mean**	**LCI**	**UCI**
Rabbitsfoot grass[1]	1	2529	NA	NA
Common reed[2]	12	1662.3	895.44	2429.07
Marsh arrowgrass	13	849.47	591.48	1107.45
Cattail[2]	16	593.57	32.93	1154.2
Saltmarsh dodder	8	401.5	270.83	532.18
Hardstem bulrush	15	294.8	124	465.61
Unknown	10	177.3	40.97	313.63
Perennial pepperweed[1]	16	147.44	23.61	271.27
Alkali Russian thistle[1]	3	117.67	-93.26	328.59
Saltgrass	3	91	-230.18	412.18
Pickleweed	34	74.09	28.79	119.39
Salt marsh baccharis	3	57	-188.25	302.26
Tricorner bulrush	22	55.73	20.43	91.03
Western goldenrod	7	45.43	-57.04	147.9
Fat-hen[1]	14	42.07	16.29	67.85
Knotweed[2]	3	41.67	-28.65	111.99
Salt marsh fleabane	10	38.1	7.29	68.92
Western hedge bindweed	7	36.15	-14.02	86.32

APPENDIX A – SUPPLEMENTAL INFORMATION

Table 3-A-1a. Waterfowl diet preferences as reported by Mall 1969.

	Use	Selection
Alkali bulrush	High	High
Brass buttons	High	High
Fat-hen[1]	High	High
Cultivated barley & oats[2]	High	High
Pickleweed	High	Low
Wild annual grasses[3]	High	Low
Hardstem bulrush	Low	Low
Saltgrass	Low	Low
Cattail spp.	Low	Low
Baltic rush & Tricorner bulrush	Low	Low

[1] Miscellaneous herbs, primarily fat-hen.
[2] *Hordeum vulgare* & *Avena sativa*
[3] Italian ryegrass (*Lolium multiflorum*), rabbitsfoot grass, and wild barley (*Hordeum* sp.).

Table 3-A-1b. Waterfowl diet metrics as reported by Burns 2003.

	% Occurrence in Waterfowl Population		% Aggregate Esophageal Dry Matter	
	Pintail	Mallard	Pintail	Mallard
Alkali bulrush	82.9	69.6	8.8	34.1
Italian ryegrass	0.0	0.0	10.9	10.0
Sea purslane	85.4	71.2	63.0	27.0
Watergrass	29.3	39.1	9.6	23.4
Rabbitsfoot grass[1]	32.0	-	11.8	-
Fat-hen	-	-	2.5	0.3
Pickleweed	-	-	1.9	0.1

[1] In Sacramento-San Joaquin Delta only.

APPENDIX B – SPECIES LIST

Table 3-B-1. Common and Scientific Names of Plants and Animals in Set and Seasonal Menus. Superscripts denote non-native plants ([1]) and plants with some non-native varieties or genotypes present ([2]).

Common Name	Scientific Name
Alkali bulrush	*Bolboschoenus maritima*
Alkali heath	*Frankenia salina*
Alkali Russian thistle[1]	*Salsola soda*
Annual grass	*Lolium multiflorum, Hordeum* spp., *Leymus triticoides, etc.*
Arrowgrass	*Triglochin maritima*
Aster spp.	*Symphyotrichum spp.*
Baltic rush	*Juncus balticus*
Birdsfoot trefoil[1]	*Lotus corniculatus*
Brass buttons[1]	*Cotula coronopifolia*
Bristly oxtongue	*Picris echioides*
California rose	*Rosa californica*
Cattail[2]	*Typha* spp.
Coastal gumweed	*Grindelia stricta*
Common reed[2]	*Phragmites australis*
Common yarrow	*Achillea millefolium*
Coyote brush	*Baccharis pilularis*
Dock spp.	*Rumex* spp.
Fat-hen[1]	*Atriplex prostrata*
Fennel[1]	*Foeniculum vulgare*
Fleshy jaumea	*Jaumea carnosa*
Hardstem bulrush (tule)	*Schoenoplectus californicus, S. acutus*
Invertebrates	Unidentified *Amphipoda* and *Coleoptera*
Knotweed[2]	*Polygonum* and *Persicaria* spp.
Lamb's quarters[1]	*Chenopodium album*
Perennial pepperweed[1]	*Lepidium latifolia*
Pickleweed	*Salicornia pacifica*
Prickly lettuce[1]	*Lactuca serriola*
Rabbitsfoot grass[1]	*Polypogon monspeliensis*
Salt marsh baccharis	*Baccharis douglasii*
Salt marsh fleabane	*Pluchea odorata*
Saltgrass	*Distichlis spicata*
Saltmarsh dodder	*Cuscuta salina*
Sea purslane	*Sesuvium verrucosum*
Tricorner bulrush	*Schoenoplectus americanus*
Watergrass	*Echinochloa crus-galli*
Western goldenrod	*Euthamia occidentalis*
Western hedge bindweed	*Calystegia sepium*

CHAPTER 4 - Demography of the salt marsh harvest mice (*Reithrodontomys raviventris halicoetes*) and associated rodents in tidal and managed wetlands

*Suisun Marsh is the largest contiguous marsh remaining on the West Coast of the United States, and makes up approximately 10% of the wetlands remaining in the San Francisco Estuary. The Suisun Marsh was safeguarded from development primarily through the operation of over 100 privately owned and operated waterfowl hunting clubs, which manage for diked, ponded waterfowl habitat. However, this management and the subsequent loss of tidal influence on these ponds has been considered harmful for some species, including the federally endangered salt marsh harvest mouse (*Reithrodontomys raviventris*). To determine the value of tidal wetlands relative to those managed for waterfowl, we performed periodic surveys for rodents in paired managed and tidal wetlands over five years, and utilized a robust design capture-mark-recapture analyses to estimate demographic parameters and abundance for the three most common rodents in the Suisun Marsh – the northern salt marsh harvest mouse (R. r. halicoetes), the western harvest mouse (a sympatric native species;* R. megalotis*) and the house mouse (a sympatric non-native species;* Mus musculus*). Wetland type had no effect on detection, temporary emigration, or survival for any of these species. However, fecundity and population growth for all three species were affected by an interaction of season and wetland type, although none of these species was consistently superior in either habitat type in all seasons. Estimated abundance of salt marsh harvest mice and house mice were similar in both wetland types, whereas western harvest mice were more abundant in managed than tidal wetlands. Salt marsh harvest mice also showed no affinity for any microhabitat characteristics associated with tidal wetlands. Managed wetlands in Suisun Marsh support salt marsh harvest mice and house mice equally in terms of key demographic parameters and abundances, and abundances of western harvest mice were greater in managed wetlands, suggesting that managed wetlands may be superior in terms of*

supporting native rodents overall. As climate change and associated sea level rise is predicted to threaten coastal marshes, these results suggest that a proactive management strategy for salt marsh harvest mice should include development of managed wetlands such as those documented in Suisun Marsh.

INTRODUCTION

Coastal wetlands and the species they support are imperiled worldwide. A recent meta-analysis of 189 reports indicates that over 50% – and up to 87% – of global wetlands have been lost to anthropogenic activities (Davidson 2014). Losses in the San Francisco Estuary (SFE) have been even more extreme, and it is estimated that <10% of historical tidal wetlands remain (Goals Project 2015). However, this loss has not been homogeneous throughout the SFE. While ponds managed for commercial salt production provide habitat for only a very select group of wildlife (e.g., shorebirds and waterfowl, Warnock et al. 2002), wetlands managed for waterfowl habitat support much of the remaining wildlife community, including the salt marsh harvest mouse (*Reithrodontomys raviventris;* SMHM hereafter) (Sustaita et al. 2011; Smith et al. 2014).

The SMHM (Fig. 4-1) is an endangered species endemic to the SFE (USFWS 2013). It is the only mammal species entirely restricted to coastal marshes (Greenberg et al. 2006) and exhibits numerous morphological and physiological adaptations for life in this challenging environment (Fisler 1965). SMHM can subsist on salt water, they climb well in emergent vegetation, and they swim well compared to their upland counterparts (Fisler 1965). This apparent specialization for tidal wetlands, along with a legacy of research with regional foci, led managers and researchers to conclude that SMHM are dependent on tidal wetlands dominated by pickleweed (*Salicornia* spp.) and, by inference, that management of wetlands in a non-tidal state would be harmful to the species (Shellhammer et al. 1982). Nonetheless, surveys in managed wetlands soon confirmed

that these habitats support substantial SMHM populations (Shellhammer et al. 2010; Sustaita et al. 2011). However, with almost no data regarding the demographic value of tidal and managed wetlands, managers have been unable to properly evaluate the importance of managed wetlands. Important demographic parameters (e.g., population density, survival, fecundity) may vary across managed and un-managed areas of otherwise similar habitat (i.e., in production forests where downed woody debris is removed or left behind) (Homyack et al. 2014; Fritts et al. 2017; Larsen et al. 2018), and some small mammals may perform better in, or adjacent to, managed areas (Hadley and Wilson 2004a; b; Converse et al. 2006; Sustaita et al. 2011). Understanding which habitat features favor native species, and disfavor non-native species, is critical for the recovery of species facing severe habitat loss, such as SMHM. Hence, determining environmental and biotic variables that affect interactions between SMHM and sympatric small mammals was listed as an objective in the recovery plan for the species (USFWS 2013).

We investigated the relative value of tidal and managed wetlands for rodent species in the Suisun Marsh, with a focus on the three most abundant species. These are the SMHM (*R. raviventris halicoetes*), a sympatric native congener (the western harvest mouse, *R. megalotis*; WHM hereafter), and a sympatric non-native (the house mouse, *Mus musculus*; *Mus* hereafter). We addressed three specific objectives. First, do tidal and managed wetlands differ in their demographic value (e.g., survival, fecundity, population growth rate) for these rodents? Managed wetlands experience greater daily habitat stability than do tidal wetlands, where nests are vulnerable to flooding and adults must avoid tidal inundation twice daily. Based on previous work in the system (Sustaita et al. 2011), and these differences in habitat stability, we predicted that survival, fecundity and population growth of these rodents would be equal to or greater in managed wetlands than in tidal wetlands. Our second objective follows directly from the first;

we ask if abundances of these three species differ in tidal and managed wetlands. Because management of the latter emphasizes high food production (for waterfowl), and we expected small mammals to have greater survival, fecundity and population growth there (prediction #1), we also expected these wetlands to support higher densities of all three rodent species. Finally, we sought to determine whether a series of microhabitat and other environmental characteristics (e.g., high plant species and structural diversity, average temperatures and rainfall) influenced estimated abundance of small mammals.

Different small mammal species are likely to favor different habitat characteristics, which in turn vary across wetland types. Since SMHM are more likely to occur deep in wetland habitat, as opposed to the transitional and upland margins of wetlands (Sustaita 2011), we expected this species to be associated with microhabitat characteristics that provide refuge – both to adults and their nests – from water fluctuations as well as predators. These were predicted to include dense vegetation with high structural complexity, high pickleweed cover, and greater distances from anthropogenic influence, which can subsidize native and non-native predators. We expected WHM to be associated with low plant species and structural diversity, and high grass cover, similar to the grassy habitats where this species is best known (Webster and Jones 1982), especially in habitats adjacent to marshes in the SFE, and that provide abundant grass seed, the preferred food of the species in the SFE (Fisler 1965). Finally, *Mus* is an extreme habitat generalist that has invaded diverse habitats across the globe (Long 2003), so we expected no strong associations with any particular microhabitat characteristics. We did, however, expect *Mus* to be most abundant at sites nearer to roads and other anthropogenic development, as they frequently are human commensals, and dispersal from developed areas into wetlands may supplement local *Mus* populations.

MATERIALS AND METHODS

Study Area.—Suisun Marsh is the largest remaining contiguous marsh on the West Coast of North America and comprises approximately 10% of wetlands remaining in the SFE (Moyle et al. 2014). It also contains more than half of remaining SMHM habitat, and supports some of the highest recorded densities of SMHM. Suisun Marsh is situated between the SFE and the Sacramento-San Joaquin Delta. Due to a large influx of fresh water from the Sacramento and San Joaquin rivers, waters here are more brackish than in other parts of the species' range. This area was largely protected from filling, development, and industrial use because it naturally provided excellent waterfowl habitat. Abundant waterfowl hunting opportunities in the mid 1800's to early 1900's led to the development of numerous waterfowl hunting clubs throughout Suisun Marsh, and today over 150 private and public landowners maintain the majority of the acreage in the marsh as wildlife habitat (Moyle et al. 2014). Most of this habitat is maintained as diked, managed wetlands through an extensive network of levees and ditches. Vegetation is subject to discing, burning, mowing, herbicides, and other activities meant to increase heterogeneity and provide food and cover for waterfowl (Coates et al. 2012). Managed wetlands are generally flooded in September or October, held as circulated ponds until February or March, and then flushed with fresher water during March and April, before draining in June. After leaching and draining, managed wetlands persist as moist to dry fields with a mix of wetland and upland plant species, and small shallow ponds that may persist until the fall flood-up.

Our field efforts occurred at three blocks within Suisun Marsh (Fig. 4-2). Joice Island Wildlife Area and the Goodyear Slough Unit (Joice and Goodyear hereafter) are part of the California Department of Fish and Wildlife's Grizzly Island Wildlife Area, and each was represented by one trapping grid in tidal wetland and one in a managed wetland. Denverton Property (Denverton

hereafter) is a private property owned by the California Waterfowl Association. This site was sampled with one trapping grid in a tidal wetland and two in managed wetlands. Managed wetlands were all subject to the standard flood and leach cycles associated with waterfowl management (Moyle et al. 2014). One of the managed wetlands at Denverton was under heavy management during the project; the trapping grid area was almost completely disced directly before the project began. The other three managed grids were subject to moderate management activity, which included discing adjacent to the second managed grid at Denverton, mowing adjacent to the managed grid at Goodyear, and burning near (~200 m) the managed grid at Joice. However, no vegetation control or ground disturbance occurred within these three trapping grids.

Live trapping.—Within the three blocks outlined above, we monitored small mammals at seven trapping grids from fall 2013 through winter 2017-2018. Sampling varied somewhat over the course of this study. During the first year (September 2013 through August 2014) we sampled Denverton and Joice every month. During years two and three (September 2014 through August 2016) we added Goodyear and sampled all sites bimonthly. During the last 1.5 years of the study (September 2016 through February 2018) we sampled only Goodyear and Joice sites, and did so quarterly. This study followed ASM guidelines (Sikes 2016) and was approved by the University of California at Davis animal care and use committee.

Small mammals at all sites were censused using Sherman live traps (Model LFA; H.B. Sherman Traps, Tallahassee, FL) arrayed in 6x10 grids (15-m spacing; ca. 1 ha total area). Trapping occurred simultaneously in managed and tidal wetlands within blocks. Trapping grids were placed to sample representative vegetation and microhabitat types. Traps were set in the evening and checked and closed in the morning for three consecutive nights, except during waterfowl hunting season when a one day gap was necessary to safely accommodate hunt days.

All captured rodents were identified to species and individually marked with uniquely numbered ear tags (Monel self-piercing tags, Model 1005-1, National Band & Tag Co., Newport, KY). We collected standard characteristics and measurements, including sex, reproductive condition, and weight measured to the nearest 0.25 g using a spring scale. We assessed all captured rodents for reproductive condition based on the condition of the testes in males (abdominal or scrotal), and of nipples (haired, developed, or worn), pregnancy, or copulatory plugs in females (Adler and Wilson 1987; Skupski 1995).

Because SMHM may be difficult to distinguish from WHM, we applied a multiple logistic regression model developed by Sustaita et al. (2011, 2018) to improve our accuracy. We collected standard measurements, including total length, tail length (Hall 1962; Nagorsen and Peterson 1980), body length (by subtracting tail from total length), tail diameter 2 cm from the base (SMHM have thicker tails than do WHM). Total length was measured by draping the animals across the end of the ruler and letting them grasp the edge with their paws. Field technicians then used one hand to line up the tip of the mouse's nose with the edge of the ruler by placing a finger behind the animal's skull, and with the other hand, smoothed the tail out to its full length. We recognize that readers may question the accuracy and consistency of this measurement, but it was possible due to the docility of SMHM, which allowed them to be manipulated with limited resistance. Moreover, measurements are very consistent across multiple captures and even different technicians. We also note that total length as recorded here is not comparable with that recorded with standard museum specimens (e.g., Hall 1962; Nagorsen and Peterson 1980). Because SMHM tend to have much blunter tails than WHM (Sustaita et al. 2018), we characterized the tail tip as blunt, intermediate, or pointed. SMHM also tend to be redder in coloration than WHM, often with a reddish venter and orange ear tufts, while WHM

are much more gray (Sustaita et al. 2018); consequently, we recorded the color of both dorsal and ventral pelage, that of tail hairs, and the presence of orange ear tufts. Finally, reflecting the docility that we referred to earlier, we recorded observations of behavior (e.g., docile or active). We asked field technicians to record provisional identification of harvest mice in the field, based on measurements, appearance, and behavior while the mouse was in hand. Additionally, many mice were photographed, and a large number of individuals were identified with genetic markers. We made final (synthetic) species identification based on a combination of field identifications, photographs, genetics, and the multiple linear regression of Sustaita et al. (2018). Supporting our approach, animals identified as SMHM in the field by experienced crew members matched the synthetic final species determination about 98% of the time, and fewer than 1% of animals identified in the field as probable SMHM were subsequently identified as WHM using these methods. Further, genetic testing was preferentially performed on the most ambiguous individuals (n=213), 56 (35.67%) of which were juveniles or subadults. Of the 462 provisional field identifications recorded for these most ambiguous individuals, genetic tests confirmed that 434 were correct (93.55%). We conclude that even without secondary tools (e.g., genetics, multiple linear regression), experienced technicians were highly successful at correctly identifying the species of even the most difficult to identify harvest mice while they were in hand.

Habitat characteristics.—We measured habitat characteristics seasonally (e.g., summer, fall, winter, spring). We recorded the plant species that comprised dominant vegetation, the percent cover (ocular estimation), and the height of this vegetation within a 5-m radius of each trap location. We defined vegetative species diversity as the number of plant species within 5 m of a trap location, and vegetative structural diversity as the mean difference in vegetative height at a

given station relative to the 8 most proximal stations. Weather data, including total rainfall and mean daily (24-hr) temperature during the 14 days preceding a given trap period, were obtained from the Rush Ranch weather station, which is maintained by the National Estuarine Research Reserve System (station code SFBRRMET; located <3 km from Joice, <10 km from Denverton, and <15 km from Goodyear). These habitat characteristics were utilized in all RMark models to test for their effects on the parameters.

Parameter and abundance estimates and statistical analyses—Prior to this effort, the longest study of SMHM demography spanned two years and sampled only three seasons (spring, summer, fall) each year (Sustaita et al. 2011). The current study incorporates monthly to quarterly sampling that encompasses all seasons over five years, including both drought and average rain years. Additionally, whereas Sustaita et al. (2011) sampled two managed and two tidal sites, we have increased replication both within and across wetland types. Consequently, we were able to incorporate a large number of parameters in our analyses (e.g., annual variation within season) that have not been applied to SMHM demography before. Because so little is known about SMHM demography, and because managers and researchers have a wide variety of data needs, we included a relatively large suite of factors and covariates to test a number of potential models. These included trap night, trap session, month, season, year, wetland type, pickleweed cover, vegetative species diversity, vegetative structural diversity, recent mean daily temperature, and recent rainfall, and preliminary estimated abundances of SMHM, WHM, and Mus. These were used in analysis of capture-mark-recapture models (CMR) to estimate survival, fecundity, population growth, and other parameters for each species; they were subsequently used, along with final estimated abundances of SMHM, WHM, and Mus, in a generalized linear model (GLM) to evaluate potential effects of these factors and covariates on

the final abundance estimates for each of the 3 focal species, as described below.

CMR modeling.—A goodness-of-fit test in program MARK (White and Burnham 1999) through extension RELEASE (Burnham et al. 1987) indicated good fit of CMR data (TEST 2 + TEST 3: $p > 0.90$ for all species), and we used a median ĉ adjustment and a quasi-likelihood Akaike's Information Criterion (QAIC) for selection of competitive models (e.g., ΔQAIC < 2.0). We applied Pradel's robust design with a Huggins full likelihood closed capture estimator (RMark model RDHFHet; Pollock et al. 1990; Huggins 1991) in RMark (Laake and Rextad 2009) to estimate abundance (N) and both capture (p) and recapture (c) probabilities during each trapping period, and survival (S) and temporary emigration (γ'' = the probability of temporarily moving out of the study area, and γ' = the probability of remaining outside the study area) between trapping periods ("survival models"; Tables 4-2, 4-A-1). We used Pradel's robust design with a Huggins closed capture estimator (Huggins 1991; Pradel 1996) to estimate fecundity (f; RMark model RDPdfHugFullHet; "fecundity models") and population growth rates (λ; RMark model RDPdLHugFullHet; "population growth models"; Tables 4-1 and 4-2). Candidate CMR models were specified a priori (e.g., random movement, Markovian movement, etc.). Capture-mark-recapture models were designed by addressing fitted detection parameters first (p, c), then fitted temporary emigration parameters (γ', γ''), and finally fitted demographic parameters (S, f, and λ; see Table 4-1 for parameter descriptions). We calculated all CMR parameters as monthly rates. To accommodate the large number of factors we wished to evaluate, we tested a suite of structures for each parameter (e.g., fixed, random, and by covariate), and we accepted as informative those structures for which QAIC < 2.0 (sensu Reeves et al. 2016). These parameter structures were then compared in the final CMR models to determine the most competitive survival, fecundity, population growth models (e.g., QAIC < 2.0). After running the final

models, we model averaged all estimated demographic parameters and derived abundance estimates ($\widehat{N}$), based on Akaike's weights (w_i), when more than one competitive model with identical structures for the parameter was available. We considered factors biologically informative if a model that included a given factor performed substantially better than a model without that factor (based on ΔAIC). After being model averaged within each of the three CMR model types, an unweighted mean was calculated for values of $\widehat{N}$ across the survival, fecundity, and population growth models.

GLM modeling.—Since estimated abundance ($\widehat{N}$) is derived from initial capture probability (White and Burnham 1999), the effects that factors included in these CMR models may have on $\widehat{N}$ could not be tested directly within the CMR models. However, the demographic parameters that have strong effects on abundance (e.g., survival, fecundity, and population growth) are tested within the CMR models. To test for effects of these factors on abundance estimates, we used a post-hoc GLM with a Poisson distribution and Type III sum of squares to determine whether the factors determined to affect S, f, and λ also had an effect on derived abundance estimates (R Development Core Team 2013). All means are reported ± standard error (SE).

RESULTS

Across 73 primary trapping occasions totaling almost 30,000 trap nights we captured 2,028 SMHM, 583 WHM, and 1,213 *Mus*. We were unable to identify 312 harvest mice, most of which were juveniles; these were classified as "unknown harvest mice" and excluded from analysis. Captures of other species totaled less than 150 individuals and are omitted from analysis here; these included 55 California voles (*Microtus californicus*), 43 rats (*Rattus* spp.), and 20 deer mice (*Peromyscus maniculatus*).

Demographic Parameters

Salt marsh harvest mice.— Most CMR model parameters for SMHM were best modeled with a single structure (e.g., only one variable, or one interaction of two variables were competitive; Table 4-A-1a); the single exception was temporary emigration (γ' and γ''), which presented two competitive structures (structure 1: $\gamma'(\text{sex}) = \gamma''(\text{sex})$; structure 2: $\gamma'(\text{sex}) \neq \gamma''(\text{sex})$). This resulted in two final CMR models for survival (which utilizes temporary emigration), and one each for the fecundity and population growth models (which do not utilize temporary emigration; Table 4-2). This species exhibited no behavioral response to trapping; that is, none of the factors tested affected capture probabilities, and neither capture (p) nor recapture (c) probabilities varied across trap nights within primary trapping periods. However, both probabilities did vary across primary trapping periods, and capture and recapture probabilities differed within primary trapping periods ($p(\text{period}) \neq c(\text{period})$; Table 4-A-1a), indicating a random response to trapping by SMHM. Temporary emigration was affected by sex, and both a constant random ($\gamma'(\text{sex}) = \gamma''(\text{sex})$) and a Markovian temporary ($\gamma'(\text{sex}) \neq \gamma''$ (sex)) model were competitive, and indicated that temporary immigration was occurring.

Monthly survival was influenced by an interaction between season and sex (S(season x sex); Table 4-A-1a). Survival was highest in fall, intermediate in winter and summer, and lowest in spring, and differed between males and females in the winter and summer (based on SE). Both fecundity and population growth rates for SMHM were driven by an interaction of wetland type with season, although interaction plots show that seasonal changes in these parameters were much more important than wetland type (Table 4-A-1a, Figs. 4-4 and 4-5). For both wetland types, fecundity followed a bimodal annual cycle, being low in winter (managed: 0.32 ± 0.03; tidal: 0.42 ± 0.04) and summer (managed: 0.18 ± 0.03; tidal: 0.15 ± 0.03); consequently, population growth rates also were lowest in the winter (managed: 0.89 ± 0.03; tidal: 0.99 ± 0.07)

and summer (managed: 0.76 ± 0.03; tidal: 0.73 ± 0.03) in both wetland types. Population growth rates in both wetland types were substantially higher in fall than in other seasons (managed: 1.49 ± 0.11; tidal: 1.37 ± 0.10), followed by spring (managed: 0.99 ± 0.07; tidal: 1.13 ± 0.08).

Western harvest mice.—Temporary emigration and survival were influenced by more than one factor for WHM (Table 4-A-1b), resulting in four competitive models for survival (which utilizes temporary emigration and survival), and two for both fecundity and population growth (both of which utilize survival; Table 4-2). The probability of initial capture of WHM was strongly influenced by trap night, with capture probability increasing substantially with each successive night (night 1: 0.25 ± 0.03; night 2: 0.39 ± 0.06; night 3: 0.43 ± 0.10) and an overall mean of 0.36 ± 0.06. Temperature positively influenced recapture probability for WHM, albeit weakly (β = 0.05 ± 0.02). The overall mean recapture rate (0.35 ± 0.01) was very similar to the overall mean for initial capture. Temporary emigration was dependent on the density of WHM, and both random ($\gamma'(\text{WHM}) = \gamma''(\text{WHM})$) and Markovian ($\gamma'(\text{WHM}) \neq \gamma''$ (WHM)) models were competitive, indicating that temporary immigration was occurring.

Monthly survival of WHM was influenced by recent rainfall (over the previous 14 days) and by an interaction of season and recent rainfall (Table 4-A-1b, Fig. 4-3). Beta values indicate that the seasonal influence of rain was largely driven by a strong positive effect of rainfall during summer months. Survival was highest in the summer ($0.58 \pm 0.11 \times 10^{-2}$) and lowest in the winter (0.36 ± 0.01), and overall mean rates were 0.49 ± 0.02 (for the S(rain) model) and $0.50 \pm 0.15 \times 10^{-2}$ (for the S(season x rain) model; Table 4-A-1b). As with SMHM, both fecundity and population growth rates for WHM were influenced by an interaction of season and wetland type (Figs. 4-4 and 4-5). Fecundity in both wetland types was highest in the winter (managed: 0.74 ± 0.07; tidal: 1.08 ± 0.21), and lowest either in fall (managed: 0.36 ± 0.06) or summer (tidal: 0.20 ±

0.07). Fecundity and population growth rates were generally lower, but more stable across seasons, in managed wetlands than tidal (e.g., seasonal means differed less in managed wetlands, and standard errors were smaller).

House mice.—Recapture probability and temporary emigration were influenced by more than one factor for *Mus* (Table 4-A-1c), resulting in a total of six models for survival, and three each for fecundity and population growth (Table 4-2). House mouse capture probabilities were strongly influenced by trap night, with capture probability more than doubling between the first and third trap night (night 1: 0.19 ± 0.03; night 2: 0.32 ± 0.07; night 3: 0.43 ± 0.15), and an overall mean of 0.31 (± 0.08). The probability of recapture was influenced by abundance of rodents in the trapping area (SMHM+WHM+*Mus*) as well as temperature and rain. Beta values indicate that density of SMHM had a very minor positive effect on *Mus* captures, WHM had a minor negative effect, and *Mus* had a moderate negative effect. Temperature had a slightly positive effect on recapture probability, while rain had a slightly negative effect. Recapture values across the 6 models ranged from 0.30 (± 0.04) to 0.44 (± 0.03), and the mean for the highest ranked model was 0.40 (± 0.03). Temporary emigration for *Mus* was affected by season, and models where it was both constant and random ($\gamma'(\text{season}) = \gamma''(\text{season})$), and Markovian ($\gamma'(\text{season}) \neq \gamma''(\text{season})$) were competitive, though the Markovian model had a very low AIC weight; cumulatively, these values indicate that temporary immigration was occurring, and that it was largely constant and random,

Monthly survival of *Mus* varied only by season, and other than fall, survival was lower than that observed for either harvest mouse species (Fig. 4-3). Survival was lowest in the winter (0.13 ± 0.04), and increased seasonally until it reached its highest point in the fall (0.52 ± 0.10; Fig. 4-3, Table 4-A-1c). As was the case for both harvest mouse species, fecundity and population growth

rates for *Mus* were influenced by an interaction of season and wetland type. For *Mus*, monthly fecundity declined from fall (0.59 ± 0.02) to spring (0.23 ± 0.03) in tidal wetlands, but exhibited no seasonal pattern in managed wetlands (Table 4-A-1c, Fig. 4-4). Finally, population growth was low in all seasons, exhibiting modest seasonal variation (Fig. 4-5); values in managed wetlands were slightly higher in winter (0.57 ± 0.01) than other seasons, and those in tidal wetlands were greater in summer (0.61 ± 0.03) and fall (0.59 ± 0.03) than in winter (0.43 ± 0.02) or spring (0.42 ± 0.02).

Abundance Estimates and Microhabitat Associations

Both SMHM and WHM displayed clear and dominant influences of seasonality in terms of survival, fecundity, and population growth rates; for *Mus*, only survival was notably influenced by season (Figs. 4-3 through 4-5). Parameters were secondarily influenced by sex (on survival in SMHM), rainfall (survival in WHM), or wetland type (fecundity and growth rate in all three species). Notably, microhabitat factors did not emerge in any of the competitive models for survival, fecundity, or population growth rates. For each species, only season (SMHM), wetland type (WHM), or their interaction (*Mus*) significantly influenced abundance estimates (Table 4-3).

Overall, SMHM was the most abundant species, and WHM least abundant (Table 4-3, Figs. 4-6 and 4-7). Abundances of SMHM were significantly affected by season but not by wetland type, and there was no significant interaction between these factors (Table 4-3a). Abundance estimates were highest in winter (managed = 24.80 ± 1.65; tidal = 38.50 ± 1.68) and lowest in summer (managed = 9.49 ± 0.49; tidal = 12.81 ± 0.81). In contrast to SMHM, WHM abundance was significantly affected by wetland type (managed = 6.10 ± 0.43; tidal = 3.20 ± 0.63) but neither by season nor the interaction effect (Table 4-3b). Finally, *Mus* abundances were not influenced by

season or wetland type, but the interaction between these was significant (Table 4-3c). This appears to reflect a strongly modal pattern in tidal wetlands (high abundance in fall [10.19 ± 10.38] and winter [11.40 ± 13.42]; low abundance in spring [4.10 ± 4.19] and summer [4.81 ± 3.74]) but relatively constant numbers across seasons in managed wetlands (Table 4-4, Fig. 4-7).

DISCUSSION

Suisun Marsh comprises one of the most extensive areas of suitable habitat for the endangered salt marsh harvest mouse (Sustaita et al. 2011). We applied sophisticated demographic analyses to the longest time-series available for this species, as well as the two most abundant potential competitors there, the western harvest mouse and the house mouse. Our objectives were three-fold. First, to determine whether tidal and managed wetlands differ in their demographic value to the dominant rodent species found there. Second, to determine whether any such differences result in variation in abundance estimates between tidal and managed wetlands. Finally, to determine what – if any – microhabitat characteristics are associated with the abundances of these species. Perhaps surprisingly, wetland type in the Suisun Marsh had a significant influence on abundance estimates for only one species (WHM), although abundances of *Mus* were influenced by an interaction between season and wetland type. Abundance estimates of SMHM, in contrast, showed greater seasonal variation in tidal than managed wetlands, but overall were most influenced by season.

Demography of SMHM, the presumed wetland specialist, was not strongly influenced by most of the factors we tested. Wetland type affected fecundity and population growth, but only seasonally (Table 4-A-1a). Temporary emigration rates for SMHM were low overall, but females were much more likely than males to move on or off the trapping area. This is unusual for rodents, a group for which males generally are more likely to disperse than females (Dobson

1982; Selonen and Wistbacka 2017; Kawamura et al. 2018). Monthly survival was generally quite low, and was affected by an interaction of sex and season. If low survival rates lead to frequently vacated home ranges, this could account for the limited dispersal (i.e., low temporary emigration rates). Survival varied greatly with seasons, being highest in the fall, but declining by over 50% by spring. This could be due to density-dependent effects: the long breeding season (peaking from spring to fall) results in the largest abundance estimates during the fall and winter, which could reduce the per capita risk of predation. Alternatively, high survival during the fall could reflect an abundance of food, as many of the common plant species that SMHM consume produce seed during this period (Smith 2018). The bimodal pattern of reproductive parameters for SMHM (high fecundity and population growth in the fall and spring) could be an artifact of the almost year round breeding observed during this study (pregnant females were captured during every season). If peak breeding begins immediately in early spring, the summer lull could be a result of a recovery period of reduced breeding effort for breeding individuals, after which breeding increases again during the fall. It could also be due to the relatively mild weather during these periods. Winters are cold and wet, and summers warm and humid in the Suisun Marsh, which could make reproduction more stressful. The winter peak in abundance estimates of SMHM likely reflect the culmination of almost continuous breeding from early spring to fall. It is worth emphasizing that juvenile SMHM generally are too small to be trapped, so trapping efforts effectively sample only the adult population. Regardless of the mechanisms driving these patterns, results reported here suggest that tidal and managed wetlands provide relatively similar demographic value for SMHM, although demographic parameters may exhibit greater seasonal variation in tidal wetlands.

As WHM largely is more of an upland generalist, it is not surprising that this species is

competitively inferior in wetland habitat (Fisler 1965). Our data suggest that this species is somewhat more sensitive to environmental and competitive dynamics than SMHM (Table 4-A-1b). Nonetheless, results for WHM are unremarkable and predictable. Survival was lowest in the winter and highest in the summer, an unsurprising trend for a species less adapted for wetland life (Fisler 1965) and that has a strong preferences for food sources that are common during the summer and uncommon during the winter (Smith and Kelt 2018). Because SMHM abundances are highest in winter, competition for food or nesting resources may also contribute to lower survival for WHM during that season. However, fecundity and population growth rates for WHM were highest in the winter in both wetland types, so there may be some nuanced drivers at play. Further work on potential competition between these species would be informative. Though reproductive parameters for WHM generally were lower in managed wetlands, abundance estimates were still significantly greater there, indicating that tidal wetlands may represent a poorer habitat type for WHM.

Similar to WHM, *Mus* showed some response to environmental and competitive influences, and while season was a driver in their demography, the magnitude of this influence (excluding survival) generally was minor, and was lower than in either SMHM or WHM (Figs. 4-4, 4-5, Table 4-A-1c). Many estimates for temporary emigration rates hovered near 0.50, suggesting that *Mus* moves more randomly across these wetlands than SMHM or WHM, consistent with the abilities of these extreme habitat generalists to exploit almost any habitat type (Long 2003; Macholán et al. 2012). Survival, fecundity, and population growth were all driven by season (interacting with wetland type for fecundity and population growth models), and whereas for former of these parameters showed strong seasonality (Fig. 4-3) the latter two tended to be relatively constant across seasons, albeit differing slightly in each wetland type (Figs. 4-4, 4-5).

Overall, abundance estimates of *Mus* were not higher in either wetland type (Table 4-3), suggesting that these two wetland types provide similar value for *Mus*, although it is notable that seasonal variation was much greater in tidal than managed wetlands (Fig. 4-7).

We predicted that SMHM would be associated with microhabitat characteristics that provide good refuge. Somewhat surprisingly, no physical microhabitat characteristics (i.e., vegetation species and structure, pickleweed cover) were retained in any models, suggesting that these had relatively minor effects on the dynamics and abundance estimates of the species we studied. Moreover, despite the fact that the interaction of wetland type and season affected demographic parameters for all species, there was no consistent trend to indicate the superiority of either wetland type for any of the species. Additionally, none of these factors affected temporary emigration for SMHM, indicating that SMHM may view the two wetland types similarly. We predicted that SMHM would be associated with microhabitats providing dense vegetation with high structural complexity, high pickleweed cover, and greater distances from anthropogenic influence (which can subsidize native and non-native predators), as these microhabitats should provide refuge to adults and nests from standing and tidal water, as well as from predators. None of these predictions were borne out in this study.

Capture success varied greatly across trapping areas, and did not appear to correlate with any microhabitat characteristic. To some extent, this variation directly counters prevailing understanding of SMHM biology, and assumptions that SMHM are strongly dependent on relatively pristine and undisturbed tidal marshes dominated by pickleweed (USFWS 2013). For example, the tidal wetland grid at Joice – which is directly adjacent to the relatively heavily utilized Grizzly Island Road and to a gravel parking area – had the highest monthly abundances of SMHM (overall mean 20.50 ± 5.58), while the tidal wetland grid at Denverton – which was

the most spatially isolated from anthropogenic influence – had the lowest monthly abundance estimates (overall mean 7.90 ± 2.26), and was the only site (managed or tidal) where no SMHM were captured during at least one month. It is important to note that all tidal wetlands in this study have had some degree of disturbance; there are no undisturbed habitats in the SFE (Smith et al. 2018) Additionally, trapping grids with the greatest pickleweed cover (~60% or more) did not have significantly greater monthly SMHM abundances (overall mean 11.66 ± 3.14) than grids with moderate (~30-60%) pickleweed cover (overall mean 17.30 ± 6.04). In spite of half a century of careful study, it appears that for SMHM, as with most species, we cannot simplify "ideal SMHM habitat" to a singular wetland type with one dominant vegetation type.

We predicted that WHM abundance estimates would be larger in managed than tidal wetlands, as the former more closely mimic upland habitat where this species more generally is found, and that they would be associated with microhabitats with low plant species and structural diversity. In this we were partially correct; populations of WHM were indeed larger in managed wetlands, but they exhibited no association with plant species or structural diversity.

Finally, we expected *Mus* populations to be larger in managed than tidal wetlands, and largest at sites in close proximity to roads and other anthropogenic development, as they are highly associated with disturbance. Neither of these predictions were supported. Wetland type had no effect on population size for *Mus* (although they were more stable across seasons in managed than tidal wetlands; Fig. 4-7), and they were no more common at sites near disturbance than at very isolated sites.

MANAGEMENT IMPLICATIONS

Overall, results presented here indicate that the relative habitat value of tidal and managed wetlands do not differ markedly in terms of demography and population estimates for either the

most common native or non-native rodents of the Suisun Marsh. Whereas tidal wetlands are subject to natural diel fluctuations in water levels, managed wetlands are managed for production of foods favored by waterfowl and SMHM (Smith and Kelt 2018). Where wetland type did affect demographic parameters of these rodents, these manifested as relative shifts in timing rather than absolute differences; one wetland type supported high reproduction during one season, while this was shifted, either earlier or later, in the other wetland type. This clearly documents that these species respond to these habitat types differently (e.g., potentially responding to cues such as seed set); it also indicates that neither habitat is implicitly superior to the other. On the contrary, the seasonally differential use of the two wetland types for supporting life history events could buffer sensitive species such as SMHM from stochastic influences, such as the catastrophic weather events projected to become more common as a result of climate change (Thorne et al. 2018). For example, if an extreme spring storm (e.g., the peak reproductive season for SMHM in tidal wetlands) were to cause unusually high inundation in a tidal wetland, leading to high adult and nest mortality, high reproductive effort during the fall in nearby managed wetlands (the peak reproductive season in that wetland type) may offset those local losses.

The fact that population estimates for the upland-associated WHM differed by wetland type, while those of SMHM did not, indicates that SMHM may perceive little or no difference between their historical tidal habitat, and the novel, anthropogenically managed wetlands that currently occur in the Suisun Marsh. Why WHM differ is not clear, but it is tempting to speculate that they may simply fare poorer in competition with SMHM in tidal marshes, to which the latter is better adapted. Notably, one of the managed trapping areas was fully disced directly before trapping began (fall 2013), and in several of the managed wetlands, about 5% of the

trapping area was occupied by gravel levee roads. These sites therefore presented lower acreage of usable habitat in the managed than tidal trapping areas in this study; it is possible that without these factors, SMHM populations in managed wetlands could exceed those in tidal wetlands. Results presented here suggest that waterfowl management is not inherently harmful to SMHM; indeed, the efforts of recreational waterfowl hunters over the last century have resulted in the protection of the largest remaining tract of SMHM habitat, indirectly benefiting SMHM. Because the relationship between the brackish tidal marshes and managed marshes in Suisun Marsh may differ in other parts of SMHM range where salinities are higher, and vegetation less diverse, we recommend that this study be replicated in the marshes of San Pablo and South San Francisco bays. Overall, however, for the purposes of supporting SMHM and its associated species, our data suggest that managed wetlands are at least as valuable as tidal wetlands, and in some respects (e.g., supporting populations of other native rodents) may be superior.

ACKNOWLEDGEMENTS

This work would not have been possible without the assistance of dozens of colleagues and volunteers. For invaluable field assistance we thank, from the California Department of Fish and Wildlife, Susan Fresquez, Meredith Smith, and Orlando Rocha; from the California Department of Water Resources, Caitlin Roddy, Sarah Zorn, Elaine Jeu, Rhiannon Klingonsmith, and Cliff Feldheim; and from the California Waterfowl Association, Robert Eddings. We also thank dozens of volunteers, primarily undergraduates from the Department of Wildlife, Fish and Conservation Biology at UC Davis. During data collection and preparation of this manuscript K. Smith was supported by the Delta Stewardship Council Delta Science Program under Grant No. F12AC00887. The contents of this material do not necessarily reflect the views and policies of the Delta Stewardship Council.

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Table 4-1. Notations and definitions for important parameters used in robust design mark-recapture models.

Parameter	Notation	Definition
capture probability	p	Probability that an individual is encountered
recapture probability	c	Probability that an individual is encountered during time i, given it was encountered at any time before time i
population mixture	π	The proportion of individuals that are more likely to be captured than other individuals in the sample
gamma prime	γ’	The probability of being off the study area, unavailable for capture during primary trapping session i given that the animal was not present on the study area during primary trapping session i − 1, and survives to trapping session i. More simply put, the chance of staying off the trapping area, or, if values are interpreted inversely, the chance of moving on to the trapping area between primary trapping sessions.
gamma double prime	γ”	The probability of being off the study area, unavailable for capture during the primary trapping session i given that the animal was present during primary trapping session i − 1, and survives to trapping session i. More simply put, the chance of leaving the trapping area between trapping sessions.
survival	S[1]/Phi[2]	probability of surviving from release occasion i to subsequent sampling period i+1
fecundity/ recruitment	f	rate at which new individuals enter the observable population
population growth rate	λ	rate of population change

[1]Survival, survival parameter used in the survival model. [2]Apparent survival, survival parameter used in the fecundity and population growth models.

Table 4-2. We applied Pradel's robust design with a Huggins full likelihood closed capture estimator (RMark model RDHFHet, "survival model") to estimate abundance ($\widehat{N}$), capture (p) and recapture (c) probabilities, and temporary emigration (γ'' and γ') and survival (S). We used Pradel's robust design with a Huggins closed capture estimator to estimate abundance ($\widehat{N}$) and fecundity (f; RMark model RDPdfHugFullHet; "fecundity model"), and to estimate abundance ($\widehat{N}$) and population growth rates (λ; RMark model RDPdLHugFullHet; "population growth model"). Presented in this table are the final competitive survival, fecundity, and population growth models (ΔQAIC < 2.0) for salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris halicoetes*), western harvest mouse (WHM; *R. megalotis*), and house mouse (*Mus musculus*). The results of analyzing our capture-mark-recapture data using these models (e.g., the results of the calculations of demographic parameters) are presented in Table A-1 and include cumulative AIC weight, beta values, real parameter estimates.

Species	Model Type	Final Models
SMHM	Survival	1. p(period), c(period), γ'(sex), γ''(sex), S(season*sex) 2. p(period), c(period), γ'(sex) = γ''(sex), S(season*sex)
	Fecundity	1. p(period), c(period), Phi(rain*season), f(season*wetland)
	Population Growth	1. p(period), c(period), Phi(rain*season), λ(season*wetland)
WHM	Survival	1. p(night), c(temp), γ'(WHM), γ''(WHM), S(season*rain) 2. p(night), c(temp), γ'(WHM), γ''(WHM), S(season) 3. p(night), c(temp), γ'(WHM) = γ''(WHM), S(season*rain) 4. p(night), c(temp), γ'(WHM) = γ''(WHM), S(season)
	Fecundity	1. p(night), c(temp), S(season*rain), f(season*wetland) 2. p(night), c(temp), S(season), f(season*wetland)
	Population Growth	1. p(night), c(temp), S(season*rain), λ(season*wetland) 2. p(night), c(temp), S(season), λ(season*wetland)
Mus	Survival	1. p(night), c(SMHM+WHM+HM), γ'(season), γ''(season), S(season) 2. p(night), c(temp), γ'(season), γ''(season), S(season) 3. p(night), c(rain), γ'(season), γ''(season), S(season) 4. p(night), c(SMHM+WHM+HM), γ'(season) = γ''(season), S(season) 5. p(night), c(temp), γ'(season) = γ''(season), S(season) 6. p(night), c(rain), γ'(season) = γ''(season), S(season)
	Fecundity	1. p(night), c(SMHM+WHM+HM), S(season*rain), f(season*wetland) 2. p(night), c(temp), S(season), f(season*wetland) 3. p(night), c(rain), S(season), f(season*wetland)
	Population Growth	1. p(night), c(SMHM+WHM+HM), S(season*rain), λ(season*wetland) 2. p(night), c(temp), S(season), λ(season*wetland) 3. p(night), c(rain), S(season), λ(season*wetland)

Table 4-3. Estimated abundances ($\widehat{N}, SE$) for salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris halicoetes*), western harvest mouse (WHM; *R. megalotis*), and house mouse (*Mus musculus*), summarized by wetland type and season. Values presented are the mean of three estimates (based on the best survival, fecundity, and population growth models in Table 2).

	Fall				**Winter**				**Spring**				**Summer**			
	Managed		Tidal		Managed		Tidal		Managed		Tidal		Managed		Tidal	
	$\widehat{N}$	*SE*	$\widehat{N}$	*SE*	$\widehat{N}$	*SE*	$\widehat{N}$	*SE*	$\widehat{N}$	*SE*	$\widehat{N}$	*SE*	$\widehat{N}$	*SE*	$\widehat{N}$	*SE*
SMHM	19.86	1.36	19.59	1.16	24.80	1.65	38.50	1.68	14.87	0.89	19.01	1.28	9.49	0.49	12.81	0.81
WHM	6.88	0.44	4.00	0.24	5.74	0.32	4.43	0.52	5.06	0.26	1.64	0.04	6.71	0.44	2.73	0.43
Mus	10.44	0.94	10.19	1.21	9.88	1.21	11.40	1.51	8.16	0.79	4.10	0.51	10.21	0.74	4.81	0.53

Table 4-4. Test of effects of the environmental factors on derived abundance estimates ($\widehat{N}$) using Poisson regression in a generalized linear model with a type III F test for salt marsh harvest mouse (a; *Reithrodontomys raviventris halicoetes*), western harvest mouse (b; *R. megalotis*), and house mouse (c; *Mus musculus*). Significant effects are indicated by asterisks.

a. SMHM	**DF**	**Deviance**	**F value**	**Pr(>F)**
Intercept	*NA*	840.82	*NA*	*NA*
Season	3	1031.98	11.67	< 0.001*
Wetland Type	1	840.85	0.01	0.94
Season * Wetland Type	3	865.95	1.53	0.21

b. WHM	**DF**	**Deviance**	**F value**	**Pr(>F)**
Intercept	*NA*	213.97	*NA*	*NA*
Season	3	217.05	0.59	0.61
Wetland Type	1	225.43	6.64	0.01*
Rain	1	214.40	0.25	0.62
Season * Wetland Type	3	220.77	1.31	0.27
Season * Rain	3	216.61	0.51	0.68

c. *Mus*	**DF**	**Deviance**	**F value**	**Pr(>F)**
Intercept	*NA*	766.51	*NA*	*NA*
Season	3	771.12	0.27	0.85
Wetland Type	1	766.93	0.07	0.79
Season * Wetland Type	3	843.16	4.50	< 0.01*

Figure 4-1. A northern salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes*).

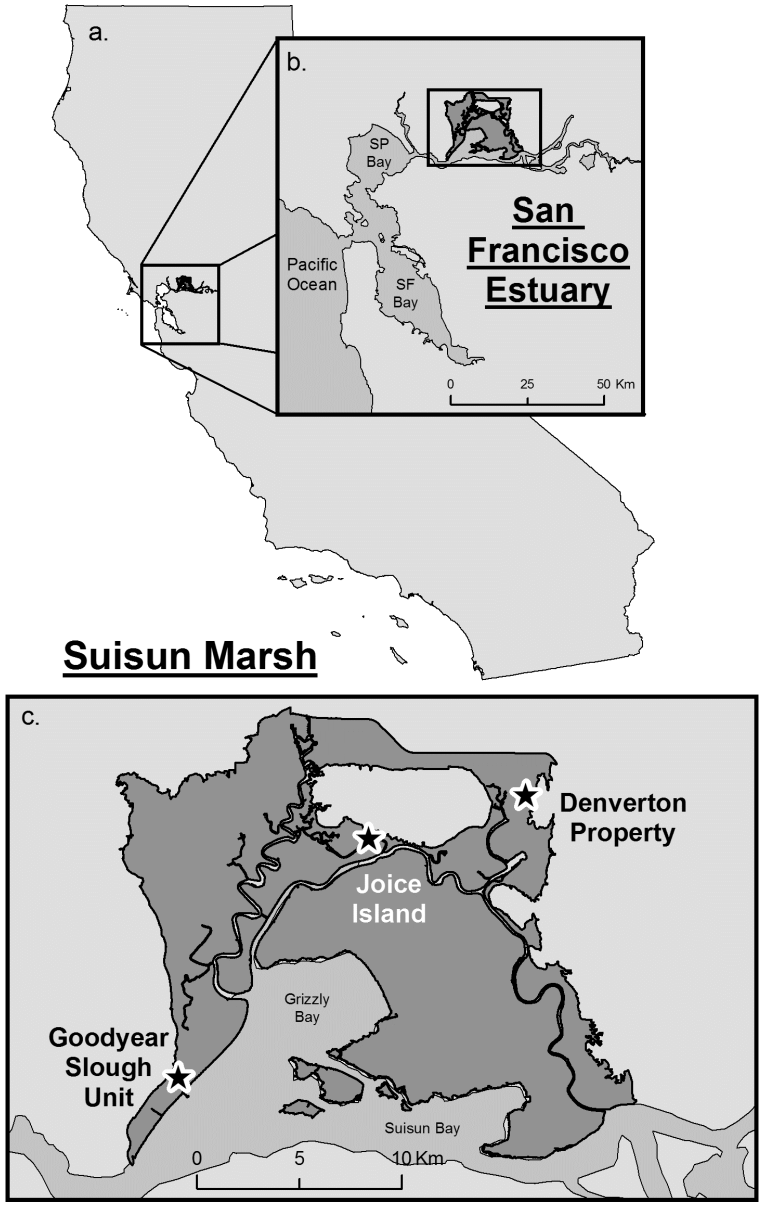

Figure 4-2. Location of three study blocks within the Suisun Marsh in the San Francisco Estuary. Blocks included two California Department of Fish and Wildlife properties (Goodyear Slough Unit and Joice Island Wildlife Area), and one property owned and managed by the California Waterfowl Association (Denverton Property).

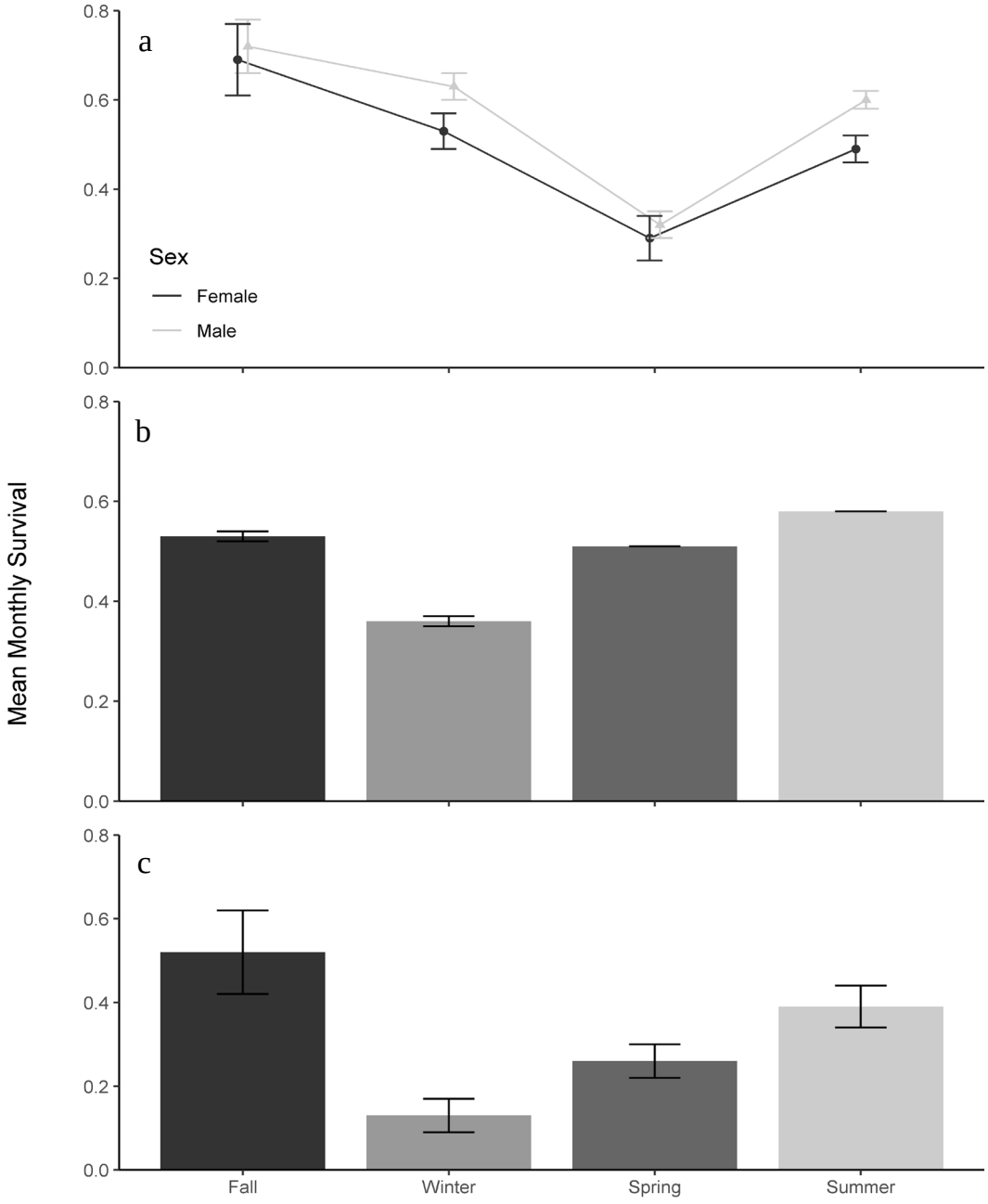

Figure 4-3. Monthly survival (± SE) for three species of rodent at Suisun Marsh, California. (a) Survival for salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris halicoetes*) was best explained by an interaction between season and sex; (b) for western harvest mouse (WHM; *R. megalotis*), survival was explained both by rain and by a season x rain interaction (Table 4-A-1b); presented here are monthly estimates from the season x sex interaction; (c) survival of house mice (*Mus musculus*) was best modeled by season.

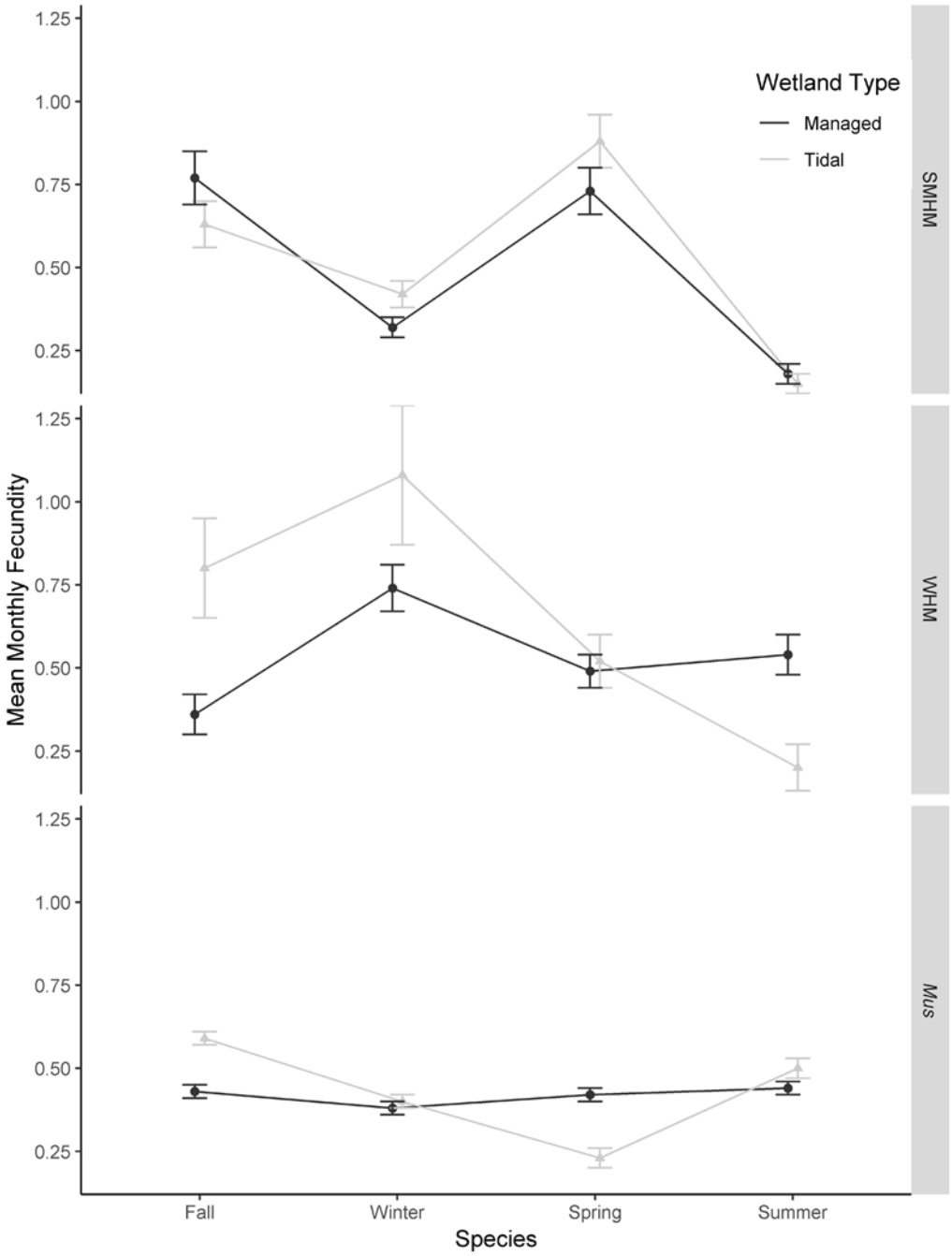

Figure 4-4. Monthly fecundity (± SE) for salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris halicoetes*), western harvest mouse (WHM; *R. megalotis*), and house mouse (*Mus musculus*) by season and wetland type.

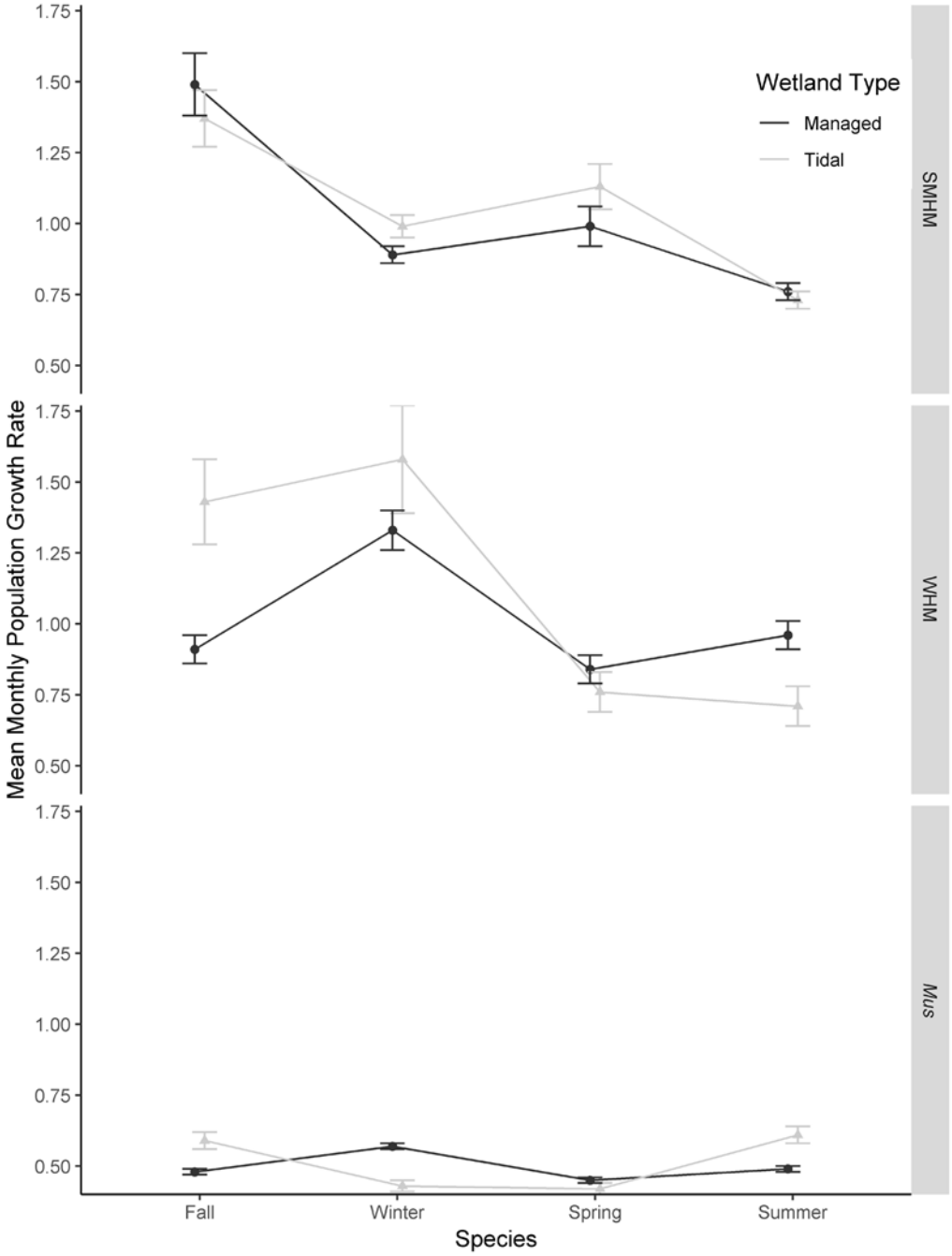

Figure 4-5. Monthly population growth rate (± SE) for salt marsh harvest mouse (SMHM; R*eithrodontomys raviventris halicoetes*), western harvest mouse (WHM; *R. megalotis*), and house mouse (*Mus musculus*) by season and wetland type.

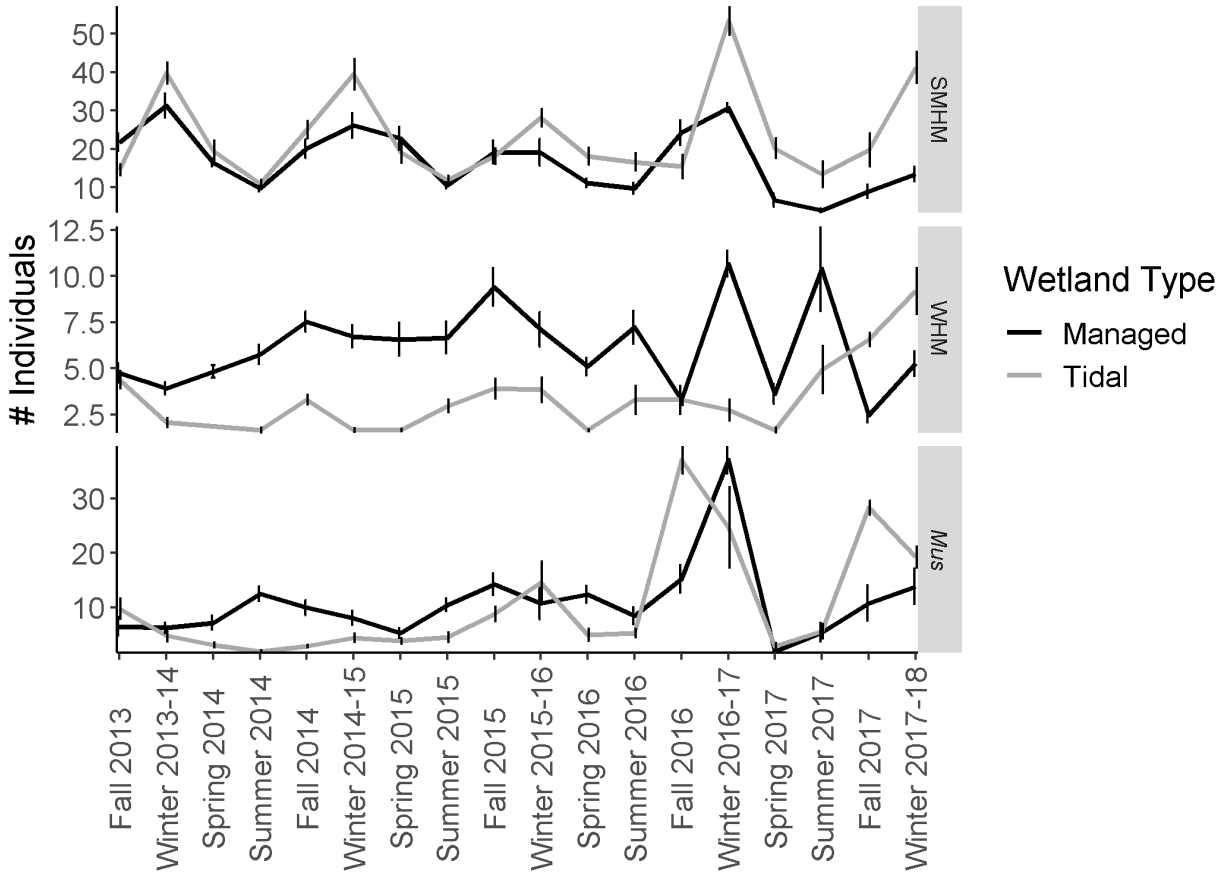

Figure 4-6. Mean abundance estimates (± SE) for salt marsh harvest mouse (SMHM; R*eithrodontomys raviventris halicoetes*), western harvest mouse (WHM; *R. megalotis*), and house mouse (*Mus musculus*) by season, year, and wetland type. Note the different scales for each species.

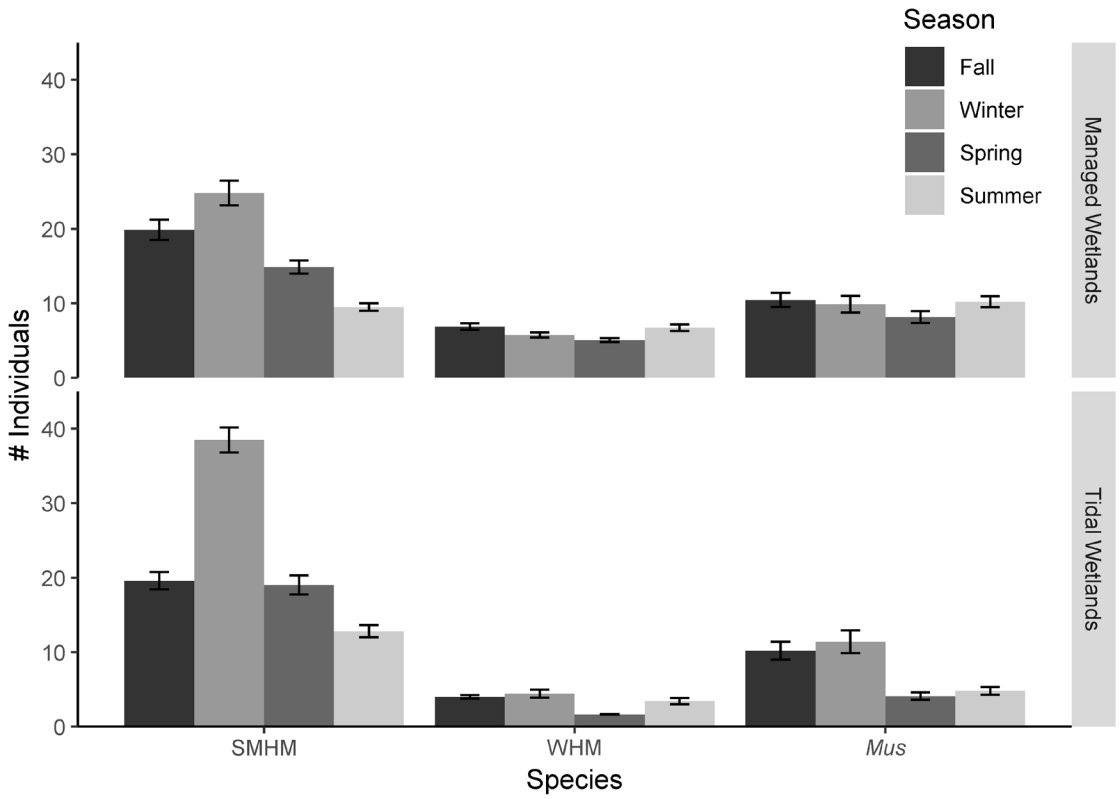

Figure 4-7. Mean seasonal abundance estimates (± SE) for salt marsh harvest mouse (SMHM; R*eithrodontomys raviventris halicoetes*), western harvest mouse (WHM; *R. megalotis*), and house mouse (*Mus musculus*) by wetland type.

Table 4-A-1. Parameters, parameter structure, weights, beta values (± SE) for the highest ranked model containing that parameter, and mean (± SE; model averaged when appropriate, range in parentheses if applicable) of monthly estimates for final survival[1], fecundity[2], and population growth[3] models for salt marsh harvest mouse (a; *Reithrodontomys raviventris halicoetes)*, western harvest mouse (b; *R. megalotis*), house mouse (c; *Mus musculus*).

a. Parameter	**Parameter Structure**	**Cum. Weight**	**β Values ± SE for Top Model**	**$\bar{X}$ ± SE (Range) of Parameter Estimates**
Capture & Recapture[1,2,3]	p(period) ≠ c(period)	1	p = -13.32 ± 28.04 – 2.21 ± 2.66	p = 0.28 ± 0.24 × 10^{-2} (0.07 ± 0.07 – 0.54 ± 0.12)
			c = -2.54 ± 1.12 – 1.86 ± 0.52	c = 0.44 ± 0.01 (0.05 ± 0.05 – 0.81 ± 0.04)
Temporary Emigration[1]	γ'(sex) = γ"(sex)	72	γ'(female) = γ"(female) = -1.99 ± 0.46 γ'(male) = γ"(male) = -9.44 ± 28.24	γ'(female) = γ"(female) = 0.12 ± 0.05 γ'(male) = γ"(male) = 0.23 x 10^{-20} ± 0.30 x 10^{-16}
	γ'(sex) ≠ γ"(sex)	28	γ'(female) = 0.08 ± 0.96 γ'(male) = 9.08 ± 11.46 γ"(female) = -2.32 ± 0.47 γ"(male) = -0.85 ± 1.00	γ'(female) = 0.52 ± 0.24 γ'(male) = 0.99 ± 0.40 x 10^{-3} γ"(female) = 0.09 ± 0.04 γ"(male) = 0.04 ± 0.04
Survival[1,2,3]	S(season x sex)	1	S(female x fall) = 0.80 ± 0.36 S(female x winter) = -0.90 ± 0.22 S(female x spring) = -0.04 ± 0.12 S(female x summer) = 0.10 ± 0.15 S(male x fall) = 0.93 ± 0.31 S(male x winter) = -0.77 ± 0.16 S(male x spring) = 0.40 ± 0.09 S(male x summer) = 0.54 ± 0.11	S(female x fall) = 0.69 ± 0.08 S(female x winter) = 0.53 ± 0.04 S(female x spring) = 0.29 ± 0.05 S(female x summer) = 0.49 ± 0.03 S(male x fall) = 0.72 ± 0.06 S(male x winter) = 0.63 ± 0.03 S(male x spring) = 0.32 ± 0.03 S(male x summer) = 0.60 ± 0.02

Fecundity[2]	f(season x wetland)	1	f(fall x managed) = -0.26 ± 0.10 f(winter x managed) = -0.06 ± 0.18 f(spring x managed) = -1.43 ± 0.18 f(summer x managed) = -0.89 ± 0.17 f(fall x tidal) = -0.19 ± 0.12 f(winter x tidal) = 0.37 ± 0.17 f(spring x tidal) = 0.02 ± 0.21 f(summer x tidal) = 0.48 ± 0.20	f(fall x managed) = 0.77 ± 0.08 f(winter x managed) = 0.32 ± 0.03 f(spring x managed) = 0.73 ± 0.07 f(summer x managed) = 0.18 ± 0.03 f(fall x tidal) = 0.63 ± 0.07 f(winter x tidal) = 0.42 ± 0.04 f(spring x tidal) = 0.88 ± 0.08 f(summer x tidal) = 0.15 ± 0.03
Population Growth[3]	λ(season x wetland)	1	λ(fall x managed) = 0.40 ± 0.07 λ(winter x managed) = -0.41 ± 0.13 λ(spring x managed) = -0.67 ± 0.08 λ(summer x managed) = -0.52 ± 0.09 λ(fall x tidal) = -0.08 ± 0.06 λ(winter x tidal) = 0.22 ± 0.10 λ(spring x tidal) = 0.04 ± 0.07 λ(summer x tidal) = 0.20 ± 0.09	λ (fall x managed) = 1.49 ± 0.11 λ (winter x managed) = 0.89 ± 0.03 λ (spring x managed) = 0.99 ± 0.07 λ (summer x managed) = 0.76 ± 0.03 λ (fall x tidal) = 1.37 ± 0.10 λ (winter x tidal) = 0.99 ± 0.04 λ (spring x tidal) = 1.13 ± 0.08 λ (summer x tidal) = 0.73 ± 0.03

b.

Parameter	Parameter Structure	Cum. Weight	β Values ± SE for Top Model	$\bar{X}$ ± SE (Range) of Parameter Estimates
Capture and Recapture[1,2,3]	p(night)	1	p(night 1) = -1.10 ± 0.15 p(night 2) = -0.45 ± 0.24 p(night 3) = -0.26 ± 0.40	p(night 1) = 0.25 ± 0.03 p(night 2) = 0.39 ± 0.06 p(night 3) = 0.43 ± 0.10
	c(temp)	1	c(temp) = 0.05 ± 0.02	c(temp) = 0.35 ± 0.01 (0.24 ± 0.04 – 0.43 ± 0.03)
Temporary Emigration[1]	γ'(WHM) ≠ γ"(WHM)	0.64	γ'(WHM) = -0.88 ± 2.80 γ"(WHM) = -0.18 ± 0.65	γ'(WHM) = 0.11 ± 0.02 (0.00 ± 0.00 – 0.69 ± 1.03) γ"(WHM) = 0.37 ± 0.04 (0.02 ± 0.06 – 0.77 ± 0.12)
	γ'(WHM) = γ"(WHM)	0.36	γ"(WHM) = γ'(WHM) = -0.19 ± 0.09	γ"(WHM) = γ'(WHM) = 0.27 ± 0.04 (0.00 ± 0.01 – 0.71 ± 0.11)
Survival[1,2,3]	S(rain)	0.57	S(rain) = -0.05 ± 0.09	S(rain) = 0.49 ± 0.02 (0.02 ± 0.01 – 0.72 ± 0.38)
	S(season x rain)	0.43	S(fall x rain) = 0.33 x 10^{-2} ± 0.02 S(winter x rain) = -0.03 ± 0.01 S(spring x rain) = -0.02 ± 0.01 S(summer x rain) = 0.53 ± 2.50	S(season x rain) = 0.50 ± 0.15 x 10^{-2} S(fall) = 0.53 ± 0.01 S(winter) = 0.36 ± 0.01 S(spring) = 0.51 ± 0.11 x 10^{-2} S(summer) = 0.58 ± 0.11 x 10^{-2}

Fecundity[2]	f(season x wetland)	1	f(fall x managed) = -0.82 ± 0.13 f(winter x managed) = 0.11 ± 0.19 f(spring x managed) = 0.16 ± 0.14 f(summer x managed) = 0.48 ± 0.18 f(fall x tidal) = 0.72 ± 0.20 f(winter x tidal) = -0.70 ± 0.32 f(spring x tidal) = -1.62 ± 0.39 f(summer x tidal) = -0.38 ± 0.35	f(fall x managed) = 0.36 ± 0.06 f(winter x managed) = 0.74 ± 0.07 f(spring x managed) = 0.49 ± 0.05 f(summer x managed) = 0.54 ± 0.06 f(fall x tidal) = 0.80 ± 0.15 f(winter x tidal) = 1.08 ± 0.21 f(spring x tidal) = 0.52 ± 0.08 f(summer x tidal) = 0.20 ± 0.07
Population Growth[3]	λ(season x wetland)	1	λ(fall x managed) = -0.09 ± 0.05 λ(winter x managed) = -0.08 ± 0.09 λ(spring x managed) = 0.06 ± 0.07 λ(summer x managed) = 0.38 ± 0.09 λ(fall x tidal) = 0.45 ± 0.12 λ(winter x tidal) = -0.55 ± 0.19 λ(spring x tidal) = -0.76 ± 0.16 λ(summer x tidal) = -0.29 ± 0.21	λ(fall x managed) = 0.91 ± 0.05 λ(winter x managed) = 1.33 ± 0.07 λ(spring x managed) = 0.84 ± 0.05 λ(summer x managed) = 0.96 ± 0.05 λ(fall x tidal) = 1.43 ± 0.15 λ(winter x tidal) = 1.58 ± 0.19 λ(spring x tidal) = 0.76 ± 0.07 λ(summer x tidal) = 0.71 ± 0.07

c. Parameter	Parameter Structure	Cum. Weight	β Values ± SE for Top Model	$\bar{X}$ ± SE (Range) of Parameter Estimates
Capture & Recapture[1,2,3]	p(night)	1	p(night 1) = -1.35 ± 0.25 p(night 2) = -0.60 ± 0.38 p(night 3) = 0.03 ± 0.77	p(night 1): 0.19 ± 0.03 p(night 2): 0.32 ± 0.07 p(night 3): 0.43 ± 0.15
	c(SMHM+WHM+*Mus*)	0.59	c(SMHM) = 0.73 x 10^{-3} ± 0.39 x 10^{-2} c(WHM) = -0.29 x 10^{-2} ± 0.01 c(*Mus*) = -0.24 ± 0.16	c = 0.40 ± 0.03 (0.30 ± 0.04 – 0.44 ± 0.03)
	c(temp)	0.22	c(temp) = 0.02 ± 0.01	c = 0.37 ± 0.03 (0.34 ± 0.03 – 0.39 ± 0.03)
	c(rain)	0.19	c(rain) = -0.22 x 10^{-2} ± 0. 22 x 10^{-2}	c = 0.36 ± 0.00 (0.31 ± 0.06 – 0.38 ± 0.02)
Temporary Emigration[1]	γ'(season) = γ"(season)	0.94	γ'(fall) = 0.01 ± 0.61 γ'(winter) = -12.56 ± 592.92 γ'(spring) = -28.27 ± 5.99 γ'(summer) = 0.12 ± 1.64 γ"(fall) = 1.08 ± 0.63 γ"(winter) = -1.17 ± 0.88 γ"(spring) = -1.08 ± 1.59 γ"(summer) = -3.75 ± 2.63	γ'(fall) = 0.52 ± 0.15 γ'(winter) = 0.55 ± 0.38 γ'(spring) = 0.54 x 10^{-5} ± 0.21 x10^{-2} γ'(summer) = 0.17 x 10^{-12} ± 0.15 x 10^{-8} γ"(fall) = 0.75 ± 0.12 γ"(winter) = 0.01 ± 0.17 γ"(spring) = 0.48 ± 0.21 γ"(summer) = 0.50 ± 0.39
	γ'(season) ≠ γ"(season)	0.06	γ'(fall) = γ"(fall) = 0.45 ± 1.04 γ'(winter) = γ"(winter) = -0.99 ± 1.07 γ'(spring) = γ"(spring) = -2.44 ± 4.30 γ'(summer) = γ"(summer) = -7.67 ± 663.37	γ'(fall) = γ"(fall) = 0.61 ± 0.33 γ'(winter) = γ"(winter) = 0.74 x 10^{-3} ± 0.81 γ'(spring) = γ"(spring) = 0.37 ± 0.56 γ'(summer) = γ"(summer) = 0.12 ± 0.75
Survival[1,2,3]	S(season)	1	S(fall) = 0.11 ± 0.42 S(winter) = -2.02 ± 0.52 S(spring) = -1.19 ± 0.48 S(summer) = 0.56 ± 0.49	S(fall) = 0.52 ± 0.10 S(winter) = 0.13 ± 0.04 S(spring) = 0.26 ± 0.04 S(summer) = 0.39 ± 0.05

Fecundity[2]	f(season x wetland)	1	f(fall x managed) = -0.27 ± 0.10 f(winter x managed) = -0.22 ± 0.14 f(spring x managed) = -0.07 ± 0.11 f(summer x managed) = 0.05 ± 0.15 f(fall x tidal) = 0.63 ± 0.12 f(winter x tidal) = -0.54 ± 0.18 f(spring x tidal) = -1.50 ± 0.19 f(summer x tidal) = -0.40 ± 0.23	f(fall x managed) = 0.43 ± 0.02 f(winter x managed) = 0.38 ± 0.02 f(spring x managed) = 0.42 ± 0.02 f(summer x managed) = 0.44 ± 0.02 f(fall x tidal) = 0.59 ± 0.02 f(winter x tidal) = 0.40 ± 0.02 f(spring x tidal) = 0.23 ± 0.03 f(summer x tidal) = 0.50 ± 0.03
Population Growth[3]	λ(season x wetland)	1	λ (fall x managed) = 0.13 ± 0.05 λ(winter x managed) = -0.39 ± 0.09 λ(spring x managed) = -0.15 ± 0.06 λ(summer x managed) = 0.09 ± 0.09 λ(fall x tidal) = 0.47 ± 0.09 λ(winter x tidal) = -0.39 ± 0.14 λ(spring x tidal) = -1.01 ± 0.12 λ(summer x tidal) = -0.31 ± 0.14	λ(fall x managed) = 0.48 ± 0.01 λ(winter x managed) = 0.57 ± 0.01 λ(spring x managed) = 0.45 ± 0.01 λ(summer x managed) = 0.49 ± 0.01 λ(fall x tidal) = 0.59 ± 0.03 λ(winter x tidal) = 0.43 ± 0.02 λ(spring x tidal) = 0.42 ± 0.02 λ(summer x tidal) = 0.61 ± 0.03

CITIZENS COMMITTEE TO COMPLETE THE REFUGE

453 Tennessee Lane, Palo Alto, CA 94306 Tel: 650-493-5540 www.bayrefuge.org cccrrefuge@gmail.com

Sent via electronic email to: Sophia.mangalam@newark.org

Ms. Sophia Mangalam, Senior Planner
Planning Department
City of Newark
37101 Newark Blvd.
Newark, CA 94560

21 October 2019

Re: Sanctuary West Residential Area Project (E-19-4)

Dear Ms. Mangalam:

These comments are submitted by Citizens' Committee to Complete the Refuge (CCCR) regarding the Sanctuary West Residential Area Project for the public hearing before the Newark Planning Commission scheduled for October 22nd. It is most unfortunate that the public hearing has been scheduled for this date as it is the same day as the State of the Estuary Conference.

We respectfully request that this letter be provided to the members of the Planning Commission. This letter follows up on a September 27, 2019 letter submitted on behalf of CCCR by Mr. Richard Grassetti, environmental consultant, a September 30, 2019 memorandum prepared by Geoffrey Hornek, environmental air quality consultant and a letter dated October 21, 2019 submitted by our attorney Stuart M. Flashman. These letters and memorandum detailed procedural and substantive inadequacies in the environmental review of the Project. The identified inadequacies must be corrected before the City can consider approving the Project, specifically, a supplemental environmental impact report (EIR) should be circulated for agency and public review and comment.

Additionally, according to the recently circulated October 22nd Planning Commission packet an October 1, 2019 letter submitted to the City by Mr. Xavier Fernandez of the San Francisco Bay Regional Water Quality Control Board (RWQCB), an email sent to the City by Kim Squires of the U.S. Fish and Wildlife Service (USFWS) on September 26, 2019, and a letter submitted by the U.S. Fish and Wildlife Service, Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) identified specific substantive concerns with the City's environmental review of the Project.

The letters submitted by Richard Grassetti and Stuart Flashman describe why a supplemental EIR must be circulated. In this letter we attempt to identify issues that should be analyzed within a supplemental EIR, though due to the limited amount of time we have had to review the response to comments and information that has not been provided in the Checklist/Addendum (Checklist) and its appendices, this list may be incomplete. Reference materials to support the substantive concerns we have indentified will be supplied as soon as possible by separate communication.

Corps Jurisdictional Delineation of Wetlands:

The staff response to comments submitted by the RWQCB (provided in the Planning Commission packet) asserts that reverification of waters of the U.S. (and therefore, according to the staff response, waters of the State) occurred in 2014. CCCR subsequently contacted the San Francisco Regulatory Division of the U.S. Army Corps of Engineers (Corps) and was informed that there is no record of a letter re-verifying the 2007 jurisdictional delineation.

We request that documentation regarding reverification of the 2007 jurisdictional delineation be provided.

Proximity of fill to wetlands needs to be clearly delineated:

[refer to comment above regarding the expired jurisdictional delineation map] The Checklist asserts that no direct fill will occur in wetlands. This is difficult to ascertain based upon the figures provided in the Checklist. Figure 3.2-6 Pedestrian and Bicycle Circulation identifies at least some of the wetland boundaries, but there are so many lines on this figure that it is not always easy to determine exactly where the wetland boundary is. Based upon the limitations of the maps provided it appears the proposed development is extremely close to the wetlands boundary in a number of locations throughout the proposed development. In the area of the Stevenson Blvd. overcrossing, the alignment of the graded fill is oddly configured in several locations, presumably to avoid wetlands.

The information regarding the location of the development within Sub Areas B and C was not provided in the EIR/REIR, nor were any details included regarding how the Stevenson Blvd. overcrossing would be constructed. Preliminary grading plans or even conceptual grading plans have not been provided in the Checklist or the appendices.

Given that the project is claiming there will be no direct fill in wetlands, a greater level of detail should be provided regarding the proximity of the proposed facilities to wetlands boundaries. Without this information how can the public and regulators confirm impacts will not occur to waters of the U.S.? To add to the lack of clarity, Figure 3.2-7 suggests that the sidewalk along S Drive overlays an area identified as wetlands and that the pedestrian-bicycle path and biotreatment area near Parcel I are extremely close to, if not within the wetland boundaries.

The 2014 REIR states, "...At the time project-specific applications are proposed for residential development in Area 4, the detailed plans will be subject to tiered environmental review, in conformance with CEQA Section 21094, including more detailed evaluation of wetland impacts and identification of mitigation measures." That detailed evaluation is not evident in the information provided in the Checklist.

As an example, the Checklist provides a plan view of the Stevenson Blvd. overcrossing (Figure 3.2-4) that depicts what appear to be vertical walls holding back the fill embankment of the overcrossing approach. These walls appear to be directly adjacent to and almost touching the existing wetland areas. What type of retaining wall construction will be employed? Will excavation immediately adjacent to wetland areas occur? How will temporary impacts to wetlands be avoided the construction process in areas of such vertical fills? The proximity of the wetlands to the Stevenson Blvd. overpass provides limited area to access the site with the construction equipment necessary to build the structure. How will permanent and temporary fill in these wetlands be avoided? None of the mitigation measures provided in the REIR appear adequate to address the concern of fill materials being introduced to the adjacent wetlands at this location.

Evaluation of the quality of undeveloped upland escape habitat for SHMH must be analyzed:

The City must identify and evaluate the impacts of the proposed development on the salt marsh harvest mouse (SMHM), in particular, the removal of suitable upland escape habitat should be analyzed. The Checklist response to comments states:

> "Response C.4: The commenter is incorrect in stating that the non-developed area would consist almost entirely of wetlands and other waters, and that the only high water refugia would consist of steep-sided perimeter levees and created transition zones. The portions of Area 4 that would not be developed or altered by the Project do contain a mosaic of uplands and wetlands." [emphasis added]

Nothing is provided in the EIR/REIR or the Checklist and its appendices to verify suitable upland habitat will remain if the site is developed as proposed. In fact, previous descriptions provided in the EIR/REIR would suggest that uplands that provide the most suitable escape habitat for the SMHM will be consumed by the proposed development.

What are the elevations of the uplands that would not be impacted by the proposed project? The environmental review of the proposed project should include a base map of existing ground elevations and we request a copy be provided.

The EIR/REIR described the elevations of the land as tending to be relatively flat and appearing "to slope gently towards the southwest." The elevations in Area 4 "generally range from approximately elevation 0 to 10 feet." The Checklist response to comments suggests that other than the areas proposed for development, the remaining uplands may not differ greatly from the areas depicted as wetlands, for this reason we question the ability of the remaining uplands to provide escape habitat for the SMHM in instances of flooding.

Figure 4.4-1 of the Checklist depicts the habitat for selected special-status species. Potential salt marsh harvest mouse habitat is identified as being immediately adjacent to the levees of the Alameda County Flood Control and Water Conservation District (ACFCWCD) Line D to the north and Residential Area C of the proposed development. If in fact SMHM are concentrated in the area depicted on Figure 4.4-1, then the only remaining viable upland escape habitat areas are the flood control levees and the development footprint. Needless to say, neither of these is acceptable, as they are not really habitat areas and would expose SMHM to predation and other hazards and risks (e.g., into the path of bicycles or pedestrians or being run over by vehicles). The proposed development would therefore have significant adverse impacts on the sustainability and continued survival of the federally listed endangered salt marsh harvest mouse within Area 4.

Additionally, the Checklist response to comments states the area is disced regularly *and that these areas may continue to be disced after the project is constructed* raising the substantive concern that implementation of the project will result in the extirpation of the SMHM from this site, in violation of both state and feral endangered species acts. This would be a significant and adverse impact to a federally listed species.

Park impacts:

While we certainly support the concept of parks and open space for Newark residents, we are extremely concerned by the proximity of the recreational facilities to wetlands and wildlife habitat. The locations of the parks within the development envelopes of Area 4 were not previously identified. The pedestrian-bicycle path that winds through the development as well as the parks themselves are all located immediately adjacent to areas identified as wetlands. Cross sections should be provided to illustrate the relationship between these recreational features and the wetlands/wildlife habitat areas.

The biological mitigation measures identified in the EIR/REIR are inadequate to protect wildlife at these recreational interfaces with wetlands. Issues that would result from the proposed locations of the recreational facilities, include without limitation noise, pets and nuisance species. These have not adequately addressed by the previously proposed mitigation measures, given the close proximity of the proposed parks and pedestrian/bicycle path to wetlands and wildlife habitat. Additional mitigation measures, such a fencing or other barriers to prevent trespass into wetlands areas (while using landscaping etc. to allow use of the areas as flooding escape habitat for the SMHM) from the trails, closure of these areas during and immediately after flooding events, tamper-proof refuse disposal bins (to avoid attracting raccoons, opossums, and other potential predators), and restrictions on pet access/use must be included, including adequate enforcement mechanisms. Biological Mitigation Measure Bio-4.7 restricts off-leash dogs in "conservation areas." Are the wetlands considered "conservation areas?" If not, how will wildlife be protected in areas adjacent to the trails?

Slope stability mitigation measures require additional analysis:

The majority of the Geology mitigation measures in the EIR/REIR targeted issues relating to settlement of the fill material and in particular how to reduce settlement associated with the placement of fill material and building loads, how to reduce differential settlement across the site, containment of fill during the construction of the development pads and prevention of erosion. The only mitigation measure pertaining to containment of fill during or after construction provided in the EIR/REIR is Biological Mitigation Measure 12.1:

> "Standard erosion control and slope stabilization measures will be required for work performed in any area where erosion could lead to sedimentation of a waterbody. For example, silt fencing will be installed just outside the limits of grading and construction in any areas where such activities will occur upslope from, and within 50 feet of, any wetland, aquatic, or marsh habitat. This fencing shall be inspected and maintained regularly throughout the duration of construction." [sic]

Appendix E of the Checklist – "Preliminary Geotechnical Exploration" provides a one paragraph discussion of slope stability:

> "The design level geotechnical report conducted pursuant to REIR mitigation measure GEO-3.1 will include a study to evaluate the risk of slope deformation and instability along the perimeter slopes of the project during grading, surcharge program and post-construction static and seismic conditions. Pursuant to REIR mitigation measure GEO-3.1, the Project applicant engaged ENGEO to undertake a site-specific investigation resulting in the Preliminary Geotechnical Report, which states graded slopes up to 6 feet may be constructed at an inclination of 2:1 (horizontal:vertical) and recommends measures for reinforcement as anticipated by the REIR, including a geogrid. If slope instability conditions, such as a "mud wave", are identified in the additional design-level geotechnical exploration, the required design-level geotechnical exploration would ensure that appropriate design details, such as properly placed retaining walls or staging of fill placement, will be provided to prevent a potential "mud wave" from forming at the toe of the fill slope."

The EIR/REIR did not discuss the slope of the fill pads and there was no previous mention of the use of geogrid to stabilize 2:1 slopes. Given the very close proximity of the developed area to the adjacent wetlands and substantive

concerns that fill will occur in wetlands, contrary to what is stated in the project description, the issue of slope stability requires additional analysis. The discussion in the appendix of the Checklist of potential "mud waves" forming at the toe of the fill slope is new information that was not previously identified in the EIR or REIR nor was any analysis provided or mitigation measures identified to ensure such significant and adverse impacts would be prevented. This issue has been identified in the Preliminary Geotechnical Exploration but never properly analyzed under CEQA.

Illegal fill activity in Area 4:

Geology Mitigation Measure 5.1 states:

> "Construction-level evaluation of undocumented fills shall be undertaken as necessary as part of the lot-specific geotechnical evaluation. The undocumented fills shall be over-excavated and recompacted or removed and replaced with engineered fill material as required to stabilize each lot in accordance with standard engineering practice, prior to site development. The Director of Public Works shall review and approve the specified approach for all undocumented fill area prior to issuance of grading permits."

The FREIR acknowledged that illegal fill was placed in Area 4 in September 2014:

> "It should be noted that on September 8, 2014, a representative of the property owner discovered that a construction firm had been illegally dumping on Newark Area 4. The representative immediately called the Newark Police Department who arrived on site several minutes later. H. T. Harvey & Associates were asked to visit the property the next morning, September 9, 2014, for the purpose of documenting the extent of dumping. H.J. Harvey & Associates personnel drove and hiked the perimeter of the fill areas which were obvious due to the significantly different soil color and composition of the fill material which included roots, small pieces of concrete, rocks and gravel in contrast to the native soils on the property. It is estimated that the fill area comprises 22.08 acres, consisting of 1.33 acres of aquatic habitat, 11.85 acres of wetlands, and 8.9 acres of upland habitat. The City considers this activity to be outside the scope of the project and the result of illegal unauthorized dumping. The resolution of this incident is the subject of an on-going investigation by the regulatory agencies including USEPA, the Corps, and the Alameda County District Attorney's Office. The presence of this unauthorized fill does not change the project's impacts or any of the conclusions in this REIR."

It is pertinent to the construction of the proposed project that the City/Landowner disclose how this illegal fill will be dealt with. How will the illegal fill's composition be evaluated to ensure it will not, through spreading or erosion, result in contamination of the sensitive wetlands areas or underlying groundwater? If contamination is found, requiring removal of the illegal fill, how will the excavation be done to avoid spreading the contamination, and how will the contaminated material be disposed of? These questions raise issues about potentially significant impacts that must be answered adequately before project approval is considered. Will the illegal fill be "over-excavated and recompacted or removed and replaced?" Will these actions take place in the 8.9 acres of upland habitat as it appears to be in an area proposed for development or in close proximity and how would impacts to adjacent wetlands be avoided? Will the illegal fill be removed from the wetlands areas or left in place? This is a change in the circumstances of the site since the certification of the EIR and REIR and should be identified and discussed in a supplemental EIR (resolution of the illegal activity was unknown at the time of REIR certification).

Climate Change/SLR:

What provisions are being made to prevent this project from being primarily accessed by single occupancy vehicles, with the resulting increase in vehicle miles traveled and GHG production? What provisions are being made to encourage use of renewable energy sources by the project (e.g., rooftop solar, windmill placement, placement of electric vehicle charging stations at individual homes and public spaces in the project)? How will the project provide good access to public transit and provide incentives for the use of public transit and alternative transportation modes? Again, all these questions need to be reconsidered now that a specific project has been proposed. The generic, program-level discussions in the prior EIRs need to be supplemented in a supplemental EIR.

Public safety:

Has consideration been given to how fire trucks and other emergency response vehicles will navigate the narrow streets and sharp turns on project roadways? Should there be parking restrictions to ensure access to emergency vehicles? What plans have been made for EVA passages if evacuation should prove necessary (e.g., earthquake, tsunami, or major fire)? What assurance will there be that such EVAs will remain usable after such an event? None of these questions could be answered in the prior EIRs, as there were no plans for how and where this project would be placed. They must be addressed adequately before approval is considered.

2018 California Rail Plan and 2019 Capitol Corridor Alviso Wetland Railroad Adaptation Alternatives Study:

The 2018 California Rail Plan calls for triple tracking the UPRR line through Newark. The Alvisio Wetland Railroad Adaptation Alternatives Study evaluates a range of alternatives for raising and triple tracking the rail line from Santa Clara to Newark. The rail line is proposed to be raised above the combined projections for sea level rise, storm surge and wave run up which are all conditions anticipated to impact this section of the Capitol Corridor line.

Over the past year and a half, consultants for the Capitol Corridor have been meeting with local environmental groups to discuss the long-term plans for running passenger rail service every half hour during peak commute times and at least bi-hourly rail service in non-peak times. The plans call for triple tracking the rail lines from Newark to Santa Clara. Currently the UPRR tracks extend from the rail switching yard just north of Mowry Avenue as triple tracks and diminish to double tracks down to a single track at Stevenson Blvd. The expansion of the line to triple tracks will allow for more frequent commuter rail service and expanded freight service directly adjacent to the proposed Area 4 development.

At this time potential alignments are very conceptual, with one proposed alignment cutting through a portion of Area 4 and three others following the existing rail alignment. There has been discussion to raise the rail embankment upon which the rail lines are constructed to elevate the tracks above the combined projected impacts of sea level rise, storm surge and wave run up to provide resilience for rail operations. Raising the tracks also has the potential to impact the horizontal width of the existing rail right-of-way (ROW). [see attached map]

These proposed rail service changes raises the question of whether the proposed height of the Stevenson Blvd. overcrossing will be sufficient to accommodate any increase in the elevation of the rail embankment. Raising the rail lines could necessitate a taller overcrossing to provide the required vertical clearance necessary for train passage. A taller bridge has the potential to change the footprint of the structure, which could in turn impact Area 4 wetlands that are located in close proximity to the overpass alignment. It also raises the question of whether there will be adequate room within the existing ROW or whether the ROW will need to be expanded to accommodate raising the rail line. If the rail lines are to be raised for sea level rise and flood resilience, will the proposed residential project be able to avoid filling wetlands?

The proposed increase in passage and freight service resulting from the triple tracking and the potential to elevate the tracks could not have been anticipated when the original noise analysis conducted for the EIR in 2009. No changes were made to the noise analysis presented in the 2015 FREIR. The 2015 FREIR Section 3.4.2.2 states that:

> "Noise barriers could be constructed to reduce noise levels in the yards of homes adjacent to the UPRR. Preliminary barrier calculations indicate that a soundwall eight (8) feet high would be required at the residential property line to reduce noise levels in the rear yards to "normally acceptable" levels (at or below 60 dBA Ldn). Table 3.4-3 summarizes the future exterior noise levels of homes adjacent to the UPRR assuming various barrier heights."

Will the noise mitigation measures proposed for the residential development, such as construction of sound walls, remain effective with increased rail services and potentially raised rail tracks? While the use of horns may be avoided at

the Stevenson Blvd crossing due to the construction of the overcrossing, horns will still be necessary at the Mowry Avenue at grad crossing.

A huge public safety concern is the at-grade crossing at Mowry Avenue. The project proposes to construct a locked and gated emergency vehicle access (EVA)/multi-use trail from the edge of the Area 4 development, across the Alameda County Flood Control and Water Conservation District (ACFDWCD) channel and exiting at Mowry Avenue to serve as the only EVA route. How will emergency vehicles enter Area 4 when the EVA is congested with the vehicular traffic of up to 469 housing units fleeing the area? With increased rail traffic and the immediate adjacency of the rail switching yard what happens in the event of an emergency if a train is stuck at the crossing, a very common occurrence in Newark? Of greater concern is the fact that the proposed EVA will also serve as a continuation of a bicycle and pedestrian path. It is highly concerning from a public safety perspective to have increased frequency of train traffic and an at-grade crossing that children might use to access the recreational facilities at the Silliman Center. The California Public Utilities Commission (CPUC) in their January 26, 2010 comment letter recommended a grade separated pedestrian and bicycle crossing in this location. Have the potential circulation and safety risks associated with the Mowry Avenue EVA/multi-use trail received adequate review given the changed circumstance resulting from the 2018 California Rail Plan and 2019 Capitol Corridor Alviso Wetland Railroad Adaptation Alternatives Study?

Has any coordination occurred between the City/landowner and Union Pacific Railroad or with the Capitol Corridor? The 2018 California Rail Plan and the consequences it may have for project design and public safety measures are issues that should be further analyzed and mitigated. It is incumbent upon Newark to evaluate the needs of this critical regional rail infrastructure project relative to any and all discretionary development approvals.

We have identified some of the many issues that were not and could not have been analyzed in the EIR/REIR since project details and scientific information were not available at the time those documents were produced. We have raised substantive issues that require additional environmental review in a supplement EIR.

We will provide additional materials in advance of the public hearing before the City Council. We ask that we be informed of any additional opportunities to provide public comment and that a map depicting the ground level elevations of Area 4 be provided.

Sincerely,

Carin High

Carin High
CCCR Co-Chair

Bay Area Air Quality Management District:
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Josephine Fong, jfong@baaqmd.gov
Bay Conservation and Development Commission:
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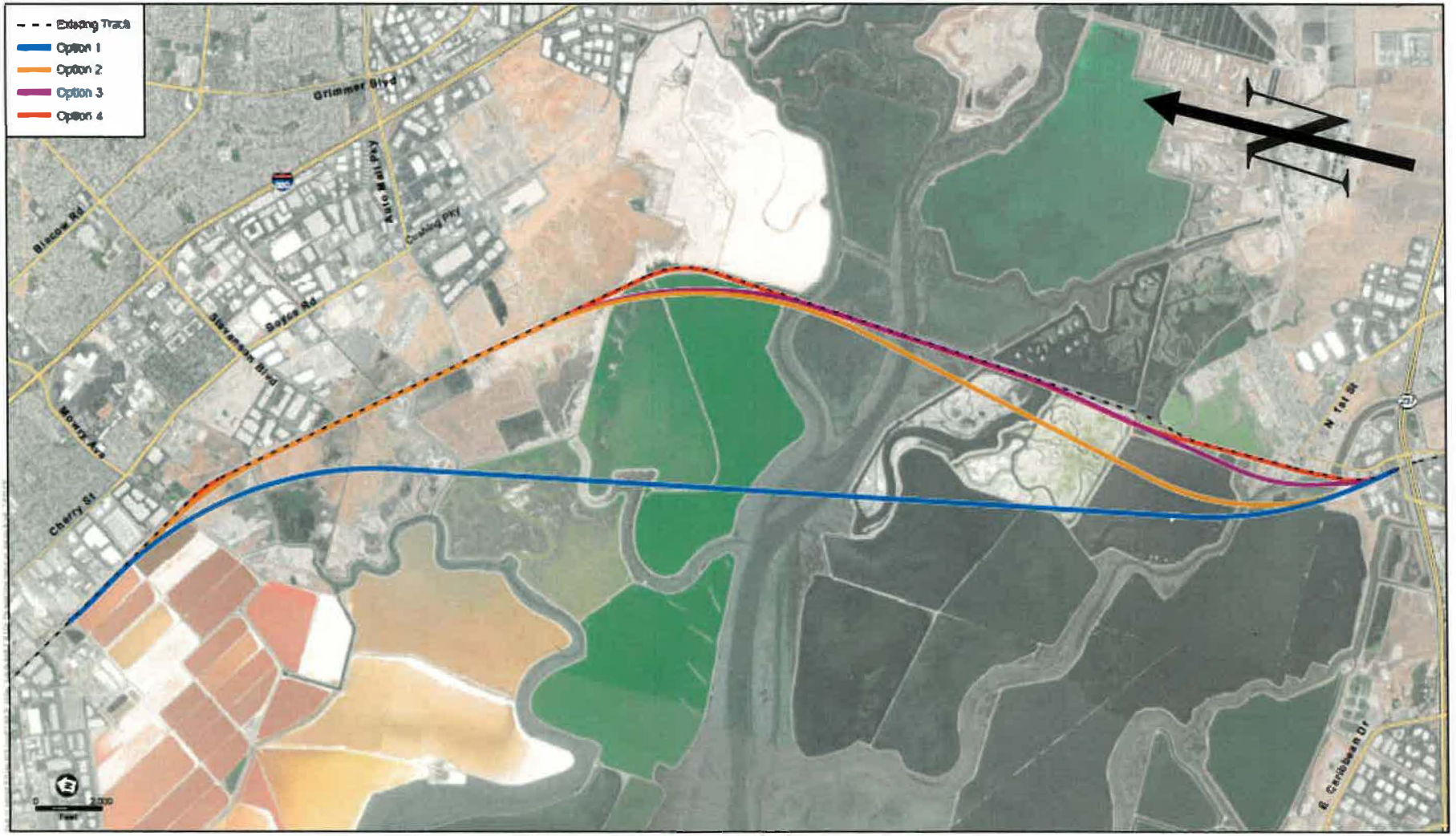
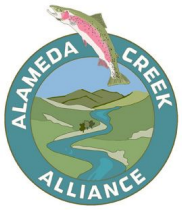
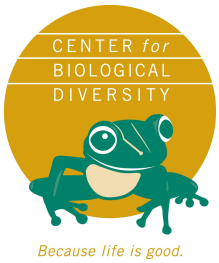
Study Area Overview





CALIFORNIA NATIVE PLANT SOCIETY
East Bay Chapter



CITIZENS COMMITTEE TO
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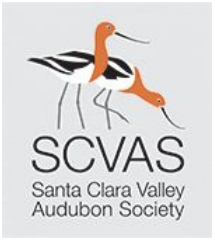

SIERRA CLUB
SAN FRANCISCO BAY

SAVE
THE BAY

October 22, 2019

City of Newark Planning Commission
37101 Newark Boulevard, Newark, CA 94560-3796
Via Facsimile 510-578-4265

Sofia Mangalam
City of Newark
Planning Department
37101 Newark Boulevard, Newark, California 94560
Via email: sofia.mangalam@newark.org

Re: City of Newark Sanctuary West Residential Project - Planning Commission October 22, 2019 Public Hearing - Request for Completion and Circulation of a Supplementary Environmental Impact Report

Dear Planning Commissioners,

We are writing jointly on behalf of the environmental organizations signed below to respectfully urge the Planning Commission to recommend that the CEQA Compliance Checklist be rejected for the Sanctuary West Residential Project, including the Vesting Tentative Map, Conditional

Use Permit, and Planned Unit Development for construction of a 469-unit residential subdivision in Newark's shoreline "Area 4."

We join state and federal resource agencies (see attached letters from SF RWQCB and US F&WS) in requesting the completion and circulation of a Supplemental EIR for this project before consideration for approval by the Newark Planning Commission and City Council. The proposed use of the CEQA Compliance Checklist is wholly inadequate and inappropriate for a project of such magnitude with significant and far-reaching impacts on the environment.

Many of our organizations have long been on record in expressing our deep concern and opposition to development within Area 4. As a mosaic of undeveloped diked wetlands and low-lying uplands, supporting nearly a dozen special-status species, including the endangered Salt Marsh Harvest Mouse, and susceptible to flooding and sea level rise, the 559-acre Area 4 is an inappropriate place for development - and a critical natural resource worth protecting and restoring. We urge the City of Newark to follow the consistent and overwhelming recommendations of the region's scientific community in pursuing the long-term protection and restoration of this critical open space area, and promoting its eventual inclusion in the Don Edwards SF Bay National Wildlife Refuge, as authorized by the U.S. Congress.

Reports and recommendations from the regional scientific community and resource managers are unanimous in their agreement on the ecological value of Area 4:

- **The Baylands Ecosystem Habitat Goals Project (Updated in 2015)** - The scientific roadmap for the restoration of the Bay shoreline, identifies Area 4 as being uniquely situated for the restoration of both tidal marsh and adjacent upland transition zones, two habitats critical to the health of the Bay. (Baylands Ecosystem Goals 2015 Update, Section Q: Mowry Slough Area, p.211-214)

- **U.S. Fish and Wildlife Service Recovery Plan for Tidal Marsh Ecosystems in Northern and Central California (2013)** - A plan delineating actions to recover special-status species throughout tidal marsh ecosystems identifies Area 4 as within the recovery unit, and as a priority site for ecotone restoration. (Figure III-23. Segment Q, p. 275)

- **San Francisco Bay Shoreline Adaptation Atlas (2019)** - A joint project of the San Francisco Estuary Institute and SPUR, provides recommendations for nature-based climate adaptation solutions around the San Francisco Bay shoreline. It describes the Area 4 area as "a rare buffer between the Bay and developed communities" where restoration opportunities have the ability to "increase the climate resilience of both ecosystems and developed communities." (Section 21 - Mowry)

- **The U.S. Fish and Wildlife Service, Don Edwards SF Bay National Wildlife Refuge Comprehensive Conservation Plan (2012) -** Guiding management of the Refuge for the next 15 years, the plan notes that **"**the Refuge is particularly interested in acquiring unprotected high marsh, ecotonal, and upland habitats that will benefit migratory birds that are Refuge trust species… [and] acquiring those lands within the approved acquisition boundary that can address climate change efforts." (p. 191.) Development of Area 4 would conflict with the CCP's goal to "conserve, restore, enhance, create and acquire habitats to support the diversity and abundance of migratory birds and other native flora and fauna that depend on Refuge lands." (p. 180.) In fact, Area 4 is one of

the largest remaining sites within the Refuge's acquisition boundary that can meet these specific needs.

- **Bay Conservation and Development Commission's San Francisco Bay Plan (Amended 2011)** - Guiding the future conservation and development of San Francisco Bay, the Bay Plan's Climate Change Policies, unanimously approved in 2011, included Policy #4, describing sites like Area 4 deserving special consideration for protection: "To address the regional adverse impacts of climate change, undeveloped areas that are both vulnerable to future flooding and currently sustain significant habitats or species, or possess conditions that make the areas especially suitable for ecosystem enhancement, should be given special consideration for preservation and habitat enhancement and should be encouraged to be used for those purposes."

Additional comments from regulatory and resource agencies:

- **The San Francisco Bay Regional Water Quality Control Board** has stated that "large expanses of undeveloped uplands immediately adjacent to tidal sloughs are extremely rare in the south and central San Francisco Bay" and that "Area 4 represents a rare opportunity to … provide an area for tidal marsh species to move up slope in response to sea level rise" (San Francisco Bay Regional Water Quality Control Board letter to City of Newark in response to Areas 3 and 4 Specific Plan FEIR, June 23, 2010, p.2)

- **The U.S. Fish and Wildlife Service** has been consistent in stating their interest in protecting and acquiring Area 4 for the Don Edwards SF Bay National Wildlife Refuge, emphasizing that, "the proposed development of Area 4 will only add to the cumulative loss of tidal wetlands in San Francisco Bay and endangered species that are dependent on that habitat," and "Area 4 would be an extremely valuable addition to the Refuge as it could provide valuable ecotonal habitat transitioning from restored wetlands to upland areas" (US Fish and Wildlife Service letter to City of Newark in response to the General Plan DEIR, Sept. 19, 2013)

In short, the science is clear that if we are to achieve our region's goals of protecting and restoring biodiversity, combating climate change, and advancing climate resilience to protect our communities from the impacts of sea level rise, the preservation and restoration of Area 4 is critical.

As an undeveloped shoreline area at risk of flooding and sea level rise, containing significant wildlife habitat and considerable restoration potential, this project is the epitome of the type of development that should not move forward. With Alameda County already facing $15 billion in infrastructure and property at risk from sea level rise ("The impacts of Sea Level Rise on the San Francisco Bay, Pacific Institute, July 2012) - the 2nd most of any county in the state - and global wildlife species facing rapid declines, we all need to work together to quickly increase the resilience and adaptability of our communities and environment - not make these problems worse, as this development proposal would do.

We urge the Planning Commission to please consider our comments and those of the resource agencies, and move away from this destructive development path. We also request that we be kept informed of any future public meetings regarding this project and opportunities to provide public comments.

Sincerely,

Alameda Creek Alliance
California Native Plant Society - East Bay Chapter
Center for Biological Diversity
Citizens Committee to Complete the Refuge
Defenders of Wildlife
Greenbelt Alliance
Ohlone Audubon Society
San Francisco Baykeeper
Santa Clara Valley Audubon Society
Save The Bay
Sierra Club SF Bay Chapter
Tri-City Ecology Center

Please add the following contacts to your public notification list for this project:

- Jeff Miller, Alameda Creek Alliance - jeff@alamedacreek.org
- Jim Hanson, California Native Plant Society - East Bay Chapter - jimhmail@sonic.net
- Lisa Belenky, Center for Biological Diversity - lbelenky@biologicaldiversity.org
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- Jewell Spalding, Southern Alameda Group, Sierra Club SF Bay Chapter - jewellspalding@mac.com
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LETTER TO THE EDITOR

Newark's last chance to save bayfront

In 1959, the Army Corps of Engineers developed a map that would forever change the course of our region. Later entitled, "Bay or River" the map showed an image of what San Francisco Bay would look like if current development trends continued. At the time, the Bay was abused in almost every imaginable way: wetlands were turned into trash dumps, raw sewage was dumped directly into its waters, and nearly every city along the Bay had plans to fill in and develop its portion of the shoreline. By 2020, the Army Corps predicted that if current development trends continued, the Bay would be nothing more than a shipping channel.

This map sparked grassroots movements to save the bay and create the first urban national wildlife refuge. Through congressional actions and state regulations, we have largely stopped the filling of our Bay, and have instead restored tens of thousands of acres of wetlands, built dozens of parks, cleaned our waters, and reconnected millions of people with the incredible San Francisco Bay estuary we call home.

Yet, here in Newark, it is as if these past 60 years of progress never happened. For decades, developers and city leaders have worked together to advance plans to fill in Newark's Bay shoreline—specifically the area around the former Pintail and Whistling Wings Duck Clubs, now called "Area 4." Despite pushback from almost every major environmental group and concern from numerous regulatory agencies, the city has continued to move forward with their plan to truck in 1.67 million cubic yards of fill (more than 100,000 dump trucks of fill to bury the shoreline) and build nearly 500 single-family houses in Area 4. It will all come to a head when the Newark Planning Commission will vote to approve the plan.

The real question is, "why?" As cities across the region are restoring their sections of the Bay—why should we in Newark be turning our back on the Bay, paving over wildlife habitat, and treating our shoreline like "quick land" for developers to make billions by building million-dollar houses?

We have another vision. Rather than paving over our Bay shoreline, let's embrace it. Let's protect our shoreline and restore it. "Area 4," which is currently an undeveloped mosaic of wetlands, ponds and upland habitat, has been prioritized by the scientific community for protection, and is already included within the expansion boundaries of the Don Edwards SF Bay National Wildlife Refuge. If restored, Area 4 can help provide flood protection for our community in the face of sea level rise, provide critical habitat for wildlife, and equally importantly, offer an opportunity to reconnect Newark residents to our Bay shoreline for the first time in decades.

We urge the Planning Commission to oppose plans to develop "Area 4;" instead, reset our city on a path of protecting our shoreline, rather than paving it over. Newark residents—and our Bay—deserve nothing less.

Jana Sokale
Citizens Committee to Complete the Refuge
Newark

CITIZENS COMMITTEE TO COMPLETE THE REFUGE

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22 October 2019

Re: Public Hearing Item E-19-4, Proposed Sanctuary West Development in Area 4

Members of the Planning Commission,

I have spent yesterday and today listening to presentations by regulators, resource agencies, scientific and academic experts all focused on the San Francisco Bay estuary, from the delta to south and our end of the Bay. And this collective group, from divergent backgrounds, ethnicities and priorities could agree on a few things – sea level rise is proceeding at a rate we all hoped we would never have to consider and with that reality, there are hard choices we will have to make as a society. Many of the discussions centered on how we protect our communities and the incredible natural and societal benefits that the Bay provides to each of us.

Tidal marshes were a large focus of this conference because we have suffered devastating loses of that habitat – up to 90% by some accounts, and this in turn has had real world consequences for the health of the Bay, the natural communities it supports and for our own communities.

Tidal marshes are crucial to protect the biodiversity of the Bay – think fisheries, shellfish, aquatic mammals, birds and of course endangered species - species largely imperiled because we have consumed the habitat that supports them.

Tidal marshes are also importance to those for whom wildlife are not a priority, because tidal marshes support improved water quality, can fix carbon, can reduce flood risk and thus are a hedge against sea level rise.

You might be wondering why I am bothering to mention this. Here's the reason – every major scientific publication dealing with this question of how we restore tidal marshes has identified Area 4 as one of the very few remaining locations in the South Bay proper where this opportunity still remains. If you look around the edges of the South Bay, we have for the most part built right up to the edges of the Bay or the salt ponds and while restoration of salt ponds is occurring in the South Bay we are racing against time, hoping we will have enough sediment for tidal marshes to be restored. There is no such problem with Area 4 and if this community

wants the benefits that tidal marshes provide, it is one of the few options that has not been paved over.

I understand the City wants and needs to build homes. I understand that the landowners want to make money, possibly a lot of money, that's a realistic business perspective.

However, you have only to look at this site, it's location on the landscape, the elevations of the site, the distance to public transit and the fact that to go about their daily lives, the majority of people who would populate this development would choose to get in their cars and drive to the store, to school, to work, etc. to know this isn't the right place for development.

Then there's the issue I began with, sea level rise. Rates of sea level rise are increasing faster than once expected-predicted, and those outrageous elevations that we feared but secretly hoped would never come to be, are now becoming mainstream and rather conservative estimates. If the Western Antarctic ice continues unabated, all bets are off. Building on elevated fill pads may buy you several decades, I would like to be wrong, but I would be surprised if flooding doesn't become an issue by 2050.

Mr. Richard Grassetti and Attorney Stuart Flashman have submitted comments on behalf of the Citizens Committee to Complete the Refuge documenting the reasons that the City must prepare a Supplemental EIR for the proposed Sanctuary West Residential Project.

There is in fact, new information of substantial environmental significance has been released since the certification of the 2015 REIR and details provided about the project in the Checklist/Addendum that have raised issues that were not adequately analyzed or mitigated at the previous programmatic level of environmental review.

As an example, there is the issue of increased passenger rail service on the UPRR tracks, the expansion and potential raising of the rail berm, these are new issues that were not known at the time the REIR was certified and they are pertinent to the proposed project. We have outlined some of these issues in the letter we submitted late last night. One issue of great concern is public safety for the residents of the proposed development, another is the danger posed by terminating a pedestrian-bicycle path at the at grade railroad crossing at Mowry Avenue, especially when you consider the plan for increased passenger rail service, and the potential that children might be using this path to get to the Silliman Center.

Stabilization of the fill slopes was another issue for which mitigation measures were not proposed in the previous environmental review documents – particularly the potential for the formation of "mud waves" at the toe of the fill slopes.

The jurisdictional delineation of wetlands and waters was last verified by the Corps in 2007. This has been confirmed by a phone call to the Regulatory Division of the San Francisco District.

There are other issues identified in the letters that have been submitted, and I am sure more will be revealed before the City Council meeting.

I want to leave you with one last piece of information regarding the endangered salt marsh harvest mouse. A presentation of the most recent research concerning the behavior, feeding, movements, etc. of the endangered species was the last presentation I was able to attend today. What I learned confirmed all the issues that were raised in the letter we submitted as well as the letters of the Regional Water Quality Control Board and the U.S. Fish and Wildlife Service. The mouse can forage in pickleweed habitat up to uplands habitat, with some mice having very restricted ranges to others that moved several hundred meters throughout the marsh. Some mice routinely foraged between the pickleweed habitat and uplands habitat. The biggest concern with the proposed project from a biological resource perspective is that the development will consume all the "higher" upland habitat thereby dooming the salt marsh harvest mouse on this site if flooding becomes the norm for the wetlands areas.

The proposed project represents the opposite of the solutions to sea level rise that were proposed during the many presentations of the past two days from a natural resource and societal perspective.

I urge the Planning Commission to recommend compliance with the requirements of CEQA by requiring a supplemental EIR to be circulated to identify, analyze and mitigate the negative impacts of the proposed project on the environment and future residents.

Respectfully submitted,

Carin High

Carin High
CCCR