Eelgrass and Waterbirds in Richardson Bay

Habitat and Wildlife Monitoring – June 2022

Audubon | CALIFORNIA

Bufflehead and American Coots in Richardson Bay
Photo: Mike Fernandez/Audubon California

Contents

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Executive Summary

Richardson Bay is critically important to tens of thousands of diving ducks, grebes and other waterbirds who rely on the bay for roosting and feeding each winter. During these winter months, Richardson Bay teems with Surf Scoters, Lesser and Greater Scaup, Western and Horned Grebes, Double-crested Cormorants and many other birds. Richardson Bay is also well known for its annual winter herring runs that are an important local fishery for humans and provide important food for wintering birds. Sadly, there is concern that the long-term decline in bird numbers and herring in Richardson Bay as well as other parts of the greater San Francisco Bay is linked to the decline of native eelgrass beds.

The purpose of this paper is to synthesize the data gathered from July 2021 through March 2022 on damage to Richardson Bay's eelgrass beds as well as the usage patterns of rafting waterbirds within the waters. All current data is compared to previous years' studies conducted by Audubon California staff.

Overview

The goal of the larger project funded by Ocean Protection Council is to use a spatial planning approach to restore as well as protect eelgrass in Richardson Bay. Acreage goals for restoration and protection were 80 and 200, respectively.

Audubon California staff provided project support through our expertise in habitat and wildlife monitoring. More specifically, Audubon California facilitated an eelgrass survey and associated spatial analysis of gathered images as well as conducted drone surveys to identify rafting waterbirds in Richardson Bay.

EELGRASS DAMAGE

With the continued partnership of 111th Group, a flight occurred on July 27th, 2021 at 9:08am when the low tide was at -0.12 m (relative to Mean Lower Low Water, NOAA Chart Datum). Methods for image collection were replicated for the flight completed in July 2017. More information is available in *Kelly et al.* Images were manually digitized, and particular attention was paid to circular anchor scour near anchored vessels. Staff analyzed eelgrass damaged within the same minimum-bounding study area polygon determined in 2017 study.

To estimate damage to the eelgrass bed, staff used a two-fold approach – high confidence and moderate confidence estimation. For the high confidence estimation, lack of and/or damage to eelgrass is *highly likely* a direct result of anchor scour. Moderate confidence is where the lack of and/or damage to eelgrass is *more than likely* directly from anchor scour, but there is less direct evidence.

Current data shows the low damage estimate indicates that of the 83.2 hectares of existing eelgrass bed, 26% was damaged by anchor scour. The high damage estimate indicated that 52% of the eelgrass bed was damaged by anchor scour (Figure 1).

DRONE SURVEYS OF RAFTING WATERBIRDS

Richardson Bay Audubon Center & Sanctuary has a long history of monitoring waterbirds within the 900-acre subtidal sanctuary. Over the last many decades, volunteer community scientists counted the tens of thousands of waterbirds and shorebirds seek refuge during wintering months during herring spawn season using spotting scopes and binoculars from the shore. However, this intensive approach can be replaced by, and similar data is achieved via drone technology.

Audubon California staff facilitated six surveys during the 2021/2022 wintering waterbird season. Over 4,000 photographs were manually analyzed and searched for presence of rafting waterbirds. Presence/absence maps (Figure 4) and statistically calculated heat maps (Figure 6) were created.

KEY FINDINGS

For eelgrass, per the most recent analysis of images gathered in July 2021, it is safe to estimate 26%-52% (52.6-106.5 acres) of surveyed damage within the minimum-bounding survey area (moderate to high confidence) directly correlates to anchor scour. For an eelgrass bed that fluctuates and has been measured at just under 500 acres, this amount of damage greatly worrisome.

During the Winter 2021/2022 monitoring season rafts were most frequently observed near the northern and eastern shorelines of Richardson Bay. Very few waterbird rafts were observed resting or feeding Sausalito and Belvedere.

The difference in results from the two years of study are discussed more in later sections. At this time, we attribute the difference in location of rafting waterbirds to the chosen study methodology i.e., data gathered should be viewed as a conservation snapshot and not indicative of preferred rating location.

Rafting Surf Scoters in Richardson Bay
Photo: National Audubon Society

Eelgrass and Waterbirds in Richardson Bay

Audubon's Role

Richardson Bay Audubon Center & Sanctuary has been a part of the Marin County community since 1957. Staff are the stewards and protectors of a 900-acre subtidal waterbird sanctuary within the great waters of Richardson Bay. Furthermore, over the last 65 years, Audubon California's expertise in environmental engagement, habitat restoration, and waterbird conservation has helped protect countless acres throughout the greater San Francisco Bay.

Richardson Bay is critically important to tens of thousands of diving ducks, grebes and other waterbirds who rely on the bay for roosting and feeding each winter. During the winter months, Richardson Bay teems with Surf Scoters, Lesser and Greater Scaup, Western and Horned Grebes, Double-crested Cormorants and other birds. Richardson Bay is also well known for its annual winter herring runs that are an important local fishery and provide essential food for wintering birds. There is concern that the long-term decline in bird numbers and herring in Richardson Bay and other parts of San Francisco Bay is linked to the decline in native eelgrass beds.

The purpose of this paper is to support Richardson Bay Regional Agency's Eelgrass Protection and Management Plan, through the synthesis of data gathered from July 2021 through March 2022, on the damage to Richardson Bay's eelgrass beds and the usage patterns of rafting waterbirds. All data is compared to Audubon's 2017 peer-reviewed article[1] in *Environmental Management*.

On a larger scale, Audubon hopes to continue to support the protection of eelgrass habitat in Richardson Bay as well as provide Richardson Bay Regional Agency with needed data that could inform the Transition Plan and Eelgrass Protection and Management.

Measuring Eelgrass Damage in Richardson Bay

Goals

Audubon's goal was to complete a second year of aerial eelgrass surveys in Richardson Bay using the same methodologies as the previous study from 2017. This included working with the same aerial photography firm, the 111th Group, as well as utilizing the identical analysis process for captured images. We re-mapped the bed within the minimum-bounding study area polygon identified in 2017. This polygon contains the highest use area by anchor-outs within the eelgrass bed observed during the 2017 Richardson Bay flyover. The analysis would also determine locations both unaffected and assumed to be damaged by anchor scour. Again, all analysis was completed using methods consistent with Kelly *et al.* 2019.[1]

Study Methodologies

For eelgrass bed analysis, we used the same study boundaries (37°52'30" N; 122°29'00" W) determined in Kelly et al. A flight from the 111th Group, an aerial photography company that specializes in mapping and surveys, occurred on July 27th, 2021 at 9:08 am when the low tide was at -0.12 m (relative to Mean Lower Low Water, NOAA Chart Datum). Methodology for image collection was replicated from the flight completed in July 2017.

Like the previous Audubon-led study, staff assessed damage within the eelgrass bed by manually digitizing the location of damage within the study area to determine the acreage of anchor scars and eelgrass loss as a result of anchored out boats. To account for uncertainty in attributing eelgrass damage to anchored-out boats, we used manual classification to assess damage at two levels. For the low damage estimate, we identified anchor scars as circular scour areas in the eelgrass bed that appeared to be under anchored-out boats, or if not under anchored-out boats, had a similar appearance, suggesting direct damage by a vessel. For the high damage estimate, we included the former areas plus any circular scars in the bed that were near anchor-outs, and circular scars that were likely caused by boats (presumed to be past anchoring). In both cases, we manually digitized the extent of the eelgrass beds from the aerial imagery and calculated the overall maximum, minimum, and mean of the eelgrass bed extent within the minimum-bounding polygon.

Paige Fernandez, Audubon California's biologist based out of the Richardson Bay Audubon Center & Sanctuary, performed manual digitation and analyzed the imagery for eelgrass damage.

Results

We quantified the existing eelgrass bed to cover 83.2 hectares in 2021, compared with 84.4 hectares in 2017. The low damage estimate indicated that 26% of the existing eelgrass bed was damaged by anchor scour. The high damage estimate indicated that 52% of the eelgrass bed was damaged by anchor scour. (See Figure 1.)

In 2017, the low damage estimate indicated that of the 80.7 hectares of existing eelgrass bed, 25% was damaged by anchor scour. The high damage estimate indicated that of the 82.7 hectares of existing eelgrass bed, 41% of the eelgrass bed was damaged by anchor scour.

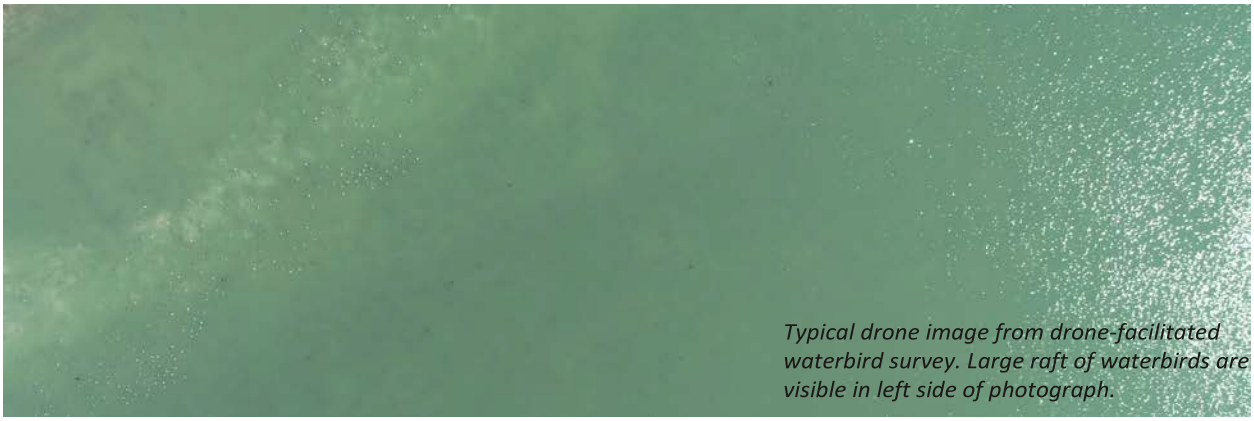
In 2017 there were 94 boats located within the boundaries of the of the minimum-bounding polygon. By the date the 2021 image was taken that number had dropped to 53. (These numbers are a snapshot in time and do not represent the current or seasonal fluctuation in vessel numbers.)

Major Takeaways and Limitations

From 2017 to 2021, the low damage estimate of eelgrass damaged increased 1% from 49.3 acres to 52.6 acres where the high damage estimate increased 11% from 83.9 acres to 106.6 acres. (Table 1)

The locations of damaged eelgrass have shifted from 2017 to 2021 and closely follows the current location of anchoring vessels. There are a considerable number of anchor scars that have not recovered and are still clearly visible in the eelgrass bed due to a continued presence of anchored vessels from 2017 to 2021 (Figure 2).

However, by comparing the imagery across the two separate study years, there are a few instances where the removal of an anchored-out vessel resulted in the recolonization of eelgrass in a previous scar. One clear example of eelgrass growth in a previous scar can be found in Figure 3. Revegetation of old scars appears to have occurred in areas where the adjacent eelgrass bed is densely vegetated. Scars where the surrounding eelgrass is sparse and patchy did not appear to revegetate as successfully.



Typical drone image from drone-facilitated waterbird survey. Large raft of waterbirds are visible in left side of photograph.

Over the last five years, there has been a concerted effort to reduce the number of anchored out vessels in Richardson Bay, which will likely aid in decreasing the total acreage of damaged eelgrass observed in future surveys.

Overall, images gathered in 2021 produced an ambiguous picture of eelgrass density in the central section of the minimum-bounding polygon. It appears there is little to no eelgrass in that area. Although there are a fair number of consistent vessels there, the total density is less than in 2017. It is currently unknown if that area is totally denuded of eelgrass; eelgrass shoots are alive, but small and are not highly visible in the imagery; or if eelgrass cover was distorted from photographic glare. We hope to complete site visits during the summer of 2022 to confirm these assumptions.

Assessing Rafting Waterbird Usage of Richardson Bay

Goals

The main goal of the drone surveys was to gather an additional year of seasonal data on rafting waterbird usage in Richardson Bay to add to data collected during 2020. Subsequently, we hoped to learn where rafts of waterbirds were frequently observed and how this related to the location of the eelgrass bed and anchor-outed vessels. Finally, data gathered during the surveys would support Eelgrass Protection Zone noted in Richardson Bay Regional Agency's Eelgrass Protection and Management Plan. [3]

As an Audubon Important Bird Area, Richardson Bay is critical habitat for wintering waterbirds and is home to the second largest eelgrass bed in San Francisco Bay. Therefore, gathering rafting waterbird data supports the overall conservation goals of Audubon California and the Richardson Bay Audubon Center & Sanctuary.

Study Methodologies

Study mythology replicated our 2020 data collection process. Drone-based waterbird surveys were conducted by an Audubon staff, who was an FAA Part 107 licensed pilot, six times during the wintering season. Survey dates were November 3, 2021; December 10, 2021; January 10, 2022; February 4, 2022; February 17, 2022; and March 22, 2022. Captured photographs covered approximately 1,700 bay acres, resulting in roughly 700 photographs per survey (Figure 4). These images were analyzed for presence and location of rafting waterbirds. The drone was launched from five separate locations around Richardson Bay in compliance with FAA rules and regulations.

Paige Fernandez, Audubon California's biologist based out of the Richardson Bay Audubon Center & Sanctuary, performed all drone flights and analyzed waterbird rafts.

Results

Staff manually analyzed over 4,000 drone images taken across six surveys from November 2021 to March 2022. Paige Fernandez, Biologist for Audubon California, and Christina Cen, Richardson Bay Community Conservation Fellow - Christina Cen, led the analysis and created associated maps. These images show that waterbird rafts were most frequently observed near the northern and eastern shorelines of Richardson Bay, within Richardson Bay Audubon Center's sanctuary waters. Very few rafts of waterbirds were observed between Sausalito and Belvedere. (Figure 5) Finally, statistically calculated hotspots were most often observed along the northern and eastern shorelines. (Figures 7, 8).

During 2020 monitoring, waterbirds consistently gathered near the coastline along the northeastern most edge of Richardson Bay (Figure 6). Rafts were frequently observed in the waters between Sausalito and Belvedere where it was not uncommon to observe rafts of birds around boats anchored out. Waterbird

rafts closer to the middle of the bay tended to contain higher number of birds compared to rafts closer to the coast (Figure 9).

Major Takeaways and Limitations

The primary goal of this survey is to show what locations within Richardson Bay are most frequently used by waterbirds. This was done by combining data collected over 5 surveys in 2020 with the 6 surveys collected during 2021/2022. The goal of this survey was not to assess population trends.

Waterbirds were frequently observed in the shallow waters along the northern and eastern shorelines of Richardson Bay. These locations tend to have calmer waters where birds can rest out of the wind and waves. Occasions when rafts were observed in the middle, deeper waters of Richardson Bay were likely instances where the birds were responding to fish spawning events. Fish entering Richardson Bay would naturally flow along the central spine of the Bay where they would eventually end up within the eelgrass beds.

Differences between years is likely due to the caveats of the monitoring methodology as well as food availability for the waterbirds. Waterbird surveys are scheduled weeks in advance and are not reactively surveyed when Pacific Herring (or other fish species) are actively spawning in Richardson Bay. It is possible that the 2020 surveys captured more bird responses to herring spawn events compared to the 2021/2022 surveys resulting in the higher number of rafts observed. This assumption could be ground truthed by comparing Pacific Herring Spawn dates (from California Department of Fish and Wildlife) to past survey dates.

The figures on the following pages highlight locations of rafting waterbirds at a moment in time. They are not indicative of comprehensive waterbird populations or usage of Richardson Bay across a single day or season. Due to the fact each survey can take up to 8 hours to complete, it must be assumed waterbirds are moving locations throughout the survey window. Therefore, it is difficult to completely count or photograph all locations waterbirds are rafting or prevent recounts of the same bird on each survey date.

References

1. Kelly, J. J., Orr, D., & Takekawa, J. Y. (2019). Quantification of damage to eelgrass (Zostera marina) beds and evidence-based management strategies for boats anchoring in San Francisco Bay. Environmental management, 64(1), 20-26.
2. Audubon California. 2018. Eelgrass, herring, and waterbirds in San Francisco Bay: a threats and opportunities assessment. Report to the Gordon and Betty Moore Foundation. Richardson Bay Audubon Center & Sanctuary. Tiburon, California.
3. Lesberg, R.S. 2021. Richardson Bay Regional Agency: Richardson's Bay Eelgrass Protection and Management Plan. Coastal Policy Solutions (Document No. 0721). Vallejo, CA
4. Richardson Bay Regional Agency: Transition Plan. Adopted June 11, 2020
5. NOAA Tides & Currents. Retrieved June 1, 2022, from https://tidesandcurrents.noaa.gov/

Maps and Eelgrass Damage Table

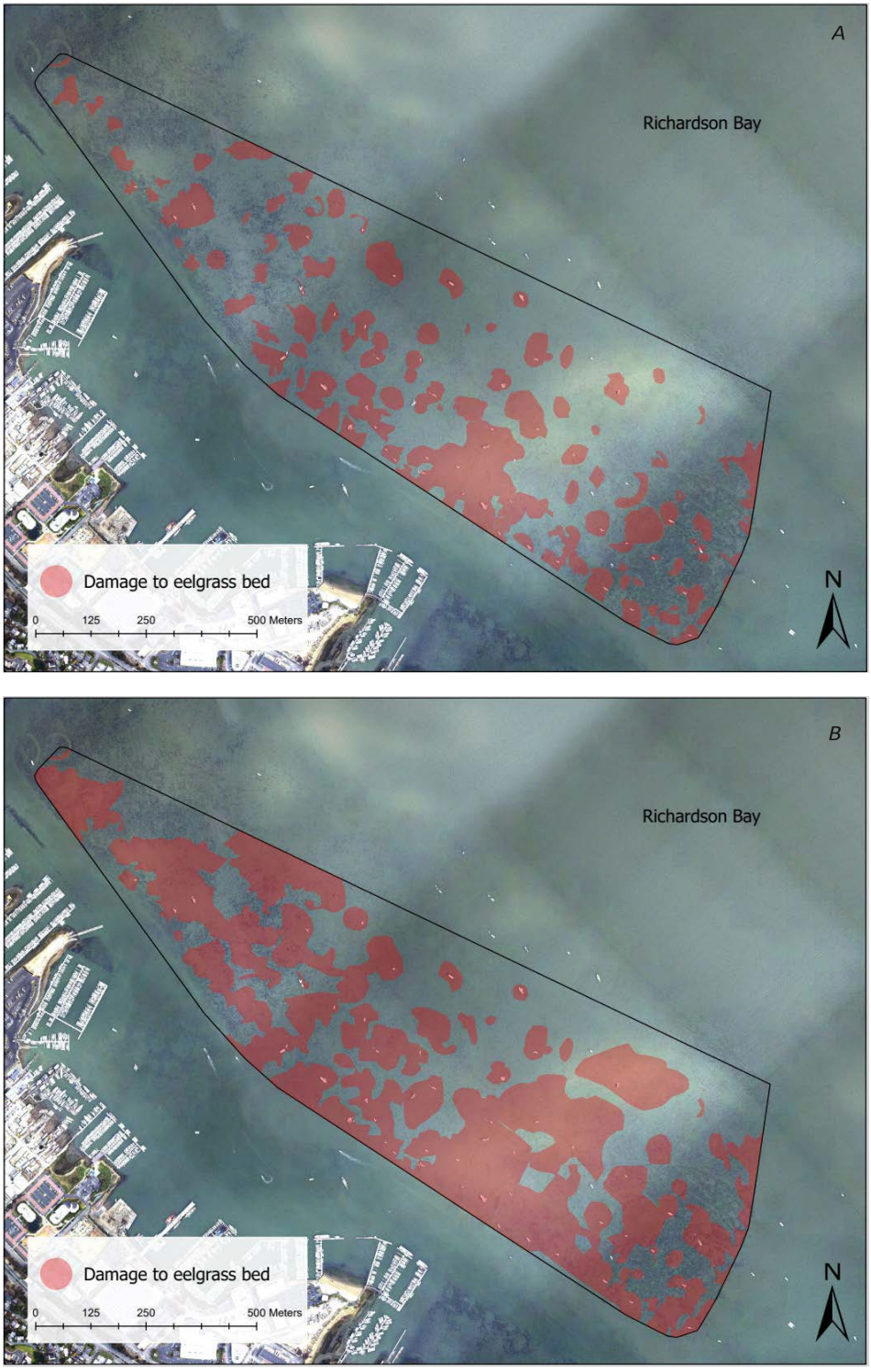


Figure 1. Map A (above) shows 2021 low damage estimate of eelgrass loss in red underneath vessels. Map B (below) shows 2021 high damage estimate of eelgrass loss) below vessels and is assumed to be past anchor scours.

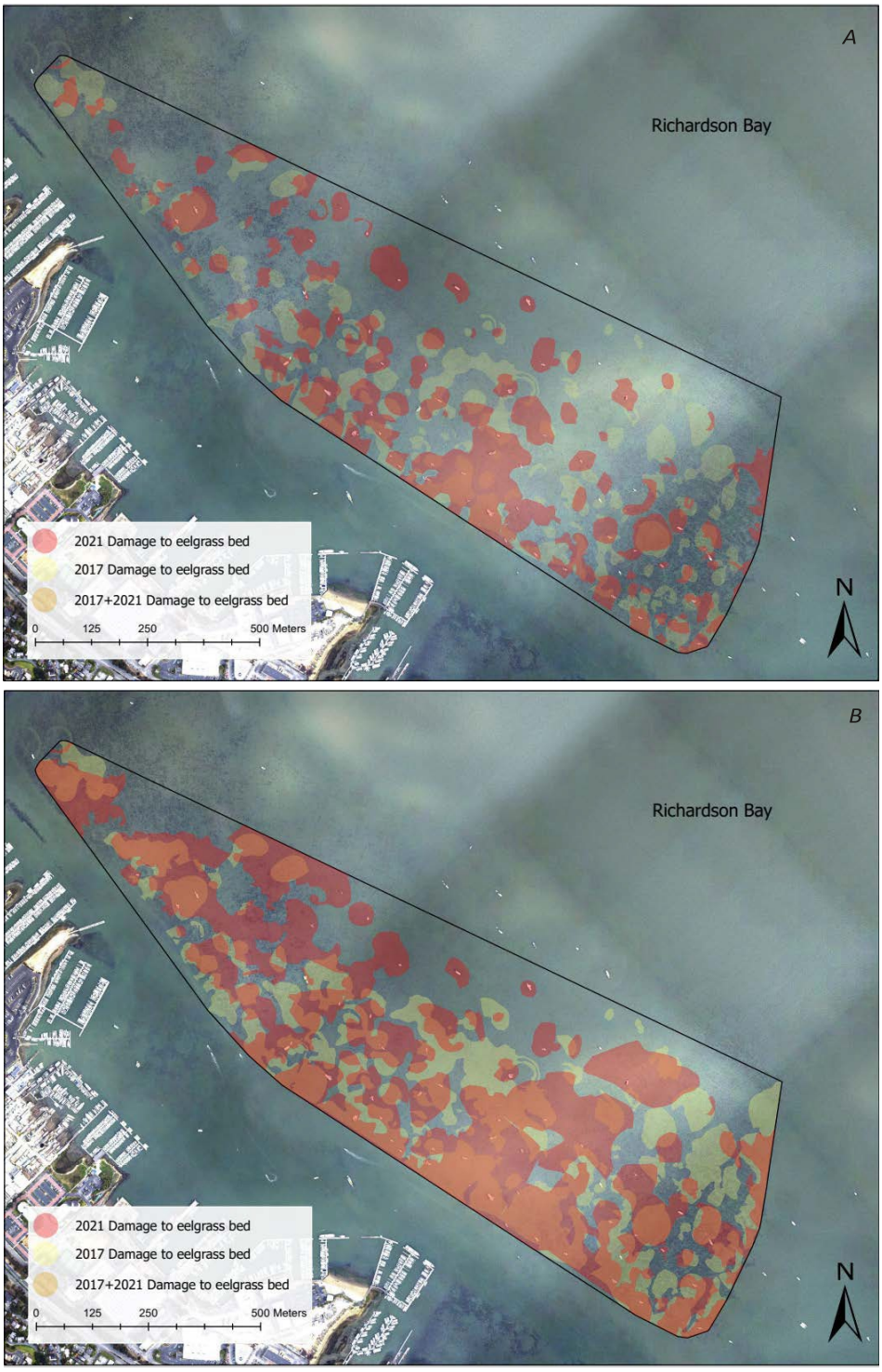


Figure 2. Map A (above) shows low damage estimate of eelgrass loss in 2021 (red), 2017 (yellow), and combined years (orange) below vessels. Map B (below) shows high damage estimate of eelgrass loss in 2021 (red), 2017 (yellow), and combined years (orange) below vessels and is assumed to be past anchor scours.

Figure 3. Examples of anchor scars in Richardson Bay eelgrass bed from 2017 (above) that scars that appear to have begun to recover in 2021 (below).

Figure 4. Monitoring extent for drone flights assessing rafting waterbird usage of Richardson Bay.

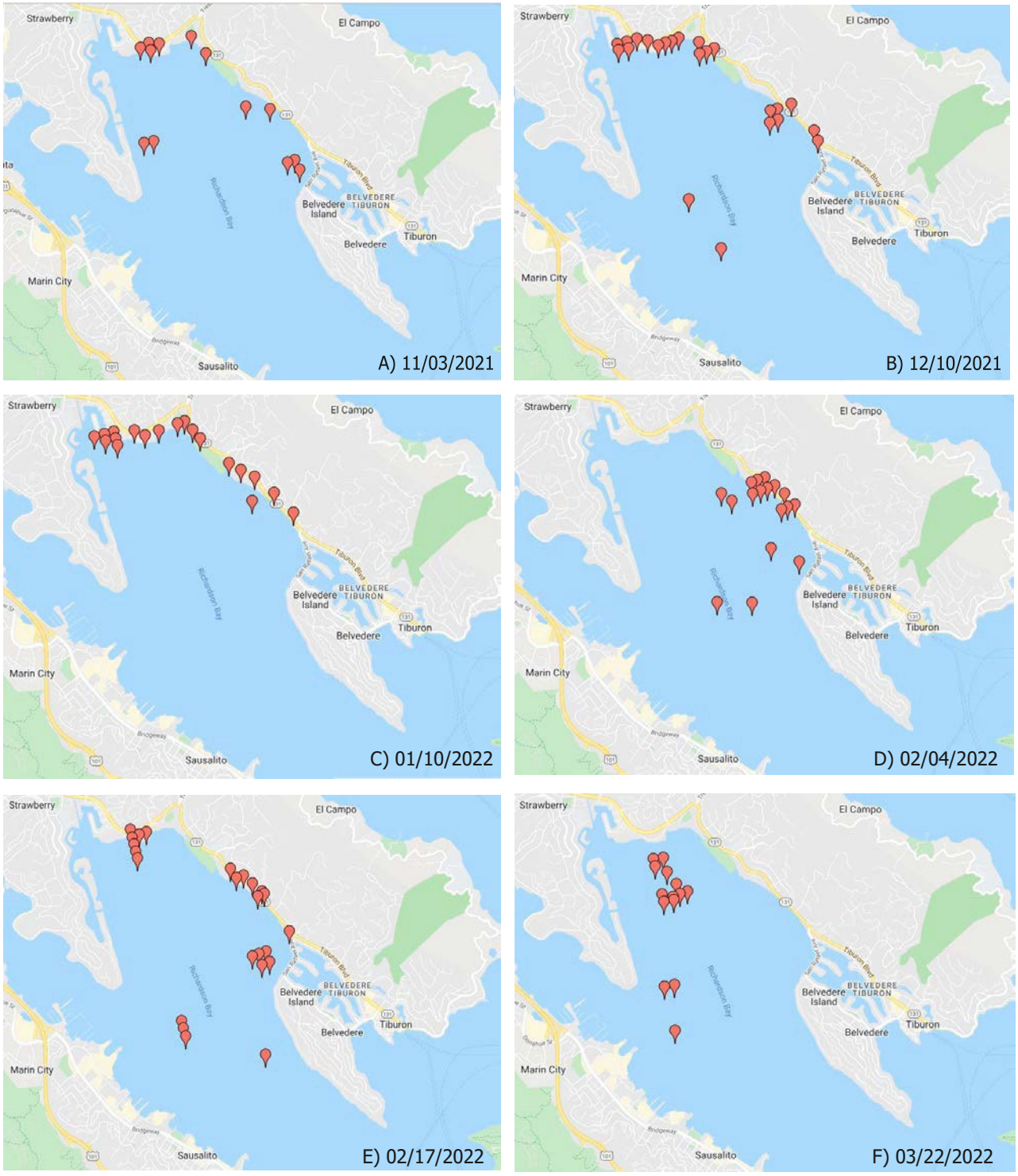


Figure 5. Locations of rafting waterbirds in Richardson Bay from November 2021 to March 2022. Red pins represent partial or whole rafts. (A raft of birds is 40 individuals or more.)

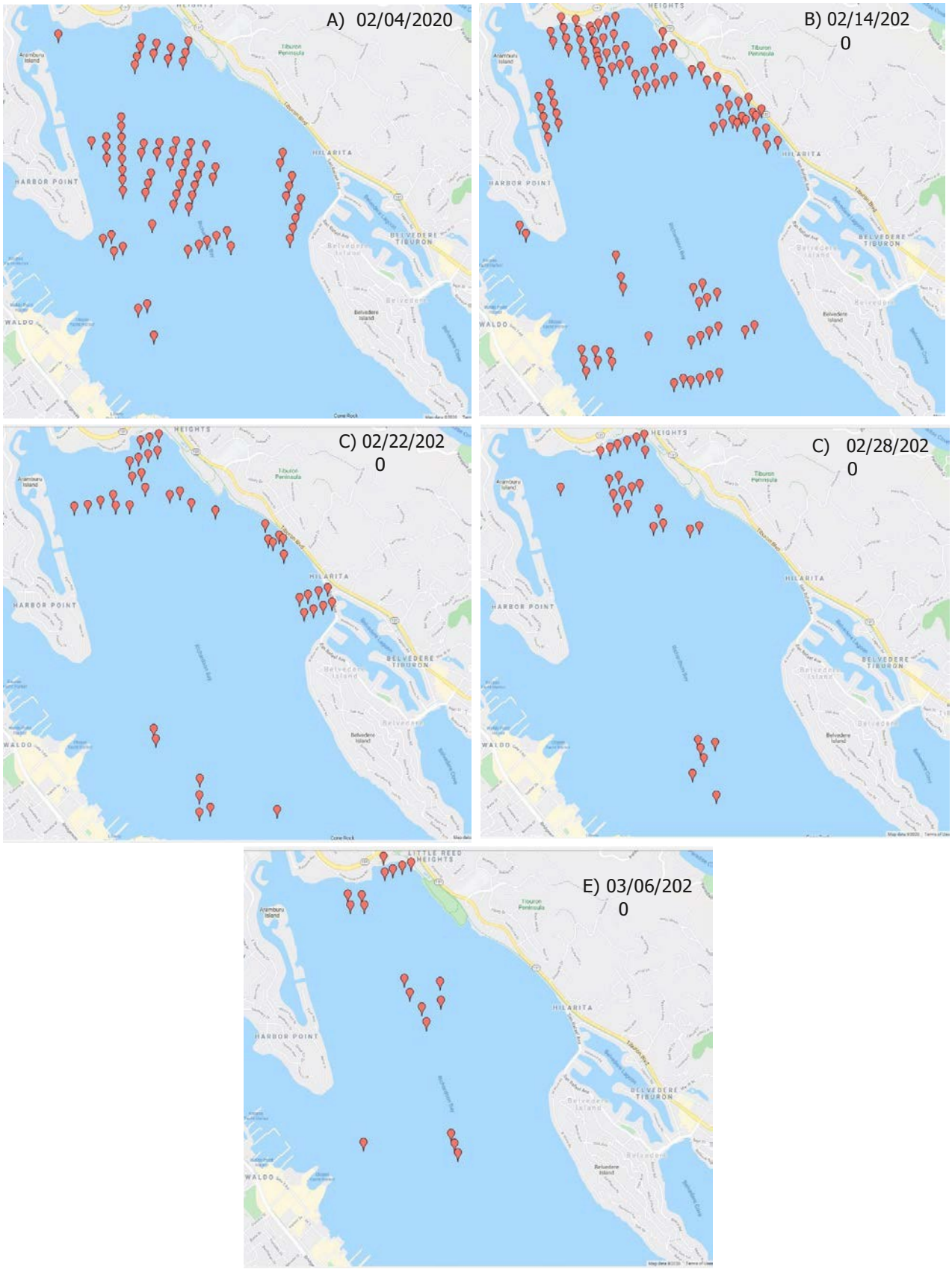


Figure 6: Locations of rafting waterbirds in Richardson Bay from February 2020 to March 2020. Red pins represent partial or whole rafts. (A raft of birds is 40 individuals or more.)

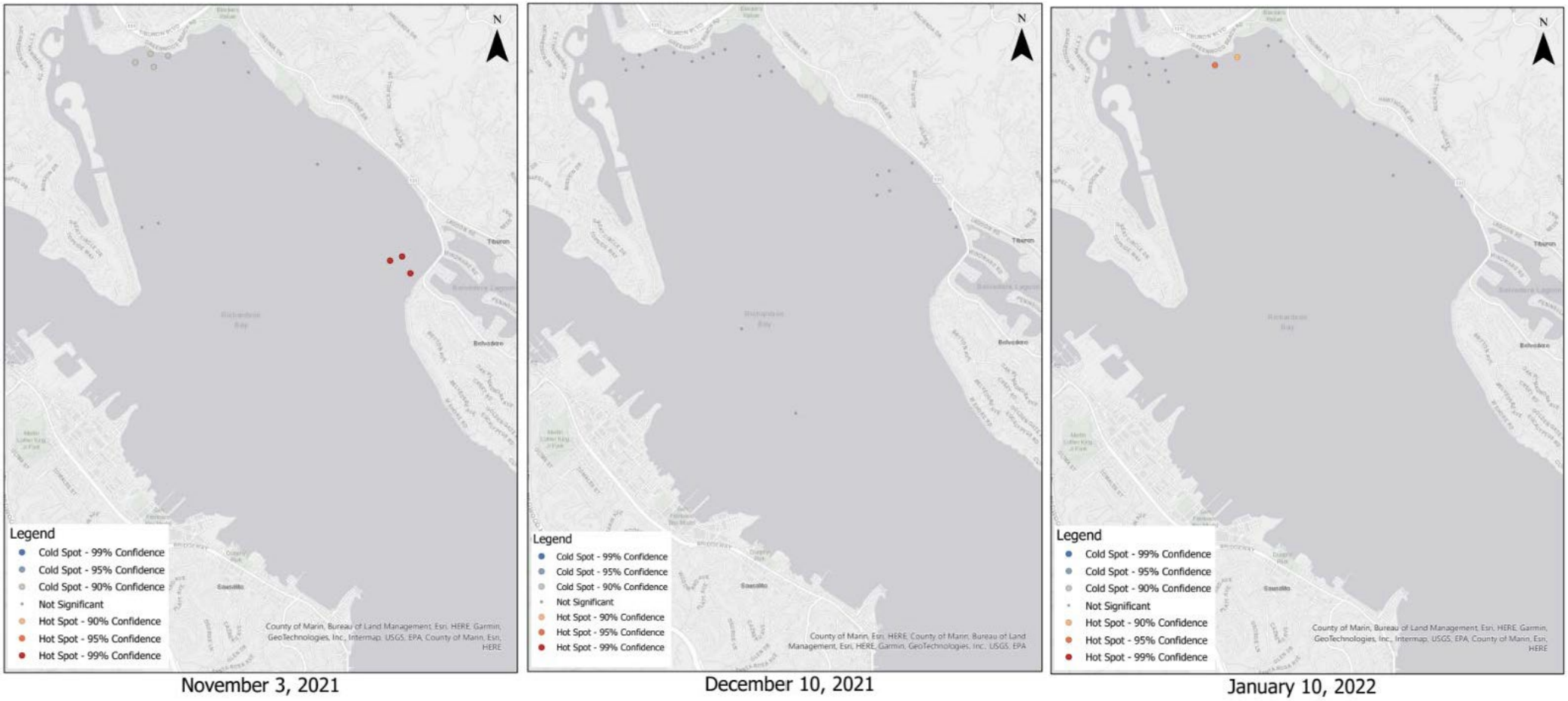


Figure 7a: Rafting waterbird heat maps of Richardson Bay across 2021-2022 survey period. Dots indicate the locations of rafting birds. Warmer colors indicate statistical hotspots with the largest number of birds. Cooler colors indicate statistical cool spots with the lowest number of birds.

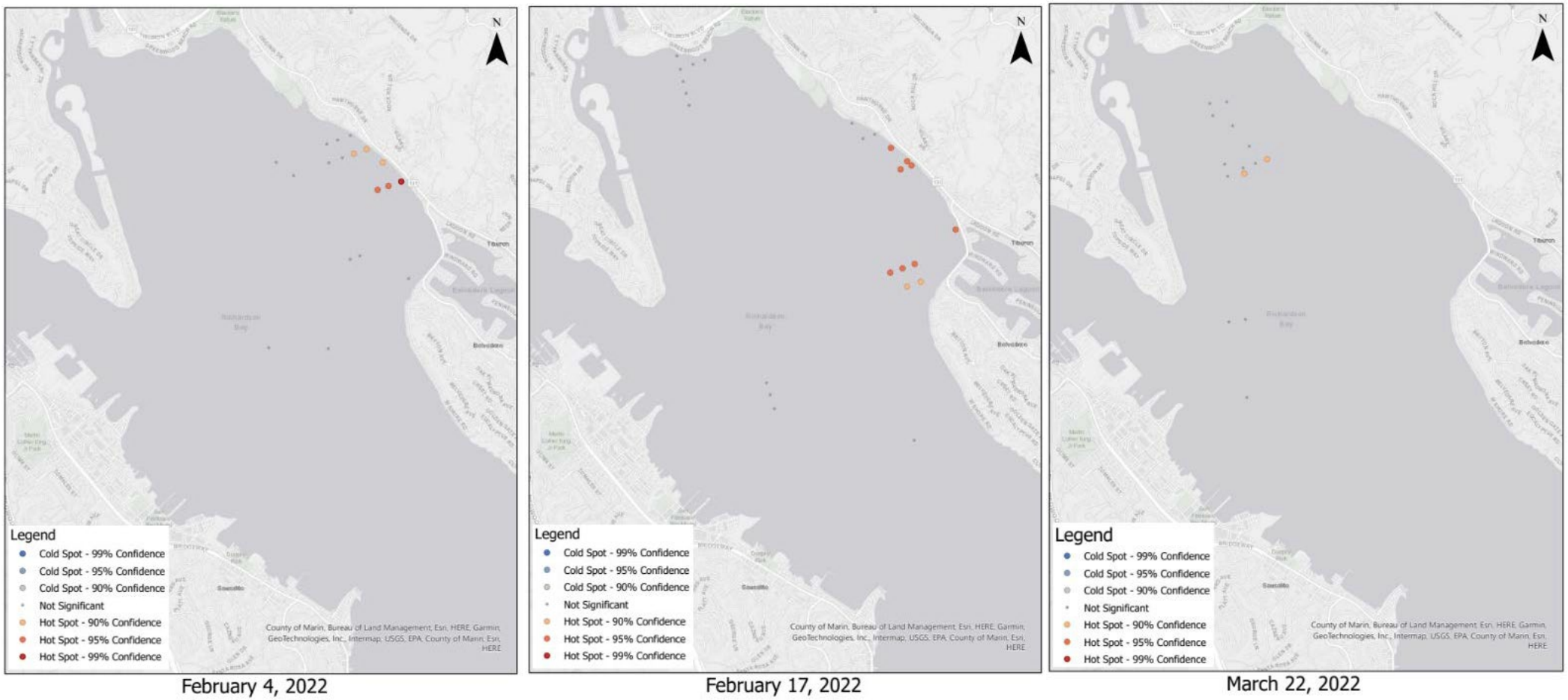
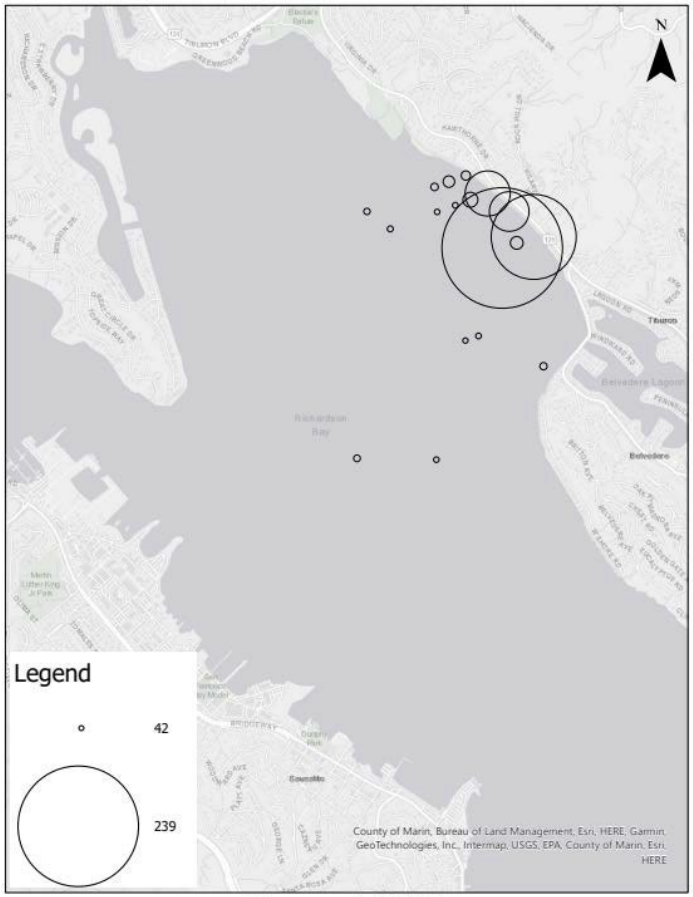
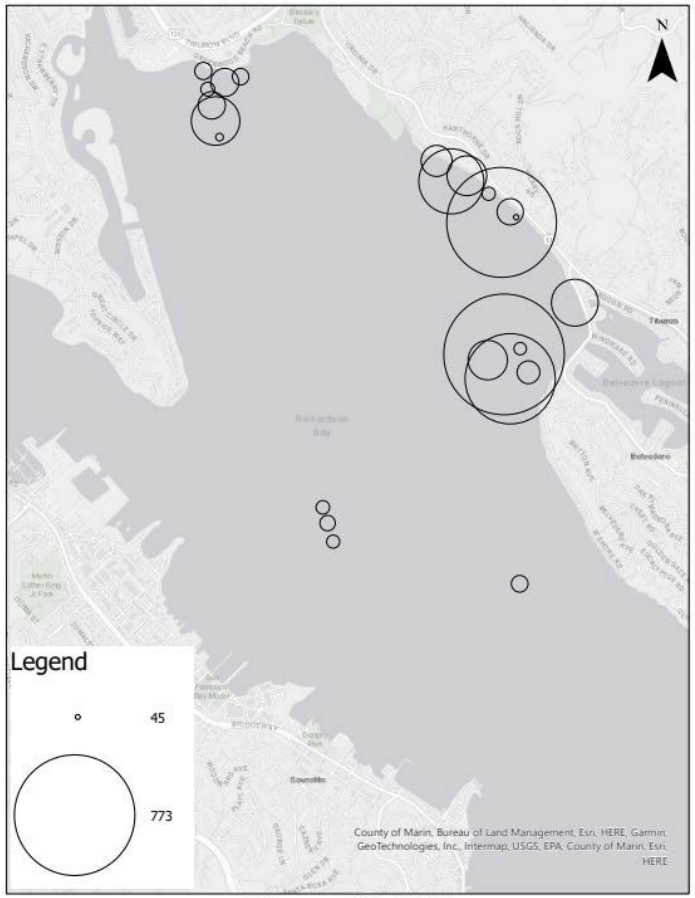


Figure 7b: Rafting waterbird heat maps of Richardson Bay across 2021-2022 survey period. Dots indicate the locations of rafting birds. Warmer colors indicate statistical hotspots with the largest number of birds. Cooler colors indicate statistical cool spots with the lowest number of birds.

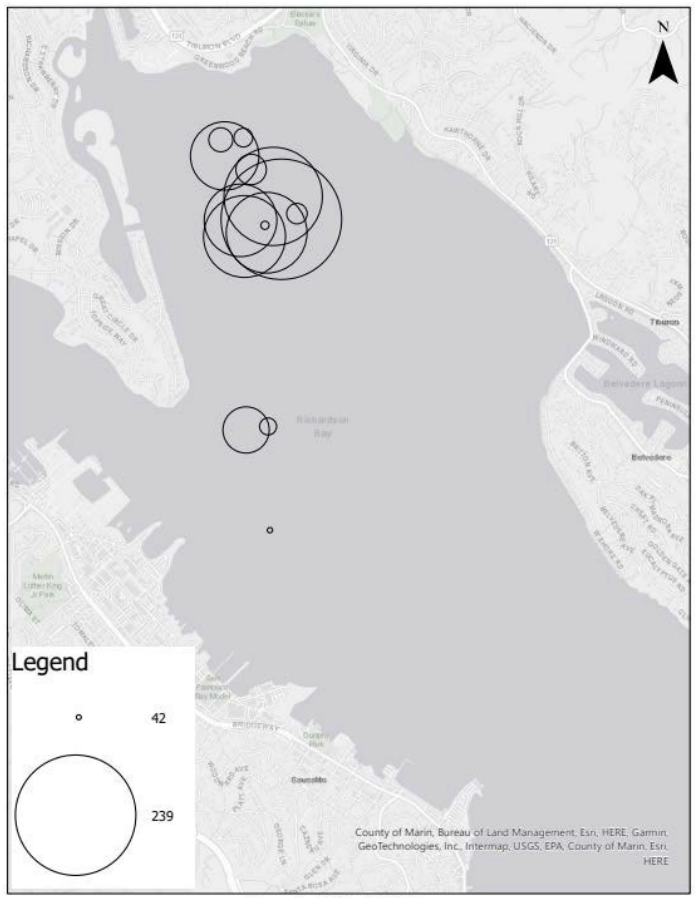
Figure 8a: Rafting waterbirds in Richardson Bay across 2021-2022 survey period. Concentric circle sizes correspond to number of waterbirds counted within each whole or partial raft. Please note, each survey has unique upper and lower bounds.



February 4, 2022



February 17, 2022



March 22, 2022

Figure 8b: Rafting waterbirds in Richardson Bay across 2021-2022 survey period. Concentric circle sizes correspond to number of waterbirds counted within each whole or partial raft. Please note, each survey has unique upper and lower bounds.

Figure 9: Rafting waterbird heat maps of Richardson Bay across 2020 study period. Dots indicate the locations of rafting waterbirds. Warmer colors indicate rafts with the largest number of birds where cooler colors indicate rafts with the lowest number of birds for that survey date.

Year	Estimate	Eelgrass Bed Extent (ha)	Direct Damage (ha)	Not directly damaged (ha)	Not Eelgrass (ha)
2017	Low Damage	80.7	20.0	60.7	3.7
	High Damage	82.7	34.0	48.8	1.7
2021	Low Damage	83.2	21.3	61.8	1.2
	High Damage	83.2	43.1	40	1.2

Table 1. Anchor scour damage to eelgrass in Richardson Bay, San Francisco Bay, California, USA.