Guiding restoration of upland transition zones to benefit tidal marsh wildlife

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Cover photo: Muzzi Marsh and transition zone, Corte Madera, CA. Photo by Megan Elrod

Summary of Findings

- Transition zones are ecotones linking tidal marsh and upland habitats and were historically common in the San Francisco Bay Estuary, but are now rare and usually confined to steep levee slopes. Restoring transition zone habitat on levees or in natural settings to support tidal marsh dependent wildlife is widely recognized as a priority, especially so in the future as the transition zones become especially important due to effects of sea-level rise, and increased risk of inundation due to storms.
- Our study identified important marsh-upland transition zone habitat characteristics that are associated with increasing populations of at-risk tidal marsh dependent birds including the endangered California Ridgway's Rail (*Rallus obsoletus obsoletus*).
- Ridgway's Rail populations increased in marshes with transition zones that were relatively wide and that had vegetation up to 1 m (3.3 ft) tall, providing refuge from predators, especially during extreme tides.
- Increases in the abundance of a key tidal marsh bird community indicator, Song Sparrow (*Melospiza melodia),* was associated with dense vegetation at or above 30 cm (1 ft) from the ground.
- A monitoring framework containing study design recommendations and four detailed field survey protocols for assessing transition zone birds, vegetation, and other site characteristics that may benefit tidal marsh wildlife was developed as part of this study and is available at www.pointblue.org/tbirds. The framework can be used for pre- and post-restoration assessments and to experimentally test novel restoration approaches; the framework is designed to provide information at the site-specific and regional scales.
- The following restoration recommendations can provide measurable benefits to tidal marsh dependent birds, both in the short- and long-term:
    - Restore plants that are between 50 and 100 cm (20-40 in) tall
    - Restore for dense vegetation, at or above 30 cm (1 ft)
    - Design for wider (>25 m) transition zones
    - Restoration of steep levees can be beneficial for tidal marsh birds.

Introduction

Point Blue has been working closely with fellow practitioners to assess and guide the restoration of a habitat critical to tidal marsh-dependent wildlife, the wetland-upland transition zone. This habitat provides refuge for marsh species, such as the endangered California Ridgway's Rail (*Rallus obsoletus obsoletus*), during extreme high tides and storms and also buffers tidal marshes against adjacent urban areas, which support human-associated predators that put wildlife at risk. Despite their importance, transition zones are highly degraded or missing in most of the San Francisco Bay Estuary (Collins and Ball 2015). The Baylands Ecosystem Habitat Goals Update (Goals 2015) calls for *restoring whole systems*, including transition zones to support abundant and diverse tidal marsh wildlife and provide other benefits such as flood protection through wave attenuation. Transition zones will be especially important in the future due to impacts of climate change, such as inundation of tidal marsh habitat. Although major transition zone restoration investments have taken place recently, no one has previously quantified the benefits of this habitat for tidal marsh species or identified the specific design features to be maintained or restored for the benefit of wildlife. This lack of information inhibits our ability to design restoration or other adaptation strategies that maximally benefit target species. Hence, this project focused on addressing the questions:

- What transition zone features and characteristics support a resilient tidal marsh ecosystem, one that can maintain wildlife populations in the face of climate change and other stressors?
- How can tidal marsh dependent wildlife benefit from a healthy transition zone?
- Which key transition zone characteristics should be targeted for restoration or enhancement?

For this study, we focused on how transition zones may benefit bird species that are highly dependent on the adjacent tidal marsh habitat. The species we focused on, the federally endangered California Ridgway's Rail, the state-threatened California Black Rail, three tidal marsh Song Sparrow subspecies and the Saltmarsh Common Yellowthroat, are of management concern, and also indicators of high quality tidal marsh habitat. This study can be expanded upon in the future to quantify transition zone benefits to other wildlife of management concern such as the salt marsh harvest mouse.

The Upland/Marsh Transition Zone

For the purposes of this project, we broadly defined the transition zones as the gradient (ecotone) between tidal marsh and uplands; it extends from the upper tidal marsh (also referred to as "high marsh") up to the present day effective limit of tidal influence (Thomson et al. 2013) as shown in Figure 1. Though historically extensive in the San Francisco Estuary, natural transition zones such as those found at China Camp, are uncommon today; instead, many transition zones currently are constrained to the steep sides of levees, where restoration efforts are often focused.

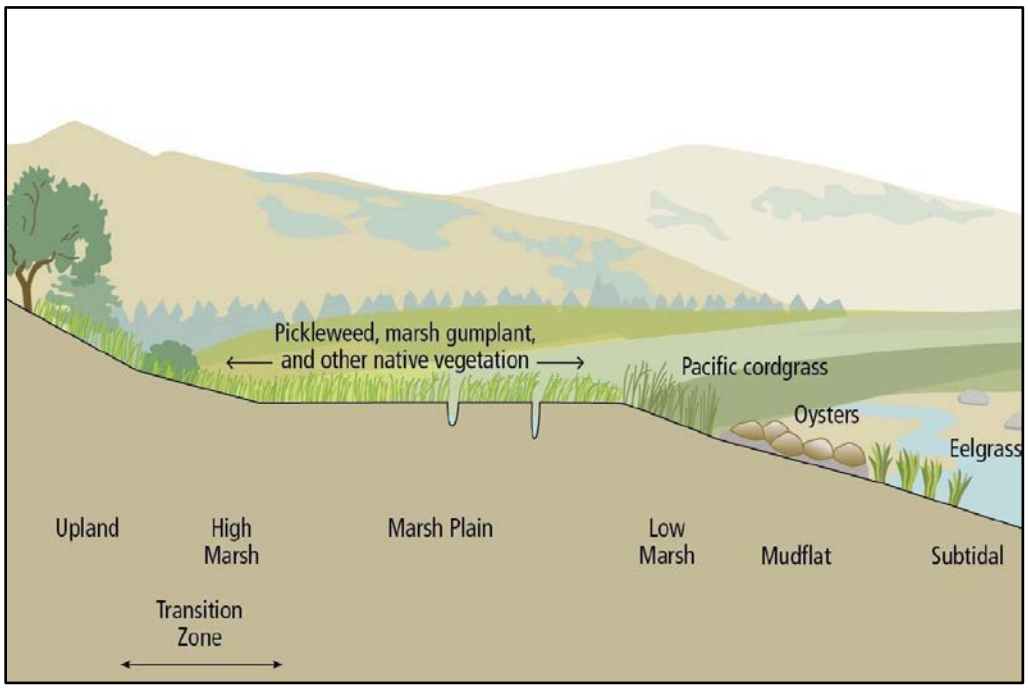

Figure 1. The marsh-upland transition zone in a natural setting is located between the upland and the edge of the marsh plain (diagram from Goals Project 2015).

Our Approach

Our broad-scale, collaborative project included three leading restoration practitioners: Save The Bay, San Francisco Bay Bird Observatory, and the Students and Teachers Restoring A Watershed (STRAW) Program of Point Blue. We established transition zone study plots at 16 tidal marsh sites, chosen from among 45 candidate sites. The selected sites represented the range of existing transition zones throughout the Estuary and included restored levees, unrestored levees, and natural transition zones (Figure 2). The natural zones included gradual and steep slopes. Transition zone widths in this study varied from 6 to up to 50 m. Further details are found in *Transition Zone Monitoring 2017 Pilot Protocol and Metadata* (at www.pointblue.org/tbirds).

To determine how wildlife benefit from specific transition zone features and thus to guide restoration, we initiated a comprehensive monitoring effort of the transition zone in 2017 that included birds, vegetation and other site characteristics. Because no comprehensive transition zone monitoring protocols existed before this study, we developed and field tested four new protocols. Lessons learned from the 2017 field season were used to refine the protocols, which are part of the *Transition Zone Monitoring Framework*, available to all at www.pointblue.org/tbirds.

Fig 2. The 16 study sites in the San Francisco Bay Estuary: Sites had levees or natural transition zone; were either restored or not. Non-restored sites ("comparison" sites) were either levee or natural.

Our transition zone monitoring had four field survey components:

1) Bird surveys during winter extreme tides (bird use of transition zone and inundation assessment),
2) Vegetation assessment in winter (brief assessment of cover type, vegetation height),
3) Bird surveys in spring (number of individuals of each species in transition zone) and,
4) Vegetation assessment in spring (more detailed including ground cover, plant species cover and height, dense vegetation cover and physical features such as slope and width).

Details on data collection are found in the Monitoring Protocol and Metadata document; details on analyses can be found are provided in the Summary Report (both at www.pointblue.org/tbirds).

These surveys all focused on the transition zone habitat itself. In order to determine how tidal marsh birds are impacted by characteristics of the adjacent transition zone, we compiled information on the abundance and diversity of tidal marsh dependent birds in the adjacent tidal marsh habitat. These data came from long-term surveys conducted by Point Blue and partners at locations throughout the Estuary. Specifically, we determined the recent 5-year trends in abundance for each tidal marsh-dependent species (2013-2017) at each site. We then analyzed how the trends in abundance for each species varied

in relation to important features of the adjacent transition zone, such as width and slope of the transition zone and with respect to characteristics of the vegetation such as height and density of vegetation cover. Our analyses statistically controlled for additional factors that influence tidal marsh population trends such as age and size of the marsh and surrounding land-use.

Key Findings

Our study has confirmed the importance of the transition zone for tidal marsh dependent bird species and identified specific characteristics of the transition zone found to be beneficial. These findings have important implications for the design of transition zones as part of the restoration or enhancement of tidal wetlands. We found that **both physical features and characteristics of vegetation within the transition zone contributed to healthy tidal marsh-bird populations**.

We identified several features that were associated with recent population growth in tidal marsh species. Specifically, our study demonstrated that **Ridgway's Rail population growth was more positive in marshes with wider transition zones** (Fig 3A). In addition, Ridgway's Rail **population growth was more positive in marshes with taller vegetation**; a positive response was evident up until the canopy height reached 90-100 cm, with little further increase beyond that (Fig 3B). Details of the analysis are presented in the Summary Report.

A)

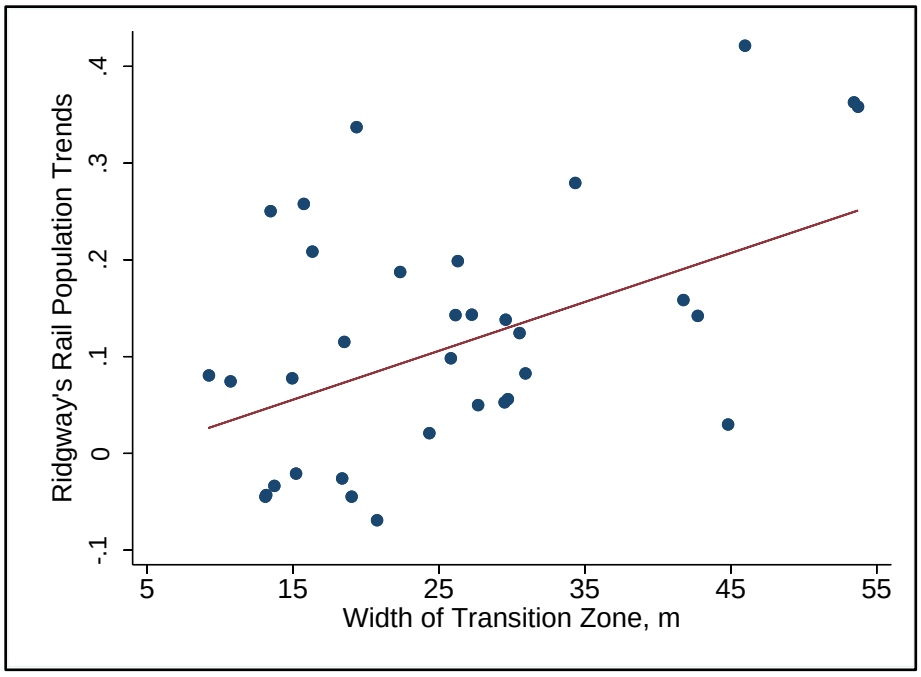

Figure 3. Rail population trends show greater increase for marshes with wider transition zones (A) and taller vegetation (B). Trends shown are annual rates of change (as proportional change per year) for most recent 5 years, are significant ($P < 0.05$) and depict the model of best fit. Zero indicates population stability, while positive or negative values indicate population growth or decline, respectively.

B)

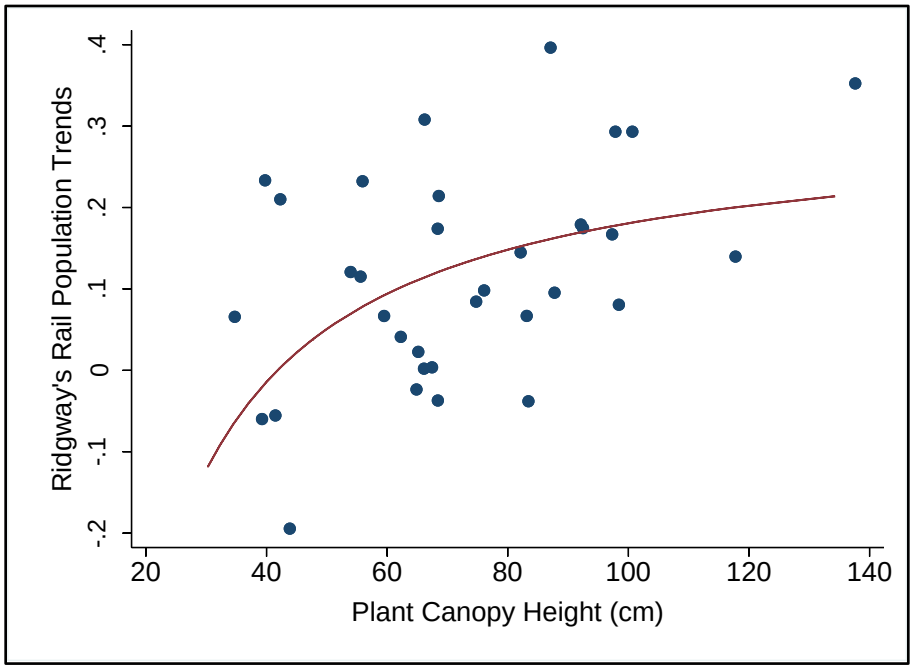

Photo Credit: Steven Tucker

We also assessed response of other tidal marsh dependent bird species to transition zone characteristics. Song Sparrows, a key tidal marsh ecosystem indicator, demonstrated population trends that were mirrored by the other tidal marsh dependent bird species dependent, including the Saltmarsh Common Yellowthroat, California Black Rail and Marsh Wren. Specifically, trends in abundance for tidal marsh Song Sparrows, in the last 5 years, were more positive the more densely vegetated was the adjacent transition zone abutting the tidal marsh (Figure 4). In marshes whose transition zone had very little dense vegetation, 5% or less, Song Sparrow abundance demonstrated strong declines.

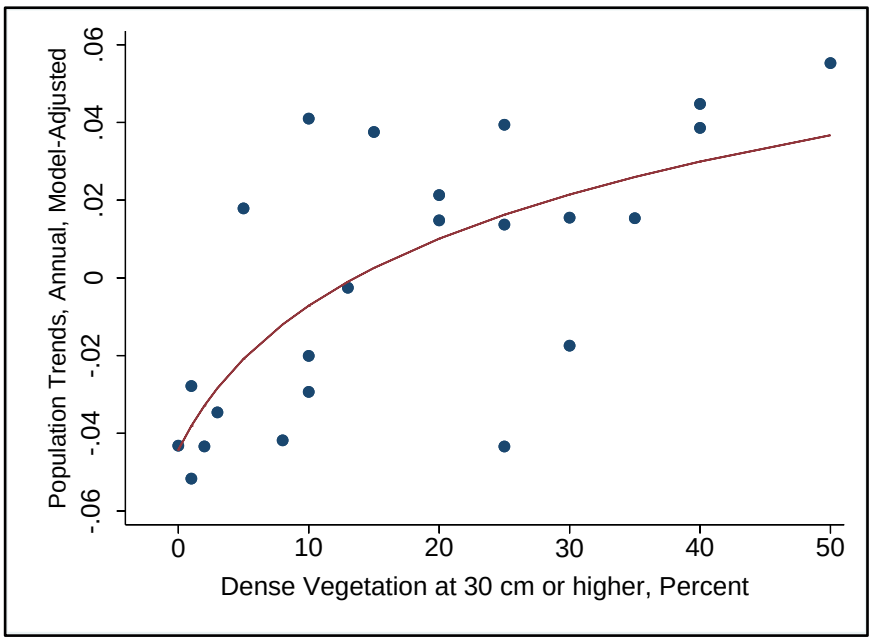

Photo Credit: Peter LaTourette

Figure 4. At marshes bordered by transition zones with dense vegetation, population trends of the Song Sparrow, a key tidal marsh bird indicator species, were more positive. Shown are annual rates of change as proportional change per year, calculated for the most recent 5 years.

Our findings provide insights into what makes for a healthy transition zone, one that provides important benefits to species of conservation concern that rely on tidal marsh habitat. Wider transition zones with more structural complexity (i.e., dense, tall vegetation) were correlated with positive trends in population abundance of bird species in the adjacent tidal marsh. Wider, more structurally complex transition zones may buffer against predators entering the adjacent marsh, or provide a source of cover to escape from predators. Further studies are needed to confirm hypothesized differences in predation as well as to investigate specific mechanisms by which predation may be reduced.

While we found evidence that vegetation structural characteristics benefited tidal marsh-dependent birds, we found a lack of association between tidal marsh bird trends and specific plant species. Thus, several different plant species may prove beneficial and this has implications for planting in restored transition zones. Our study found no evidence that the slope of the transition zone affected tidal marsh populations: where transition zones were narrow to moderate in width, population trends were similar whether the slope was steep (e.g., on a levee) or shallow. However, since width and slope tend to be negatively correlated, it is not easy to disentangle the effects of the two variables. Nevertheless, the benefits of wide transition zones is clearly apparent.

While our study has demonstrated the value of transition zone habitat in supporting bird populations in the adjacent tidal marsh, we found that the transition zone habitat provides an additional benefit: this habitat is used by a number of species for foraging and possibly nesting. Our study documented 9 species that commonly used the transition zone, both tidal marsh-dependent species and those associated with upland habitat (Figure 5). Furthermore, we found that transition zones with taller,

denser vegetation overall supported greater abundance of birds, similar to what was seen in the adjacent tidal marsh populations.

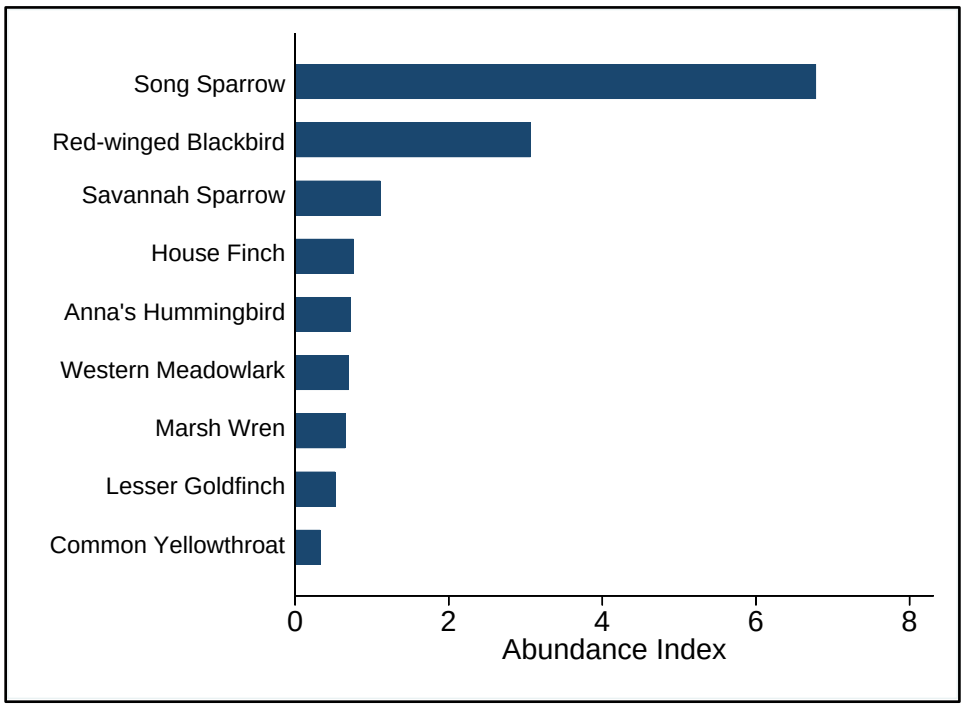

Figure 5. Index of abundance for 9 species, commonly observed in the transition zone. Shown is the number of detections per survey per plot, from the 16 sites. Song Sparrow, Marsh Wren, and Common Yellowthroat are also tidal-marsh associated focal species; the others are upland-associated or generalist.

Transition Zone Monitoring Framework

As a part of this project, we developed a novel monitoring framework specifically designed to assess the success of transition zone restoration in terms of its benefit to wildlife. The framework includes a study design, and four field protocols. These protocols, when implemented together, provide seasonal snapshots of the vegetation and bird use within the transition zone. Winter and extreme tide surveys, as well as spring vegetation and bird survey protocols were developed by the project partners to address the question of what characterizes a high-quality transition zone for birds. Monitoring the transition zone throughout the year provides important data to determine how bird use could potentially shift with the seasonal pattern of vegetation growth and senescence and the tides. The protocols and resources from this effort are available online at www.pointblue.org/tbirds.

Next Steps to Address Data Gaps

- Build on this framework to incorporate measurements of physical processes (e.g., hydrology) and wildlife behavior during extreme tides to better understand mechanisms by which transition zones benefit marsh wildlife.
- Develop and refine extreme tide survey designs and protocols; consider involving fixed cameras, audio recorders, drones, and citizen science to understand the abundance and movement patterns of predators through transition zones.
- Extend these studies to additional sites that represent areas not well represented in the present study (Suisun, East Bay), and to consider other fauna, e.g., salt marsh harvest mouse and other small mammals.
- Continuing these studies over time will enable us to quantify how birds and other wildlife change as the vegetation matures and other habitat characteristics change during the course of restoration.

Restoration Recommendations

Design restoration to evaluate and compare new practices- Test new ideas (e.g., planting clumps of dense vegetation) by using an experimental design incorporating treatment and control plots within, and if possible, among sites.

Use the transition zone monitoring framework to improve site- and regional-scale understanding - This provides an integrated and standardized means to assess success, test new ideas, and increase knowledge, both for individual sites and at the regional level (see www.pointblue.org/tbirds)

Restore for dense vegetation ≥30 cm - Having at least 15% of the transition zone area covered in dense vegetation (≥ 30 cm from the ground) is beneficial to tidal marsh birds.

Restore for tall plants, 50-100 cm- Plant height up to about 100 cm was associated with increasing Ridgway's Rail populations. However, benefits to rails plateaued above 100 cm.

Design wider transition zones, greater than 25 m- Wider transition zones were associated with tidal marsh bird population growth. Transition zones wider than 25 m were more likely to have positive trends in the adjacent tidal marsh bird population.

Restoring steep levees has benefits- Whereas we found wide, gently sloping transition zones to be good for tidal marsh birds, we also found no negative effects of a steep sloped transition zone. Therefore, restored levees with taller, dense vegetation can provide benefits to tidal marsh birds as well.

Don't restrict restoration to a single plant species- Plant structure (height and dense vegetation) was more important than a specific plant species. The height and stem density of marsh gumplant is beneficial to tidal marsh birds but other plant species such as California sage (*Artemisia californica*) and salt marsh baccharis (*Baccharis glutinosa*) may fulfill those needs.

Grasses can be beneficial- Grasses can provide cover for tidal marsh birds, while their removal (absent supplemental planting of tall dense vegetation) can reduce the benefits to tidal marsh birds such as Ridgway's Rails. Grasses may also provide forage for additional tidal marsh species such as the salt marsh harvest mouse.

Literature Cited

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