State of the Estuary Report 2015

Summary

WILDLIFE – Ridgway's Rail

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State of the Estuary 2015: Wildlife
Ridgway's Rail Population Indicator

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1. Background and Description of Indicator and Benchmark

The 2015 State of the Estuary includes two indicators reflecting the condition of biotic resources that specifically focus on tidal marsh habitat: Tidal Marsh Bird Population Indicator (which was included in the 2011 Report) and this Indicator, Ridgway's Rail Population Indicator.

a) Background and Indicator:

Extensive loss of tidal marsh habitat was well-documented in the Goals Project (1999). In addition, there has been substantial alteration of habitat, reflected in changes in salinity and channelization (e.g., reduction of sinuous, dendritic channels characteristic of mature tidal marsh habitat); habitat fragmentation; invasive plant and animal species; contaminants (e.g., mercury), and loss of natural transitional habitat bordering tidal marsh. These stressors are well-documented in the Tidal Marsh Recovery Plan (TMRP; USFWS, 2013) and the Bayland Ecosystem Habitat Goals Technical Update Report (2015; see especially Case Study by Overton and Wood 2014).

While all species relying on tidal marsh habitat are affected by habitat loss, alteration, and stressors, California Ridgway's Rail, formerly California Clapper Rail, is an especially sensitive subspecies because of their use of low marsh for foraging, their dependence on channelized marshes, and their use of mid-marsh and upper marsh areas for nesting and as refugia from predators, especially during extreme tides (Overton and Wood 2014). Furthermore, the California Ridgway's Rail (*Rallus obsoletus obsoletus*) in the San Francisco Estuary is of much reduced population size compared to the 1970's, and its numbers may currently be in the vicinity of 1000 individuals (Liu et al. 2012), thus subjecting this subspecies to stochastic fluctuations which may lead to local extirpation or inhibit recovery.

At the same time, the California Ridgway's Rail, as a Federally Endangered subspecies, has been the focus of extensive tidal marsh restoration efforts throughout the San Francisco Estuary (see TMRP), as well as a number of management activities. Hence, the Ridgway's Rail Population Indicator serves an important function, reflecting both the condition of the suite of species that depend on tidal marsh habitat, as well as being an indicator of a species of intrinsic significance with respect to its current viability and how this has changed, and will change, over time with respect to restoration and management activities.

The specific indicator metric is the density of birds per hectare as determined from comprehensive, standardized breeding season surveys conducted throughout the San Francisco

Estuary since 2005 (Liu et al. 2012). Surveys have been conducted by the Invasive Spartina Project (of the State Coastal Conservancy), Point Blue Conservation Science, USFWS, USGS, CDFW, EBRPD, and others. The most recent, state-of-the-art analysis is that conducted by Point Blue for surveys carried out in 2005-2013, and is presented here.

b) Benchmark, Scoring Breaks and their justification:

We established a benchmark breeding population density separately for the North Bay and the South Bay populations, using results from the first three years that comprehensive standardized surveys for Ridgway's Rail were available, 2005-2007 (Liu et al. 2012). The 3-year mean density for each region (North Bay or South Bay) is used as the Benchmark. On this basis we then scored the index as Good, Fair, or Poor.

For distinguishing Good from Fair we use a 10% increase in density over the benchmark value. Thus, Good represents a modest improvement over the average density observed in 2005-2007. Considerable management effort is currently directed at improving habitat quality, including reduction of invasive species, reduction of predation and disturbance; this is in addition to the expectation that habitat quality for Ridgway's Rail will increase as recently restored tidal marshes (say about 20 years before the present) become more mature, and thus of increased suitability for Ridgway's Rail. Therefore, a modest increase in density can reasonably be expected as habitat conditions improve in the future relative to those of 2005-2007. Note that the TMRP sets a goal of increasing the total population per region by five-fold over 50 years; hence the target set here (10% increase in density) is relatively modest.

Benchmark means were 0.54 and 0.49, respectively for North and South Bay regions. Thus, the criterion of Good is a density of at least 0.60 birds/ha for the North Bay and 0.54 for the South Bay. Note that this criterion was reached in 2005 for the North Bay as a whole and in 2006 for the South Bay as a whole (Figure 1), which underlines the point that Good is a feasible target to achieve.

For distinguishing Poor from Fair we chose a value that represented a meaningful decrement relative to the same benchmark, i.e., the mean density for 2005-2007, calculated for each bay region. The value we use is 20% below the mean. A 20% decrease over 4 to 8 years (comparing 2011-2013 to 2005-2007) is of some concern especially if such a trend were to continue. Thus, the criterion of Poor is a density below 0.43 birds/ha in the North Bay and below 0.39 birds/ha in the South Bay. In summary, the range for Fair extends from 0.43 up to, but not including 0.60 in the North Bay, and from 0.39 up to, but not including, 0.54 in the South Bay (see Table 1).

Relative to the benchmark value, the two cut-points (Good vs Fair, and Fair vs Poor) are not symmetric. That is because a 10% decrease in density does not represent reason for concern, whereas a 10% increase in density represents a substantial achievement, one that is only attainable once management actions (e.g., predator reduction) have been implemented and/or newly restored habitat has become sufficiently mature to support relatively high densities of Ridgway's Rail.

2. Scoring Assessment and Trends:

In the **North Bay**, the mean density for the 3 most recent years is 0.47 birds/ha, and therefore this indicator is scored Fair (Table 1). Note that the mean for 2011-2013 is 13% below that of 2005-2007. Over the entire period 2005-2013 there has been on average a slight decline of 2.4% per year (NS, $P > 0.5$). However, there has been a significant "bottoming out" during this period: the quadratic curvature is significant ($P = 0.016$), demonstrating an upturn starting in about 2009. In other words, most of the decline in density observed between 2005 and 2008 has been reversed.

In the **South Bay**, however, the mean density for the 3 most recent years is 0.23, and therefore this indicator is scored Poor. Note that the mean for 2011-2013 is 53% below that of 2005-2007. Over the entire period 2005-2013, there has been a significant decline of 10.8% per year, on average ($P = 0.025$). During this period, the quadratic trend was not significant ($P > 0.14$). Thus, there was little statistical evidence that the declining trend had been reversed as of 2013.

To summarize, the density of Ridgway's Rail declined in the North Bay between 2005 and 2008, but since then the trend has mostly been reversed. In the South Bay, density declined between 2006 and 2008, and apparently into 2009. Though no further decline has been seen since 2009, neither is there clear evidence of a reversal.

It is important to note that these results are only through 2013. A full analysis of surveys completed in 2014 and 2015 is needed, but note that 2015 was characterized by reduced survey effort. A full survey effort in 2016 and comprehensive analysis of 2014-2016 survey data are needed.

3. Brief Write-Up of Scientific Interpretation:

The goal of the Tidal Marsh Recovery Plan (USFWS 2013) is to increase the current population size of Ridgway's Rail in the San Francisco Bay Estuary to approximately 5500 individuals over a 50-year period. The best recent estimate (for the period 2009-2011) for this region is fewer than 1200 individuals (Liu et al. 2012). To meet the TMRP's ambitious goal will require both an increase in the overall density of Ridgway's Rail in current tidal marsh habitat as well as an increase in the total amount of tidal marsh habitat, as a result of restoration of habitat and tidal action (as described in the current NFWF Business Plan for Tidal Marsh. The Ridgway's Rail Population Indicator reflects the first component: density of breeding populations. The SOTE tidal marsh habitat Indicator reflects the second component.

Changes in density reflect several factors, including (1) habitat suitability for this species, in particular suitability for nesting, foraging, and refugia from extreme tides, and (2) the impact of stressors such as invasive species, disturbance from humans, excess predation, inundation of habitat, and contaminants. One aspect of habitat quality to highlight is vegetation structure, which plays an important role for Ridgway's Rail, providing cover, refugia from predators, and suitable locations for successful nesting. This is one reason for current management actions and activities (conducted by SCC and USFWS) directed at planting or maintaining important plant species, in particular gumplant (*Grindelia stricta*) and native cordgrass (*Spartina foliosa*).

The time series presented here indicates two distinct trends in Ridgway's Rail density. For the North Bay, a decline in density was observed up to 2009, followed by an increase in recent years, back to a level comparable to that observed in 2006-2007. For the South Bay, a decline began in 2007, was especially steep between 2007 and 2008, with no further decline since 2009, but also no appreciable recovery observed as of 2013.

The declines observed in both regions reflect multiple causes. An important contribution to the decline, especially in the South Bay, was loss of intact vegetation structure as a consequence of the large-scale removal of invasive *Spartina* (especially the *alterniflora x foliosa* hybrid) during the period 2006 to 2010. The peak of non-native *Spartina* infestation was observed in 2005 through 2007, with high levels observed in 2005 and 2006 and, to a lesser extent, 2007. In some cases where hybrid Spartina invaded mudflats and converted the open tidal flats to a monoculture, cordgrass marsh, the removal of invasive *Spartina* also removed all available Ridgway's Rail habitat. For those areas below Mean Higher High Water, where tidal mudflat is the native condition, recovery to 2005-2007 levels may not be realistic (J. McBroom, pers. comm.). Instead, an increase in bay-wide rail numbers to 2005 – 2007 levels will require time for the current habitat restoration efforts to provide mature native tidal marsh, in addition to management actions targeting Ridgway's Rails.

While South Bay populations demonstrated a sharp decline, coincident with invasive *Spartina* eradication efforts, in the North Bay there was also a substantial decline, though there was much less eradication in the North Bay, due to reduced infestation by invasive *Spartina*. Thus, the large bay-wide decline in California rail detections in 2008, including areas unaffected by invasive *Spartina* eradication, highlights the sensitivity of this species to annual variation in ecological conditions.

The partial recovery of density in recent years in the North Bay merits "fair" status, indicating that further improvement is needed and can be expected as the impact of stressors on the population are reduced (USFWS 2013). The as-yet lack of recovery of density in the South Bay highlights the need for management actions to improve habitat suitability and population viability. One example of such actions is the planting of important species for Ridgway's Rail, *Grindelia stricta* and *Spartina foliosa*; another area to address is provision of refugia from high tides, which is also being pursued by SCC, USGS, and others. There is also a current focus on improvement of the transition zone between marsh and upland habitat. Reduction of predation (e.g., due to cats) is yet another action under consideration. We can expect that implementation of such management actions will result in an increase of the Ridgway's Rail population density in future years, and that this will be tracked by the Ridgway's Rail population Indicator.

In addition to specific management actions, as discussed above, further information is needed regarding survival and reproductive rates of Ridgway's Rail, and the factors that directly influence these demographic rates (Overton and Wood 2014). Completion of full survey efforts in 2016 (after a reduced effort in 2015) is needed as well as a complete analysis of survey data since 2013.

Table 1.

Benchmark and Indicator Results for Ridgway's Rail Population Indicator

Region		Explanation	Value	Score
North Bay				
	Benchmark	2005-2007 Mean for region	0.54	
	Cutpoint Good vs Fair	10% above benchmark	0.60	
	Cutpoint Fair vs Poor	20% below benchmark	0.43	
	Observed value	2011-2013 Results	0.47	Fair
South Bay				
	Benchmark	2005-2007 Mean for region	0.49	
	Cutpoint Good vs Fair	10% above benchmark	0.54	
	Cutpoint Fair vs Poor	20% below benchmark	0.39	
	Observed value	2011-2013 Results	0.23	Poor

4. Related Figures.

Indicator results are displayed in Figure 1.

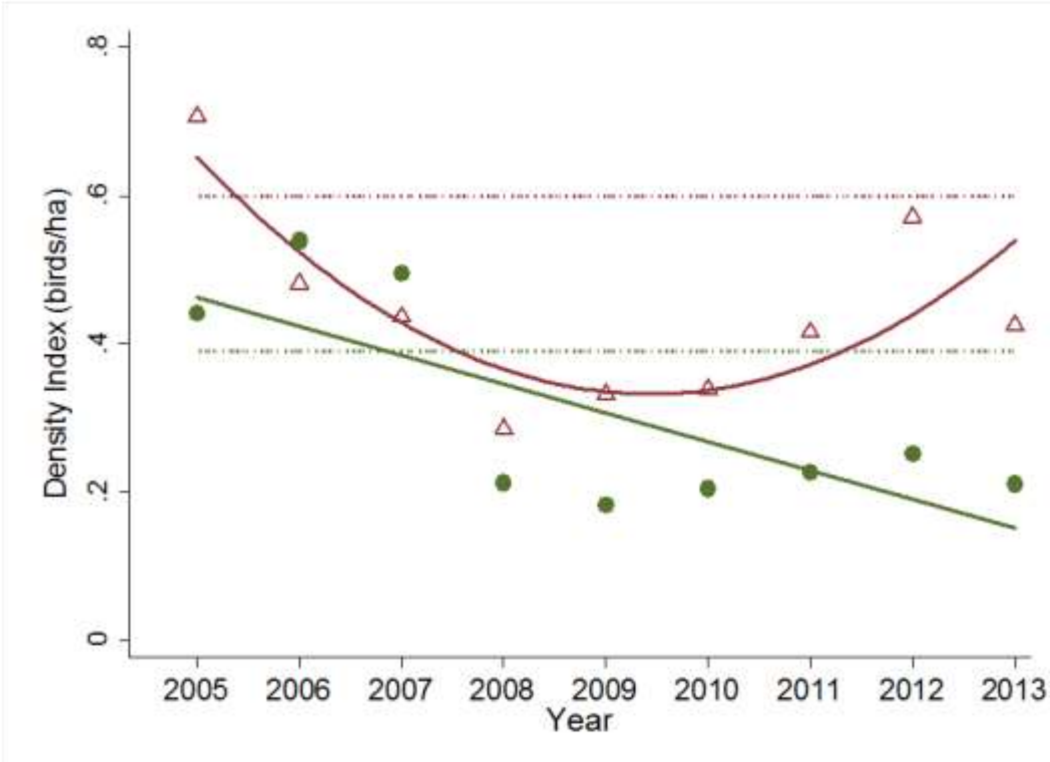

Figure 1. Density Index of Ridgway's Rail, from comprehensive, standardized surveys, conducted by multiple partners throughout San Francisco Estuary. The methodology is a modification of Liu et al. (2012), as well as the addition of results from 2012 and 2013 surveys (see Technical Appendix). North Bay estimates (triangles) and trend of best fit (quadratic) shown in maroon; cutpoint "Good/Fair" for North Bay is shown as dotted maroon line. South Bay estimates (green) and trend of best fit (linear) shown in green; cutpoint for "Fair/Poor" for South Bay is shown as dotted green line.

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Technical Appendix

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5. Technical appendix

Background and Rationale

Background and Rationale for the choice and interpretation of this indicator is provided above, in section 1.

Benchmark

The benchmark, its calculation, and its justification are described in detail above, see section 1.b. In brief, the benchmark chosen was a 10% increase in density relative to the 2005-2007 period, which is the earliest period available for comparison. For scoring Poor vs. Fair, the scoring break is a 20% decrease.

The primary basis for choosing a 10% increase in density is that the Tidal Marsh Recovery Plan has set ambitious goals for the recovery of the California Ridgway's Rail (USFWS 2013). Specifically, the TMRP goals are an approximate five-fold increase in total population size over 50 years. Achieving these goals will require both an increase in density as well as an increase in the total amount of habitat available for the subspecies through habitat restoration. A 10% increase relative to 2005-2007 may not appear to be a substantial increase, but note that density levels dropped by about 50% in the North Bay and South Bay regions, comparing 2008-2009 to 2005-2007 (the reference period). Hence, achieving a 10% increase above the 2005-2007 levels represents a significant accomplishment and thus merits a score of "Good."

- **Limitations of the benchmark and possible improvements**.

Density alone does not provide a complete measure of condition. Compiling information on reproductive success and/or survival will be essential in the future. The criterion of 10% increase relative to 2005-2007 should be scaled to the time frame. Thus, for the 2019 State of the Estuary Report, a new criterion may need to be used, e.g., by choosing a greater percent increase for the current period relative to 2005-2007.

Methods and Data Sources

The data and methods used in calculating indicator values are for the most part described in Liu et al. (2012). The data used here updates Liu et al. (2012) by including results from all available surveys in 2012 and 2013. Data were provided by Point Blue collaborators, including Invasive Spartina Project, USFWS, and others (Liu et al. 2012).

In addition, the methods are slightly modified as described herein. In this analysis, we analyzed call count data during the Ridgway's Rail breeding season period (15 January to 15 April) from 123 "transects," where a transect generally corresponded to a local marsh site, and consists of multiple survey stations (often six to 10, depending on marsh size).

The number of survey visits to each survey station was usually three (sometimes four or five) per breeding season. Because of the multiple visits, we were able estimate detection probability in relation to date (i.e., Day of Year), fitting a quadratic effect, see below (detection probability peaks in February, and then declines).

For the analysis, we excluded those transects where Ridgway's Rails was never detected in any year, at any of the survey stations for a transect. Such transects were assumed to be in either unsuitable habitat for Ridgway's Rail, or outside the current range. We fit hierarchical imperfect detection models, allowing for failure to detect a Ridgway's Rail, given that one was present, and examined covariates that may be affecting detection probability (see Liu et al. 2012 for details).

We compared multiple competing models and chose the best model based on comparison of AIC values, evaluation of negative log-likelihood values, and model coefficients. The best model for the Ridgway's Rail analysis included quadratic effects of Julian day and difference in time since sunrise or sunset for the detection function. For the abundance function (a component of the hierarchical model), the model chosen had only year and Bay effects (and their interaction). That is we allowed year to year differences to be estimated independently for the North Bay and South Bay regions. Estimates of density and associated confidence intervals were calculated by profiling the values of the detection model estimates and calculating the mean of the distribution of the abundance parameter (i.e., density), for each combination of year and bay, incorporating random effects (Royle and Dorazio 2008).

Assumptions and uncertainties.

The strength of our approach is that we statistically estimate two components determining number of Ridgway's Rails detected per survey: detection probability and the true, underlying abundance. Parameters affecting detection probability included date of the survey as well as time before or after sunrise/sunset. However, one difficulty, and thus source of uncertainty, is that any errors in estimating detection probability will also affect our estimates of abundance.

The second issue to consider is the representativeness of our sample. However, because the sample of sites surveyed was large in almost all years, lack of representativeness is not likely a major problem. The exception was 2013; due to budgetary constraints the sample of sites surveyed in 2013 was relatively small. Thus, it is difficult to ascertain how 2013 may have differed from 2011 and 2012, or how similar it may have been.

However, additional surveys were conducted in 2014 and 2015 (not analyzed here) and an extensive survey program is planned for early 2016. Analyses of 2014-2016 will go far to clarify the current status of Ridgway's Rails.

Peer Review

We thank Jen McBroom and Cory Overton for providing helpful review of the Indicator and this Summary and Technical Appendix.

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