Trinity River Bird and Vegetation Monitoring: Report Card Methods

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Dam construction on the Trinity River in the 1960s changed its natural hydrology and morphology, resulting in unintended consequences to the river's ecology. These changes included the accumulation of fine sediments into hardened berms, homogenization of channel morphology, and reduction of fresh gravel inputs, all of which were highly detrimental to habitat for salmonid fish. The restoration strategy of the Trinity River Restoration Program (TRRP) integrates managed flow releases, gravel inputs, and in-stream restoration. Physical features have been constructed at multiple bank rehabilitation sites with the goal of increasing channel complexity and creating fish habitat. This bank rehabilitation process requires the removal of riparian vegetation and its subsequent replacement in different locations. Thus, restoration methods used by the TRRP to enhance fish abundance and maintain riparian habitat complexity are expected to affect riparian and riverine bird communities on the Trinity River.

Klamath Bird Observatory (KBO), in collaboration with the TRRP, is implementing a multi-scale, multiple-methodology monitoring program designed to meet and assess compliance requirements and inform the adaptive management process by tracking avian response to restoration actions. This work builds on earlier bird monitoring conducted by the U.S. Forest Service Redwoods Sciences Laboratory from 2002-2010 (Miller et al. 2010). Our monitoring takes place in the TRRP program area - the 40-mile stretch of the Trinity River between the Lewiston Dam and the confluence with the North Fork. Our three overarching goals are to (1) monitor temporal changes in riverine bird species performance metrics at the scale of the river reach and 40-mile program area, (2) monitor temporal changes in riparian bird species performance metrics at the scale of the restoration site, river reach, and 40-mile program area, and (3) determine restoration-associated changes in vegetation that explain variation in riparian bird performance metrics at the scale of the restoration site.

To summarize our findings for bird population trends and riparian habitat health within the TRRP program area, we have developed this Report Card – a graphic, visual format that uses a graded color scale to track the progress of restoration. We chose five categories of habitat health related to the three monitoring goals described above to evaluate in the report card: Riverine Bird Trends, Land Bird Trends, Vegetation, Bird Territories, and Nest Success. Each category is made up of five or six contributing metrics, selected based on their ability to act as ecological indicators, their relation to stakeholders' goals and interests, and availability of data. Each metric is calculated on a scale of either 0-100% or a categorical A through F letter grade. The score for each metric is represented by a color (dark green=A [80-100%], light green=B [60-80%], yellow=C [40-60%], orange=D [20-40%], red=F [0-20%]) in a "habitat health index." The overall category grade is generated from the mean of its metric scores. Trend arrows included with each metric show the direction and strength of change in the TRRP program area (Riverine Bird Trends, Land Bird Trends) or in the restoration sites (Vegetation, Bird Territories, Nest Success) alone, but arrow directions and colors are not used in calculating the overall letter grades.

Five survey methodologies were implemented: trend monitoring (riverine float surveys, riparian point counts) was completed from 2002-2014, and restoration site monitoring (spot-mapping, nest monitoring,

and vegetation surveys) was completed from 2012-2015. To survey riverine birds, float surveys were conducted four times annually along the entire 40-mile program area. For each riverine bird detected, we recorded species, location, and behavior. To monitor riparian birds, point count data were collected via a panel study design, where a subset of the total available points spaced evenly along the Trinity River within the program area was surveyed every year, and another subset of points was randomly selected to be surveyed in the current year; total number of points was ≥ 180 each year. At each point, an observer recorded all individual birds detected, including species, detection type, distance from observer to bird, and location of bird (riparian or upland, and on which side of the river). Spot-mapping surveys were performed ten times each year (approximately once a week between late April and early July) on six restored sites and four reference sites. Field personnel systematically walked through study plots, mapping the location and behavior of four target riparian species. Territories were delineated by aggregating visits and using location and behavioral data to establish territory boundaries. Observers searched a subset of four study sites at least three times a week throughout the breeding season, and used behavioral cues and systematic search techniques to locate nests of target riparian species following standard protocols. Nest locations were recorded with GPS, and then monitored every 1-3 days to determine nest contents and nest fate. During intensive vegetation surveys, we recorded number and species of trees and snags, and percent canopy cover, within an 11.3m radius circle around survey points. Within a nested 5m radius circle subplot, we recorded number and species of shrub stems (<8cm DBH and <5m tall). See *Trinity River Restoration Program Riparian and Riverine Bird Monitoring* for detailed study design and field methods (Stephens and Ausprey 2012).

The Riverine Bird Trend category has six metrics representing trends within the entire program area for focal riverine species: American Dipper, Bald Eagle, Belted Kingfisher, Common Merganser, Green Heron, and Spotted Sandpiper. The Land Bird Trend category has six metrics representing trends within the entire program area for focal riparian species (Black-headed Grosbeak, Song Sparrow, Tree Swallow, Yellow-breasted Chat, and Yellow Warbler), as well as an overall landbird diversity metric. The metrics in both of these categories were calculated with data from 2002-2014 float surveys or point count surveys covering the entire 40-mile program area. Relative abundance indices were calculated as birds per reach or per point, respectively, and trends were calculated as the overall change in abundance over time, using generalized linear mixed models with reach or point ID as a random effect. The scores were generated by comparing the trend for each species within the program area to Breeding Bird Survey (BBS) trends for the Northern Pacific Rainforest region (Sauer et al. 2014), and assigning a color score in the habitat health index. A light green or dark green score indicates that populations in the program area are doing as well or better than in the wider geographic region represented by BBS data. If the metric received an orange or red score, then the population trend in the program area had a lower slope than the BBS trend. The landbird diversity metric was calculated as the change in species richness per point over time. It does not have a ready baseline for comparison, but is scored only by its own trend strength and direction. The average score for all metrics within each category was used to assign an overall letter grade based on the traditional scale used in schools (A, B, C, D, or F). Trend arrows show the direction and significance of trends just within the TRRP program area, taken from the most recent population trends report (Rockwell and Stephens 2016).

The Vegetation, Bird Territories, and Nest Success categories are based on comparing results from six restored sites under intensive study (Connor Creek, Hocker Flat, Indian Creek, Lewiston-Sven, Sawmill, and Valdor Gulch) to four unmanipulated reference sites that represent target conditions (Limekiln Gulch, Lower Rush Creek, Sheridan Creek/Deep Gulch, and Soldier Creek/Evan's Bar). Metrics within all three of these categories were calculated by comparing the most recent year's data at restored sites to target conditions (the mean of all years at unmanipulated reference sites). Each metric was assigned a color

score based on where it fell along the habitat health index. The index is divided into five colors, as described above, with a score of 0-20% equaling red, 20-40% orange, 40-60% yellow, 60-80% light green, and 80-100% dark green. For example, restoration sites on average had 52.5% of the canopy cover found on reference sites, receiving a score of yellow. Each metric was also assigned a trend arrow, based on visual inspection of the change in metric scores at restoration sites from 2012-2015. A negative arrow indicates the score decreased every year, a slightly decreasing arrow indicates it decreased most years, a neutral arrow indicates the metric stayed consistent over time, a slightly increasing arrow indicates it increased most years, and an increasing arrow indicates the metric increased every year.

The Vegetation category has six metrics representing different aspects of vegetation structure and composition related to habitat value for wildlife: Canopy Cover, Shrub Stems, Number of Trees, Tree Diversity, and Blackberry Cover. Vegetation metrics were calculated using data from intensive vegetation surveys completed at stratified random sampling points at both restoration sites and unmanipulated reference sites. All metrics were scored based on their means per point at restored sites in 2014 (data were not collected in 2015), and divided by the means at reference sites for all years (2012-2014). For the Shrub Stems metric, only species for which stems could be counted are included, such as willows (*Salix* spp.), dogwoods (*Cornus* spp.), and small (<5 m tall) alders (*Alnus* spp.) and cottonwoods (*Populus* spp.). Species with a more complicated growth form, such as blackberry (*Rubus* spp.), currants (*Ribes* spp.), roses (*Rosa* spp.), vines, skunkbush (*Rhus trilobata*), and poison oak (*Toxicodendron diversilobum*), were not included in this metric. One of the TRRP restoration goals is to remove non-native species; therefore, the metric for invasive Blackberry Cover (*Rubus discolor*) was scored on an inverse scale so that the higher its percent cover on restoration sites, the lower the score it received. The Number of Snags metric includes all snags with a DBH >23cm. Number of Trees includes all stems with a DBH >23cm and height >5m. For Tree Diversity, all DBH classes of trees taller than 5m were included. Trend arrows show the strength and direction of change in these vegetation metrics at restoration sites alone over time.

The Bird Territories category has five metrics representing territory density of the five focal riparian bird species derived from spot-mapping data. Each species' score is calculated by dividing the mean number of territories per hectare at restored sites in 2015 by the mean number of territories per hectare at reference sites from 2012-2015. Tree Swallows do not maintain strict territories, and are thus not spot-mapped, so the number of first-attempt nests per hectare was used as a proxy for the number of Tree Swallow breeding pairs. Arrows displayed within each metric show the strength and direction of change in territory density at restoration sites from 2012-2015.

The Nest Success category includes metrics for the percent of successful nests for the five focal riparian bird species, plus an additional metric representing the percent of nests unparasitized by Brown-headed Cowbirds (see inset box in Report Card). The Nest Success metrics use data from Song Sparrows, Tree Swallows, Yellow-breasted Chats, and Yellow Warblers at the subset of three restoration sites and one reference site where we monitored nests. There were an insufficient number of Black-headed Grosbeak nests found to include this species as a metric. The score for each species compares the percent of successful nests at restoration sites in 2015 to the percent of successful nests at the reference site from 2012-2015. We use apparent nest success as our metric, defined as the number of observed nests that fledged ≥1 offspring divided by the number of total nests found. The Unparasitized Nests metric calculates the percent of unparasitized nests for three focal species combined at restoration sites in 2015 divided by the percent of unparasitized nests at the reference site from 2012-2015. This metric does not include Tree Swallows; they are cavity nesters, and thus less likely to be parasitized, but also we are unable to observe nest contents inside cavities to determine parasitism status. Trend arrows show whether nest success on restoration sites alone has been generally increasing or decreasing for each species.

This report card provides a summary of data from ongoing monitoring in a visual, graphic format, assigning color grades to each category of habitat health. This is intended to help track progress at restored sites, and adaptively improve management to best achieve restoration objectives on the Trinity River. The grades given for each category are based on metrics measuring bird abundance, density, nest success, and associated riparian vegetation on restoration sites that serve as indicators of the health and functioning of the ecosystem. We anticipate that this report card will be produced annually, with three of the five categories (Vegetation, Bird Territories, and Nest Success) updated each year, and the other two (Riverine Bird Trends, Land Bird Trends) updated every five years.

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Appendix I. Table of data used to calculate the metric scores within each graded category.

Graded Category	Metric	Current Condition of TRRP sites	Baseline (target condition)	Percent	Color Score
Riverine Bird Trends	American Dipper	TRRP trend (significant increase)	BBS data (no trend)	N/A	Dark green
	Bald Eagle	TRRP trend (significant increase)	BBS data (significant increase)	N/A	Dark green
	Belted Kingfisher	TRRP trend (no trend)	BBS data (no trend)	N/A	Light green
	Common Merganser	TRRP trend (no trend)	BBS data (no trend)	N/A	Light green
	Green Heron	TRRP trend (significant decrease)	BBS data (no trend)	N/A	Orange
	Spotted Sandpiper	TRRP trend (no trend)	BBS data (no trend)	N/A	Light green
Land Bird Trends	Black-headed Grosbeak	TRRP trend (significant increase)	BBS data (significant increase)	N/A	Dark green
	Song Sparrow	TRRP Trend (near-significant decrease)	BBS data (significant decrease)	N/A	Light green
	Tree Swallow	TRRP trend (significant increase)	BBS data (near-significant decrease)	N/A	Dark green
	Yellow-breasted Chat	TRRP trend (significant decrease)	BBS data (no trend)	N/A	Orange
	Yellow Warbler	TRRP trend (significant increase)	BBS data (no trend)	N/A	Dark green
	Landbird Diversity	TRRP trend (near-significant decrease, small magnitude)	No baseline available	N/A	Yellow
Riparian Vegetation (mean of all 11.3m radius survey plots)	Canopy Cover	Restoration sites 25.71%	Reference sites 48.91%	52.57%	Yellow
	Shrub Stems	Restoration sites 109.8	Reference sites 33.67	>100%	Dark green
	Blackberry Cover	Restoration sites 24.8%	Reference sites 33.10%	74.92%	Orange
	Number of Snags	Restoration sites 0.143	Reference sites 0.105	>100%	Dark green
	Number of Trees	Restoration sites 2.27	Reference sites 3.072	73.93%	Light green
	Tree Diversity	Restoration sites 1.27	Reference sites 2.348	54.13%	Yellow
Bird Territories (# per ha)	Black-headed Grosbeak	Restoration sites 0.003	Reference sites 0.62	0.40%	Red
	Song Sparrow	Restoration sites 1.29	Reference sites 1.58	81.60%	Dark green
	Tree Swallow	Restoration sites 0.29	Reference sites 0.79	36.70%	Orange
	Yellow-breasted Chat	Restoration sites 0.51	Reference sites 0.91	55.70%	Yellow

	Yellow Warbler	Restoration sites 0.95	Reference sites 1.22	78.40%	Light green
Nest Success	% Unparasitized nests (3 species)	Restoration sites 100%	Reference site 96.7%	>100%	Dark green
	Nest success (Song Sparrow)	Restoration sites 33.3%	Reference site 30.4%	>100%	Dark green
	Nest success (Tree Swallow)	Restoration sites 50%	Reference site 44.4%	>100%	Dark green
	Nest success (Y.b. Chat)	Restoration sites 50%	Reference site 35.3%	>100%	Dark green
	Nest success (Yellow Warbler)	Restoration sites 25%	Reference site 24.1%	>100%	Dark green