Relationships Among Animal Species and Site Attributes in Riparian Ecosystems of the Sacramento Valley, California

Prepared for:

Placer County Planning Department
Dewitt Center, 11414 "B" Avenue
Auburn, CA 95603
Contact: Melissa Batteatte
530/886-3000

Prepared by:

Jones & Stokes
2600 V Street
Sacramento, CA 95818-1914
Contact: John C. Hunter, Ph.D.
916/737-3000

May 10, 2004

Jones & Stokes. 2004. Relationships Among Animal Species and Site Attributes in Riparian Ecosystems of the Sacramento Valley, California. May 10. (J&S 03-133.) Sacramento, CA.

Contents

Page

Summary **S-1**

Relationships Among Animal Species and Site Attributes in Riparian Ecosystems of the Sacramento Valley, California **1**
Introduction 1
Methods 2
Sample Design 2
Field Data Collection 3
Geographic Information Systems Data Collection 4
Data Analysis 5
Results 8
Discussion 13
Implications for Biological Site Surveys to Assess Riparian Biodiversity 13
Implications for a FAM 13
Implications for Riparian Setbacks 15
Acknowledgements 16
References Cited 16

Appendix A RAP Forms

Appendix B Summary of Species Observations

Tables and Figures

Table

On Page

1 Riparian-Associated Birds of Western Placer County 6

2 Riparian-Associated Butterfly Species..... 6

3 Presence of Infrastructure and Evidence of Disturbance in Plots..... 8

4 Summary of Plot Vegetation and Surrounding Land Cover..... 9

5 Correlations Among Plot Attributes..... follows 10

6 Summary of Species Observations 11

7 Correlations Among Species Groups ..... follows 12

8 Correlations of Species Observations with Plot Attributes..... follows 12

9 Contribution of Variables to Multiple Regression Models for Relationship of Species Groups to Site Attributes..... follows 12

10 Evaluation of Habitat Functions by Representative Functional Assessment Methods..... follows 14

Figure

Follows Page

1 Cumulative Number of Bird Species Observed During Area Searches..... 10

2 Correspondence of Species Richness among Riparian-Associated Birds and Riparian-Associated Butterflies..... 12

3 Relationship of Species Richness of Riparian-Associated Birds and Selected Site Attributes 12

4 Relationship Between Number of Riparian-Associated Bird Species Potentially Nesting at a Site and Adjacent Agricultural Land..... 12

Summary

This report summarizes the relationships between riparian site attributes and biodiversity in the data sets collected in Tasks 2.8 (Evaluation of Habitat Assessment) and 2.10 (Validate RAP and Habitat Assessment) for the Placer County Riparian Ecosystem Assessment. More specifically, for one-hectare (2.5 acres) plots located in riparian corridors of the Sacramento Valley and adjacent foothills, we describe the relationships between species richness (i.e., number of species) of selected taxonomic groups (i.e., birds, mammals, reptiles, amphibians, butterflies, dragonflies, and damselflies) and measured vegetation and land cover attributes. The primary goals for collecting and analyzing these data were to support the development of a functional assessment model (FAM) for Central Valley riparian habitats, and to provide setback guidance for riparian corridors in western Placer County. The key results of the study were:

- vertebrate data from multiple site surveys provide a much stronger basis for assessing a riparian site than do data from a single site visit;
- non-destructive area searches for mammals, amphibians, and reptiles were not effective rapid assessment survey techniques, even with the placement of cover boards to provide artificial shelter for these species;
- for the 50 riparian sites surveyed, species richness was not strongly correlated among the different taxonomic groups, nor was the width or structure of the riparian vegetation strongly correlated with richness for any taxonomic group; however
- land cover in the vicinity (i.e., within 250 meters to 5 kilometers) of plots was related to the species richness of several taxonomic groups we examined, and in some cases, these relationships were strong.

These results have implications for the development of a riparian FAM and for guidance regarding riparian setbacks. However, they should be interpreted with caution since they were based on a small sample size (e.g., only 12 plots were visited for multiple surveys), a large geographic area was covered, and only presence data were collected for species in each taxonomic group. Assessment of overall riparian habitat functions should not be based on a single taxonomic group because none indicates the overall habitat functions provided by a site and responses vary within each taxonomic group. Also, assessments of habitat values should consider, attributes of surrounding land cover, in addition to attributes of the riparian vegetation itself. Similarly, the basis for setback widths should consider the upland habitat requirements of riparian species and the effects of adjacent upland land uses on riparian habitat, as these factors have significant relationships with species richness of riparian-associated species for at least

several taxonomic groups (e.g., birds, dragonflies, and butterflies). Separate technical reports will propose a draft FAM and will provide guidance regarding riparian setbacks. The implications of this study will be considered more fully in these reports.

Relationships Among Animal Species and Site Attributes in Riparian Ecosystems of the Sacramento Valley, California

Introduction

This report summarizes the results of Tasks 2.8 (Evaluation of Habitat Assessment) and 2.10 (Validate RAP and Habitat Assessment) of the Riparian Ecosystem Assessment that Jones & Stokes is conducting for the Placer County Planning Department, with assistance from the Point Reyes Bird Observatory (PRBO). These tasks were intended to support development of assessment techniques, preparation of a functional assessment model (FAM) and summarizing setback guidance for the riparian corridors of western Placer County. These tasks involved collection of data on species presence and site attributes at a random sample of riparian sites in Placer County and throughout the Sacramento Valley. Task 2.8 consisted of a field and geographic information systems (GIS) assessment of 47 sites. Task 2.10 consisted of additional, more intensive, data collection (including multiple surveys) at 12 of these sites.

Our analyses of these data focused on the relationships typically serving as the basis for setbacks and indicator-based assessments. Some FAMs base their measures of terrestrial habitat functions on the presence of selected taxa (e.g., bird species) that are presumed to indicate habitat suitability for other taxonomic groups. However, most FAMs are based on a combination of site attributes that are predicted to influence habitat area or quality for most species. The widths of riparian setbacks that are intended to conserve habitat functions are based on the relationships between species presence and the area of habitat types and the potential influence of adjacent land uses. Therefore, we examined criteria for assessments and setbacks by comparing the relationships among the species richness of taxonomic groups and their relationships to measured site attributes. In this analysis we included only riparian-associated bird species, which are presumably more responsive to riparian site attributes than other species that may use a range of habitat types, including riparian. Our general hypotheses were:

1. The number of riparian–associated bird species (riparian bird species richness) is positively associated with the species richness of other vertebrates and of invertebrates (i.e., bird species richness is a valid indicator of overall biodiversity);

For each taxonomic group:

2. Species richness increases with the width of riparian vegetation;
3. Species richness increases with the cover of woody plants (i.e., trees and shrubs) in the riparian vegetation;
4. Species richness increases with the total area of riparian vegetation in a plot and its surrounding landscape;
5. Species richness increases with the proportion of surrounding land area in natural vegetation; and
6. Species richness is negatively associated with the proportion of developed and agricultural land uses in the surrounding landscape.

We evaluated these hypotheses for riparian-associated bird species, riparian-associated butterflies, odonates (dragonflies and damselflies), mammals, amphibians and reptiles.

Methods

In addition to the following summary, our sample design and data collection methods were described (in more detail) in the sample design memo and field protocols provided to the Placer County Planning Department in 2003 (Appendix A).

Sample Design

Study site locations (plots) were a stratified random sample of existing PRBO point count survey sites along tributary streams in the Sacramento Valley where information regarding riparian corridor width was available and site access was know to be possible. Additional plots in Placer County were also included in cases where permission to enter private lands had been granted. Although not along a tributary stream, PRBO sites along the Cosumnes River were included in the list of potential plots because this area was considered reasonably similar to many of the included tributary streams in its riparian attributes. This set of potential plots was stratified on the basis of riparian corridor width. Data from PRBO records, digital aerial photographs, and a draft land cover map of Placer County were used to assign each plot to a width category. These categories were: 0–20 meters (m), >20–40 m, >40–60 m, >60–100 m, and >100–200 m. From each width category, ten plots were randomly selected, each at least 500 m from all other selected plots.

Sample size was limited by access to suitable survey sites and the available budget. On this basis, we estimated the maximum sample size would be 50 plots. The power associated with this sample was sufficient to identify correlations between variables (power > 0.8 for even small values of r); however, it was of more marginal size for the application of multivariate analyses, such as multiple

regression analyses. Statistical power is the ability of a statistical test to the identify relationships and differences that exist (i.e., it is the ability to reject the null hypothesis of no difference or association when it is incorrect).

From those plots located on Placer County, public or Nature Conservancy properties, 12 were randomly selected as more intensive data collection plots, each at least 5 kilometers (km) apart. At these plots, in addition to the data collection taking place at other plots, the following surveys were performed: small mammal trapping; placement of cover boards that might be used as artificial shelters for amphibians and reptiles; and multiple surveys for butterflies and vertebrate groups. These data collection plots were included in the study, despite their cost, to allow the value of this additional data to be evaluated. However, for these additional data, the small sample size substantially limits the analyses that can be applied, the power of these analyses, and thus the conclusions that can be drawn from the data. For example, the power associated with data from these 12 plots was only sufficient for the identification of strong correlations (i.e., r values > 0.7), and important combinations of site attributes had few or no replicates.

During our study, access or scheduling difficulties prevented most data collection at three plots, and seven plots were not surveyed for odonates. Thus, sample sizes were reduced to $n = 47$ for riparian-associated butterflies and single surveys for riparian-associated birds and $n = 43$ for odonates.

Field Data Collection

A 1-ha plot (100 m by 100 m) was located along the bank of the stream channel at all of the study sites. For each plot, information on site attributes was recorded and area searches were conducted for vertebrate and invertebrate species.

Recorded site attributes included: onsite infrastructure, disturbance, vegetation, surrounding land use, and evidence of overbank flows (Appendix A). Presence of infrastructure (roads, bridges, levees, or bank protection) and evidence of disturbance (grazing, trash dumping, cutting of trees and shrubs, etc.) were recorded for the riparian and non-riparian portions of the plot and for lands within 250 m of the plot. (The riparian portion of the plot was defined as the zone covered by riparian trees and shrubs.) For the riparian vegetation within the plot, we recorded its width along the stream (at the plot's edges and center), cover of the tree, shrub and herb layers, and the cover of each woody species, as well as snag density, and predominant tree size class. We also recorded the length and continuity of riparian vegetation along the stream corridor, and estimated the percent of adjacent land (within 250 m) that was in natural vegetation, agricultural, and developed land cover types.

Standardized, time-constrained area searches (Ralph et al. 1993) were conducted separately for vertebrate and invertebrate species (see Appendix A for protocols). For vertebrates, searches of the entire plot were conducted for one hour (between 6 and 11 a.m.) on one day between mid-May and mid-June, 2003. However, at 12 intensive data collection plots we conducted area searches four times at

approximately one-week intervals from mid-May to July 1. During the area searches, we recorded all species observed, and species for which scat or tracks were observed, and noted whether the species was observed in the riparian or non-riparian portions of the plot. Woody debris and rocks were not disturbed to avoid degrading habitat. For birds, we also recorded total numbers of individuals and observed behaviors (e.g., territorial displays, carrying food or nesting material, or observation of nests). Observed behaviors (and presence of nests or fledglings) were used to identify potential residents, and the number of potential resident species among riparian-associated birds was included in the analysis. Point counts (Point Reyes Bird Observatory 2003) also were conducted at plots in Placer County because no PRBO point count data existed for those locations.

Each plot was also surveyed twice for butterfly species, once during May 15–30 and again during June 2–14, 2003 and most plots (43 of 47) were surveyed once for odonates during August 19-29, 2003. These searches were conducted between 9 a.m. and 4 p.m. because of the daily flight patterns of these animals. As with the vertebrate area searches, the odonate and first butterfly surveys at each site were one hour long and each observed species was recorded. For butterflies, the number of observed individuals also was recorded. Based on the results of the first butterfly survey and to reduce costs, the second survey at each site was shortened to 50 minutes.

Small mammal live-trapping was also conducted at the 12 intensive data collection sites. Along the length of the plot's streambank side, 15 Sherman live traps were evenly spaced. An additional 15 traps were placed along a second line 10 m away and parallel to the first trap line. Each trap was baited with peanut butter and rolled oats, and a wad of cotton was placed at the back of each trap for bedding. These traps were set within 2 hours of sunset and checked within 3 hours of sunrise on three consecutive nights between June 10 and July 3, 2003.

At the 12 intensive data collection sites, cover boards also were placed within plots (Fellers and Drost 1994). These cover boards were approximately 0.9-m by 0.6 m pieces of 1.9 centimeters (cm) thick plywood. Along the length of the plot's streambank side, 10 cover boards were evenly spaced. An additional 10 boards were placed along a second line 10 m away and parallel to the first. These boards were lifted during each area search to determine the presence of amphibians and reptiles.

Geographic Information Systems Data Collection

In addition to site attributes recorded in the field, GIS data layers were used to estimate the area of four land cover types within 250 m, 1 km, and 5 km of each plot center including: riparian vegetation, natural vegetation (including riparian), developed, and agricultural land cover types. For this analysis, we used the best available data for each plot's location in the Sacramento Valley. These land cover data were from the California Department of Fish and Game's Wetland and Riparian GIS Mapping Layers (Ducks Unlimited 1997), Sacramento River riparian vegetation (California Sate University Chico 1998), U.S. Forest Service existing vegetation (U.S. Forest Service 1999–2000), California Department of

Water Resources' land use layer (California Department of Water Resources various years), and the Draft Land Cover Map of Western Placer County (Jones & Stokes 2004). The process by which a single coverage was produced from these data sources involved converting each data source from its vector format to a 31 m grid. For tabulating the area of riparian vegetation within 250 m, 1 km and 5 km, cells attributed as riparian in any of the data layers were counted as riparian. Surrounding land use information was calculated from the California Department of Water Resources land use layer. This layer was a composite of counties that were photographed and mapped in different years. The land use categories in this layer were aggregated into three broad categories: natural vegetation, and agricultural and developed lands.

Data Analysis

Our data analysis consisted of summarizing the data sets and testing our six general research hypotheses. In evaluating these hypotheses, we used scatter plots, correlation coefficients, and simple or multiple stepwise regression models (Sokal and Rolf 1994). All statistical analyses were performed with the S-Plus statistical software package (MathSoft, Inc. 1999).

We evaluated our hypotheses with respect to eight species groups: 1) All bird species; 2) Riparian-associated bird species; 3) All mammals; 4) Small mammals; 5) All amphibians and reptiles; 6) All butterflies; 7) Riparian-associated butterflies; and 8) all odonates. For all of these groups (except small mammals), species richness (i.e., number of species) was used as the measure of the habitat provided for that group at an individual site. In other words, species richness was analyzed with respect to the amount, quality and diversity of habitat. Density of trapped individuals was the metric used for small mammals. For the purpose of our analysis, we considered riparian-associated birds and butterflies to be those species that in the Sacramento Valley and adjacent foothills are primarily associated with riparian vegetation (Tables 1 and 2). These lists were determined on the basis of relevant literature (Pool and Gill 1990–2003) and our professional judgments; the draft bird list also was revised in response to comments by PRBO ornithologists.

Table 1. Riparian-Associated Birds of Western Placer County

Common Name	Scientific Name
Cooper's Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Swainson's Hawk	*Buteo swainsoni*
Black-chinned Hummingbird	*Archilochus alexandri*
Downy Woodpecker	*Picoides pubescens*
Western Wood Pewee	*Contopus sordidulus*
Willow Flycatcher	*Empidonax traillii*
Pacific-slope Flycatcher	*Empidonax difficilis*
Warbling Vireo	*Vireo gilvus*
Tree Swallow	*Tachycineta bicolor*
House Wren	*Troglodytes aedon*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Yellow-breasted Chat	*Icteria virens*
Song Sparrow	*Melospiza melodia*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Grosbeak	*Guiraca caerulea*
American Goldfinch	*Carduelis tristis*

Table 2. Riparian-Associated Butterfly Species

Common Name	Scientific Name
Sara Orange-tip	*Anthocaris sara*
Pipevine Swallowtail	*Battus philenor*
Lorquin's Admiral	*Limentis lorquini*
Mourning Cloak	*Nymphalis antiopa*
Two-tailed Swallowtail	*Papilio multicaudatus*
Western Tiger	*Papilio rutulus*
Umber Skipper	*Paratrytone melane*
Green-veined White	*Pieris napi*
Satyr Comma	*Polygonia satyrus*
Sylvan Hairstreak	*Satyrium sylvinus*
Red Admiral	*Vanessa atalanta*
California Dogface	*Zerene eurydice*

Prior to calculating correlation coefficients or constructing regression models, variables were transformed to improve normality and homogeneity of variances. Percents were arcsine transformed, areas and widths were log transformed, and count data were square root transformed (Sokal and Rolf 1994; Zar 1999). Correlation coefficients were used to evaluate the magnitude and significance of relationships between pairs of variables. (Magnitude is the degree that two variables co-vary, while significance indicates that the correspondence is unlikely to have occurred by chance.) We used these coefficients to evaluate relationships among plot attributes, the different species groups, and between species groups and plot attributes.

Regression models were also used to evaluate the strengths of relationships between plot attributes and the measured species richness of taxonomic groups. A least-squares regression model is the equation for the straight line that best "fits" the data. In other words, it is the line that comes as close to passing through the data points as is possible. Unlike correlation coefficients, regression models can be used to quantify the degree to which combinations of readily observed plot attributes could be considered predictors of species richness. The interpretation of each regression model was based on its R^2 value and the partitioning of the sum of squares among variables (i.e., the sum of the squared deviations from the mean). In developing a regression model for each species group, species richness was the dependent variable and 1–4 plot attributes were the independent variables considered. Only variables significantly correlated with a group's species richness ($\alpha = 0.05$) were considered for initial inclusion in a model. When two or three variables representing an adjacent land cover type (e.g., percent natural vegetation within 250 m and within 1 km) were correlated with a species group, only the variable with the highest correlation was included. This was done to avoid including strongly correlated independent variables that could complicate interpretation of the results. Stepwise multiple regression analysis was used to define the final regression model if two or more variables were included in the initial model.

In interpreting the statistical significance of relationships, we adjusted the threshold for significance to account for making multiple statistical comparisons to evaluate one research hypothesis. Traditionally, a P value < 0.05 is used to indicate statistical significance. However, as more statistical tests are performed the odds of encountering a low P value due to chance increase. Therefore, we adjusted the P value considered significant through a Bonferroni correction (Sokal and Rolf 1994) so that the probability of erroneously considering a result significant (i.e., when the pattern was due to random variation in the absence of an actual relationship) was < 0.05 for the entire set of statistical tests addressing one of our general research hypotheses. Each of our hypotheses was addressed by 8–24 statistical comparisons, therefore, P values of 0.0063–0.0021, respectively, were considered the thresholds for significant relationships. Since Bonferroni adjustments are sometimes criticized as being overly strict, especially when the consequences of false negatives (β error) are worse that the consequences of false positives (α error), P values above these thresholds but < 0.01 were considered suggestive of possible relationships among the variables.

Although more than one dependent variable (i.e., richness based on one or four site surveys) was analyzed for several of the species groups, not every variable was used to evaluate any one of our research hypotheses. Because few mammal, amphibian or reptile species were detected over the course of a single area search, we only used richness based on four visits for these species groups.

Results

Most of the plots were situated in moderately to substantially altered riparian corridors, including Placer County plots (Table 3, Appendix B). Only 6 of the 47 plots (13%) were completely surrounded by natural vegetation and did not contain any infrastructure. In contrast, for 16 plots (34%) agricultural or developed land accounted for over half the adjacent land cover within 250 m, and 44% contained a road or other infrastructure (Table 3). On average, agricultural or developed lands accounted for 43% of the lands within 1 km of the plots (Table 4).

The riparian vegetation within most survey plots also was somewhat altered in its composition and structure. In general, the tree layer was discontinuous and averaged only 46% cover, and the shrub layer also had a comparable cover (Table 4). Willows and Fremont's cottonwood accounted for just 16% of tree cover, and oak species (primarily interior live oak and valley oak) accounted for 26%. Non-native species occupied little of this tree layer (5%), but Northern California black walnut, a species absent from this region 150 years ago, accounted for an additional 4% of total tree cover. In the shrub layer, the non-native Himalayan blackberry accounted for over half of all shrub cover.

Table 3. Presence of Infrastructure and Evidence of Disturbance in Plots[1]

Attribute	Total *N = 47*	Placer County Plots *N = 23*	Other Plots *N = 24*
Presence of Bank Protection	4	5	4
Levee or Berm	15	4	25
Road in Plot	46	50	42
Stream Incision	61	55	67
Evidence of Overbank Flow	57	41	71
Evidence of Grazing	21	17	25
Evidence of Tree Cutting	0	0	0
Evidence of Brush Clearing	4	4	4
Evidence of Dumping	21	22	21
Evidence of Other Disturbance	13	17	8

Note:
[1] Values in table are percents.

Table 4. Summary of Plot Vegetation and Surrounding Land Cover[1,2]

Attribute	Total Mean (Range)	Placer County Mean (Range)	Other Plots Mean (Range)
Riparian Width (meters [m])[3]	37 (2–200)	25 (2–80)	49 (10–200)
Tree Cover (%)	46 (3–95)	48 (3–95)	44 (10–80)
Shrub Cover (%)	41 (1–90)	38 (1–80)	44 (2–90)
Herb Cover (%)	76 (10–100)	84 (10–98)	69 (10–100)
Riparian Vegetation 250 m (hectares [ha])	5 (0–13)	4 (0–9)	6 (0–13)
Riparian Vegetation 1 kilometers (km) (ha)	36 (0–147)	26 (0–74)	45 (0–147)
Riparian Vegetation 5 km (ha)	365 (33–1,001)	261 (132–554)	465 (33–1,001)
Natural Vegetation 250 m (%)	66 (0–100)	69 (0–100)	64 (18–100)
Natural Vegetation 1 km (%)	58 (6–100)	59 (6–23)	56 (10–100)
Natural Vegetation 5 km (%)	60 (8–100)	63 (25–91)	57 (8–100)
Agricultural Land Cover 250 m (%)	20 (0–81)	10 (0–68)	28 (0–81)
Agricultural Land Cover 1 km (%)	29 (0–87)	18 (0–62)	39 (0–87)
Agricultural Land Cover 5 km (%)	26 (0–88)	15 (0–49)	37 (0–88)
Developed Land Cover 250 m (%)	14 (0–100)	20 (0–100)	8 (0–81)
Developed Land Cover 1 km (%)	14 (0–49)	23 (0–94)	5 (0–26)
Developed Land Cover 5 km (%)	14 (0–73)	22 (0–73)	5 (0–26)

Notes:

1 n = 47.

2 Riparian width, and tree, shrub and herb covers are ground-based measurements and land-cover variables are geographic information systems (GIS)–based.

3 SD = standard deviation.

4 Sample was stratified by anticipated riparian width, thus these width statistics are not representative of riparian vegetation width in the Sacramento Valley (e.g., the Valley's mean width is narrower).

The six relatively unaltered plots (i.e., no infrastructure in plot and no agricultural or developed land within 250 m) varied widely in their vegetation structure and species composition. The width of their riparian vegetation ranged from 8 m to 200 m. In the tree layer, the cover of oak species ranged from 0 to 78% and the cover of willows and cottonwood from 0 to 30%. The shrub layer varied from over 80% Himalayan blackberry (*Rubus discolor*) to a sparse cover (5%) of shrubs and tree saplings. With the exception of tree cover, these relatively unaltered plots bracketed the range of conditions observed in other plots that were more altered. None of the unaltered plots had low tree covers (range 40-80%); in contrast, 49% of other plots had tree covers below 40%.

There were relatively few strong relationships among site attributes (Table 5); however, suggestive positive relationships existed among riparian vegetation width with tree and shrub cover. Otherwise, most negative relationships were between variables that are inversely related by definition (e.g., land cover proportion) and most positive relationships were between variables that represented the same land cover category at different scales (e.g., developed land within 250 m, 1 km and 5 km).

Data collected at the 12 intensive data collection sites varied in their value for assessing riparian habitats. Almost no amphibians or reptiles were found beneath the cover boards. The results of the small mammal trapping varied substantially among sites (Table 6, Appendix B), and they did not correspond closely to the results of surveys for other taxonomic groups. However, conducting area searches for vertebrates on multiple dates resulted in more complete species lists (i.e., greater species richness) compared to lists based on a single area search, and species richness estimates based on multiple surveys had stronger relationships to site attributes than single survey estimates (Tables 7 and 8, Figure 1).

Three of the relatively unaltered plots were intensive data collection sites, and at these plots, results were comparable to other more altered sites, with the exception of small mammal density and the number of potential nesting bird species. The total number of small mammals trapped at the unaltered sites averaged 32 ± 4 (mean $\pm$ standard error) versus 3 ± 1 at the other plots. The number of potential nesting bird species at the unaltered sites averaged 3.3 ± 0.3 versus 1.1 ± 0.4 at the other plots (Table 6).

Table 5. Correlations Among Plot Attributes[1,2]

	Riparian Width	Tree Cover	Shrub Cover	Riparian (250 m)	Riparian (1 km)	Riparian (5 km)	Natural (250 m)	Natural (1 km)	Natural (5 km)	Agricultural (250 m)	Agricultural (1 km)	Agricultural (5 km)	Developed (250 m)	Developed (1 km)	Developed (5 km)
Riparian Width	1.00	**0.48**	**0.44**	0.30	-0.01	-0.04	0.04	**0.43**	0.01	0.13	-0.28	-0.17	-0.14	-0.16	0.19
Tree Cover	–	1.00	**0.44**	0.03	0.03	-0.04	-0.07	-0.06	-0.05	0.05	-0.01	-0.06	0.05	0.13	0.18
Shrub Cover	–	–	1.00	-0.18	-0.12	-0.04	-0.13	-0.01	0.16	-0.07	-0.08	-0.02	0.26	0.17	-0.10
Riparian (250 m)	–	–	–	1.00	**0.91**	**0.63**	-0.21	-0.21	-0.04	0.24	0.28	0.15	0.01	-0.03	-0.08
Riparian (1 km)	–	–	–	–	1.00	**0.73**	-0.29	-0.26	-0.06	0.28	0.27	0.13	0.06	0.04	-0.05
Riparian (5 km)	–	–	–	–	–	1.00	-0.29	-0.27	-0.03	0.28	0.20	0.02	0.07	0.13	0.04
Natural (250 m)	–	–	–	–	–	–	1.00	**0.84**	**0.59**	**-0.55**	**-0.44**	**-0.37**	**-0.59**	**-0.49**	-0.20
Natural (1 km)	–	–	–	–	–	–	–	1.00	**0.74**	**-0.53**	**-0.65**	**-0.55**	**-0.44**	**-0.42**	-0.11
Natural (5 km)	–	–	–	–	–	–	–	–	1.00	**-0.48**	**-0.54**	**-0.61**	-0.21	-0.23	-0.30
Agricultural (250 m)	–	–	–	–	–	–	–	–	–	1.00	**0.83**	**0.68**	**-0.34**	**-0.35**	-0.30
Agricultural (1 km)	–	–	–	–	–	–	–	–	–	–	1.00	**0.88**	-0.28	**-0.40**	**-0.49**
Agricultural (5 km)	–	–	–	–	–	–	–	–	–	–	–	1.00	-0.22	**-0.38**	**-0.57**
Developed (250 m)	–	–	–	–	–	–	–	–	–	–	–	–	1.00	**0.89**	**0.49**
Developed (1 km)	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	**0.71**
Developed (5 km)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00

Notes:

m = meters, km = kilometers

[1] *n* = 47

[2] Numbers in table are correlation coefficients (r) between the site attributes, and those with a p value <0.01 are in bold; P values are based on the r value and number of observations (n), and in this analysis values <0.01 are considered to indicate suggestive relationships among variables. Variables were transformed as described in methods prior to calculation of correlation coefficients.

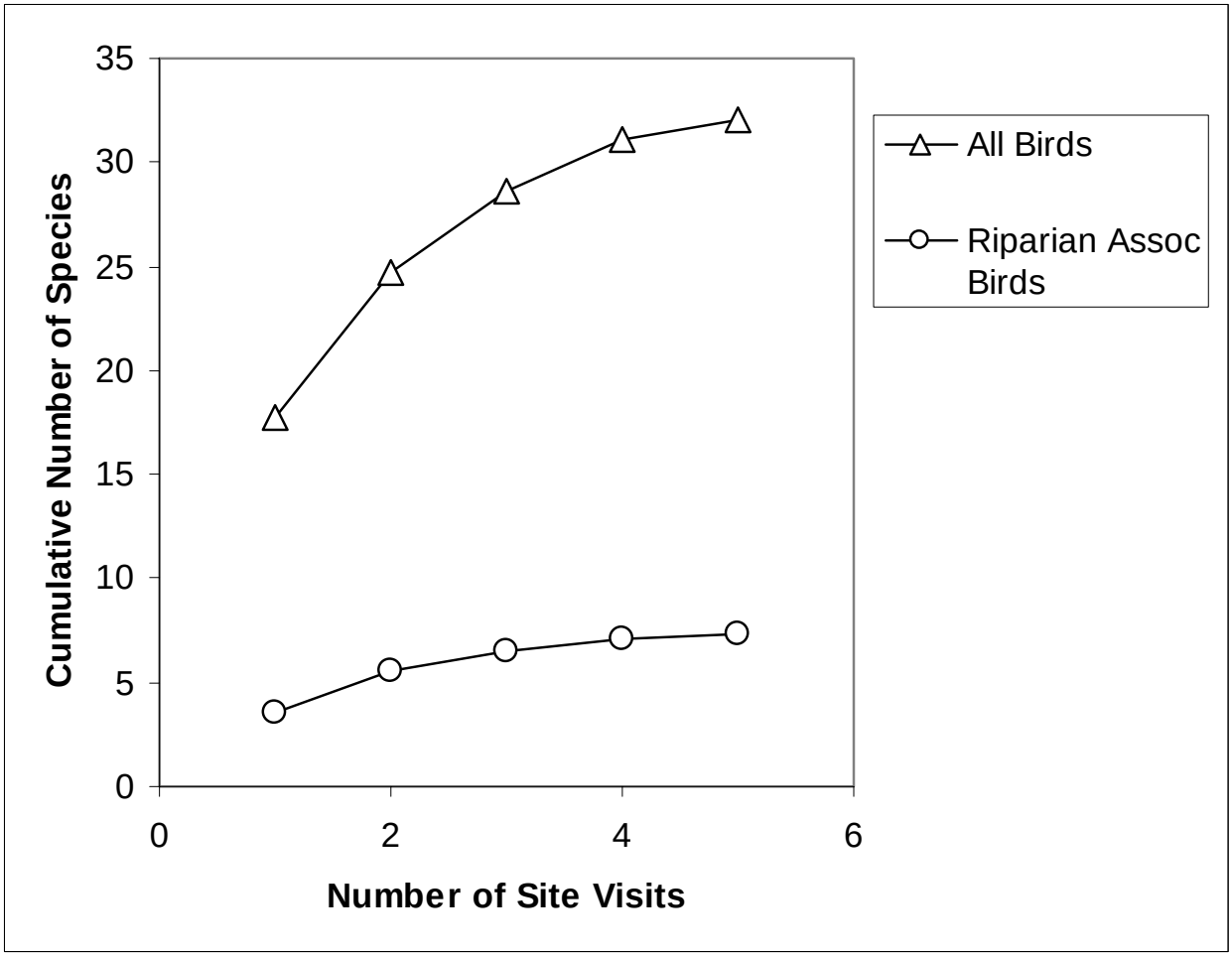


Figure 1. Cumulative Number of Bird Species Observed During Area Searches

Table 6. Summary of Species Observations[1,2]

Species Group	*n*	Mean	SD	Range
Butterfly Spp (2 Surveys)	47	8.6	2.6	4–14
Riparian-Associated Butterfly Spp (2 Surveys)	47	2.4	1.2	0–5
Odonate Spp (1 Survey)	43	7.8	2.3	3–12
Bird Spp (1 Survey)	47	16.3	4.3	6–29
Riparian-Associated Bird Spp (1 Survey)	47	4.3	2.0	0–8
Riparian Associated Bird Spp (4 Surveys)	12	7.4	2.0	4–14
Small Mammal Density (3 nights trapping)[3]	10	12	15	0–39
Mammal Spp (1 Survey)	47	1.5	1.3	0–4
Mammal Spp (4 Surveys)	12	2.3	1.2	1–4
Amphibian and Reptile Spp (1 Survey)	47	0.8	1.0	0–3
Amphibian and Reptile Spp (4 Surveys)	12	2.7	1.1	1–4

Notes:

1 Numbers in table are numbers of species, except for small mammal density, which is number of individuals.

2 Abbreviations: N = number of plots, SD = standard deviation, Spp = species.

3 Number of individuals per unit area (not number of species).

With the exception of relationships between surrounding land cover types and vertebrate species richness, our results did not strongly support our initial research hypotheses. In most cases, the species richness of riparian-associated birds was not strongly related to the species richness of other animal groups, though two relationships were significant (Table 7, Figure 2). There was a significant relationship between riparian-associated birds and mammal species (4 surveys, $df = 10$, $r = 0.71$, $p < 0.05$ and < 0.01 without Bonferroni adjustment). There were also significant relationships between potentially resident riparian-associated birds and amphibians and reptiles (based on 4 surveys, $df = 10$, $r = 0.76$, $p < 0.01$, without Bonferroni adjustment $p < 0.005$).

Species richness did not increase significantly with the width of riparian vegetation for any animal group. Correlation coefficients between species groups and riparian width generally were all below 0.40 (Table 8). Results for riparian-associated birds (based on 1 survey) suggested a positive relationship with riparian width ($df = 45$, $r = 0.35$, $p < 0.07$ and < 0.009 without Bonferroni adjustment; Table 8, Figure 3). However, for the multiple survey plots, there was not a relationship between the number of riparian-associated bird species and riparian width ($df = 10$, $r = 0.16$, $p > 0.25$ without Bonferroni adjustment; Figure 3). Similarly, the species richness of other animal groups had no significant or suggestive positive relationships with riparian width. Riparian width was initially included in four regression models (Table 9), although, in one case (riparian-associated birds based on 1 survey), width was not included in the final model.

In general, species richness of the animal groups had no significant or suggestive relationships with the area of riparian vegetation, and only weak relationships with tree or shrub cover (Table 8). However, riparian-associated birds,, based on 1 survey, had a highly significant relationship with tree cover ($df = 45$, $r = 0.49$, $p < 0.004$ and $p < 0.0005$ without Bonferroni adjustment; Figure 3). The species richness of other animal groups did not have significant or suggestive relationships with riparian woody plant cover.

For the plots receiving multiple surveys, significant correlations existed between vertebrate species richness and surrounding land cover. For these data, nearly half the correlation coefficients were between 0.50 and 0.87, and 14 of these were significant or suggestive (Table 8).

The species richness of riparian-associated birds was significantly related to the extent of surrounding natural and agricultural lands. Riparian-associated birds (based on 4 surveys) had suggestive relationships with percent of surrounding land in natural vegetation within 250 m, 1 km and 5 km ($r = 0.67–0.73$, $p < 0.22$-0.09 and $p < 0.009–0.004$ without Bonferroni adjustment). If the count of riparian-associated bird species at each plot were restricted to just potential nesting species, the relationships to adjacent land cover were stronger. For this set of observed riparian-associated bird species, correlations with agricultural and natural land cover within 250 m had coefficients of -0.84 and 0.82, respectively, indicating strong relationships with surrounding land cover (p values < 0.01-0.02 and < 0.0005 without Bonferroni adjustment). This group also had suggestive relationships to natural and agricultural land cover at other scales (Table 8). Furthermore, no breeding or nesting behaviors were observed for riparian-associated birds at the sites with higher portions of the surrounding area in agricultural land at 250 m (Figure 4).

Similarly, in the multiple survey data sets, the species richness of amphibians, reptiles and mammals was related to surrounding land-cover within 250 m to 5 km. Species richness of amphibians and reptiles had a significant relationship with the portion of the surrounding area in agricultural land for the areas within 1 km and 5 km ($r = -0.78$ and -0.85, respectively, $p < 0.04$ and 0.01, respectively, and p values < 0.002 and < 0.0005 without Bonferroni adjustment). Similarly, species richness of mammals had a significant negative correlation with developed land cover within 250 m and 1 km ($r = -0.82$ and -0.87, respectively, $p < 0.02$ and 0.01, and p values < 0.001 and 0.0005 without Bonferroni adjustment), and suggestive correlations to natural land cover (Table 8).

Although some of the relationships between vertebrate species richness and surrounding land cover were considered just suggestive in the context of this analysis's numerous hypothesis tests, each of these relationships accounted for a moderate portion of the variability among the multiple survey plots in the species richness of a vertebrate group.

Combinations of variables did not produce substantially stronger models for predicting species richness than did single variables. For the individual taxonomic groups, simple linear and stepwise multiple regression produced models with p values between < 0.0001 and 0.064 (Table 9). For all vertebrate species, the models consisted of one or two variables and almost all independent

Table 7. Correlations Among Species Groups[1,2]

	All Bird Spp	R-A Bird Spp (1 Survey)	R-A Bird Spp (4 Surveys)	R-A, PN Bird Spp (4 Surveys)	Mammal Spp (1 Survey)	Mammal Spp (4 Surveys)	Small Mammal Density	Amphibian & Reptile Spp (1 Survey)	Amphibian & Reptile Spp (4 Surveys)	All Butterfly Spp	R-A Butterfly Spp	Odonate Spp
All Bird Spp (*n* = 47)	1.00	–	–	–	–	–	–	–	–	–	–	–
R-A Bird Spp 1 survey (*n* = 47)	**0.75**[3]	1.00	–	–	–	–	–	–	–	–	–	–
R-A Bird Spp 4 Surveys (*n* = 12)	**0.50**	**0.78**[3]	1.00	–	–	–	–	–	–	–	–	–
R-A, PN Bird Spp 4 Surveys (*n* = 12)	0.53	0.20	0.54	1.00	–	–	–	–	–	–	–	–
Mammal Spp 1 survey (*n* = 47)	0.18	0.06	0.12	0.16	1.00	–	–	–	–	–	–	–
Mammal Spp 4 surveys (*n* = 12)	0.11	0.43	**0.71**[3]	0.32	0.42	1.00	–	–	–	–	–	–
Small Mammal Density (*n* = 10)	0.12	-0.12	0.00	0.58	0.16	0.25	1.00	–	–	–	–	–
Amphibian & Reptile Spp 1 Survey (*n* = 47)	0.32	0.18	0.28	**0.87**[3]	0.29	0.31	-0.13	1.00	–	–	–	–
Amphibian & Reptile Spp 4 Surveys (*n* = 12)	0.20	0.06	0.29	**0.76**[3]	-0.04	-0.13	0.59	**0.62**	1.00	–	–	–
All Butterfly Spp 2 Surveys (*n* = 47)	0.10	0.14	-0.08	-0.06	-0.09	-0.09	-0.26	0.13	-0.02	1.00	–	–
R-A Butterfly Spp 2 Surveys (*n* = 47)	0.14	0.33	-0.30	-0.23	-0.10	-0.15	-0.07	-0.01	0.43	**0.57**	1.00	-
Odonate Spp 1 Survey (*n* = 43)	0.19	-0.01	**0.58**	0.52	-0.24	0.09	-0.07	0.23	0.45	0.04	-0.13	1.00

Notes:

[1] Numbers in table are correlation coefficients (*r*) between the number of species observed and the value of a site attribute, and those with a *p* value <0.01 are in bold; *P* values are based on the *r* value and number of observations (*n*), and in this analysis values <0.01 are considered to indicate suggestive or significant relationships among variables. Variables were transformed as described in methods prior to calculation of correlation coefficients.

[2] Abbreviations are: R-A = riparian-associated, PN = potentially nesting, and Spp = Species.

[3] Correlation significant at $\propto = 0.05$ with Bonferroni adjustment.

Table 8. Correlations of Species Observations with Plot Attributes[1]

Species Group[2]	Riparian Width	Tree Cover	Shrub Cover	Riparian (250 m)	Riparian (1 km)	Riparian (5 km)	Natural (250 m)	Natural (1 km)	Natural (5 km)	Agricultural (250 m)	Agricultural (1 km)	Agricultural (5 km)	Developed (250 m)	Developed (1 km)	Developed (5 km)
All Bird Spp (*n* = 47)	0.18	0.27	0.12	-0.05	-0.08	-0.03	0.18	0.15	0.05	-0.03	-0.16	-0.18	-0.22	-0.07	0.13
R-A Bird Spp 1 survey (*n* = 47)	**0.35**	**0.49**[3]	0.18	0.07	0.07	0.16	0.21	0.20	0.20	0.03	-0.10	-0.14	-0.28	-0.16	-0.04
R-A Bird Spp 4 Surveys (*n* = 12)	0.16	0.33	0.04	-0.15	-0.33	-0.40	**0.67**	**0.70**	**0.73**	-0.38	-0.31	-0.23	-0.43	-0.61	-0.50
R-A, PN Bird Spp 4 Surveys (*n* = 12)	-0.01	-0.07	0.34	-0.45	-0.46	-0.52	**0.82**[3]	**0.73**	0.52	**-0.84**[3]	**-0.70**	**-0.67**	-0.15	-0.29	-0.05
Mammal Spp 1 survey (*n* = 47)	0.14	-0.17	0.06	0.32	**0.36**	0.21	0.01	-0.11	-0.10	0.19	0.28	0.27	-0.19	-0.20	-0.21
Mammal Spp 4 surveys (*n* = 12)	0.32	0.33	0.20	-0.12	-0.18	-0.36	**0.70**	**0.76**	0.42	0.05	-0.01	0.12	**-0.82**[3]	**-0.87**[3]	-0.47
Trapped Mammal Density (*n* = 10)	0.39	0.02	0.50	-0.31	-0.37	-0.42	0.62	0.67	0.29	-0.40	-0.47	-0.29	-0.29	-0.30	-0.03
Amphibian & Reptile Spp 1 Survey (*n* = 47)	-0.24	-0.19	-0.17	0.27	0.25	0.30	0.21	0.22	0.28	-0.04	-0.14	-0.25	-0.20	-0.12	-0.04
Amphibian & Reptile Spp 4 Surveys (*n* = 12)	-0.18	-0.19	0.62	-0.44	-0.45	-0.34	0.02	0.35	0.46	-0.46	**-0.78**[3]	**-0.85**[3]	0.37	0.31	0.38
All Butterfly Spp 2 surveys (*n* = 47)	**-0.39**	0.07	-0.11	0.16	0.16	0.05	0.33	0.20	0.25	-0.18	-0.15	-0.29	-0.22	-0.10	0.07
R-A Butterfly Spp 2 surveys (*n* = 47)	0.05	0.30	0.23	0.15	0.18	0.07	0.10	0.13	0.27	-0.06	-0.10	-0.17	-0.08	-0.04	-0.06
Odonate Spp 1 survey (*n* = 43)	-0.24	-0.11	-0.08	-0.19	-0.27	-0.25	0.03	0.04	-0.02	0.11	0.13	0.06	-0.15	-0.26	-0.15

Notes:

[1] Numbers in table are correlation coefficients (r) between the number of species observed and the value of a site attribute, and those with a p value <0.01 are in bold; P values are based on the r value and number of observations (n), and in this analysis values <0.01 are considered to indicate suggestive or significant relationships among variables. Variables were transformed as described in methods prior to calculation of correlation coefficients.

[2] Abbreviations are: R-A = riparian-associated, PN = potentially nesting, and Spp = Species.

[3] Correlation significant at $\propto = 0.05$ with Bonferroni adjustment.

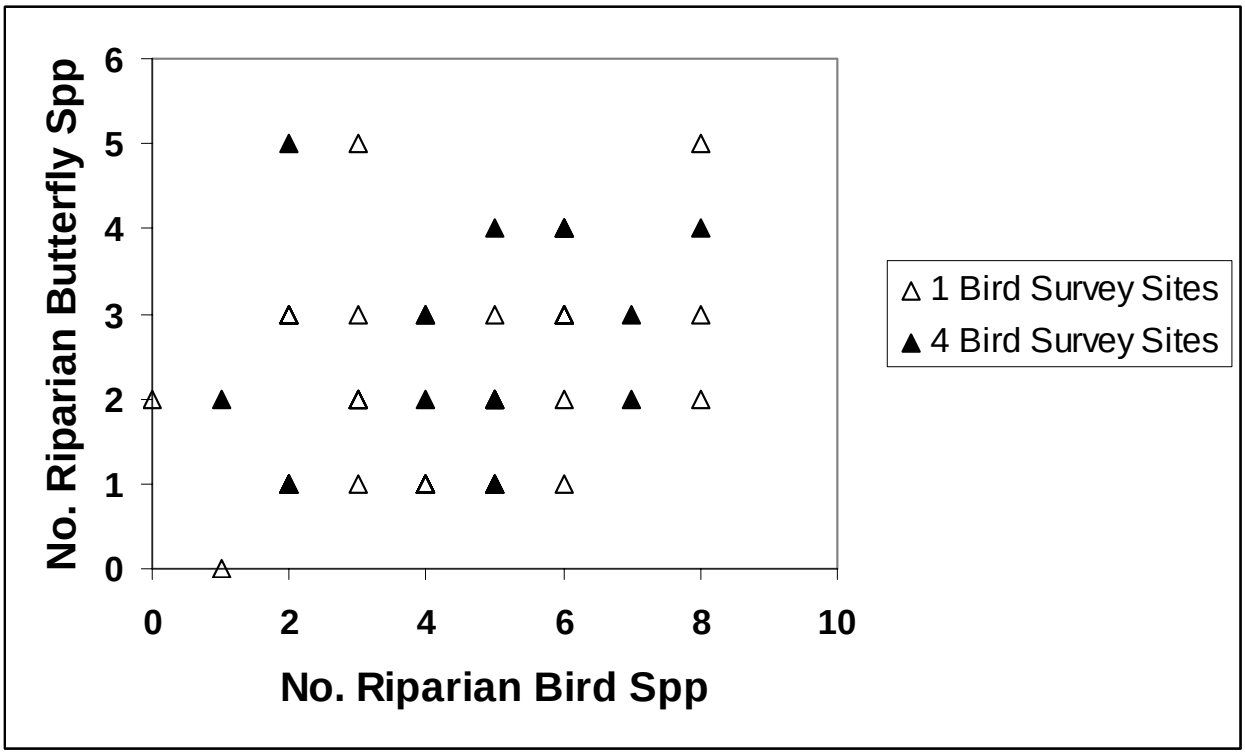
Table 9. Contribution of Variables to Multiple Regression Models for Relationship of Species Groups to Site Attributes[1]

			Sum of Squares (SS) Associated with Variables												
Species Group[2]	R^2	Total SS	Riparian Width	Tree Cover	Shrub Cover	Riparian (1 km)	Riparian (5 km)	Natural (250 m)	Natural (1 km)	Natural (5 km)	Agricultural (250 m)	Agricultural (1 km)	Agricultural (5 km)	Developed (250 m)	Developed (1 km)
All Bird Spp (n = 47, p = 0.0426)	0.09	13.59 (100%)	–	1.20 (9%)	–	–	–	–	–	–	–	–	–	–	–
R-A Bird Spp 1 Survey (n = 47, p = 0.0003)	0.31	11.63 (100%)	0 (0%)	2.89 (25%)	–	–	–	–	–	–	–	–	–	0.71 (6%)	–
R-A Bird Spp 4 Survey (n = 12, p = 0.0115)	0.63	1.53 (100%)	–	–	–	–	–	–	–	0.67 (44%)	–	–	–	–	0.29 (19%)
R-A, PN Bird Spp (n = 12, p < 0.0001)	0.90	3.41 (100%)	–	–	–	–	0 (0%)	2.63 (77%)	–	–	0.44 (13%)	–	–	–	–
Mammal Spp 1 Survey (n = 47, p = 0.0132)	0.13	9.99 (100%)	–	–	–	1.29 (13%)	–	–	–	–	–	0 (0%)	–	–	–
Mammal Spp 4 Survey (n = 12, p = .0175)	0.45	1.37 (100%)	–	–	–	–	–	–	0 (0%)	–	–	–	–	–	0.61 (45%)
Sm. Mammal Density (n = 10, p = 0.0641)	0.37	40.16 (100%)	–	–	–	–	–	–	14.68 (37%)	–	–	–	–	–	–
A & R Spp 1 Survey (n = 47, p = 0.0505)	0.13	7.74 (100%)	0.62 (8%)	–	–	–	0 (0%)	–	–	0.36 (5%)	0 (0%)	–	–	–	–
A & R Spp 4 Survey (n = 12, p = 0.0017)	0.64	1.01 (100%)	–	–	0 (0%)	–	–	–	–	–	–	–	0.65 (64%)	–	–
All Butterfly Spp (n = 47, p = 0.0006)	0.29	8.75 (100%)	1.43 (16%)	–	–	–	–	1.08 (12%)	–	–	–	–	0 (0%)	–	–
R-A Butterfly Spp (n = 47, p = 0.0453)	0.09	6.49 (100%)	–	–	–	–	–	–	–	0.56 (9%)	–	–	–	–	–
Odonate Spp (n = 43, p = 0.0405)	0.19	7.47 (100%)	0.44 (6%)	–	–	0.44 (6%)	–	–	–	–	–	–	–	–	0.54 (7%)

Notes:

[1] Variables were transformed as described in methods prior to calculation of regression models.

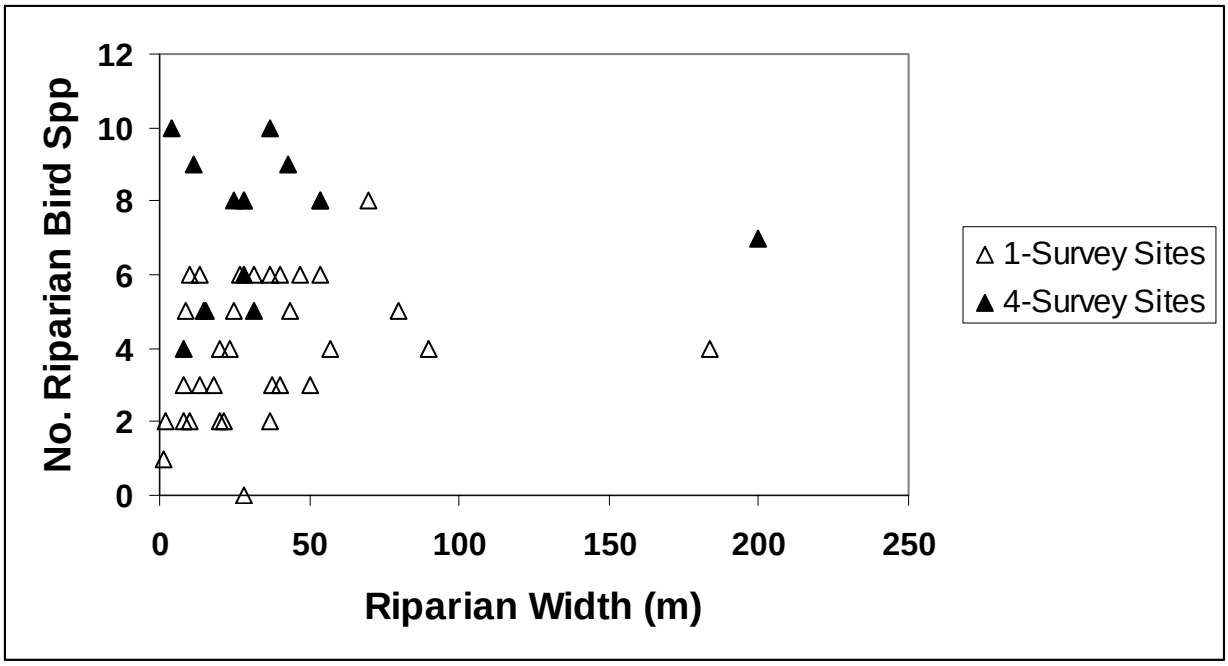
[2] Abbreviations are: R-A = riparian-associated, PN = potentially nesting, A & R = Amphibian and Reptile, and Spp = Species.

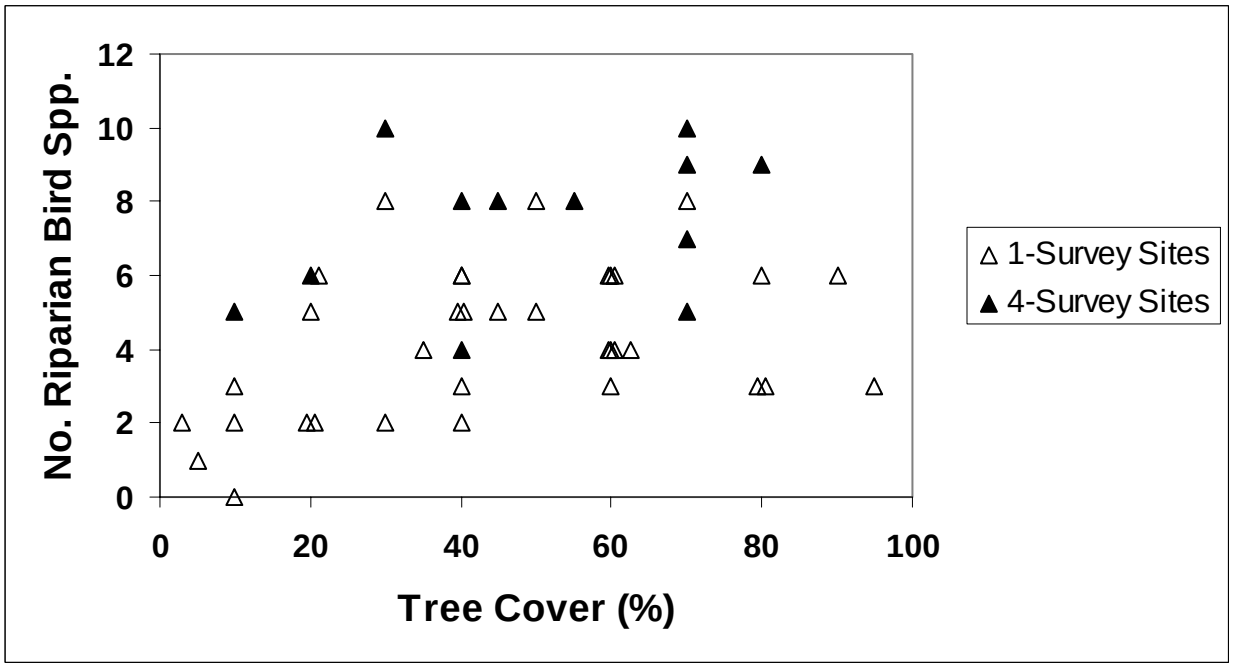


Note:

[1] *n* = 47

Figure 2. Correspondence of Species Richness among Riparian-Associated Birds and Riparian-Associated Butterflies[1]





Note:

[1] $n = 47$

Figure 3. Relationship of Species Richness of Riparian-Associated Birds and Selected Site Attributes[1]

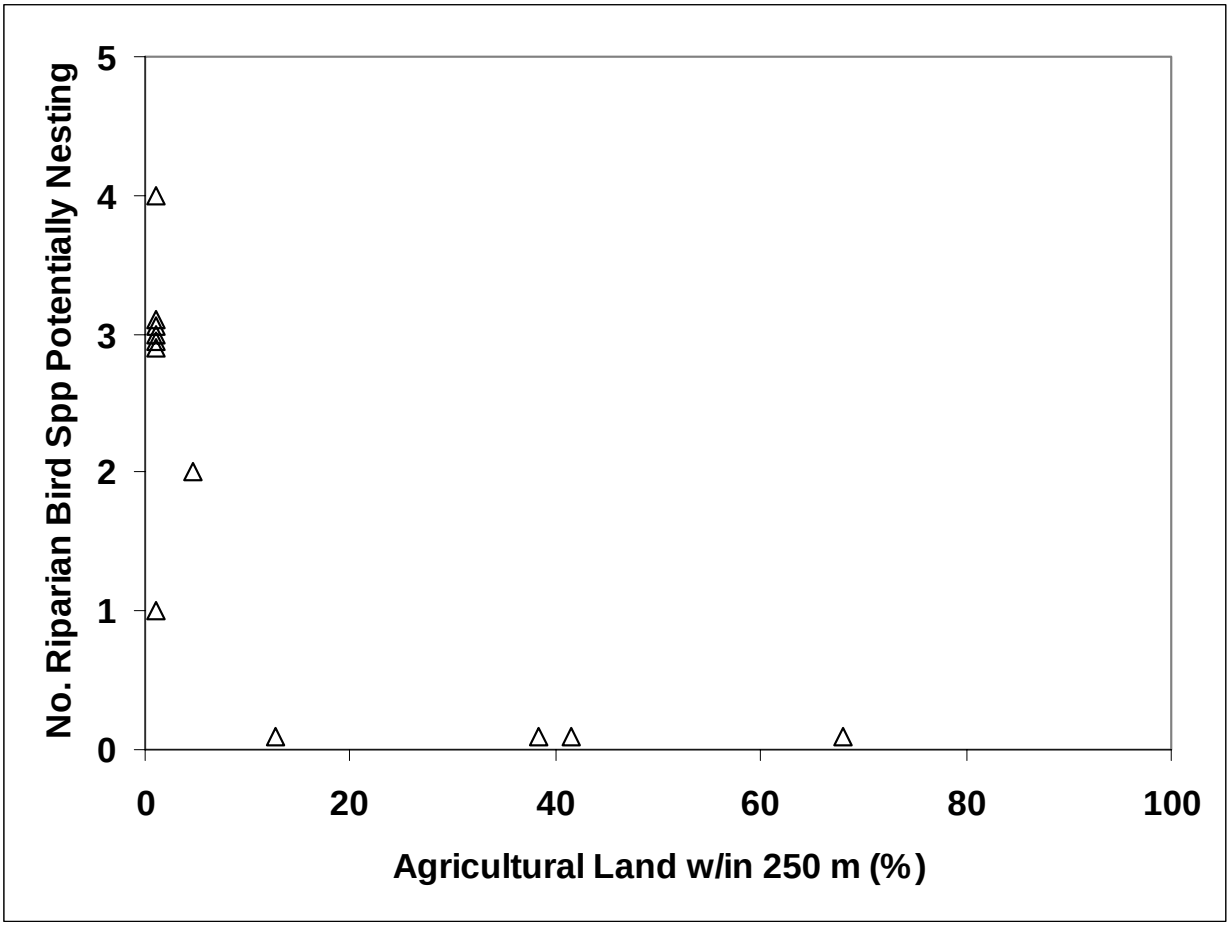


Figure 4. Relationship Between Number of Riparian-Associated Bird Species Potentially Nesting at a Site and Adjacent Agricultural Land

variables represented surrounding land cover. Only three of these models had R^2 values > 0.5: riparian-associated birds (4-surveys), riparian-associated birds potentially nesting (4 surveys) and amphibians and reptiles (4 surveys). The amphibian and reptile model was based only on the percent of area within 5 km that was in agricultural land. The model for potential nesting riparian-associated birds was based on two land cover variables, but just one of these (natural vegetation within 250 m) accounted for 86 % of the variability explained by the model. For riparian-associated birds (all observed during 4 surveys regardless of behavior), the regression model based on two variables was substantially stronger than for any one variable ($R^2 = 0.63$).

Discussion

Implications for Biological Site Surveys to Assess Riparian Biodiversity

These results indicated that data from multiple site surveys for vertebrates provide a much stronger basis for assessing a riparian area than data from a single site visit. Not only did data from four site surveys document more species than a single survey of those sites, but the results of single and multiple surveys were not highly correlated with each other. Overall, multiple site surveys provide a much more consistent basis for evaluating the habitat value of riparian sites.

These results also indicate that non-destructive area searches for mammals, amphibians, and reptiles were not an effective survey technique, even with the placement of cover boards. Overall, few species were observed during these area searches, usually less than one amphibian or reptile species during a single survey. Though few amphibian or reptile species may have been present, the results still demonstrate that a single non-destructive area search is not an effective means of inventorying the mammal, amphibian, and reptile species using a site. In most plots surveyed multiple times, additional species were observed, indicating that during a single survey most species using a site were not detected. No amphibian or reptiles species was observed beneath any of the 240 cover boards set out and checked 4–6 times during this study. However, cover boards may be more effective is used during late winter-early spring rainy season, and possibly if constructed using thicker materials that provided better insulation from higher temperatures.

Implications for a FAM

Overall, our results indicate that, for the smaller streams and rivers of the Sacramento Valley, developing a single model that *precisely* quantifies *overall* habitat functions on the basis of readily measured site attributes is problematic, particularly on the basis of available information. However, the results do show that some readily measured site attributes are related to the species richness of

particular taxonomic groups. For particular species, guilds, or taxonomic groups, this indicates that useful assessment criteria based on readily measured site attributes could be developed as shown in the examples in Table 10.

In this study, the species richness of different groups (particularly between vertebrates and invertebrates) was not related, and species groups often differed in their relationships to plot attributes. In general, species differ in their biology and thus their habitat requirements, particularly across major taxonomic groups such as vascular plants, butterflies and mammals. Therefore, numerous specific site attributes such as disturbance history, vegetation structure, and presence of host plants, refugia, or rock outcrops affect these species groups differently, and many of these attributes are themselves only loosely related to the landscape variables that are most useful for a cost-effective FAM (e.g., surrounding land use, area and width of riparian vegetation). Thus, models, or assessment criteria, that focus on individual species or guilds will likely provide more useful assessments of a site's habitat value than a model that attempts to quantify habitat value for all species combined (Stein et al. 2000; Smith 2000; Bryce et al. 2002).

In this study, the vertebrate groups had relationships to site attributes, and thus for particular vertebrate taxonomic groups, guilds or species effective assessment criteria based on readily measured site attributes probably could be developed through additional studies. In data from multiple site visits, which were most effective at documenting species' presence, relationships between species richness and surrounding land use were important.

Unfortunately, due to their sample size and the types of data collected, these data sets have substantial limitations. They consist of only twelve plots, and they contain few or no replicates of some important types of sites (e.g., wide riparian corridors in urban areas). They also were scattered over a wide and heterogeneous geographic area. Furthermore, they contain little information on abundance and no information on rates of growth, survival or reproduction. Thus, while these data indicate the importance of surrounding land uses, and other readily measured site attributes, additional studies with larger sample sizes, and collecting other types of ecological data (e.g., density, survival or reproduction), are necessary for defining assessment criteria that precisely quantify habitat values under different combinations of site attributes. We consider such studies important next steps for the conservation planning process.

As one of these next steps, PRBO's point count dataset provides an excellent opportunity to evaluate relationships between the abundance (i.e., number of individuals) of riparian-associated bird species and riparian width and surrounding land cover. Point count surveys are designed to record the relative abundance of individual species, and PRBO has conducted these surveys for over a thousand locations over multiple years. Their analysis would require the calculation of GIS-based landscape metrics (comparable to the surrounding land cover variables used in this study) and an aerial photo-based interpretation of riparian width. Nonetheless, the analysis of existing PRBO point count data would be a cost-effective means to rigorously analyze relationships between the abundance of species and riparian width and surrounding land cover.

Table 10. Evaluation of Habitat Functions by Representative Functional Assessment Methods

Assessment	Terrestrial Habitat Functions	Variables used to Assess Habitat Function	Tested[1]
Spatial Wetland Assessment for Management and Planning, SWAMP (Sutter 2001)	Terrestrial wildlife habitat	Area of interior habitat Heterogeneity of vegetation Presence of surface water	No
Assessment of riverine wetlands in Washington State (Hruby et al. 1999)	Bird, Mammal, Amphibian Habitat	Density and condition of snags Presence of special features Evidence of disturbance on adjacent land Interspersion of vegetation types	No
Hydrogeomorphic assessment (HGM) of riverine floodplains in the Northern Rocky Mountains (Hauer et al. 2002)	Characteristic vertebrate habitats	Cover in herb and shrub layers and of native species Tree density Inundation frequency Connectivity of vegetation types	No
Suggested revisions to BLM's Proper Functioning Condition assessment procedure (Stevens et al. 2002)	Fish and wildlife habitat	Canopy connectivity Vegetation patch density Fluvial landform diversity	No
Southern California Riparian Model (Stein et al. 2000)[2]	Condition units[2]	Cover of native plants Percent invasive species Vegetation structural diversity Riparian vegetation continuity Adjacent land cover	No
Bird Integrity Index (Bryce et al. 2002)	Overall riparian integrity including overall habitat integrity	Number or proportion of bird species (or of individuals) in selected guilds	Yes
Tidal freshwater wetlands along Hudson River (Findley et al. 2002)	Breeding Bird, Muskrat and Waterfowl Habitat[3]	Cover or stem density of plant species Soil texture	No[3]
Wetland Assessment, WEA, for San Francisco Bay Region (Breaux and Martindale 2003)	Wildlife Utilization Rating	Guidelines for professional judgment	No
San Diego Creek Assessment (Smith 2000)	Riparian habitat integrity	Native riparian vegetation area Riparian corridor continuity Adjacent land use/land cover	No
Indicator Value Assessment, IVA (Hruby et al. 1995)	General waterfowl, General wildlife	Numerous (>60 indicators)	No
Wetland Habitat Assessment Technique, HAT (Cable et al. 1989)	Habitat quality	Bird species presence Wetland area	No

Notes:

[1] Tested by comparison to direct measurements of species presence, abundance or demography. For assessments that used direct measures of animal species group (e.g., birds) presence to assess overall site condition or habitat quality, testing requires comparison to direct measurements of other animal groups.

[2] Habitat function incorporated into overall rating (i.e., condition units), and only habitat variables are listed in this table.

[3] This study also included fish and aquatic invertebrate habitat functions that were tested by comparison to direct measurements.

Because of the differences among species groups, and the limitations of current knowledge, a FAM for western Placer County that calculates a single score for a riparian area's habitat functions should be considered only a very general indicator of the overall provision of habitat functions. Such a score should be based on a limited number of variables, preferably just one or two variables that are broadly related to most habitat values and the processes sustaining them (e.g., proportion of surroundings in natural vegetation, hydraulic connectivity). This would limit inaccuracies caused by the operations and coefficients selected to combine variables, and would maintain a mechanistic basis for the assessment.

Implications for Riparian Setbacks

Though width of riparian vegetation was not significantly related to species richness, this result should not be interpreted as evidence that the width of a riparian setback is not an important consideration for habitat conservation. This study's sample size, particularly for the multiple survey sites, was small and spread over a large geographic area. Thus, it is likely that only effects of larger magnitude would have been identified and locally important effects would not have been detected without a larger sample size. Width may be important for some species, but these species might be few in number or absent from our data sets. Because all but a few plots represented landscapes substantially altered by human use, most species sensitive to these alterations (including a reduction in riparian width) may no longer be present at any of the study sites. For example, Western Yellow-billed Cuckoo is such a species (Greco et al. 2002) and was not detected at any of the 47 plots during our surveys.

Riparian setbacks would include both riparian and other natural vegetation, and their width would be directly related to the extent of adjacent natural, agricultural and developed land cover; and the proportions of surrounding land-cover types were related to species richness in this study's results. Furthermore, other studies, have shown relationships between the width of riparian vegetation and the presence of riparian-associated animals (Greco et al. 2002).

This study's results indicated that there are important relationships between adjacent land use within 250 m–5 km and the biodiversity of riparian corridors in the Sacramento Valley. These relationships are consistent with studies of riparian habitat elsewhere (Findlay and Houlahan 1996; Forman and Alexander 1998; Bryce et al. 2002; Miller et al. 2003; Semlitsch and Bodie 2003) and with our understanding of factors known to affect riparian species in the Sacramento Valley, such as the availability of upland habitats also used by many of these species. Thus, riparian setbacks should consider both the condition and management of riparian vegetation and the buffer between this vegetation and adjacent developed and agricultural lands. Also, the results suggest that riparian setbacks may not be able to prevent all adverse effects of surrounding land uses on riparian biodiversity, and thus that other conservation measures may be necessary as well.

However, the results of this study are not by themselves a sufficient basis for recommending setback or buffer widths. For this reason, our report providing guidance for riparian setbacks (Task 5 of the Riparian Ecosystem Assessment), will consider these results together with other available data, and a review of the scientific literature regarding the use of adjacent land by riparian species and the influences of adjacent land uses on those species.

Acknowledgements

We would like to acknowledge the guidance provided by Placer County Planning Department staff (M. Batteate and L. Clark) and by the members of the County's technical advisory Committee, and the collaboration of the Point Reyes Bird Observatory. For their personal assistance, we also thank G. Ballard, P. Cylinder, C. Hicks, K. Keller, W. Kohn, D. Leslie, S. Myers, S. Parsons, G. Platenkamp, J. Robins, E. Routt, W. Shaul, D. Stralberg, E. West, and M. Widdowson.

References Cited

Breaux, A. and M. Martindale. 2003. Wetland ecological and compliance assessments in the San Francisco Bay Region, California. A report to the San Francisco Bay Regional Water Quality Control Board, California State Water Resources Control Board, California Coastal Conservancy, and U.S. Army Corps of Engineers, San Francisco District. Available at: <http://www.swrcb.ca.gov/rwqcb2/Download.htm>.

Bryce, S. A., R. M. Hughes and P. R. Kaufman. 2002. Development of a bird integrity index: using bird assemblages as indicators of riparian condition. *Environmental Management* 30: 294-310.

Cable, T. T., V. Brack and V. R. Holmes. 1989. Simplified method for wetland habitat assessment. *Environmental Management* 13: 207-213.

California Department of Water Resources . 2001. California Department of Water Resources, Division of Planning and Local Assistance, land use data. Last Revised: December 27, 2001. Available at: <http://www.waterplan.water.ca.gov/landwateruse/landuse/ludataindex.htm>

California State University Chico. 1998. Sacramento River riparian vegetation coverage draft. California State University, Chico, CA. Available at: <http://phobos.lab.csucuico.edu/projects/veg_mapping/sacriver/sacrmetadata-f.htm>.

Ducks Unlimited. 1997. California wetland and riparian geographic information system project. Ducks Unlimited, Sacramento, CA. Available at: <http://maphost.dfg.ca.gov/wetlands/metadata/wet_ph1.pdf>

Fellers, G. M. and C. A. Drost. 1994. Sampling with artificial cover. Pages 146-150 in W. R. Heyer, M. Donnelley, R. W. McDiarmid and L. C. Hayek (eds.) Measuring and monitoring biological diversity: standard measures for amphibians. Smithsonian Institution Press, Washington, D.C.

Findlay, C. S., and J. Houlahan. 1996. Anthropogenic correlates of species richness in Southeastern Ontario wetlands. *Conservation Biology* 11: 1000-1009.

Findlay, S. E. G., E. Kiviat, W. C. Nieder and E. A. Blair. 2002. Functional assessment of a reference wetland set as a tool for science, management and restoration. *Aquatic Sciences* 64: 107-117.

Forman, R. T. T. and L. E. Alexander. 1998. Roads and their ecological effects. *Annual Review of Ecology and Systematics* 29:207-231.

Gaines, D. 1974. A new look at the nesting riparian avifauna of the Sacramento Valley, California. *Western Birds* 5:61-80.

Greco, S. E., R. E. Plant and R. H. Barrett. 2002. Geographic modeling of temporal variability in habitat quality of the yellow-billed cuckoo on the Sacramento River, Miles 196-219, California. Pages 183-195 in: J. M. Scott, P. J. Heglund, M. L. Morrison, J. B. Haufler, M. G. Raphael, W. A. Wall and F. B. Samson (eds.) Predicting species occurrences: issues of accuracy and scale. Island Press, Covelo, CA.

Hauer, F. R., B. F. Cook, M. C. Gilbert, E. J. Clairain, Jr. and R. D. Smith. 2002. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of riverine wetlands in the Northern Rocky Mountains. Engineer Research and Development Center, U.S. Army Corps of Engineers, Vicksburg, MS.

Hruby T., W. E. Cesanek and K. E. Miller. 1995. Estimating relative wetland values for regional planning. *Wetlands* 15: 93-107.

Hruby, T, T. Granger, K. Brunner, S. Cooke, K. Dublanica, R. Gersib, L., Reinelt, K. Richter, D. Sheldon, E. Teachout, A. Wald and F. Weinmann. 1999. Methods for assessing wetland functions volume I: riverine and depressional wetlands in the lowlands of Western Washington. Washington State Department Ecology, Publication #99-115.

Jones & Stokes. 2004. Placer County natural resources report: a scientific assessment of ecosystems, watersheds, and species. Prepared for: Placer County Planning Department.

MathSoft, Inc. 1999. S-Plus 2000 standard edition two. MathSoft, Cambridge, MA.

Miller, J. R., J. A. Weins, N. T. Hobbs and D. M. Theobald. 2003. Effects of human settlement on bird communities in lowland riparian areas of Colorado. *Ecological Applications* 13: 1041-1059.

Point Reyes Bird Observatory. 2003. PRBO point count protocol. PRBO Conservation Science, Stinson Beach, CA. Available at: <http://www.prbo.org/tools/pc/pc.htm>

Poole, A. and F. Gill (eds.). 1990–2003. The Birds of North America. Philadelphia, PA.

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring land birds. Gen. Tech. Rep., USDA Forest Service, Pacific Southwest Research Station 144.

Semlitsch, R. D. and J. R. Bodie. 2003. Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles. *Conservation Biology* 17: 1219–1228.

Smith, R. D. 2000. Assessment of riparian ecosystem integrity in the San Diego Creek watershed, Orange County, California. Report prepared for U.S. Army Corps of Engineers, Los Angeles District, Los Angeles.

Sokal, R. R. and F. J. Rolf. 1994. Biometry: The principles and practice of statistics in biological research. W. H. Freeman & Co., Menlo Park, CA.

Stein, E. D., F. Tabatabai and R. F. Ambrose. 2000. Wetland mitigation banking: a framework for crediting and debiting. *Environmental Management* 26: 233–250.

Stevens, L. E., P. Stacey, D. Duff, C. Gourley and J. C. Catlin. 2002. Riparian ecosystem evaluation: a review and test of BLM's proper functioning condition assessment guidelines. Final report submitted to the National Riparian Service Team, U.S. Department of the Interior, Washington, D.C. Available at: <http://www.envsci.nau.edu/cp_scb/files/FinalversiontoNRST.htm>.

Sutter, L. 2001. Spatial wetland assessment for planning (SWAMP): technical discussion. Technical Management and Planning Corporation, NOAA Coastal Services Center, Charleston, SC.

U.S. Forest Service. 1999–2000. Existing vegetation: Northern and Central Sierra Province areas. Pacific Southwest Region, Forest Service, U.S. Department of Agriculture, Berkeley, CA.

Zar, J. H. 1999. Biostatistical Analysis. Prentice Hall, Upper Saddle River, NJ.

Appendix A

RAP Forms

Protocol for Description of Riparian Ecosystem Assessment Plots

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the site description and any other RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING THE PLOT

Proceed to the pre-determined coordinates for the plot center point. Centered on this point, the plot edge ds 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank). In most cases, the actual center of the located plot will differ from the pre-determined coordinates used to locate the plot. Therefore, once the plot boundaries have been determined, the actual coordinates for the plot center point are determined and recorded on the data form (see below).

RIPARIAN RAP DATA FORM

The intent of the RAP data form is to facilitate the collection of field data at selected plots rapidly and accurately. At each plot record the required data in each of the following data fields:

Location

- Provide the River/Creek name and number the plot (e.g., Deer Creek #1).
- Provide the survey date(s) and names of surveyors.
- Use the GPS unit to determine coordinates for the center point of each plot; and record the lat/long on the form. (Elevation will be determined from USGS topographic map and recorded on the form afterwards.)

- Take photographs facing North, East, South, and West, and of a representative view of the riparian corridor. Record their numbers on the form.

Environmental Description

This provides a brief description of the general slope exposure and steepness of the riparian plot that is sampled. If slope varies within the plot, record the slope across the plot as a whole (i.e., from the stream-side to the inland side of the plot).

ADJACENT LAND USES AND IMPACTS

Developed Non-industrial Land Uses **-** Record the extent of adjacent residential and suburban development with 250 m of the center of the survey plot both by noting the percentage of area covered by these land uses and recording the number of development units (du) observed, including barns and other out buildings.

Agricultural Land Uses **–** Record agricultural development within 250 m of the center of the plot both by recording the percentage of area covered by agricultural land uses, and by noting the general agricultural type(s) observed.

Industrial Land Uses **–** Record industrial development within 250 m of the center of the plot both by recording the percentage of area covered by industrial land uses and by noting the general type of industrial uses observed.

Impact Types **–** In the table provided, for both the riparian and non-riparian portions of the plot, record the presence of the following impacts: brush removal, tree cutting, roadedness, grazing, and trash dumping. The adjacent area extends 250 m from the center of the plot. If the adjacent area is not in natural vegetation, do not record brush cutting, tree cutting, or trash dumping as occurring in the adjacent area. In documenting roadedness, all roads, including dirt and gravel, and other impervious or heavily compacted surfaces are included in this type of impact. For the other category, specify the impact type.

Channel Condition **–** Indicate whether bank protection has been used in the channel adjacent to the plot, and whether the channel shows evidence of incision. Note whether levees are present at or near the site that may confine the extent of potential riparian habitat areas, and indicate whether there is evidence of overland flow on the plot. Also, indicate the distance to the nearest road (paved, gravel or dirt).

ADDITIONAL COMMENTS

Add any additional comments on site access or interpretation, including management of creeks (e.g., recent revegetation or clearing, channelization, herbicide use, etc.). Also, if aerial photos are available and vegetation has changed since the photograph was taken, this should be noted. Add these additional comments, as necessary, at the bottom of the form.

VEGETATION DESCRIPTION

- In the box provided, enter the Habitat Type(s) using the appropriate Placer County WHR codes (Attachment 2).
- Estimated width of the riparian vegetation. Estimate the width of the riparian stand using a range finder at the center and both ends of each plot and record these widths on the data form.
- Record the surrounding habitat types using the Placer County WHR codes.
- Estimate the total size of the stand from aerial photos and ground inspection, and record its approximate length and continuity, as indicated on the form.
- Record estimates of total absolute cover (expressed as a percentage) of the tree, shrub, and herbaceous layers, and estimate the total extent of unvegetated ground (i.e., bare ground).

- Estimate the total snag density as high (> 20 per hectare), moderate (10-19 ha^{-1}), low (< 10 ha^{-1}), or absent.
- Check the appropriate habitat stage category for that represents the size of the trees dominating the tree layer.
- In the table provided, based on a visual estimate, record the scientific name and check the appropriate category for absolute cover for each woody species in the tree layer (> 3 m), and in the shrub layer (0.5-3 m).

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- From topographic maps, add plot elevations to the RAP data form.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Download the digital photographs into the P drive folder and rename with the site, point number and orientation (e.g., Thomes 7-1 N, Thomes 7-1 E etc.).
- Download the site coordinates from the GPS into the P drive folder.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

RIPARIAN ECOSYSTEM ASSESSMENT SURVEY PLOTS
RAPID BIOLOGICAL ASSESSMENT FIELD FORM

(J&S--Revised May 7, 2003)

LOCATION

RIVER/CREEK NAME _____ **Plot #**_____

Surveyors _____**Date** _____

Photo #s: _____

GPS Coordinates: Lat. ____°_____'_____" **Long.** _____°_____'_____" **Elevation** (ft/m) _____
(WGS 84)

ENVIRONMENTAL DESCRIPTION

General Slope Exposure: _____

General Slope Steepness: 0 degrees_____ **1-5 degrees** _____ **5-25 degrees** _____ **> 25 degrees**

ADJACENT LAND USES AND IMPACTS:

Developed Non-industrial Land Uses ___% of adjacent area**;**
Number of development units per acre: < 1du/ha ___**1-2 du/ha** _____ **> 2 du/ha**
Agricultural Land Uses: ___% of adjacent area; Types**:** _____**Orchard** _____
Vineyard _____ **Row Crops** ____ **Grain** ___ **Pasture** ___ **Other**
Industrial Land Uses: ___% of adjacent area; Types: ___**Gravel Mining** ____**Other**

Comments _____

Impact Types in Riparian Plot and Adjacent Areas (within 250 m)

IMPACT TYPE	Riparian portion of plot	Non-riparian part of plot	Adjacent Area
Brush removal[1]			
Tree-cutting[1]			
Roadedness[2]			
Grazing[1,3]			
Trash dumping[1]			
Other – specify			

[1] – For adjacent areas not in natural vegetation, do not consider this impact type to be present.
[2] – As roads, include dirt, gravel and paved roads, and other paved surfaces.
[3] – Evidence of grazing includes cows, cow excrement, and tracks.

Bank Protection (e.g. riprap): __% of plot length Channel Incised? Yes No (circle one)

Levee (circle one): [None along stream] [In plot] [Between plot & channel] [Plot between channel & levee]

Evidence of overland flow within plot? Yes No (circle one)

Nearest road : In Plot: Yes No (circle one) If No Road in Plot: Nearest road within ___meters of plot center point.

ADDITIONAL COMMENTS

_____

_____

_____

_____

_____

VEGETATION DESCRIPTION

Habitat Type (CWHR)	Stand Width (Plot Edge)	Stand Width (Plot Center)	Stand Width (Plot Edge)	Surrounding Habitat Types

Estimated size of total stand: ___< 0.5 ha ___ >0.5-1 ha ___>1-5 ha ___>5-10 ha ___ >10-25 ha ____ >25 ha

Stand Length and Continuity: > 1 km, continuous_____ > 1 km, not continuous _____ 0.5-1 km, continuous _____ 0.5-1 km , not continuous _____ < 0.5 km, continuous _____ <0.5 km, not continuous _____

Total Cover (absolute): Tree Layer: __% Shrub Layer: ___% Herbaceous Layer: __% Bare:___%

Snag Density: High (> 20/ha)_____ **Moderate** (< 20 to 10/ha) _____ **Low** (< 10/ha) _____ **Absent _____**

Predominant Tree Size Class (refer to WHR Habitat Stages for visual examples of each)

Size Class (circle one)	**1**	**2**	**3**	**4**	**5**	**6**
Stage	Seedling	Sapling	Pole	Small	Medium-Large	Multi-storied
DBH	< 1”	1”-6”	6”-11”	11”-24”	>24”	Size 5 over 4 or 3

Woody Plant Absolute Cover in Riparian Portion of Plots

(Check 1 category for each species present)

Species	**0-1 %**	**>1-5 %**	**>5-25%**	**>25-50%**	**>50-75%**	**>75-95%**	**>95%**
Tree layer (> 3 m)							
Shrub layer (< 3 m)							

Attachment 1. Riparian Assessment Field Equipment

Equipment List

Road maps, area maps, and aerial photographs (as available).
Compass
Clipboard
Rangefinder
Thermometer
Digital Camera
GPS
Cell phone
Fine Sharpies, pencils
J&S equipment bag
Cover boards (if 1st visit to a site where amphibian & reptile data will be collected)

Data Forms

Plot Description Fomr RAP Data Form and Attachments 1, 2, 3
PRBO Area Search Form
Amphibian and Reptile Search Form
Mammal Area Search Form
PRBO Pont Count Form
Small Mammal Trapping data Collection Form
Continuation Pages

Reference Package
RAP Protocols (Plot Description, Area Search and Small Mammal trapping)
Attachment 1. Field Equipment
Attachment 2. CWHR Land Cover and Habitat Types and Codes
Attachment 3. Key to Woody Plants of Central Valley Riparian Zones
Attachment 4. Beaufort Wind Scale
Road map(s)
USGS Quad map

Contacts List

Becky N.	916.752.0973
Ted	530.274.7232
Eric	530.292.0100
Brad	916.752.0923
Margaret	916.752.0941
Kate	916.752.0930
John S.	916.752.0899
Bud	916.752.0938
Jen H.	916.752.0985
Doug	916.835.3197

Placer Wildlife Habitat Relationship Classification
Placer Legacy Phase 1 Area - Land Cover & Habitat Types
2-20-03

Aquatic – Open Water

WL Lacustrine (Lakes/Reservoirs) (generally these features are greater than 1 acre in size)
WR Riverine (Rivers and Creeks) (only mapped if large enough to be mapped accurately on the photographs)

Barren

BR Barren (Cliffs, rock outcrops)
BD Disturbed Lands (Landfills, Graded lands-Non agricultural)

Herbaceous

HA Annual Grassland
HP Pasture - Irrigated
HW Fresh Emergent Wetland
VP Vernal Pool (individual vernal pool >0.5 acre in size) (only mapped if not included in previous mapping and not within a complex)
VC Vernal Pool Complex
- VCh—(High) vernal pool density >7%
- VCm—(Medium) vernal pool density 4-7%
- VCl—(Low) vernal pool density <3%

HS Seasonal Wetland

Shrub

SC Foothill Chaparral

Forested

FR Riparian
FH Foothill Hardwood - includes where signatures are distinguishable:
- FHV Valley Oak Woodland
- FHB Blue Oak Woodland
- FHL Interior Live Oak Woodland

FS Oak Woodland-Savanna (low density oak woodland/savanna mix where density is <= 5 'large' trees per acre)
FOP Oak-Foothill Pine
FP Ponderosa Pine
FE Eucalyptus

Agricultural

AR Rice
AC Row Crops
AA Alfalfa
AP Pasture
AV Vineyards
AO Orchards
AU Unidentified Croplands (including plowed, idle)

Urban

US Urban/Suburban (>1 unit / acre)

UR Rural-residential (0.1 – 1.0 unit / acre) (less than 70% canopy cover of large trees)

URF Rural-residential Forested (0.1-1.0 unit/acre plus 70-90% canopy cover of large trees)

UP Urban Parks (includes isolated city parks: playgrounds, grass fields, etc)

UG Golf Courses

UT Urban riparian (includes internal riparian areas such as greenbelts, most often surrounded by residential/urban development)

UF Urban woodland (includes city parks with predominate woodland type vegetation and windbreaks with mostly non-native trees)

UW Urban wetland (includes vernal pools, seasonal wetlands, and emergent marshes surrounded by urban uses)

Small-Patch Ecosystems

XW Springs and Seeps

XP Stock Ponds (less than 1 acre)

XL Landscape and Golf Course Ponds (less than 1 acre)

Special Geologic Formations and Soils

XG Gabbrodiorite Soils

XS Serpentine Soils

MR Mehrten Formation Soils

BIRD AREA SEARCH PROTOCOL

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank).

CONDUCTING THE AREA SEARCH

The area search involves conducting a census of the entire1 ha plot (100 m X 100 m) and recording all bird species detected there. Please use the PRBO area search form to record data. Each area search plot is covered in approximately 1 hour to provide comparable search time at each plot. Typically, at least 3 plots should be covered in a single morning.

Begin the area search by filling out the observer and census information at the top of the PRBO AREA SEARCH FORM. Complete the weather information, and record the air temperature, % cloud cover (% of sky covered in clouds), and approximate wind speed using the attached Beaufort wind scale.

During the census, carefully record the name of each species seen, heard, or for which tracks or scat was observed. Please use the species' common name (not 4-letter codes) to avoid later confusion. For each individual of each species, record a single letter (S=song, V=visual, C=call), in the order of priority explained in the code key. You should change the data (i.e. from a call to a song) if a higher priority observation later occurs for that individual. Also, record breeding and nesting behavior. Recording other special behaviors (such as food carries, flocking, displaying), is strongly recommended but not required; there are respective columns on the form for these observations, following breeding bird atlas methodology. Other species observed off the plot or flying over may be recorded under Notes and Flyovers or on a separate sheet of paper.

In recording species on the data form, note whether the species was observed in the riparian or non-riparian portions of the plot.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Beaufort Wind Scale

Used to guage wind speed using observations of the winds effects on trees and other objects. Often used in monitoring projects because it doesn't require fancy equipment.

Format: Beaufort Number * Wind Speed in Miles/hour(Km/hour) *** Description**

0 *** <1 (<1.6)***__Calm:__ Still: Smoke will rise vertically.

1***1-3(1.6-4.8)*** **Light Air:** Rising smoke drifts, weather vane is inactive.

2***4-7(6.4-11.3)***__Light Breeze:__ Leaves rustle, can feel wind on your face, weather vane is inactive.

3***8-12(12.9-19.3)***__Gentle Breeze:__ Leaves and twigs move around. Light weight flags extend.

4***13-18 (20.9-29.0)***__Moderate Breeze:__ Moves thin branches, raises dust and paper.

5***19-24 (30.6-38.6)***__Fresh Breeze:__ Moves trees sway.

6***25-31(40.2-50.0) ***__Strong Breeze:__ Large tree branches move, open wires (such as telegraph wires) begin to "whistle", umbrellas are difficult to keep under control.

7***32-38 (51.5-61.2)***__Moderate Gale:__ Large trees begin to sway, noticeably difficult to walk.

8***39-46(62.8-74.0)***__Fresh Gale:__ Twigs and small branches are broken from trees, walking into the wind is very difficult.

9***47-54(75.6-86.9)***__Strong Gale:__ Slight damage occurs to buildings, shingles are blown off of roofs.

10***55-63 (88.5-101.4)***__Whole Gale:__ Large trees are uprooted, building damage is considerable.

11***64-72 (103.0-115.9)***__Storm:__ Extensive widespread damage. These typically occur only at sea, and rarely inland.

12***>73 (>115.9)***__Hurricane:__ Extreme destruction.

NOTE: The Beaufort number is also referred to as a "Force" number, for example,
"Force 10 Gale".

* To calculate knots, divide miles/hour by 1.15.

PRBO AREA SEARCH FORM

Observer Information	**Census Information**
Observers	River/Creek Plot #
Date	Location (County)

__________°F or °C (circle one)   _________%   _________ mph , knots, or kmph (circle one)
Temperature   Cloud Cover   Wind Speed

Number of Observers: ______ **Start Time:** _______________ **End Time:** _____________

Species	**Tally of Individuals** (<u>S</u>ong, <u>V</u>isual, <u>C</u>all, one letter per individual)	**TOTAL**	**Behavior** (check if applicable)*								
			forag.	flock	copul.	displ.	pair	carry mater.	carry food	nest	fledg.

*Forag. = foraging, Copl. = copulation, Displ. = courtship or territorial display, Food carry includes fecal sack, Fledg. = fledgling.

Notes and flyovers:____

____

____

____

____

PRBO Conservation Science
4990 Shoreline Highway
Stinson Beach, CA 94970
415-868-1221
www.prbo.org

prbo

Be sure you have the following:

- binoculars
- watch which indicates seconds
- at least 2 pens
- field notebook
- sufficient blank data forms
- clipboard
- rubber bands (for holding forms on clipboard)

Depending on the route, census type, and your experience level, you may also need:

- directions and maps
- GPS unit & extra batteries
- cell phone or radio
- range finder
- field guide
- water and snacks

Counts begin approximately 15 minutes after local sunrise and should be completed within 3-4 hours, generally by 10AM.

We recommend 2-3 visits per season (e.g., twice in May and once in June). Visits should be at least 10-15 days apart. Timing of the field season will vary by location, but should cover the local breeding season with as little overlap with migration or dispersal as possible.

When possible, the order in which points are surveyed should vary between visits. Ideally, observers should also vary among visits.

Do not conduct surveys during weather conditions that likely reduce detectability (e.g., high winds or rain). If conditions change for the worse while doing a count, remaining points can be completed <7 days from the first day, but this should be avoided as much as possible.

Approach the point with as little disturbance to the birds as possible, and begin your count as soon as you are oriented and are confident you can estimate distances accurately (less than 1 minute).

PRBO point counts are 5 minutes duration at each point. Record the time the survey begins at each point using the 24-hour clock. If something interferes with your ability to detect birds during the 5-minute count, stop the count until

PRBO Conservation Science
4990 Shoreline Highway
Stinson Beach, CA 94970
415-868-1221
www.prbo.org

prbo

the disturbance has passed and start over. Cross out the interrupted data and note what happened on your form.

Every species detected at a point is recorded, regardless of how far from the observer. Use the standardized banding lab 4-letter abbreviation for species codes (http://www.pwrc.usgs.gov/bbl/manual/bandsize.htm) and follow the naming conventions maintained by the American Ornithologists Union (http://www.aou.org/aou/birdlist.html). For unknown species, record "XXXX." For unknown members of various families, use "XX" plus two letters to signify the family – "XXHU" for unidentified hummingbird, for example. You can follow birds after the completion of a point in order to verify identification. If no birds are detected at a point, write "No birds detected" on your form. We recommend keeping a list of all species detected between points (i.e., not during the 5 minute counts) on the back of your form.

For each individual detected we record the distance to the detection and the behavior that alerted us to the individuals' presence. Also, for each species we record any indications of breeding status. Make every effort to avoid double counting individuals detected at a single point. However, if an individual is known or thought to have been counted at a previous point, make a note of it, but record its presence at the current point anyway. No attracting devices, recordings, or "pishing" should be used.

Distance: All point counts involve recording distance to detections at some level of resolution. Depending on project, we use either 50m fixed-radius counts, or Variable Circular Plots (VCP), in which the distance to each detection is recorded to the nearest 10m (though this distance may vary by project and habitat type – consult project leader). Both methods also specify whether or not detections were beyond 100m.

Note: Fifty m radius counts may not provide sufficient data for calculating population density or trends for some species or habitats where the use of VCP's may improve estimates. We recommend the use of range finders and extensive training for either method, but especially for VCP. VCP data should always be taken in a way that is transferable to 50m format.

The distance recorded is the distance from the point to the first location an individual was observed, regardless of its behavior. If the bird subsequently moves, *do not change the original distance recorded*. If a bird is flying (but not "flying over" – see below), or perched high in a tree, the distance recorded is to the point at which a plumb line would hit the ground if hung from the point at which the bird was first observed. This distance should be measured as

PRBO Conservation Science
4990 Shoreline Highway
Stinson Beach, CA 94970
415-868-1221
www.prbo.org

prbo

though a tape were laid across the ground, that is, including any intervening topographic features.

A bird flushed from within 10m of the point when you arrive should be included in the count. Birds that are flushed from farther away should be noted on the back of the form if they are species that didn't occur during the count.

We record the behavioral cue that alerted us to the presence of the individual - generally "S" for song, "V" for visual, or "C" for call ("D" for drumming woodpecker, "H" for humming hummingbird). If a bird sings after it has been detected via a different cue, this is indicated in the data, but the initial detection cue is preserved. Circle the original detection cue ("V" or "C") to note that a bird was singing subsequent to its initial detection, but otherwise, no changes in behavior are noted. Juvenile birds are recorded as "J"s regardless of their behavior, and are not included in most analyses.

Birds that are flying over but not using the habitat on the study area are recorded in the fly-over column. Birds flying below canopy level, flying from one perch to another, or actively foraging on or above the study area are recorded as described in the previous paragraphs.

Breeding status: We record any potential indications of breeding if noted for species at each point as follows:

- CO – copulation
- DI – territorial display.
- DD – distraction display
- FC – food carry
- FL – fledglings
- FS – fecal sac carry
- MC – material carry
- NF – nest found
- PA – pair

Riparian Ecosystem Assessment Mammal Area Search Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank).

SEARCHING FOR MAMMALS

Area searches are conducted for approximately 1 hour to ensure comparable search effort on each plot. Begin the area search by entering the observer, date, time and site information at the top of the *Mammal Area Search* form. During the census, carefully record the name of each species seen or heard. Please use the species' common name (not 4-letter codes) to avoid later confusion. The area search involves walking throughout the entire (100 m by 100 m) plot.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.

- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Mammal Area Search Form

Site: _____ **Plot**: _____

Date: _____ **Start Time**: _____ **Stop Time:** _____

Observer: _____

Temperature: _____ **Cloud Cover**: _____

Species	Visual Observation	Vocalization	Scat	Tracks	Prey Remains	Notes

Additional Comments:

Riparian Ecosystem Assessment Amphibian & Reptile Search Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

Where data on amphibians and reptiles will be collected, cover boards will be placed out during the first visit to the site, and will be checked during the next visit (at least a week later).

LOCATING COVER BOARDS WITHIN THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank). Locate the first 100 m line of cover boards along the length of the stream bank side of the plot. Place 10 cover boards, evenly spaced apart, along this first line. Place an additional 10 cover boards along a second 100 m line 10 m in from the stream bank side of the plot and parallel to the first line of cover boards.

SEARCHING FOR AMPHIBIANS AND REPTILES

Area searches are conducted for approximately 1 hour to ensure comparable search effort on each plot. (If area searches deviate from the 1 hour duration, note this in the “Additional Comments” section of the data form.) Begin the area search by entering the observer, date, time and site information at the top of the *Amphibian and Reptile Data Collection* form. During the census,

carefully record the name of each species seen or heard. Please use the species' common name (not 4-letter codes) to avoid later confusion. The area search involves walking throughout the entire (100 m by 100 m) plot and also checking under all cover boards. In checking cover boards, quickly lift each cover board and identify species present. Only handle amphibians and reptiles if you have a DFG permit and you cannot identify them. Most species should be identifiable without handling them. After it has been checked, replace each board in its original position. Please collect all cover boards and remove any flagging after the final plot survey.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Amphibian and Reptile Data Collection Form

Site: _____ **Plot**: _____

Date: _____ **Start Time**: _____ **Stop Time:** _____

Observer: _____

Temperature: _____ **Cloud Cover**: _____

Species	Visual Observation	Vocalization	Under Cover Board?	Notes

Additional Comments:

Riparian Ecosystem Assessment Butterfly Search Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

Where data on amphibians and reptiles will be collected, cover boards will be placed out during the first visit to the site, and will be checked during the next visit (at least a week later).

SEARCHING FOR BUTERFLIES

All butterfly area searches must take place between 9 AM and 4 PM because of the daily flight patterns of butterflies. Area searches are conducted for approximately 1 hour to ensure comparable search effort on each plot. (If area searches deviate from the 1 hour duration, note why in the "Additional Comments" section of the data form.) Begin the area search by entering the observer and site information at the top of the *Butterfly Area Search* form. The area search involves walking throughout the entire (100 m by 100 m) plot. During the census, carefully record the name of each species seen. Please use the species' scientific name (not 4-letter codes) to avoid later confusion. Indicate the relative abundance of each species in the *General Abundance* column of the data form using the following scale: Rare (1 individual), Uncommon (2-5 individuals), Common (5-10 individuals), Abundant (> 10 individuals).

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.

- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Area Search for Butterfly Species

Site: _____ **Plot**: _____

Date: _____ **Start Time**: _____ **Stop Time**: ____

Observer: _____

Notes on Weather: _____

_____

Species	In Riparian	Out of Riparian	General Abundance	Notes

Additional Comments:

Riparian Ecosystem Assessment Small Mammal Trapping Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING TRAPS WITHIN THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank). Locate the first 100 m line of traps along the length of the stream bank side of the plot. Place 15 traps, evenly spaced apart, along this first line. Place an additional 15 traps along a second 100 m line 10 m in from the stream bank side of the plot and parallel to the first line of traps.

CONDUCTING THE SMALL MAMMAL TRAPPING

Trapping will be conducted for three consecutive nights at each plot All traps will be set within 2 hours of sunset and checked within 3 hours after sunrise the following morning. Each trap will be baited with peanut butter and rolled oats, and a wad of cotton was placed at the back of each trap for bedding.

Each animal captured will be identified to species, and its age, sex, reproductive condition, and general health will be evaluated and noted. The time, location of capture, and general weather and habitat conditions also will be recorded. Photographs will be taken of each study plot and each new species captured. All data will be recorded on standardized Jones & Stokes field forms

(Attached). Each captured animal will be marked with a permanent nontoxic felt pen so it could be identified as a recapture if trapped on subsequent trap-nights. All animals will be released at the site of capture.

All Jones & Stokes biologists conducting the small mammal surveys will wear appropriate protective clothing and respirators during the handling of the animals to avoid potential exposure to Hantivirus. Standard precautionary measures identified in Mills et al. (1995) *Guidelines for Working with Rodents Potentially Infected with Hantivirus* will be observed during this work.

Once tapping has been completed all traps and flagging will be removed from the site.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Project: Placer Riparian Ecosystem Assessment

Site:_______________ **Plot:** _____________

Date:_____/_____/03 **Start Survey Time:**____________ **End Survey Time:**____________

Team Members:

Weather: Temp:______F; **Wind:** _______mph from_______; **Clouds:** __________; **Precip:**________

Other Site Conditions:

Photos: _________________________

Trap Survey Results

Time	Site	Location	Cl	Species	Sex	Age	Condition	Recapture?	Marked?

Trap check-off

Trap #	Trap Line 1	2	3
1			
2			
3			
4			
5			
6			
7			
7			
8			
10			
11			
12			
13			
14			
15			

Enter species code for each capture.

If trap is empty, put "x" in box

Notes:

Project Manager sign-off:

Draft 19 May, 2003

A KEY TO THE WOODY PLANTS OF RIPARIAN ZONES IN CALIFORNIA"S CENTRAL VALLEY

By John C. Hunter, Jones & Stokes, 2600 V Street, Sacramento CA 95818 jhunter@jsanet.com

1. Plant a large (up to several m high), densely clumped grass, with thick (> 2 cm) woody stems … *Arundo donax* (Giant reed)
1. Plant not a grass … 2
    2. Leaves compound (the thin flat portion of the leaf discontinuous) … 3
        3. Leaves opposite (> 1 leaf attached to stem in same plane) … 4
            4. Leaflets palmately arranged (radiating from a central point), flowers > 1 cm long, fruit with a husk that separates from the large (> 3 cm in diameter) round seed … *Aesculus californica* (California buckeye)
            4. Leaflets pinnately arranged (feather-like, arranged like ribs off a backbone), flowers < 1 cm long and fruits either flat and winged or small (<5 mm across) round and fleshy … 5
                5. Fruits dry and winged (with a thin flat extension), flowers inconspicuous, pith (in center of stem) not particularly large … 6
                6. Fruit two-parted, each part with a wing; Leaves with 3-7 leaflets; Leaflet margins coarsely toothed … *Acer negundo* (box elder)
                6. Fruit one-parted with one wing; Leaves with 5-7 leaflets; Leaflet margins smooth or with fine (small) teeth … *Fraxinus latifolia* (Oregon ash)
                5. Fruits fleshy without a wing, pith conspicuously large and spongy, flowers small and white (or cream) but showy in a dense inflorescence (cluster) … 7
                7. Flowers in a broad flat clusters, Fruits black (sometimes white) with a white waxy coating that causes them to appear blue … *Sambucus mexicana* (Blue elderberry)
                7. Flowers in rounded to cylindrical clusters, Fruits red, or black, without a waxy covering … *Sambucus racemosa* (Red elderberry)
        3. Leaves alternate (just 1 leaf attached to stem at any perpendicular plane) … 8
            8. Plant a legume (Our woody species in the Central Valley have pea-like flowers in drooping clusters, fruit a dry pod with multiple seeds) … 9
                9. A tree with white flowers, spines at the base of leaves, and a flat pod … *Robinia pseudoacacia* (black locust)
                9. A shrub or small tree with red flowers, no spines, and a pod with four "wings" … *Sesbania punecia*
            8. Plant not a legume … 10
                10. Plant w/ prickles … 11
                11. Fruits dry, enclosed in a fruit-like fleshy to leathery sac (a rose hip); Leaflets pinnately arranged (feather-like, arranged like ribs off a backbone) … *Rosa californica* (California rose)
                11. Fruits fleshy, blackberry-like; Leaflets palmately arranged (radiating from a central point) … 12
                12. Leaves white on underside; Prickles broad-based; Stems often stout and ribbed (ridged); Leaflets 3-5; Flowers/fruits > 10 in each inflorescence (cluster) … *Rubus procerus* (Himilayan blackberry)
                12. Leaves light green on underside; Prickles slender; Stems round; Leaflets 3; Flowers/fruits 2-15 in an inflorescence … *Rubus ursinus* (California blackberry)
                10. Plant w/o prickles … 13
                13. Leaflets with a round gland (a thickened dot) near the base, fruit flat, dry with a wing … Ailanthus (Tree-of-Heaven)
                13. Leaflets without a basal gland, fruit round, fleshy or leathery and without a wing … 14
                14. Plant a vine or shrub; Leaflets 3-5; Leaflet margins lobed, coarsely toothed or smooth; Fruits small (< 1 cm) … *Toxicodendron diversilobum* (Poison oak)

                14. Plant a tree, Leaflets 11-19; Leaflet margins sharply toothed but not lobed; Fruits large (> 2.5 cm across) … *Juglans californica* var. *hindsii* (Northern California black walnut)

2. Leaves simple (the thin flat portion of the leaf continuous)
    15. Plant a willow: Fruit a capsule with seeds embedded in cottony fluff; Leaves alternate, deciduous and narrow (ranging from linear (almost not taper) to lance-shaped); Buds covered by a single scale; Bark bitter tasting and astringent with an aspirin-like flavor … 16
        16. Scale covering bud in axil of leaf (where leaf meets stem) has free and overlapping margins (you can see this by pressing down on the tip of the bud and rocking it from side to side); Axillary bud small (< 3 mm), conical and pointed … 17
            17. Leaf dull green on both sides; stipules (a pair of small leafy or dry and papery bracts where the leaf joins the stem) absent; Twigs of the current year tend to be yellow to olive, Plant a tree to 30 m high … *Salix gooddingii* (Gooding's black willow)
            17. Leaf glossy green above and glaucous (waxy white) below; stipules generally present; Current year twigs typically red to yellowish brown; Plant a tree to 14 m … *Salix laevigata* (Red willow)
        16. Scale covering bud in axil has margins fused together so that the scale forms a cap; Axillary bud small to large, with a rounded tip and shape elliptic to conical … 18
            18. Leaves narrow (linear and generally < 1 cm wide) with upper and lower surfaces similar, both covered (thickly or thinly) in silky hairs; Plant a clonal, multi-stemmed shrub to 6 m … *Salix exigua* (Sandbar or Narrow leaf willow)
            18. Leaves broader (elliptic to lance-shaped and generally > 1 cm wide) with upper surfaces shiny green and lower surfaces pale green or glaucous (waxy white), hairs generally restricted to young leaves; Plant a shrub or small tree to 18 m … 19
                19. Petiole (stalk of leaf) with glands at base of blade (these glands appear as small warty, irregular protrusions); Leaves 5-17 cm long, lance-shaped and gradually tapering towards the tip with concave sides (long acuminate)… *Salix lucida* var. *lasiandra*, (Shining willow)
                19. Petiole without glands; Leaves 3-12 cm long, narrowly lance-shaped to elliptic, tapers to tip with convex sides … *Salix lasiolepi*s, (Arroyo willow)
    15. Plant not a willow and the complete set of attributes not as above; Fremont's cottonwood is in the willow family and shares some of the traits described above except that its leaves are broad and triangular to heart-shaped and its buds have > 1 scale; For other species: Fruit not a capsule and seeds not embedded in cottony fluff; Leaves alternate or opposite, deciduous or evergreen and narrow or broad; Buds covered by more than one scale; Bark taste varied but without an aspirin-like flavor;
        20. Plant an oak: Fruit an acorn; Buds clustered near the branch tips; Plant a tree … 21
            21. Leaves with bristles *Quercus wislizenii* (Interior live oak) – However, at higher elevations, if underside of leaf has a pale bluish cast and it covered in powdery dust, the plant could be could be *Quercus chrysolepis* (Canyon live oak)
            21. Leaves w/o bristles … 22
                22. Leaves deeply lobed (often > ½ distance to midrib); Acorn 3-5 cm long; Leaves upper surface with a greenish cast … *Quercus lobata* (Valley oak)
                22. Leaves shallowly lobed (< ½ distance to midrib) or wavy margined; Acorn 2-3.5 cm long; Leaves upper surface often with a bluish cast … *Quercus douglasii* (Blue oak)
        20. Plant not an oak: Fruit not an acorn; Buds generally not clustered near branch tips; Plant a tree, shrub or vine … 23
            23. Plant a woody vine … 24
                24. Plant evergreen, lacking tendrils … *Hedera helix* (Ivy)
                24. Plant deciduous and with tendrils opposite leaves … *Vitis californica* (California wild grape)
            23. Plant a shrub or tree … 25
                25. Plant evergreen … 26
                26. Plant a shrub, often sticky; Flowers in dense clusters (surrounded by bracts so that they almost appear to be a single flower) developing into dry fruits with a tuft of bristles (pappus) at the top … 27
                27. Leaves up to 15 cm long, narrow with a gradual taper, widest near middle; Leaf stalks (petioles) winged (i.e., having a thin, flat extension running along them) … *Baccharis salicifolia* (mule fat)

27. Leaves up to 5 cm long, broad and strongly tapering to base, often widest above middle; Leaf stalks very short … *Baccharis pilularis* (coyote brush)

26. Plant a shrub or tree, not sticky; Flowers not as above, clearly on separate stalks (pedicels), and fruits fleshy … 28

28. Leaf margin entire (smooth); Fruits 1-3 cm long, green or black when mature … 29

29. Leaves alternate, green on both sides, aromatic … *Umbellularia californica* (California bay laurel)

29. Leaves opposite, green above, silvery below, not particularly aromatic … *Olea europea* (olive)

28. Leaf margin toothed; Fruits about 0.6 cm long, red when mature … *Heteromeles arbutifolia* (toyon)

25. Plant deciduous … 30

30. Leaves opposite or whorled … 31

31. Leaf margins jagged (toothed); Fruit 2-parted, each part with a wing (a thin flat extension), and not splitting open, seeds not hairy … *Acer saccharinum* (Silver maple)

31. Leaf margins smooth; Fruit lacking a wing, seeds with or without a fringe of hairs …

32. Fruits arranged in a dense ball at or near tips of branches, and each fruit composed of two hard, dry pieces; Seeds without a fringe of hairs; Plant a shrub or small tree; Leaves with a dry scale (interpetiolar stipule) between adjacent leaf bases … *Cephalanthus occidentalis* (Button-willow)

32. Fruit a long woody pod; Seeds with fringes of hairs at their ends; Plant a tree; Leaves without scales (stipules) at the base of their stalks … *Catalpa* species (common name also Catalpa)

30. Leaves alternate … 33

33. Leaves small (< 3mm), triangular and close against the stem; Petioles (leaf stalks) absent … *Tamarix parviflora* (Smallflower tamarisk)

33. Leaves larger (> 1 cm), shapes various but not triangular, and spreading away from stem; Petioles present … 34

34. Leaves lobed … 35

35. Leaves 2-5 cm wide and hairless, base of leaf stalk does not completely enclose bud; Plant a shrub … *Ribes aureum* (Golden currant)

35. Leaves 10-20 cm wide and pubescent, base of leaf stalk either encircles stem or completely encloses bud; Plant a large shrub to large tree … 36

36. Leaves and stems exude milky sap when broken; Fruit fleshy; Bark relatively smooth and not flaking … *Ficus carica* (Fig)

36. Leaves and stem do not exude milky sap when broken; Fruit hard and dry with a tuft of hairs, arranged in dense round heads; Bark flakes in thin sheets to reveal smooth pale surface … *Platanus racemosa* (Western sycamore)

34. Leaves toothed but not lobed; Bark varied but not as above; Fruits various but not as above ... 37

37. Leaves triangular to heart-shaped; Petiole (leaf stalk) flattened near leaf blade; Fruit a capsule opening to release small seeds in cottony fluff; Plant a large tree to 30 m … *Populus fremontii* (Fremont's cottonwood)

37. Leaves elliptic to lance-shaped; petiole more or less round, not conspicuously flattened; Fruit not a capsule and seeds not embedded in cottony fluff; Plant a small to large tree … 38

38. Plant with two types of shoots – long and short shoots, the short shoots with closely spaced leaves and also bearing the flowers and fruits; Leaves with lateral veins that fork and bend before reaching the leaf margin (the edge of the leaf) … *Prunus* species (the stone fruits including cherries and almond)

38. Plant with one type of shoot, though these may vary in orientation and spacing of leaves; Leaves with straight lateral veins only some of which fork before reaching the leaf margin … 39
    39. Fruits produced on woody scales arranged in a cone-like structure; Buds on a small stalk, not offset from leaf stalk … *Alnus rhombifolia* (White alder)
    39. Fruits not produced in a cone-like structure; Buds not stalked, offset from leaf stalk … *Ulmus* species (Elm species)

Appendix B

Summary of Species Observations

Table B-1. Frequency of Observed Odonate Species

Common Name	Scientific Name	Total (%) *N = 43*	Placer County Plots (%) *N = 20*	Other Plots (%) *N = 23*
Damselflies	**Zygoptera**			
American Rubyspot	*Hetaerina americana*	47	50	43
Spotted Spreadwing	*Lestes congener*	2	0	4
California Spreadwing	*Archilestes californica*	7	0	13
California Dancer	*Argia agrioides*	19	20	17
Emma's Dancer	*Argia emma*	28	25	30
Sooty Dancer	*Argia lugens*	14	5	22
Aztec Dancer	*Argia nahuana*	2	0	4
Vivid Dancer	*Argia vivida*	40	45	35
Unknown sp. teneral dancer	*Argia* sp.	5	10	0
Boreal Bluet	*Enallagma boreale*	5	5	4
Familiar Bluet	*Enallagma civile*	44	40	48
Unknown sp. female bluet	*Enallagma* sp.	5	5	4
Pacific Forktail	*Ischnura cervula*	42	35	48
Western Forktail	*Ischnura perparva*	5	10	0
Desert Firetail	*Telebasis salva*	2	5	0
Dragonflies	**Anisoptera**			
Blue-eyed Darner	*Aeshna multicolor*	65	75	57
Common Green Darner	*Anax junius*	93	90	96
Pale-faced Clubskimmer	*Brechmorhoga mendax*	42	50	35
Western Pondhawk	*Erythemis collocata*	26	20	30
Eight-spotted Skimmer	*Libellula forensis*	0	0	0
Widow Skimmer	*Libellula luctuosa*	9	10	9
Common Whitetail	*Plathemis lydia*	7	10	4
Twelve-spotted Skimmer	*Libellula pulchella*	9	5	13
Flame Skimmer	*Libellula saturata*	21	0	39
Blue Dasher	*Pachydiplax longipennis*	30	35	26
Red Rock Skimmer	*Paltothemis lineatipes*	5	0	9
Wandering Glider	*Pantala flavescens*	44	40	48
Spot-winged Glider	*Pantala hymenaea*	26	25	26
Variegated Meadowhawk	*Sympetrum corruptum*	51	40	61
Striped Meadowhawk	*Sympetrum pallipes*	5	0	9
Black Saddlebags	*Tramea lacerata*	84	85	83

Table B-2. Observed Butterfly Species

Common Name	Scientific Name	Total (%) *N = 43*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
California Sister	*Adelpha bredowii*	11	13	8
Sara Orange-tip	*Anthocharis sara*	6	9	4
Field Skipper	*Atlopedes campestris*	23	35	13
Pipevine Swallowtail	*Battus philenor*	72	70	75
Persius Duskywing	*Erynnis persius*	2	0	4
Northern Checkerspot	*Charidryas palla*	4	4	4
California Ringlet	*Coenonympha tullia*	45	70	21
Orange Sulphur	*Colias eurytheme*	77	74	79
Monarch	*Danaus plexipus*	0	0	0
Propertius Duskywing	*Erynnis propertius*	6	4	8
Mournful Duskywing	*Erynnis tristis*	2	4	0
Common Checkerspot	*Euphydryas chalcedona*	4	0	8
Eastern Tailed Blue	*Everes comyntas*	51	57	46
Gorgon Copper	*Gaeides gorgon*	2	0	4
Fiery Skipper	*Hylephila phyleus*	6	13	0
Buckeye	*Junonia coenia*	96	96	96
Lorquin's Admiral	*Limentis lorquini*	15	30	0
Purplish Copper	*Lycaena helloides*	4	9	0
Mourning Cloak	*Nymphalis antiopa*	11	17	4
The Farmer	*Ochlodes agricola*	4	9	0
Pale Swallowtail	*Papilio eurymedon*	2	4	0
Western Tiger	*Papilio rutulus*	70	78	63
Anise Swallowtail	*Paplio zelicaon*	13	17	8
Umber Skipper	*Paratrytone melane*	13	22	4
Common sSoty-wing	*Pholisora catullus*	2	0	4
Mylitta Crescent	*Phyciodes mylitta*	34	52	17
Cabbage Butterfly	*Pieris rapae*	89	91	88
Acmon Blue	*Plebejus acmon*	30	17	42
Sandhill Skipper	*Polites sabuleti*	2	4	0
Satyr Comma	*Polygonia satyrus*	4	0	8
Checkered White	*Pontia protodice*	2	4	0
Common Checkered	*Pyrgus communis*	4	0	8
California Hairstreak	*Satyrium californicum*	17	17	17
Hedge-row Hairstreak	*Satyrium saepium*	0	0	0
Sylvan Hairstreak	*Satyrium sylvinus*	11	9	13
Common Hairstreak	*Strymon melinus*	28	48	8
West Coast Lady	*Vanessa annabella*	4	0	8
Red Admiral	*Vanessa atalanta*	34	43	25
Painted Lady	*Vanessa cardui*	55	61	50
American Lady	*Vanessa virginiensis*	6	13	0

Table B-3. Amphibian and Reptile Species Observed During One Survey of Plots

Common Name	Scientific Name	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Pacific Treefrog	*Pseudacris regilla*	2	4	0
Foothill Yellow-legged Frog	*Rana boylii*	0	0	0
Bullfrog	*Rana catesbeiana*	32	26	38
Western Pond Turtle	*Emys marmorata*	0	0	0
Western Fence Lizard	*Sceloporus occidentalis*	28	26	29
Western Skink	*Eumeces skiltonianus*	0	0	0
Aligator Lizard	*Elgaria* sp.	13	4	21
Gopher Snake	*Pituophis catenifer*	2	0	4
Garter Snake	*Thamnophis* sp.	2	0	4
Western Rattlesnake	*Crotalis viridis*	6	4	8

Table B-4. Amphibian and Reptile Species Observed During Four Surveys of Plots

Common Name	Scientific Name	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Pacific Treefrog	*Pseudacris regilla*	8	0	25
Foothill Yellow-legged Frog	*Rana boylii*	8	13	0
Bullfrog	*Rana catesbeiana*	42	38	50
Western Pond Turtle	*Emys marmorata*	8	0	25
Western Fence Lizard	*Sceloporus occidentalis*	83	88	75
Western Skink	*Eumeces skiltonianus*	0	0	0
Aligator Lizard	*Elgaria* sp.	33	50	0
Gopher Snake	*Pituophis catenifer*	8	13	0
Garter Snake	*Thamnophis* sp.	0	0	0
Western Rattlesnake	*Crotalis viridis*	8	0	25

Table B-5. Mammal Species Observed During One Survey of Plots

Common Name	Scientific Name	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Virginian Opossum	*Didelphis virginiana*	2	0	4
Desert Cottontail	*Sylivlagus audubonii*	4	4	4
Black-tailed Jackrabbit	*Lepus californicus*	11	13	8
Western Gray Squirrel	*Sciurus griseus*	19	22	17
Botta's Pocket Gopher	*Thomomys bottae*	9	4	13
American Beaver	*Castor canadensis*	6	0	12.5
Coyote	*Canis latrans*	6	9	4
Racoon	*Procyon lotor*	40	35	46
Northern River Otter	*Lontra canadensis*	2	0	4
Bobcat	*Lynx rufus*	9	9	8
Mule Deer	*Odocoileus hemionus*	34	26	42

Table B-6. Mammal Species Observed During Four Surveys of Plots

Common Name	Scientific Name	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Virginian Opossum	*Didelphis virginiana*	8	13	0
Desert Cottontail	*Sylivlagus audubonii*	8	0	25
Black-tailed Jackrabbit	*Lepus californicus*	17	13	25
Western Gray Squirrel	*Sciurus griseus*	33	38	25
Botta's Pocket Gopher	*Thomomys bottae*	8	0	25
Deer Mouse	*Peromyscus maniculatus*	8	0	25
California Meadow Mouse	*Microtus californicus*	17	13	25
Feral Dog	*Canis familiaris*	8	0	25
Coyote	*Canis latrans*	17	25	0
Gray Fox	*Urocyon cinereoargenteus*	8	0	25
Raccoon	*Procyon lotor*	75	75	75
Feral Cat	*Felis catus*	17	25	0
Bobcat	*Lynx rufus*	17	13	25
Mule Deer	*Odocoileus hemionus*	67	63	75
Muskrat	*Ondatra zibethicus*	8	0	25

Table B-7. Mean Abundance of Small Mammals Trapped at Plots[1]

Common Name	Scientific Name	Total *N = 10*	Placer County Plots *N = 6*	Other Plots *N = 4*
Opossum	*Didelphis virginiana*	0.1 ± 0.1	0.2 ± 0.2	–
Brush Mouse	*Peromyscus boylii*	3.5 ± 2.3	–	8.8 ± 5.1
Deer Mouse	*Peromyscus maniculatus*	5.1 ± 1.8	2.0 ± 1.6	9.8 ± 2.5
California Meadow Mouse	*Microtus californicus*	3.2 ± 2.5	1.2 ± 0.7	6.3 ± 6.3
House Mouse	*Mus musculus*	1.3 ± 0.9	0.8 ± 0.8	2.0 ± 2.0
Black Rat	*Rattus rattus*	0.6 ± 0.2	0.7 ± 0.3	0.5 ± 0.3

[1] Values are means ± 1 standard error.

Table B-8. Bird Species Observed During One Survey of Plots

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Pied-billed Grebe	*Podilymbus podiceps*	X		2	4	0
Great Blue Heron	*Ardea herodias*	X		2	4	0
Green Heron	*Butorides virescens*	X		2	0	4
Wood Duck	*Aix sponsa*	X		2	4	0
Mallard	*Anas platyrhynchos*	X		11	17	4
Cinnamon Teal	*Anas cyanoptera*	X		2	4	0
Common Merganser	*Mergus merganser*	X		0	0	0
Turkey Vulture	*Cathartes aura*	X		4	4	4
White-tailed Kite	*Elanus leucurus*	X		2	0	4
Cooper's Hawk	*Accipiter cooperii*	X		2	4	0
Red-shouldered Hawk	*Buteo lineatus*	X		11	13	8
Swainson's Hawk	*Buteo swainsoni*	X		2	4	0
Red-tailed Hawk	*Buteo jamaicensis*	X		6	0	13
American Kestrel	*Falco sparverius*	X		0	0	0
Ring-necked Pheasant	*Phasianus colchicus*	X		2	4	0
Wild Turkey	*Meleagris gallopavo*	X		4	9	0
California Quail	*Callipepla californica*	X		17	13	21
Common Moorhen	*Gallinula chloropus*	X		2	4	0
American Coot	*Fulica americana*	X		2	4	0
Killdeer	*Charadrius vociferus*	X		9	4	13
Spotted Sandpiper	*Tringa macularia*	X		0	0	0
Mourning Dove	*Zenaida macroura*	X		28	26	29
Barn Owl	*Tyto alba*	X		0	0	0

Table B-8. Continued

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Great Horned Owl	*Bubo virginianus*	X		0	0	0
Black-chinned Hummingbird	*Archilochus alexandri*	X		17	17	17
Anna's Hummingbird	*Calypte anna*	X		32	30	33
Belted Kingfisher	*Megaceryle alcyon*	X		11	9	13
Acorn Woodpecker	*Melanerpes formicivorus*	X		30	48	13
Nuttall's Woodpecker	*Picoides nuttallii*	X		60	52	67
Downy Woodpecker	*Picoides pubescens*	X		40	39	42
Hairy Woodpecker	*Picoides villosus*	X		2	0	4
Northern Flicker	*Colaptes auratus*	X		11	4	17
Western Wood-Pewee	*Contopus sordidulus*	X		32	26	38
Willow Flycatcher	*Empidonax traillii*		X	13	22	4
Dusky Flycatcher	*Empidonax oberholseri*		X	2	4	0
Pacific-slope Flycatcher	*Empidonax difficilis*	X		19	22	17
Black Phoebe	*Sayornis nigricans*	X		51	61	42
Ash-throated Flycatcher	*Myiarchus cinerascens*	X		68	70	67
Western Kingbird	*Tyrannus verticalis*	X		30	26	33
Hutton's Vireo	*Vireo huttoni*	X		9	13	4
Warbling Vireo	*Vireo gilvus*	?		28	30	25
Western Scrub-Jay	*Aphelocoma californica*	X		57	65	50
Yellow-billed Magpie	*Pica nuttalli*	X		19	26	13
American Crow	*Corvus brachyrhynchos*	X		2	4	0
Common Raven	*Corvus corax*	X		0	0	0
Tree Swallow	*Tachycineta bicolor*	X		38	26	50
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	X		15	4	25
Cliff Swallow	*Hirundo pyrrhonota*	X		4	0	8

Table B-8. Continued

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Barn Swallow	*Hirundo rustica*	X		2	4	0
Oak Titmouse	*Parus inornatus*	X		53	61	46
Bushtit	*Psaltriparus minimus*	X		57	61	54
White-breasted Nuthatch	*Sitta carolinensis*	X		51	65	38
Bewick's Wren	*Thryomanes bewickii*	X		40	26	54
House Wren	*Troglodytes aedon*	X		55	74	38
Western Bluebird	*Sialia mexicana*	X		9	4	13
Swainson's Thrush	*Catharus ustulatus*		X	9	0	17
American Robin	*Turdus migratorius*	X		30	30	29
Wrentit	*Chamaea fasciata*	X		15	26	4
Northern Mockingbird	*Mimus polyglottos*	X		13	17	8
European Starling	*Sturnus vulgaris*	X		40	48	33
Cedar Waxwing	*Bombycilla cedrorum*		X	2	0	4
Phainopepla	*Phainopepla nitens*	X		0	0	0
Orange-crowned Warbler	*Vermivora celata*	X		19	22	17
Nashville Warbler	*Vermivora ruficapilla*		X	2	0	4
Yellow Warbler	*Dendroica petechia*		X	21	13	29
Common Yellowthroat	*Geothlypis trichas*	X		11	9	13
Wilson's Warbler	*Wilsonia pusilla*	?		30	17	42
Yellow-breasted Chat	*Icteria virens*	X		30	22	38
Western Tanager	*Piranga ludoviciana*		X	26	22	29
Black-headed Grosbeak	*Pheucticus melanocephalus*	X		45	35	54
Blue Grosbeak	*Guiraca caerulea*	X		4	0	8
Lazuli Bunting	*Passerina amoena*	X		19	22	17
Spotted Towhee	*Pipilo maculatus*	X		28	30	25

Table B-8. Continued

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
California Towhee	*Pipilo crissalis*	X		19	9	29
Lark Sparrow	*Chondestes grammacus*	X		2	0	4
Savannah Sparrow	*Passerculus sandwichensis*	X		2	0	4
Song Sparrow	*Melospiza melodia*	X		26	26	25
Red-winged Blackbird	*Agelaius phoeniceus*	X		13	17	8
Western Meadowlark	*Sturnella neglecta*	X		13	13	13
Brewer's Blackbird	*Euphagus cyanocephalus*	X		11	0	21
Brown-headed Cowbird	*Molothrus ater*	X		51	30	71
Bullock's Oriole	*Icterus bullockii*	X		32	13	50
House Finch	*Carpodacus mexicanus*	X		49	43	54
Lesser Goldfinch	*Carduelis psaltria*	X		45	57	33
American Goldfinch	*Carduelis tristis*	X		45	48	42
House Sparrow	*Passer domesticus*	X		9	9	8

Table B-9. Bird Species Observed During Four Site Visits

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Pied-billed Grebe	*Podilymbus podiceps*	X		0	0	0
Great Blue Heron	*Ardea herodias*	X		0	0	0
Green Heron	*Butorides virescens*	X		8	13	0
Wood Duck	*Aix sponsa*	X		17	25	0
Mallard	*Anas platyrhynchos*	X		25	38	0
Cinnamon Teal	*Anas cyanoptera*	X		0	0	0
Common Merganser	*Mergus merganser*	X		8	0	25
Turkey Vulture	*Cathartes aura*	X		17	13	25
White-tailed Kite	*Elanus leucurus*	X		8	0	25
Cooper's Hawk	*Accipiter cooperii*	X		8	13	0
Red-shouldered Hawk	*Buteo lineatus*	X		42	63	0
Swainson's Hawk	*Buteo swainsoni*	X		8	0	25
Red-tailed Hawk	*Buteo jamaicensis*	X		25	13	50
American Kestrel	*Falco sparverius*	X		8	13	0
Ring-necked Pheasant	*Phasianus colchicus*	X		8	13	0
Wild Turkey	*Meleagris gallopavo*	X		0	0	0
California Quail	*Callipepla californica*	X		42	25	75
Common Moorhen	*Gallinula chloropus*	X		0	0	0
American Coot	*Fulica americana*	X		0	0	0
Killdeer	*Charadrius vociferus*	X		17	13	25
Spotted Sandpiper	*Tringa macularia*	X		8	0	25
Mourning Dove	*Zenaida macroura*	X		58	38	100
Barn Owl	*Tyto alba*	X		0	0	0

Table B-9. Continued

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Great Horned Owl	*Bubo virginianus*	X		8	13	0
Black-chinned Hummingbird	*Archilochus alexandri*	X		58	50	75
Anna's Hummingbird	*Calypte anna*	X		67	88	25
Belted Kingfisher	*Megaceryle alcyon*	X		42	38	50
Acorn Woodpecker	*Melanerpes formicivorus*	X		83	88	75
Nuttall's Woodpecker	*Picoides nuttallii*	X		92	88	100
Downy Woodpecker	*Picoides pubescens*	X		75	88	50
Hairy Woodpecker	*Picoides villosus*	X		0	0	0
Northern Flicker	*Colaptes auratus*	X		17	25	0
Western Wood-Pewee	*Contopus sordidulus*	X		58	50	75
Willow Flycatcher	*Empidonax traillii*		X	33	38	25
Dusky Flycatcher	*Empidonax oberholseri*		X	8	13	0
Pacific-slope Flycatcher	*Empidonax difficilis*	X		33	50	0
Black Phoebe	*Sayornis nigricans*	X		92	88	100
Ash-throated Flycatcher	*Myiarchus cinerascens*	X		100	100	100
Western Kingbird	*Tyrannus verticalis*	X		33	13	75
Hutton's Vireo	*Vireo huttoni*	X		17	25	0
Warbling Vireo	*Vireo gilvus*	?		33	38	25
Western Scrub-Jay	*Aphelocoma californica*	X		75	75	75
Yellow-billed Magpie	*Pica nuttalli*	X		25	25	25
American Crow	*Corvus brachyrhynchos*	X		17	25	0
Common Raven	*Corvus corax*	X		8	0	25
Tree Swallow	*Tachycineta bicolor*	X		58	38	100
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	X		50	50	50
Cliff Swallow	*Hirundo pyrrhonota*	X		17	25	0

Table B-9. Continued

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Barn Swallow	*Hirundo rustica*	X		0	0	0
Oak Titmouse	*Parus inornatus*	X		92	100	75
Bushtit	*Psaltriparus minimus*	X		100	100	100
White-breasted Nuthatch	*Sitta carolinensis*	X		92	100	75
Bewick's Wren	*Thryomanes bewickii*	X		83	88	75
House Wren	*Troglodytes aedon*	X		92	88	100
Western Bluebird	*Sialia mexicana*	X		17	13	25
Swainson's Thrush	*Catharus ustulatus*		X	8	0	25
American Robin	*Turdus migratorius*	X		67	75	50
Wrentit	*Chamaea fasciata*	X		33	38	25
Northern Mockingbird	*Mimus polyglottos*	X		25	13	50
European Starling	*Sturnus vulgaris*	X		92	100	75
Cedar Waxwing	*Bombycilla cedrorum*		X	8	13	0
Phainopepla	*Phainopepla nitens*	X		17	13	25
Orange-crowned Warbler	*Vermivora celata*	X		42	50	25
Nashville Warbler	*Vermivora ruficapilla*		X	8	0	25
Yellow Warbler	*Dendroica petechia*		X	25	25	25
Common Yellowthroat	*Geothlypis trichas*	X		17	0	50
Wilson's Warbler	*Wilsonia pusilla*	?		58	50	75
Yellow-breasted Chat	*Icteria virens*	X		42	38	50
Western Tanager	*Piranga ludoviciana*		X	58	50	75
Black-headed Grosbeak	*Pheucticus melanocephalus*	X		83	88	75
Blue Grosbeak	*Guiraca caerulea*	X		0	0	0
Lazuli Bunting	*Passerina amoena*	X		25	25	25
Spotted Towhee	*Pipilo maculatus*	X		67	63	75

Table B-9. Continued

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
California Towhee	*Pipilo crissalis*	X		25	25	25
Lark Sparrow	*Chondestes grammacus*	X		0	0	0
Savannah Sparrow	*Passerculus sandwichensis*	X		0	0	0
Song Sparrow	*Melospiza melodia*	X		42	38	50
Red-winged Blackbird	*Agelaius phoeniceus*	X		0	0	0
Western Meadowlark	*Sturnella neglecta*	X		0	0	0
Brewer's Blackbird	*Euphagus cyanocephalus*	X		8	0	25
Brown-headed Cowbird	*Molothrus ater*	X		75	63	100
Bullock's Oriole	*Icterus bullockii*	X		58	50	75
House Finch	*Carpodacus mexicanus*	X		83	75	100
Lesser Goldfinch	*Carduelis psaltria*	X		92	100	75
American Goldfinch	*Carduelis tristis*	X		75	88	50
House Sparrow	*Passer domesticus*	X		25	25	25