A Watershed-Scale Survey for Stream-Foraging Birds in Northern California[1]

Sherri L. Miller[2] and C. John Ralph[2]

Abstract

Our objective was to develop a survey technique and watershed-scale design to monitor trends of population size and habitat associations in stream-foraging birds. The resulting methods and design will be used to examine the efficacy of quantifying the association of stream and watershed quality with bird abundance. We surveyed 60 randomly selected 2-km stream reaches of all stream orders in the Smith River watershed in northern California. In addition to counts and foraging activity of American Dippers (*Cinclus mexicanus*) and other bird species that forage in the stream, we collected a large variety of physical and biological measurements of the stream and bank habitats to identify the factors most related to abundance. We found highest dipper densities on larger streams and main stems of the river, and they were present in cascades significantly more often than expected. We also conducted an intensive color-banding and census effort along one creek where we banded most of the resident breeding population over four years. By surveying about once per month between April and November, we have located nests, documented triple-clutching, nest fidelity, and feeding of nestlings by three or more birds at one nest.

Introduction

There has been great interest in the vegetation of riparian habitats and their importance to the many birds that nest and forage in them, but stream-foraging birds are also affected by riparian habitat, through the habitat's relationship to stream quality. For example, American Dipper (*Cinclus mexicanus*) abundance and reproductive success have been found to be low with acidic stream conditions (Tyler and Ormerod 1994) and extensive cattle grazing (Osborn 1999). Loegering and Anthony (1999) found the extent and condition of riparian habitat and streamside trees to be a predictor of abundance for three stream-associated species: American Dippers, Belted Kingfishers (*Ceryle alcyon*), and Great Blue Herons (*Ardea herodias*). Land use practices, such as timber harvesting and recreation, may also affect the condition of streams and rivers within a watershed, and result in changes in bird abundance or reproductive success. It is important to assess the effects of landscape scale forest management programs, such as the federal-lands Northwest Forest Plan, on birds that depend on streams to forage.

Our objectives were to develop a protocol and sampling design for watershed scale surveys of stream-foraging birds that could be used to: (1) model associations of bird abundance and riparian and stream habitat types, (2) model relationships between stream bird abundance and covariates that quantify physical and biotic parameters of the stream and riparian habitats, and (3) monitor stream-bird densities to identify trends from year to year.

Methods

Our research was conducted in northwestern California in the Smith River watershed (*fig. 1*), a relatively small (about 206,200 ha) natural system without dams. Topography is usually steep and many of the small streams are difficult to access. The dominant vegetation is mixed-conifer forest, but some unique botanical areas and about 21,900 ha of old-growth coastal redwood are included in the watershed. The lower portion of the main stem, where the river is bordered by agricultural land managed for grazing and cut flowers, was not included in the study area. Several major streams in the southwest and northwest portions of the watershed are located on approximately 14,600 ha of private timberlands. Most of the remaining lands in the watershed are on national forests. Past and current land uses include logging, mining, recreation, and some grazing.

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[2]USDA Forest Service, Redwood Sciences Laboratory, 1700 Bayview Drive, Arcata, California 95521

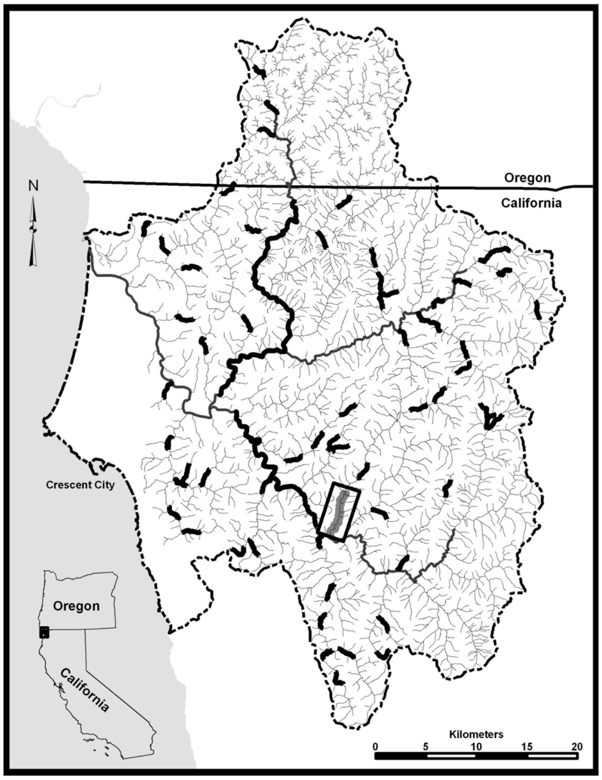

Figure 1— The Smith River watershed in Del Norte County, California. Thick, black lines are surveyed 2-km stream segments and surveyed sections of the main stems. Hurdy Gurdy Creek, the 7-km demographic study area, is contained in the rectangle near the south fork of the river.

We randomly selected sixty 2-km stream segments throughout the watershed for sampling. All stream segments were within 1 km of a road or trail and were classified as stream Orders 1 (small) through 5 (large) (Strahler 1957), a measure of stream size and flow volume. On the main stems of the river—the middle (above the south fork confluence), south, and north forks—we surveyed birds along the entire length of river between access points and collected habitat measures in the pre-selected 2-km segments.

We walked in the streams or at the edge while recording location and behavior for all stream-foraging birds seen or heard, including American Dippers, Belted Kingfishers, Spotted Sandpipers (*Actitis macularia*), Common Mergansers (*Mergus merganser*), Wood Ducks (*Aix sponsa*), Great Blue Herons, Green Herons (*Butorides striatus*), Osprey (*Pandion haliaetus*), and other occasionally-observed species. In addition to counts, we recorded foraging activity, nest locations, and observed activity at nests.

We mapped each stream habitat unit (a length of similar habitat type) as pool, run, riffle, rapid, or cascade (Bisson et al. 1981). Habitat types were classified by gradient and depth, from pools, low gradient and deep water, through cascades, steep gradient or waterfalls. We recorded many habitat measures of the stream and bank vegetation including bank substrate and vegetation; nest substrate availability and characteristics; water depth, width, and flow speed; stream substrate size and depth of silt; and availability of perching and foraging substrate. Macroinvertebrate samples were collected using a Surber net sampler (Hauer and Resh 1996) at foraging locations and at 3 systematic locations in the segments.

In the lower 7 km of Hurdy Gurdy Creek, a tributary to the south fork (*fig. 1*), we captured dippers using mist-nets placed across the stream. Captured birds were color-marked and data were collected on age, breeding status, molt extent, condition, and wing, bill, and leg measurements. The study reach was surveyed 3 to 4 times each year when water levels permitted access, generally from April through November, completing over 110 km of survey. Bird locations were mapped to identify territories and site and pair fidelity. Nest locations were recorded and nests checked for activity throughout the breeding season.

Results

We surveyed 61 stream segments in 2000, 2002, and 2003. Order 1 streams generally flow intermittently, largely during winter and spring, yet, we observed dippers in these streams during the breeding season. We found higher densities of dippers in stream Orders 3 and 4 (*fig. 2*), with the highest density, 4.6 dippers per km, in Order 4 streams. We found significant differences in the number of dippers per kilometer by stream order ($p=0.005_{alpha\ 0.05,\ 4\ df}$) using analysis of variance with a general linear model for unbalanced sampling design (Zar 1984, SAS 1996). Higher densities in Order 3 and 4 streams, and lower density in Order 1 streams, were indicated by Duncan's Multiple Range Test (Zar 1984, SAS 1996).

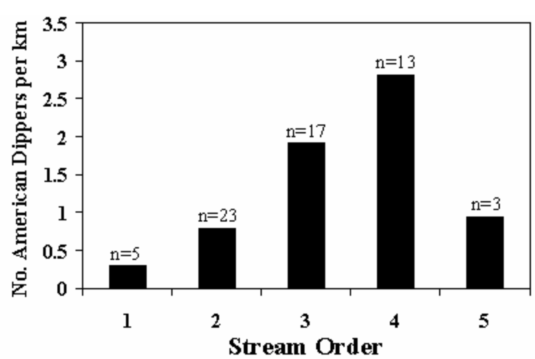

Figure 2— The number of American Dippers per kilometer of stream survey, Smith River, California. We surveyed randomly selected 2-km segments in stream orders 1 through 5; n = the number of segments surveyed in each order.

Table 1— *The percentage of each stream habitat type for total meters sampled and the number of sampled segments by stream order (Strahler 1957). Habitat types (Bisson et al. 1981) are classified by gradient and depth, from pools, low gradient and deep, through cascades, steep gradient or waterfalls.*

Stream order	Stream habitat type					Number of segments
	Pool	Run	Riffle	Rapid	Cascade	
1	6	25	13	52	2	5
2	15	14	27	41	3	23
3	16	27	28	25	5	17
4	23	24	45	8	1	13
5	19	27	51	1	0	3

Table 2— *The proportion of stream habitat types on the surveyed 2-km stream segments in the Smith River watershed in Del Norte County, California. The expected number of American Dippers according to the proportion of each habitat available and the number of dippers observed during surveys.*

Habitat type	Pool	Run	Riffle	Rapid	Cascade
Proportion of the 120 km of streams surveyed	0.16	0.21	0.31	0.29	0.03
Expected number of dippers by habitat type	29	38	56	53	5
Number of observed dippers, Total = 181	23	33	63	48	14

The percentage of each habitat type by segment was similar for stream Orders 1, 2, and 3 (*table 1*). Stream Orders 4 and 5 had a higher percentage of riffles and a lower percentage of rapids. Few cascades were observed in all stream orders. We observed dippers more often in cascades (short, steep waterfalls) and less often in pools (calm, deep water) than expected given the amount of each habitat available (*table 2*). Using a Chi-square analysis (Zar 1984) we found the birds did not use the habitats in proportion to the amount of each habitat available (χ^2=16.643$_{\text{alpha 0.05 = 9.488 df = 4}}$, K=5).

We captured and color-marked 17 adult and 20 juvenile dippers during four breeding seasons, from 2000 to 2003. Five nests were located and observed during surveys. One female, an adult when captured, nested successfully in the same territory for the four years of the study. In the second year, this female successfully raised three broods in two months. During the third year of observations at this nest we observed three birds feeding nestlings in succession: the banded female, the banded male, and an unbanded bird. We observed three banded female dippers using the old and new nests within the same territories over multiple years. We continued to observe the banded adults and juveniles on Hurdy Gurdy Creek throughout our survey season. Only three banded juveniles were observed after their first year, apparently having dispersed. In fall 2002, a color-banded dipper was observed on the Rogue River, 153 air miles and two watersheds to the northeast. This bird had been banded as a juvenile in 2001.

Discussion

Because the distribution of habitat types was similar for all orders (*table 1*), lower numbers of dippers in pools and higher numbers in cascades appeared to represent a real difference in habitat use by the dippers. Prey abundance, quality, or accessibility also may play a roll in differences in habitat use. We are continuing to analyze habitat data from foraging activity to address these questions.

In the future we will assess the effectiveness of our sampling design to measure dipper abundance at the watershed scale. We will compare density estimates derived from the 2-km segments to 1-km subsamples of the data. If we can obtain similar statistical power from 1-km segments, we could complete more samples in a season. Because the birds were relatively shy for assessing foraging success rates and habitat characteristics, a separate sampling effort to collect foraging activity and foraging plot data would be necessary. We will be using our repeated observations of color-banded birds to quantify detectability. We plan to conduct additional surveys on three or four consecutive days for four sessions throughout a breeding season to complete the dataset for this analysis.

We are continuing to study molt patterns in this near-coastal population. The timing of molt is important for a monitoring design. Changes in behavior during molt, such as less vocalizing or secretiveness, might affect detectability. We may need to adjust for differences in detectibility by changing the sampling period or accounting for biases when analyzing data. Knowing when fledglings complete the first pre-basic molt, losing their easily distinguished immature plumage, will help us interpret density estimates, especially since second and third broods are a possibility. A better understanding of molt limits may help us identify second-year birds and better understand the demographics of this species. Documenting plumage changes on juveniles throughout the season will help us better identify age by sightings alone.

Because we observed dippers on even the small and intermittent Order 1 streams, it is important to sample all orders when assessing abundance at a watershed scale. Osborn (1999) surveyed two Order 1 streams and observed dippers on both, but others surveyed only larger streams (Price and Bock 1983, Loegering and Anthony 1999). The large number of small streams in most watersheds can represent a sizeable portion of a watershed and could provide habitat for an important component of the dipper population.

We are continuing analyses to examine relationships in abundance and stream and riparian habitat conditions. We will incorporate our findings into a protocol that assesses dipper abundance at a watershed scale.

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