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Distribution, Abundance, and Habitat Association of Riparian-Obligate and -Associated Birds in the Oregon Coast Range

Abstract

We studied the abundance, distribution, and habitat associations of the aquatic-foraging riparian-associated vertebrate community along four stream basins transecting managed forests in the Oregon Coast Range, 1992-1994. The riparian-associated community we observed consisted primarily of birds with few observations of mammals. Belted kingfishers (*Ceryle alcyon*), American dippers (*Cinclus mexicanus*), great blue herons (*Ardea herodias*), and mallards (*Anas platyrhynchos*) comprised >85% of these observations, but we observed only one group (≥1 individual observed together) from this community for each kilometer of stream surveyed. Bird abundances among years were not different (all $P > 0.05$). Species distribution was affected by stream order, stream basin, and season in each species, but to varying degrees. Belted kingfishers, common mergansers (*Mergus merganser*), great blue herons, green herons (*Butorides striatus*), and mallards were more abundant in larger, 6th-order streams than in smaller, 4th-order streams ($P < 0.05$). Dippers used step channel units disproportionally more and riffles disproportionately less than expected ($P < 0.5$). Similarly, kingfishers used fewer riffles and more pool channel units than was expected ($P < 0.5$). Key habitat components that were predictive of use were species specific. Most notably, the presence of a forested riparian area, streamside trees, and valley walls that constrain the stream were important predictors of use by the three most abundant species; dippers, kingfishers, and great blue herons. Monitoring programs to assess populations of these species in mountainous habitat must be sensitive to the potential effects of stream order, basin, and season and encompass a large spatial and temporal extent.

Introduction

The forest lands of western Oregon and Washington are some of the most productive in the world (Franklin and Dyrness 1973, Waring and Franklin 1979). More than 78% of the approximately 35 million acres west of the crest of the Cascade Range is forested (Brown and Curtis 1985) and intensively managed for the production of wood products. Riparian areas transecting these managed forests are subject to conflicting land-use demands for development and timber harvest as well as protection for water quality and fish and wildlife habitat.

Riparian areas are important to wildlife (Bull 1978, Thomas et al. 1979, Oakley et al. 1985), but little is known about the extent of the riparian-wildlife associations in the Pacific Northwest (McGarigal and McComb 1988). Prior to 1971, timber harvest on private, state, and, to a lesser degree, federal lands proceeded without concern for riparian areas, and harvest units often have extended to the stream's edge. However, the Oregon Forest Practices Act mandated decreased harvest along streams and the retention of forested riparian areas to protect water quality and fish populations. The use by and importance of forested buffer strips to wildlife was largely unknown. In western Oregon and Washington, 87% (n = 414) of the resident species of amphibians, reptiles, birds, and mammals use riparian zones or wetlands (Oakley et al. 1985), and 10% are noted as using specialized habitats within riparian zones. In the Oregon Coast Range, most information on riparian-associated wildlife is qualitative with some quantitative information on small mammals (Anthony et al. 1987b, Corn and Bury 1991a, Suzuki 1992, McComb et al. 1993, Gomez and Anthony 1996), amphibians (Bury 1988, Corn and Bury 1991b, Gomez 1992, Vesely 1996), and songbirds (Carey 1988, Carey et al. 1991, McGarigal and McComb 1992). Even less is known about the subset of terrestrial vertebrates that are considered riparian obligates (Anthony et al. 1987a), those that depend on the stream for foraging or reproduction.

We know of no large-scale, inter-basin surveys of aquatic foraging species or assessments of factors affecting their abundance and distribution. Yet recent federal and state guidelines (e.g., FEMAT 1993, Oregon Forest Practices Act 1994) stipulate riparian reserves and require monitoring programs for selected species. Thus, the purpose of

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this study was to assess the breeding abundance, distribution, and habitat relationships of selected aquatic-foraging riparian-obligate and -associated species in the Oregon Coast Range. We evaluated habitat associations at three spatial scales (Johnson 1980) of increasing specificity: large-scale habitat patches (Johnson's 2nd level; riparian zone and streamside features; hereafter, streamside habitat); specific habitat patches (3rd level; selection among stream channel units); and selection within each patch (4th level; discrimination within each channel unit; hereafter, stream habitat). Specifically, we tested the hypotheses that: 1) the distribution and abundance of each species did not differ within and among basins, 2) species used habitat types in proportion to their availability, and 3) the stream and streamside habitat where we observed species was not different from available habitats.

Methods

Study Areas

We surveyed Drift Creek, Lobster Creek, Lake Creek, and Five Rivers basins in the central Oregon Coast Range. These basins were in Benton, Lane, and Lincoln counties and drained into the Alsea and Siuslaw rivers, 6-23 km east of the Pacific Ocean. We selected these basins arbitrarily because of logistical constraints. These basins were all in the central Coast Range and had similar elevation, gradient, vegetation, and management regimes. The topography was steep with moderately flat valleys. Stream bed elevation ranged from 3 to 365 m above sea level. Average stream gradient was generally <4% (range 0.5-5%), but was higher in smaller streams. The maritime climate was characterized by mild wet winters and cool dry summers. Average annual precipitation varied geographically and was 180-300 cm, with 75-85% falling during October-March. Mean temperature was seldom below 0°C in the winter, and summer temperatures were generally less than 27°C (Franklin and Dyrness 1973). A mosaic of federally and privately managed forests dominated the upslope areas adjacent to these streams; pastures were common along the lower portions. All basins had extensive networks of roads from past timber harvest activities, with the exception of the Drift Creek Wilderness Area. Upslope vegetation was characteristic of the western hemlock (*Tsuga heterophylla*) zone (Franklin and Dyrness 1973) dominated by Douglas–fir (*Pseudotsuga menziesii*), western hemlock, western redcedar (*Thuja plicata*), and red alder (*Alnus rubra*). Upslope seral stages ranged from recently harvested to mature forests. Riparian areas were typically forested by red alder, Douglas-fir, bigleaf maple (*Acer macrophyllum*), and western redcedar.

Stream Surveys

We surveyed the entire width (3–15 m range) of streams on foot, walking upstream (25% of surveys) or downstream (75%) within the wetted stream channel. No attempt was made to survey areas greater than 5 m from the stream edges. We surveyed portions of 5th- and 6th-order streams that were too deep to be readily walked by floating downstream in inflatable kayaks on 19 days (<12% of survey days). We conducted surveys between 0715 and 1756 hours [mean survey midpoint was 1041 hours, mean survey rate was 1.2 km / hour (n = 396)]. We excluded a 9.4-km segment of Lobster Creek and the lower 28 km of Drift Creek because of access problems.

We used the same data-collection methods during stream surveys among years but the geographic extent and the length of stream surveyed differed so that multiple research objectives could be accomplished (Loegering 1997). In May-September 1992, we used a stratified random sampling design to select stream segments to survey in the four basins. We stratified by basin and stream order, a stream classification system. Each small unbranched tributary is a first-order stream, two first-order streams join to make a second-order stream. A third-order stream is formed by the joining of two second-order streams, and so on (Strahler 1957, Everest et al. 1985). We surveyed 30 km of stream in each basin, distributed equally (10 km each) among fourth-, fifth-, and sixth-order streams. The 10 km surveyed in each order was composed of five 2-km survey units. We randomly determined the stream and location of the starting point for each survey unit in each basin and during each survey cycle. We surveyed all four basins every 3-4 weeks, completing a total of five survey cycles in 1992. In March-August 1993 and 1994, we surveyed the entire length of all 4–6th-order streams three times each year only in Drift and Lobster creek basins; Five Rivers and Lake Creek were not surveyed.

We plotted the initial locations of individuals or groups (≥1 individual in close proximity; e.g., an adult with a brood) of individuals of avian and mammalian species on United States Geological Survey (U.S.G.S.) 7.5' topographic maps. We plotted only observations of individuals not noticeably affected by our presence, and we made every attempt to count all individuals only once. We recorded the stream channel and streamside habitat (Appendix A) at each sighting location and at randomly-determined locations (see below) to assess habitat associations. We categorized the stream channel habitat at each location into six general units of increasing stream gradient according to Bisson et al. (1982): pools, glides, riffles, rapids, cascades, and steps (hereafter referred to as channel units). We characterized stream habitat by the channel unit length, width, and depth; channel form; streambed substrate size; number of exposed substrate items; number of pieces of large wood; and overhead vegetative shading of the stream. We used channel form to indicate if the channel contained a majority (single or primary channel) or minority (secondary or side channel) of the stream's total flow volume. We categorized the dominant substrate of stream beds into eight size classes based on particle size from smallest (=2) to largest (=9) (Platts et al. 1983).

We used six variables to characterize streamside habitat on each side of the stream; valley form, adjacent land use, riparian zone overstory vegetation, stream bank vegetation, overstory canopy cover, and the distance to human activity. We characterized the overstory riparian zone vegetation 25-m perpendicular distance from the stream at each sighting location. We visually estimated riparian zone canopy cover in a 5-m diameter plot centered 25-m perpendicular distance from the stream's edge at the sighting location. We collected data in the field and reduced it similarly for riparian zone vegetation and vegetation that was immediately adjacent to the stream (hereafter, stream bank vegetation). In the field, we visually identified the dominant plant species, defined as the species or community with the largest proportion of overstory canopy cover. For the analyses, we simplified our assessment of vegetation to one binary variable indicating if the dominant vegetation was a tree (woody vegetation > 5 m tall), or not; and a second binary variable indicating if the vegetation was a conifer, or not. Conifer trees were Douglas-fir (all size classes >5 m tall), Sitka spruce (*Picea sitchensis*), western redcedar, and western hemlock. Non-conifer trees were red alder and bigleaf maple. Young Douglas-fir (0-15 years, <5 m tall) plantations were the only vegetative category in the non–tree, conifer group. The fourth group of vegetation communities that were not trees and not conifers were shrubs, grasses, and herbs and dominated by elderberry (*Sambucus* spp.), cascara (*Rhamnus purshiana*), willow (*Salix* spp.), willow and salmonberry (*Rubus spectabilis*), salmonberry, vine maple (*Acer circinatum*), unidentified grasses or sedges, ferns or mosses, forbs, lichens, cow-parsnip (*Heracleum lanatum*), ninebark (*Physocarpus capitatus*), blackberry (*Rubus* spp.), thimbleberry (*Rubus parviflorus*), stink currant (*Ribes bracteosum*), recent clearcut with no regeneration, devil's club (*Oplopanax horridum*), skunk cabbage (*Lysichitum americanum*), stinging nettle (*Urtica dioica*), snowberry (*Symphoricarpos* spp.), horsetail (*Equisetum* spp.), salal (*Gaultheria shallon*), and red huckleberry (*Vaccinium parvifolium*). We used Hitchcock and Cronquist (1973) to identify vegetation.

Habitat Availability

We used the same stream and streamside variables to characterize the available habitat as we used to characterize used habitat in June and August, 1992. In each 2-km survey unit, we randomly sampled a minimum of 10 sites (points or locations) including at least three pools, three glides, three riffles, and all rapids and cascades, which were quite rare. The 10 sample sites were distributed uniformly along the 2-km survey unit. We used two levels of randomization in the field to reduce observer bias in selecting available channel units. Observers randomly selected 1) the type of unit to sample (e.g., pool, glide, or riffle), and 2) the direction (upstream or downstream) to travel to the next available unit of that type. These methods characterized the available channel units allowing within channel unit comparisons, but they do not represent relative abundance of these units. To determine the proportion of each available channel unit, we measured each channel unit within 500 m of each dipper nest (1000 m total) in 4–5th-order streams (>12 km total) in Drift and Lobster creeks.

Statistical Analyses

We measured stream lengths with a map wheel on 7.5' (1:24,000) U.S.G.S. topographic maps and expressed species abundance as the number of individuals observed per km of stream. We divided all observations into early (February-June) and late (July-September) seasons to account for changes in weather patterns and hydrologic regimes in the analysis. We used similar sampling effort among basins within seasons.

We used an Analysis of Variance for an unbalanced design (ANOVA; Proc GLM, SAS Institute 1989) to compare abundances of each species in 1992 among stream basin, stream order, and survey cycle as well as all first–order interactions. We compared abundance among years with an ANOVA but limited these analyses to stream segments we surveyed all three years during comparable time periods. We used pairwise *t*-tests equivalent to Fisher's least-significant-difference (LSD) test in the case of equal cell sizes (SAS Institute 1989) for comparisons within groups. We did not examine specific effects of the survey time of day or weather because such a design was not consistent with other research objectives.

We compared the use of channel units by American dippers (*Cinclus mexicanus*) and belted kingfishers (*Ceryle alcyon*) relative to availability with a simultaneous confidence interval comparison (Bailey 1980, Cherry 1996). We defined use as the proportion of observations in each channel unit and availability as the proportion of the total area of each channel unit. We limited the analysis to 4–5th-order streams because availability data were collected only in those orders. We constructed 95% confidence intervals on use for each unit to estimate the true proportion of use. If the available proportion was less than the lower limit, channel units were used more than expected. If the available proportion was greater than the upper limit, units were used less than expected, or avoided.

We developed logistic regression models to identify stream and streamside variables that distinguished between habitats where we observed dippers, kingfishers, great blue herons (*Ardea herodias*), and mallards (*Anas platyrhynchos*) versus available habitats. Because our objective was to examine habitat selection patterns after accounting for any effects of the four stream basins, three stream orders, or two seasons, we included six indicator or dummy (0/1) variables in all regression models (3 for basin + 2 for order + 1 for season). We used a backward selection procedure to remove habitat variables that did not contribute to the regression model's explanatory power based on a drop-in-deviance test at a significance level ≤ 0.10. We compared competing models with Akaike's Information Criterion (AIC) and selected the model with the lowest score. All models met the Hosmer and Lemeshow goodness–of–fit test ($P > 0.05$, Hosmer and Lemeshow 1989). We tested all first–order interactions between significant main effects for each model after the initial variable selection. All odds ratios from logistic regression analyses are reported relative to a base comparison, that is, an odds ratio = 1. We excluded from the analysis of habitat use all observations that may have been affected by the presence of the observer, including disturbed or agitated birds, or birds in flight.

For each species, we used two models to assess habitat associations—one model compared stream habitats, and another compared adjacent, streamside habitats. Stream habitat was dynamic and may have differed among years, and we collected availability data only in 1992. Therefore, we analyzed only observations from 1992 when both use and availability data were collected. In addition, our sampling objective was to characterize the available stream habitat for each channel unit; therefore, we were limited to evaluating stream habitat selection within each channel unit (e.g., used vs. available pools). To assess streamside habitat selection, we included all observations of used habitat during 1992-1994 and the availability data collected only in 1992 because adjacent streamside features (e.g., a constrained valley form) were stable, and their availability was unlikely to change among years.

Results

We surveyed 966 km of stream (533, 230, and 203 km in 1992, 1993, and 1994; respectively) and observed 1047 groups of riparian–associated birds (96%) and mammals (<4%, Table 1).

Distribution and Abundance

Abundance was distributed differently among basins, stream orders, and survey cycle in 1992 for American dippers (ANOVA, F = 3.3, 52 df, $P = 0.004$), belted kingfishers (F = 4.0, 52 df, $P = 0.001$), common mergansers (F = 2.5, 52 df, $P = 0.024$), great blue herons (F = 2.7, 52 df, $P = 0.015$), and mallards (F = 2.4, 52 df, $P = 0.026$), but not for green herons (F = 2.0, 52 df, $P = 0.064$) or

TABLE 1. Number of groups observed and mean (SE) group size of riparian-associated species in the Oregon Coast Range, 1992-1994.

Species	Scientific name	Groups observed	% total	Group size
belted kingfisher	*Ceryle alcyon*	352	33.6	1.21 (0.03)
American dipper	*Cinclus mexicanus*	338	32.3	1.26 (0.03)
great blue heron	*Ardea herodias*	104	9.9	1.0 (0)
mallard	*Anas platyrhynchos*	101	9.6	2.94 (0.26)
wood duck	*Aix sponsa*	26	2.5	1.96 (0.39)
common merganser	*Mergus merganser*	25	2.4	5.60 (0.93)
green heron	*Butorides virescens*	21	2.0	1.05 (0.05)
unidentified ducks		17	1.6	2.18 (0.46)
hooded merganser	*Lophodytes cucullatus*	10	1.0	2.80 (0.71)
spotted sandpiper	*Actitis macularia*	4	0.4	1.25 (0.25)
domestic duck		2	0.2	5.50 (2.50)
cormorant spp.	*Phalacrocorax* spp.	2	0.2	1 (0)
other bird species[1]		5	0.5	
mammals[2]		40	3.8	
Total		1047		

[1] Other bird species includes an observation of one group each of a bald eagle (*Haliaeetus leucocephalus*), cinnamon teal (*Anas cyanoptera*), unidentified merganser, osprey (*Pandion haliaetus*), and red-breasted merganser (*Mergus serrator*).
[2] Includes 19 river otter (*Lutra canadensis*), 18 beaver (*Castor canadensis*), 2 raccoons (*Procyon lotor*), and 1 mink (*Mustela vison*).

TABLE 2. Mean (SE) abundance (individuals / 10 km of stream) of riparian-associated birds in 4–6th-order streams in the Oregon Coast Range, 1992. Values are least-squared means from the analysis of variance model including stream order, basin, and cycle effects (n = 53 surveys, 533 km of stream).

stream order	American dipper	belted kingfisher	common merganser	great blue heron	green heron	mallard	wood duck
4	2.8 (0.6) ab[1]	2.8 (0.8) a	0 (0.7) a	0.9 (0.3) a	0.1 (0.1) a	1.4 (1.2) a	0.1 (0.4) a
5	4.7 (0.6) a	7.7 (0.8) b	0.5 (0.7) a	1.2 (0.3) ab	0.4 (0.1) ab	6.0 (1.2) b	1.5 (0.4) a
6	1.4 (0.9) b	8.6 (1.0) b	4.0 (0.9) b	2.3 (0.4) b	0.6 (0.2) b	7.7 (1.6) b	0.9 (0.5) a
P	0.008	0.0001	0.002	0.015	0.029	0.005	0.082

[1]Means with the same letters within each column are not different (Fisher's LSD $P > 0.05$).

TABLE 3. Mean (SE) abundance (individuals / 10 km of stream) of riparian-associated birds in four basins in the Oregon Coast Range, 1992. Values are least-squared means from the analysis of variance model including stream order, basin, and cycle effects (n = 53 surveys, 533 km of stream).

Basin	American dipper	belted kingfisher	common merganser	great blue heron	green heron	mallard	wood duck
Drift Creek	5.7 (0.7) a[1]	5.3 (0.9) a	1.9 (0.7) a	1.2 (0.3) a	0.1 (0.2) a	1.7 (1.4) a	0.8 (0.4) a
Five Rivers	2.3 (0.8) b	6.8 (0.9) a	1.0 (0.8) a	1.5 (0.3) a	0.1 (0.2) a	5.9 (1.5) ab	0.8 (0.5) a
Lake Creek	2.6 (0.8) b	7.2 (0.9) a	0.9 (0.8) a	0.9 (0.3) a	0.6 (0.2) a	4.0 (1.5) ab	0.9 (0.5) a
Lobster Creek	1.2 (1.0) b	6.2 (1.1) a	2.1(1.0) a	2.0 (0.4) a	0.6 (0.2) a	8.5 (1.8) b	0.8(0.6) a
P	0.002	0.46	0.66	0.21	0.078	0.029	0.99

[1]Means with the same letters within each column are not different (Fisher's LSD $P > 0.05$).

wood ducks ($F = 1.3$, 52 df, $P = 0.27$). Dippers were more abundant in 5th than in 6th-order streams ($P < 0.05$, Table 2). Belted kingfishers, common mergansers, blue herons, and mallards were most abundant in 6th-order streams and increased monotonally from 4th to 6th-order streams ($P < 0.05$, Table 2). Dippers were more abundant in Drift Creek than the other study basins ($P < 0.05$), whereas mallards were more abundant in Lobster Creek than in Drift Creek ($P < 0.05$, Table 3). Abundance of other species did not differ among study basins. Only great blue heron abundance differed among seasons ($P = 0.01$), with twice as many observations after 1 July than earlier in the year ($\bar{x} = 1.0$, SE = 0.3 vs. $\bar{x} = 1.9$, SE = 0.2 individuals / 10 km of stream for early and late seasons, respectively). In addition, we found no significant ($P \leq 0.05$) interactions among the main effects of stream order, basin, and survey cycle for dippers, kingfishers, mergansers, great blue herons, green herons, mallards or wood ducks. There were no significant differences in abundance among years for any species (all $P > 0.07$, Loegering 1997). In addition, we detected no autocorrelation among the years for any species (Durbin–Watson D, all $P > 0.10$).

Streamside Habitat Features

Each species was associated with different landscape and riparian zone features. Four variables distinguished areas used by American dippers from those that were available (logistic regression, $\chi^2 = 211$, 14 df, $P = 0.0001$, max. re-scaled $R^2 = 0.23$). We located dippers in areas where trees were the dominant riparian zone overstory species on one or both stream banks (Table 4). Compared to streams with no riparian–zone trees (logistic regression odds ratio = 1), we were less likely (90% confidence interval [CI] on the odds ratio = 0.3 - 0.9, $P = 0.047$, Table 5) to find dippers where there were overstory trees on one side of the stream but more likely to find dippers where both banks had overstory trees. Dippers were 1.5 to 3.1 times (90% CI) more likely to be found on reaches constrained by the valley walls on both sides of the stream ($P = 0.0005$, Table 5) than in unconstrained stream reaches, and this pattern was similar but not as pronounced for reaches that were constrained by only one valley wall ($P = 0.27$). Dippers also selected areas where trees dominated the vegetation immediately adjacent to the stream on one or both sides of the stream compared to the available habitat ($P = 0.64$ and $P = 0.06$, respectively; Table 5). The interaction between stream bank trees and constrained valley form explained additional variability in the data ($P = 0.06$).

Three significant variables contributed to the model for habitat selection by belted kingfishers ($\chi^2 = 79$, 11 df, $P = 0.0001$, max. re-scaled $R^2 = 0.12$). Kingfishers were 4.2 to 24 times (90% CI) more likely to use an area with trees immediately adjacent to the stream on both banks ($P = 0.0001$, Table 4 and Table 5) than reaches without streamside trees. However, kingfishers were only 0.5 - 0.9 and 0.4 - 0.8 times (90% CI on odds ratio) as likely to use reaches with a constrained valley form on one or both sides of the stream (both $P = 0.02$, Table 5) compared to unconstrained reaches (odds ratio = 1). They selected stream sections that were constrained on one or both sides less often than were available. Kingfishers also used habitat that was slightly closer to human activity (Table 4) than the available habitat ($P = 0.09$, Table 5).

Presence of riparian trees, the valley form, and the distance to human activity distinguished between areas used by great blue herons and those available ($\chi^2 = 47$, 12 df, $P = 0.0001$, max. rescaled $R^2 = 0.11$). Herons were 0.3 - 0.7 and 0.2 - 0.8 times (90% CI on odds ratio) as likely to use reaches that were constrained on one or both sides of the stream than unconstrained reaches ($P = 0.007$ and $P = 0.03$, respectively, Table 5); they used less constrained valley forms than were available (Table 4). Herons were 0.5 - 0.95 and 0.53 - 0.98 times (90%CI on odds ratio) as likely to be found where the riparian–zone vegetation was trees on one or both sides of the stream compared to treeless riparian zones (odds ratio = 1). The interaction of the distance to humans and constrained valley form also was significant ($P = 0.02$).

Three variables explained habitat use by mallards ($\chi^2 = 89$, 11 df, $P = 0.0001$, max. re-scaled $R^2 = 0.19$); riparian zone canopy cover, valley form and upslope land use. Mallards were 1.3 to 4.8 times (90% CI) more likely to be found where both adjacent upslopes were managed forests (odds ratio = 2.5, $P = 0.02$, Table 5) rather than another land use type (odds ratio = 1). The likelihood of use by mallards decreased (odds ratio = 0.68 to 0.85, 90% CI) for each 10% increase in overstory canopy cover in the riparian area (odds ratio = 0.76, $P = 0.001$). Mallards also were 15% to 53% as likely (90% CI) to be located on reaches that were constrained on both sides than in unconstrained reaches (odds ratio = 0.3, $P = 0.001$).

Channel Unit Use and Selection. We located dippers most often in riffles (37%), rapids (27%), and pools (19%); and kingfishers were found perched over pools (47%), glides (31%), and riffles (16%). The available habitat was composed of riffles (57%), rapids (17%), glides (16%), and pools (10%). Dippers were located on steps more than expected and riffles less than expected (Table 6).

TABLE 4. Mean (SE) percent occurrence (%) and distance (m) of streamside habitat characterizing sites used by riparian-associated birds in the central Oregon Coast Range, 1992-94. * indicates variables included in the logistic regression model[1]. Samples sizes were 250,152,72,79, and 1120 for American dippers, belted kingfishers, great blue herons, mallards and the available habitat, respectively.

	Riparian Zone					Stream Bank								
	dominated by trees[2](%)		dominated by conifers[3](%)		canopy cover (%)	dominated by trees[2](%)		dominated by conifers[3](%)		valley form (% constrained)		land use (% managed forests)		distance to human activity (m)
	one bank	both banks	one bank	both banks		one bank	both banks	one bank	both banks	one bank	both banks	one bank	both banks	
American dipper	12.8 (2.1)*	82.0 (2.4)*	30.4 (2.9)	10.4 (1.9)	52.3 (1.2)*	6.4 (1.5)*	6.0 (1.5)*	0 (0)	0 (0)	41.6 (3.1)*	33.2 (3.0)*	9.2 (1.8)	78.8 (2.6)	303 (33)
belted kingfisher	25.7 (3.5)	57.9 (4.0)	27.0 (3.6)	5.3 (1.8)	42.4 (1.8)	6.6 (2.0)*	5.3 (1.8)*	0.7 (0.7)	0.7	36.2 (3.9)*	17.1 (3.1)*	22.4 (3.4)	56.6 (4.0)	160 (29)*
great blue heron	25.0 (5.1)*	55.6(5.9)*	31.9 (5.5)	6.9 (3.0)	41.8 (2.7)	2.8 (1.9)	0 (0)	0 (0)	0 (0)	29.2 (5.4)*	20.8 (4.8)*	19.4 (4.7)	61.1 (5.7)	295 (71)*
mallard	44.3 (5.6)	41.8 (5.5)	34.2 (5.3)	6.3 (2.7)	33.5 (2.2)*	2.5 (1.8)	2.5 (1.8)	1.3 (1.3)	0 (0)	35.4 (5.4)*	15.2 (4.0)*	20.3 (4.5)*	62.0 (5.5)*	136 (32)
available habitat	30.4 (1.4)	59.3 (1.5)	25.7 (1.3)	7.1 (0.8)	43.9 (0.6)	4.5 (0.6)	0.8 (0.3)	0.2 (0.1)	0 (0)	42.4 (1.5)	18.6 (1.2)	21.6 (1.2)	60.6 (1.5)	280 (17)

[1] Species abundance and habitat features may vary among basin, stream order, and season. Presented means pool all observations whereas the statistical models assessing habitat selection first account for differences inherent to basin, stream order, and season before identifying habitat selection patterns. Consequently, the pooled means may mask more substantial differences.

[2] Contains conifer and hardwood trees.

[3] Contains conifer trees and shrubs.

TABLE 5. Variables distinguishing between used and available streamside habitat for American dippers, belted kingfishers, great blue herons, and mallards in the Oregon Coast Range, 1992-1994. Wald χ^2 and P values are from logistic regression models fitted with indicator variables for basin, stream order, and season. Each set of variables remained after backward logistic regression eliminated others at a significance level = 0.10. See Loegering (1997) for model details.

Species Habitat variable	Wald's χ^2	P	Odds ratio[1]	90% confidence interval on odds ratio Lower	 Upper
American dipper					
tree-dominated riparian zone (%)					
- one bank	3.9	0.047	0.47	0.3	0.9
- both banks	0.6	0.431	1.35	0.7	2.5
riparian zone canopy cover (10% increments)	2.3	0.131	1.08	1.0	1.2
trees on the stream bank (%)					
- one bank	0.2	0.642	1.23	0.6	2.6
- both banks	3.6	0.058	3.52	1.2	10.5
constrained valley form					
- one bank	1.2	0.273	1.23	0.9	1.7
- both banks	12.3	0.001	2.15	1.5	3.1
streambank trees * constrained valley form	3.6	0.059	1.68	1.1	2.6
belted kingfisher					
trees on the stream bank (%)					
- one bank	2.2	0.135	1.76	0.9	3.3
- both banks	18.6	0.000	10.07	4.2	24.3
constrained valley form					
- one bank	5.2	0.022	0.63	0.5	0.9
- both banks	5.4	0.020	0.54	0.3	0.8
distance to human activity (km)	2.8	0.095	0.62	0.4	1.0
great blue heron					
tree-dominated riparian zone (%)					
- one bank	3.2	0.075	0.49	0.3	0.9
- both banks	2.9	0.088	0.53	0.3	1.0
constrained valley form					
- one bank	7.4	0.007	0.44	0.3	0.7
- both banks	4.5	0.033	0.42	0.2	0.8
distance to human activity (km)	1.5	0.220	0.52	0.2	1.2
distance to humans * constrained valley form	5.6	0.018	2.23	1.3	3.9
mallard					
riparian zone canopy cover (10% increments)	15.1	0.000	0.76	0.7	0.9
constrained valley form					
- one bank	2.3	0.126	0.65	0.4	1.0
- both banks	10.6	0.001	0.28	0.1	0.5
upslopes managed forests					
- one bank	0.1	0.751	1.14	0.6	2.3
- both banks	5.6	0.018	2.53	1.3	4.8

[1] multiplicative likelihood of use given a 1-unit increase in the value of a given variable. Odds <1 indicate that an increase in the value of that variable decreases the likelihood of use whereas odds >1 indicate a greater likelihood of use with an incremental increase in the value of that variable.

TABLE 6. Channel unit use by American dippers (n = 95) and belted kingfishers (n = 32) in Drift and Lobster creeks in the Oregon Coast Range, 1992-1994. Proportion of available habitat calculated from the area of 269 channel units (total length = 12,273 m, total area = 91,047 m^2).

Channel unit	Number of observations	Proportion[1] of available channel units	Proportion of observed use	95% confidence limit on observed use		Selection[2]
				Lower	Upper	
American dipper						
pool	18	0.098	0.189	0.093	0.311	0
glide	7	0.162	0.074	0.018	0.169	0
riffle	35	0.569	0.368	0.237	0.503	-
rapid	26	0.167	0.274	0.158	0.404	0
cascade	3	0.003	0.032	0.001	0.110	0
step	6	0.000	0.063	0.013	0.155	+
Total	95	100	100			
belted kingfisher						
beaver pond	1		0.031	0.004	0.198	
pool	15	0.098	0.469	0.231	0.689	+
glide	10	0.162	0.313	0.116	0.542	0
riffle	5	0.569	0.156	0.027	0.370	-
rapid	1	0.167	0.031	0.004	0.198	0
cascade	0	0.003				
step	0	0.000				
Total	32	100	100			

[1] Proportion of channel units represents expected bird observations if each habitat was used in exact proportion to availability.
[2] Channel units used less than (-), more than (+), or in proportion (0) to expected use with the assumption of proportional use.

Kingfishers were found over pools more than expected and riffles less than expected (Table 6). No other species had adequate sample sizes to assess selection of channel units.

Stream Habitat Features

Pool channel units were different between used and available habitat for dippers ($\chi^2 = 45$, 9 df, $P = 0.0001$), kingfishers ($\chi^2 = 35$, 7 df, $P = 0.0001$), herons ($\chi^2 = 25$, 8 df, $P = 0.002$), and mallards ($\chi^2 = 24$, 8 df, $P = 0.002$). Pools used by dippers were more likely to be shorter (Table 7, odds ratio = 0.97, $P = 0.06$), wider (odds ratio = 1.1, $P = 0.04$), and had larger substrate items (odds ratio = 1.4, $P = 0.06$, Table 8) than the available pools (odds ratio = 1). Great blue herons and mallards selected pools that were more open and were in secondary channels. Both species were observed in secondary channel pools 11% and 8% of the time even though these pools comprised only 2% of the available habitat. Consequently, stream segments with pools adjacent to the primary channel increased the likelihood of use by herons and mallards by 3 to 34 and 1.4 to 19 times (90% CI; odds ratios = 9.7 and 5.2; $P = 0.003$ and $P = 0.04$, respectively). Herons and mallards used shaded stream segments less than available. A 10% increase in stream shading decreased the likelihood of use by approximately 23% and 20% for herons and mallards ($P = 0.002$, and $P = 0.03$, respectively; Table 8).

Glide channel units used by kingfishers were different than available glides ($\chi^2 = 24$, 9 df, $P = 0.005$; Table 8). The likelihood that a kingfisher would use a glide increased with glide length (odds ratio = 1.02, $P = 0.07$). However, the likelihood of kingfisher use decreased with increasing substrate size class (odds ratio = 0.8, $P = 0.06$) and the number of exposed substrate items (odds ratio = 0.97, $P = 0.09$).

Riffle use by dippers and kingfishers differed than availability ($\chi^2 = 24$, 7 df, $P = 0.001$ and $\chi^2 = 18$, 8 df, $P = 0.025$; respectively). The likelihood of dipper use decreased with an increase in the number of pieces of large wood in the riffle (odds ratio = 0.94, $P = 0.08$) compared to the available habitat (odds ratio = 1). Kingfishers used riffles that were longer (odds ratio = 1.05, $P = 0.04$) and deeper (odds ratio = 1.1, $P = 0.003$) than the average riffle (odds ratio = 1).

TABLE 7. Mean (SE) stream habitat characterizing sites used by riparian-associated birds in the Oregon Coast Range, 1992. * indicates variables included in the logistic regression model[1]. Loegering (1997) contains a more detailed summary.

Channel unit Species	n	Channel unit dimensions Length (m)	 Width (m)	 Depth (cm)	Channel form[2]	Substrate size[3]	Exposed substrate (#/100 m²)	Large wood (#/100 m²)	Stream shading (%)
Pool									
American dipper	21	19.1 (3.7)*	9.9 (1.1)*	40.0 (4.2)	4.8 (4.7)	7.5 (0.2)*	11.9 (3.4)	2.4 (1.4)	37.4 (5.6)
belted kingfisher	60	109 (32.1)	14.0 (0.8)	59.0 (6.9)	1.7 (1.7)	7.0 (0.3)	2.5 (0.7)	0.8 (0.2)*	23.3 (3.2)
great blue heron	37	123 (44.8)	11.1 (1.1)	63.0 (9.6)	10.8 (5.1)*	6.4 (0.3)	3.2 (1.2)	2.4 (0.6)	21.2 (3.6)*
mallard	37	76.3 (27.9)	13.7 (1.1)	56.3 (6.8)	8.1 (4.5)*	6.5 (0.4)	4.7 (3.2)	0.7 (0.2)	19.4 (3.0)*
available habitat	342	76.0 (9.7)	11.0 (0.4)	56.6 (2.2)	2.05 (0.8)	6.5 (0.1)	8.2 (2.0)	4.5 (1.0)	32.5 (1.4)
Glide									
American dipper	28	13.5 (1.5)	7.4 (0.9)	25.0 (1.8)	3.6 (3.5)	7.6 (0.2)	20.1 (4.5)	2.2 (1.2)	44.6 (5.2)
belted kingfisher	33	24.9 (5.9)*	10.9 (1.1)	27.6 (2.9)	0 (0)	7.4 (0.3)*	4.7 (1.5)*	1.1 (0.3)	27.9 (4.2)
great blue heron	11	13.9 (2.7)	11.1 (1.6)	25.9 (2.0)	0 (0)	7.6 (0.6)	9.5 (3.5)	2.0 (1.2)	29.0 (9.4)
mallard	17	17.3 (2.0)	11.5 (1.5)	30.0 (4.0)	0 (0)	8.1 (0.3)	3.9 (1.8)	1.4 (0.6)	21.5 (3.4)
available habitat	337	15 (0.7)	8.3 (0.3)	25.5 (0.7)	0 (0)	7.5 (0.1)	30.9 (5.0)	4.4 (0.7)	37.2 (1.5)
Riffle									
American dipper	59	14.8 (1.4)	6.4 (0.6)	16.1 (1.2)	1.7 (1.7)	7.5 (0.1)	63.2 (16.4)	1.4 (0.3)*	43.2 (3.9)
belted kingfisher	14	20.7 (3.7)*	8.8 (1.6)	22.9 (4.0)*	0 (0)	7.4 (0.3)	57.3 (41.0)	0.7 (0.5)	34.7 (9.1)
great blue heron	4	21.7 (8.2)	9.6 (2.7)	21.3 (5.9)	0 (0)	6.5 (1.0)	7.9 (4.2)	52.1 (52.1)	18.8 (10.3)
mallard	4	15.9 (3.7)	15.4 (4.0)	21.3 (5.2)	0 (0)	8.5 (0.5)	12.1 (3.3)	0 (0)	10.0 (3.5)
available habitat	344	14.2 (0.6)	8.0 (0.3)	16.5 (0.5)	1.5 (0.6)	7.6 (0.1)	57.3 (5.2)	6.7 (2.3)	36.9 (1.5)
Rapid									
American dipper	12	6.3 (2.1)	6.5 (1.3)	16.7 (3.4)	0 (0)	8.0 (0.3)	68.6 (17.9)	2.6 (1.3)	42.9 (9.3)
available habitat	45	8.5 (1.1)	10.0 (1.0)	22.1 (1.7)	0 (0)	8.4 (0.1)	37.9 (8.5)	2.0 (0.7)	26.5 (4.4)
Cascade									
American dipper	3	20.0 (15.0)	13.2 (4.6)	35.0 (7.6)	0 (0)	8.3 (0.3)	25.4 (11.4)	1.0 (0.6)	63.3 (8.8)
available habitat	11	11.5 (3.0)	11.1 (1.5)	16.8 (2.5)	9.1 (8.7)	8.4 (0.2)	18.9 (5.4)	0.6 (0.4)	45.9 (9.4)
Step									
American dipper	6	2.1 (1.2)	6.6 (2.5)	28.3 (13.3)	0 (0)	8.2 (0.4)	75.1 (40.8)	20.1 (13.2)	44.2 (11.4)
available habitat	19	3.8 (1.6)	7.8 (1.2)	15.6 (3.8)	0 (0)	8.9 (0.1)	107.0 (45.6)	99.7 (90.4)	40.7 (6.3)

[1] Species abundance and habitat features may vary among basin, stream order and season. Presented means pool all observations whereas the statistical models assessing habitat selection first account for differences inherent to basin, stream order, and season before identifying habitat selection patterns. Consequently, the pooled means may mask more substantial differences.

[2] Percent of locations in the secondary channel.

[3] Size class of the average substrate particle from the smallest (clay = 2) to largest (bedrock = 9, Appendix A).

Discussion

Distribution and Abundance

All riparian–associated birds we studied differed in abundance and distribution among stream basins and stream orders. Factors explaining these differences include differences in the response of these species to basin and stream order differences in geomorphology, topography, hydrology, and riparian zone vegetation (Loegering 1997). Differences in abundance among basins likely reflected the differences in the geomorphology of those basins. Only dippers were more abundant in Drift Creek than in other basins, Drift Creek was the highest–gradient basin, and dippers typically inhabit swift mountain streams (Kingery 1996). Mallards were more abundant in Lobster Creek than in other basins, and Lobster Creek was a low–gradient stream with many pools and slow–water channel units. The juxtaposition of grass–dominated agricultural lands and these low-gradient streams in Lobster Creek may be important for mallard brood rearing because most of the groups we observed were adult females with young. Regardless of the underlying geomorphic and management differences among the four basins, kingfishers were similarly abundant

TABLE 8. Variables distinguishing between used and available stream channel units for American dippers, belted kingfishers, great blue herons, and mallards in the Oregon Coast Range, 1992. Wald χ^2 and P values are from logistic regression models fitted with indicator variables for basin, stream order, and season. Each set of variables remained after backward logistic regression eliminated others at a significance level = 0.10. See Loegering (1997) for model details.

Species Variable	Wald's χ^2	P	Odds ratio[1]	90% confidence interval on odds ratio Lower	Upper
American dipper					
Pool					
Length	3.5	0.063	1.0	0.9	1.0
Width	4.2	0.041	1.1	1.0	1.2
Substrate Size	3.6	0.057	1.4	1.0	1.8
Riffle					
Pieces of wood / 100 m2	3.0	0.083	0.9	0.9	1.0
belted kingfisher					
Pool					
Wood / 100 m2	2.2	0.141	0.9	0.8	1.0
Glide					
Length	3.1	0.074	1.0	1.0	1.0
Substrate Size	3.7	0.056	0.8	0.6	1.0
Exposed rocks / 100 m2	2.9	0.091	1.0	0.9	1.0
Riffle					
Length	4.14	0.042	1.05	1.0	1.1
Depth	8.84	0.003	1.10	1.0	1.2
great blue heron					
Pool					
Shade (10% increments)	10.0	0.002	0.8	0.7	0.9
Secondary Channels	8.9	0.003	9.7	2.8	33.9
mallard					
Pool					
Shade (10% increments)	4.9	0.027	0.8	0.7	0.9
Secondary Channels	4.3	0.039	5.2	1.4	19.3

[1] Multiplicative likelihood of use given a 1-unit increase in the value of a given variable. Odds <1 indicate that an increase in the value of that variable decreases the likelihood of use whereas odds >1 indicate a greater likelihood of use with an incremental increase in the value of that variable.

throughout the study area. However, kingfisher abundance may have been ameliorated because they will readily use a number of different substrates for nesting burrows (Hamas 1994). These include road cuts (Bent 1940) along the extensively–roaded study area, as well as cut–banks along the stream (Davis 1982) and banks created by headwall failures (pers. obs.). In addition, they can range a great distance from nest sites and may nest up to 2.4 km from the water (Hamas 1974, Prose 1985).

The abundance of riparian–associated species differed by stream order and likely reflects the ecology and behavior of the birds we observed. Mallards and mergansers often used streams as loafing and brood–rearing habitat, and their abundance was greatest lower in the basins. Both the frequency and extent of micro–habitats with lower stream velocities was greater here, allowing birds to expend minimal energy to maintain position. However, most dippers, kingfishers, and herons we observed were actively foraging and their abundance likely reflected their selection of foraging habitat. Dipper associations with streams <15 m wide and nest sites on stream-side cliffs (Kingery 1996, Loegering 1997) likely limited dipper distribution to the lower order, higher gradient, streams. Similarly, herons found more suitable foraging micro–habitat, such as slow-moving, off–channel pools (e.g., Butler 1992), in the larger streams lower in the basins.

Riparian-associated birds in the Oregon Coast Range were generally less abundant than elsewhere in North America. Dippers were over 4 times more abundant in Montana and Colorado. Sullivan (1973) and Price and Bock (1983) report breeding densities >1.0 *nests* / km and Ealey (1977) observed 1.2 *birds* / km compared to 0.2–0.5 *birds* / km in our study. The 5th-order reach of Drift Creek, with the most abundant dipper population, was marginally comparable ($\bar{x} = 0.97$ birds / km, SE = 0.13, n = 12 surveys). Parsons (1975) found 1-4 dippers / km during the winter in the Oregon Cascades. The breeding density of Eurasian dippers (*C. cinclus*) in Europe averaged >1 adult / km (Ormerod et al. 1985, Daulne 1990, Vickery 1991). Availability of nest sites may have limited the overall abundance of dippers in our study area (Loegering 1997) as has been concluded elsewhere (Price and Bock 1983, Fite 1984, Kingery 1996). Streams where we saw dippers often had nests nearby. However, we rarely saw dippers in streams that contained no suitable nest sites, regardless of the apparent ecological similarity to streams where dippers where present.

Abundance of kingfishers in fifth and sixth-order streams was nearly 1 individual / km of stream, whereas all other species were less than half that abundance. Breeding densities in similar sized streams in Pennsylvania were comparable (Brooks and Davis 1987); however, in Ohio, breeding densities were nearly four times larger (Davis 1982). Studies of kingfishers in mountainous habitat are few.

Overall, we saw slightly more than one group of riparian-associated species for each kilometer of stream surveyed but no single species was very abundant. Although we believe there is no alternative way to sample this community, future research must expect the labor-intensive nature of these studies. Also, abundance estimates may have been biased because of different probabilities of detecting and identifying each species. This bias may have been greatest in stream sections with difficult footing where the observer split attention between looking ahead and carefully placing nearly every step. Although we did not directly quantify this bias, we offer this assessment. Dippers were likely censused. They seldom leave the course of the stream (Kingery 1996), and did not avoid human contact. Kingfishers and herons, however, occasionally left the area quietly and some birds may have been missed by an observer. Moreover, the low incidence of mammals in our study likely reflects the bias of our daytime surveys and not the relative abundance of these species.

Streamside Habitat Association

Selection of streamside habitat by dippers, kingfishers, herons, and mallards was disproportional to availability, and the valley form was the only factor important to all four species. Dippers were associated with streams having riparian zones and stream banks dominated by trees on both sides. This was especially important because dippers were more abundant in the smaller, high gradient streams, where forests managed for timber production were common in the Oregon Coast Range. Constrained valley forms also were important predictors of dipper use, a likely correlate of their affinity to mountain streams (Kingery 1996).

Kingfisher's association with streamside habitat in less constrained reaches and the presence of stream-side trees are a consequence of its foraging ecology. Kingfishers were associated with the presence of trees on the stream banks, yet these features occurred <7% of the time. Presumably trees on the stream bank provide perches from which kingfishers detect prey; most of the perched birds we observed were on the branches of stream-side trees. Moreover, kingfishers are generally absent from habitats lacking perches (Hamas 1994, Root 1988). Kingfishers may be simply responding to salmonid abundances when selecting to forage in less constrained stream reaches. In the Oregon Cascades, cutthroat (*Oncorhynchus clarki*) and rainbow (*O. mykiss*) trout abundance in unconstrained reaches was more than double than in adjacent constrained reaches (Moore and Gregory 1989). Great blue herons also may be responding to prey abundances as they selected stream reaches in less constrained valleys.

Dippers, kingfishers, and mallards were associated in some way with a tree-dominated riparian zone; however, the minimum or optimum riparian buffer strip that is needed for these species is unclear. We did not evaluate different widths of riparian buffer strips but limited our evaluation of the riparian forest to a single plot 25 meters from the stream at each point a bird was located. Current forest practices rules protecting riparian areas generally meet or exceed this distance on federal land, but not on private lands. Riparian reserves on federal lands require limited or no harvest within 91 m (300') of fish-bearing streams (FEMAT 1993). In contrast, Oregon Forest Practices Rules call for riparian management areas with requirements to retain targeted stocking levels within 30 m (100') of the stream on state and private lands. The extent that these stocking levels adequately provide habitat for riparian-associated species remains unclear. Many vertebrates, especially riparian mammals, reptiles, and amphibians, are active within 60 m of water (Brinson et al. 1981). Consequently, establishing the appropriate buffer-strip width must consider factors such as the target species or community, location within the stream basin, and the composition of the current riparian zone. Harvest of stream-side trees has been commonplace and many streams have little or no legacy of large trees that can contribute large wood to the stream. Minimum conifer stocking levels (Oregon Forest Practices Act 1994) developed to retain and recruit large wood may change the composition of hardwood-dominated riparian areas in the Coast Range. Fortunately, dippers, kingfishers, and great blue herons appear to respond to the riparian forest structure and not whether the forest is coniferous or deciduous.

Channel Unit Selection

Dippers and kingfishers were found along the same streams; however, they selected different channel units early in the breeding season. Although we found dippers less often than expected in riffle units, it is important to note that these units represent >30% of observed use and >56% of the available habitat. While they may use disproportionately fewer riffles, dippers were observed foraging nearly one-third of the time in riffles (unpubl. data) and riffles may provide important foraging habitat during other time periods (e.g., brood-rearing; Loegering 1997).

Kingfishers strongly selected pools and avoided riffles in this study. Conversely, foraging kingfishers selected riffles, rather than pools in Pennsylvania and Ohio (Davis 1982, Brooks and Davis 1987); specifically, the downstream tail-out transition to pools within riffles were selected (Brooks and Davis 1987). Although seemingly contradictory, these observations are consistent in that the kingfishers were responding to fish distributions. Brooks and Davis (1987) observed fish abundance was greatest in the downstream portion of riffles, and we believe their study streams may have been lower gradient than those in our study. Hamas (1994) hypothesized that "fast currents that reduce visibility" may reduce foraging effectiveness. Most of our observations were of birds perched over the stream and presumably foraging. The fourth- and fifth-order streams we evaluated were high gradient (1-3%) with higher surface turbulence and visual disturbance than in Pennsylvania or Ohio. Moreover, salmonids, primarily juvenile coho salmon (*Oncorhynchus kisutch*), were more abundant in pools (Phillips 1986, Bisson et al. 1988, Schlosser 1991).

Stream Habitat Association

Channel unit length, width, and depth, secondary channels, wood, substrate size, exposed substrate items, and stream shading were useful in discriminating between pools, glides, and riffles that were used versus those available; however, many confidence intervals on the odds ratio indicated marginal statistical significance and low statistical power (i.e., spanning or approaching 1.0). Channel heterogeneity and structural complexity were important features. Pools that were in a secondary or side channel with less shade were more likely to be used by mallards and great blue herons. Generally, these pools had sustained flow during the winter months when stream flow was highest. However, as flow volume decreases throughout the summer, the pools were partially or entirely cut off from the main channel, trapping prey or creating a current-free loafing site.

Belted kingfishers strongly selected sites with trees on both stream banks, and they were located above pools more than expected based on channel unit availability. However, kingfishers were less likely to use pools with more wood in them. This paradox may be the result of historical harvest extending to the stream, thereby eliminating recruitment of large wood during the past two decades. Alternatively, the increase in channel unit complexity because of wood may reduce kingfisher foraging efficiency (e.g., Kelly 1996) and high complexity units would be used less frequently. In addition, kingfishers were located above riffles less frequently than expected, but the likelihood of finding them over a riffle increased with increasing stream depth.

Finally, we recognize a number of limitations of this study. We chose the four study basins subjectively, representing a non-random sample of the Oregon Coast Range. Consequently, inference of abundance to larger geographic scales beyond these basins should be done with caution. Although several important habitat variables were identified by the logistic regression models, none explained >25% of the observed variability (R^2). Although the variables identified by the habitat selection models contributed to the model's fit and as a whole were important descriptors of the habitat–use patterns we observed, they individually were not different from a zero effect (i.e., 90% CI on the odds ratio included or approached 1.0). In part, this may be attributed to the natural variability in the environment, variable habitat selection patterns for each species, and variability among the stream orders and basins we studied. Further improvement of sampling techniques, habitat quantification, and focusing on a more specific spatial and temporal scale may improve the study's explanatory power but also may decrease the generality.

Management Implications

Because these systems are intensively managed for forest products, we offer these suggestions. Managers should consider the basic ecological information on species composition, abundance, and habitat associations of riparian-associated species, including terrestrial riparian-associated species not addressed by this study, when refining the goals and objectives of riparian zone management. Monitoring programs to assess populations of these species must be sensitive to the potential effects of stream order, basin, and season. The low abundance and sparse distribution of these species in the Oregon Coast Range provide additional challenges in evaluating the cumulative effects of management within and among basins. Population–level responses may be difficult to quantify at the scale of most silvicultural experiments (e.g., 200-m long riparian management zones). Monitoring plans and riparian zone management attempts should consider a large spatial (e.g., watersheds) and temporal extent to detect species presence and account for differences in abundance among basin and order. Monitoring at smaller spatial scales could be inadequate and allow cumulative impacts on the entire watershed to go undetected. We strongly recommend an *a priori* assessment of study objectives and statistical power to evaluate the potential success of the project.

Trees on the bank immediately adjacent to the stream were associated with increasing likelihood of use by dippers and kingfishers, the two most abundant species. Management regimes and silvicultural prescriptions should retain or establish streamside trees. Riparian zones dominated by tree species were positively associated with dippers, and were present at 95% of our dipper observations. However, appropriate riparian buffer strip widths need to be evaluated at a variety of spatial scales.

Few attributes were different between used and available channel units, and most significant variables would be difficult to successfully manage (e.g., substrate size). Riparian zone management should include aspects that maintain stream channel heterogeneity, allow the stream to interact with the flood plain, and include secondary and alternate channels within the riparian forest. Policies that encourage channel heterogeneity and retain large wood also would benefit riparian-associated species by providing varied habitats, although kingfishers were negatively associated with wood in pools.

Wildlife associated with riparian areas are important resources. As riparian areas become more intensively managed, the challenge will be to create strategies that do not compromise the ecological requirements of riparian-associated species. Efforts to monitor and maintain stream systems with good water quality and sustainable populations of aquatic invertebrates and vertebrates should protect the resources needed by riparian obligates. Conservation strategies developed for terrestrial riparian wildlife, fish, and aquatic habitat (e.g., Bisson et al. 1992, FEMAT 1993, Thomas et al. 1993:427-482) that focus on the restoration and maintenance of physical and biological integrity of aquatic systems (Karr et al. 1986, Karr 1991, Naiman et al. 1992) should protect riparian-associated species as well.

Acknowledgements

The Coastal Oregon Productivity Enhancement Program and the Bureau of Land Management funded this study. The Oregon Cooperative Wildlife Research Unit provided financial and technical support throughout the entire project. We are grateful to N. Verne Marr, Lisa Loegering, Ken Popper, Amy Deller, Jennifer Purvine, and Julie Rosenthal for field assistance. Catherine Ortega and one anonymous reviewer provided comments that improved the manuscript.

Appendix A.

Habitat variables assessed at bird locations and randomly-selected points along Oregon Coast Range streams, 1992-1994.

Variable	Units
Stream habitat	
channel unit	pool, glide, riffle, rapid, cascade, step (from Bisson et al. 1982)
length, width, and depth	meters
channel form	single or primary vs. secondary, tertiary, or side channel
substrate size	8 size classes based on particle size: clay (<0.004 mm), silt (0.004-0.062 mm), sand (0.062-2 mm), small gravel (2-32 mm), large gravel (32-64 mm), cobble (64-500 mm), bolder (500-2000 mm), and bedrock (>2000 mm) (Platts et al. 1983)
exposed substrate	number / m^2 of exposed rocks <0.25 m high and surrounded by water in the channel unit
wood	number / m^2 of pieces >1 m long and 0.3 m diameter in the channel unit
shade	% of stream shaded from directly above by vegetation
Streamside habitat	
valley form	unconstrained or constrained (valley floor < twice the active channel width)
adjacent land use	managed forests or not
riparian zone[1] vegetation and stream bank vegetation	Dominant species at each location reduced to 2 indicator variables for 1) the presence of trees taller than 5 m versus shrubs, grasses, or herbaceous plants and 2) whether the vegetation was coniferous or not
riparian zone[1] canopy cover	% canopy cover of adjacent forest overstory visually estimated in a 5-m diameter plot 25 m from the stream
human activity	distance (m) to nearest area frequented by humans (e.g., roads, dwellings, etc.)

[1] Evaluated 25-m perpendicular distance from the stream bank.

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Received 6 October 1998
Accepted for publication 28 April 1999

Thomas, J. W., M. G. Raphael, R. G. Anthony, E. D. Forsman, A. G. Gunderson, R. S. Holthausen, B. G. Marcot, G. H. Reeves, J.R. Sedell, and D.M. Solis. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest: report of the scientific analysis team. United States Department of Agriculture Forest Service Research Publication. 530pp.

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