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IMPACT OF A CATASTROPHIC FLOODING EVENT ON RIPARIAN BIRDS

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Few studies have evaluated the impacts of flooding on riparian bird communities (Brown and Johnson 1987, Knopf and Sedgwick 1987). Most research has focused on inundation of the riparian zone rather than structurally devastating flooding events. Floods in mountain streams are often brief and catastrophic, due to rapid movement of water, coarse sediment, and woody debris down steep slopes and channels (Swanson et al. 1998). Here, we describe the effect of a catastrophic flooding event on riparian bird communities in west central Idaho and northeastern Oregon. This event provided us with an opportunity to compare bird communities at riparian sites before and after flood damage. Specifically, we investigated whether overall bird abundances and individual species abundances differed at sites pre- (1995, 1996) and post-flood (1997, 1998).

We conducted our research along tributaries to the Snake River in the Hells Canyon reach, situated in west central Idaho and northeastern Oregon. Moderate to steep slopes characterize the area. Grasslands and upland shrub habitat are interspersed and found upslope of the riparian zone. White alder (*Alnus rhombifolia)* was the most common tree species found in the riparian communities sampled. Other common tree and shrub species included netleaf hackberry (*Celtis reticulata*), rocky mountain maple (*Acer glabrum*), hawthorn (*Crataegus* spp.), blue elderberry (*Sambucus cerulea*), poison ivy (*Toxicodendron rydbergii*), and chokecherry (*Prunus virginiana*).

In 1995, as part of a larger study (Turley and Holthuijzen 2000), we established 288 bird survey plots in homogenous patches of Forested Wetland and Scrub-Shrub Wetland habitat cover types along 57 tributaries to the Snake River. Riparian vegetation cover types generally followed the classification system described by Cowardin et al. (1979) and modified for Habitat Evaluation Procedures (HEP; U.S. Fish and Wildlife Service 1981). Each plot was permanently marked and coordinates were established using a Global Positioning System (Geo Explorer II, Trimble Navigation Limited, Sunnyvale, CA). During January 1997, twenty-seven plots located in 8 tributaries experienced high to severe flooding disturbance. Flood damage was patchy within a tributary, with damaged or even completely denuded patches interspersed with undamaged ones. Vegetation at 8 plots was categorized as "highly disturbed" and at 19 plots as "severely disturbed." In "highly disturbed" plots most herbaceous, small- and larger-diameter woody species were impacted, whereas at "severely disturbed" plots nearly all vegetation was removed.

In 1995 we measured shrub and tree cover at 13 of 27 plots that were flooded in 1997; these 13 plots were resampled in 1998 (6 highly disturbed and 7 severely disturbed). We used the line-intercept method (Müller-Dombois and Ellenberg 1974) to determine percent canopy cover for the shrub and tree layers. Tree and shrub canopies, identified to species, were projected vertically to the tape, and the length of line segments covered by woody plant species was recorded (Hays et al. 1981). We used simple paired t tests to evaluate percent tree and shrub canopy cover pre- and post-flood. Average percent shrub cover was higher before flooding in 1995 (80.3%) than after flooding in 1998 (20.4%; 1-tailed paired t test: $t = 4.90$, $P < 0.001$). Likewise, average percent tree cover was higher before

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TABLE 1. Number of plots at which a species was observed and relative abundance (birds/count and standard errors) of 8 bird species at 27 plots in Hells Canyon, Idaho and Oregon, 1995–96 and 1997–98.

Species	Foraging guild[a]	Number of plots[b] Pre-flood (1995–96)	Number of plots[b] Post-flood (1997–98)	Relative abundances Pre-flood (1995–96)	Relative abundances Post-flood (1997–98)	*P*-value
Lazuli Bunting (*Passerina amoena*)	LCF	10	15	0.29 (0.06)	0.42 (0.08)	0.226
Yellow-breasted Chat (*Icteria virens*)	LCF	5	4	0.11 (0.04)	0.07 (0.03)	0.742
Black-capped Chickadee (*Poecile atricapilla*)	LCG	9	3	0.24 (0.08)	0.06 (0.03)	0.078
Yellow Warbler (*Dendroica petechia*)	LCG	9	2	0.20 (0.05)	0.03 (0.03)	0.004
Nashville Warbler (*Vermivora ruficapilla*)	LCG	6	0	0.09 (0.04)	0	0.032
Spotted Towhee (*Pipilo maculatus*)	GF	13	12	0.24 (0.06)	0.21 (0.05)	0.626
Red-eyed Vireo[c] (*Vireo olivaceus*)	UCG	6	8	0.11 (0.04)	0.22 (0.07)	0.376
American Dipper (*Cinclus mexicanus*)	RBG	0	5	0	0.06 (0.03)	0.062
All birds				2.04 (0.25)	1.56 (0.19)	0.197

[a]LCF–lower-canopy forager, GF–ground forager, LCG–lower-canopy gleaner, UCG–upper-canopy gleaner, RBP–riparian bottom gleaner (De Graaf et al. 1985).
[b]A total of 85 surveys were conducted pre-flood and 86 surveys post-flood.
[c]Red-eyed Vireos relative abundances are based on June surveys, the only time the species was observed.

flooding (77.6%) than after flooding (33.6%; $t = 5.04$, $P < 0.001$).

Riparian zones along tributaries of the Snake River are generally narrow. We sampled available tributaries where the riparian zone was at least 40 m in width. We used fixed-radii plots (20-m plots) and conducted point counts at each plot. From 1995 through 1998, we intended to survey each plot twice during the breeding season (May and June). However, in May 1995 only 4 plots were established and surveyed. In May 1997 we surveyed only 5 plots because many plot markers washed away during the flood and had to be reestablished. During May 1996 and 1998 and June 1995–1998 point counts were conducted at all 27 plots. Hence, we conducted 31 surveys in 1995, 54 in 1996, 32 in 1997, and 54 in 1998.

We conducted point counts following standard protocols (Ralph et al. 1995) to minimize bias and make bird detectability rates as consistent as possible. Fixed-radius point counts are effective in providing indices of abundance between treatments (Petit et al. 1995). We chose 10-minute counts to maximize species detection since travel time between plots was often greater than 15 minutes (Buskirk and McDonald 1995, Dawson et al. 1995, Ralph et al. 1995). Radii of less than 50 m reduce bias due to vegetation structure and observer limitations, and maximize species detections (Petit et al. 1995). We excluded birds flying over the plots from further analyses. Surveys began up to 30 minutes before sunrise and were completed no later than 5 hours after sunrise. Bird surveys were not conducted during inclement weather conditions such as strong winds (>20 km · hour^{-1}) or rain (Robbins 1981).

We calculated the relative abundance of each bird species individually and all bird species combined as the total number of individual birds observed divided by the number of times a plot was surveyed during pre- and post-flood periods. Relative abundances were calculated only for species observed on at least 5 plots, either pre- or post-flood. Because relative abundance estimates were not normally distributed, we used the Wilcoxon matched-pairs signed rank test to compare relative abundances of individual species and pooled across all species between pre- and post-flood periods (Zar 1984). Also, we classified all bird species observed into foraging guilds for bird community analysis (Table 1).

Forty bird species were observed at the plots. Bird species richness was highest in 1996 (23 species) and lowest in 1997 (15 species). Overall relative bird abundances declined, but not significantly, between pre- and post-flood periods (P = 0.197; Table 1). Relative abundance of lower-canopy foragers (Lazuli Bunting [*Passerina amoena*] and Yellow-breasted Chat [*Icteria virens*]), a ground forager (Spotted Towhee [*Pipilo maculatus*]), and an upper-canopy gleaner (Red-eyed Vireo [*Vireo olivaceus*]) was similar between pre- and post-flood periods ($P > 0.20$; Table 1). Relative abundance of Yellow Warblers (*Dendroica petechia*) and Nashville Warblers (*Vermivora ruficapilla*), lower-canopy gleaners, was higher pre-flood than post-flood (Yellow Warbler: P = 0.004; Nashville Warbler: P = 0.032). Relative abundance of American Dippers (*Cinclus mexicanus*) was higher post-flood than pre-flood but was not significant (P = 0.062). Relative abundance of Black-capped Chickadees (*Poecile atricapilla*) was lower post-flood than pre-flood, but was not significant (P = 0.078).

Brown and Johnson (1987) evaluated the impacts of high-water releases on bird species nesting in the zone of inundation along the Colorado River in the Grand Canyon. They reported that, similar to our findings, several species exhibited declines attributed to nest inundation and loss of habitat, while other species experienced unexpected increases. Likewise, Knopf and Sedgwick (1987) found that populations of Brown Thrashers (*Toxostoma rufum*) and Spotted Towhees, both foraging and nesting on or near the ground, did not significantly decline during a flood year that inundated an area along the South Platte in Colorado. Declines, however, were reported the year following the flood. Knopf and Sedgwick (1987) suggested that site tenacity may explain the similarity in pre-flood bird densities and those during a flood year; unsuccessful nesting is a likely result of riparian zone inundation, which in turn brought about lower densities in the year following flooding. In other habitats time lags in bird response to disturbance also were observed probably due to site tenacity of breeding individuals (Wiens and Rotenberry 1985). In Hells Canyon lower-canopy gleaners may have been displaced, presumably to areas that provided sufficient foraging and nesting substrates. Yellow Warbler and Nashville Warbler prefer early successional habitats such as thickets or open forest with shrubby undergrowth (Williams 1996, Lowther et al. 1999). Because the shrub understory was either greatly reduced or absent at our flood-damaged sites, habitat was unavailable and both species were not observed in 1998 (Table 1). Other foraging guilds did not decline and some species appeared to show site tenacity. During both 1997 and 1998, the Red-eyed Vireo was observed in small clumps of live alders in tributaries that had been otherwise scoured of vegetation (Turley personal observation), exhibiting apparent site tenacity. Two common species, Lazuli Bunting (lower-canopy forager) and Spotted Towhee (ground forager), were often observed in upland habitat adjacent to riparian habitats in Hells Canyon (Turley and Holthuijzen 2000) and were the 2 most frequently observed species at flood-damaged sites. These species and other lower-canopy foragers, as well as ground foragers, may be able to forage outside the riparian zone and remain at a site even with reduced riparian habitat available.

The American Dipper, a riparian bottom feeder, had highest abundances the 2nd year following flooding disturbance. This bird species was uncommonly observed in the study area. Of 288 riparian plots we sampled (Turley and Holthuijzen 2000), the American Dipper was observed at only 8 plots: 1 plot in 1995, 6 plots in 1997 and 1998 with flooding damage, and 1 plot in 1998 with mild flooding disturbance (Turley unpublished data). Lamberti et al. (1991) found that debris-flow disturbance of riparian vegetation opened up the canopy, resulting in increased light levels in the stream, which led to several years of increased primary productivity by aquatic plants and increased secondary productivity in communities of invertebrates that graze on aquatic vegetation. Thus, American Dippers may have responded to increased densities of aquatic insects.

Response of birds to flooding likely depends on the disturbance magnitude of the flood and life history traits of the individual species. Riparian patches within a tributary that remain intact and even disturbed patches may provide foraging and nesting habitat for some bird species during the recovery of the system. Also, adjacent upland habitat may provide foraging habitat for some riparian species. At our sites where average percent shrub cover declined from 80.3% to 20.4% and average percent tree cover declined from 77.6% to 33.6%, we found that flooding damage displaced lower-canopy gleaners whereas other guilds continued to use the sites.

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