Selection of Fresh Vegetation for Nest Lining by Red-shouldered Hawks

Author(s): Cheryl R. Dykstra, Jeffrey L. Hays, Melinda M. Simon
Source: The Wilson Journal of Ornithology, 121(1):207-210. 2009.
Published By: The Wilson Ornithological Society
DOI: 10.1676/08-035.1
URL: http://www.bioone.org/doi/full/10.1676/08-035.1

The Wilson Journal of Ornithology 121(1):207–210, 2009

Selection of Fresh Vegetation for Nest Lining by Red-shouldered Hawks

Cheryl R. Dykstra,[1,4] Jeffrey L. Hays,[2] and Melinda M. Simon[3]

ABSTRACT.—Red-shouldered Hawks (*Buteo lineatus*) typically line their nests with fresh branches of coniferous and deciduous trees. We recorded all species of green material present in 63 nests from 2003 to 2005 in suburban Cincinnati in southwestern Ohio, and in 35 nests in Hocking Hills in southeastern Ohio, United States. We identified all trees within 0.08-ha plots at 33 nest sites in southwestern Ohio and 30 in Hocking Hills. Red-shouldered Hawks in southwestern Ohio and Hocking Hills used black cherry (*Prunus serotina*) branches as a nest lining more frequently than expected, based on Bailey's 95% confidence intervals. Black cherry was found in >80% of nests but present in only 57–58% of the vegetation plots, and composed only 4–5% of the trees in the forests of the study areas. White pine (*Pinus strobus*), red pine (*P. resinosa*), and eastern hemlock (*Tsuga canadensis*) also were used more than expected in both study areas. Black cherry is a cyanogenic species and may provide an advantage to nesting Red-shouldered Hawks by functioning as a natural pesticide. *Received 26 February 2008. Accepted 1 July 2008.*

Many raptors line their nests with fresh green vegetation consisting primarily of branches or sprigs of trees (hereafter "greenery") (Preston and Beane 1993, England et al. 1997, Buehler 2000, Ferguson-Lees and Christie 2001). The purpose of the lining has not been definitively shown. However, it has been suggested that vegetation brought to the nest might serve a signaling function, indicating the occupancy status of the nest to conspecifics and others (Newton 1979), or a nest-sanitation function, covering prey remains and waste (Newton 1979).

Red-shouldered Hawks (*Buteo lineatus*) line their nests with branches of fresh vegetation (Dykstra et al. 2008). They begin bringing greenery during the nest-building phase (early Feb in southern Ohio; Dykstra et al. 2008) and continue to add fresh vegetation throughout the incubation and nestling phases. Red-shouldered Hawks in southern Ohio, United States, bring only coniferous greenery from February through mid-April, but after leaves appear on deciduous trees, they carry both deciduous and coniferous branches to the nests (C. R. Dykstra and J. L. Hays, unpubl. data). The objective of our study was to examine if Red-shouldered Hawks selectively used particular species of green vegetation to line their nests.

METHODS

Study Areas.—We studied Red-shouldered Hawks nesting in two regions of southern Ohio. The southwest Ohio study area (SWOH) in Hamilton, Clermont, and Warren counties in the suburbs of Cincinnati, is composed of residences surrounded by lawns and non-native plantings, interspersed with small areas of natural forest dominated by second-growth mixed mesophytic, oak-hickory (*Quercus* spp., *Carya* spp.) and beech-maple (*Fagus grandifolia*, *Acer saccharum*) associations.

The Hocking Hills study area (HH) in southeastern Ohio is composed of portions of Wayne National Forest, Hocking State Forest, Zaleski State Forest, and associated private lands in Athens, Hocking, Vinton, and Perry counties. The predominant forest type is oak-hickory with plantations of white pine (*Pinus strobus*) and red pine (*P. resinosa*).

Green Vegetation Used in Nests.—Red-shouldered Hawk nest locations and breeding areas were previously known to us (Dykstra et al. 2000, 2004). We climbed to all accessible nests containing nestlings between 4 May and 13 June, 2003–2005 to document greenery and to band nestlings. We identified all branches or sprigs of fresh green vegetation in the nests to species or species-group, and recorded the presence/absence of each species. We identified only fresh greenery; it is likely this vegetation was

[1] Raptor Environmental, 7280 Susan Springs Drive, West Chester, OH 45069, USA.
[2] RAPTOR Inc., 1419 Holmanview, Wyoming, OH 45215, USA.
[3] 9016 Winthrop, Cincinnati, OH 45249, USA.
[4] Corresponding author;
e-mail: cheryldykstra@juno.com

collected by hawks after deciduous leaves had emerged in mid-April.

Tree Species Available in the Study Areas.— We recorded tree species and diameter at breast height (dbh) of trees >8 cm dbh to provide a sample for trees available near Red-shouldered Hawk nest sites in the SWOH and HH study areas in 1997–1998 (Dykstra et al. 2000). We centered a 0.04-ha circular plot (James and Shugart 1970) on each nest tree (n = 33 in SWOH, n = 30 in HH) and located a paired random plot at a distance of 75–200 m in a random direction from the nest. All trees within the plots were identified and measured (Dykstra et al. 2000). We combined data from each nest plot with that from its paired random plot to create a combination vegetation plot of 0.08 ha. Nests for which we identified trees in circular plots in 1997–1998 were not the same as those where we identified green vegetation in nests in 2003–2005; however, plots and nests were well distributed throughout the same study areas. This study design necessitated a pooled statistical analysis.

Statistical Analyses.—We recorded nest lining vegetation at some breeding areas in 2 or 3 years during 2003–2005. We randomly selected 1 year of data for inclusion in the data set for these breeding areas to avoid pseudoreplication associated with individual pairs of birds or territories, leaving 63 independent nests in SWOH and 35 in HH. We limited our analyses to the 10 species of greenery most commonly found in nests. We used Bailey's 95% CI (following Boal et al. 2005) constructed following a χ^2 goodness-of-fit test (with Systat 8.0). The CIs for the proportion of nests using a particular species for nest lining were compared to the proportion of vegetation plots containing at least one tree of that species (availability). If the proportion of plots containing the species was below or above the 95% CI, we considered the nesting Red-shouldered Hawks had used that species as a lining more or less than expected, respectively. We also recorded the number of trees of each species in the combination plots and reported the sum as a percentage of total trees in all plots combined.

RESULTS

Red-shouldered Hawks in both study areas used black cherry (*Prunus serotina*) branches as a nest lining more frequently than expected (Table 1). Black cherry was found in >80% of nests but present in only 57–58% of the 0.08-ha vegetation plots (Table 1), and composed only 4–5% of the trees in the forests of the study areas (i.e., in the vegetation plots).

The 95% CI assessment indicated white pine, red pine, and eastern hemlock (*Tsuga canadensis*) were used as nest-lining material more than expected based on availability in both SWOH and HH (Table 1). Red cedar (*Juniperus virginiana*) was used more than expected in SWOH. The remaining species were used in proportion to their availability or less often than expected (Table 1).

The average number of species of greenery was 4.3 ± 0.2 (SE) per nest in SWOH and 3.5 ± 0.2 per nest in HH. However, the amount of greenery in nests varied widely, from a few small sprigs in the center of the nest cup to many large branches that covered the entire nest (C. R. Dykstra and J. L. Hays, unpubl. data). The average number of trees per 0.08-ha plot was 32.7 ± 2.5 in SWOH and 33.4 ± 2.5 in HH. Totals of 1,079 and 1,001 trees were identified in circular plots in SWOH and HH, respectively.

DISCUSSION

Use of Coniferous Species as Nest Lining.— Red-shouldered Hawks in both study areas apparently used red pine, white pine, and eastern hemlock more than expected based on availability. Both pines are non-native in the study areas and are nonrandomly distributed (i.e., planted primarily in plantations or in residential areas); it is possible that our vegetation plots may not have adequately sampled the distribution of pines in the habitat. Hemlock is native in the Hocking Hills region, growing primarily in north-facing ravines and along streams. It is not native to southwestern Ohio although it is planted in some residential areas. Red cedar, used more than expected in SWOH but not in HH, is native to both study areas. It is much more common in SWOH than in HH, probably because the species' nature as a scrubby, early-colonizer makes it more suited to the developed habitats of SWOH than to the heavily forested HH. Red-shouldered Hawks also carry significant amounts of these conifers to their nests before deciduous leaf-out (C. R. Dykstra and J. L. Hays, unpubl. data).

TABLE 1. Tree species used in nest linings of Red-shouldered Hawk nests vs. tree species availability, southwestern Ohio and Hocking Hills region in southeastern Ohio. Assessment based on Bailey's 95% CI, comparing the percentage of nests using each tree species as a nest lining vs. the percentage of vegetation plots containing that species (availability).

Region	Tree species	Percent of nests having species as nest lining material (Use) Mean	95% CI	Percent of vegetation plots containing species (Availability)	Use vs. Availability[a]
Southwestern Ohio	Black cherry[b]	81.0	66.1–90.3	57.8	More
	Red cedar	73.0	57.9–84.2	9.1	More
	White pine	28.6	16.2–42,7	0	More
	Red pine	7.9	1.9–18.7	0	More
	Ash spp.	22.2	11.3–35.8	78.8	Less
	Buckeye spp.	1.6	0–9.4	24.2	Less
	White oak	11.1	3.7–22.8	18.2	No difference
	Northern red oak	15.9	6.7–28.6	33.3	Less
	Sugar maple	28.6	16.2–42.7	72.7	Less
	Eastern hemlock	14.3	5.6–26.7	0	More
Hocking Hills	Black cherry	82.9	62.5–93.9	56.7	More
	Red cedar	2.9	0–16.3	0	No difference
	White pine	48.6	28.4–67.5	23.3	More
	Red pine	28.6	12.5–48.0	3.3	More
	Ash spp.	5.7	0.2–20.7	26.7	Less
	Buckeye spp.	20.0	6.7–38.7	33.3	No difference
	White oak	20.0	6.7–38.7	26.7	No difference
	Northern red oak	11.4	2.1–28.4	36.7	Less
	Sugar maple	2.9	0–16.3	46.7	Less
	Eastern hemlock	22.9	8.5–41.9	3.3	More

[a] We consider the species was used as a nest lining more or less than expected based on availability, respectively, if the percent of vegetation plots containing the species was below or above the 95% CI.
[b] Scientific names of tree species: black cherry (*Prunus serotina*), red cedar (*Juniperus virginiana),* white pine (*Pinus strobus*), red pine (*P. resinosa*), Ash spp. (*Fraxinus americana* and *F. pennsylvanica*), Buckeye spp. (*Aesculus glabra* and *A. octandra*), white oak (*Quercus alba*), northern red oak (*Q. rubra*), sugar maple (*Acer saccharum*), and eastern hemlock (*Tsuga canadensis*).

Use of Deciduous Species as Nest Lining.— Red-shouldered Hawks in both study areas used black cherry more than expected based on availability: more than 80% of nests we studied contained this species as a nest lining. Black cherry, a medium-sized tree native to both study areas, is present in small numbers in most forest types throughout the region. Black cherry is a cyanogenic species, releasing volatile hydrogen cyanide (HCN) from its leaves when they wilt or become damaged by herbivory (Conn 1979). The cyanogenesis reaction, in addition to HCN, also releases other volatile compounds such as acetone, 2-butanone, and benzaldehyde, the last of which has been shown to repel ants (Formicidae) (Peterson et al. 1987).

We suggest the black cherry used by Red-shouldered Hawks may provide an advantage to the nesting birds by functioning as a bactericide, insecticide, or insect repellent. Clark (1991) suggests greenery some passerines add to their nests may release volatile compounds having insecticidal properties. The addition of yarrow (*Achillea millefolium*) to Tree Swallow (*Tachycineta bicolor*) nest boxes reduced flea abundance (Shutler and Campbell 2007), and removal of greenery from nests of European Starlings (*Sturnus vulgaris*) resulted in an increase in mite populations (Clark 1991). It would be interesting to examine the relationship between microbe and insect abundance, and presence of black cherry in hawk nests, to learn if black cherry has a positive effect on reproductive success. It would also be interesting to learn if Red-shouldered Hawks in other regions selectively line their nests with black cherry or any other species.

ACKNOWLEDGMENTS

We are grateful to Ann Wegman and Sandra Stone for assistance with field work. We thank the many landowners in southwestern Ohio and Hocking Hills who allowed access to private property. D. E. Andersen kindly reviewed an earlier version of this manuscript. This research was supported in part by RAPTOR, Inc., Martin and Julie Wiltz, Brad and Marsha Lindner, and the Ohio Biological Survey.

LITERATURE CITED

BOAL, C. W., D. E. ANDERSEN, AND P. L. KENNEDY. 2005. Foraging and nest habitat of breeding male Northern Goshawks in the Laurentian mixed forest province, Minnesota. Journal of Wildlife Management 69:1516–1527.

BUEHLER, D. A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). The birds of North America. Number 506.

CLARK, L. 1991. The nest protection hypothesis: the adaptive use of plant secondary compounds by European Starlings. Pages 205–221 *in* Bird-parasite interactions: ecology, evolution and behaviour (J. E. Loye and M. Zuk, Editors). Oxford University Press, Oxford, United Kingdom.

CONN, E. E. 1979 Biosynthesis of cyanogenic glycosides. Naturwissenschaften 66:28–34.

DYKSTRA, C. R., J. L. HAYS, AND S. C. CROCOLL. 2008. Red-shouldered Hawk (*Buteo lineatus*). The birds of North America. Number 107.

DYKSTRA, C. R., J. L. HAYS, F. B. DANIEL, AND M. M. SIMON. 2000. Nest site selection and productivity of suburban Red-shouldered Hawks in southern Ohio. Condor 102:401–408.

DYKSTRA, C. R., J. L. HAYS, M. M. SIMON, J. B. HOLT JR., G. R. AUSTING, AND F. B. DANIEL. 2004. Dispersal and mortality of Red-shouldered Hawks banded in Ohio. Journal of Raptor Research 38:304–311.

ENGLAND, A. S., M. J. BECHARD, AND C. S. HOUSTON. 1997. Swainson's Hawk (*Buteo swainsoni*). The birds of North America. Number 265.

FERGUSON-LEES, J. AND D. A. CHRISTIE. 2001. Raptors of the world. Houghton Mifflin Company, New York, USA.

JAMES, F. C. AND H. H. SHUGART JR. 1970. A quantitative method of habitat description. Audubon Field Notes 24:727–736.

NEWTON, I. 1979. Population ecology of raptors. T. and A. D. Poyser Ltd., London, United Kingdom.

PETERSON, S. C., N. D. JOHNSON, AND J. L. LEGUYADER. 1987. Defensive regurgitation of allelochemicals derived from host cyanogenesis by eastern tent caterpillars. Ecology 68:1268–1272.

PRESTON, C. R. AND R. D. BEANE. 1993. Red-tailed Hawk (*Buteo jamaicensis*). The birds of North America. Number 52.

SHUTLER, D. AND A. A. CAMPBELL. 2007. Experimental addition of greenery reduces flea loads in nests of a non-greenery using species, the Tree Swallow *Tachycineta bicolor*. Journal of Avian Biology 38:7–12.

The Wilson Journal of Ornithology 121(1):210–212, 2009

Ad Libitum Water Source for a Common Raven

Lawrence M. Hanks,[1,5] James D. Barbour,[2] Kim Kratz,[3] and William C. Webb[4]

ABSTRACT.—We report a Common Raven (*Corvus corax*) that learned to turn on a water faucet in a campground at Death Valley National Park, Inyo County, California, USA, and drink from it. *Ad libitum* availability of water has important implications for survival and reproductive success of desert birds. Ravens commonly exploit anthropogenic sources of water and food; these behaviors are of interest because ravens can be important predators of the federally-threatened desert tortoise (*Gopherus agassizii*). Our observation is further evidence of the resourcefulness of ravens and challenges involved in limiting access to anthropogenic resources for an intelligent, subsidized predator. *Received 14 January 2008. Accepted 6 June 2008.*

Anthropogenic sources of water, whether provided intentionally or not, can influence the size and quality of habitats for birds that require free water (Fisher et al. 1972, Kotler et al. 1998, Harrington 2002, Boarman 2003). Ravens (*Corvus* spp.) commonly drink from unrestricted artificial water sources such as stock tanks (Knight et al. 1998, Harrington 2002), sewage ponds (Boarman 2003), and wildlife water catchments (O'Brien et al. 2006). Common Ravens (*C. corax*) in the Mojave Desert of North America greatly improve their survivorship and fecundity by exploiting anthropogenic subsidies (Webb et al. 2004, Kristan and Boarman 2007), which has resulted in a dramatic increase in their population size in recent years (Boarman and Berry

[1] Department of Entomology, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA.
[2] University of Idaho, South West Idaho Research and Extension Center, Parma, ID 83660, USA.
[3] National Oceanographic and Atmospheric Administration-Fisheries, 1201 Northeast Lloyd Boulevard, Suite 1100, Portland, OR 97232, USA.
[4] College of Forest Resources, Box 352100, University of Washington, Seattle, WA 98195, USA.
[5] Corresponding author;
e-mail: hanks@life.uiuc.edu

1995, Kristan and Boarman 2007). This increase in raven abundance is of concern because Common Ravens can be important predators of the federally-threatened desert tortoise (*Gopherus agassizii*) (Boarman 2003). We observed a Common Raven that learned to exploit an artificial water source usually unavailable to wildlife: a water faucet that was intended for use of campers and travelers in Death Valley National Park where Common Ravens are abundant year round (National Park Service 2006) and the desert tortoise is present (Morafka and Berry 2002).

OBSERVATIONS

At ~1700 hrs PST on 9 April 2007, three of the authors (LMH, JDB, and KK) observed a Common Raven at Emigrant Campground (36° 29′ 47.73″ N, 117° 13′ 39.26″ W; elevation 656 m) in Death Valley National Park, Inyo County, California, USA. Natural sources of water were limited at the time because of low amounts of precipitation during the previous 6 months (Western Regional Climate Center 2007). The raven landed on the ground near a picnic table and walked slowly by, unsuccessfully searching for food. After a few minutes, it flew to a sign above a nearby water faucet. It then hopped down to the faucet, turned it on, and bent down to drink several times. The raven hopped back onto the sign and then flew to a tree ~30 m away. There also was a smaller raven perched in the tree, and it visited the campground, but did not drink from the faucet. The two birds were the only ravens in the vicinity of the trees at that time. We suspected the larger raven was a male and the smaller raven was its mate because male ravens are larger than females, they more readily engage in potentially risky foraging behaviors, and because the two birds were amicable and in close association (all diagnostic of mated pairs; WCW, unpubl. data). The smaller bird was probably not a juvenile, because juveniles of the current year would not yet have fledged at the time of our observation, and juveniles of the previous year would have dispersed from their natal territory by that time (Heath and Ballard 2003, Webb et al. 2004).

The larger raven returned to the sign after <30 min and again turned on the faucet and drank from it. We photographed the male during the second visit, and also video recorded it with a digital camera (Olympus C-765 Ultra Zoom, Olympus America Inc., Center Valley, PA, USA). The faucet was a brass self-closing hose bib with a lever handle with an internal spring that shut it off automatically. It was operated by pushing down on the lever to start the flow of water, then releasing the lever to stop the flow. The raven landed with its left foot on the handle; it was not possible to identify the position of its right foot. Water began flowing immediately, the raven bent down and the flow stopped, then started again, and the raven drank for about 1 sec. The raven then straightened up, and the flow of water nearly stopped, apparently because the bird had reduced pressure on the lever. It bent down again, the flow of water increased, it drank for about 1 sec, straightened up, and the flow nearly stopped again. It repeated this sequence of behaviors (bending down and increasing the flow, drinking for 1 sec, then straightening up and slowing the flow) another four times. The entire process, from landing on the faucet to the last drink, lasted ~20 seconds. A raven of similar size drank from the faucet later that afternoon in a similar manner, but we could not be certain it was the same bird.

DISCUSSION

Desert birds are subject to desiccation by water loss from respiration and evaporative cooling that may be exacerbated by flight (Fisher et al. 1972, Kotler et al. 1998). Desiccation can be a leading cause of mortality of birds in lower elevation areas of Death Valley (Wauer 1962). Availability of free water has important implications for desert birds, particularly because it may be of much higher quality than water from natural desert sources (California Department of Water Resources 2004). This is especially true for diurnal species that are permanent residents (Bartholomew and Cade 1963, Lynn et al. 2006).

Ravens are capable of learning sophisticated behaviors to solve problems (Range et al. 2006, Heinrich and Bugnyar 2007), allowing them to adapt to extreme environments and obtain essential resources (Restani et al. 2001). The raven we observed may have learned to operate the faucet by individual problem-solving, imitating another raven, or by imitating human campground visitors (e.g., Hosey et al. 1997, Sasvári and Hegyi 1998). Ravens use a wide variety of anthropogenic resources, including those available in campgrounds (Marzluff and Neatherlin 2006). Our observation is evidence of the resourcefulness of the Common Raven and challenges involved in limiting access to anthropogenic resources for an intelligent, subsidized predator.

ACKNOWLEDGMENTS

We acknowledge two anonymous reviewers for helpful comments on this manuscript. We also thank Michael Bellamy and park rangers Matthew Martin and Vicki Wolfe for confirming the basic design of the faucet and its mode of operation. Edited video footage of the raven drinking from the faucet may be viewed at http://www.life.uiuc.edu/hanks/raven.html.

LITERATURE CITED

BARTHOLOMEW, G. A. AND T. J. CADE. 1963. The water economy of land birds. Auk 80:504–539.

BOARMAN, W. I. 2003. Managing a subsidized predator population: reducing Common Raven predation on desert tortoises. Environmental Management 32:205–217.

BOARMAN, W. I. AND K. H. BERRY. 1995. Common Ravens in the southwestern United States, 1968–92. Pages 73–75 *in* Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems (E. T. Laroe, Editor). USDI, National Biological Survey, Washington, D.C., USA.

CALIFORNIA DEPARTMENT OF WATER RESOURCES. 2004. South Lahontan Hydrologic Region, Death Valley Groundwater Basin. California's Ground Water Bulletin Number 118. California Department of Water Resources, Sacramento, USA. http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/6-18.pdf (accessed 2 June 2008).

FISHER, C. D., E. C. LINDGREN, AND W. R. DAWSON. 1972. Drinking patterns and behavior of Australian desert birds in relation to their ecology and abundance. Condor 74:111–136.

HARRINGTON, R. 2002. The effects of artificial watering points on the distribution and abundance of avifauna in an arid and semi-arid mallee environment. Dissertation. University of Melbourne, Australia.

HEATH, S. A. AND G. BALLARD. 2003. Bird species composition, phenology, nesting substrate, and productivity for the Owens Valley alluvial fan, Eastern Sierra Nevada, California, 1998–2002. Great Basin Birds 6:18–35.

HEINRICH, B. AND T. BUNGYAR. 2007. Just how smart are ravens? Scientific American 296:64–71.

HOSEY, G. R., M. JACQUES, AND A. PITTS. 1997. Drinking from tails: social learning of a novel behaviour in a group of ring-tailed lemurs (*Lemur catta*). Primates 38:415–422.

KNIGHT, R. L., R. J. CAMP, AND H. A. L. KNIGHT. 1998. Ravens, cowbirds, and starlings at spring and stock tanks, Mojave National Preserve, California. Great Basin Naturalist 58:393–395.

KOTLER, B. P., C. R. DICKMAN, AND J. S. BROWN. 1998. The effects of water on patch use by two Simpson Desert granivores (*Corvus coronoides* and *Pseudomys hermannsburgensis*). Australian Journal of Ecology 23:574–578.

KRISTAN III, W. B. AND W. I. BOARMAN. 2007. Effects of anthropogenic developments on Common Raven nesting biology in the west Mojave Desert. Ecological Applications 17:1703–1713.

LYNN, J. C., C. L. CHAMBERS, AND S. S. ROSENSTOCK. 2006. Use of wildlife water developments by birds in southwest Arizona during migration. Wildlife Society Bulletin 34:592–601.

MARZLUFF, J. M. AND E. NEATHERLIN. 2006. Corvid response to human settlements and campgrounds: causes, consequences, and challenges for conservation. Biological Conservation 130:301–314.

MORAFKA, D. J. AND K. H. BERRY. 2002. Is *Gopherus agassizii* a desert-adapted tortoise, or an exaptive opportunist? Implications for tortoise conservation. Chelonian Conservation Biology 4:263–287.

NATIONAL PARK SERVICE. 2006. Death Valley birds checklist. USDI, National Park Service. http://www.nps.gov/deva/naturescience/upload/DEVA_Birdlist.pdf (accessed 2 June 2008).

O'BRIEN, C. S., R. B. WADDELL, S. S. ROSENSTOCK, AND M. J. RABE. 2006. Wildlife use of water catchments in southwestern Arizona. Wildlife Society Bulletin 34:582–591.

RANGE, F., T. BUGNYAR, C. SCHLÖGL, AND K. KOTRSCHAL. 2006. Individual and sex differences in learning abilities of ravens. Behavioural Processes 73:100–106.

RESTANI, M., J. M. MARZLUFF, AND R. E. YATES. 2001. Effects of anthropogenic food sources on movements, survivorship, and sociality of Common Ravens in the arctic. Condor 103:399–404.

SASVÁRI, L. AND Z. HEGYI. 1998. How mixed-species foraging flocks develop in response to benefits from observational learning. Animal Behaviour 55:1461–1469.

WAUER, R. H. 1962. A survey of the birds of Death Valley. Condor 64:220–233.

WEBB, W. C., W. I. BOARMAN, AND J. T. ROTENBERRY. 2004. Common Raven juvenile survival in a human-augmented landscape. Condor 106:517–528.

WESTERN REGIONAL CLIMATE CENTER. 2007. Death Valley, California, monthly total precipitation. Western Regional Climate Center, Reno, Nevada, USA. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca2319 (accessed 2 June 2008).