KILLING BARRED OWLS TO HELP SPOTTED OWLS I: A GLOBAL PERSPECTIVE

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ABSTRACT—Barred Owls (*Strix varia*) expanded their range to include western North America and have been competing with federally threatened Northern Spotted Owls (*S. occidentalis caurina*) for the past few decades. To help protect Spotted Owls, the US Fish and Wildlife Service is considering conducting a 3- to 10-y study in which as many as 2150 to 4650 Barred Owls would be killed and, possibly, conducting long-term management of Barred Owls. To help give these considerations a global perspective, I gathered information concerning instances of negative effects between native (non-introduced) birds worldwide (n = 194) and how managers address these effects. I found reports for 15 species of native birds of concern negatively affected by hybridization, 22 by brood parasitism, 58 by competition, and 99 by predation. Control commonly is used to address brood parasitism by cowbirds (*Molothrus* spp.), and predation by gulls (Larinae) and corvids (Corvidae), whereas control rarely is used to address competition and is never used to address hybridization. Globally, very few raptors are killed for any of these threats. If the precedent-setting removal study as described here is implemented, it would, during its 1st year, result in the death of 36 times more raptors than in all other conservation-based projects combined in the United States and its territories, and 84 times more raptors than in the largest ongoing effort worldwide. This study could cost $1 million annually; simplifying the cost to dollars per Barred Owl killed approximates $700 per Barred Owl for the 1st year and $2800 per Barred Owl for each subsequent year.

Key words: Barred Owl, lethal control, native birds, Northern Spotted Owl, *Strix occidentalis caurina*, *Strix varia*

Barred Owls (*Strix varia*) recently expanded their distribution from eastern to western North America (Livezey 2009a, 2009b), and now occur throughout the range of the federally threatened Northern Spotted Owl (*S. occidentalis caurina*; hereafter ''Spotted Owl''; USFWS 1990) in southern British Columbia, western Washington, western Oregon, and northern California. During the past few decades, Barred Owls have physically attacked Spotted Owls (Leskiw and Gutiérrez 1998; Eric Forsman, US Forest Service, Corvallis, OR, pers. comm.; Gene Stagner, US Fish and Wildlife Service (USFWS), Olympia, WA, pers. comm.), eaten their food (Hamer and others 2001; Forsman and others 2004; Livezey 2007; Livezey and others 2008), appropriated their territories (Kelly and others 2003; Pearson and Livezey 2003, 2007; Gremel 2005; Olson and others 2005; Hamer and others 2007), and, evidently, decreased their reproduction (Olson and others 2004), lessened their survival (Anthony and others 2006), and depressed their calling behavior (Olson and others 2005; Crozier and others 2006; Bailey and others 2009). Only 47 hybrids with Barred Owls were found in an analysis of more than 9000 banded Spotted Owls (Kelly and Forsman 2004). Consequently, hybridization between these 2 species is considered to be ''an interesting biological phenomenon that is probably inconsequential compared with the real threat—direct competition between the 2 species for food and space'' (Kelly and Forsman 2004:808).

For the 1st time, USFWS is considering the killing of many hundreds of native raptors in an attempt to protect a threatened or endangered species. Courtney and Franklin (2004), Buchanan and others (2007), and Gutiérrez and others (2007) recommended conducting both observational studies and removal studies to assess the effects of Barred Owls on Northern Spotted Owls. Livezey and Fleming (2007) recommended modifying survey methods and conducting observational studies to examine these effects rather than carrying out removal studies. In the Sierra Nevada of California, where there are

very few Barred Owls, Livezey and others (2007) explored methods to remove Barred Owls so the California Spotted Owl (*S. o. occidentalis*) would not decline to the point of requiring listing as a threatened or endangered species in the future (USFWS 2006). The *Northern Spotted Owl Recovery Plan* (USFWS 2008a:31–32) recommended designing and implementing ''large-scale control experiments in key Spotted Owl areas [and] various parts of the Spotted Owl's range, including a wide range of Barred Owl/Spotted Owl densities in both managed and unmanaged lands.'' On December 10, 2009, USFWS published an intent to prepare an Environmental Impact Statement concerning this removal study (USFWS 2009a).

The most effective method of ''removal'' or ''control'' appears to be by lethal means (Buchanan and others 2007; Gutiérrez and others 2007; Livezey and others 2007), which probably would be shooting individual owls with shotguns as was done in the only scientific collection of Barred Owls to date in the range of the Spotted Owl (Lowell Diller, Green Diamond Resource Company, Korbel, CA, pers. comm.; Brian Woodbridge, USFWS, Yreka, CA, pers. comm.). For this work, California Academy of Sciences collected, under a general scientific permit, 20 Barred Owls in 2006 from 2 regions of northern California and 20 more Barred Owls from 1 of these regions in 2009 (Lowell Diller, Green Diamond Resource Company, Korbel, CA, pers. comm.; Brian Woodbridge, USFWS, Yreka, CA, pers. comm.). In addition to the scientific goals of the general collecting permit, most of the Barred Owls were collected at sites formerly occupied by Spotted Owls to provide case studies of how Spotted Owls would respond to the removal of Barred Owls, and to provide information on the feasibility of conducting removal studies. These collections are not considered to be ''control,'' and results from this work were not available to report here.

USFWS contracted a team of biologists and statisticians to produce designs for removal studies (Johnson and others 2008). This team explored 4 of what they termed ''approaches,'' each representing response variables that could be measured to estimate effects on Spotted Owls by removal of Barred Owls. The first 3 would be conducted anywhere in the range of the Spotted Owl where Barred Owls occur in more than very low numbers. They would test: (1) changes in survival, productivity, or overall population size of Spotted Owls in ongoing demographic study areas (Appendix 1); (2) changes in numbers, density, or site-occupancy of Spotted Owls in demographic study areas or other large areas; and (3) changes in occupancy or productivity of Spotted Owls at the single-territory level. Approach 4 studies would be conducted at the leading edge of the Barred Owl range expansion and would test at what densities Barred Owls begin to have negative effects on occupancy or productivity of Spotted Owls. For the purposes of this paper, I focus on Approach 1 based on reasons provided in Johnson and others (2008:ii, 15–19). Approach 1 ''would provide the greatest value'' and it is ''the most powerful means to understand the influences of Barred Owls on Spotted Owl vital rates.'' Approach 2 includes ''concerns about small sample size'' and does not allow for identification of differences in reproduction or survival of Spotted Owls. Approach 3 has ''many limitations'' including inability to calculate survival of Spotted Owls, increased influence of confounding biotic and abiotic variables, ''low strength of inference,'' and poor ability to interpret turnover of individual Spotted Owls due to small spatial scale. Approach 4 ''should only be viewed as complimentary [*sic*]'' to the other 3 approaches due to its ''key limitation'' of dependence on a natural increase in numbers of Barred Owls that may make it ''impractical'' and its ''limitation of requiring a relatively long time before any results could be obtained.'' Numbers of Barred Owls to be killed in a 3–5-y (Johnson and others 2008) or 10-y (USFWS 2008a:42) study were not provided in the Recovery Plan (USFWS 2008a), but my estimate for an Approach 1 study using information provided in Johnson and others (2008) and other sources indicates that approximately 2150 to 2850 Barred Owls would be killed for a 3- to 5-y study, and 4650 Barred Owls would be killed for a 10-y study (Appendix 1).

If a removal study is conducted, deemed to be significantly beneficial to Spotted Owls, and economically feasible, the Recovery Plan recommended consideration of long-term, ''local or large-scale control of Barred Owl populations'' (USFWS 2008a:32). To give these precedent-setting recommendations a global perspective, I present information concerning instances

of negative effects between native birds worldwide and how managers address these effects.

METHODS

To keep this analysis pertinent to the issue of Spotted Owls versus Barred Owls, I included only information concerning native birds: those that are in the areas in question without having been introduced by humans. Negative effects include hybridization, brood parasitism, competition, and predation. Competition herein includes interference competition, which involves direct, typically agonistic interactions over resources that can result in injury or death (Jaksic 1988; Sergio and others 2003; Hakkarainen and others 2004; Zuberogoitia and others 2005; Martínez and others 2008), and exploitive competition, which is comprised of indirect interactions in which one species more efficiently uses resources and depletes the availability of these resources to another species (Nilsson 1984; Hayward and Garton 1988; Suhonen and others 2007). Both types of competition are evidenced between Spotted and Barred Owls (Leskiw and Gutiérrez 1998; Hamer and others 2001).

To gather cases in which negative effects between avian species have been documented or considered for species of concern and instances of legal control (especially of raptors) to benefit native birds, I used the following sources of information: (1) the online ''red list of threatened species'' database from the International Union for Conservation of Nature (IUCN 2009); (2) the literature database EBSCO (2009); (3) the USFWS online Recovery Plan information search (USFWS 2009b); (4) communications with USFWS personnel and other biologists; and (5) other pertinent literature. For source (1), species ranked by IUCN (2009) as ''near threatened,'' ''conservation dependent,'' ''vulnerable,'' ''endangered,'' or ''critically endangered'' (n = 2047) were included, thereby excluding only species ranked ''least concern,'' ''data deficient,'' ''extinct in the wild,'' and ''extinct.'' IUCN (2009) ranks bird species, not subspecies, and considers the Spotted Owl species to be ''near threatened''; therefore I included IUCN ranks down to that level. I used the sort ''Threat/Problematic native species'' to find possible species (n = 205), and reviewed the ''Threats'' and ''Conservation Actions'' sections in each species account to determine which species were affected by non-introduced birds. As a check, I also reviewed the ''Threats'' and ''Conservation Actions'' sections for all bird species ranked ''near threatened'' or above from Canada, United States, Pacific, and the Caribbean (n = 222) and for all raptors (Strigiformes, Falconiformes) worldwide (n = 148). Of the scores of species brood-parasitized by Brown-headed Cowbirds (Hahn and others 1999; Purcell and Verner 1999), I included only those species found in IUCN (2009) by these methods. For source (2), I searched titles and key words under the ''Advanced Search'' option choosing ''control AND owl OR removal AND owl OR experiments AND owl'' (n = 480), and ''control AND hawk OR removal AND hawk OR experiments AND hawk'' (n = 247), and included pertinent publications. For source (3), I sorted the following ''Work Types'': ''Management: Depredation Control,'' ''Management: Predator and Competitor Control,'' ''Research: Competition,'' and ''Research: Predation.'' I exported results to an Excel file (n = 187 entries), retained results concerning non-introduced birds and reviewed pertinent Recovery Plans (n = 30). Overall, each instance included here met at least one of the following criteria: (a) IUCN (2009) reported it as hybridization, brood parasitism, competition, or predation; (b) the affected species was ranked by IUCN (2009) as near threatened or above or by USFWS as threatened or endangered; and (c) control was recommended or conducted to address these negative effects. Management actions were excluded if they focused on reducing destruction to native vegetation without specific regard to wildlife habitat (Bédard and others 1995). I reported number of birds controlled only if management actions were based totally on lessening effects from native birds, not if, for example, they also addressed human health or collisions with aircraft (Wanless and others 1996; Harris and Wanless 1997; Finney and others 2003). Interactions between species that included competition and predation were grouped as predation. I surveyed biologists who are conducting lethal removal to estimate the annual costs of their programs using cost categories (< $1000, $1001–$10,000, $10,001–$25,000, etc.).

RESULTS

Hybridization

Hydridization affects 15 reported species, 5 of which are ranked by IUCN (2009) as critically

endangered or endangered (Table 1, Appendix 2; scientific names are in Appendix 2). Hybridization was considered to be the most-important threat to Madagascar Little Grebe, Madagascar Red-necked Grebe, Yellow-crowned Parakeet, Chatham Parakeet, Black-eared Miner, Taiwan Bulbul, and Golden-winged Warbler. Habitat management to favor the rarer species was proposed for 3 species. Control was recommended to address hybridization for only 1 species (Golden-winged Warbler), but it was never carried out (Confer 2001; John Confer, Ithaca College, Ithaca, NY, pers. comm.).

Brood Parasitism

Brood parasitism affects 22 reported species of concern (Table 1, Appendix 2). Hosts include 1 species ranked as critically endangered (Pale-headed Brush Finch) and 6 species ranked as endangered by IUCN (2009). USFWS ranked 6 host species as endangered: Southwestern Willow Flycatcher; Black-capped Vireo; Least Bell's Vireo; Kirtland's Warbler; Golden-cheeked Warbler; and Yellow-shouldered Blackbird. No actions were recommended by IUCN (2009) to address brood parasitism for 7 species. Managing landscapes to lessen habitat suitability for Brown-headed Cowbirds was a recommended action to benefit Black-capped Vireos (USFWS 1991; Eckrich and others 1999) and Southwestern Willow Flycatchers (USFWS 2002). Control of Brown-headed Cowbirds or Shiny Cowbirds has been conducted for 7 of these species. For example, to help Black-capped Vireos, recent numbers of Brown-headed Cowbirds killed annually include 250 to 400 at Balcones Canyonlands National Wildlife Refuge, Texas (USFWS 2007; Chuck Sexton, USFWS, Marble Falls, TX, pers. comm.), 1000 to 2000 at Wichita Mountains National Wildlife Refuge, Oklahoma (Walter Munsterman, USFWS, Lawton, OK, pers. comm.), and 1500 to 3500 at Fort Hood, Texas (Summers 2008; Gil Eckrich, US Army, Fort Hood, TX, pers. comm.; Scott Summers, The Nature Conservancy of Texas, Fort Hood, TX, pers. comm.).

Competition

Fifty-eight reported species of concern compete with other native bird species for food, space, or nest-sites (Table 1, Appendix 2). Of these, 6 are ranked critically endangered by

TABLE 1. IUCN and USFWS status of affected species of native birds (for 2 highest categories), number of native bird species negatively affected by other native bird species, and actions to address the effects.

		IUCN status[1]			USFWS status[1]			Recommended actions[2]				Implemented
Negative effect	*n*	EN	CR	Other	TH	EN	Other	None	Research, monitoring	Control	Other	control
Hybridization	15	3	2	10	1	0	14	3	12	1	3	0
Brood parasitism	22	6	1	15	0	6	16	7	13	2	2	7
Competition	58	16	6	36	1	11	46	25	27	2	10	2
Predation	99	19	12	68	8	22	69	48	43	4	18	23
Total	194	44	21	129	10	39	145	83	95	8	33	32

[1] CR = critically endangered, EN = endangered, TH = threatened

[2] Many "Research, monitoring" and "Other" recommended actions are being implemented, whereas recommended "Control" actions reportedly are not being implemented

IUCN (2009), 4 of which compete with congeners. For critically endangered Chatham Islands Petrel and Blue-throated Macaw, competition is considered to be their greatest threat. Examples of the 16 IUCN-endangered species that compete with other native birds include Imperial Parrot, Long-billed Black-Cockatoo, Madagascar Sacred Ibis, Egyptian Vulture, and Regent Honeyeater. White-tailed Tropicbirds compete for nest-sites with 2 IUCN-endangered species (Mauritius Parakeet and Bermuda Petrel). Eleven USFWS-endangered species are in competition with other native birds; examples include Puerto Rican Sharp-shinned Hawk, Puerto Rican Broad-winged Hawk, Mauritius Parakeet, Red-cockaded Woodpecker, and Palm Crow (Table 1, Appendix 2). Twenty-six of the 58 species compete with congeners (Appendix 2); in the case of the Imperial Parrot and Red-necked Amazon, both of the competing congeners are USFWS-endangered species. The only USFWS-threatened species reported to be negatively affected by competition with another native bird is the Northern Spotted Owl.

Of the 58 reported species in competition with other native birds, recommendations without apparent implementation were made to control native birds in 2 instances. These were Red-necked Pigeon for the USFWS-endangered Puerto Rican Plain Pigeon and Barred Owl for the USFWS-threatened Northern Spotted Owl. Only 2 reported species were the focus of implemented control programs to address competition: (1) an average of 2 White-tailed Tropicbirds are killed annually (range = 0–3, total = 25, 1994–2008) to stop them from appropriating nest-boxes installed for endangered Mauritius Parakeets (IUCN 2009; Nicolas Zuël, Mauritian Wildlife Foundation, Republic of Mauritius, pers. comm.); and (2) thousands of Double-crested Cormorants are killed annually in Ohio (5868 in 2006, 3579 in 2007, 2597 in 2008; ODNR 2009) to address competition for nests and damage to nest sites of non-listed Great Blue Herons, Great Egrets, and Black-crowned Night-Herons.

Predation

Predation negatively affects 99 reported species of concern (Table 1, Appendix 2). Twelve of these species are IUCN-critically endangered and 19 are IUCN-endangered; 22 are USFWS-endangered and 8 are USFWS-threatened. In 5 cases, USFWS-endangered species prey upon IUCN-critically endangered or USFWS-listed species. Management actions other than control to address predation include placing wire-mesh cages over nesting Piping Plovers (USACE 2009); installing monofilament lines that prevent nesting by Ring-billed Gulls and Herring Gulls but permit nesting by Common Terns (Blokpoel and others 1997); using pyrotechnics to scare away Herring and Great Black-backed Gulls from a nesting colony of Piping Plovers (Olijnyk and Brown 1999); training pre-released endangered Puerto Rican Parrots to avoid hawks (White and others 2005); and minimizing the numbers of structures that could be used as perches by avian predators of the federally threatened San Clemente Sage Sparrow (Melissa Booker, US Navy, San Clemente Island, CA, pers. comm.). According to IUCN (2009), control was neither recommended nor implemented to help many species, even when predation was listed as the primary threat to the species; these included Brown Teal (endangered), Inaccessible Island Rail (vulnerable), Black Stilt (critically endangered), Japanese Murrelet (vulnerable), Polynesian Imperial Pigeon (endangered), Golden-shouldered Parrot (endangered), and Montserrat Oriole (critically endangered). Control recommendations were not implemented to benefit Cuban Flicker (vulnerable), Polynesian Imperial Pigeon (endangered), Ashy Storm Petrel (endangered), and Izu Thrush (vulnerable) (IUCN 2009).

Control to address predation has been implemented for 23 reported species (Table 1). Predator species being controlled are gulls (Larinae), corvids (Corvidae), and raptors, and control actions include killing individuals and destroying eggs and nests. Examples of control actions for gull predation include: elimination of 23 to 41 Laughing, Herring, or Great Black-backed Gulls annually to benefit USFWS-endangered Roseate Terns in New York (2005–2007; Valerie Crane-Slocumb, USFWS, Medford, MA, pers. comm.); removal of as many as 4000 to 12,000 eggs of Ring-billed or Herring Gulls to protect non-listed Forster's and Common Terns in the midwestern United States (USFWS 2009c); and elimination of 733 Ring-billed or California Gulls and 4307 of their nests to lessen predation of Piping Plovers in Montana and North Dakota

(USFWS 2009d). The numbers of corvids affected by ongoing control projects designed to address predation range from 1 nest of Common Ravens destroyed annually to benefit Steller's and Spectacled Eiders in Alaska (Sonja Jahrsdoerfer, USFWS, Anchorage, AK, pers. comm.) to hundreds of Common Ravens killed annually to protect Greater Sage-Grouse, Western Snowy Plover, and California Least Terns (USFWS 2009c).

When raptors are controlled, often they are moved to other locations or held in captivity during the nesting season of the species being protected. When lethal control of raptors is used, very few, individually targeted birds are killed. Five examples are: (1) 1 Great Horned Owl moved 160 km away in 2007, 5 moved in 2008, and 6 moved in 2009 to benefit Piping Plovers and Interior Least Terns on the Missouri River in South Dakota and Nebraska (USACE 2009; C. Aron, USFWS, Bismarck, ND); (2) 3 Great Horned Owls shot in Horicon National Wildlife Refuge in 2006 to protect nesting Forster's Terns and Common Terns (USFWS 2009c); (3) 3 American Kestrels, 2 Northern Harriers, and 1 Barn Owl shot and 4 Barn Owls, 1 American Kestrel, and 1 Short-eared Owl moved to benefit California Least Terns and Western Snowy Plovers in San Diego National Wildlife Refuge in 2005 (USDAWS 2005); (4) 4 Peregrine Falcons moved and 1 Great Horned Owl either moved or shot to help California Least Terns and Western Snowy Plovers in 2009 (USFWS 2009c); and (5) approximately 1 Red-tailed Hawk shot annually from 2001–2008 to protect endangered Mississippi Sandhill Cranes (USFWS 2009c).

Sources used here reported only 2 cases in which more than just a few native raptors have been killed recently to address predation of avian species. To protect the federally endangered San Clemente Loggerhead Shrike, 49 American Kestrels, 27 Red-tailed Hawks, and 9 Barn Owls were lethally removed during the late 1990s (Roemer and Wayne 2003; Melissa Booker, US Navy, San Clemente Island, CA, pers. comm.). Lethal control of native predators (including San Clemente Island Fox) for the shrike was stopped almost completely in 2000 in response to public concern (Roemer and Wayne 2003). After that time, only 1 American Kestrel and 1 Red-tailed Hawk with its 2 young have been lethally removed for the shrike; managers replaced lethal control of native species with hazing of raptors and corvids by airhorns and shotgun blasts when captive-reared shrikes are released (Melissa Booker and Eric Kershner, US Navy, San Clemente Island, CA, pers. comm.). The 2nd case concerns the largest reported number of native raptors killed in an ongoing project. To benefit the federally endangered and IUCN-critically endangered Puerto Rican Parrot, an average of 17 Red-tailed Hawks were shot annually between May 2003 and August 2009, and this control continues to the present (Tom White, USFWS, Rio Grande, PR, pers. comm.).

Discussion

Global Perspective

This review was not intended to present all of the information concerning effects from hybridization, brood parasitism, competition, and predation in native birds worldwide or the methods employed to address these effects. I undoubtedly missed some pertinent instances of lethal control (especially of gulls) outside of the United States, but I believe this is an accurate general summary worldwide and a relatively exhaustive accounting of conservation-motivated control of all birds in the United States (USFWS staff) and of raptors in Europe and Africa (Fabrizio Sergio, Estación Biológica de Doñana, Seville, Spain, pers. comm.).

The only reported efforts that control or have recently controlled more than a few raptors to benefit listed avian species are those conducted for the San Clemente Loggerhead Shrike and the Puerto Rican Parrot. There are some marked similarities between these 2 species that support the need to control avian predators, none of which apply to Spotted Owls: both populations are endemic to oceanic islands and are so low in numbers that they are being maintained through captive-breeding programs. In 2009, there were fewer than 180 San Clemente Loggerhead Shrikes in the wild (Melissa Booker, US Navy, San Clemente Island, CA, pers. comm.) and only 28 or 29 wild Puerto Rican Parrots (Tom White, USFWS, Rio Grande, PR, pers. comm.). In contrast to these 2 species, the Northern Spotted Owl has a much larger (though uncounted) population with a continental distribution including 1 province and 3

states. In further support of the need to lethally intervene for Puerto Rican Parrots, Red-tailed Hawks outnumber the parrots by 10 to 1 in the range of the parrot (Tom White, USFWS, Rio Grande, PR, pers. comm.), with a population that is ''one of the densest (1.6 pairs/km2) ever reported for the species'' (Boal and others 2003:278).

Data I collected indicated that no more than about 10 owls are killed annually to address threats to avian species of concern in the United States and its territories. The removal study as described here (Appendix 1) would result in the death of 143 times more owls during its 1st year than are being killed annually in all other conservation efforts combined in the United States and its territories (1428/10). Expanding comparisons to include all raptors, it appears that no more than approximately 40 raptors are killed annually to address negative effects between native birds in the United States and its territories, and no more than 17 raptors are killed annually in any single project worldwide. If the removal study as described here is implemented, it would, during its 1st year, result in the death of 36 times more raptors than in all other projects combined in the United States and its territories (1428/40) and 84 times more raptors than are being killed in the largest ongoing effort worldwide (1428/17). All other reported projects in which raptors are killed target specific, problem-causing individuals, whereas the removal study would kill all individuals of a species throughout large areas.

In addition to the Northern Spotted Owl, there is another federally listed bird species dependent on older forests in the Pacific Northwest: the threatened Marbled Murrelet (USFWS 1992). IUCN (2009) considers the Marbled Murrelet to be at higher risk of extinction (endangered) than they do the Spotted Owl (near threatened). Population declines of Spotted Owls in the Pacific Northwest (3.7%; Anthony and others 2006) are similar to those of Marbled Murrelets (2.4–4.3%; USFWS 2009e), and the 2.15-million ha Spotted Owl critical habitat (USFWS 2008b) overlaps virtually all of the 1.57-million ha of Marbled Murrelet critical habitat (USFWS 1996). Nest predation by Steller's Jays, American Crows, and Common Ravens is one of the most significant threats to Marbled Murrelets (USFWS 1997, 2009e). Densities of these corvids have increased significantly within the 3-state range of the Marbled Murrelet due to human-caused fragmentation of forests (Malt and Lank 2007, 2009) and placement of food-rich campgrounds and towns in and near these forests (Neatherlin and Marzluff 2004; Peery and others 2004; Marzluff and Neatherlin 2006). It appears that localized control of corvids may be well justified, especially since control might be needed only in specific forest stands containing Marbled Murrelet nests, and not, as in the case of Spotted Owls, throughout large territories, each of which range from about 1000 to 2000 ha (Glenn and others 2004; Forsman and others 2005). However, there is no recommendation in the *Marbled Murrelet Recovery Plan* for actions to control corvids (USFWS 1997), only a few corvids are killed in 1 project in northern California to benefit the Marbled Murrelet (5 to 25 Common Ravens annually; Portia Halbert, California Department of Parks and Recreation, Felton, CA, pers. comm.), and there are no other proposed projects to control corvids to protect this species (Kim Flotlin and Deanna Lynch, USFWS, Lacey, WA, pers. comm.; John Marzluff, Univ. of Washington, Seattle, WA, pers. comm.). Exploring reasons for the disparity between how managers are attempting to address effects from avian competitors or predators of Spotted Owls vs. Marbled Murrelets might inform the debate concerning whether to control Barred Owls to benefit Spotted Owls.

Many native species negatively affect critically endangered or endangered species (Appendix 2). If managers address these effects with lethal control, it would result in the deaths of many thousands of grebes, pelicans, egrets, stilts, skuas, vultures, harriers, hawks, eagles, owls, pigeons, toucans, toucanets, macaws, parrots, parakeets, hummingbirds, cuckoos, woodpeckers, miners, martins, shrike-tyrants, flowerpeckers, bulbuls, thrashers, wood-wrens, finches, and weavers (Appendix 2). If, as considered in the Barred Owl removal study, negative effects to USFWS-threatened species are addressed with lethal control, many individuals of many more species (including, for example, oystercatchers and turnstones) also would be killed.

Killing of native raptors to benefit threatened or endangered birds is in addition to the

thousands of raptors killed annually by shooting (Bildstein 2001), contaminants (Woodbridge and others 1995; Elliott and others 1996; Goldstein and others 1996; Cade 2007), vehicles (Harden 2002), wind turbines (Hoover and Morrison 2005; Madders and Whitfield 2006; Smallwood 2007; Drewitt and Langston 2008) and other structures (Bevanger 1998; Janss 2000; Erickson and others 2005; Manville 2005), as well as lethal control of native birds to protect non-avian, listed species (Boarman 1992, 2002) and economic interests (Belant and others 2000; Blackwell and others 2000, 2003; Glahn and others 2002; Tobin 2002; Taylor and Dorr 2003). Analyses of the ecological effects of these cumulative sources of human-caused mortality would be prudent before significantly increasing the level at which conservationists kill native raptors.

Factors to Evaluate

Deciding whether to conduct a Barred Owl removal study is challenging. Managers have experience controlling exotic species, but control of native species for the conservation benefit of species of concern is relatively rare. For example, Garrott and others (1993) found no article focused on control of native species to help other native species in the 341 articles published in *Conservation Biology* from its inception in 1987 until their paper was published in 1993. Continuing their effort, I found only 9 such articles in the approximately 3200 articles published in that journal from 1993 to February 2010 (0.25%, 1987–2010; excluding efforts to improve availability of game species for hunting), 6 of which concerned birds (Garrott and others 1993; Trail and Bapista 1993; Goodrich and Buskirk 1995; Côté and Sutherland 1997; Woodworth 1999; Schmidt and Whelan 1999). Similarly, managers rarely consider the ethics of killing wildlife during field experiments (Farnsworth and Rosovsky 1993) or what also has been called ''shotgun ecology'' (Bangert 2005:241). For example, in an article in which Vucetich and Nelson (2007) questioned the need and ethics of killing 60 Black-throated Blue Warblers as part of a behavior experiment (Sillett and others 2004), they found only 14 articles containing the word ''ethics'' or ''ethical'' in their title or keywords in *Animal Conservation*, *Biological Conservation*, *Conservation Biology*, *Ecology*, *Ecological Monographs*, *Ecological Applications*, *Journal of Animal Ecology*, *Journal of Applied Ecology*, and *Oikos* from 1995 to 2005. However, during the same years, they found 173 such papers in *The Journal of the American Medical Association*. Due to how infrequently managers are faced with or even consider these issues and the problematical nature of such projects, considerations to conduct lethal control should be conducted with a long-term focus (Yaffee 1997) while weighing all pertinent factors (Goodrich and Buskirk 1995; Regan and others 2005). Factors which can affect degree of public involvement and level of analysis under the National Environmental Policy Act (42 U.S.C. 4321 *et seq*.) include listing statuses (Courchamp and others 2003), perceived values (Kellert 1996; Menon and Lavigne 2006; Thomas and others 2006), and effects to populations of all species involved, as well as total number and sentience (Vucetich and Nelson 2007) of the animals to be killed.

Information to be gained.—Inasmuch as carrying out the 4 approaches of Barred Owl removal studies under consideration here would entail the killing of native owls, I suggest that more should be required of the approaches than that they merely be interesting intellectual exercises that could generate funding, provide research projects, and produce publications. I suggest that they be able to produce information necessary for the recovery of the Spotted Owl that cannot be attained through studies that do not include lethal control. To help evaluate whether this is the case for these removal studies, a comparison of results obtainable from Spotted and Barred Owl observational studies and removal studies follows. A statistical advantage of the removal studies would be increased power of inference. A disadvantage of the removal studies would be that any chance of documenting direct interactions between the species including territorial confrontations, physical attacks, real-time spatiotemporal use or avoidance of habitat and avoidance of Barred Owls by Spotted Owls (in radio-telemetry studies), and competition for nest sites would be eliminated along with the Barred Owls. Comparisons of the response variables in observational studies (for example, Kelly and others 2003, Olson and others 2005) and an Approach 1 removal study in areas with or

without Barred Owls represent equivalent designs and would employ similar analytical methods (traditional statistical tests or multimodel procedures), regardless of whether Barred Owls are naturally absent or removed. Results of observational studies and all approaches of removal studies are (or would be) influenced by: uncontrollable variation in confounding factors such as weather, prey abundance, and habitat quality, all of which are known to affect the dynamics of Spotted Owl populations (Carey and others 1992; Franklin and others 2000; Gutiérrez and others 2004); changes in detectability of Spotted Owls due to presence of Barred Owls (Bailey and others 2009); and statistical problems stemming from lack of randomization and poor representation of occupied habitats (Smith 2002). At most, for both types of studies, data may be inferred to be consistent with a cause-and-effect relationship (Fox 1991; Beyers 1998; Feldman 1999; Smith 2002; Suter and others 2002; Hewitt and others 2003).

The weight of evidence clearly indicates that Barred Owls exert negative effects on Spotted Owls (Leskiw and Gutiérrez 1998; Hamer and others 2001, 2007; Kelly and others 2003; Pearson and Livezey 2003, 2007; Olson and others 2004, 2005; Gremel 2005; Anthony and others 2006; Crozier and others 2006; Livezey and others 2008; Bailey and others 2009). Furthermore, I am unaware of any published study with appropriate methods (Iverson 2004; Livezey 2005) that failed to show negative effects, even when ''coarse'' covariates were used (Anthony and others 2006:30). Whether an Approach 1 removal study is necessary to corroborate these findings remains to be decided. Less-rigorous approaches may be considered due to, for example, unavailability of demographic study areas, insufficient sample sizes of Spotted Owls in demographic study areas, budget constraints, or unwillingness to kill so many Barred Owls. The experimental results that could be obtained from these other approaches would need to be weighed against the necessity to conduct them, the ''concerns'' and ''limitations'' inherent in them (Johnson and others 2008:18), and their ethical and financial costs.

Benefit to protected species.—Whether killing Barred Owls during a removal study would benefit Spotted Owls is an important factor to evaluate when deciding whether to conduct it. Pertinent results from control of cowbirds, gulls, raptors, and other predators follow. Species appear to be able to withstand at least moderate levels of brood parasitism by Brown-headed Cowbirds without experiencing negative effects to the dynamics of their populations. Therefore, control of cowbirds may not be needed until the frequency of parasitism consistently exceeds 60% in a sample of at least 30 nests over at least 2 y (Smith 1999). Restricted distributions and loss of habitat led to the listing of the 5 federally endangered species parasitized by Brown-headed Cowbirds: Kirtland's Warbler, Golden-cheeked Warbler, Black-capped Vireo, Least Bell's Vireo, and Southwestern Willow Flycatcher. For these species, protection and management of their habitat is at least as important as control of cowbirds. For example, almost 125,000 cowbirds were killed on the breeding grounds of the Kirtland's Warbler from 1972 to 2002 (Rothstein 2004). Although parasitism rates decreased and reproduction rates of warblers increased markedly soon after control began, the breeding population remained at about 200 pairs for 18 y before starting to increase in 1990 and then jumping to 1050 pairs by 2002 (Rothstein 2004). The significant increase coincided with the aging of a 10,500-ha burned area into what became suitable nesting habitat for the warblers (Rothstein 2004). By contrast, cowbird trapping programs to aid Least Bell's and Black-capped Vireos clearly have resulted in large increases to their breeding populations (Hall and Rothstein 1999; Kus and Whitfield 2005). Effects from cowbird-removal programs to benefit Southwestern Willow Flycatchers are mixed. A synthesis concluded that brood parasitism by cowbirds historically reduced many flycatcher populations and continues to slow or prevent the recovery of the subspecies (Whitfield and Sogge 1999). A study in Malheur National Wildlife Refuge, however, showed no significant effect from cowbirds on reproductive success of these flycatchers after their 1st year (Sedgwick and Iko 1999) and control of cowbirds has been terminated in many areas due to lack of proven benefits to the flycatchers (Debra Hill, USFWS, Albuquerque, NM, pers. comm.). An analysis of the long-term programs to control cowbirds to benefit Least Bell's Vireos

and Southwestern Willow Flycatchers concluded that cowbird control: lacks predetermined biological criteria to signal its completion, thereby rendering the protected species' dependence on human intervention open-ended; should be reserved for management of short-term crises; and should be replaced, when appropriate, with restoration and maintenance of natural processes (Kus and Whitfield 2005).

Concerning the effectiveness of removing gulls, recruitment rate of Atlantic Puffins in Scotland was significantly higher in areas where Herring and Lesser Black-backed Gulls had been controlled (Finney and others 2003). With control of Ring-billed Gulls throughout Common Tern nesting seasons from 1990 to 1993, tern numbers on an island in the St. Lawrence River of Ontario increased from 2 nests to 135 nests (Blokpoel and others 1997). With only partial-season control of gulls from 1994 to 1996, Ring-billed Gull nests increased from 2 to 100, while Common Tern nests decreased from 141 to 3 (Blokpoel and others 1997). However, other areas showed mixed or no significant effects from control. For example, control of Great Black-backed and Herring Gulls in Maine facilitated significant increases in populations of Arctic, Common, and Roseate Terns but had no evident effect on populations of Black Guillemots, Common Eiders, or Leach's Storm-Petrels (Kress 1983). Atlantic Puffins on the Isle of May, Scotland, provisioned their chicks at a higher rate and had lower risk of kleptoparasitism where Herring and Lesser Black-backed Gulls had been controlled than in areas without control, but there was no significant difference between gull-free and gull-occupied habitat in growth and survival of puffin chicks (Finney and others 2001). Populations of Eurasian Oystercatchers on the Isle of May increased only in areas that were completely free of gulls, but not in areas with much-reduced numbers of gulls (Harris and Wanless 1997).

Survival of captive-released Puerto Rican Parrot fledglings has been significantly higher in years with control of Red-tailed Hawks than in years without control (Tom White, USFWS, Rio Grande, PR, pers. comm.). A meta-analysis of 20 published studies of predator-removal programs showed that removal of avian and mammalian predators had a large, positive effect on hatching success and post-breeding-season population sizes, but had varying and insignificant effects on breeding population sizes (Côté and Sutherland 1997). The authors attributed this difference to density-dependent regulations of avian populations, incomplete removal of predators, and inadequate monitoring of individuals that emigrate from study areas (Côté and Sutherland 1997). They concluded that predator removal on islands may be an effective, long-term solution if predators cannot recolonize, but on the mainland any benefits from predator removal disappear quickly if the program is not maintained (Côté and Sutherland 1997). If birds can recolonize areas, long-term management is required (Blokpoel and others 1997; Olijnyk and Brown 1999; Guillemette and Brousseau 2001; Oro and Martínez-Abraín 2007).

Results from studies of cowbirds, gulls, raptors, and other predators, and studies of Spotted Owls lead to several conclusions. First, protection, restoration, and maintenance of suitable habitat are crucial for Spotted Owls. In addition, co-existence of both species may be possible because a low-level presence of Barred Owls may not result in negative population-level effects to Spotted Owls, and some individuals or subpopulations of Spotted Owls may be better able than others to withstand negative effects from Barred Owls. Although local populations of Spotted Owls would benefit temporarily from killing all Barred Owls within areas of removal studies, long-term commitment would be required to maintain these gains. Finally, management of Barred Owls, if initiated, should include the establishment of criteria by which success could be determined and control could be lessened or discontinued.

Cost.—Direct cost of the removal study as proposed in the Northern Spotted Owl Recovery Plan would be approximately $600,000 annually (USFWS 2008a:42). I estimate indirect costs for additional activities would average at least $400,000 annually. These activities would include salaries and expenses for participating staff of USFWS, US Forest Service, Bureau of Land Management, and state agencies in planning, conducting, and monitoring these studies and addressing possible lawsuits; preparation of an Environmental Impact Statement per the National Environmental Policy Act (42 U.S.C. 4321 *et seq*.) and a biological opinion per the

Endangered Species Act (16 U.S.C. 1531 *et seq.*); and disposition of carcasses. If 1428 Barred Owls were killed in an Approach 1 study in the 1st year and 357 in each subsequent year (Appendix 1), then simplifying the cost to dollars per Barred Owl killed yields approximately $700 per Barred Owl for the 1st year and $2800 per Barred Owl for each subsequent year. An economic analysis (Engeman and others 2003; Shwiff and others 2005) of a Barred Owl removal study is beyond the scope of this paper, but costs of some of the disparate projects presented here are pertinent. For example, it costs less than $1000 annually, or approximately $55 per Red-tailed Hawk killed, to protect the critically endangered Puerto Rican Parrot (Tom White, USFWS, Rio Grande, PR, pers. comm.); $100 annually to destroy 1 nest of Common Ravens to benefit Steller's and Spectacled Eiders (Ted Swem, USFWS, Fairbanks, AK, pers. comm.); $200 annually to shoot 1 Red-tailed Hawk for Mississippi Sandhill Cranes (Scott Hereford, USFWS, Gautier, MS, pers. comm.); and $1000 to $10,000 annually to shoot many hundreds of gulls and destroy several thousand gull nests to benefit Piping Plovers (Carol Aron, USFWS, Bismarck, ND, pers. comm.). Depending on the size of the program, costs to control Brown-headed Cowbirds to protect endangered species varied from $1000 to $10,000 (Walter Munsterman, USFWS, Lawton, OK, pers. comm.), to $200,000 to $300,000 (Gil Eckrich, US Army, Fort Hood, TX, pers. comm.). At Fort Hood, Texas, each cowbird trapped costs $4 to $153, and each cowbird shot costs $14 to $19 (Summers and others 2006a, 2006b). Due to the high densities and flocking behaviors of gulls and cowbirds and their tendencies to be situated in open areas, it is possible to control them much more inexpensively than could be done for individual owls widely dispersed in forests. An additional challenge in a Barred Owl removal study would be removing all Barred Owls from large areas, especially if they evade humans to avoid being shot.

In addition to the many criteria Johnson and others (2008) listed concerning locating removal studies to optimize their experimental value (for example, sufficient numbers of Spotted and Barred Owls; similar quantity, quality, and distribution of habitat between treated and untreated areas; adequate access), I suggest that another criterion should be a strong likelihood of commitment to long-term management. This would minimize the number of Barred Owls killed merely as part of short-term studies, allow for continuation of local benefits to Spotted Owls, and lower the overall cost of a program that includes long-term management.

The total area of the 4 demographic studies appropriate for an Approach 1 study (Appendix 1) is 10,561 km^2, and the range of the Spotted Owl is 230,690 km^2 (Anthony and others 2006:6). Consequently, such a large study would result in the deaths of Barred Owls throughout only 2.3% of the range of the Spotted Owl. Recovery of the Spotted Owl in the United States is dependent on the species attaining stable or increasing populations throughout its 3-state range (USFWS 2008a). If it is determined that ''large-scale control of Barred Owl populations'' (USFWS 2008a:32) is required for this to occur, it appears that far more than several thousand Barred Owls would be killed and far more than $1 million would be spent annually. Monitoring in a large portion of one of the long-term Spotted Owl demographic study areas was discontinued in 2006 due to lack of funds (Forsman and others 2009a). With further competition for limited conservation budgets (Wilcove and Chen 1998; Shogren and others 1999; Leonard 2008; Joseph and others 2009; Moran and others 2010), it may be problematic to fund a large removal study, long-term management of Barred Owls, and ongoing monitoring of Spotted Owls (Anthony and others 2006). It is vitally important, however, that ongoing monitoring continue not only to track trends in populations of Spotted Owls but to help identify situations in which the 2 species can coexist without lethal intervention.

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APPENDIX 1

Estimate of numbers of Barred Owls that could be killed in an Approach 1 study

Total numbers of Barred Owls to be removed in a 3-y, 5-y (Johnson and others 2008) or 10-y (USFWS 2008a:42) study were not provided in the *Northern Spotted Owl Recovery Plan* (USFWS 2008a) or Johnson and others (2008). I, however, approximated these totals using information provided in Johnson and others (2008) and other sources assuming Approach 1 would be chosen (see introduction). Johnson and others (2008:4) assumed that ''> 1 study areas will be employed, with each study area consisting of a control area where Barred Owls are not removed, and a treatment area where Barred Owls are removed'' and recommended that analyses be conducted by ''analyzing individual study areas separately and then combining them through a meta-analysis to estimate the effect of Barred Owl removal.'' They ran Monte Carlo simulations to determine potential statistical power with 3 study areas, larger and smaller sample sizes, and a range of annual rates of recruitment and population change with 3 y of post-treatment data (pp. 5–9). Their larger sample sizes were 200, 150, and 100 marked Spotted Owls in 3 study areas including halves with and without removal of Barred Owls, and their smaller sample sizes were 100, 66, and 50 Spotted Owls similarly divided. The larger sample would have power >0.80 to detect a 5% increase (from 0.93 to ≥0.98) in annual rate of population change; whereas the smaller sample would require >7% increase (from 0.93 to ≥1.005) to provide similar power (pp. 8–9). Spotted Owls have a long history of population declines and, because they typically reproduce only once every 2 y (Anthony and others 2006), the 3-y study might include 2 y with little or no reproduction. So, a 5% increase to me seems optimistic and a 7% increase excessively optimistic. Consequently, I use the larger sample size to estimate numbers of Barred Owls that would be removed.

Johnson and others (2008) recommended the 3 study areas be chosen from 2 demographic study areas (DSAs) in Washington (Eastern Cascades and Olympic) and 3 DSAs and 1 density study area in Oregon (Oregon Coast Ranges, HJ Andrews, Southern Oregon Cascades, Tyee; p. 25), and also referred to possible inclusion of another DSA in Washington (Rainier; p. 17). Percentages of historical, surveyed Spotted Owl sites occupied by pairs for these areas in 2008 were 13.3% in Eastern Cascades (10 sites with pairs/75 sites surveyed; Forsman and others 2008:4, 17); 18.3% in Rainier (11/60;

Herter and others 2009:6); 18.8% in Olympic National Forest (9/48; Forsman and others 2009a:3); 27.8% in Southern Oregon Cascades (47/169; Anthony and others 2009a:3); 29.1% in Oregon Coast Ranges (59/203; Forsman and others 2009b:7); 34.6% in Olympic National Park (18/52; Gremel 2009:4); 47.7% in H.J. Andrews (73/153; Anthony and others 2009b:4); and 71.2% in Tyee (47/66; Forsman and others 2009c:11). Following suggestions by Johnson and others (2008:17), here I exclude DSAs in Eastern Cascades due to ''small samples,'' Mt. Rainier National Park due to ''potential control/treatment problems,'' and Olympic National Park due to ''potential access/control treatment problems.'' Many Barred Owls would need to be removed to benefit very few Spotted Owls in areas where Spotted Owls have exceptionally large territories. Sizes of Spotted Owl territories in the Olympic Peninsula are the largest anywhere in the range of the Northern Spotted Owl (Forsman and others 2005), so I suggest the DSA in Olympic National Forest also be excluded. These exclusions leave 4 acceptable study areas: Southern Oregon Cascades, Oregon Coast Ranges, HJ Andrews, and Tyee which together, in 2008, had 226 occupied pair sites out of 591 sites surveyed.

The larger sample sizes used in Johnson and others (2008) were 200, 150, and 100 marked Spotted Owls (450 individuals or 225 pairs; p. 8) in all study areas and 100, 75, and 50 marked Spotted Owls (225 individuals or 113 pairs; p. 6) in the halves of the study areas throughout which Barred Owls would be killed. To achieve the desired number of 225 pairs of Spotted Owls, use of all 4 of the acceptable study areas, which had a total of 226 pairs in 2008, would be required. So all currently occupied and unoccupied Spotted Owl sites in these 4 areas (591) would be surveyed, and Barred Owls would be killed in one-half of them (296). Johnson and others (2008:24) assumed Barred Owls outnumber Spotted Owls by 3 to 1, and Spotted Owl territories overlap by 25%. Employing these assumptions and following their methods results in 665 pairs of Barred Owls (296 $\times$ 3 $\times$ 0.75) or 1330 individual Barred Owls to be killed in the 1st year. In addition, they estimated there would be approximately 10 Barred Owl ''floaters'' (unmated individuals without defended territories) per 68 pairs of Barred Owls (p. 24). Adjusting for floaters increases the 1st-year total to 1428 individual Barred Owls. Each year thereafter, based on a colonization rate of 25% (1424 $\times$ 0.25; p. 24), an additional 357 Barred Owls would be killed. Consequently, approximately 2142 Barred Owls (annual mean = 714) would be killed for a 3-y study, 2856 (annual mean = 571) for a 5-y study, and, if the study continued, 4640 (annual mean = 464) for a 10-y study.

In the example Johnson and others (2008:24) provided to estimate numbers of Barred Owls, they assumed ''Barred Owls will be removed from 30 Spotted Owl sites in a demography study landscape'' that included ''30 Spotted Owl pairs,'' ''Spotted Owl sites overlapped by about 25 percent,'' and ''all forest in the study area occurred in the Spotted Owl management circles.'' So they assumed the area to be full of overlapping, occupied Spotted Owl territories from which Barred Owls would be removed. To make my estimates more realistic, I based them on the assumption that the study areas would be full of overlapping occupied and unoccupied Spotted Owl territories from which Barred Owls would be removed. An alternative strategy for a study would be to remove Barred Owls only from occupied Spotted Owl sites. By that method, however, increases in site occupancy by Spotted Owls due to removal of Barred Owls would be unlikely, significant increases in overall population size of Spotted Owls would be much more difficult to attain, overlap among occupied sites would range from 0 to 25%, and annual colonization rate of Barred Owls could be as high as 100% depending on how many reproducing Barred Owls surrounded these partially or completely isolated territories.

Estimates of numbers of Barred Owls to be killed would be increased by removing Barred Owls from areas between non-overlapping Spotted Owl territories: if there were more than 10 floaters per 136 resident Barred Owls (Rohner 1997; Severinghaus 2002); if relative density of Barred Owls was greater than 3 to 1 (Pearson and Livezey 2007); or if the DSA in Olympic National Forest was included in the study. Numbers of Barred Owls removed could be decreased without affecting the sample size of Spotted Owls by excluding edges of study areas that contained only unoccupied Spotted Owl sites.

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APPENDIX 2. Affected species, affecting species, and IUCN and USFWS status of species ordered within effect categories by alpha of scientific name of affected species.

AFFECTED SPECIES				AFFECTING SPECIES		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
HYBRIDIZATION						
Aquila clanga	Greater Spotted Eagle	VU	NL	Lesser Spotted Eagle (*Aquila pomarina*)	LC	NL
Cyanoramphus auriceps	Yellow-crowned Parakeet	NT	NL	Red-fronted Parakeet (*Cyanoramphus novaezelandiae*)	VU	NL
Cyanoramphus forbesi	Chatham Parakeet	EN	NL	Red-fronted Parakeet	VU	NL
Gubernatrix cristata	Yellow Cardinal	EN	NL	Common Diuca-Finch (*D. diuca*)	LC	NL
Himantopus novaezelandiae	Black Stilt	CR	NL	Black-winged Stilt (*H. himantopus*)	LC	NL
Manorina melanotis	Black-eared Miner	EN	NL	Yellow-throated Miner (*Manorina flavigula*)	LC	NL
Mayrornis versicolor	Versicolored Monarch	VU	NL	Slaty Monarch (*Mayrornis lessoni*)	LC	NL
Nesospiza wilkinsi	Grosbeak Bunting	VU	NL	Tristan Bunting (*Nesospiza acunhae*)	VU	NL
Pachycephala rufogularis	Red-lored Whistler	NT	NL	Gilbert's Whistler (*Pachycephala inornata*)	LC	NL
Pycnonotus taivanus	Taiwan Bulbul	VU	NL	Chinese Bulbul (*Pycnonotus sinensis*)	LC	NL
Strix occidentalis caurina	Northern Spotted Owl	NT	TH	Barred Owl (*Strix varia*)	LC	NL
Tachybaptus pelzelnii	Madagascar Little Grebe	VU	NL	Little Grebe (*Tachybaptus ruficollis*)	LC	NL
Tachybaptus rufolavatus	Madagascar Red-necked Grebe	CR	NL	Little Grebe	LC	NL
Tauraco ruspolii	Prince Ruspoli's Turaco	VU	NL	White-cheeked Turaco (*Tauraco leucotis*)	LC	NL
Vermivora chrysoptera	Golden-winged Warbler	NT	NL	Blue-winged Warbler (*Vermivora pinus*)	LC	NL
BROOD PARASITISM						
Agelaius xanthomus	Yellow-shouldered Blackbird	EN	EN	Shiny Cowbird (*Molothrus bonariensis*)	LC	NL
Anthus spragueii	Sprague's Pipit	VU	NL	Brown-headed Cowbird (*Molothrus ater*)	LC	NL
Asthenes luizae	Cipó Canastero	VU	NL	Shiny Cowbird	LC	NL
Atlapetes pallidiceps	Pale-headed Brush Finch	CR	NL	Shiny Cowbird	LC	NL
Calcarius ornatus	Chestnut-collared Longspur	NT	NL	Brown-headed Cowbird	LC	NL
Cichlherminia lherminieri	Forest Thrush	VU	PE	Shiny Cowbird	LC	NL
Cistothorus apolinari	Apolinar's Wren	EN	NL	Shiny Cowbird	LC	NL
Corvus florensis	Flores Crow	EN	NL	Channel-billed Cuckoo (*Scythrops novaehollandiae*), Asian Koel (*Eudynamys scolopacea*)	LC, LC	NL
Dendroica chrysoparia	Golden-cheeked Warbler	EN	EN	Brown-headed Cowbird	LC	NL
Dendroica kirtlandii	Kirtland's Warbler	NT	EN	Brown-headed Cowbird	LC	NL
Empidonax traillii extimus	Southwestern Willow Flycatcher	LC	EN	Brown-headed Cowbird	LC	NL
Icterus bonana	Martinique Oriole	VU	NL	Shiny Cowbird	LC	NL
Icterus laudabilis	St Lucia Oriole	NT	NL	Shiny Cowbird	LC	NL
Loxia megaplaga	Hispaniolan Crossbill	EN	NL	Shiny Cowbird	LC	NL
Nesopsar nigerrimus	Jamaican Blackbird	EN	NL	Shiny Cowbird	LC	NL

APPENDIX 2. Continued.

AFFECTED SPECIES				AFFECTING SPECIES		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
Passerina ciris	Painted Bunting	NT	NL	Brown-headed Cowbird	LC	NL
Sturnella defilippii	Pampas Meadowlark	VU	NL	Shiny Cowbird	LC	NL
Turdoides hindei	Hinde's Pied-babbler	VU	NL	Jacobin Cuckoo (*Clamator jacobinus*)	LC	NL
Vermivora chrysoptera	Golden-winged Warbler	NT	NL	Brown-headed Cowbird	LC	NL
Vermivora crissalis	Colima Warbler	NT	NL	Brown-headed Cowbird	LC	NL
Vireo atricapilla	Black-capped Vireo	VU	EN	Brown-headed Cowbird	LC	NL
Vireo bellii pusillus	Least Bell's Vireo	NT	EN	Brown-headed Cowbird	LC	NL
COMPETITION						
Accipiter striatus venator	Puerto Rican Sharp-shinned Hawk	LC	EN	Red-tailed Hawk (*Buteo jamaicensis*)	LC	NL
Acrocephalus luscinia	Nightingale Reed Warbler	EN	EN	Other native wildlife	SNP	SNP
Agelaius xanthomus	Yellow-shouldered Blackbird	EN	EN	Caribbean Martin (*Progne dominicensis*)	LC	NL
Agelastes meleagrides	White-breasted Guineafowl	VU	NL	Crested Guineafowl (*Guttera pucherani*)	LC	NL
Agriornis albicauda	White-tailed Shrike-Tyrant	VU	NL	Black-billed Shrike-Tyrant (*Agriornis montana*)	LC	NL
Amazona imperialis	Imperial Parrot	EN	EN	Red-necked Amazon (*Amazona arausiaca*)	VU	EN
Amazona vinacea	Vinaceous Parrot	VU	NL	Other hole-nesting birds	SNP	SNP
Anas aucklandica	Auckland Islands Teal	VU	NL	Comb Duck (*Sarkidiornis melanotos*), parrots (*Coracopsis* spp.)	LC, LC	NL
Aplonis feadensis	Atoll Starling	NT	NL	Singing Starling (*Aplonis cantoroides*)	LC	NL
Ara glaucogularis	Blue-throated Macaw	CR	NL	Other macaws, toucans, large woodpeckers	SNP	SNP
Ardea herodias, Egretta thula, Nycticorax nycticorax	Great Blue Heron, Great Egret, Black-crowned Night-Heron	LC	NL	Double-crested Cormorant (*Phalacrocorax auritus*)	LC (all)	NL (all)
Buteo platypterus brunnescens	Puerto Rican Broad-winged Hawk	LC	EN	Red-tailed Hawk	LC	NL
Calyptorhynchus baudinii	Long-billed Black-Cockatoo	EN	NL	Maned Duck (*Chenonetta jubata*)	LC	NL
Calyptorhynchus latirostris	Short-billed Black-Cockatoo	EN	NL	Galah (*Cacatua roseicapilla*)	LC	NL
Centropus chlororhynchus	Green-billed Coucal	VU	NL	Greater Coucal (*Centropus sinensis*)	LC	NL
Charadrius thoracicus	Madagascar Plover	VU	NL	Kittlitz's Plover (*Charadrius pecuarius*), White-fronted Plover (*Charadrius marginatus*)	LC, LC	NL, NL
Cichlherminia lherminieri	Forest Thrush	VU	PE	Bare-eyed Robin (*Turdus nudigenis*)	LC	NL
Circus maurus	Black Harrier	VU	NL	African Marsh Harrier (*Circus ranivorus*)	LC	NL
Columba inornata wetmorei	Puerto Rican Plain Pigeon	NT	EN	Red-necked Pigeon (*Patagioenas squamosa*)	LC	NL
Colinus virginianus ridgwayi	Masked Bobwhite Quail	NT	EN	Gambel's Quail (*Callipepla gambelii*)	LC	NL, NL

APPENDIX 2. Continued.

AFFECTED SPECIES				AFFECTING SPECIES		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
Corvus palmarum	Palm Crow	NT	EN	Cuban Crow (*Corvus nasicus*)	LC	NL
Dicaeum quadricolor	Cebu Flowerpecker	CR	NL	Red-striped Flowerpecker (*Dicaeum australe*)	LC	NL
Dryocopus galeatus	Helmeted Woodpecker	VU	NL	Lineated Woodpecker (*Dryocopus lineatus*), Robust Woodpecker (*Campephilus robustus*)	LC, LC	NL, NL
Falco fasciinucha	Taita Falcon	NT	NL	Peregrine Falcon (*Falco peregrinus*)	LC	NL
Falco hypoleucos	Grey Falcon	NT	NL	Peregrine Falcon	LC	NL
Henicorhina negreti	Munchique Wood-Wren	CR	NL	Congeners	SNP	SNP
Heteroglaux blewitti	Forest Spotted Owlet	CR	NL	Other cavity nesters	SNP	SNP
Icterus laudabilis	St. Lucia Oriole	NT	NL	Bare-eyed Robin	LC	NL
Ixos siquijorensis	Streak-breasted Bulbul	EN	NL	Philippine Bulbul *(Ixos philippinus)*	LC	NL
Larus audouinii	Audouin's gull	NT	NL	Yellow-legged Gull (*Larus michahellis*)	LC	NL
Larus relictus	Relict Gull	VU	NL	Other gulls	SNP	NL
Lanius ludovicianus mearnsi	San Clemente Loggerhead Shrike	LC	EN	American Kestrel (*Falco sparverius*)	LC	NL
Lathamus discolor	Swift Parrot	EN	NL	Large nectarivores	SNP	SNP
Malimbus ibadanensis	Ibadan Malimbe	EN	NL	Other malimbes, weavers	SNP	NL
Milvus milvus	Red Kite	NT	NL	Black Kite (*Milvus migrans*)	LC	NL
Mirafra degodiensis	Degodi Lark	VU	NL	Gillett's Lark (*Mirafra gilletti*)	LC	NL
Neophron percnopterus	Egyptian Vulture	EN	NL	Griffon Vulture (*Gyps fulvus*)	LC	NL
Paradisaea guilielmi	Emperor Bird-of-paradise	NT	NL	Raggiana Bird-of-paradise (*Paradisaea raggiana*)	LC	NL
Pardalotus quadragintus	Forty-spotted Pardalote	EN	NL	Noisy Miner (*Manorina melanocephala*)	LC	NL
Phalacrocorax ranfurlyi	Bounty Islands Shag	VU	NL	Salvin's Albatross (*Thalassarche salvini*), Erect-crested Penguin (*Eudyptes sclateri*)	VU, EN	NL, NL
Picoides borealis	Red-cockaded Woodpecker	VU	EN	Pileated Woodpecker (*Dryocopus pileatus*), Red-bellied Woodpecker (*Melanerpes carolinus*)	LC, LC	NL, NL
Ploceus batesi	Bates's Weaver	EN	NL	Preuss's Weaver (*Ploceus preussi*)	LC	NL
Porphyrio hochstetteri	Takahe	EN	NL	Weka (*Gallirallus australis*), Swamp Harrier *(Circus approximans)*	VU, LC	NL, NL
Prioniturus luconensis	Green-crowned Racket-tailed Parrot	VU	NL	Blue-crowned Racquet-tail (*Prioniturus discurus*)	LC	NL
Pseudobulweria rostrata	Tahiti Petrel	NT	NL	Wedge-tailed Shearwater (*Puffinus pacificus*)	LC	NL
Psittacula eques	Mauritius Parakeet	EN	EN	White-tailed Tropicbird (*Phaethon lepturus*)	LC	NL
Pterodroma axillaris	Chatham Islands Petrel	CR	NL	Broad-billed Prion (*Pachyptila vittata*)	LC	NL
Pterodroma cahow	Bermuda Petrel	EN	NL	White-tailed Tropicbird	LC	NL
Pterodroma pycrofti	Pycroft's Petrel	VU	NL	Little Shearwater (*Puffinus assimilis*)	LC	NL

APPENDIX 2. Continued.

AFFECTED SPECIES				AFFECTING SPECIES		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
Sephanoides fernandensis	Juan Fernández Firecrown	CR	NL	Green-backed Firecrown (*S. sephaniodes*)	LC	NL
Stagonopleura guttata	Diamond Firetail	NT	NL	Red-browed Finch (*Neochmia temporalis*)	LC	NL
Strix occidentalis caurina	Northern Spotted Owl	NT	TH	Barred Owl	LC	NL
Sturnella defilippii	Pampas Meadowlark	VU	NL	Long-tailed Meadowlark (*Sturnella loyca*), White-browed Blackbird (*Leistes superciliaris*)	LC, LC	NL, NL
Thalassarche cauta	Shy Albatross	NT	NL	Australasian Gannet (*Morus serrator*)	LC	NL
Thinornis rubricollis	Hooded Plover	NT	NL	Beach Thick-knee (*Esacus giganteus*)	NT	NL
Threskiornis bernieri	Madagascar Sacred Ibis	EN	NL	Dimorphic Egret (*Egretta dimorpha*)	LC	NL
Toxostoma bendirei	Bendire's Thrasher	VU	NL	Curve-billed Thrasher (*Toxostroma curvirostre*)	LC	NL
Xanthomyza phrygia	Regent Honeyeater	EN	NL	Noisy Miner	LC	NL
PREDATION						
Accipiter striatus venator	Puerto Rican Sharp-shinned Hawk	LC	EN	Red-tailed Hawk	LC	NL
Acrocephalus familiaris	Nihoa Millerbird	CR	EN	Nihoa Finch (*Telespiza ultima*)	CR	EN
Acrocephalus sechellensis	Seychelles Brush-Warbler	VU	NL	Seychelles Fody *(Foudia sechellarum)*	NT	NL
Agelaius xanthomus	Yellow-shouldered Blackbird	EN	EN	Pearly-eyed Thrasher (*Margarops fuscatus*)	LC	NL
Amazona vittata	Puerto Rican Parrot	CR	EN	Red-tailed Hawk	LC	NL
Amphispiza belli clementeae	San Clemente Sage Sparrow	LC	TH	San Clemente Loggerhead Shrike, American Kestrel	LC, LC	EN, NL
Anarhynchus frontalis	Wrybill	VU	NL	Kelp Gull (*Larus dominicanus*)	LC	NL
Anas chlorotis	Brown Teal	EN	NL	Purple Swamphen (*Porphyrio porphyrio*)	LC	NL
Anas spp.	Waterfowl	LC	NL	Black-billed Magpie (*Pica hudsonia*)	LC	NL
Aphelocoma coerulescens	Florida Scrub Jay	VU	TH	Native birds	SNP	SNP
Aphrastura masafuerae	Más Afuera Rayadito	CR	NL	Red-backed Hawk (*Buteo polyosoma*)	LC	NL
Ardea herodias	Great Blue Heron	LC	NL	Great Horned Owl (*Bubo virginianus*)	LC	NL
Atlantisia rogersi	Inaccessible Island Rail	VU	NL	Tristan Thrush (*Nesocichla eremite*)	NT	NL
Brachyramphus marmoratus	Marbled Murrelet	EN	TH	Common Raven (*Corvus corax*), American Crow (*Corvus brachyrhynchos*), Steller's Jay (*Cyanocitta stelleri*)	LC (all)	NL (all)
Buteo platypterus brunnescens	Puerto Rican Broad-winged Hawk	LC	EN	Red-tailed Hawk	LC	NL
Caprimulgus noctitherus	Puerto Rican Nightjar	CR	EN	Short-eared Owl (*Asio flammeus*)	LC	NL
Centrocercus urophasianus	Greater Sage-Grouse	NT	NL	Common Raven	LC	NL

APPENDIX 2. Continued.

AFFECTED SPECIES				AFFECTING SPECIES		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
Charadrius alexandrinus nivosus	Western Snowy Plover	LC	TH	Barn Owl (*Tyto alba*), Great Horned Owl, Gull-billed Tern (*Sterna nilotica*), Common Raven, other raptors, corvids, gulls	LC (all)	NL (all)
Charadrius melodus	Piping Plover (Atlantic coast and northern Great Plains populations)	NT	TH, TH	Ring-billed, California (*Larus californicus*), Great Black-backed (*Larus marinus*) Gulls, Great Horned Owl, crows, Common Raven, grackles (*Quiscalus* spp.)	LC (all)	NL (all)
Charadrius melodus	Piping Plover (Great Lakes population)	NT	EN	Ring-billed and Herring Gull (*Larus argentatus*) Gulls, Common Raven, Merlin (*Falco columbarius*)	LC (all)	NL (all)
Colaptes fernandinae	Cuban Flicker	VU	NL	West Indian Woodpecker (*Melanerpes superciliaris*)	LC	NL
Columba inornata wetmorei	Puerto Rican Plain Pigeon	NT	EN	Red-tailed Hawk	LC	NL
Corvus hawaiiensis	Hawaiian Crow	EN	EN	Hawaiian Hawk (*Buteo solitarius*)	NT	EN
Corvus leucognaphalus	White-necked Crow	VU	NL	Pearly-eyed thrasher	LC	NL
Dicrurus aldabranus	Aldabra Drongo	NT	NL	Crows, bulbuls (Pycnonotidae)	SNP	SNP
Ducula aurorae	Polynesian Imperial Pigeon	EN	NL	Swamp Harrier	LC	NL
Egretta vinaceigula	Slaty Egret	VU	NL	Raptors and other species	SNP	SNP
Eulipoa wallacei	Moluccan Megapode	VU	NL	Raptors	SNP	SNP
Falco fasciinucha	Taita Falcon	NT	NL	Peregrine Falcon, Lanner Falcon (*Falco biarmicus*), Spotted Eagle-owl (*Bubo africanus*)	LC (all)	NL (all)
Falco femoralis septentrionalis	Northen Aplomado Falcon	LC	EN	Great Horned Owl, Barn Owl	LC, LC	NL, NL
Fratercula arctica	Atlantic Puffin	LC	NL	Herring, Lesser Black-Backed (*Larus fuscus*), Great Black-backed Gulls	LC (all)	NL (all)
Fulica cornuta	Horned Coot	NT	NL	Andean Gull (*Larus serranus*)	LC	NL
Garrulus lidthi	Amami Jay	VU	NL	Large-billed Crow (*Corvus macrorhynchos*)	LC	NL
Geronticus calvus	Southern Bald Ibis	VU	NL	Raptors	SNP	SNP
Glareola nordmanni	Black-winged Pratincole	NT	NL	Corvids	SNP	SNP
Grus americana	Whooping Crane	EN	EN	Common Raven, Bald Eagle (*Haliaeetus leucocephalus*), Golden Eagle (*Aquila chrysaetos*)	LC, LC	NL, NL
Grus antigone	Sarus Crane	VU	NL	Corvids	SNP	SNP
Grus canadensis pulla	Mississippi Sandhill Crane	LC	EN	Red-tailed Hawk	LC	NL
Gymnogyps californianus	California Condor	CR	EN	Common Raven, Golden Eagle	LC, LC	NL, NL
Gymnomyza aubryana	Crow Honeyeater	EN	NL	New Caledonian Crow (*Corvus moneduloides*), White-bellied Goshawk (*Accipiter haplochrous*)	LC, NT	NL, NL
Haematopus chathamensis	Chatham Island Pied Oystercatcher	EN	NL	Weka	VU	NL

APPENDIX 2. Continued.

AFFECTED SPECIES				AFFECTING SPECIES		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
Haematopus moquini	African Black Oystercatcher	NT	NL	Kelp Gull	LC	NL
Haematopus osralegus	Eurasian Oystercatcher	LC	NL	Herring Gull, Lesser Black-backed Gull	LC, LC	NL, NL
Heteroglaux blewitti	Forest Spotted Owlet	CR	NL	Raptors	SNP	SNP
Himantopus novaezelandiae	Black Stilt	CR	NL	Swamp Harrier, Kelp Gull	LC, LC	NL, NL
Icterus oberi	Montserrat Oriole	CR	NL	Pearly-eyed Thrasher	LC	NL
Icterus bonana	Martinique Oriole	VU	NL	Carib Grackle (*Quiscalus lugubris*)	LC	NL
Lanius ludovicianus mearnsi	San Clemente Loggerhead Shrike	LC	EN	Red-tailed Hawk, American Kestrel, Barn Owl, Great Horned Owl, Common Raven	LC (all)	NL (all)
Larus audouinii	Audouin's Gull	NT	NL	Yellow-legged Gull (*Larus michahellis*), Peregrine Falcon, other raptors	LC	NL, NL
Larus relictus	Relict Gull	VU	NL	Other gulls	SNP	SNP
Laterallus spilonotus	Galápagos Rail	VU	NL	Short-eared Owl, Barn Owl	LC, LC	NL, NL
Loxioides bailleui	Palila	EN	EN	Short-eared Owl, Hawaiian Hawk (*Buteo solitarius*)	LC, NT	NL, EN
Mayrornis versicolor	Versicolored Monarch	VU	NL	Swamp Harrier, Barn Owl	LC, LC	NL, NL
Morus capensis	Cape Gannet	VU	NL	Great White Pelican (*Pelecanus onocrotalus*)	LC	NL
Myadestes palmeri	Puaiohi	CR	EN	Short-eared Owl	LC	NL
Numenius tahitiensis	Bristle-thighed Curlew	VU	NL	Raptors, Parasitic Jaeger (*Stercorarius parasiticus*), Common Raven	SNP, LC, LC	SNP, NL, NL
Oceanodroma homochroa	Ashy Storm Petrel	EN	NL	Western Gull (*Larus occidentalis*), Burrowing Owl (*Speotyto cunicularia*), Barn Owl	LC (all)	NL (all)
Oceanodroma tristrami	Tristram's Storm Petrel	NT	NL	Laysan Finch (*Telespiza cantans*), Nihoa Finch	VU, CR	NL , EN
Pandion haliaetus	Osprey	LC	NL	Great Horned Owl	LC	NL
Petroica phoenicea	Flame Robin	NT	NL	Pied Currawong (*Strepera graculina*)	LC	NL
Phalacrocorax bougainvillii	Guanay Cormorant	NT	NL	Band-tailed Gull (*Larus belcheri*)	LC	NL
Phalacrocorax carunculatus	New Zealand King Shag	VU	NL	Gulls	SNP	SNP
Phalacrocorax gaimardi	Red-legged Cormorant	NT	NL	Kelp Gull	LC	NL
Phalacrocorax neglectus	Bank Cormorant	EN	NL	Kelp Gull, Great White Pelican	LC, LC	NL, NL
Phalacrocorax nigrogularis	Socotra Cormorant	VU	NL	Gulls	SNP	SNP
Phalacrocorax onslowi	Chatham Islands Shag	CR	NL	Weka, gulls	VU, LC	NL, NL
Podiceps gallardoi	Hooded Grebe	NT	NL	Kelp Gull	LC	NL
Polysticta stelleri	Steller's Eider	VU	TH	Common Raven, jaegers, gulls	LC (all)	NL (all)
Pomarea dimidiata	Cook Islands Flycatcher	EN	NL	Long-tailed Koel (*Eudynamys taitensis*)	LC	NL
Porphyrio hochstetteri	Takahe	EN	NL	Swamp Harrier, Barn Owl	LC, LC	NL, NL
Procellaria conspicillata	Spectacled Petrel	VU	NL	Southern Skua (*Catharacta antarctica*)	LC	NL

APPENDIX 2. Continued.

AFFECTED SPECIES				AFFECTING SPECIES		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
Psephotus chrysopterygius	Golden-shouldered Parrot	EN	NL	Pied Butcherbird (*Cracticus nigrogularis*)	LC	NL
Pterodroma feae	Cape Verde Petrel	NT	NL	Yellow-legged Gull (*Larus cachinnans*)	LC	NL
Pterodroma incerta	Atlantic Petrel	EN	NL	Southern Skua	LC	NL
Pterodroma leucoptera	Collared Petrel	VU	NL	Pied Currawong (*Strepera graculina*), Australian Raven (*Corvus coronoides*)	LC, LC	NL, NL
Pterodroma phaeopygia	Galápagos Dark-rumped Petrel	CR	NL	Galápagos Hawk (*Buteo galapagoensis*), Short-eared Owl	VU, LC	EN, NL
Pterodroma phaeopygia sandwichensis	Hawaiian Dark-rumped Petrel	CR	EN	Short-eared Owl	LC	NL
Pterodroma puffinus newelli	Newell's Manx Shearwater	LC	EN	Short-eared Owl	LC	NL
Pterodroma solandri	Providence Petrel	VU	NL	Lord Howe Rail (*Gallirallis sylvestris*)	EN	EN
Pyrrhura orcesi	El Oro Parakeet	EN	NL	Crimson-rumped Toucanet (*Aulacorhynchus haematopygus*)	LC	NL
Rallus longirostris levipes	Light-footed Clapper Rail	LC	EN	Western Gull, Northern Harrier (*Circus cyaneus*), American Kestrel, Short-eared Owl, Barn Owl, American Crow, Common Raven	LC (all)	NL (all)
Recurvirostra avocetta	Pied Avocet	LC	NL	Black-headed Gull (*Larus ridibundus*), Common Kestrel (*Falco tinnunculus*)	LC, LC	NL, NL
Semnornis ramphastinus	Toucan Barbet	NT	NL	Plate-billed Mountain-Toucan (*Andigena laminirostris*)	NT	NL
Somateria fischeri	Spectacled Eider	LC	TH	Common Raven, jaegers, gulls	LC, LC	NL, NL
Somateria mollissima	Common Eider	LC	NT	Great Black-backed Gull, Herring Gull	LC, LC	NL, NL
Spheniscus demersus	African Penguin	VU	NL	Kelp Gull	LC	NL
Sterna antillarum athalassos	Interior Least Tern	LC	EN	Great Horned Owl, Long-eared Owl (*Asio otus*), Ring-billed Gull, hawks	LC (all)	NL (all)
Sterna antillarum browni	California Least Tern	LC	EN	Barn Owl, Great Horned Owl, American Kestrel, Peregrine Falcon, other raptors, Gull-billed Tern, corvids, gulls	LC (all)	NL (all)
Sterna dougallii dougallii	Roseate Tern (Caribbean)	LC	TH	Ruddy Turnstone (*Arenaria interpres*), American Oystercatcher (*Haematopus palliatus*), Laughing Gull (*Larus atricilla*), Peregrine Falcon, American Kestrel, Red-tailed Hawk	LC (all)	NL (all)
Sterna dougallii dougallii	Roseate Tern (NE US and Canada)	LC	EN	Laughing, Herring, Great Black-backed Gulls, corvids	LC (all)	NL (all)
Sterna forsteri	Forster's Tern	LC	NL	Ring-billed Gull, Herring Gull, Great Horned Owl	LC (all)	NL (all)

APPENDIX 2. Continued.

Affected species				Affecting species		
Scientific name	Common name	IUCN status[1]	USFWS status[2]	Common name (scientific name)	IUCN status	USFWS status
Sterna hirundo	Common Tern	LC	NL	Ring-billed, Herring, Great Black-backed Gulls, Great Horned Owl, Black-crowned Night-heron, Ruddy Turnstone	LC (all)	NL (all)
Sterna lorata	Peruvian Tern	EN	NL	Raptors	SNP	SNP
Sterna paradisaea	Arctic Tern	LC	NL	Great Black-backed, Herring, Ring-billed Gulls	LC (all)	NL (all)
Synthliboramphus wumizusume	Japanese Murrelet	VU	NL	Crows	SNP	NL
Thinornis novaeseelandiae	Shore Plover	EN	NL	Morepork (*Ninox novaeseelandiae*), Swamp Harrier	LC, LC	NL
Thinornis rubricollis	Hooded Plover	NT	NL	Silver Gull (*Larus novaehollandiae*), Raven (*Corvus* spp.)	LC, SNP	NL, NL
Todiramphus ruficollaris	Cook Islands Kingfisher	VU	NL	Long-tailed Koel *(Eudynamys taitensis)*	LC	NL
Turdus celaenops	Izu Thrush	VU	NL	Large-billed Crow	LC	NL
Zosterops modestus	Seychelles Grey White-Eye	EN	NL	Seychelles Bulbul (*Hypsipetes crassirostris*)	LC	NL

[1] LC = least concern, NT = near threatened, VU = vulnerable, EN = endangered, CR = critically endangered, SNP = species not provided
[2] NL = not listed, TH = threatened, PE = proposed endangered, EN = endangered, SNP = species not provided

ADDITIONAL SCIENTIFIC NAMES OF COMMON NAMES USED IN THE TEXT: Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Atlantic Puffin (*Fratercula arctica*), Black Guillemot (*Cepphus grylle*), Black-throated Blue Warbler (*Dendroica caerulescens*), San Clemente Island Fox (*Urocyon littoralis clemente*)

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