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BIOLOGY AND CONSERVATION OF BLAKISTON'S FISH-OWLS (*KETUPA BLAKISTONI*) IN RUSSIA: A REVIEW OF THE PRIMARY LITERATURE AND AN ASSESSMENT OF THE SECONDARY LITERATURE

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ABSTRACT.—Blakiston's Fish-Owl (*Ketupa blakistoni*) is a little-studied endangered species endemic to northeast Asia. Although it is a species of global conservation interest, much of the primary literature on Blakiston's Fish-Owls is limited to Russian- and Japanese-language publications, with content summarized for the broader English-speaking scientific community in secondary, English-language sources. We here examine and summarize content of 44 publications from the primary Russian Blakiston's Fish-Owl literature, assess the accuracy of 24 publications from the secondary literature, and determine the dependence of authors of primary *Ketupa* genus literature on secondary sources for information. We also provide an overview of contemporary knowledge of the species and summarize primary conservation issues. Despite increasing threats from human encroachment and industrial logging, we found that most publications on Blakiston's Fish-Owls in Russia focused only on the species' presence and lacked sufficient breadth to guide conservation efforts. We also found the secondary literature to be generally accurate; however, we noted a pattern of errors involving misinterpretation of original sources and repetition of false records. Finally, we found a strong dependence on secondary literature by authors of primary *Ketupa* literature.

KEY WORDS: *Blakiston's Fish-Owl*; Ketupa blakistoni; *conservation*; *Far East*; *logging*; *riparian*; *Russia.*

BIOLOGÍA Y CONSERVACIÓN DE *KETUPA BLAKISTONI* EN RUSIA: UNA REVISIÓN DE LA LITERATURA PRIMARIA Y UNA EVALUACIÓN DE LA LITERATURA SECUNDARIA

RESUMEN.—*Ketupa blakistoni* es una especie poco estudiada en peligro de extinción y endémica del noreste de Asia. A pesar de que es una especie de interés global de conservación, gran parte de la literatura primaria de *K. blakistoni* está limitada a publicaciones en ruso y japonés, con un resumen del contenido disponible para la comunidad científica más amplia de habla inglesa, en fuentes secundarias de idioma inglés. Aquí examinamos y sintetizamos el contenido de 44 publicaciones sobre *K. blakistoni* de la literatura primaria rusa, evaluamos la exactitud de 24 publicaciones de la literatura secundaria y determinamos la dependencia que tienen los autores que escriben la literatura primaria del género *Ketupa* de las fuentes secundarias de información. Brindamos además un repaso del conocimiento contemporáneo de la especie y resumimos los tópicos de conservación más importantes. A pesar de que han aumentado las amenazas de deterioro ambiental por actividades humanas y de explotación forestal industrial, encontramos que la mayoría de las publicaciones sobre *K. blakistoni* en Rusia se enfocaron sólo en la presencia de la especie y no tuvieron una amplitud suficiente como para guiar esfuerzos de conservación. Encontramos también que la literatura secundaria generalmente es exacta; sin embargo, detectamos un patrón de errores que involucra la interpretación errada de las fuentes originales y la repetición de registros falsos. Finalmente, encontramos una fuerte dependencia de la literatura secundaria por parte de los autores que escriben la literatura primaria de *Ketupa*.

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The endangered Blakiston's Fish-Owl (*Ketupa blakistoni*) is endemic to northeast Asia. Its apparent reliance on old-growth forests, many that are threatened by intensive natural resource extraction, may result in the Blakiston's Fish-Owl becoming the 'Spotted Owl (*Strix occidentalis*) of Asia.' Despite being a species of strong conservation interest, the scientific community outside of Russia and Japan is generally unfamiliar with this owl and its conservation issues. A modest body of English-language Blakiston's Fish-Owl literature from Japan exists for the island subspecies (*K. b. blakistoni*), and recent translations of important Russian texts (Berzan 2003, Pukinskii 2003) have helped to disseminate information on this subspecies and the mainland subspecies (*K .b. doerriesi*) in Russia. However, most information emanating from Russia is either inaccessible or only available indirectly through secondary sources. The accuracy of secondary sources is therefore paramount, as few researchers or students can easily access the original Cyrillic texts to verify content. Furthermore, authors of primary *Ketupa* literature are frequently required to consult secondary literature for information on this and other species in the genus. The purpose of this paper is to summarize Blakiston's Fish-Owl (hereafter ''fish-owl,'' except when distinguishing between this and other *Ketupa* species) research found in the primary Russian literature, assess secondary English-language sources for content and accuracy, and quantify reliance of primary *Ketupa* literature on secondary literature as an information source.

METHODS

We reviewed and summarized content of 44 papers written between 1891 and 2006 from the primary fish-owl literature in Russia and assessed the content and accuracy of derived information from 24 journal articles written between 1934 and 2001 of the secondary fish-owl literature. Primary publications were written in Russian (N = 35), English (N = 6), German (N = 2), and French (N = 1). Secondary literature was written in English (N = 17), Russian (N = 4), and German (N = 3). We defined primary literature as publications that presented original information about fish-owls, whereas secondary literature was defined as publications that derived information from primary or unspecified sources. We also searched the online database Zoological Record Plus (ProQuest-Cambridge Scientific Abstracts 2007) and reference sections of fish-owl publications to find primary English-language literature of Blakiston's Fish-Owls and other species in the *Ketupa* genus (N = 15) to determine author reliance on secondary sources for information. We included all *Ketupa* publications in this search due to the small sample size of English-language Blakiston's Fish-Owl literature, and the fact that many studies of other *Ketupa* species refer to Blakiston's Fish-Owl research. Primary literature from Japanese sources (N = 10) were only used for comparative purposes. All literature reviewed but not directly cited are listed in Appendix.

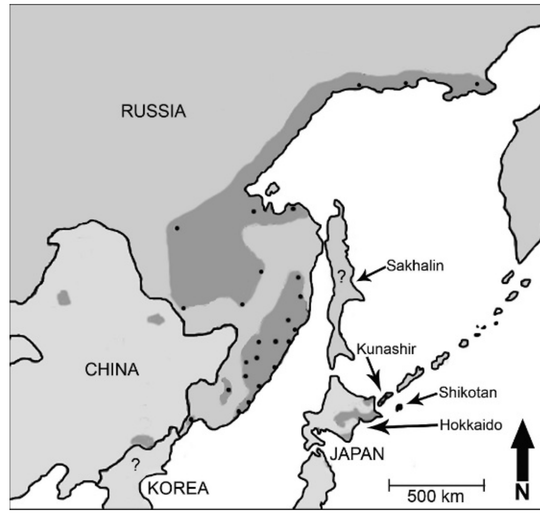

Figure 1. Global distribution of Blakiston's Fish-Owls. Shading represents potential range. Credible records (1980–present) in Russia derived from the primary Russian literature and our data are denoted by black circles (●). Distribution in China was estimated from Collar et al. (2001) and distribution in Japan was estimated from Takenaka (1998). Question marks denote uncertainty due to absence of survey effort (North Korea) or lack of recent records (Sakhalin Island).

RESULTS

Distribution. Fish-owls have a fragmented distribution in the Russian Far East, northern Japan, and northeastern China (Fig. 1). There are two generally recognized subspecies: an island subspecies, which occurs on Hokkaido Island, Japan, and Kunashir and Shikotan Islands of the southern Kuril Islands, Russia (Dykhan and Kisleiko 1988, Brazil and Yamamoto 1989, Takenaka 1998, Berzan 2005), and a more broadly distributed mainland subspecies, which ranges in Russia from Magadan south to Primorye (Surmach 1998). Fish-owls may occur in North Korea; however, no recent surveys have been conducted in that area (W. Duckworth pers. comm.). Most secondary sources included Sakhalin Island (Russia) in fish-owl global distribution (Dementev 1936, 1951, 1970, Fogden 1973, 1992, Flint et al. 1984, Pererva 1984, Collar and Andrew 1988, Voous 1988, Clark and Mikkola 1989, Hume 1991, Collar et al. 1994, del Hoyo et al. 1999, König et al. 1999, Stattersfield and Capper 2000, Collar 2001). Although fish-owls were previously reported on Sakhalin Island (Kuroda 1931, Gizenko 1955, Nechaev 1969), recent surveys there did not confirm their current presence (Berzan 2005, Grigorev 2005). The last documented record of a fish-owl on Sakhalin Island was in 1974 (Nechaev 1991). Lake Khanka (in Primorye on the border with China) was also specifically listed by several sources as part of fish-owl range (Voous 1988, König et al. 1999); however, the lowland habitat of this area is not suitable for the species. The source of this information was likely a secondary Russian source (Dementev 1936, 1951, 1970), which may have been based on a secondhand report by Taczanowskii (1891).

A distribution record from Collar (2001) was an incorrect translation of the original source (Vorobev 1954) that reported secondhand that fish-owls were ''not uncommon'' in 1949 and 1950 along some rivers in the Amur River drainage and near the Amgun River. Collar (2001) described these records as undated detections of rare breeding; however, we believe this is a misinterpretation of the original text.

Population Size. Of the <60 breeding pairs (150–205 individuals) that compose the island subspecies, ca. 30–35 pairs (80–120 individuals) inhabit Hokkaido Island (Brazil and Yamamoto 1989, Takenaka 1998), with the remaining ca. 20–25 pairs (70–85 individuals) primarily on Kunashir Island (Dykhan and Kisleiko 1988, Berzan 2005). There have been recent detections, but no confirmation of breeding, on Shikotan Island (Grigorev 2005).

The population of the mainland subspecies is more difficult to quantify because of insufficient surveys across a vast area of potential range. Population numbers for all Russia (mainland and island subspecies combined) were estimated at 300–400 pairs in the early 1980s (Pererva 1984), an estimate that was the basis for many reports in the secondary literature (Collar and Andrew 1988, Collar et al. 1994, del Hoyo et al. 1999, König et al. 1999, Stattersfield and Capper 2000). Surmach (1998) suggested that the population in southeastern Russia (encompassing all Primorye and Khabarovskii Krai south from the Amur River) was approximately 100–130 pairs based on his surveys. With extrapolation to the entire fish-owl range, the population could be >800 pairs (S. Surmach, in Collar 2001).

Recent surveys by Surmach (2006) estimated one pair of fish-owls per 3.8 river km along the Samarga River in northern Primorye, possibly the highest documented concentration of this species. In the secondary literature, concentrations of breeding pairs in suitable habitat (defined below) were generally described as one pair per 6–12 river km (Pererva 1984, Voous 1988, Hume 1991, Collar et al. 1994, del Hoyo et al. 1999, König et al. 1999).

Habitat, Breeding, and Behavior. The primary literature frequently focused on two factors to define suitable fish-owl habitat: cavernous old-growth tree cavities for suitable nest sites and stretches of productive rivers with open water in winter for hunting (Yakovlev 1929, Vorobev 1954, Spangenberg 1960, Shibnev 1963, Pukinskii 1973, Dykhan and Kisleiko 1988, Dugintsov and Teryoshkin 2005). Twenty-three nest tree descriptions in the Russian literature included eight in elm (*Ulmus* sp.), five in Japanese poplar (*Populus maximowiczii*), four in willow (*Salix* sp.), two in chosenia (*Chosenia arbutifolia*), two in Mongolian oak (*Quercus mongolica*), one in ash (*Sorbus* sp.), and one in stone birch (*Betula ermanii*). Nest types were cavity nests ($N = 12$), broken-top (snag) nests ($N = 7$), tree fork nests ($N = 1$), and unspecified ($N = 3$). Nest height ranged from 2–18 m (Nechaev and Kurenkov 1986, Dykhan and Kisleiko 1988, Voronov and Zdorikov 1988, Takenaka 1998, Pukinskii 1973, 1993, Dugintsov and Teryoshkin 2005, Yelsukov 2005, S. Surmach unpubl. data). Takenaka (1998) documented one pair of fish-owls nesting on a cliff ledge in Japan. Although Dementev (1951, 1970) cited a personal communication with Spangenberg that fish-owls occasionally nested on the ground and subsequent secondary sources perpetuated this statement (Fogden 1973, Sayers 1976, del Hoyo et al. 1999, König et al. 1999), we did not find any ground nest records in the primary Russian literature, including Spangenberg's (1940, 1948, 1960, 1965) own publications.

Access to open water in winter is another important habitat characteristic for fish-owls (Yakovlev 1929, Spangenberg 1948, Surmach 1998). In fish-owl range, open water in winter is generally found only where the current is sufficiently fast or there is an upwelling of warm spring water (Surmach 1998). Dugintsov and Teryoshkin (2005) reported that these areas are found at an average of every 5–7 km on the Selemdzha River. Additionally, Surmach (1998) suggested that slower-moving streams are more important to fish-owls than the main river channels and, given sufficient prey, openings as small as a few square meters are sufficient to sustain a pair of resident fish-owls through the winter.

Fish-owls formed pair bonds as early as their second year, and reached sexual maturity by age 3 (Pukinskii 1973). It is not clear what prompted breeding attempts, as the species did not breed every year (Pukinskii 1973, Berzan 2000, Dugintsov and Teryoshkin 2005, S. Surmach unpubl. data). Courtship occurred from January–February, with a clutch of one or two eggs laid in March (Nechaev 1969, Pukinskii 1973, Dykhan and Kisleiko 1988, Voronov and Zdorikov 1988). The female incubated the clutch while the male brought food to the nest (Brazil 1985, S. Surmach pers. obs.) After chicks hatched, the female continued to brood them during the day, but joined the male to bring food to the nest at night (J. Slaght unpubl. data). Young fledged no more than 50 d post-hatching (Pukinskii 1993). Data on breeding success are scant and the lone description suggested breeding success of 24% with six fledglings resulting from 25 eggs on Kunashir Island, Russia, during a 6-yr period (Berzan 2000). Juveniles remained on their natal territory into their second year, apparently dispersing as late as July the following year (Pukinskii 1973). This unusually long post-fledging period may be why Shibnev (1963) interpreted (and Voous [1988] repeated) several full-grown fish-owls in a single tree in April as evidence of gregarious behavior. Pukinskii (1973) considered this a misunderstanding of fish-owl biology. An observation by Pukinskii (1973) of congregations of five to six fish-owls at open-water areas was also misinterpreted by several secondary sources (Voous 1988, Hume 1991) as evidence of gregarious behavior. The original text clearly identified such congregations as rare events in unseasonably cold winters, when regular foraging habitat was presumably ice-covered.

Both Pukinskii (1973) and Mikhailov and Shibnev (1998) stated that fish-owls are nonmigratory. Although Pukinskii (1973) dismissed a description by Shibnev (1963) of apparent fish-owl migration in the Bikin River basin in winter, several secondary sources have cited it (Voous 1988, König et al. 1999). Overall, the seasonal movements of fish-owls are poorly understood and there are few data to verify either assertion. Although long-distance migration is unlikely (Pukinskii 1973, Mikhailov and Shibnev 1998, S. Surmach unpubl. data), short-distance movements, such as seasonal shifts in home range, may occur and should be investigated.

Prey Base and Hunting. Several sources linked fish-owl distribution to rivers rich with large salmonid fish (Pukinskii 1973, Dykhan and Kisleiko 1988), but fish-owls persisted on smaller prey items as well (Surmach 1998). Fish-owl prey included fish, waterfowl, small mammals, and amphibians (Vorobev 1954, Pukinskii 1973, Dykhan and Kisleiko 1988, Voronov and Zdorikov 1988, Dugintsov and Teryoshkin 2005). Reliance on certain prey species appears to be seasonal. For example, frogs (*Rana* sp.) are particularly important in spring (Pukinskii 1973, S. Surmach unpubl. data). Although many secondary sources listed crayfish as an important food source (Fogden 1973, 1992, Flint et al. 1984, König et al. 1999, Collar 2001), the most recent of only two documented crayfish predations on the mainland was by Pukinskii (1973), with the only other report from Yakovlev (1929), although Voronov and Zdorikov (1988) described finding crustacean remains in fish-owl pellets on Kunashir Island. A similar report by Pererva (1984) erroneously cited Dementev (1951) as a reference, although this information was not found in that publication. There are anecdotal reports of crayfish population declines in Primorye over the last several decades; perhaps this decline may account for their apparent disappearance from fish-owl diet on the mainland (S. Surmach unpubl. data).

The most commonly described hunting technique used by fish-owls is dropping onto prey in shallow water, often from a low perch, such as a snag or rock, or from the ice edge (Yakovlev 1929, Pukinskii 1973, Dykhan and Kisleiko 1988, Voronov and Zdorikov 1988, Dugintsov and Teryoshkin 2005). Fish-owls also hunted by wading in the shallows (Yakovlev 1929, J. Slaght unpubl. data), but this type of behavior was not described in the island subspecies (Brazil 1985, Voronov and Zdorikov 1988). Fish-owls generally took frogs and other small prey directly back to a survey perch or another roost to be consumed. Larger prey such as fish and waterfowl were partially consumed on the riverbank or ice edge before being taken to a habitual roost to be finished (Yakovlev 1929, Pukinksii 1973, Voronov and Zdorikov 1988, Dugintsov and Teryoshkin 2005).

Vocalizations. Pukinskii (1974) described a variety of fish-owl vocalizations, including the duet. Duets are described vaguely as ''elaborate'' (Hume

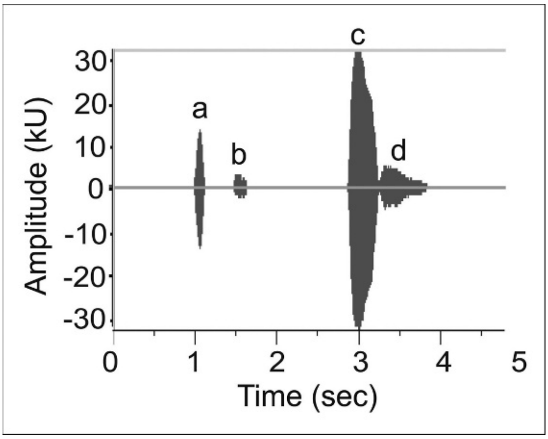

Figure 2. Oscillogram of Blakiston's Fish-Owl duet recorded May 2006 near Olga, Primorye, Russia. From left, male vocalizations are parts a,c; female vocalizations are parts b,d. Oscillogram generated using Raven 1.1 software (Cornell Bioacoustics program, Ithaca, NY, U.S.A.).

1991, del Hoyo et al. 1999, König et al. 1999) and ''complicated'' (Voous 1988) in the secondary literature. Duet structure differed between the mainland and island subspecies. On the mainland, a duet consisted of four distinct, highly synchronized notes, where the male produced the first and third notes, and the female produced the second and fourth notes (Fig. 2). In contrast, an island subspecies duet was three notes, where the male produced a two-note call followed immediately by a single note from the female (Brazil and Yamamoto 1989). Duets were occasionally reversed when the pair was agitated, with the female initiating the call and the male responding (Pukinskii 1974, J. Slaght unpubl. data).

Conservation Threats. Although other sources of mortality may remain undetected due to lack of study, most known fish-owl mortality in the literature was due to contact with humans (all but two records; Pukinskii 1993, Yelsukov 2005). Of 12 cases of fish-owl mortality known to Yelsukov (2005), nine resulted from shooting by hunters. Surmach (1998) reported 10 cases of fish-owls shot wantonly and two birds shot for commercial gain (i.e., sale of taxidermic specimens). In winter, fish-owls were accidentally trapped in furbearer snare lines, apparently while scavenging bait (Vorobev 1954, Dykhan and Kisleiko 1988, Averin and Antonov 2005, Yelsukov 2005). Surmach (1998) suggested that fish-owls can survive 3–5 d in such snares, and are often healthy enough to be released once found; however, 41 of 48 fish-owls caught in furbearer snare lines were killed by the trapper. As such, education of local populations may be a key conservation tool (Pererva 1984, Surmach 1998).

Historically, the native Udege peoples of the Bikin and Samarga river basins hunted fish-owls in winter for food (Vorobev 1954, Mikhailov and Shibnev 1998). Meise (1933) reported similar findings from Manchuria. Spangenberg (1965) described many encounters along the Iman River in 1938 and 1939 with Udege hunters, who used dried fish-owl wings as fans to dissipate biting insect swarms during red deer (*Cervus elaphus*) hunts. Although recent interviews with Udege in the Samarga River basin indicated that purposeful hunting of fish-owls may no longer be common (J. Slaght unpubl. data), fish-owl hunting still occurs (V. Solomatin pers. comm.) and should be considered a threat.

Logging is a primary threat to fish-owl conservation. Although Russian law prohibits logging within 5 km of both banks of major waterways (Surmach 1998), riparian areas are still being directly or indirectly affected by logging in several ways. First, the law is not always enforced in remote areas of eastern Russia, and loopholes in the law are often exploited (Newell and Lebedev 2000). Second, riparian areas are indirectly affected by the creation of roads to facilitate resource extraction (Slaght 2005). Old-growth Japanese poplar, a fish-owl nest tree species, is chosen by loggers to create makeshift bridges across waterways (J. Slaght pers. obs.). Ash and Mongolian oak, also fish-owl nest tree species, are valued in the timber industry and are removed illegally (Newell and Lebedev 2000). Finally, logging roads often remain accessible after an area has been harvested, facilitating illegal logging in riparian areas (Vandergert and Newell 2003). Following an example from Japan where artificial nest boxes were used to restore nesting opportunities in logged forest (Brazil 1985), researchers placed fish-owl nest boxes on Kunashir Island after natural senescence of nest trees was found to cause nest tree abandonment (Berzan 2000, Grigorev 2005). In both cases, fish owls readily utilized the artificial nests and successfully fledged young.

The suggestion that fish-owls are intolerant of human encroachment was prevalent in the secondary literature (i.e., Voous 1988, Hume 1991, del Hoyo et al. 1999, Collar 2001); however, this suggestion appears premature (Surmach 1998) for several reasons. First, not all of the reports of intolerant behavior were credible. For example, Collar (2001) cited Vaskovskii (1956) when noting fish-owl displacement in Magadan due to increased human activity; however, the original text indicated that fish-owls were observed in Magadan with some regularity. Further, there were numerous records of fish-owls found close to human settlements and nesting in proximity to villages (Bergman 1935, Gizenko 1955, Pukinskii 1973, Tarkhov and Potapov 1986, Shokhrin 2005, S. Surmach unpubl. data). Second, we documented several successful fish-owl nests located near human foot trails, and of a pair of fish-owls that nested in a forest selectively logged several decades ago. These observations suggest that fish-owls may exhibit some tolerance and adaptability to human activities (Surmach 1998), although more study is needed to evaluate reproductive success and survivorship of individuals living near human settlements.

Reliance on Secondary Literature. Of the 15 primary English-language articles on *Ketupa* owls that we examined, 13 cited one of the secondary sources we reviewed here (exceptions were Hayashi and Nishida-Umehara 2000 and Yamada et al. 2004). The most commonly cited sources were Fogden (1973, 1992; $N = 7$) and Voous (1988; $N = 6$), with other secondary sources cited ≤ 3 times each (Mikkola 1983, Flint et al. 1984, Pererva 1984, Clark and Mikkola 1989, Hume 1991, Collar et al. 1994, del Hoyo et al. 1999, König et al. 1999). Eight of the primary English-language publications on *Ketupa* owls referred to Blakiston's Fish-Owls in Russia, and six of these cited primary Russian sources. Of these, all cited Pukinskii (1973), with three publications doing so exclusively.

DISCUSSION

Our review of the Russian literature suggested that fish-owls are a species well adapted to sedentary life in old-growth deciduous or mixed deciduous-conifer forests which contain large tree cavities, as well as access to water that remains ice-free in winter. Most fish-owl publications in Russia, particularly from the mainland, were based on general surveys or anecdotal records (i.e., Panov 1973, Smirenskii and Smirenskaya 1980, Poyarkov and Budris 1991, Voronov and Pronkevich 1991, Averin and Antonov 2005, Shokhrin 2005, Yelsukov 2005). Our review of the secondary fish-owl literature demonstrated that species information was generally accurate, but also contained inaccuracies that led to an erroneous view of fish-owl ecology. Among other errors, a number of secondary sources misinterpreted original sources and repeated false records.

Encouragingly, 75% of primary publications on *Ketupa* owls that included information on Blakiston's Fish-Owls in Russia cited primary Russian texts, but were strongly reliant on only one source (Pukinskii 1973). Reliance on secondary sources was also evident; 87% of the primary English-language publications on *Ketupa* owls that we examined cited one or more of the secondary publications reviewed. It is noteworthy that one of the more misleading and poorly documented secondary sources (Voous 1988) also was one of the most cited. We suspect that researchers of other little-studied taxa may be similarly dependent on secondary literature for knowledge. We recommend that authors of future editions of secondary publications recognize their importance in disseminating information concerning fish-owls and other little-known species, and take our comments into consideration.

Overall, few studies were conducted with sufficient scientific and statistical rigor to assist conservation or management efforts of fish-owls. Although fish-owls have shown signs of adapting to changing landscapes, the effects of anthropogenic disturbances on fish-owl habitat use and demography have not been examined. We recently initiated a fish-owl habitat use study in Primorye to quantify resource use, and endeavor to correlate these data to adult survivorship and nest success. If successful, this effort will help to alleviate the fish-owl information deficit and lead to development of an effective fish-owl conservation plan.

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