DISCOVERY OF A NEW BREEDING SITE FOR THE ENDANGERED JAPANESE MURRELET *SYNTHLIBORAMPHUS WUMIZUSUME* IN NAGASAKI, JAPAN

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ABSTRACT

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We report a breeding site for the Japanese Murrelet *Synthliboramphus wumizusume* discovered for the first time in March 2023 on Hahakojima (Hakoshima), a small island in Nagasaki City, Nagasaki Prefecture, off Kyushu, Japan. We counted 129 Japanese Murrelets among at-sea congregations during spotlight surveys around Hahakojima. This provided strong evidence that murrelets were breeding on the island. During a brief search of Hahakojima, we discovered 18 nests in rock crevices. Seven of these nests included incubating adults and 11 nests contained unattended eggs. We also found 22 broken eggs in open areas and observed a Large-billed Crow *Corvus macrorhynchos* carrying a murrelet egg in its beak. Future efforts to evaluate and reduce the impacts of crow predation at this breeding site will be required. Our findings should encourage similar survey efforts at potential breeding islands throughout the murrelet's range to better understand the status and distribution of this threatened and vulnerable species.

Key words: Japanese Murrelet, *Synthliboramphus wumizusume*, breeding distribution, Hahakojima, Japan

INTRODUCTION

Five species of *Synthliboramphus* murrelets breed on islands along the rim of the North Pacific Ocean from Baja California, Mexico, to China (Gaston & Jones 1998). While the general distribution of these species is widely recognized, detailed information regarding murrelet breeding colonies and population size can be difficult to obtain due to their nocturnal activity at the colony and concealed nests located within breeding habitats that are often inaccessible. The Japanese Murrelet *S. wumizusume* is one of the rarest and most threatened alcids in the world, with a small worldwide population (< 10 000 breeding birds; Otsuki *et al*. 2017) that is likely decreasing due to human disturbance and non-native predators (Nettleship & Kirwan 2020, IUCN 2023). As a result, the Japanese Murrelet is categorized as Vulnerable on the International Union for Conservation of Nature (IUCN) Red List of Threated Species and has been declared a Japanese Natural Monument by the Agency for Cultural Affairs.

Japanese Murrelet breeding colonies are located on small islands and islets in warm waters off the coasts of southern Japan and Korea (Otsuki *et al*. 2017). However, due to their secretive breeding habits, identifying murrelet breeding islands is often challenging, and there are likely many undiscovered colonies in the region. In March and April 2023, we conducted surveys to determine whether Japanese Murrelets breed on Hahakojima (also called "Hakoshima" by locals), one of the many small islands off the coast of Nagasaki City, Nagasaki Prefecture, Kyushu, Japan, and determine if this island may harbor undiscovered murrelet colonies. Hahakojima is located in the western part of the species' breeding range (Fig. 1). However, Hahakojima is distant from the nearest known murrelet colonies in the East China Sea, which are located at Hanagurijima (~150 km away) in the Danjo Islands, Nagasaki Prefecture, and Okinoshima (~115 km away) in the Koshiki Islands, Kagoshima Prefecture (Otsuki *et al*. 2017).

STUDY AREA AND METHODS

Hahakojima (32°52′07″N, 129°37′51″E) is a small island (~4 ha [0.04 km^2]; maximum elevation 52.4 m) located about 4.5 km off the east coast of mainland Kyushu (Fig. 1). It measures about 250 m (north-south) × 200 m (east-west). The island is composed mostly of sandstone, but the peak is covered with a small amount of andesite lava (Hattori *et al*. 1993). The shoreline is surrounded by cliffs formed by the collapse of sandstone, with rocks that form crevices of various sizes, many of which are suitable murrelet breeding sites (Fig. 2). Sparse vegetation grows above the intertidal zone and on the steep coastal cliffs, including Coastal Hog Fennel *Peucedanum japonicum*, Hosobawadan *Crepidiastrum lanceolatum*, and O'ahu Sedge *Carex wahuensis*. The upper island is covered by a forest of Japanese Bay *Machilus thunbergii* and Japanese Cinnamon *Cinnamomum yabunikkei* trees that grew after the island was logged more than 50 years ago (Nakanishi 2019). Ozumo Rock is a small arched islet composed of well-developed basalt columns that lies 200 m southwest of Hahakojima. Steep barren cliffs surround the islet, but the upper portion is covered with O'ahu Sedge and other woody vegetation.

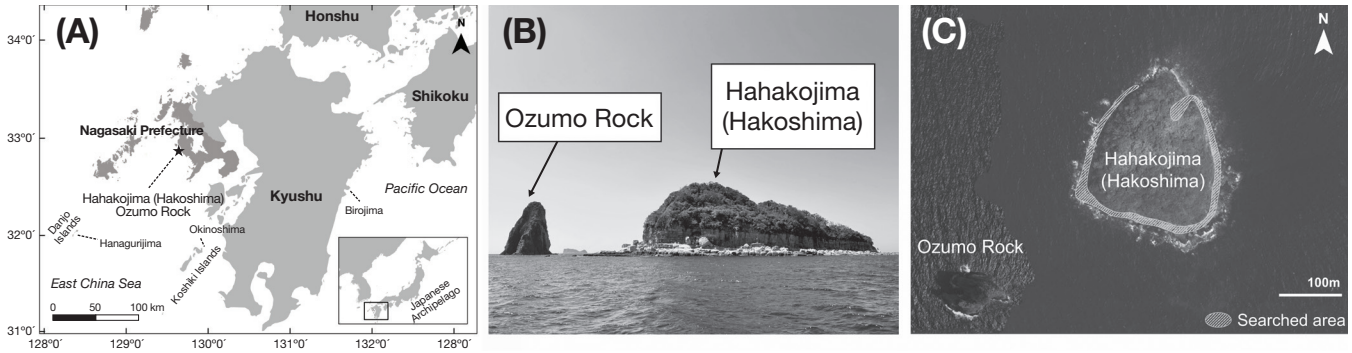

Fig. 1. Location (A), view (B), and aerial photograph (C) of Hahakojima and Ozumo Rock, in the East China Sea off the coast of west Kyushu Island, Japan. Map sources: GSI Maps (https://maps.gsi.go.jp/) (C), Natural Earth (https://www.naturalearthdata.com/) (A), and digital national land information (https://nlftp.mlit.go.jp/ksj/) (A).

Spotlight surveys

We conducted exploratory spotlight surveys to determine whether Japanese Murrelets congregated in nearshore waters around Hahakojima and Ozumo Rock at night, a reliable indicator of breeding, colony size, and population trends at the nearby islands (Whitworth & Carter 2018). Spotlight surveys followed the general methods developed for *Synthliboramphus* murrelet monitoring in California, USA (Whitworth & Carter 2014) with one major exception—we used a larger (~14-m) charter fishing vessel with a higher observer platform (similar to that used at Birojima, Miyazaki Prefecture; Whitworth *et al*. 2019) compared to the smaller (4-m) inflatable boats used in California. The observer counted all murrelets seen (flying and swimming) in the spotlight beam (rechargeable LED 1500 lumens; Good Goods Inc. model YC-15G) as the survey boat slowly (~15 km/h) circumnavigated Hahakojima and Ozumo Rock at roughly 500 m and 700 m from shore (Fig. 3). After each scan, the observer relayed data to the recorder who entered the number of murrelets, time, and location coordinates on a smartphone. Surveys were conducted on 20 March (20h00–21h00)

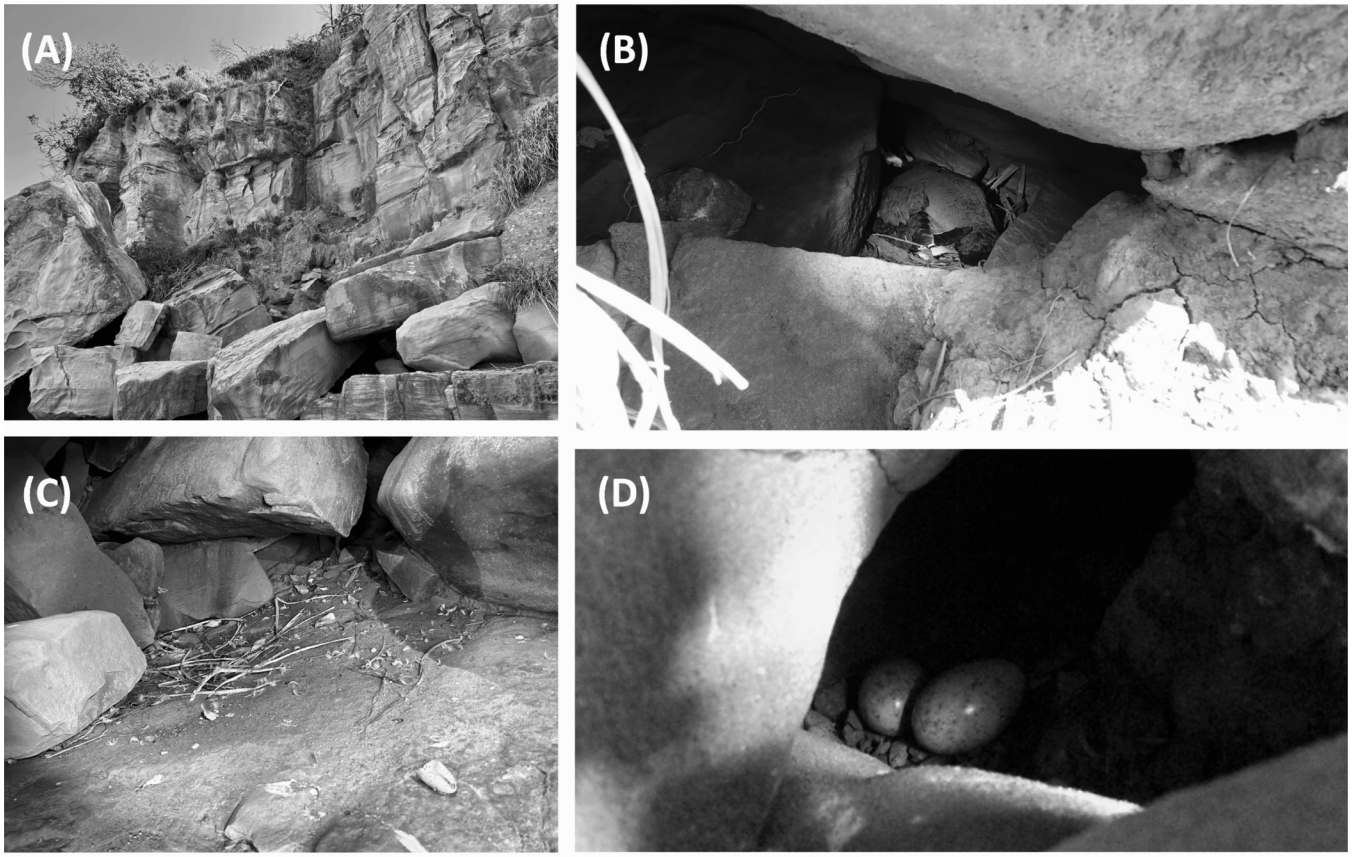

Fig. 2. Breeding environment and observations recorded during the survey of Japanese Murrelet *Synthliboramphus wumizusume* on Hahakojima, Nagasaki Prefecture, Japan. (A) A view of the breeding grounds, contained within sandstone that has collapsed to form rock crevice. (B) A parent Japanese Murrelet incubating its egg. (C) Feathers scattered about in an open place. (D) Two eggs of a Japanese Murrelet seen in a nest where parents are abesent.

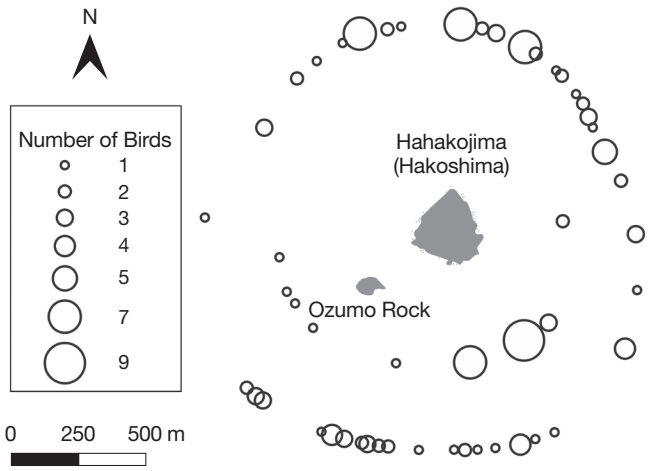

Fig. 3. The number of Japanese Murrelets *Synthliboramphus wumizusume* recorded by spotlight surveys around Hahakojima, Nagasaki Prefecture, Japan.

just before the new moon (21 March) and under good conditions with cloudy skies, little wind, and flat seas.

Nest searches

Based on the results of our spotlight survey, we considered it highly likely that Japanese Murrelets were breeding on Hahakojima. Therefore, we conducted a nest search on 03 April to confirm breeding. Japanese Murrelets typically nest in natural rock crevices, artificial crevices in stone walls, under sedges, and in hollows under tree roots (Takeishi *et al*. 2019, Whitworth *et al*. 2020; NMY pers. obs.). Six persons used hand-held flashlights to search for murrelet nests in rock crevices and sedges on the accessible shoreline and cliffs around the island for approximately for 3 h (Fig. 1). In addition to the murrelet nests (i.e., sites with incubating adults or unattended eggs) found during the 3-h search, we also recorded all depredated murrelet remains, feather piles (sign of avian predation), destroyed eggs, and potential avian predators (see Results). We also searched for evidence of mammalian predators such as feral cats *Felis catus*, rats *Rattus* spp. and mice *Mus* spp.. Nest searches at Hahakojima were conducted with permission from Nagasaki City. We did not search at Ozumo Rock because the islet was too steep for safe landing.

RESULTS

Spotlight surveys

We counted 129 Japanese Murrelets at sea around Hahakojima and Ozumo Rock. Murrelets were distributed more or less continuously around the islands but were most numerous to the east (Fig. 3). Numbers were lower near the island (26 birds at 500 m) compared to farther from the island (103 birds at 700 m).

Nest searches

We found 18 nests (one nest per person-hour) on Hahakojima, including seven nests (39%) with incubating adults and 11 nests (61%) with one to two unattended eggs (Fig. 2). Seventeen nests (94%) were in rock crevices and one nest (6%) was in a *C. wahuensis* bush. All nests with an adult were found along the western and southern shores of the island. We searched among the trees higher up on the cliffs of the northern side of the island but did not find any nests (Fig. 1C). In addition, we found at least 22 exposed (likely depredated) eggshells in open areas that were not considered suitable nest sites. We also found one wing and one vertebral column from adult murrelets and at least seven murrelet feather piles scattered around the island (Figs. 1, 2). We saw several potential murrelet predators, including Large-billed Crows *Corvus macrorhynchos*, Peregrine Falcons *Falco peregrinus*, and Black Kites *Milvus migrans*. We suspect Large-billed Crows were the main egg predator, as one was observed carrying an eggshell in its beak. No crow nests were found, but they likely nest on Hahakojima as we saw one crow carrying twigs. We also spotted what appeared to be an Osprey *Pandion haliaetus* nest, but no ospreys were seen. We did not find any evidence of mammals or reptiles. We could not search Ozumo Rock, but no crevices suitable for breeding by murrelets were visible on its steep cliffs, as viewed from the boat. However, small numbers of murrelets likely nested in the dense vegetation on top of the islet.

DISCUSSION

This study confirmed that Hahakojima is a current breeding ground for the Japanese Murrelet. As of 2017, 41 Japanese Murrelet colonies had been documented in the world, but only 25 of these were known to be active after 2000; breeding was uncertain at the remaining suspected or previously identified colonies (Otsuki *et al*. 2017). The largest known colony, Birojima in Miyazaki Prefecture, was estimated to have about 2000 breeding pairs (Whitworth *et al*. 2019), but most of the other breeding sites are small islands or rocky islets that harbor small numbers of murrelets (i.e., tens to low hundreds of pairs; Otsuki *et al*. 2017). Furthermore, some of these colonies suffer from crow predation (e.g., Whitworth *et al.* 2020, Takeishi 2021, Kongsurakan *et al*. 2023), while populations at some colonies are severely impacted by introduced rats or cats (Takeishi 1987, Choi & Nam 2017). Thus, accurately assessing the status and distribution of Japanese Murrelets throughout their range is vital to conservation efforts for this vulnerable species.

At least 971 islands lie within Nagasaki Prefecture (Nagasaki Prefecture Government, n.d.), and these islands account for 14% of all the islands in Japan (n = 6852). Many of these islands are small and uninhabited, similar to Hahakojima. Therefore, they could harbor small murrelet colonies. However, the only other known Japanese Murrelet breeding site in Nagasaki Prefecture is at Hanagurijima (Danjo Islands; Fig. 1). Local birdwatchers have long known that Japanese Murrelets visit coastal waters in the East China Sea off Nagasaki Prefecture, mainly during the murrelets' pre-breeding and breeding season in December–April. Local boat captains and fishermen have reported the presence of many "little birds" at night around Hahakojima and Ozumo Rock. The anecdotal information from these citizens led to our surveys and the discovery of this new colony. Local boat captains, fishermen, and bird watchers should be consulted to help identify potential murrelet breeding islands in the region where exploratory spotlight surveys and nest searches can be attempted.

Similar to other colonies, we confirmed that crow predation is an issue at Hahakojima. Although it is unclear whether crows or falcons preyed on the murrelet carcasses we found, it is very likely that the broken eggs we found were depredated by crows. First, these broken eggs were clearly not hatched eggshells, which are quite distinct; the dried membrane of a hatched egg usually peels away from the shell leaving the inner membranes bare (Whitworth *et al*. 2020). In fact,

eggshell membranes are considered a reliable indicator of successful breeding. Second, all the broken eggshells were found lying exposed in an open area, a pattern that is consistent with crow predation. Hatched eggshells typically remain in the nest crevice when murrelet families depart the island soon after the chicks hatch. Rodents are potential murrelet egg predators, but we found no evidence of these predators on Hahakojima and, if they were present, they rarely carried depredated eggs far from the nest.

Depredation by crows on adult murrelets and eggs has been documented at several colonies (Takeishi *et al*. 2019, Whitworth *et al*. 2020, Takeishi 2021, Minowa *et al*. 2022, Kongsurakan *et al*. 2023) and is known to seriously affect the breeding success of this species. According to interviews with the ship captain, crows have been present on Hahakojima for some time, and they sometimes steal anglers' lunch boxes and other items. Because Hahakojima is close to mainland Kyushu (~4.5 km), crows can easily fly to the island, and it remains likely that access to urban resources helps to maintain their populations. Most of the murrelet nests observed in this study were located in rock crevices created by collapsed sandstone and were too small and deep for crows to reach. However, we observed some murrelet nests in shallow crevices where crows could easily access eggs, adults, and chicks (see Fig. 2B). Future efforts are needed to evaluate the impacts of crow predation on murrelets and, where possible, to introduce measures to reduce these impacts.

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