Current Breeding Status of Two Sympatric *Synthliboramphus* Murrelet Species on Gugul-do, Republic of Korea

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Abstract

Crested Murrelets *Synthliboramphus wumizusume* were discovered breeding at Gugul-do, Shinan County, Republic of Korea in 1983. This was the first Crested Murrelet colony discovered in Korea and the only island in the world where they are known to breed sympatrically with Ancient Murrelets *S. antiquus*. Despite the ecological importance of Gugul-do, we had little recent information on the current breeding status of these two species. We conducted field surveys in 2011 and confirmed breeding of Crested Murrelets at Gugul-do 28 years after their discovery. In 2012-13, we investigated the breeding density of Crested and Ancient murrelets at different elevations on Gugul-do, and conducted spotlight surveys and captured murrelets in nocturnal at-sea congregations to estimate the size of the two sympatric breeding populations. We also deployed GPS loggers to track murrelet movements and at-sea congregation behaviors. The modified nocturnal spotlight survey method was used to search for other undetected Crested Murrelet breeding colonies in Korea; a new colony was found at Baek-do in 2012.

Key words: Gugul-do, sympatry, Ancient Murrelet, Crested Murrelet, population size

Introduction

Among Alcidae species in the Republic of Korea, Ancient Murrelets *Synthliboramphus antiquus* breed mainly on Gugul-do and Chilbal-do (Park et al. 2012, Won & Kim 2012), and Chilbal-do regarded as the largest breeding colony sites of the Ancient Murrelet in Korea (Park, unpublished data). Small numbers of Ancient Murrelets are also found at uninhabited islands around Geoje-do and Baekryeong-do in the breeding season (Park 2014). Ancient Murrelets are common wintering birds along the coastal areas of Korea, but the size of the wintering population is not known (Won & Kim 2012). The Crested Murrelet *S. wumizusume*, of which it is known that <10,000 individuals exist in the world, breeds only in Japan and Korea, and its non-breeding region ranges from the Primorsky, Korean Peninsula, Japan, and parts of the NW Pacific (BirdLife International 2001, Yamaguchi et al 2016). The Crested Murrelet is listed as 'Vulnerable' by the IUCN and also designated as a 'Natural Monument' as well as the Korean 'Red List class II'. Its breeding population in Korea was first recorded in 1983 on Gugul-do (Lee, unpublished data), and other breeding sites at Dok-do (Kwon & Yoo 2005), Baek-do (Park et al. 2013), and Mara-do (unpublished) have been recently discovered. However, detailed information on the breeding population size in Korea is still lacking. Gugul-do in Shinan County is the only place in the world where the two species co-occur in the breeding season (Park et al. 2012, Park et al. 2017), but their breeding status has not been clearly known in spite of the biogeographical and ecological importance. Therefore, in 2011 we started a monitoring program for the two breeding populations to estimate their population sizes and to understand their breeding ecology.

Study Area

Gugul-do is an uninhabited islet located 2.5 km north of Gageo-do, which is the southwestern most inhabited island of the Korean territory. Gugul-do and the surrounding uninhabited islands like Sogugul-do and Gaerin-do are known breeding sites of four seabird species: Ancient Murrelets, Crested Murrelets, Swinhoe's Storm-Petrels *Oceanodroma monorhis*, and Streaked Shearwaters *Calonectris leucomelas* (Park and Won 1993, Lee et al. 2010). The size and the altitude above sea level of Gugul-do is 13.5 ha and 122m, respectively. Most of the slopes on this island are steep, and herbaceous plant *Carex bootiana* dominates the vegetation on the island while there is a shrub zone around the top. Most of the seabirds of this island breed in the *Carex bootiana* area.

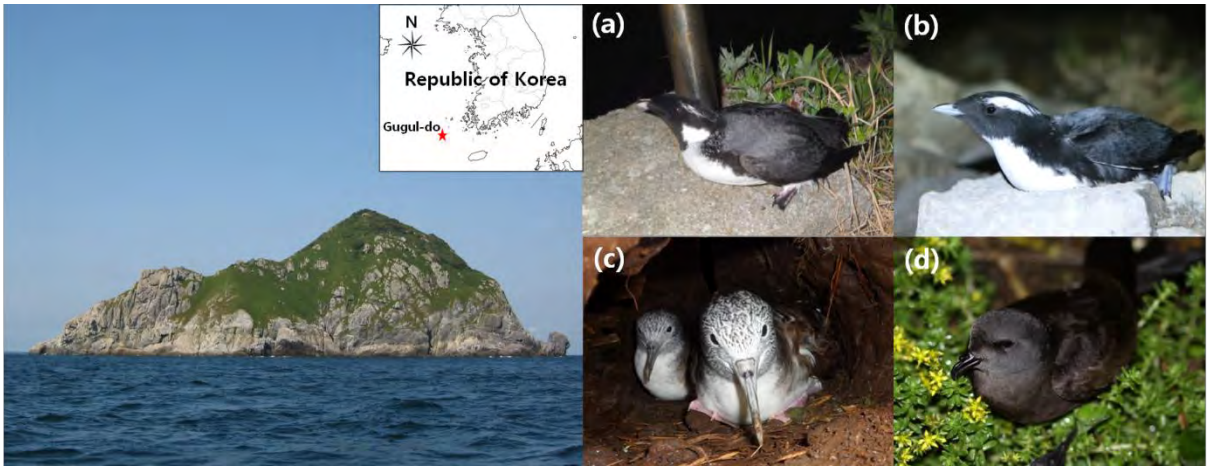

Figure 1. Four seabird species breeding on Gugul-do: (a) Ancient Murrelet, (b) Crested Murrelet, (c) Streaked Shearwater, (d) Swinhoe's Storm-Petrel

Result and Discussion

On 2 May 2011, we randomly searched active nests at the southern slope of Gugul-do and found two active nests with incubating adults. We also found two chicks that were fledging toward sea with their parents. We set up mist-nets near the nesting ground from 20:00 to 01:00 and captured 12 Crested Murrelets and 6 Ancient Murrelets. We attached metal rings to the murrelets for individual identification and measured their body sizes.

This trip re-confirmed that the Crested Murrelet does still breed on Gugul-do 28 years after the first breeding record. In addition, given the high number of captured murrelets during the short time of mist-netting and bird banding, the breeding population was much bigger than previously expected. These results were a good starting point for our subsequent survey trips.

In 2012-13, we regularly visited Gugul-do to estimate the breeding population sizes of the two species and to track the foraging range of the Crested Murrelets during the breeding season. We measured the breeding densities by altitudes in the sampling sites and deployed GPS loggers to monitor at-sea aggregating behavior at night. Because there was no facility for staying overnight on the island, we stayed for a maximum of 3 days on each trip. On rainy days, we inevitably took shelter in a small cave which was rocky and very damp.

Figure 2. (a): Eggs of Crested Murrelets on Gugul-do re-confirmed 28 years after the first breeding record, (b): egg measurement, (c): banding and size measurement for adults, and (d): an adult Crested Murrelet observed at night on the island

Figure 3. (a): We stayed on flat rocks most days, (b)~(c): A small cave protected us from rain

We used square plots (25 ㎡) randomly selected in various altitudes to estimate breeding density, and we counted the number of nests in each plot. We put our arm into deep nesting burrows and searched for incubating adults, eggs, or chicks, but did not capture adults in the nesting burrows so as not to disturb them. We were always nervous when we checked the deep nesting burrows because two venomous vipers (*Gloydius saxatilis* and *G. ussuriensis*) were seen in and around the burrows on the island. We luckily encountered no vipers but were often startled when we felt movements or touched murrelets in the burrows. The maximum number of nests found in one plot was 14, and the nesting density was higher in lower altitude probably because their chicks can easily fledge into the sea.

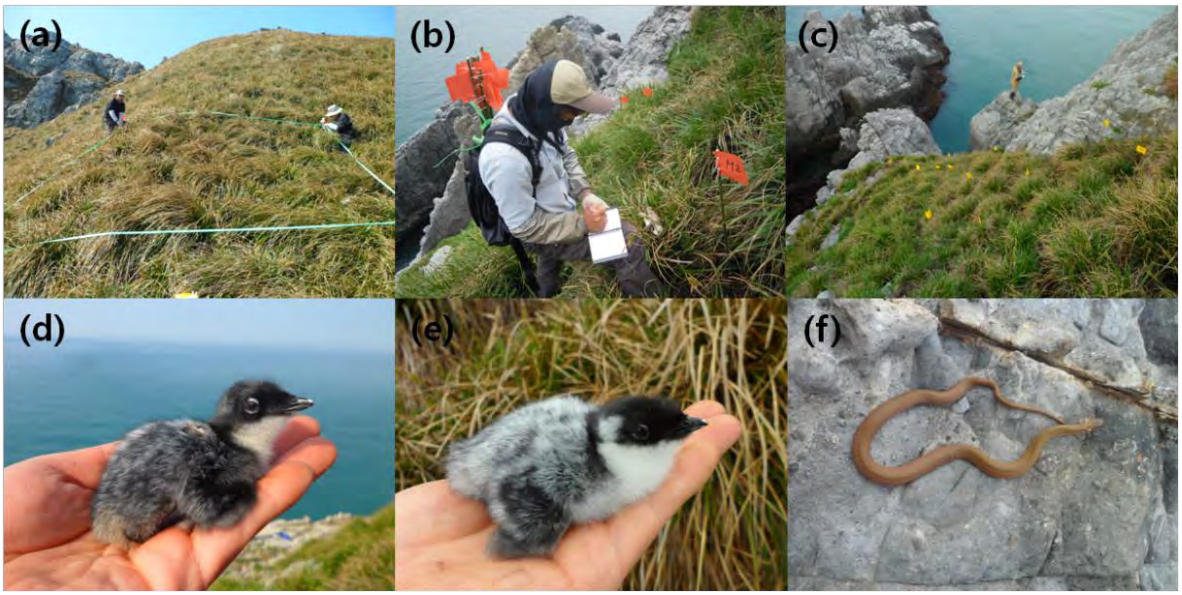

Figure 4. (a): Establishing a survey plot for the breeding density estimation, (b): flagging active nests, (c): surveying on a very steep slope, (d): a chick of the Crested Murrelet, (e): a chick of the Ancient Murrelet, (f): a venomous viper found on Gugul-do.

Nocturnal at-sea monitoring is a very useful method to assess the distribution of nests, estimate population size, and detect the population change or trend in the *Synthliboramphus* birds (Carter et al. 1996, Whitworth et al. 2012, Cater et al. 2013, Whitworth et al. 2014, Whitworth & Carter 2014). A joint survey with JMPST (Japanese Murrelet Population Survey Team) was conducted in March 2012 when Harry Carter, Darrell Whitworth, and Masayoshi Takeishi visited Gugul-do. For the quantitative comparisons between the populations of Korea and Japan, we adopted the method used by Carter and Whitworth from this joint survey.

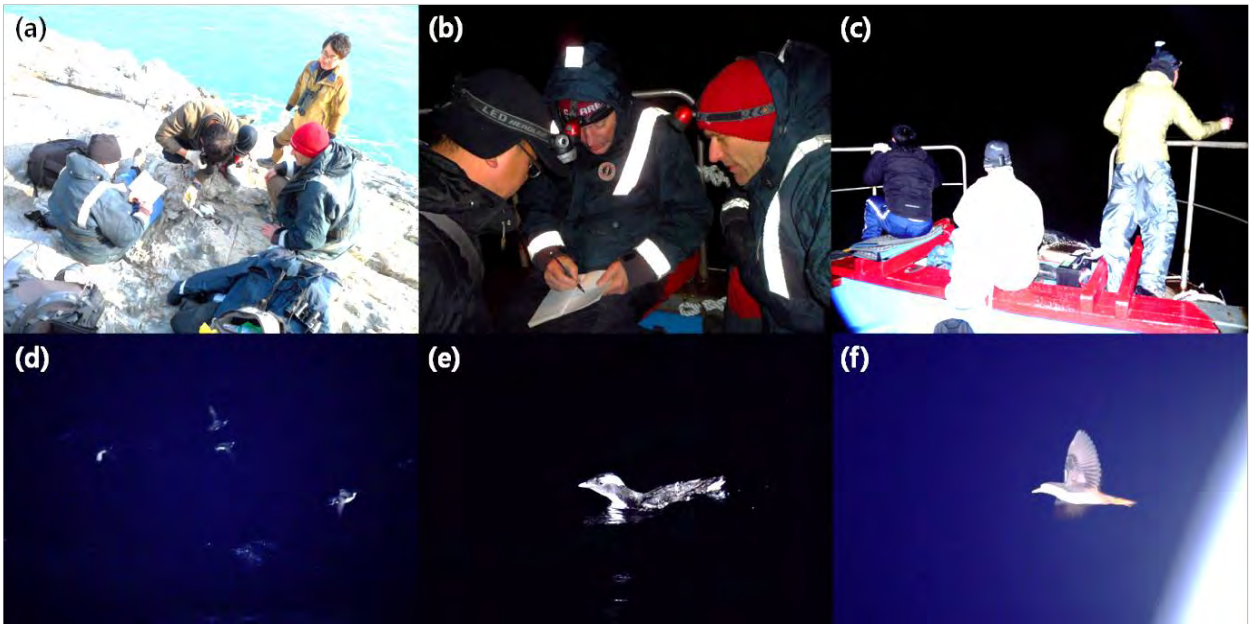

Figure 5. (a): Members of JMPST examining dead murrelets, (b): On board discussion about survey routes, (c): Nocturnal spotlight survey, (d): Hardly identifiable murrelet species at night, (e): A Crested Murrelet on the sea, (f): A rare White-breasted Waterhen (*Amaurornis phoenicurus*) observed during the survey

In 2013, we deployed GPS loggers to adults in order to understand their foraging range during a breeding season and their at-sea aggregation behavior. We used water-proof tape and glue to attach a GPS logger on the lower back feathers of each murrelet by referring to the previous tracking studies on diving birds such as penguins (Wilson et al. 1997, Phillips et al. 2003, Vandenabeele et al. 2011). For quick and safe logger deployment at night in the field, we previously exercised deploying procedures using beached Ancient Murrelet bodies. We set up mist-nets away from the nesting ground so that we did not disturb incubating individuals, and deployed five loggers to captured adults returning from their foraging trips at night. GPS data collected from the logger-deployed murrelets were automatically downloaded to a base station located on the island, upon the murrelets approach. . However, unfortunately, Crested Murrelets quickly removed the deployed loggers from their lower back, suggesting the other harnessing techniques would be useful for this species. Consequently, we could track two birds that moved westward 23km and 51km away from the breeding colony for foraging. They returned to Gugul-do after their foraging trips, but did not land at the breeding colony, demonstrating the unique at-sea aggregation behavior of murrelets. They waited for 3.5 and 6 hours, respectively, at sea before returning to their nests, and stayed only at specific sides of the island close to their nesting areas. This long-lasting and directional at-sea aggregation behavior linked with their nesting sites, rather than a random or rotational distribution around the whole island, is new information from our telemetry survey, and it also suggests that nocturnal spotlight surveys may provide a useful clue to estimate the population size, locate nesting areas, and identify a new colony. The foraging site and range found from the telemetry also provide information on key maritime areas for future protection and management in the context of the conservation of breeding Crested Murrelets on Gugul-do.

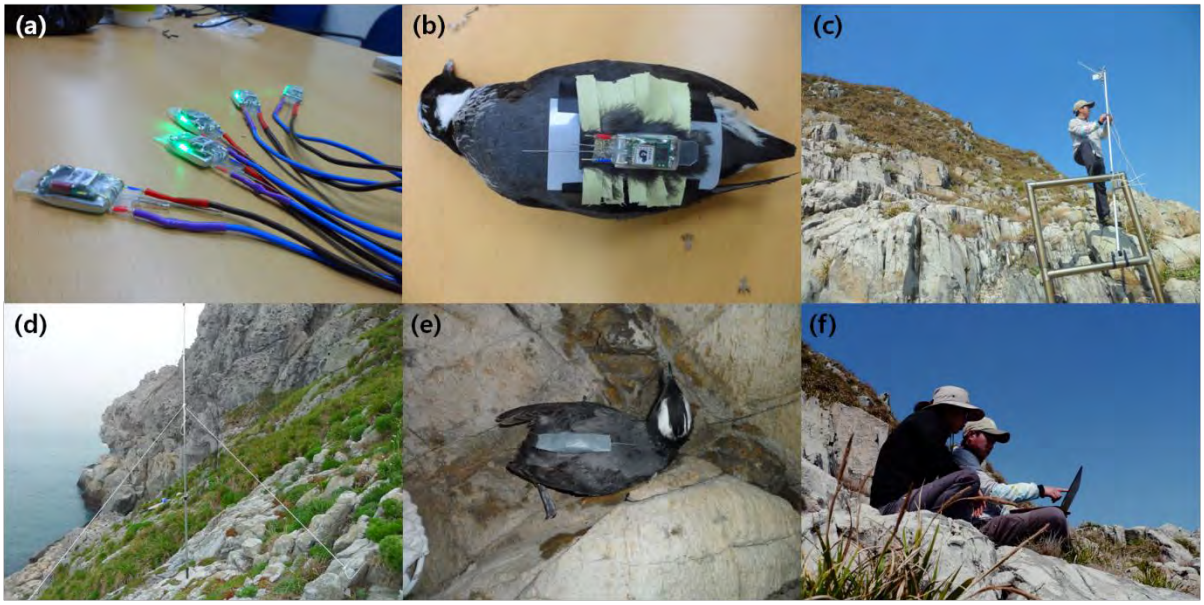

Figure 6. (a): a testing GPS logger in the lab, (b): taping and gluing logger on a frozen Ancient Murrelet. (c): establishing a base station, (d): mist nest for murrelet capture, (e): a Crested Murrelet with GPS logger on its lower back. (f): Downloading collected data from the base station.

According to all the results from our plot surveys, nocturnal spotlight surveys, night capture, and telemetry studies in 2012 and 2013, we estimated that the breeding pairs of Crested and Ancient Murrelets were about 430 and 480, respectively, on Gugul-do, respectively (Park, unpublished data). As the first reliable population size estimate, our data imply that Gugul-do is one of key breeding sites of the Crested Murrelet, hosting about 8.5% of its global population. We are trying to continue and expand our studies to provide new information and locate new colonies using the methods adopted for the Gugul-do colony for the conservation of Crested Murrelets in Korea.

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摘要

カンムリウミスズメの繁殖は，1983 年に，韓国の Shinan 郡にあるググル島で発見された．これは，韓国で発見された最初のカンムリウミスズメのコロニーであり，世界で唯一，ウミスズメと同所的に繁殖することが知られている島である．ググル島の生態学的重要性にもかかわらず，これら 2 つの種の繁殖現状に関する最新の情報は殆ど存在しなかった．私たちは，2011 年に現地調査を行い，最初の発見から 28 年後に初めて，ググル島でのカンムリウミスズメの繁殖を確認した．2012-13 年には，ググル島の標高の異なる山頂部におけるカンムリウミスズメとウミスズメの繁殖密度の調査を行った．また，両種の繁殖個体数の推定のため，夜間スポットライトサーベイと洋上でのウミスズメ類の捕獲を実施した．また，私たちは，ウミスズメ類の動きや洋上での群れ行動を追跡するために GPS ロガーを導入した．修正が加えられたスポットライトサーベイ手法が，韓国ではこれまでに記録の無い新しいカンムリウミスズメ繁殖コロニーの探索に使用された． 新しいコロニーが 2012 年に確認された．