



Threats to Murrelets in The Republic of Korea: Bycatch, Oil Pollution, and Invasive Predators

Chang-Yong Choi^{1,2*} and Hyun-Young Nam¹

¹ Migratory Birds Center, National Park Research Institute, Korea National Park Service Sinan-gun, Jeollanam Province, Republic of Korea ²Department of Forest Sciences, Seoul National University: Seoul, Republic of Korea

*Email subbuteo@hanmail.net

Abstract

Two *Synthliboramphus* murrelet species are known to breed and winter off the coast of the Republic of Korea. Crested Murrelets (*Synthliboramphus wumizusume*) are protected as a natural monument and class II endangered species, while Ancient Murrelets (*S. antiquus*) are more common and classified as a species of least concern. The distribution of murrelet breeding colonies in Korea is not fully known and many small colonies have probably not yet been discovered. Threats to murrelet breeding populations have also been poorly documented, but invasive mammalian predators are a known problem at some breeding islands. Recent information suggests that at least one of four known Crested Murrelet breeding colonies may be suffering predation by Domestic Cats (*Felis domesticus*) and Brown Rats (*Rattus norvegicus*), and two other colonies have probably been invaded by rats. Egg collecting was probably common in accessible murrelet breeding areas on Gugul-do, but collecting stopped in the early 1980's after the colony was formally discovered and protected. Gillnet fishery bycatch and oil pollution have been identified as the two major threats to murrelets wintering in Korean waters. Mortality records indicated Ancient Murrelets were the most common victims of coastal bycatch, comprising 85% of the total mortality count; more than 5,000 birds may be killed annually by gillnets in Gangwon Province alone. Small numbers of the near-threatened Long-billed Murrelet (*Brachyramphus perdix*) were also reported as bycatch. Chronic and incidental oil pollution also appears to be a constant threat to overwintering murrelets. Ancient Murrelets comprised more than half of all birds stranded or killed by oil spills off the coast of Hong-do. In addition to direct mortality from oil pollution, oiled murrelets may also face sub-lethal impacts such as increased predation. Because the geographic origins of murrelets wintering in Korean waters are still unknown, it is unclear which breeding populations are affected by bycatch and oil pollution. Long-term studies are needed to better determine the distribution and status of murrelet colonies, migratory connectivity, and potential impacts of threats to murrelet populations in Korea. Conservation actions such as invasive predator control are also needed to protect vulnerable murrelet populations at key colonies.

Key words: bycatch, invasive species, murrelet, oil contamination, threat

Introduction

Seabirds are part of the marine ecosystem and indicators of the general health of oceans (Schreiber & Burger 2001, Piatt et al. 2007, Humphries & Huettmann 2012), but many seabird populations have been decreasing due to diverse threats (Croxal et al. 2012, Humphries & Huettmann 2012). According to a recent global review and threat assessment, the most significant threats to seabirds are introduced invasive species, bycatch by commercial fishing, pollution and climate change (Croxal et al. 2012). This chapter briefly introduces the status of murrelets (family Alcidae) in the Republic of Korea (South Korea; hereafter Korea), especially emphasizing three major threats that have been commonly known to seabirds. Because the Crested Murrelet, which also occurs outside Korea (for instance, in Japan), may have similar conservation issues, information from Korea can provide a glimpse of key threats to the threatened murrelet occurring in throughout NE Asia.



Status of murrelets in the Republic of Korea

In Korea, a total of eight species have been recorded in the Alcidae family (Lee et al. 2015), while 14 species are recorded in Japan. Out of the eight alcids in South Korea, three are true murrelets belonging to two different groups. Ancient (*S. antiquus*; Figure 1) and Crested Murrelets (Figure 2) are *Synthliboramphus* murrelets, and this scientific name means a murrelet with a compact bill [Sunthlibo (Gr: to compress) + rhamphos (Gr: bill)] in ancient Greek. On the other hand, the Long-billed Murrelet (*Brachyramphus perdix*; Figure 3) belongs to the genus *Brachyramphus* [Brachy (Gr: small) + rhamphos (Gr: bill)] that means a short- or small-billed murrelet unlike its English name.

Because Long-billed Murrelets are rare winter visitors, only two *Synthliboramphus* species form five breeding colonies in South Korea (Figure 4); Crested Murrelets breed on four islands, while Ancient Murrelets breed on two islands. Interestingly, Guguldo or Gugul Island (N 34° 07', E 125° 05') is the only colony where both species breed together in the world. However, their breeding status are not fully known, and there may be more undiscovered breeding colonies.

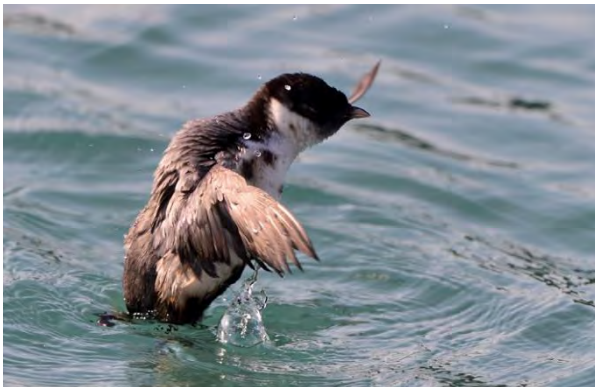


Fig. 1. An oiled Ancient Murrelet (*Synthliboramphus antiquus*) wintering in Jeju Island, Korea. Photo by Hee-Man Kang.



Fig. 2. An adult Crested Murrelet (*Synthliboramphus wumizusume*) on a breeding colony.



Fig. 3. A wintering Long-billed Murrelet (*Brachyramphus perdix*).

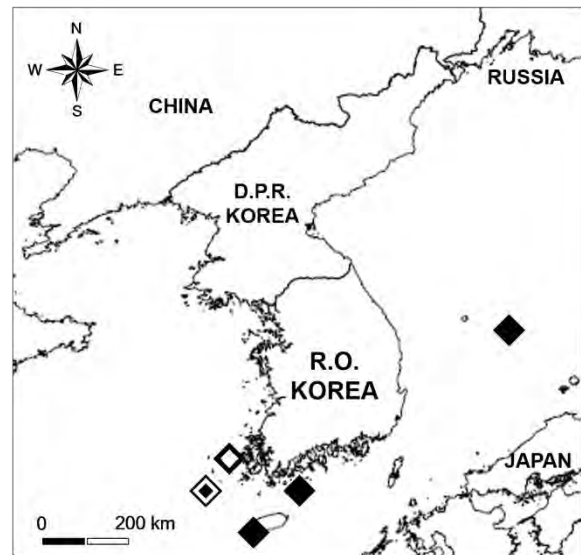


Fig. 4. Breeding colonies of Ancient (◇) and Crested Murrelets (◆) reported in the Republic of Korea. Gugul Island (◆) is the only breeding site known to host both species.

Introduced predators

Marado (N 33° 06', E 126° 16') or Mara Island is a small satellite island of Jeju. Its north-eastern cliff may support hundreds of breeding Crested Murrelets, but its population size is unknown yet. The island is home to



about 100 people and annually hosts one million tourists as the southernmost located island in Korea. Mara Island is the only breeding colony of Crested Murrelets occurring in a human-inhabited island in Korea; the island has been recently inhabited since 1883. Local researchers have found many carcasses of the murrelets in Mara Island and suspected that the murrelets were depredated by one resident pair of Peregrine Falcons (*Falco peregrinus*). Recently, one freshly killed murrelet was found inside a crevice of the volcanic cliff (Figure 5) and more carcasses were hidden in bushes. Because these sites were inaccessible by Peregrine Falcons, murrelets were killed by mammalian predators that are able to approach their nests on the cliff, crevices, and bushes. Given the sign of predation, cats are the most probable predators, but Brown Rats (*Rattus norvegicus*) may also damage nests or nesting adults.

Along with human residents, there are a lot of rats and about 20 cats in Mara Island. Rats are the most common invasive animal threatening wildlife on islands, and cats, that are often lovely pets to humans, are excellent hunters that can easily catch many species of birds. Both cats and rats are notorious invasive predators of seabirds, which have been evolved in the absence of mammalian predators. For the last 130 years of human inhabitation on Mara Island, these two alien species have threatened the breeding population of Crested Murrelets. More than 50 dead adult Crested Murrelets, probably killed by cats or rats during each breeding period, have been found, but the effect of this predation on the breeding population as a whole on Mara Island is unknown.

Unfortunately, three of four known breeding colonies of Crested Murrelets have been confirmed to be invaded by rats in Korea, yet no mitigation measures have been taken. Mara Island, invaded by both of cats and rats, would be a key area for experimental studies to understand the effects of invasive animals and to control for harmful effects on the threatened murrelet.



Fig. 5. A remaining carcass of Crested Murrelet found inside of the northern cliff at Mara Island, suggesting predation by a mammalian predator.



Fig. 6. A beached Ancient Murrelet killed by gillnet bycatch during winter.

Bycatch

Bycatch by commercial fisheries presents a big challenge for the conservation of seabirds (Croxa et al. 2012). At least 400,000 seabirds are killed annually by gillnets (Žydelis et al. 2013), including in Korea and Japan. Murrelets and fishermen want the same resources, the fish. However, murrelets are annoying non-target species for fishermen, because fisherman spend more time and money removing dead birds from their nets or abandoning their nets in cases of extreme entanglement. At the same time, murrelets are killed in the gillnet fishery, and therefore, bycatch is a very sensitive issue for local fishermen because they may be blamed for taking the lives of non-target species. Accordingly, there is no reliable estimation about which and how many seabirds are killed by coastal gillnet bycatch in Korean waters. Given the lack of information, the Korean Wild Birds Society has conducted preliminary surveys for three winters and visited 11 harbors with high commercial fishing activities. Without authority as volunteers, survey team members were not able to conduct on-board bycatch surveys so they used indirect methods by searching for dead murrelets that were discarded in trash cans and dumping sites at each harbor. According to the preliminary survey, more than 2,000 dead birds entangled and killed by the coastal gillnet



fishery were counted over the three years. Murrelets in addition to loons (*Gavia* spp.) were the most common victims of the bycatch, and in particular, Ancient Murrelets accounted for more than 85% of the total bycatch (Figure 6). Though there were no confirmed records of Crested Murrelets killed by gillnet bycatch, near threatened Long-billed Murrelets were detected. It is unknown how many murrelets are killed annually, but simple extrapolation suggests that more than 5,000-15,000 murrelets are killed every winter. About 1,000 dead Ancient Murrelets were found in the coast of Donghae city on 24-25 December 2004, and this single event is an example of mass mortality by gillnet bycatch and also supports the rough estimation. Currently, the global population of Ancient Murrelets is estimated to number c.1,000,000 -2,000,000 individuals and Korea population may include c.100-10,000 breeding pairs and c.1,000-10,000 wintering individuals (BirdLife International 2016). The amount of gillnet mortality estimated on the northeast coast of Korea alone may include 0.25-1.50% of global population of Ancient Murrelets and give significant negative effects on the involved populations of Ancient Murrelets. However, we do not know the migration connectivity of murrelet populations in NE Korea, have no information about where the bycatch murrelets came from, and which breeding populations are affected.

Marine pollution by oil spill

Oil contamination, even a tiny oil stain smaller than the size of a coin, damages key functions of seabird feathers such as waterproofing and insulation (McConnell et al. 2015). Oiled birds also preen excessively to remove the oil from their feathers, and they accidentally ingest the toxic sludge and are poisoned to death (Figure 7). Therefore, oil contamination is a fatal threat to seabirds as well as all marine wildlife.

In December 2007, about 10,900 tons or 12,500 kl of crude oil from the tanker Hebei Spirit contaminated the west coast of Korea, and this was the worst oil spill accident in Korea (MLTM 2008). This oil spill may be compared to the Diamond Grace oil spill at Tokyo Bay in 1997. Oil, sludge, and tar lumps gradually floated southward and arrived at Hongdo (Hong Island; N 34° 40', E 125° 11') in Jeonnam Province, about 26 days after the Hebei Spirit accident. Without major oil spill accidents, only 4 or 5 oiled birds have been found on Hong Island in the winter months, and they were killed by local and small-scale chronic oil contamination. However, more than 110 beached seabirds were collected just after the Hebei Spirit oil spill over three months, and therefore, the Hebei Spirit accident caused eight times higher seabird mortality by oil contamination than chronic oiling. In general, over three years, we recorded 341 oiled birds on the beaches of Hong Island, and 51% of them were murrelets (Figure 8). The data indicate that murrelets are an especially vulnerable group to major oil spills as well as chronic oil pollution in coastal areas.

According to a study on the winter diets of Peregrine Falcons on Hong Island, 16 out of 25 winter prey were Ancient Murrelets, and more importantly, 15 of 16 depredated murrelets were oil contaminated (Choi et al. 2010; Figure 9). In addition to direct and indirect effects of oil contamination, this report suggests that oil contamination increases murrelet mortality by predation because their flight and diving ability is impaired by oil contamination.



Fig. 7. The inside of a gizzard of an oiled Pacific Loon (*Gavia arctica*) covered by black oil sludge.

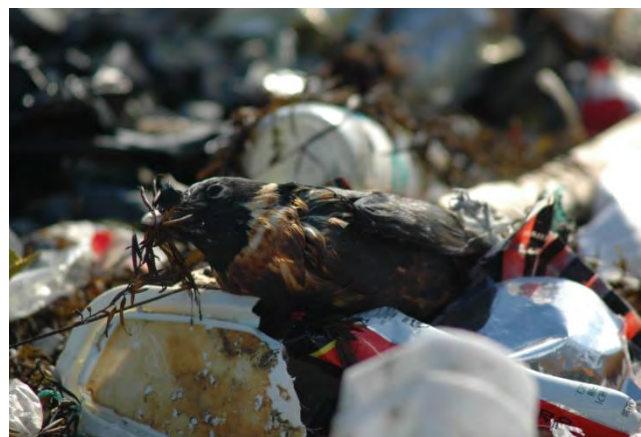


Fig. 8. A beached Ancient Murrelet killed by an oil spill accident.

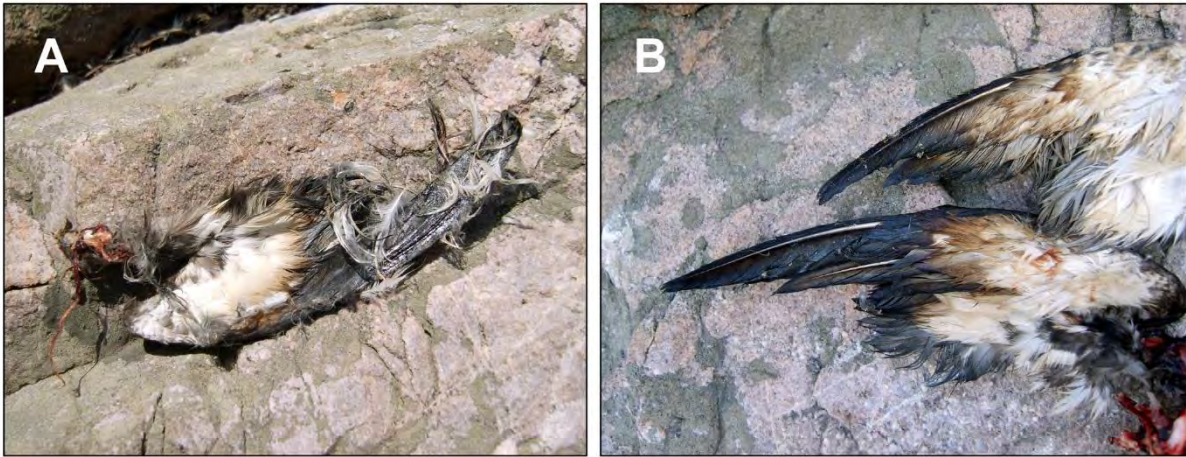


Fig. 9. Signs of oil contamination on the wings of Ancient Murrelets (*Synthliboramphus antiquus*) depredated by Peregrine Falcons (*Falco peregrinus*).

Conclusions

This chapter briefly discusses the breeding colonies of Crested Murrelets in Korea, which are threatened by alien mammals, especially by cats and rats, and that wintering Ancient Murrelets are the most common victims of gillnet bycatch and oil contamination in coastal areas. Given the similar and common ecological features in the Alcidae family, Crested and Ancient Murrelets in NE Asia, including Japan, may experience similar threats as discussed here. However, we do not yet know how these threats affect populations of Crested and other murrelets species in this region, because the geographic origin, migration connectivity, and population linkage of the dying murrelets are unknown. Unfortunately, we are not fully aware of their breeding status and the effects of invasive predators on demographic changes. We need more studies to understand the current status of these murrelets and should implement conservation actions for the long-term survival of these indicator species in coastal and insular environments. Collaboration of researchers, local fishermen, local communities, and governmental agencies are required in order to seek potential solutions to predation by cats, to minimize bycatch through modification of fishing tools and methods, and to reduce chronic oil contamination from fishing and boating activities. Most of all, communication, education, and public awareness (CEPA) activities with students, citizens, fishermen, scientists, and other stakeholders are essential to support any on-going and future conservation activities for murrelets.

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摘要

韓国では *Synthliboramphus* 属の2種のウミスズメ類が、韓国沖合の島で繁殖、越冬することが知られている。カンムリウミスズメ (*S. wumizusume*) が天然記念物および、絶滅危惧II類に指定されて保護される反面、ウミスズメ (*S. antiquus*) は相対的に個体数が多く、軽度懸念 (Least concern) にランクされている。韓国では、これら2種のウミスズメ類の繁殖コロニーの分布については、まだ完全に明らかになっていない。恐らく多くの小さなコロニーが、いまだ発見されていないものと推測される。ウミスズメ類の繁殖個体群を脅かす脅威に対する理解にも乏しいが、いくつかの繁殖地では外来の哺乳類捕食者が問題を起すことが知られている。最近の調査によれば、確認された4つのカンムリウミスズメのコロニーのうち、少なくとも1つで、おそらくネコ (*Felis domesticus*) とドブネズミ (*Rattus norvegicus*) による捕食の被害にあっていること、さらに、2つのコロニーでは、ネズミ類の侵入を受けたことが分かった。卵の収集は過去には1つのウミスズメ類の繁殖地でよくあったものと思われるが、コロニーが公式に報告され、保護地域に指定された1980年代以降は行われていない。刺し網漁業時の混獲と油汚染は、韓国の海域で越冬するウミスズメ類にとって、深刻な問題であることが明らかになってきた。ウミスズメは、沿岸地域での混獲時に最も多く犠牲になる種で、海鳥全体の死亡数の85%を占め、江原道(カンウォンド)だけでも年間5,000羽以上が刺し網にかかって死んでいる。準絶滅危惧種に指定されているマダラウミスズメ (*Brachyramphus perdix*) も少数が混獲されていることが報告された。慢性的な油の流出や偶発的な大規模の油流出事故も越冬するウミスズメ類にとって、常に脅威となっていることがわかってきた。ウミスズメは、韓国の南西端にある、油汚染によって死んだり海岸に打ちあげられたりする鳥たちの半分の以上を占めている。油汚染による直接的な死亡以外にも、油に汚染されたウミスズメ類は、被食を受ける確率が上がるというような間接的な影響もある。韓国の海域で越冬するウミスズメ類は、どこの繁殖地に由来するものなのか、まだ明らかではないため、どの繁殖地由来の個体群が混獲と油汚染により影響を受けているのかは、まだ解っていない。ウミスズメ類のコロニーの分布と状態、渡り鳥の接続性、韓国のウミスズメ類の個体群への潜在的な影響をより正確に判断するためには、長期的な研究が必要である。また、主要繁殖地においてウミスズメ類の個体数を維持するため、外来捕食者の駆除のような保全活動も必要である。

キーワード：混獲，外来種，ウミスズメ，油汚染，脅威