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The CALIFORNIA-SIBERIA Connection

CONSERVING BERINGIA'S AVIAN LEGACY

JOHN TAKEKAWA

As trade and other exchanges increase among nations on the Pacific Rim, scientists in North America, Japan, and Russia are cooperating on conservation projects that use space age technology to increase understanding of the region's shared wildlife resources.

JOHN Y. TAKEKAWA AND HARRY R. CARTER

THE COUNTRIES along the North Pacific Rim face each other across the world's largest and deepest ocean. Vast distances separate them—17,000 km (10,500 mi.) from southeast Asia to southwestern North America—yet they are connected by ancient environmental ties. These include geology, ocean currents, and the pathways of migrating sea animals and birds.

An area of volcanic activity, known as the Ring of Fire, extends around the rim of the northern Pacific, along ridges formed between tectonic plates that continue to move, increasing the distance between Asia and North America. Ocean currents flow west to east, influencing the climate of the entire Pacific Rim and creating high biological productivity along the continental shelves. Polar bears and walruses sometimes cross from one continent to another on pack ice. The migration routes of whales, sea turtles, and birds weave invisible patterns across the ocean and sky, continuing an intercontinental exchange.

In the recent geological past, some 10,000 years ago, Asia and North America were connected in an area known as Beringia, stretching across western Alaska and eastern Siberia. During glacial periods a land bridge formed as ice masses increased, ocean water warmed, and the sea level dropped as much as 100 meters (325 feet) in the Bering Strait. This Bering land bridge extended for as much as 1,600 km (1,000 mi.) from north to south. Since the end of the most recent ice age the strait has been inundated, and only the string of islands known as the Aleutians partially bridge the gap between continents.

The disappearance of the Beringia land bridge confined land animals to one of the two continents. But some avian species, undeterred by water, have maintained the ecological connection between Asia and North America across Beringia. Of 89 species of tundra avifauna found in Alaska, 71 also occur in Asia. Six species classified as North American residents also breed in Russia, and four species considered Siberian residents also breed in North America. Many of these bird species once inhabited the Bering-Chukotka platform, which remained unglaciated at times when the rest of Beringia was covered with ice, and served as a northern refuge for animals. They dispersed from this refuge along the Pacific Rim, and either retained migratory ties or evolved into distinct species and subspecies, responding in different ways to climatic conditions.

At the present time, as human links between the Pacific Rim countries are multiplying owing to expanded trade and other contacts,

On facing page: Greater white-fronted and bean geese feeding on a rice field in Japan.

The Legendary Snow Goose

IN MAY, AS THE SNOW BEGINS to melt on Wrangel Island, 60,000 lesser snow geese arrive, completing their migration from North America and across Beringia to traditional breeding grounds here in the Arctic tundra.

They have stopped several times to feed on emerging vegetation following snowmelt. About 30,000 have wintered in California's Central Valley, the largest waterfowl wintering area on the North American west coast. They have flown more than 5,000 km (3,000 mi.), continuing an ancient cycle of breeding in the Arctic while wintering in warmer southern climates.

An urgent search for nesting sites immediately begins. Snow geese nest in dense colonies, and they often return to the same area year after year. The males may engage in territorial battles: only if they secure a nest will they mate successfully. All eggs are laid in early June within a period of a few days. Snowy owls and Arctic foxes begin to circle, waiting for an opportunity to raid the nests.

Within six weeks the goslings hatch and are ready to accompany the adults on an arduous overland journey, on foot, across streams and blooming meadows, in search of food. By now, there is little left to eat around the abandoned nesting colony. Sometimes the geese walk as far as 100 km (60 mi.) to find food, staying close together, with foxes and owls ever in pursuit. They must eat now to fatten up before the cold returns in August or early September and the autumn migration begins.

The lesser snow goose, with a total population estimated at 2.2 million adults, is one of two snow goose subspecies. The greater snow goose, *Anser c. atlanticus*, breeds on islands in north Baffin Bay and in Greenland, and winters on the Gulf of Mexico, in Louisiana and Texas. Almost all lesser snow geese, *Anser c. caerulescens*, nest in Arctic North America, with the exception of the single large colony that remains in Siberia on Wrangel Island. In earlier times, when these geese were abundant in Siberia, the month of their arrival was celebrated as the month of the snow geese. When they left, according to legend, they became beautiful maidens in faraway lands.

R. H. KERBES

The adult snow goose has pure white plumage, except for black primaries that are fully visible only in flight. The bill and legs are pink. In juveniles the upper feathers are pale grayish brown during fall migration. The adult male's wing span is 34–41 cm (15–18 in.), and the mean weight is just under 2.5 kg (6 lbs.). The female is identical, but somewhat smaller and lighter. This lesser snow goose family is feeding on spring wildflowers on Wrangel Island.

biologists from Asia and North America are increasingly working together to study and protect the avian legacy of Beringia. Discussing management problems and contributing toward their solutions, scientists from Russia, Japan, the United States, and Canada hope to accomplish more cooperatively than is possible by working separately. Here we describe some examples of this new cooperation in our research with lesser snow geese and seabirds, research that may help to protect and restore these species even as human demand for their habitat grows.

The Lesser Snow Goose

Each year in March, some 30,000 of the 300,000 lesser snow geese (*Anser c. caerulescens*) wintering in California's Central Valley follow their migrational urge to return to a unique breeding area on Wrangel Island, the only large land mass between the Chukotka Peninsula in far eastern Siberia and the North Pole. They flock together and fly the 5,000 km (3,100 miles) to arrive in time for snowmelt, find a nest, lay eggs, and raise chicks that will make the return journey, reappearing in the Central Valley in November. About half of Wrangel Island's snow geese winter in the Central Valley, the largest wintering area in western North America for these and other migrating geese. Once it was a vast wetland complex, teeming with birds. Now the snow geese crowd into remnant marshes, agricultural ponds, and flooded rice fields, together with greater white-fronted geese (*A. albifrons*) and numerous ducks and swans. About 60 percent of the Wrangel Island snow geese do not fly this far, wintering instead on the Fraser River delta of British Columbia. What was once this area's biggest wetland is now the city of Vancouver. A few snow geese continue as far south as the Salton Sea, in the Imperial Valley, or to the interior highlands in Mexico.

Lesser snow geese are among the most abundant waterfowl species, with a population estimated at 2.2 million adults, but their numbers and range in Asia have been severely diminished in this century, primarily by overhunting and loss of habitat. During the 1800s their distribution extended beyond the Canadian Arctic breeding areas across northern Siberia and from Pacific Coast wintering areas in North America to East Asia. Now breeding colonies exist only in the Canadian Arctic, with the exception of one colony in Asia, on Wrangel Island, 140 km (85 mi.) north of the Siberian coast and 400 km (250 mi.) west of Alaska. A recent

genetic study indicates that the Wrangel Island colony may be the oldest, or parent, population of all current lesser snow geese.

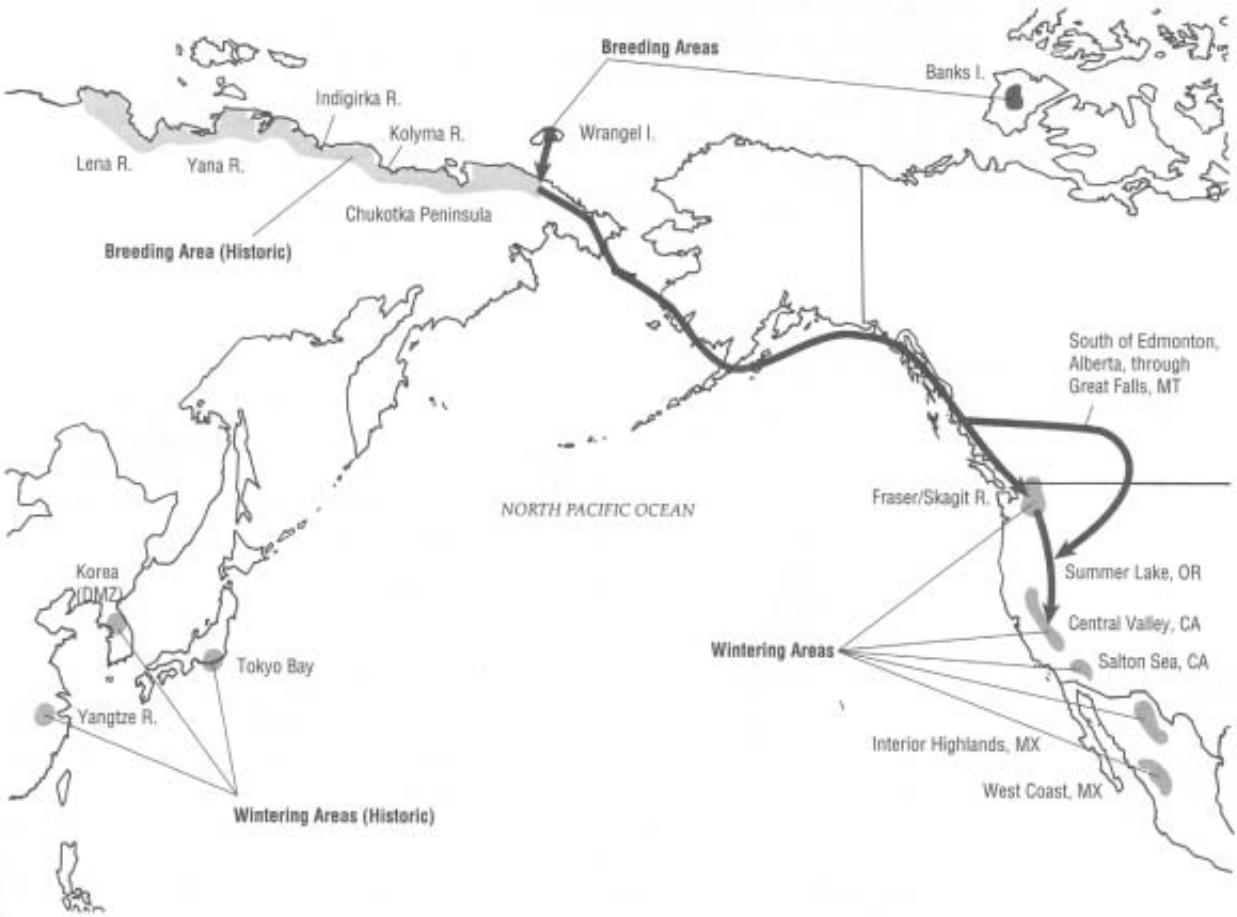
Before 1900, snow goose colonies in Russia ranged from the Lena River to the Chukotka Peninsula, a distance of some 2,000 km (1,250 mi.), and these *Bely-gus* migrated 4,000 km (2,500 mi.) or more to overwintering sites in Japan, Korea, and China. By the late 1920s, few colonies remained on the Russian mainland. On Wrangel Island there were several large colonies in 1926, when the first Soviet settlers arrived. Because of egg collecting and hunting, however, only two large colonies remained by the mid-1960s, with a total of some 200,000 birds. One of these colonies was destroyed when a geological expedition camped near it in 1967–68. In 1969 the surviving colony numbered about 120,000 adult birds, but by the early 1990s it had shrunk to only 60,000.

The precipitous decline in the Wrangel Island population created international concern. Wrangel Island has been protected by the Russian nature reserve system since 1976, and the snow goose is listed in the Russian red data book of endangered animals and is protected from hunting. However, with the collapse of the Soviet Union and the ensuing economic hardships, protection has become more uncertain.

Russian researchers had urged for 20 years that breeding colonies be reestablished on the Arctic coast of Siberia to buffer against catastrophic loss on Wrangel Island and to insure the survival of snow geese in Asia. In Japan, these recommendations fell on the receptive ears of members of the Japanese Association for Wild Geese Protection, who hoped to see the return of snow geese to historic wintering sites in their country.

Historically, geese from the Siberian mainland had migrated to China, Japan, and Korea. In Japan, historical records and artwork have documented the presence of *hakugan* in large numbers, especially on the island of Honshu. At the beginning of the Meiji period (1868), "snow geese appeared and landed flock after flock" in Tokyo Bay, according to a book written at that time. Soon after, as Tokyo Bay was developed and firearms were widely distributed, these flocks disappeared. Almost all snow geese from Russia now migrate to North America. However, bean geese and greater white-fronted geese have continued to migrate

Lesser snow geese along the North Pacific rim



SOURCE: J. TAKEKAWA AND H. CARTER

Tracking Snow Geese by Satellite Telemetry

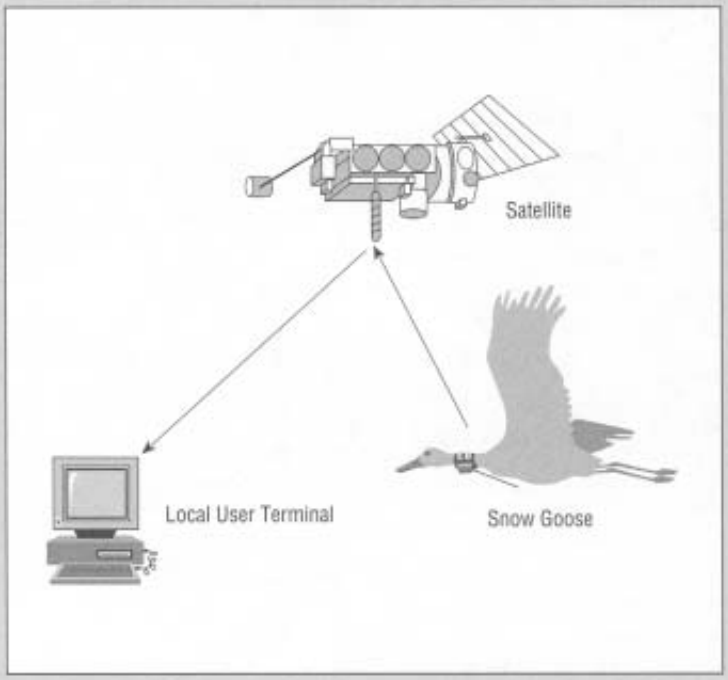
TECHNOLOGICAL ADVANCES in satellite telemetry are helping researchers in their efforts to learn about breeding, migration, and wintering areas of endangered bird populations. Satellite transmitters send a radio signal of fixed frequency to polar-orbiting weather satellites, which use the Doppler effect to calculate the transmitter's true location.

Satellite transmitters were originally designed to track buoys monitoring ocean environments. In 1970, a large transmitter was adapted to follow a migrating grizzly bear. Since then, miniaturization has made it possible to use the devices on several different mammal species as well as on migrating birds. In 1991, the first project to examine migrating geese documented the route of snow geese from Siberia to California. The smallest transmitters then available (40 g or 1.4 oz.) were attached to the necks of adult ganders on Wrangel Island before the autumn migration. Even smaller transmitters have since been developed (less than 25 g, or not quite an ounce), priced at a few thousand dollars each. These small transmitters enable researchers to gather previously inaccessible information on ever more species and their habitat needs.

Given the urgency of protecting endangered species habitat and the difficulty of studying limited populations with older research methods, satellite technology promises to be an increasingly valuable conservation tool.

DENNIS ORTHMAYER

Russian biologist Vasily Baranyuk of the Wrangel Island Nature Reserve and John Takekawa hold a snow goose with transmitter attached on a neck collar. The collars usually drop off within a year.



from Russia to Japan along the historic flyway. More than 30,000 greater white-fronted and 5,000 bean geese now spend the winter in Japan.

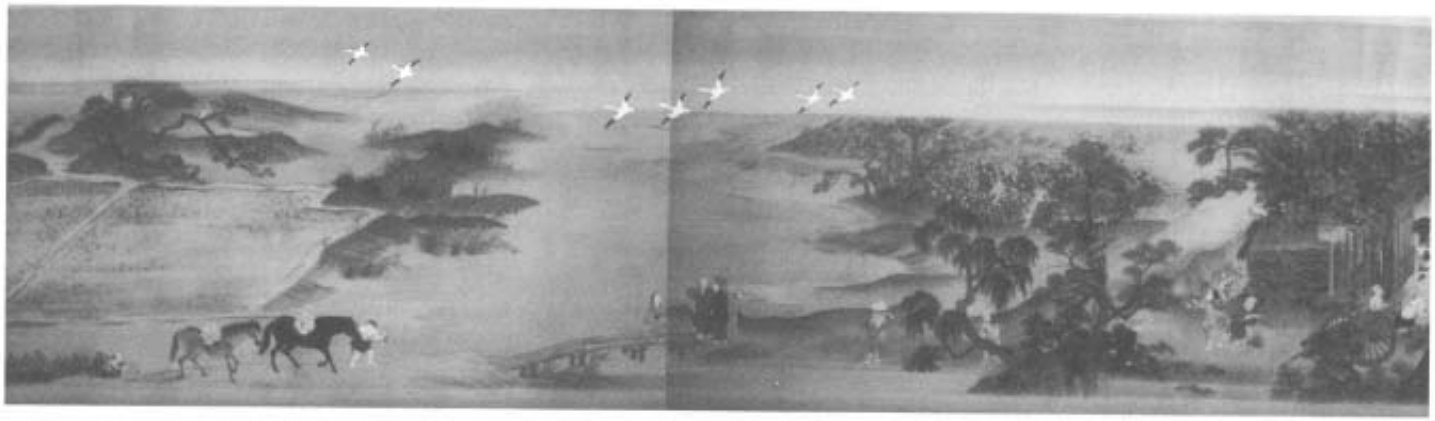
The similarity between Asian and North American wintering areas is striking. To begin with, the regions are on nearly the same latitudes. The largest wintering area for waterfowl on the west coast of North America, the Central Valley of California, extends from 36 to 39 degrees north latitude. Major wintering areas on the east coast of Asia include Japan and Korea (35–39 degrees N) and China (30–35 degrees N). In addition, climates in both areas are relatively mild. In recent times, the major habitat in most wintering areas used by geese in California is rice fields, as is the case in Japan, Korea, and China.

Lost National Treasures

All wild geese are recognized as national treasures in Japan. Hunting was prohibited in 1971, and snow and other geese are now protected by the Japanese Environment Agency and National Cultural Ministry. In 1989, the major wintering area for geese, Lake Izunuma, was given protected status under the Ramsar Convention as a wetland of international importance for waterfowl. But many of the traditional wintering sites have already been lost, and the enormous development pressures associated with the high economic value of land in Japan remain a threat. Development pressures on wetlands in wintering areas are severe in both the United States and Japan, although they are generally more extreme in the island nation of Japan.

The project of restoring snow geese to the Siberian mainland and Japan clearly required Japanese and Russian scientists to work together. To protect the Wrangel Island colony, the cooperation of North American scientists was also essential. The nations with breeding snow goose populations share many of the same problems—predation by the Arctic fox, for instance. In the past, there was not enough food to support large numbers of this fox through the winter in some northern wilderness areas. Now, though, with hunters and other humans present, it has found opportunities to scavenge even during the winter and has become established year-round, preying on snow geese in summer.

Each country on the Pacific Rim also has different assets and problems to bring to cooperative efforts. Russia has a great deal of land but is crippled by economic difficulties and change. It



Flocks of snow geese are depicted in a large mural (here seen in part) created by Sumiyoshi Gukei (1635-1705), a Buddhist monk, and titled *"Rakuchu rakugaizu-kan"* or "Inside and Outside Kyoto." The original is in the Tokyo National Museum.

has set aside huge reserves, but lacks adequate supporting funds. On Wrangel Island, reindeer have been introduced and could overpopulate the island if not managed carefully, as they are at present. Funding problems, however, are so large that the management staff may have to abandon the reserve. In August, an order of fresh food had to be turned back because the reserve lacked the funds to pay for it.

Japan has invested a smaller proportion of its gross national product in conservation than other First World nations, and environmental education in Japan is not as widespread as it is in North America. In Japanese universities, biology is taught in general, with little specialization in such areas as ornithology or wildlife ecology. Canada and the United States, meanwhile, have long-established conservation programs, technology that can be put to use, and the capacity to initiate cooperative projects. With advanced satellite telemetry, it would be possible to trace a migration in detail for the first time, and also to determine just which breeding areas on the Russian Arctic mainland are used by geese that winter in Japan.

Cooperative Projects

Recent political and technological changes have opened the way for the restoration of lesser snow geese to East Asia, and for cooperative international efforts the protect the migration route across Beringia, between Wrangel Island and California. Open exchanges of information between Russia and other countries are now frequent and have enabled Russian, Japanese, Canadian, and U.S. biologists to begin working together.

In fall 1991, a team of biologists from Russia, Canada, and the United States (a team that included J. Takekawa) followed Wrangel Island geese via satellite transmissions and documented the stops they made en route to North America. They captured 29 adult ganders, attached tiny satellite transmitters (see sidebar) to their necks, and tracked them, establishing this group's flight path for the first time.

The geese left Wrangel Island in early September and headed across eastern Siberia, where some disappeared, possibly felled by hunters. They stopped at several wetlands on the Chukotka Peninsula, then crossed the top of the Pacific Rim at the Bering Strait near its narrowest point. They paused on remote St. Lawrence Island, midway between the continents on the international dateline. After a few days of rest, the geese continued to the North American mainland, arriving at the Yukon River Delta of western Alaska in September. Here they stopped to replenish energy reserves before continuing southward to the Fraser and Skagit River deltas of British Columbia and Washington, and, in late October, to the Klamath Basin in northern California, and, finally, to the Central Valley in early November.

The entire migration took more than two months, with the geese flying at up to 80 km (50 miles) per hour. Many juveniles had been lost en route. Of the 29 ganders equipped with transmitters, seven stayed on the Fraser and Skagit River deltas, while four arrived in the Central Valley. A few geese were found dead of avian cholera, one of the diseases associated with crowding. The incidence of this disease has increased as wetlands historically used by migrating birds have been developed, confining most birds to limited reserves.

Now that the exact path of the migration has been traced, biologists are trying to find out why so many juveniles died en route and what protection measures are needed to save areas critical to Wrangel Island geese.

Restoring Snow Geese to East Asia

In January 1993, biologists from the Russian Academy of Sciences and Nature Reserves and the U.S. National Biological Survey (NBS) (J. Takekawa) were hosted by the Japanese Association for Wild Geese Protection in Sendai,

Japan. They met to develop a plan for the return of snow geese to East Asia. A committee was formed to discuss shared goals and responsibilities. This meeting received nationwide press coverage in Japan because few previous meetings about conservation had included these three countries.

During the summer of that year, members of the Japanese association traveled to Siberia to work with the Russian biologists. In June, the first snow goose eggs were transplanted from Wrangel Island to a site on the Anadyr River on the Russian mainland. The eggs were taken from nests (one egg from each of 100 different nests containing several eggs) and flown by helicopter (in slings and padded cases, to protect against vibration) to selected incubation sites. Some eggs were placed in nests of greater white-fronted geese, some of which were known to fly to Japan. Others were hatched in captivity, marked with leg bands, and released with greater white-fronted geese. Despite delays because of bad weather, 86 of the eggs hatched, and successful mixed families were observed among the white-fronted geese. These experiments were preliminary in nature, but when three juvenile snow geese were sighted in different areas of Japan later that year, biologists saw them as a sign of possible success.

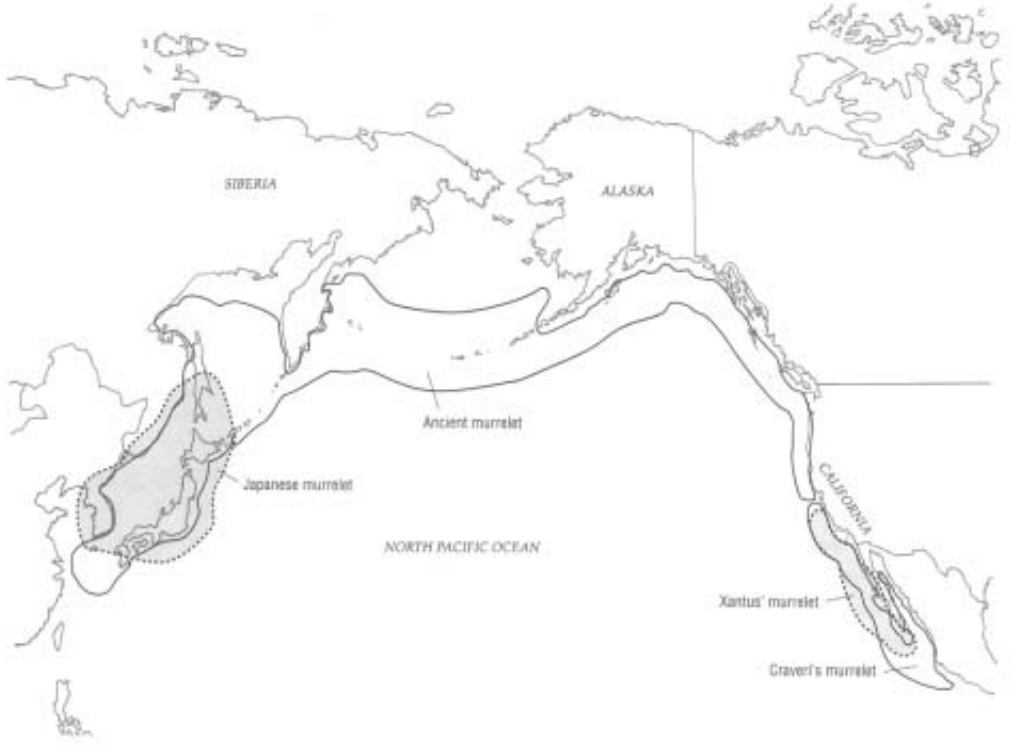
In January 1994, NBS biologists J. Takekawa and Dennis Orthmeyer traveled to Japan and captured 36 white-fronted geese, marking 10 with satellite transmitters. Eight of the 10 marked geese migrated back to their Siberian breeding grounds at the northern end of the Kamchatka Peninsula in mid-May, delineating the northern end of the migration from Japan for the first time. These breeding areas may be used to attempt to reestablish snow geese on the East Asian migration. Further studies are being conducted on the Kolyma River, where surveys have detected small numbers of breeding snow geese.

The lesser snow goose restoration project is one of several efforts that have recently brought together wildlife biologists and natural resource managers from Pacific Rim countries. The most successful restoration program for an Arctic nesting goose has been conducted on Aleutian Canada geese (see Winter/Spring 1992 issue of *Coast & Ocean*). The population rebounded from under 800 individuals in the 1970s to more than 10,000 in 1993.

Studies of Rare Murrelets

Also under way at this time is a cooperative venture to examine the status of rare murrelets on both sides of the Pacific. This project was initiated in 1993 by the Pacific Seabird Group (PSG), a nonprofit organization dedicated to the study and conservation of Pacific seabirds and their environments. In April 1993, the Wild Bird Society of Japan invited North American PSG biologists (including H. Carter and Leah deForest) to meet with researchers in Japan to discuss their similar conservation concerns for

Murrelets along the North Pacific rim



SOURCE: J. TAKEKAWA AND H. CARTER

murrelet species. For instance, problems that threaten the Xantus' murrelet (*Synthliboramphus hypoleucus*) in southern California resemble problems for the Japanese or crested murrelet (*S. Wamizusume*) in southern Japan.

Murrelets, which nest along the North Pacific Rim from China in the west to Baja California in the east, provide a good example of adaptive radiation from Beringia, which has resulted in speciation. They belong to the Alcidae family, a group of seabirds that also includes auks, puffins, auklets, and murres. All species in this family originated in the Pacific Basin, including seven species that now inhabit the North Atlantic Ocean. Alcids are wing-propelled birds that dive for their prey in nearshore and pelagic areas, and usually nest in burrows or crevices on islands or sea cliffs. Because murrelets are nocturnal in their activity on nesting islands, they are difficult to count.

Four species of murrelet belong to the *Synthliboramphus* genus: the Japanese, ancient, Xantus', and Craveri's murrelets. These species span much of the rim of the North Pacific Ocean, including the East China Sea, Sea of Japan, Sea of Okhotsk, Aleutian Islands, Gulf of Alaska, Pacific coast of North America, and the Sea of Cortez (see map, p. 34). The ancient murrelet (*S. antiquus*) is the most widely distributed of the murrelets. The center of its geographic distribution is on the Bering Sea, but its current numerical center, where a half million breed, is the Queen Charlotte Islands, British Columbia. The Japanese murrelet is the most endangered species among the murrelets (see sidebar). It may also be the rarest of the alcids. It is found only at the western edge of the North Pacific Rim, preferring areas of warmer water near the islands of southern Japan. These birds have been protected as a national cultural treasure since 1975 but, strangely, are listed in that country as only a sensitive or threatened rather than as an endangered species. Fewer than 5,000 Japanese murrelets are thought to be in existence.

The Izu Islands may have been the most important habitat area for this secretive species in the past, but several nesting sites there have been disturbed or lost because of egg collecting for human consumption, use of some islands for sport fishing, and target practice by the U.S. military. In 1993, PSG researchers visited one of the largest remaining breeding colonies, at Tadanae Island, near Kozu Island in the Izu Island chain. They had an opportunity to examine six nests and witness hundreds of birds arriving at night. They also learned about a

The Japanese Murrelet—A Very Rare Seabird

ALTHOUGH THE THREATENED marbled murrelet may be more famous in North America, the Japanese murrelet, *Synthliboramphus wumizusume*, is likely more rare. Scientists believe there are only 5,000 now in existence, though their secretiveness makes them difficult to count and study.

Japanese murrelets breed in rock crevices on islands off the coast of southern Japan. Mates take turns for 72-hour incubation shifts during a 35-to-45-day-long incubation period. The young are precocial (downcovered at hatch and very active) and leave the nest as early as two days after emerging from the egg. Their parents accompany them and feed them at sea (scientists assume they feed on fish, but do not know for certain). In fall and winter, murrelets disperse offshore and along mainland coasts from Sakhalin south to Korea. Many are killed in gill nets in the northwest Pacific. During the breeding season, Japanese murrelets appear to be tied to coastal waters influenced by the Kuroshio Current off the coasts of Kyushu, southern Honshu, and in the Izu Islands.

HARRY CARTER

The Japanese murrelet is also known as the crested murrelet. The crest is formed from long black feathers that extend from forehead to nape. A broad white stripe runs along the sides of the head, meeting on the upper nape. The body's upper parts and flanks are grayish-black, the underparts mostly white. It is related to the great auk (*Pinguinus impennis*), which went extinct exactly 150 years ago (1844) in the North Atlantic, as well as to other seabirds in the alcid family.

HARRY CARTER

The Japanese murrelet lays two eggs per clutch. Together, they represent almost half her body weight.

HARRY CARTER

Masami Hasegawa, with the Chiba Natural History Museum, examines a large garter snake on Tadanae Island. These snakes eat murrelet eggs and chicks.

JOHN TAKEKAWA

Scientists capturing lesser snow geese during the molting period on Wrangel Island. The geese are flightless in midsummer.

threat to the murrelet that typifies the problems endangered species managers are increasingly facing as wildlife populations and habitats continue to shrink. A special population of a giant garter snake, *Elaphe quadrivirgata*, lives on the island. At higher murrelet population levels, these two-meter (six-foot) -long snakes probably consume a relatively small proportion of eggs and chicks, but now that the murrelet population is sparse, they greatly reduce the breeding success of the Japanese murrelets.

Researchers with the Pacific Seabird Group have found similar heightened levels of nest predation on the Channel Islands, where a protected endemic island subspecies of deer mouse, *Peromyscus maniculatus*, preys on Xantus' murrelet eggs. Meanwhile, in fragmented old growth forests on the North American west coast, corvids (crows and jays) are exerting heavy predation on nests of the marbled murrelet (*Brachyramphus marmoratus*), a federally listed threatened species, which lays a single egg high in the branches of old growth trees from California to Alaska. Since the marbled murrelet was listed as a threatened species in 1992 it has become a symbol, along with the spotted owl *(Strix occidentalis)*, for the need to protect our dwindling coastal old growth forest.

At a meeting in Tokyo, the North American biologists were able to exchange valuable information with Japanese Environment Agency biologists concerning ongoing studies of, and the effects of predators on, various murrelets and other endangered seabird species. Japanese herpetologists and seabird biologists are planning further studies to address snake predation at Tadanae Island and other nesting islands where snakes are found.

To continue exchanging information regarding similar research, Japanese biologists Koji Ono and Yutaka Nakamura accepted an invitation to a special PSG-sponsored symposium on the status and conservation of rare alcids, held in Sacramento in January 1994. They presented a paper on the population status of the Japanese murrelet and provided a detailed picture of conservation problems throughout its range. Harry Carter and many other PSG biologists presented similar papers for the Xantus' murrelet and other rare alcids in the North Pacific. This exchange has highlighted the need to focus on specific nesting islands and to undertake restoration activities including removal of introduced predators (rats and cats, for example), reduction of other predation (by snakes, corvids, and mice, for instance), reduction of

human disturbance, and reduction of causes of mortality at sea (pollutants, gill nets). Many factors have contributed to the poor health of rare murrelets in various parts of the North Pacific Rim.

Participation in North American scientific meetings by biologists from East Asian Pacific Rim countries has not been sufficiently encouraged in the past. For seabirds, a beginning has now been made. In March–April 1994, PSG researchers (including Harry Carter) again visited Japanese biologists and Japanese murrelet nesting islands. They traveled to the four largest remaining colonies and briefly assessed their status. Two remote colonies had not been surveyed by ornithologists for almost 50 years, and it was a great relief to find that the birds still existed, although in low numbers. On all four islands the visitors found apparently high predation by jungle crows *(Corvus macrorhynchos)*, attracted by sport fishermen who leave garbage and bait on the rocks.

Through our interaction with colleagues from other countries, we have discovered that many of the conservation issues related to numerous bird species are similar on both sides of the North Pacific Rim. Our concern for these birds transcends national boundaries, and we hope to continue to work on cooperative projects, thereby improving our understanding. These endeavours, however, will succeed only if all parties continue them over the long term—a difficult task, but one well worth the effort. ■

John Takekawa is a research biologist with the National Biological Survey, California Pacific Science Center field station, in Dixon, California. He specializes in migratory birds and their habitats, including studies of greater white-fronted and lesser snow geese with satellite telemetry. He is currently continuing work on Arctic nesting geese and shorebirds, and initiating studies of salt marsh species and habitat restoration in the San Francisco Bay estuary.

Harry Carter is a contract biologist for the National Biological Survey in Dixon, California. He has assessed the status of seabird populations throughout California and British Columbia and has examined impacts from oil spills, gill nets, loss of habitat, human disturbance, and other marine conservation issues. Currently, he is studying Xantus' murrelets, ashy storm-petrels, and other threatened seabirds in the Channel Islands off southern California with funding from the U.S. Navy.

On Wrangel Island, Siberia

SEAN BOYD