December 1973

Natural and Unnatural Selection in a Wild Goose

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Natural and Unnatural Selection in a Wild Goose*

Blue goose and snow goose color phases enable the species to reproduce efficiently in the harsh Canadian climate. But hunters, more eager than sporting, are upsetting this finely tuned pattern of survival.

by Paul A. Johnsgard

Of all the ecologic, taxonomic, and evolutionary puzzles posed by North American birds, none is more intriguing than that provided by the blue goose and the lesser snow goose.

The blue goose, described in 1758 by Linnaeus on the basis of a drawing of a "blue-winged goose" from the Hudson Bay area and given the name *Anas caerulescens*, had long been a bird of mystery. Each fall enormous flocks would suddenly appear and concentrate in a very small area of coastal Louisiana to spend the winter, then return north and disappear into the wilderness of arctic Canada the following spring. As recently as 1925, Arthur C. Bent was able to summarize the situation in his famous *Life Histories of North American Birds*, as follows: "To find the breeding resorts of the Blue Goose is one of the most alluring of the unsolved problems in American ornithology. It is really surprising that such a large and conspicuous species, which is numerically so abundant, can disappear so completely during the breeding season."

* Published in *Natural History* 82:10 (December 1973), pp. 60–69.

Snow Geese wintering at the Bosque del Apache, New Mexico; note blue-phase bird at far left. Photo by Einar Einarsson Kvaran (Wikipedia).

The mystery of the blue goose breeding grounds was solved in 1929 by the Canadian ornithologist J. Dewey Soper. After a seven-year search, which covered about 30,000 miles and extended from Hudson Bay to Greenland, he discovered a major nesting colony on Baffin Island. Only a year later, George Sutton, an American ornithologist, located a second nesting colony on the southern tip of Southampton Island in Hudson Bay, approximately 400 miles from the Baffin Island colony.

Both Soper and Sutton found lesser snow geese (aptly named *Chen hyperborea hyperborea*, or goose from beyond the north wind), nesting in association with blue geese. The beautiful snow goose, always considered a distinct species, had long been known to nest in the Canadian Arctic, as well as in Greenland and Siberia. Yet on Southampton Island, Sutton found mixed pairs and apparent hybrids between blue and lesser snow geese. This raised the possibility that the two types were not different species but only subspecies or even minor genetic variants. Despite the evidence provided by the mixed pairs and hy-

brids, Sutton concluded that the lesser snow and blue geese were distinct, although closely related, species. (The greater snow goose does not exhibit color phases.)

A few years later, Canadian ornithologist T. H. Manning visited a different mixed nesting colony on Southampton Island where he found that about half of the blue geese were mated to snow geese. Although this percentage of mixed pairs was below that to be expected if the two types were randomly interbreeding (which would signify that the birds were of the same species), it was far more than would be expected if they represented separate species. As a result, he suggested that the two plumage types should be considered as different subspecies. Although the present-day attitude toward bird subspecies is to regard them as geographically separated and morphologically different populations, Manning's recommendation seemed to be the best solution to an otherwise insolvable problem and was gradually adopted.

A solution to the taxonomic dilemma was not forthcoming until the 1950s, when Graham Cooch, then a graduate student at Cornell University, spent several summers studying the breeding biology of blue and snow geese on Southampton Island. His studies demonstrated that the blue goose is only a genetically determined color phase of the snow goose, and that both birds are, in fact, one species, *Chen caerulescens*. The genetic control determining the two plumage types is a relatively simple one. The factor that prevents massive interbreeding between the two types is a behavioral barrier, the result of preferential pairing between birds of the same plumage type.

Cooch also discovered that blue and snow geese exhibited significant differences in their physiological adaptations for breeding. Although no differences were found in nest-site selection or average clutch sizes, white-phased birds normally began their nesting activities slightly earlier than blue-phased ones. Melting snow and ice at the onset of the white-phased birds' breeding season often results in the loss of some of the nests, which are constructed on slight, grassy swells on the tundra. Also, for reasons not yet understood, egg predation losses to jaegers and arctic foxes tend to be higher during the

initial stages of the breeding season. It is possible that, as the snow and ice covering the tundra begins to disappear—shortly after the first eggs are laid in late May or early June, depending on the latitude of the colony site—white-phased birds on the nest are more conspicuous to predators.

White and blue phases of lesser snow goose. Photo by Dave Menke (National Wildlife Service Digital Library).

By the same token, the blue-phased birds would be better camouflaged on the muddy ground. The two color phases, then, could serve as a protective device to keep breeding losses at an acceptable level, while maximizing the limited breeding period (approximately 80 days) possible in severe climates.

In any case, blue-phased pairs are more successful breeders than white-phased pairs, except when an unusually cold and retarded spring reduces the length of the breeding season. This can be especially disadvantageous to the blue goose because it starts breeding later.

Because the blue-phased birds are favored in relatively mild breeding, seasons, the past half century of climatic amelioration in

arctic Canada has probably benefited the blue goose and has helped account for the extension of the breeding range of birds representing this genotype. The blue goose is now found in nesting colonies north and west of Baffin and Southampton Islands, which previously were entirely comprised of snow geese, and it is scorning relatively more common breeding areas where both types traditionally occur.

Still largely unexplained was how the geese develop strong preferential mating with birds of their own plumage type rather than showing random mating behavior.

It is possible that the goslings become imprinted on the plumage type of their parents shortly after hatching and later seek out a mate of the same color. If so, goslings whose parents were blue phased would seek blue-phased mates; those with white-phased parents would prefer typical snow geese as mates. Only in cases where the young birds are the offspring of mixed parents might a gosling be imprinted on a color phase opposite from its own. Fred Cooke, a Canadian geneticist, hypothesized that in such a case the young bird did imprint on the plumage type of one of its parents, perhaps depending on the gosling's sex. The only certain way to test this idea was to band thousands of goslings in a colony that had a substantial proportional representation of both color phases. One such colony is near Churchill, Manitoba, and in 1968 Cooke and his associates began a long-term study to try to resolve this question.

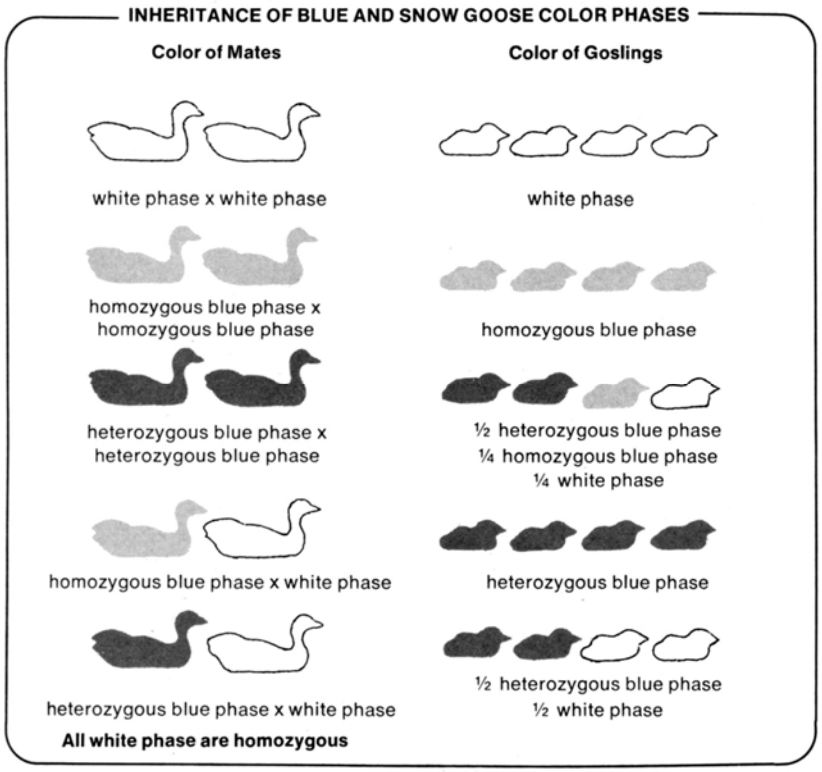
One problem associated with such a study is the goose's long period of immaturity, Among arctic geese, initial breeding normally occurs when the birds are nearly three years old. Thus, it takes at least that long from the time of initial banding to determine the mating preferences of goslings having parents of known color phases.

Nevertheless, some suggestive evidence has already begun to emerge from this research program. By raising captive goslings of the two color phases—as well as white-phased goslings dyed pink—with foster parents that were either blue, white, or pink dyed, it was possible to test the young birds' social responses when they were later placed together in a large flock. When the goslings were tested in a circular arena and allowed to move toward adults of any of the three

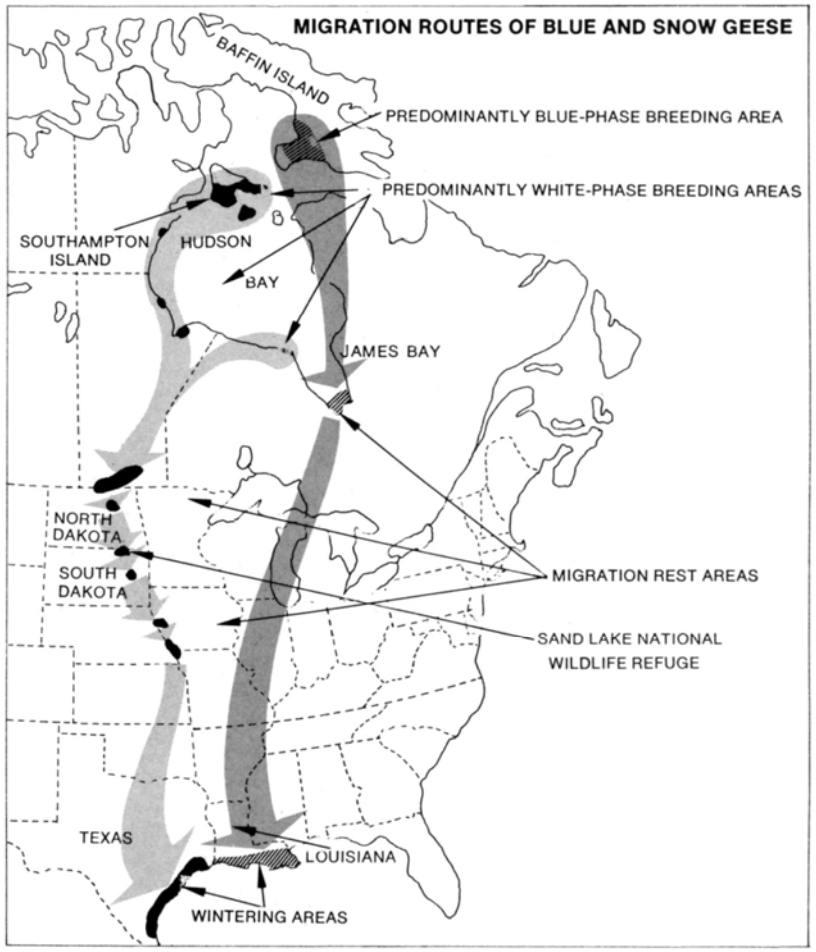
color types, they associated predominantly with adult birds of the same color as their foster parents. Even the goslings with pink foster parents responded as strongly to them as did those with normally colored parents, suggesting that color recognition is learned rather than inherited. There was no evidence to suggest that the sex of a gosling had any effect on its behavior or that the sex of the foster parent had any effect.

The banding program undertaken by Cooke and his associates has also brought to light a number of interesting points in addition to the behavioral basis for preferential mating. First, a considerable degree of mixing of both blue and snow geese from different breeding colonies apparently exists on the Gulf Coast wintering grounds, where pair formation occurs. This allows for the formation of pair bonds between birds reared in different breeding colonies. As a, result, a male from one colony may form a pair bond with a female that was reared at another colony several hundred miles away. Cooke has concluded that, as is the case with ducks, it is the female rather than the male that determines to which colony the pair will return and attempt to nest. Such behavior tends to promote outbreeding between colonies and thus would also encourage genetic uniformity between breeding populations separated by several hundred miles.

The different breeding colonies in arctic Canada—those that are predominantly blue geese, snow geese, or mixed in various proportions—all have different migration patterns when they head southward in the fall, and this also has important genetic implications, as well as ecological significance. In recent years, it has even had political ramifications. The predominantly blue-phased geese that breed on Baffin Island, for example, typically undertake a nearly nonstop flight to their Louisiana wintering grounds. The geese spend several weeks in early September in a staging area at James Bay, Canada, where the birds are subjected to fairly heavy hunting pressure, but their subsequent nonstop flight carries them out of reach of waterfowl hunters in the northern United States. It is only while the geese are passing the winter in Louisiana that hunters take a heavy toll of their number.



The color phases of the lesser snow goose are an inherited trait. Homozygous parents—those possessing genes for only one color phase—produce like offspring. Heterozygous parents—possessing genes for both white and blue color phases—account for the appearance of blue and snow geese in the same flock.



White-phased geese that breed on Southampton Island and the west coast of Hudson Bay follow an interrupted migration pattern down the Great Plains to wintering areas on the Texas coast. The predominantly blue goose breeding colonies follow a more direct, uninterrupted migration route than colonies made up largely of snow geese or mixed populations.

On the other hand, the geese, predominantly white-phased, which breed on Southampton Island and the west coast of Hudson Bay, follow a more gradual and interrupted fall migration pattern. They also spend weeks along the south coast of Hudson Bay, but from there they strike out in a southwesterly direction across Ontario and southern Manitoba toward the Dakotas. There, in the vicinity of Devils Lake, North Dakota, and Sand Lake, South Dakota, the birds rest and take on food before they continue their flight southward. In years when the breeding season is later than usual, this stopover in the northern states is especially important, since the young of the year are unable to withstand a more direct flight to the wintering area on the coast of Texas. In such years the immature birds are especially vulnerable to hunting because of their generally weaker condition, and up to a third of the young geese may fall to hunters.

The genetic and ecologic implications of these differences in migratory traditions are thus substantial. Whereas the mostly blue-phased breeding population avoids heavy hunting pressure in the northern United States by its relatively nonstop migration between James Bay and the Gulf Coast of Louisiana, the predominantly white-phased populations of Southampton Island and the west coast of Hudson Bay are subjected to the effects of intensive hunting throughout their entire fall migratory route down the Great Plains to their Texas wintering areas. In addition, most sport hunters shoot the white-plumaged birds rather than the darker blue geese, probably because they are more conspicuous and have greater trophy appeal. Thus differential effects of hunting on two plumage types supplement the differential breeding adaptations, and may influence the rate of natural selection in favoring blue-phased birds.

In the fall of 1972, an extraordinarily cold arctic summer resulted in very low breeding success for nearly all arctic-breeding birds. Another factor that reduced the goose population was the high kill rate in North Dakota, the third highest in history. Of the approximately 95,000 geese killed in that state alone, some 53 percent were white-phased snow geese and 20 percent were blue-phased birds (27 percent were other species).

After the abysmal 1972 breeding season and the heavy hunting of the fall, the winter mid-continent population of snow geese was estimated at slightly more than a million birds, or down nearly 23 percent from the previous winter.

Obviously, the prospect of such continued goose hunting as occurred in the Dakotas in 1972 will have enormous local economic impact, and state game agencies in the northern states have been eager to manage their temporary goose populations in a way that will assure the highest possible harvests for their hunters.

Their solution has been to encourage a buildup of massive fall goose populations in a few refuge areas where the birds can safely rest. To obtain food, however, the birds must fly out beyond the refuge boundaries. The resulting concentrations of geese—and hunters—that have occurred at Sand Lake National Wildlife Refuge and numerous other midwestern refuges have imposed a crass carnival atmosphere on goose hunting in the area. Now, rather than bothering with blinds, decoys, goose calls, and all the other accoutrements of goose hunting, it is only necessary to stand at the boundaries of the refuge, carry a magnum shotgun loaded with buckshot, and fire randomly at any flock of birds that comes within eyesight. (The better hunters, who kill the greatest number of birds annually, still use decoys and other lures. These sportsmen show a preference for snow over blue geese.) Although the total number of geese killed in this incredible "sport" is relatively low compared with the total taken from all states during the season, the incidence of crippled birds, which die later or fall well within the refuge boundaries and thus cannot be recovered, is substantial.

Hunters in the wintering areas of Louisiana and Texas have not remained impassive in the face of increasing harvests of snow and blue geese in the northern states. Recently, both federal and state game agencies have been accused of "shortstopping" the birds in order to increase the harvests in more northerly states. This is the term applied to the management of refuges or other controlled areas along the fall migratory route by providing food or planting grain to encourage maximum fall usage by geese and to delay their departure to

wintering areas for as long as possible. This procedure had its predictable outcome last winter, when a large flock of geese and ducks that were concentrated on Lake Andes National Wildlife Refuge in southern South Dakota were affected by a severe outbreak of viral enteritis, or "duck plague/" which killed thousands of waterfowl. The affected geese were Canada geese rather than snow geese, but the potential for a disaster of comparable or even greater magnitude certainly exists with the latter species.

Lesser Snow Goose at Slimbridge Wildfowl and Wetlands Centre, Gloucestershire, England. Photo by Adrian Pingstone (Wikipedia).

In the resultant controversy, the least of the participants' concerns appears to be the welfare of the goose population, which has been gradually losing ground in recent years. Unless adequate protection can be offered the birds on their fall migration routes—as well as in

their wintering areas—the problem of shortstopping may eventually become only an academic question.

Furthermore, the major nesting areas, such as those on Southampton and Baffin Islands must be absolutely protected from destruction or disturbance. Increased interest in oil and mineral exploration in the Canadian Arctic will make this a problem of greater concern in future years. The effect of the forthcoming James Bay Hydroelectric Project on the fall staging area of the geese still remains to be seen, but it could have an important influence on the migration routes and timing of the Hudson Bay goose flocks.

A goose population is a dynamic system that responds rapidly and intensely to subtle and manifold environmental pressures. The genetic "marker" provided by the blue-phased plumage variant allows a revealing insight into the workings of natural selection in a harsh and intolerant environment. For better or worse, man is influencing the rate at which natural selection is shifting the genetic composition of the Hudson Bay goose flock and modifying the migratory traditions of the birds as well.

Each spring the geese push relentlessly northward to rendezvous with fate on distant arctic shorelines; each fall they return with the future of their species invested in a new generation of offspring produced by the most successful genetic combinations. We could ask for no greater symbol of innate determination for survival than that provided by the snow and blue geese; accordingly, we should be content with no less than a maximum commitment to their continued existence.