The Peculiar Puzzle of the Pink Ring-billed Gulls

by Lisa Hardy

Introduction

My first reaction to the sight of a pink-tinted Ring-billed Gull was disbelief. A group of Ring-bills in a Coeur d'Alene, Idaho, parking lot had sidled up to my car, and one of them was delicately, but unmistakably, suffused with shell-pink throughout the feathers of the breast and head. Further searching in the area turned up several more of these attractive pink gulls. Back home, I pored through my bird books but could find no mention of pink-tinted Ring-billed Gulls. When I posted to the local listserver, though, I found that I was not alone: Pink Ring-bills were being seen across the Pacific Northwest.

The appearance of pink Ring-bills was so peculiar that I resolved to find out how they had acquired their unexpected color. I sent out a request for reports of pink Ring-bills that was eventually posted on twelve western birding listservers, and I began to query ornithologists as to the cause of the coloring.

The responses started to come in. I received reports of one or a few birds from Nevada, Wisconsin, and Newfoundland. I learned that 1–5% percent of the population may be pink in British Columbia, Alberta, Idaho, Montana, and Colorado. And the highest concentrations of pink Ring-bills (10–30% of local populations) were being reported from Washington, Oregon, and northern California. And I found that they are *not* being seen in southern California, northwestern Mexico, the Gulf states, or the U.S. Atlantic coast.

In this article, I ask the following questions: (1) What are the patterns of spatial and temporal variation in populations of pink Ring-billed Gulls? (2) What are the possible natural causes of pink coloration in Ring-billed Gulls? (3) Could there be a non-natural (anthropogenic) cause of pink coloration in Ring-billed Gulls?

Pink-tinted Birds: Overview

Pink coloring in the Laridae is nothing new. A search of three widely available identification guides shows that twelve other species of gulls, including most of the "hooded gulls", and five species of terns can express pink tinting (Harrison 1985, Grant 1986, Sibley 2000). Perhaps the most famous of the pink gulls is the Ross's Gull, in which most of the adult population is tinted. The other documented ABA-area species, with smaller proportions of tinted individuals, are Franklin's, Laughing, Black-headed, Bonaparte's, Little, and Sabine's Gulls. Among the ABA-area terns, Roseate, Sandwich, and Elegant Terns may show a pink wash. Curiously, there appear to be no pink four-year gulls.

A theory advanced in the 1950s (Stegmann 1956) suggested that pigment in the "preen-gland" oil was responsible for the tinting. This theory, however, was not seriously tested until work by Jocelyn Hudon and Alan Brush. Working with the feathers of a tinted Elegant Tern, they demonstrated first that the pigment occurred within the feather and not as a topical application, and second that the primary component of the pigment is a common carotenoid compound, called astaxanthin (Hudon and Brush 1990). It

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seems reasonable to suggest that their results apply to all the pink Laridae, including Ring-billed Gulls.

There are several species in other families that exhibit "carotenoid flush"—including Red-billed and Red-tailed Tropicbirds, Common Eider, Common Merganser, and several species of pelicans and ptarmigans (Vickery 1983, Harrison 1985, Hudon and Brush 1990). Carotenoid pigments are responsible for many of the yellows, oranges, and reds in bird feathers (Hill 1999), but the carotenoid flush differs from the carotenoid pigmentation found in other birds in at least two important ways. First, it occurs in varying percentages of the population of a given species, suggesting that it is an incidental, rather than intrinsic, plumage characteristic. Second, the carotenoids that form the flush are less stable, because they are not bound to proteins in the feathers, as is the case in the Northern Cardinal, for example (Hudon and Brush 1990). It is not known what, if any, advantage is conferred by expression of the carotenoid flush. The females of some species of birds have been shown to prefer more brightly colored mates, but this type of research has been confined to songbirds (Hill 1999). In particular, studies on songbirds have revealed an intriguing three-way relationship among male secondary sexual traits, ingestion of carotenoids, and immune health: Carotenoids play an important role in immune function, and male songbirds "advertise" their healthy immune systems by way of carotenoid-enhanced coloring of the bare parts or feathers (Blount *et al.* 2003, Faivre *et al.* 2003). The results of these studies may be applicable to gulls if the expression of carotenoid flush in gulls can be shown to be sex-linked.

Observations of Pink-tinted Ring-billed Gulls

Chris Thompson, a research scientist with Washington State's Department of Fish and Wildlife, responded to one of my requests for information. Each year, Thompson receives hundreds of gull carcasses that have been shot as nuisance birds in the state. He notes that about 1–2% of the Ring-bill carcasses he receives are pink, and that the pink is strongest at the base of the feather where newly emerged. These observations agree with what Hudon and Brush (1990) describe from the examination of Elegant Tern feathers. Thompson has examined birds in the process of molting from pink to white, as well as from white to pink.



In recent years, birders in the western U.S. have been noting that large flocks of Ring-billed Gulls may contain a few pink-tinted individuals. *Brighton, Colorado; 1 March 2003. © Greg Goodrich.*

One important question is whether all Ring-billed Gulls possess the mechanism for expressing the flush when fed a suitable diet. There is no evidence to suggest that geographic subpopulations of Ring-bills differ in their genetic ability to express the pink pigment. Diet is clearly a controlling factor, and variability in diet could, by itself, explain observed distributions of pink individuals. The question of whether diet is the only controlling factor, or if genetics plays some role in addition to diet, awaits further study.

Nearly all reports of pink Ring-bills come from March and April. The feathers affected by the pink pigment are the contour feathers of the body, which are molted twice a year, in spring and fall. Part of the explanation for the spike in spring reports may be that because the birds are newly molted, the pigment is at its brightest—the carotenoid pigments in gull feathers are known to fade with exposure to sunlight. But an equivalent spike that might be expected after the fall molt has not been reported. One possible reason for the seasonal disparity is that there are fewer pink birds after the fall molt because there is less access to dietary carotenoids during the fall molt than during the spring molt. Another possibility is that breeding condition may be a contributing factor to the expression

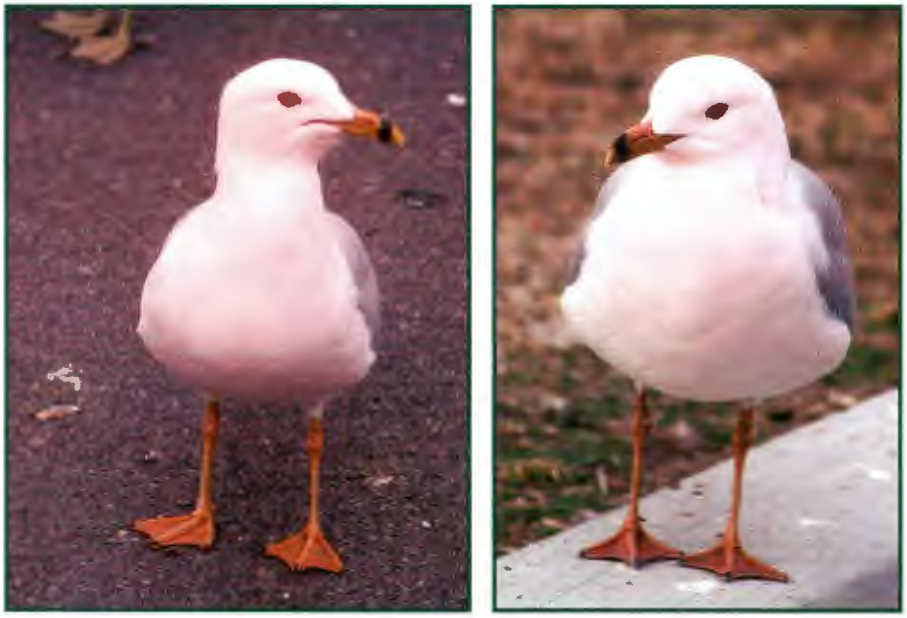


Although there appear to be no previously published accounts of pink tinting in Ring-billed Gulls, the phenomenon has been described for at least twelve other species of gulls, six of which occur regularly in the ABA Area. This second-summer Little Gull is typical of pink-tinted larids, showing the strongest concentration of pinkish coloration on the contour feathers of the underparts. *Wells, Maine; 7 June 2003; Garth McElroy.*

of the pigment. Differences in hormone levels prior to the breeding season might facilitate expression of carotenoids in plumage (C.W. Thompson, personal communication). That a few pink birds are reported in basic plumage, however, shows that breeding condition is not a prerequisite for pink plumage.

Natural Sources of Carotenoids: I. Chemical Conversion

It is not known what amount of dietary carotenoids is required to turn a gull pink, and whether or for how long a gull can store carotenoids to be used when growing feathers for its next molt. While brightly colored songbirds incorporate carotenoid pigments into their feathers only if they are obtaining them in their diet at the time of molt (McGraw *et al.* 2001), other birds, for example, domestic chickens, appear to be able to store carotenoids for use at a later time (Goodwin 1984). Birders have noted that pink Ring-bills can show an orange tint to the bill, legs, and feet, suggesting that carotenoids can be deposited in the bare parts as well as in the feathers. Hudon and Brush (1990) note that this phenomenon is common in pink-tinted birds. I have also noticed a few Ring-bills that show the orange tint in the legs and bill, but whose body feathers show no sign of pigment. [In this regard, the reader is encouraged to see the article by Wilson (2003) that begins on p. 506 of this issue of *Birding*.] These may be birds that had access to appreciable amounts of carotenoids only after their feather growth was complete, and that thus manifested the pigment only in the bare parts.



Typical adult Ring-billed Gulls have yellow legs. Pink-tinted individuals, however, often show yellow-orange or orange legs. *Reno, Nevada; March 2002; © Jack Walters.*

If the gulls are unable to store carotenoids in their bodies until their next molt, pink birds must have eaten a carotenoid-rich diet during or just before their molt, rather than sometime in the months preceding the molt. The spring molt occurs primarily in March and April, while the fall molt occurs mainly in June through September (Ryder 1993). The molt dates would thus constrain the diet possibilities in time.



Ornithologists have not yet determined whether pink coloration in Ring-billed Gulls is correlated with immune health and/or sexual attractiveness. Birders should be on the lookout for possible behavioral and ecological differences between pink-tinted *vs.* typical Ring-billed Gulls. *Sandpoint, Idaho; 5 April 2003; © Terry Gray.*

So where are the Ring-bills getting their astaxanthin? Animals do not produce carotenoids *de novo*; all of the carotenoids in the biomass are originally synthesized by plants, algae, and certain bacteria and fungi (Mera Pharmaceuticals 2003). Animals get carotenoids through their diets. They may utilize the ingested carotenoids directly, or they may convert one carotenoid into a different carotenoid before utilizing it.

Gulls either ingest astaxanthin directly or eat other carotenoids and convert them to astaxanthin. It is not known whether gulls or terns can actually convert carotenoids, but other birds do have this ability. For example, the Greater Flamingo is capable of converting beta-carotene (which is found in carrots) into canthaxanthin, which, along with astaxanthin and adonirubin, is responsible for the pink color of flamingo plumage (Goodwin 1984). Similarly, the astaxanthin that colors the wattles of Ring-necked Pheasants appears to be a conversion product of zeaxanthin, a carotenoid found in corn (Goodwin 1984). There is experimental evidence that Northern Cardinals can convert certain yellow carotenoids to the red pigments astaxan-

thin and canthaxanthin (McGraw *et al.* 2001). If gulls can convert other carotenoids into astaxanthin, there are many potential dietary sources. Songbirds typically obtain carotenoids from fruits and seeds, and Northern Cardinals eat a diet composed predominantly of fruit during their molt (McGraw *et al.* 2001). The wide availability of carot-enoids in plant tissues, ranging from the lycopene in tomatoes to the lutein in green leaves, would suggest that if Ring-billed Gulls do indeed have this conversion ability, then the limited distribution of pink individuals should have a genetic control.

Natural Sources of Carotenoids: II. Direct Ingestion of Astaxanthin

If gulls do not convert carotenoids, then pink individuals are ingesting astaxanthin directly—in which case, then, the possible sources of astaxanthin in the Ring-billed Gull diet would be much more limited. Astaxanthin is rarely synthesized directly by plants or algae. Instead, the primary source of astaxanthin in freshwater and marine systems appears to be through conversion of the carotenoids found in algae, into astaxanthin by certain zooplankton, especially microcrustaceans, that feed on the algae (Fox *et al.* 1978, Ringelberg 1980, Van Nieuwerburgh *et al.* 2001, Andersson *et al.* 2001, Łotocka and Styczyńska-Jurewicz 2001). Crustaceans in general are a significant repository of astaxanthin in nature. Other animals obtain astaxanthin by feeding, directly or indirectly, on these crustaceans. Astaxanthin is the pigment that gives salmon flesh its characteristic pink color. (It must be added to the diets of farmed salmon, whose flesh would otherwise be an unmarketable white, as well as to the diets of farmed shrimp.)



Most reports of pink-tinted Ring-billed Gulls have been of adults in alternate plumage in late winter or early spring. More work is needed to determine the extent to which pink tinting can be shown at other times of the year or on younger age classes. *Sandpoint, Idaho; 5 April 2003; © Terry Gray.*

Brine shrimp are a potential source of astaxanthin for western Ring-bills, but there does not appear to be a geographic correlation between the shrimp and pink Ring-bills. Bear River Migratory Bird Refuge in Utah, for example, has both brine shrimp and Ring-billed Gulls, yet pink Ring-bills are not seen there, and neither have they been noted to eat brine shrimp (B. Olson, J. Ryder, personal communications).



Pink tinting in Ring-billed Gulls is most commonly reported on the contour feathers of the underparts, but it may extend to the face, as well. *Klamath Falls, Oregon; 15 March 2003. © Kevin Spencer.*

Another potential source of astaxanthin is various insects such as locusts and midge larvae (Goodwin 1984). The insect food sources appear to be widely distributed, however, and probably could not account for the geographic variation that is seen in the distribution of pink-tinted Ring-billed Gulls.

The highest concentrations of pink Ring-bills are reported from the Richland (Tri-Cities) area in Washington, and from an area stretching across the Oregon-California border, from Klamath Falls to Redding. These areas are within the range of Pacific Northwest salmon species. Fish-eating gulls (and terns) have become hot research topics in light of declining salmon runs on the Columbia River and its tributaries. The opportunities for gulls to feed on salmonids occur primarily during the outmigration of juvenile salmon, and during the spawning of adult salmon. Smolt outmigration on the Columbia begins in early April and peaks in May, and many of the small fish are killed, injured, or stunned by their passage through or over the dams, leaving them an easy meal for avian predators (York *et al.* 2000). This avian predation is the focus of a number of ongoing studies. A 1996 study of Columbia River Ring-billed Gull stomach contents indicated that up to 50% of the population in May had been eating fish (York *et al.* 2000), and that some of those fish were salmonids. The juvenile salmon outmigration seems too late, however, to provide a food source for most Ring-bills during their spring molt. Spawned-out salmon carcasses may also figure in the Ring-bill's diet. The timing of Ring-billed Gull molts relative to their opportunity to feed on juvenile or adult fish requires further study.

The diet of Elegant Terns consists almost entirely of fish, and anchovies are the predominant prey species (Burness *et al.* 1999). While salmonid fishes are dis-



Almost all of the documentation of pink Ring-billed Gulls has come from the past few years, and there are hardly any verifiable reports before the late 1990s. This image, taken way back in 2000, is actually one of the earliest documentations of the phenomenon. *Freezout Lake WMA, Montana; March 2000. © Michael Schwitters.*

tinguished by astaxanthin pigmentation of their flesh, some other fish species, including anchovies, contain astaxanthin in the skin and other organs (Goodwin 1984). It is reasonable to conclude that the pink flush of the Elegant Tern is attributable to its fish diet. (Note that several of the other species showing carotenoid flush, such as Common Merganser and some pelicans, are also highly piscivorous.)

In the Klamath Falls area, the salmonid fish species are native "redband" trout, plus kokanee (landlocked sockeye) introduced into a few lakes (R. Smith, personal communication). The opportunities for Ring-billed Gulls to feed on these fish have not been documented as they have been on the Columbia River, and the dietary source of carotenoids in the Oregon-California birds may be some other, as yet unidentified, food.

Possible Increases in Pink-tinted Ring-billed Gull Populations

Are pink Ring-bills on the increase? The anecdotal evidence falls into two contradictory camps. One group sees pink gulls every year for as far back as they can remember. The other group consists of birders who have seen their first pink Ring-bill only recently. With a few exceptions, all the specific reports I have received have been in the last five years, since 1998. The exceptions are three reports from the 1980s—all three of them from the Klamath Falls, Oregon, area. This pattern of observations suggests that while the pink birds are not a new phenomenon, they are increasing in number, or traveling farther outside core areas of historical occurrence.

But trying to draw conclusions from a mass of anecdotal data can be frustrating. The increasing number of reports may simply mean that there are more birders, or more scrutiny of gulls, or some other factor not related to the actual abundance of the pink individuals. Ring-bills are probably the most common gull in North America (CWS 2003), and perhaps we don't always look them over as carefully as we might. Yet these pink birds occur in sufficient numbers that it seems odd for them not to have made an appearance in the official literature. Perhaps that is a result of "eastern bias", wherein much of the research on Ring-bills has been conducted east of the Mississippi. There has been some western research, however, by Don Miller, a biologist now retired from Washington State University. Miller and his students studied Ring-bill colonies at Potholes Reservoir and Sprague Lake in central Washington in the 1970s and 1980s. He did not observe any pink individuals (R. Johnson, personal communication). Indeed, it would have been difficult for him to overlook them, as he was handling and closely observing the birds. Yet pink Ring-bills have been reported from those areas in 2002 and 2003.

An Alternative Source of Astaxanthin?

It turns out that there is another primary source of astaxanthin besides plants and microorganisms: pharmaceutical giants Hoffman-La Roche AG and BASF AG. They produce a synthetic version for, among other customers, the aquaculture industry (Mera Pharmaceuticals 2003). Astaxanthin-enhanced feeds have been used for decades to achieve the desired pink color of flesh in both farmed and hatchery-raised adult salmonids. The feed for adult fish typically contains about 50 ppm of carotenoid, and, initially, the astaxanthin was derived from natural sources, such as various byproducts of crustacean processing (Hardy 2002). In 1990, Hoffman-La Roche began large-scale production of synthetic astaxanthin (McCoy 1999). But prior to 1996, juvenile fish were rarely fed astaxanthin-enhanced feeds, because the astaxanthin is expensive, and there was no perceived benefit. Then, starting around 1996, fish feed producers began adding small amounts of astaxanthin to their starter feeds, in response to research showing that the dietary carotenoid was not just of cosmetic value in adult fish, but actually led to significant health benefits in newly-hatched fish (Torrissen and Christiansen 1995; R. Hardy, personal communication). The role of astaxanthin in piscine health may have to do with its antioxidant properties. (Astaxanthin is sold in health food stores as a nutritional supplement.) About 120 million smolts traveling down the Columbia to the ocean each year are hatchery-raised (Brannon *et al.* 1998), comprising more than 80% of the total juvenile salmon in

the river (NWFSC 2000). These smolts are a documented prey item for Ring-billed Gulls, and the diet of the smolts has included an increased amount of astaxanthin since 1996.

Ring-bills are not the only pink gulls attracting the recent attention of birders. In April of this year, birder Elliott Bedows of Bellevue, Nebraska, anecdotally noted an unusually high number of returning Franklin's Gulls showing very pink plumage. Responses to his listserver-posted observation confirmed that higher-than-usual numbers of bright-pink Franklin's Gulls were indeed occurring throughout the Midwest.

Franklin's Gulls winter on the western coast of South America, from southern Peru to northern Chile (Burger and Gochfeld 1994), and they could be getting their spring pigment from that area. A possible explanation for the higher-than-usual number of bright-pink Franklin's Gulls reported in 2003 is that there was a bloom of the reddish protozoan alga *Euglena clorophoenicea* in wetlands along the coast of Peru in the late winter of 2003; if carotenoids in the algae were passed up the food chain to wintering Franklin's Gulls, that could have accounted for the rash of sightings of bright-pink birds a few months later in the U.S. (G. Engblom, personal communication). *Euglena* species thrive in waters with high nutrient levels, commonly from such anthropogenic sources as sewage outfalls and agricultural runoff. However, the *Euglena* blooms have occurred in Peru for two consecutive years (El Comercio 2003)—despite the fact that unusually high numbers of bright-pink Franklin's Gulls do not seem to have been reported in 2002. At present, then, the causes of the annual fluctuations in numbers of pink Franklin's Gulls remain open to speculation.

Summary

The causation of the pink Ring-bills remains unclear. While salmonid fishes are the most clearly documented source of carotenoids in the diets of Ring-billed Gulls of the Pacific Northwest, pink Ring-bills may well be obtaining their carotenoids from more than one source. The first analytical research on the nature of carotenoid flush, that done by Hudon and Brush in 1990, has also been the last. Phenomena such as the recent apparent increase in populations of pink-tinted Ring-billed Gulls—which have "fallen through the cracks" of the professional scientific community—provide opportunities for amateur ornithologists to make contributions to our understanding of birds. Several different approaches suggest themselves in the case of pink Ring-bills. Besides continuing to collect observations, especially historical reports, one approach would be to feed captive birds with astaxanthin or its precursors to quantify the timing and amount of dietary pigment needed to turn a gull pink. And it may be possible to test the origin of astaxanthin in wild birds. Most of the astaxanthin added to fish feeds is synthetic, and if the pink Ring-bills have been eating hatchery fish as opposed to wild fish, then the subtle differences between the synthetic and natural versions (Turujman *et al.* 1997) could show up in analysis of the pink plumage.

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Many birders have to remind themselves to sort through a flock of common species (such as Ring-billed Gulls, left) to find something rare (such as a Slaty-backed Gull, right). The converse can sometimes be true, though! The birders who were studying this Slaty-backed Gull wound up noticing that some of the nearby Ring-billed Gulls "didn't look right". At this writing, a great deal of the mystery of the pink Ring-billed Gulls remains to be unraveled. Birders in the field can contribute much to our understanding of this common, widespread, and disarmingly interesting species. *Sandpoint, Idaho; 19 March 2002. © Shirley Sturts.*

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