How do Ruddy Turnstones *Arenaria interpres* prepare to cross the Pacific?

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We discuss evidence that some Ruddy Turnstones use the Trans-Pacific Flyway and make long distance non-stop flights from Alaska or nearby islands to the Hawaiian archipelago and beyond. In the past they made use of abundant food resources associated with the killing of large numbers of Northern Fur Seals. This no longer occurs, so we evaluate the food supplies currently available to underpin the migration and the strategy the birds adopt, and make a call for better evaluation of shorebird migration strategies on this least-known of shorebird flyways.

INTRODUCTION AND BACKGROUND

There has been much recent attention, in both the media and the scientific press, about the spectacular non-stop migrations of 4,000–11,000 km across the Pacific Ocean made by Bar-tailed Godwits *Limosa lapponica* and Bristle-thighed Curlews *Numenius tahitiensis*. Less well-known is that similar spectacular migrations seem also to be made by some smaller waders on their autumn migration, such as juvenile Sharp-tailed Sandpipers *Calidris acuminata* (R.E.G., unpubl. data). But some of the first evidence of such migrations came from Ruddy Turnstones *Arenaria interpres*, in a paper by Max C. Thompson (1974). The story of the research behind this is intriguing, gory, and well worth repeating.

Thompson and colleagues spent several autumns in the late 1960s rocket-netting Ruddy Turnstones on St George Island in the Pribilof Islands chain south of Alaska. The lure at that time for both the turnstones and wader-catchers was that over 10,000 Ruddy Turnstones were staging there in late July and August, to feed on myriads of blow-fly larvae associated with large numbers of rotting Northern Fur Seal *Callorhinus ursinus* carcasses. In turn, the seal carcasses were there because of licensed killing every year of several thousand seals.

Catching the birds on the seal "killing fields" was not for the faint-hearted, and the paper graphically describes the challenge of "twinkling" the birds into the catching area by crawling through the rotting seal carcasses. But overall the research was highly successful: during 1964–1968 over 18,000 turnstone captures were made, with many caught in more than one year.

Ringing recoveries from Pribilof Ruddy Turnstones confirmed that the main wintering areas were on southwest Pacific islands, centred in the Marshall, Gilbert and Ellis Islands, between 3,200 and 6,500 km away from the Pribilof Islands. That these Ruddy Turnstones almost certainly made a long southwards flight towards these wintering areas is confirmed by the story of the recovery of one bird (ring number 712-06593). This bird was first captured on 23 August 1965 and weighed 174.0 g, recaptured on 27 August 1965 at 154.8 g, and then was seen 3.5 days later at the French Frigate Shoals in the NW Hawaiian Islands, 3,600 km from the Pribilofs. The tale of its collection is bizarre. In Thompson's words:

> "The POBSP [the Smithsonian Institute's Pacific Ocean Biological Survey Program] personnel then on the French Frigate Shoals were just boarding a Coast Guard aircraft to return to Honolulu when a flock of turnstones, including one color-marked bird, flew past the plane. Since the collecting equipment had been packed and was unavailable, an M-1 rifle was borrowed from Coast Guard Loran Station personnel. Three shots, none of which hit the bird, were fired: the third shot knocked a piece of asphalt out of the runway and killed the bird."

Unfortunately, the last link in the story – the weight of the bird so soon after its arrival – cannot be told because the station balance was broken.

DEPARTURE MASS AND ESTIMATED BODY CONDITION AND FLIGHT RANGES FROM THE PRIBILOF ISLANDS

In the absence of precise evidence of migratory pathways, such as from satellite transmitters which cannot yet be fitted on such small shorebirds, the evidence that Ruddy Turnstones make a long-distance non-stop autumn migration across them Pacific remains speculative, but there are indications that point clearly to these birds preparing for a long flight from the Pribilofs.

The Pribilof Ruddy Turnstones gained mass steadily during August, from around 115 g to an average of 153 g at departure time, with the heaviest bird being 195 g (Thompson 1974).

Although there is a surprising paucity of published data on autumn pre-migratory departure mass for Ruddy Turnstones, and most of this being for birds after their first major autumn (fall) migration south, the available evidence shows that the departure mass of the Pribilof Ruddy Turnstones are amongst the highest on record in autumn. Non-moulting birds (and hence those likely to be preparing for a further migration) in autumn in the UK were lighter (Morecambe Bay: average of 133.6 g (Clapham 1979); The Wash: 135 g (max. 171 g)

(Branson *et al.* 1979)), as also were birds preparing for departure from high-arctic breeding grounds (Alert, NW Territories, Canada, R.I.G. Morrison, pers. comm.: 130–140 g average departure mass, max. 156 g). Despite these lower masses all these birds were likely to be preparing to make a long-haul flight.

How far might "Thompson's Ruddy Turnstone" have been able to fly with a departure mass of 154 g (very close to the 153 g g average departure mass from the Pribilofs)? We know of no published information on the body condition of Turnstones in autumn prior to their departure on a long migratory flight, either for the Alaskan population or populations on other flyways. Although there is information on the condition of Pacific Ruddy Turnstones in the austral summer (Johnson & Morton 1976), at that time of year lean mass is likely to be considerably lower than that of "pre-migratory" birds, owing to pectoral muscle hypertrophy at such times – lean mass of these birds was only 93.2 g, considerably lower than that of pre-migratory birds (see below). Hence using such southern summering condition to estimate the lean mass and fat loads of pre-migratory birds (e.g. Houston & Barter (1990) for Ruddy Turnstones departing Australia) will overestimate fat loads and flight ranges, so such assessments should be treated with considerable caution in the absence of lean mass and fat mass condition data for the relevant season and location.

There are no available body condition analyses of Ruddy Turnstones preparing for autumn migratory departure. However, two datasets of (northern) spring body condition of Ruddy Turnstones just before their migratory departure are available. So to estimate flight range of "Thompson's bird" we have used the body condition of Ruddy Turnstones (i) in April in South Africa (Summers *et al.* 1989) and (ii) in mid-May in NE England (N.C.D. unpubl. data).

The average total mass of both these groups of Ruddy Turnstones were very similar to average departure mass from the Pribilofs: South African birds averaged 157.9 g, with an average total lean mass of 103.6 g, and were carrying an average of 34% fat. In NE England the average mass of three Turnstones in mid-May was 158 g. These birds had an average total lean mass of 110 g, and were carrying an average of 30% of their total mass as fat. Such fat loads indicate that both groups of birds were preparing for a long non-stop flight.

To estimate the flight range of the "Thompson's Ruddy Turnstone" from the NE England birds' body condition we have therefore made an assumption that it was carrying a 30% fat load, and so had a lean mass of 108 g. Applying the flight range formula of Davidson (1984), and a flight speed of either 56 kph (35 mph) (McNeil & Cadieux 1972) or 64 kph (40 mph) (Thompson 1974), flight range is estimated at between 2,520 and 2,780 km. Applying Summers & Waltner's earlier (1979) formula, which yields consistently longer ranges (see Davidson 1984), gives a flight range of 2,920–3,330 km. All these estimates are, however, shorter than the direct distance of 3,600 km between the Pribilofs and the French Frigate Islands (FFI).

Using the lighter 103.6 g lean mass from the South African birds, the flight range would have been 2,800–3,300 km (using the Davidson 1984 formula) or 3,300–3,700 km (using the Summers & Waltner 1979 formula).

At a steady 64 kph flight speed, this bird would have made the flight non-stop in 56 hours, so that there would have been up to a further 32 hours between its release on the Pribilofs and discovery on the FFI, given Thompson's (1974) information that the total time between these two events was 88 hours. We speculate that this bird is likely either to have fed and gained further fat in this period, and/or received considerable wind assistance on its flight to FFI. Using the Davidson (1984) flight range formula, this bird would need to have departed with a fat load of at least 37% of its total mass to reach the FFI in still air conditions, which coincidentally (if our assumption about lean mass is reasonable) is also the estimated fat load of this same bird when Thompson caught it on the Pribilofs a few days earlier, weighing 174 g.

We tentatively conclude that most Ruddy Turnstones departing the Pribilof Islands in autumn can make a direct non-stop flight as far as the NE Hawaiian Islands, but are very unlikely to get any further without stopping and refueling – unless they are departing the Pribilofs with much lower lean mass and hence higher fat loads. So to reach their main Pacific non-breeding areas such as the Marshall Islands at least one such refueling is likely to be needed in autumn.

HOW DO RUDDY TURNSTONES FUEL FOR A TRANS-PACIFIC FLIGHT?

Large-scale killing of seals on St George Island and nearby islands ended in the early 1970s and is now restricted to smaller-scale subsistence hunting. Also, there and elsewhere carcasses are no longer generally left to rot in the open. Some Ruddy Turnstones have, however, continued to stage on the Pribolof Islands in autumn, and continue to find carcasses to scavenge although not in such large concentrations as in the 1960s (R.E.G. pers. obs.).

In his 1974 paper, Thompson comments that Ruddy Turnstones had probably used the Pribilofs for thousands of years because of natural mortality of the large numbers of fur seals which used to live there before people appeared in the 18th century and started killing them for food and fur, so some natural fur seal-derived food for turnstones is probably still available. But since Ruddy Turnstones have been deprived of their superabundant food source on the Pribilofs at a key time and place for their autumn migration, how and where do they now find sufficiently abundant food to fuel-up for their trans-Pacific flight? And where were they earlier finding a sufficiently abundant food source for a trans-Pacific flight before large-scale seal killing on the Pribilofs began?

We are aware (R.E.G. pers. obs.) of a situation in upper Bristol Bay (about 500–700 km east of the Pribilof Islands on the Alaskan mainland) which may be an equivalent of the Pribilofs situation of old. There, beginning in late June and continuing through until September (i.e. the period of the year when turnstones are refuelling for their autumn migration), there are numerous salmon-netting sites operated from the shore. Coupled with this are many commercial and subsistence processing sites for the salmon. This results in large amounts of fish offal lying on the shore, which in turn attracts thousands of both Ruddy and Black *A. melanocephala* Turnstones (see Canaris & Kinsella 2007). This situation has probably been happening for at least scores of years. In addition, Black Turnstones and Ruddy Turnstones have also been recorded feeding on salmon eggs and dead post-spawning salmon along the rivers feeding into Bristol Bay and the southern Yukon-Kuskokwim Delta (R.E.G. pers. obs.). Ruddy Turnstones have also been regularly recorded as feeding in Alaska on racks of drying salmon (Petersen *et al.* 1991).

Since Ruddy Turnstones are so notoriously versatile and opportunistic in their feeding habits (see e.g. Gill 1986), it seems most likely that for a long time they have been exploiting a variety of these different natural and human-created food sources in the southern part of the Alaskan region in the early autumn, and that they move to exploit the most cost/beneficial source as and when each occurs.

Unlike Sharp-tailed Sandpipers, where it seems that it is

only juveniles which move from Siberian breeding grounds to stage in autumn on the south coast of Alaska before a trans-Pacific flight (R.E.G. pers. obs.), Thompson caught large numbers of juveniles as well as adult Ruddy Turnstones on the Pribilofs in the 1960s.

Ringing recovery evidence from Thompson's study suggests that the Ruddy Turnstones have a loop migration, returning north in spring around the Asian Pacific rim, including staging in Japan and Kamchatka. Thompson's ringing recovery evidence points to their breeding grounds being from Chuchotka in the far east of Siberia, east to St Lawrence Island off Alaska.

IMPROVING OUR UNDERSTANDING OF THE "TRANS-PACIFIC" SHOREBIRD FLYWAY

A large number of migratory shorebird species occur in the Pacific Region, but most migrate around the Pacific Rim, along the American Pacific flyway or the East Asian–Australasian flyway (Stroud *et al.* 2006). But it seems increasingly clear that a small number of shorebird species use a different strategy and migrate long-distances non-stop across the "Trans-Pacific Flyway" (nine species: see Stroud *et al*. 2006). For some, including Ruddy Turnstone, this seems to be only an autumn strategy, with birds following a Pacific Rim route in spring; for others such as Bristle-thighed Curlew this also involves a spring trans-Pacific flight of perhaps over 6,000 km with birds departing the Central and Southern Pacific with fat loads averaging a large 42% (Marks & Redmond 1994).

A number of flyway-scale conservation initiatives for waterbirds, both statutory and voluntary, have been developed and are being implemented around the world, but there has so far been little coherent attention to this "Trans-Pacific Flyway", the status of its shorebird populations and conservation challenges for a flyway with so much seawater and so little land.

We believe that the time is now ripe to pool our past and present knowledge, and re-examine it in the light of the recent findings from satellite telemetry and other information, so as to prepare a review of all we know (and do not know) about shorebird migration strategies on this least known of all shorebird flyways around the world, and to look at how a conservation strategy for the flyway might be initiated.

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We were first intrigued by Max Thompson's tale of Ruddy Turnstone catching on the Pribolof Islands when reading it as students in the 1970s. With the recent and spectacular research findings on non-stop Pacific crossings by larger shorebirds such as Bar-tailed Godwits and Bristle-thighed Curlews we re-read Max Thompson's 1974 paper with renewed interest and it struck us that it now has even greater relevance to our still limited understanding of the Pacific flyway for shorebirds. We are grateful to Max Thompson for his further information and suggestions and encouragement to prepare this note, to Guy Morrison for information about departure mass from Alert, and to Nils Warnock for his helpful referee's comments.

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