Waterbird phenology and opportunistic acceptance of a low-quality wader staging site at Lake Baikal, eastern Siberia

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We analyse late summer phenology, abundance, and diversity of waders and waterfowl on a small gravel island, Kosa, on the western shore of Lake Baikal, eastern Siberia. We expected that the assemblages of waterbirds at such a small-scale, low quality roosting site would be characterised by lower species-diversity and numbers compared with high-quality staging sites like coastal mudflats. In comparison with such sites, however, Kosa Island hosted a surprisingly diverse wader assemblage. Abundance, in contrast, was as expected very low, and rather equally distributed across species. Consequently, Shannon diversity indices and the evenness of species abundance were high compared to high quality staging sites like the German Wadden Sea. We speculate that the combination of high diversity and high evenness indices may generally characterise low quality staging sites that are visited by a wide array of species in an opportunistic fashion. However, comparative analyses of a larger sample of sites are needed to test this prediction.

INTRODUCTION

The value of highly productive mudflats and wetlands like the European Wadden Sea or the Yellow Sea as major stopover and refuelling sites for arctic breeding waders and waterbirds is well established (e.g. Meltofte *et al.* 1994, Poot *et al.* 1996, Hötker *et al.* 1998, Butler *et al.* 2001, Barter 2002). These areas include predator-safe roosting sites and allow efficient food-intake to quickly replenish body fat and protein loads for the remaining journey towards the wintering grounds (Goss-Custard 1980, Piersma *et al.* 1987, Zwarts 1996, Kvist & Lindstrøm 2003). Hence, they sustain impressive assemblages of staging waders and waterfowl, which are usually dominated by a few very numerous species but which also support a wide array of less abundant visitors (cf. Meltofte *et al.* 1994, Poot *et al.* 1996). In comparison, small-scale staging sites with limited feeding opportunities are of minor significance. However, even species that are known to cover vast distances in non-stop flight to reach optimal stopover sites (e.g. Piersma 1987, Butler *et al.* 2001, Baker *et al.* 2004) cannot rely solely on high-quality foraging sites along their migration routes. Under some conditions they may have to accept opportunistically almost any possible staging site in order to recover body fat and protein reserves. It is likely that this will be particularly necessary with birds suffering from low body condition or depleted resources, in adverse weather situations, or in vast areas that do not provide optimal staging sites and may thus act as migration barriers (Berthold 1996). In such cases, small-scale staging sites may be of critical importance as a "safety-exit" for migrating waterbirds. In comparison to major waterbird stopover sites, however, roosting assemblages at such low-quality sites have received much less attention. The purpose of this study is therefore to characterise the waterbird assemblages at a low-quality staging site at Lake Baikal.

Despite huge river systems and marshy lowlands, inland central and eastern Siberia lack large suitable staging sites for waders, especially for species that prefer shallow mudflats (Franz 1973, Goroshko 1999). For the latter, even the huge Lake Baikal provides relatively little suitable habitat for breeding or staging. This is mainly a consequence of its geological history. Being situated in a tectonic rift, the shores of Lake Baikal are mostly steep and rocky (Kozhov 1972, Skrjabin 1975, Mlikovsky *et al.* 2002). The delta regions of its tributaries (e.g. Selenga River, Barguzin River, Verkhnaya Angara River) are the main exceptions. There, extensive wetlands and sandy and muddy shores provide foraging opportunities for a large variety of waders and waterfowl (e.g. Tolchin *et al.* 1977, Zhuravliev *et al.* 1991, Goroshko 1999, Fefelov *et al.* 2001, Mlikovsky *et al.* 2002, Fefelov & Tupitsyn 2004).

In this study we analyse late summer phenology, abundance, and diversity of waders and waterfowl on Kosa Island, a small staging site on the western shore of Lake Baikal. Diversity and evenness indices are compared with higher quality staging sites in the Asian steppe zone and in central Europe. Our data also contribute to the knowledge of waterbird migration phenology on the east-Asian Australasian Flyway (Parish *et al.* 1987), and provide information of value to conservation for the Pribaikalski National Park

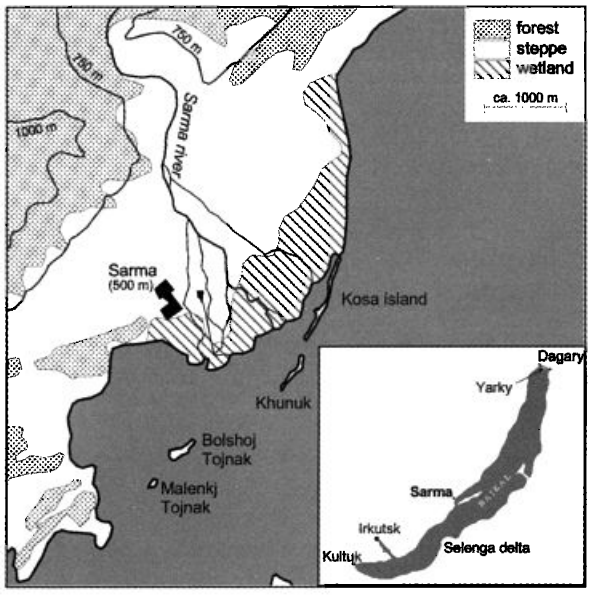

Fig. 1. Location of the study site, Kosa Island, Lake Baikal, Russia. The inset shows the whole of Lake Baikal, which is about 600 km in length.

(Mlikovsky *et al.* 2002), which has been notified as UNESCO World Heritage site.

STUDY SITE

Kosa Island is a small island 500 m off the delta of the Sarma River, west of the large Olkhon Island in the western part of Lake Baikal called the Maloe More ("small sea") (Irkutskaya Oblast, Russia, 53°05'N, 106°51'E, Fig. 1). It is sickle-shaped and about 1 km long, but only 2–20 m wide. It consists of coarse rubble sediments that were deposited by strong lake currents. The central and southernmost parts of the island, which are elevated about one metre above average lake water level, are covered with dense tussock grasses and perennial herbs. Dominant plant species include *Deschampsia sukaczevii*, *Calamagrostis langsdorfii*, *Phalaroides arundinacea*, and *Elymus sibiricus*. Shrubs and trees are absent. The majority of the island has sparsely vegetated stony beaches with gentle slopes and shallow waters suitable for foraging waders. Short grasses and herbs (e.g. *Polygonum amphibium*) growing in the shallow water and on low ground provide shelter for more elusive species like Sharp-tailed Sandpiper, Long-toed Stint, or Temminck's Stint (scientific names of birds mentioned in this paper are set out in Table 1). The island has no sandy or muddy sections. Water level increases considerably during the course of the summer from May until September or October (Kozhov 1972).

METHODS

Waders and waterfowl (Table 1) were censused daily between 3 July and 13 August 2002, and between 4 and 27 August 2003 except for five days when poor weather conditions made counts impossible. One to three observers slowly walked along the island and recorded all waterfowl and waders both on the island and in the surrounding waters within a distance of about 500 m. Adults and juveniles were distinguished whenever possible. Further records from previous expeditions in late summer 2000 and long-term observations by S.W. Pyzhjanov were included in the description of the staging site in Table 1. Species that prefer more sheltered sites with dense vegetation cover for foraging (Pacific Golden Plover, Snipes, Curlews, *Tringa* sandpipers) are considerably under-represented in our counts. These species were far more abundant in the extensive meadows of the Sarma Delta, but systematic counts there were impossible.

As an index of species diversity in 2002 and 2003 we used the Shannon Index (*Hs*) (Mühlenberg 1993, Hobohm 2000):

$$Hs = -\Sigma (p_i * \ln [p_i])$$
where $p_i = n_i/N$
and $n_i = n$ individuals of species i, and
N = total number of individuals.

In addition, evenness values (*Es*) were calculated as an index of the abundance distribution across species (*Es* = *Hs*/ln [*n* species], Mühlenberg 1993), with abundance distribution being increasingly equal with values approaching 1.

We compared indices from Kosa Island with data from the Tengiz area in Kazakhstan (31 counts at various sites in July and August 2003, L. Lachmann & H. Schielzeth, pers. obs.), the sewage farm of Münster in north-west Germany (20 counts in July and August 2002, unpub. data), and the eastern German Wadden Sea (half-monthly means July and August 1995–1998, and a synchronous count 25 August 1998, K. Günther, pers. comm.). Study sites are described in Schielzeth *et al.* (in press), Anthes *et al.* (2002), and Meltofte *et al.* (1994), respectively. Although a larger sample of sites with varying quality is necessary to statistically manifest the effect of staging site quality on species diversity and abundance, this initial comparison is made with the intention of depicting the potential magnitude of site quality effects on the composition of staging waterbird assemblages.

RESULTS

In 2002 and 2003, 56 waterbird species were recorded on Kosa Island, including six that bred (Table 1). A further 14 species have recently been found breeding in the Sarma Delta, including a significant breeding colony of Mongolian Gulls with *c.*1,100–1,200 pairs on the islands of Bolshoj Tojnak and Khunuk (Table 1, Fig. 1). Records of regionally rare species included Baikal Teal, an adult Red Knot (10–16 August 2003), and 3 observations of Little Curlew (max. 25 birds on 14 August 2003). An adult White-rumped Sandpiper (15–17 July 2002) and three Bar-tailed Godwits (adult male, 19 and 20 July 2002; two adults, 14 August 2003) were the first observations for the Baikal region (cf. Fefelov *et al.* 2001, Fefelov & Tupitsyn 2004).

Most migratory species visited Kosa Island in small numbers, although their presence is rather constant and predictable (Table 1), suggesting that the site serves as a regular staging area. Only a few species, mostly *Calidris*- (Fig. 2) and *Tringa*-sandpipers (Fig. 3), occasionally built up larger flocks. Nevertheless their abundances were magnitudes smaller compared with those at the nearby Selenga Delta (Goroshko 1999, Fefelov *et al.* 2001, Fefelov & Tupitsyn 2004). Migration of adult *Calidris* sandpipers dominated in both years until mid-August. Thereafter, juvenile Little and Temminck's Stints increased rapidly and mostly accounted for the second migration peak (Fig. 2). Observations of two orange-flagged adult Red-necked Stints (29 July 2000,

Table 1. Waterbird species (waterfowl, waders, terns, gulls) recorded on Kosa Island and the adjacent Sarma River mouth in late summer 2002 and 2003. The number of observation days gives an impression of the regularity and predictability of the presence of each species. Maximum possible figures are 42 for 2002 and 21 for 2003. Migration status is given for the whole Sarma Delta area and is mainly based on long-term observations by S.W. Pyzhjanov: av = abundant visitor, cv = common visitor in small numbers, rv = rare visitor that does not occur each year, v = vagrant with < 5 records. The number of breeding pairs on Kosa Island was estimated for 2002 and 2003. Additionally, breeding status is given for the whole Sarma Delta region (rb = regular breeder; nrb = non-regular breeder).

Common name	Scientific name	Observation days		Maximum count		Migration status	*N* pairs Kosa	Breeding status Delta
		2002	2003	2002	2003			
Anatidae								
Ruddy Shelduck	*Tadorna ferruginea*	33	17	5	20	cv	–	nrb
Eurasian Wigeon	*Anas penelope*	11	5	11	26	av	–	nrb
Falcated Duck	*Anas falcata*	8	–	2	–	rv	–	–
Gadwall	*Anas strepera*	4	1	6	3	cv	–	nrb
Baikal Teal	*Anas formosa*	3	–	2	–	rv	–	–
Common Teal	*Anas crecca*	14	10	20	90	av	–	rb
Mallard	*Anas platyrhynchos*	21	8	12	20	cv	–	rb
Northern Pintail	*Anas acuta*	11	4	12	22	av	–	nrb
Garganey	*Anas querquedula*	4	1	25	3	cv	–	–
Northern Shoveler	*Anas clypeata*	8	6	11	18	av	–	rb
Common Pochard	*Aythya ferina*	–	1	–	2	rv	–	–
Tufted Duck	*Aythya fuligula*	39	10	176	25	av	*c.*5	rb
White-winged Scoter	*Melanitta deglandi stejnegeri*	31	12	385	10	av	5	rb
Goldeneye	*Bucephala clangula*	40	10	43	24	av	–	rb
Smew	*Mergus albellus*	1	–	1	–	rv	–	–
Red-breasted Merganser	*Mergus serrator*	35	12	71	10	av	*c.*2	rb
Goosander	*Mergus merganser*	1	4	1	22	av	–	nrb
Charadriidae								
Little Ringed Plover	*Charadrius dubius*	27	19	34	11	cv	6	rb
Ringed Plover	*Charadrius hiaticula*	1	–	1	–	rv	–	–
Pacific Golden Plover	*Pluvialis dominica fulva*	2	1	11	1	av	–	–
Grey Plover	*Pluvialis squatarola*	–	3	–	1	cv	–	–
Northern Lapwing	*Vanellus vanellus*	1	3	1	1	cv	–	rb
Scolopacidae								
Red Knot	*Calidris canutus*	–	6	–	1	v	–	–
Sanderling	*Calidris alba*	5	–	2	–	rv	–	–
Red-necked Stint	*Calidris ruficollis*	20	20	5	64	av	–	–
Little Stint	*Calidris minuta*	14	18	4	17	av	–	–
Temminck's Stint	*Calidris temminckii*	27	14	9	8	av	–	–
Long-toed Stint	*Calidris subminuta*	13	6	3	3	cv	–	nrb
White-rumped Sandpiper	*Calidris fuscicollis*	3	–	1	–	v	–	–
Sharp-tailed Sandpiper	*Calidris acuminata*	14	10	12	6	cv	–	–
Curlew Sandpiper	*Calidris ferruginea*	4	5	3	2	cv	–	–
Ruff	*Philomachus pugnax*	3	–	2	–	cv	–	–
Common Snipe	*Gallinago gallinago*	–	–	–	–	av	–	nrb
Pintail Snipe	*Gallinago stenura*	1	–	1	–	cv	–	–
Swinhoe's Snipe	*Gallinago megala*	1	–	1	–	cv	–	–
Black-tailed Godwit	*Limosa limosa*	4	3	1	2	rv	–	–
Bar-tailed Godwit	*Limosa lapponica*	2	–	1	–	v	–	–
Little Curlew	*Numenius minutus*	–	1	–	2	rv	–	–
Whimbrel	*Numenius phaeopus*	1	2	1	1	cv	–	–
Eurasian Curlew	*Numenius arquata*	3	–	5	–	cv	–	–
Far Eastern Curlew	*Numenius madagascariensis*	5	–	3	–	rv	–	–
Spotted Redshank	*Tringa erythropus*	12	1	16	1	cv	–	–
Marsh Sandpiper	*Tringa stagnatilis*	2	5	1	3	cv	–	nrb
Common Greenshank	*Tringa nebularia*	28	8	13	4	cv	–	–
Green Sandpiper	*Tringa ochropus*	2	–	2	–	cv	–	–
Wood Sandpiper	*Tringa glareola*	28	20	36	19	av	–	–
Terek Sandpiper	*Xenus cinereus*	13	15	3	4	cv	–	–
Common Sandpiper	*Actitis hypoleucos*	31	17	12	3	av	–	rb
Grey-tailed Tattler	*Heteroscelus brevipes*	34	20	13	21	av	–	–
Ruddy Turnstone	*Arenaria interpres*	6	6	7	2	cv	–	–
Laridae								
Black-headed Gull	*Larus ridibundus*	13	8	30	4	cv	–	–
Common Gull	*Larus canus*	12	3	2	2	av	–	–
Mongolian Gull	*Larus mongolicus*	–	16	n.c.	60	av	5	rb
Caspian Tern	*Sterna caspia*	7	–	22	–	rv	–	–
Common Tern	*Sterna hirundo*	36	18	60	70	av	20	rb
White-winged Black Tern	*Chlidonias leucopterus*	4	10	4	120	av	–	–

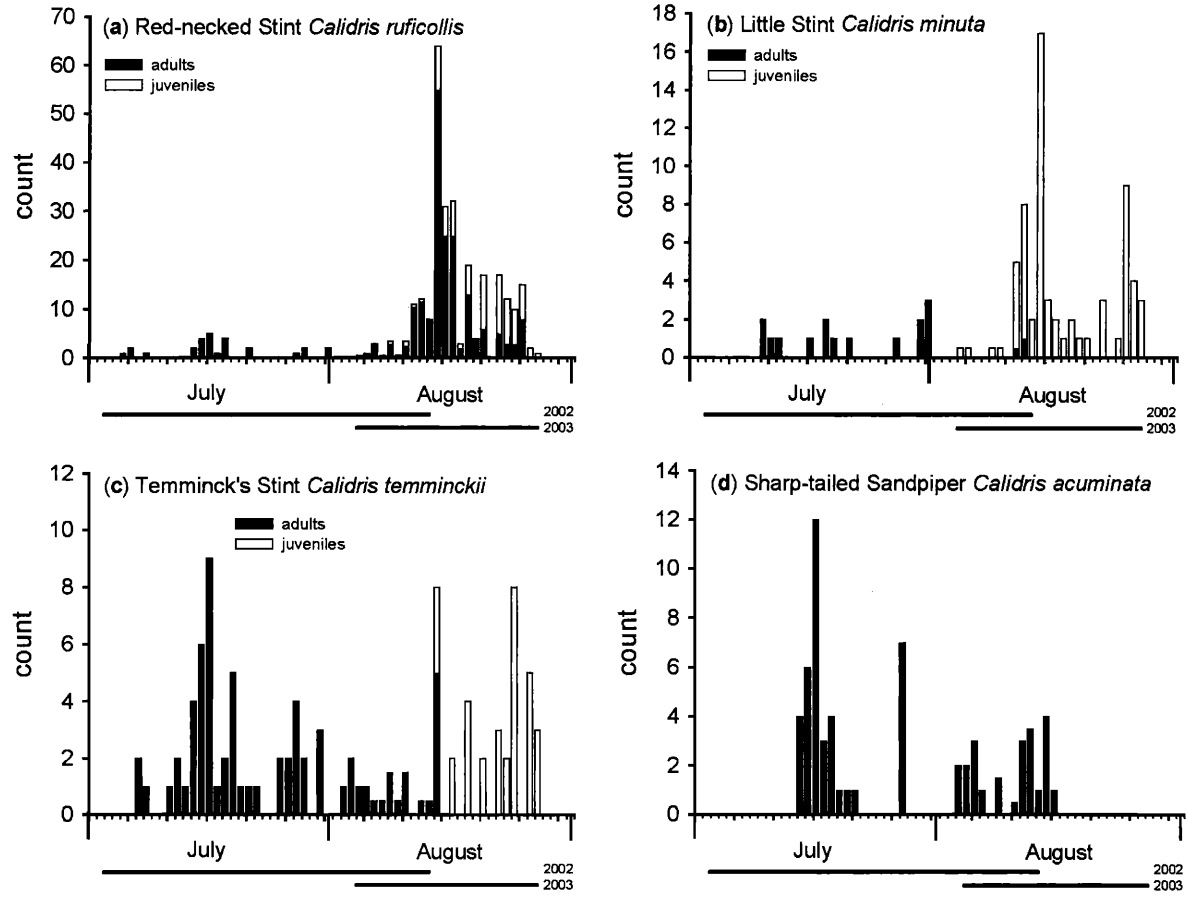

Fig. 2. Phenology of adult and juvenile *Calidris* sandpipers at Kosa Island, July and August 2002 and August 2003. Only adults were observed in Sharp-tailed Sandpiper. The lines beneath the time scale indicate observation periods in 2002 and 2003. Average counts for both years are given for the period of overlapping observations (4–13 August).

6 August 2003) confirm that waders passing through the Sarma Delta winter along the south-east Asian (Pyzhjanov & Fefelov 1997) and Australasian coasts. A Grey-tailed Tattler ringed on 28 August 2001 on Kosa Island was re-sighted at the same place on 26 July to 12 August 2002, indicating site fidelity (see also Gavrilov *et al.* 1998).

Waterbird counts revealed large flocks of some duck species in late summer (Table 1, Fig. 4). In most species, numbers peaked in July and steadily decreased towards late August. Only Common Teal numbers peaked later (in late August (Figure 4a)). We suspect that Tufted Duck, Goldeneye, and White-winged Scoter use the sheltered western part of Lake Baikal for post-breeding wing-moult, while the pattern of Common Teal migration suggests a short stopover and rapid passage. Numbers of Common Terns increased post-breeding and peaked in late July and early August, while White-winged Black Terns showed a rather short passage in mid August (Fig. 5). The post-breeding peak in Common Tern numbers was only to a small extent due to fledglings from Kosa and surrounding islands that were included in the daily counts. Mostly, the peak in 2002 resulted from actively migrating adults along the western shore of Lake Baikal.

Wader diversity and evenness indices from Kosa Island were rather high compared to staging sites in central Europe and Kazakhstan (Fig. 6). Although total species numbers in the study period were similar at Kosa Island compared to most other sites (Kosa: 32, Tengiz: 31, Münster: 20, Wadden Sea: 33), low evenness values at high-quality staging sites like the Wadden Sea reflect the dominance of a few abundant species (e.g. Dunlin, Red Knot, Bar-tailed Godwit). In contrast, species abundance was much more evenly distributed at Kosa Island, resulting in an evenness value close to 1. The low diversity and evenness values at the sewage farms of Münster reflect a combination of a low number of species with an extreme dominance of Northern Lapwing in all counts.

DISCUSSION

Our data confirm that even small, sub-optimal stopover sites like Kosa Island are frequented regularly by the full spectrum of waterbirds passing through eastern Siberia. Despite the high diversity of waders and waterfowl visiting the island, most species occur in only small numbers. This contrasts with high-quality staging sites like the European Wadden Sea and the east Asian Yellow Sea, where a few species in huge individual numbers dominate the assemblages of roosting birds (e.g. Meltofte *et al.* 1994, Barter 2002). The combination of high species richness with rather even abundance distribution across wader species at Kosa Island results in a diversity index comparable with and an evenness value that is remarkably higher than that at major wader stopover sites like the German Wadden Sea. Assuming that our one-year's data from the four sites used for comparison are representative of species composition over several years, we hypothesise that such a combined diversity–evenness pattern may

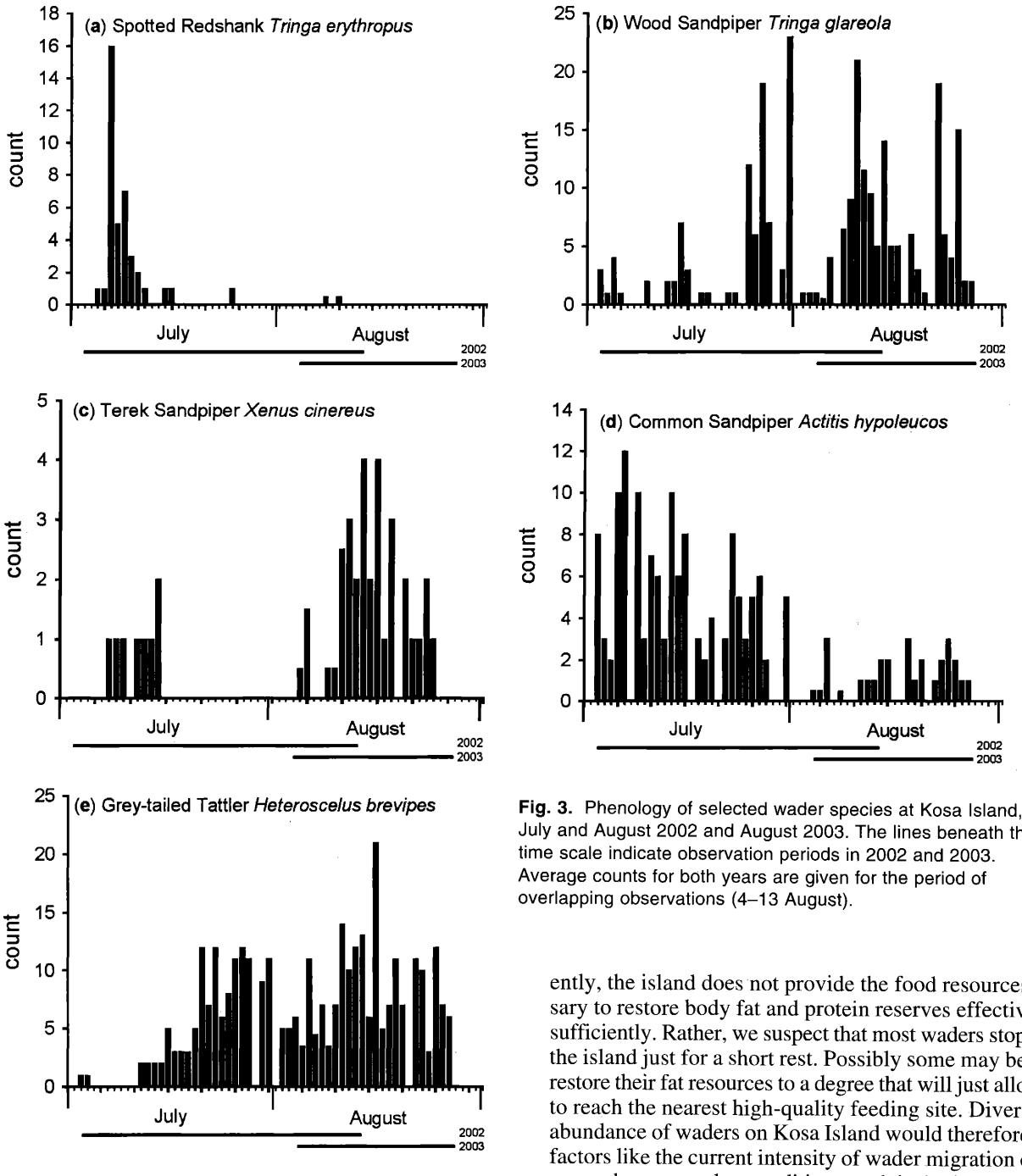

Fig. 3. Phenology of selected wader species at Kosa Island, July and August 2002 and August 2003. The lines beneath the time scale indicate observation periods in 2002 and 2003. Average counts for both years are given for the period of overlapping observations (4–13 August).

be characteristic for staging sites that are visited by a wide variety of species in an opportunistic fashion without a major component of regular use by discrete populations. In contrast, regular use by a few extremely abundant species results in an equally high diversity index, but considerably lower evenness values. Further studies comparing a larger sample of sites are necessary to test the generality of this prediction.

What are the potential factors that determine the species and abundance composition found at Kosa Island? While reliable high-quality mudflats and wetlands like the nearby Selenga Delta (Fefelov *et al.* 2001, Fefelov & Tupitsyn 2004) may serve as traditional long-term staging areas, diversity and abundance patterns found at Kosa Island are more likely the result of opportunistic stopover decisions. Anecdotal observations indicate that most waders only rest on the island and do not search for food there (low pecking rate). Apparently, the island does not provide the food resources necessary to restore body fat and protein reserves effectively and sufficiently. Rather, we suspect that most waders stopover on the island just for a short rest. Possibly some may be able to restore their fat resources to a degree that will just allow them to reach the nearest high-quality feeding site. Diversity and abundance of waders on Kosa Island would therefore reflect factors like the current intensity of wader migration over the area, adverse weather conditions, and the body conditions of the birds migrating overhead. In contrast, regular use of the island as a stopover site for feeding may only apply in those species for which the island provides suitable feeding habitat, such as Common Sandpiper, Little Ringed Plover, Grey-tailed Tattler, and Red-necked Stint. However, the way in which waders use Kosa Island needs to be addressed with specifically designed studies.

The vast distance between Lake Baikal and the nearest coast may contribute to the comparatively small passage of particular wader species at Kosa Island. For example, most arctic-breeding *Calidris* sandpipers take long coastal routes along the Atlantic or Pacific shores towards their tropical winter quarters (e.g. Boere 1976, Evans & Davidson 1990, Hötker *et al.* 1998, Wilson & Barter 1998), while the shorter cross-continental route is used to a much lesser extent (e.g. Parish *et al.* 1987, Gavrilov *et al.* 1993, Minton 1996, 1998).

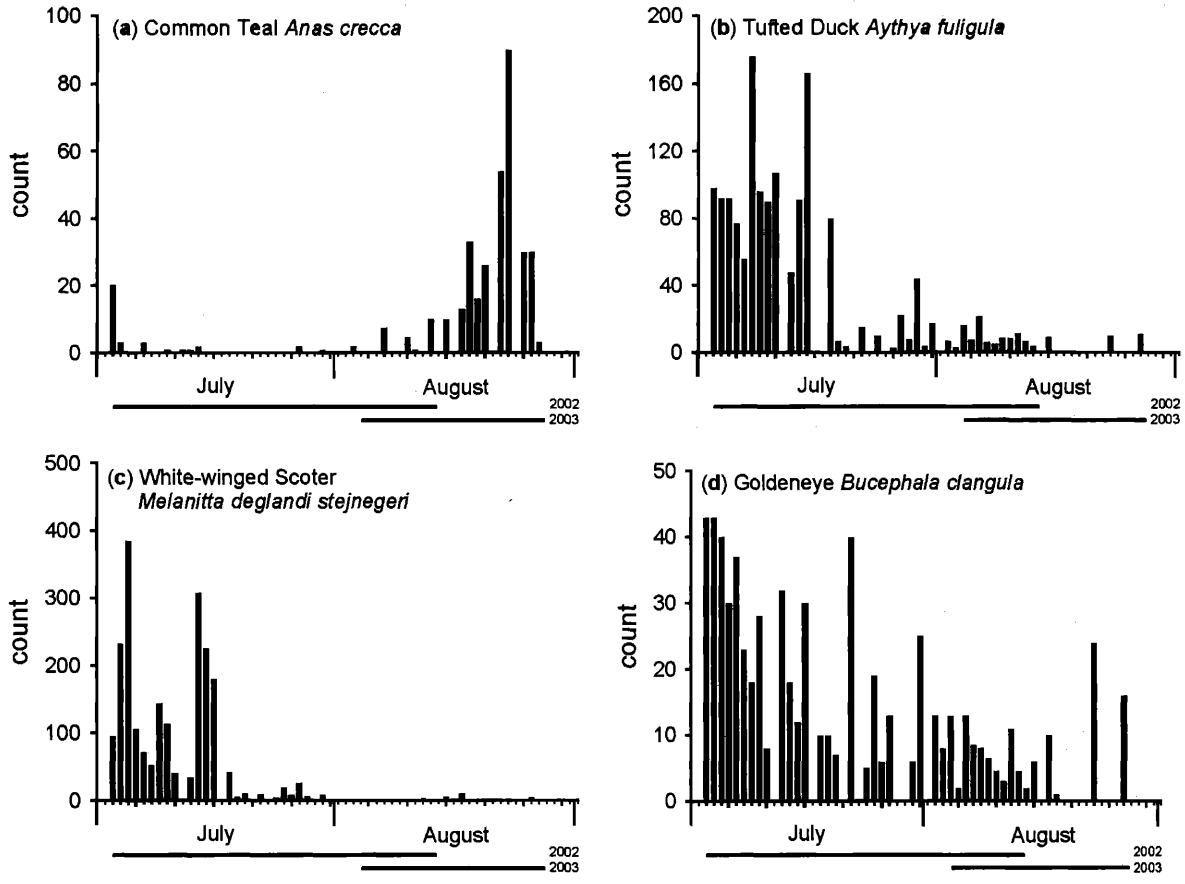

Fig. 4. Phenology of selected waterfowl species at Kosa Island, July and August 2002 and August 2003. The lines beneath the time scale indicate observation periods in 2002 and 2003. Average counts for both years are given for the period of overlapping observations (4–13 August).

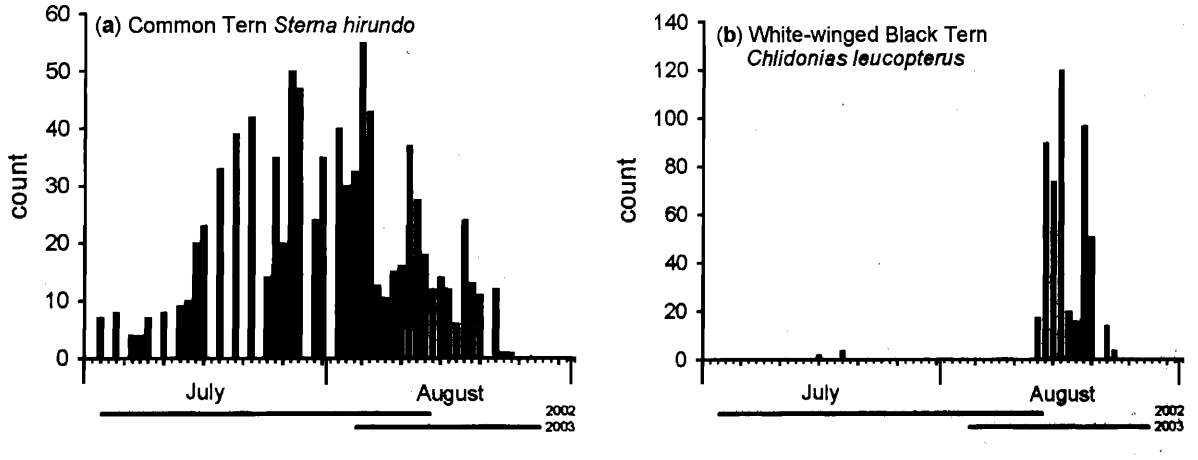

Fig. 5. Phenology of (a) Common Tern and (b) White-winged Black Tern at Kosa Island, July and August 2002 and August 2003. The lines beneath the time scale indicate observation periods in 2002 and 2003. Average counts for both years are given for the period of overlapping observations (4–13 August).

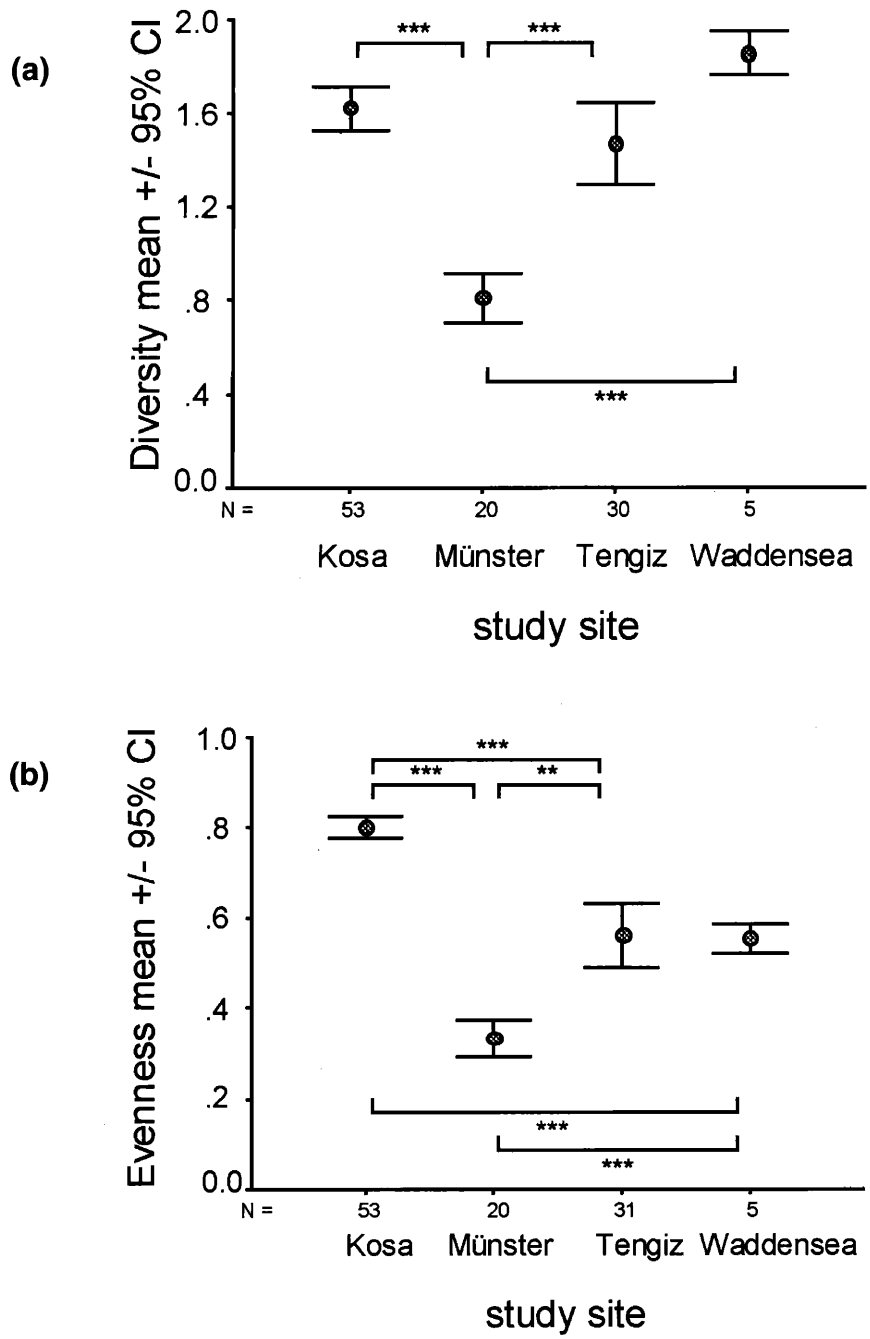

Fig. 6. Species Diversity (a) and Species Evenness (b) indices for Kosa Island, the sewage farms of Münster, the Tengiz area, and the Northern German Wadden Sea (Schleswig Holstein) in July and August. Mean values ±95% confidence intervals are given. One-way-ANOVA (a) $F_{3,104} = 27.6$, $P < 0.001$, (b) $F_{3,105} = 71.7$, $P < 0.001$. Significant group mean differences are indicated (Tukey HSD post-hoc test; $^{**}P < 0.01$, $^{***}P < 0.001$).

The long coastal routes are preferable from an energetic perspective (Parish *et al.* 1987, Alerstam 2001, Alerstam *et al.* 2003), because coastal regions provide the required network of high-quality staging sites. In addition, some of those species that choose the inland route may pass Lake Baikal without stopping. Sharp-tailed Sandpipers or Little Curlews, for example, are well capable of covering distances of up to 4,000–7,000 km in non-stop flight (Parish *et al.* 1987, Wilson & Barter 1998, Battley 2002). Having fuelled up at a first stopover close to their breeding grounds, these birds may migrate directly to more suitable staging sites in the steppe zone further south and south-east. In contrast, low counts of typical inland migrants such as Pacific Golden Plover or *Tringa* and *Gallinago* sandpipers at Kosa Island probably do not reflect low numbers using the inland east-Asian Australasian flyway. Mostly, these species stopover in widely dispersed vegetated wetlands and meadows. Furthermore, Kosa Island does not provide suitable staging habitat for these species, which are known to rest in large numbers in wetlands around Lake Baikal (e.g. Fefelov & Tupitsyn 2004).

Compared with other staging sites at the same latitude, autumn wader migration at Kosa Island, and especially juvenile passage, apparently occurs rather early in the season (Figs 2 & 3), though our lack of data for September means that we cannot be quite sure about this. In central Europe, juvenile migration of most *Calidris* sandpipers takes

place in September, ending in late September or early October (e.g. Thyen *et al.* 2000). Although some waders like Dunlin and Sanderling pass the Russian Far East rather late during September and until mid October (P. Tomkovich, pers. comm.), earlier passage through eastern Siberia by some species could result from two overlapping factors. First, waders choosing a southerly rather than a south-westerly migration route have to cover a shorter distance to reach the same latitude. Second, weather conditions in eastern Siberia become adverse very quickly in September and might constrain the time available for migration on this route. Likewise, passerine and waterfowl migration in the Russian Far East (Lake Khanka near Vladivostok, pers. obs., Schielzeth & Doer 2003) apparently occurs earlier and over a much shorter period compared with Europe.

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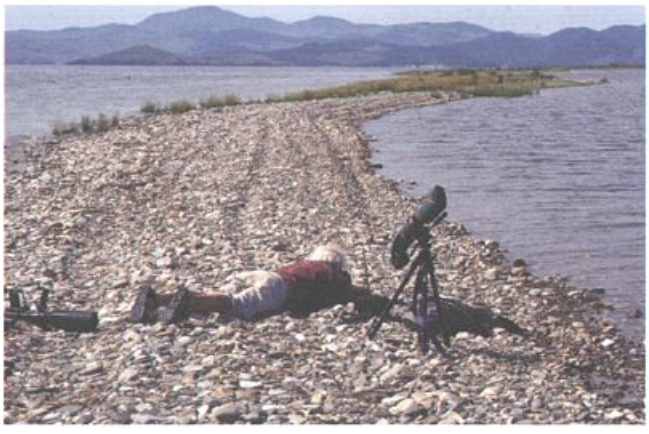
Aerial view of the Sarma River delta. The delta with its wetlands and riparian woodland is set in a dry steppe landscape. The narrow pale band in the lake on the left is Kosa Island. (Photo: Nils Anthes, July 2002.)



The long, narrow stretch of gravel that is Kosa Island: not a place that affords extensive feeding habitats for waders. Here, Hans-Heiner Bergmann documents the nest site of a Little Ringed Plover. (Photo: Nils Anthes, July 2002.)

This adult White-rumped Sandpiper on Kosa Island was the first record of the species for inland Asia. (Photo: Jan Ole Kriegs, July 2002.)

Juvenile Little Stints are common migrants on Kosa Island. (Photo: Jan Ole Kriegs, July 2002.)

Long-toed Stints mostly occur during migration, but they occasionally breed in the extensive meadows of the adjacent Sarma River delta. (Photo: Jan Ole Kriegs, July 2002.)

Terek Sandpipers rarely occur in larger numbers, but are regular visitors to the Sarma River delta. (Photo: Jan Ole Kriegs, July 2002.)