Annual variation in breeding numbers of two gull species in response to regional stock size and local availability of Japanese Sand Lance on Rishiri Island, northern Japan

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Abstract Breeding population abundance such as colony size of seabirds is not generally considered to be particularly sensitive to the annual dynamics of the food conditions because of the long life-span and high adult survival rate. However, in seabird species in which adults decide to breed or not depending on the food conditions, population abundance can respond sensitively to the annual variation in the food conditions. Here, we examine the effects of the regional annual stock abundance of Japanese Sand Lance Ammodytes personatus, and their local temporal availability during the egg-laying period on the size of a Black-tailed Gull Larus crassirostris and Slaty-backed Gull L. schistisagus, breeding colony over 12 years on Rishiri Island, northern Japan. The total number of nests of both gull species increased significantly with the regional annual stock abundance, but not with the local temporal availability of the sand lance. The number of Black-tailed Gull nests without eggs was significantly higher in the year with lower local temporal availability indicating that more Black-tailed Gull parents gave up egg-laying after nest building. Colony size in these species can be a useful indicator reflecting local food conditions.

Key words Bio indicator, Breeding decision, Nest abandonment, Prey availability, Sabbatical

The breeding performance of seabirds, such as timing of breeding, clutch size, provisioning rate, or number of fledglings, varies considerably among years in relation to the annual dynamics of the food condition (reviewed by Furness & Camphuysen 1997; Durant et al. 2009). Unlike the breeding performance, breeding population abundance such as colony size and number of nests of seabirds, in general, is not considered to be so sensitive to annual dynamics of the food condition (Morrison 1986; Temple & Wiens 1989; Furness & Greenwood 1993). This is because seabirds are long lived and have high adult survival rates. Therefore, their population sizes generally vary very little from one year to the next independent of the annual variations of the food condition (Furness & Camphuysen 1997). However, in some seabird species adult birds can skip breeding and potential new recruits can choose not to establish breeding territories and nests in years of food shortage (Boekelheide & Ainley 1989; Bradeley et al. 2000; Pyle et al. 2001), thus the population abundance can decrease in the years of food shortage. Although in those species population abundance can respond sensitively to annual variations in the food condition, only a few studies have shown a close relationship between breeding population abundance and food condition (Crawford & Dyer 1995; Phillips et al. 1996; Parsons et al 2008). Furthermore, in some seabird species, breeders may stop breeding and desert their nests or offspring during the early stages of breeding when they face abrupt unfavorable conditions, including food shortage (Yorio & Boersma 1994; Crawford & Dyer 1995). In those species, the
number of deserted empty nests, as well as those of active nests with offspring may also reflect the food condition.

Seabirds are considered to decide whether to breed or not before the breeding season commences (Boekelheide & Ainley 1989; Bradeley et al. 2000; Pyle et al. 2001), then decide to lay eggs or not during the early stage of breeding (Giudici et al. 2010; Goutte et al. 2010), and to continue or abandon their offspring after starting to breed (Yorio & Boersma 1994; Crawford & Dyer 1995). Their decisions are thought, therefore, to be dependent on the food conditions during the different periods and in different areas. Before breeding begins, they have no breeding duties such as incubation or nest/chick guarding, so they can search their food and forage across a broad area; after breeding begins, and because of those duties, they can only forage over a narrow area (Hedd et al. 2014). Therefore, the decisions that seabirds make before and after beginning to breed can be affected by food conditions at different spatio-temporal scales.

Black-tailed Gull *Larus crassirostris* and Slaty-backed Gull *L. schistisagus* are both Larids that breed in northeastern Asia and southeastern Russia during April to August (The Ornithological Society of Japan 2012). A large colony of Black-tailed Gulls and a large breeding population of Slaty-backed Gulls occur on Rishiri Island, located in the northern Sea of Japan (Kazama et al. 2014, and this study). Black-tailed Gulls frequently skip breeding (Kazama et al. 2013) and Slaty-backed Gulls may also do so because other closely-related species also skip breeding (Calladine & Harris 1997). During the incubation period empty Black-tailed Gull nests are often observed (Kazama et al. 2014), indicating that many parents may desert during the early stages of breeding. A study using stable isotope analyses and examining stomach contents of the breeding adults has revealed that the diets of the two gull species on the island during the egg-laying period consist of krill, pelagic- and demersal fishes, mainly 0+ (larvae) and 1+(adult) Japanese Sand Lance *Ammodytes personatus* (hereafter referred to as sand lance) (Ito et al. 2012). In that study, simulation models indicated that the probability of sand lance consumption to all observed prey species was 52.4% for Black-tailed Gulls and 16.7% for Slaty-backed Gulls during egg formation (Ito et al. 2012). Around Rishiri island, sand lance are harvested commercially during the periods just before the gulls start breeding (March) to a month after breeding finishes (August), and the harvests varied considerably among years (Department of Fisheries and Forestry of Hokkaido Government 2013, and this study). Therefore, breeding population abundance of the gulls, including both active and empty nests, can be expected to reflect to the harvest conditions of the sand lance during different periods and in different areas.

In the present study, we examined the effects of food conditions at different spatio-temporal scales on the breeding population abundance of two gull species on Rishiri Island. First, we counted the active and empty nests of the two gull species during incubation over a period of 12 years (2001–2011). Then, to investigate the rate of nest desertion of Black-tailed Gulls, we observed their nest building and egg-laying behavior during the early stage of breeding for two years. Finally, we examined the relationship between the annual stock abundance of sand lance in the broad region and the species’ local temporal availability during the egg-laying period of the gulls within their foraging range, and the numbers of both active and empty nests. We predicted that total number of nests increases with annual sand lance stock abundance, but the proportion of empty nests to total nests increases depending on the local temporal availability of sand lance.

**METHODS**

1) **Study area**

The study was conducted on Rishiri Island (45°14′N, 141°09′E) located about 40 km off the west coast of Northern Hokkaido, Japan (Fig. 1). The Black-tailed Gulls breeding on the island migrate seasonally. After breeding they move southward and winter in the southwestern part of the Sea of Japan, returning to the study colony in late March or April (Kazama et al. 2013). Slaty-backed Gulls do not migrate and are observed all year around on the island (K. Kosugi personal observation). Both species establish their breeding territories and build their nests in early May, and lay their first eggs during the period from mid May to mid June (Kazama et al. 2008; K. Kazama personal observation). Black-tailed Gulls breed colonially on a gently sloping coastal meadow. From 2001 to 2009 the Black-tailed Gull colony was located entirely in the Oiso area, in the northwestern part of the island. However, after 2010 some birds began breeding in the Shinminato area, 2 km southwest of Oiso; thus the colony became...
2) **Counts and estimates of nest numbers**

Nests of both gull species were counted during late May and June every year, during the period after the completion of the clutch and before the hatching of the chicks. During 2001 to 2011, mean clutch initiation and completion date of the study colony of Black-tailed Gulls was estimated from the breeding information obtained by monitoring studies at the same colonies following the methods of Kazama et al. (2008). Nest counts were made 10 to 15 days after the estimated clutch completion date. In 2012, when the monitoring study was not conducted, Black-tailed Gull nests were counted at the same date as in 2011.

Black-tailed Gull nests were counted from 2001 to 2011 using the method prescribed by the Soya sub-prefectural office and the Northern Hokkaido branch of the Wild Bird Society of Japan (Kazama et al. 2014). After 2010 nests were counted at both the Oiso and Shinminato colonies. The Black-tailed Gull colony was clearly subdivided into several small “sub-colonies” which contained nest cups defined as shallow hollows containing nesting material such as grasses. First, we defined each sub-colony as a polygon by surveying on foot and logged the coordinates of the vertices of the polygon using a hand-held GPS unit (Garmin International, Olathe, KS). The size of each sub-colony (m²) was calculated from the GPS data. Second, we established five transect lines crossing each sub-colony, and counted the number of nest cups and checked for the presence or absence of eggs within those nest cups along each two meter wide transect while surveying on foot. The total number of nests in each sub-colony was estimated using the following equation:

\[
\text{Total number of nests in sub-colony} = \text{average nest density of each transect (nests/m²)} \times \text{size of the sub-colony (m²)}
\]

The total number of nests in the whole colony was calculated as the sum of the total number of nests in all sub-colonies. Nests of Black-tailed Gulls containing one or more eggs were defined as “active” (breeding), and those without eggs were defined as “empty” including deserted, abandoned, or depredated nests (see Results and Discussion).

Slaty-backed Gull nests were counted by searching the coastline of the island from 2003 to 2012. Their nests consisted of a shallow cup made from grasses or branches and attended by one or both parents incubating or guarding. Since the contents of Slaty-backed Gull nests were not observed, because of the difficulty of access to their nests, their nests were not categorized as either active or empty.

3) **Observation of nest desertion behavior in 2007 and 2008**

To determine how to treat the empty nests, we observed nest desertion behavior before egg-laying by the Black-tailed Gulls from 25 April to 20 June in 2007 and 2008. Those periods were from two weeks before the date of first egg-laying (approximately early May) to the date of the first chick hatching (mid to late June) in the two years. Study sites (0.02 ha and 0.03 ha) were established in the sub-colonies at Oiso including 70 nests in 2007 and 107 nests in 2008. We observed territorial attendance, nest-building, and egg-laying behaviors of 24 individually identifiable pairs within the study sites in each year (Kazama et al. 2011). Observation was conducted from a blind, placed 5 m from the edge of the study sites, from 0600 to 1800 (Japan Standard Time) on two or three days each week. We defined the breeding territory of each pair as an area of <1.0 m radius within which both the male and female of the pair were observed attending and exhibiting one
or more mating behaviors such as courtship feeding or copulation, following Kazama et al. (2012). We checked whether nest cups (same definition as above) were formed or not, and whether eggs had been laid or not in each breeding territory, every five days to reduce disturbance. Observations amounted to a total of 2,400 nests-hours each year. These observations allowed us to establish the proportion of pairs not laying egg after nest building.

4) Collection of sand lance catch and sea-surface temperature data

We used data on the sand lance harvest provided by the Hokkaido Government (Department of Fisheries and Forestry of Hokkaido Government 2013). Harvest data of 0+ and 1+ sand lance were totalized and could not be separated. Most of the harvests were obtained using otter- and round setting-trawl nets in >40 m deeper water, in addition to dip-nets in the surface water (Fisheries Agency of Japan and Fisheries Research Agency 2013). The regional stock size of the species in the study region (the northern Sea of Japan and southwest Sea of Okhotsk) was not estimated (Fisheries Agency of Japan and Fisheries Research Agency 2013). Furthermore, although catch per unit effort (CPUE) data would be preferable to assumption of the annual stock size, CPUE of sand lance in the study region and period was not calculated (Fisheries Agency of Japan and Fisheries Research Agency 2013). However, in the Sea of Okhotsk, where this study was located (see Fig. 1), annual catch and CPUE of sand lance was significantly correlated during 2001 to 2011, our study period (otter-trawl: Pearson correlation coefficient $r=0.868$, $p=0.001$, round setting-trawl: $r=0.843$, $p=0.001$, data from Fisheries Agency of Japan and Fisheries Research Agency 2013). Thus, in the whole region of our study, the regional annual catch of sand lance was correlated with CPUE, and thus could be treated as the annual stock size. Therefore we used the annual total catch in the Soya sub-prefectural region, which was totalized in metric tons and contained several important fishing grounds for the species such as offshore from Rishiri and Rebun islands, and the east coast of Wakkanai (Area B in Fig. 1), as an index of the annual stock size in the region, and defined this as the “regional-annual catch”.

As an index of local temporal prey availability, we used monthly total sand lance catch which was also totalized in metric tons, using figures provided by Wakkanai City, Rishiri, and Rishiri-fuji towns (Area A in Fig. 1), which overlapped the foraging range of the gulls (approximately <40 km; Yoda et al. 2012), during May and June, the egg-laying period of the gulls, and defined this as the “local-temporal catch”. In these areas during May and June, sand laces were captured by small fishing boats mainly using dip- and lift-nets in the 10–40 m surface water, although some were captured by trawl-net in deeper water (Hokkaido Research Organization Fisheries Research Department 2013a, b). Therefore, the local temporal catch could be regarded as temporal availability of the sand lance for surface feeding gulls, although CPUE was not available for this catch data.

The northern Sea of Japan has high primary productivity in spring (April) because that is when the bloom in phytoplankton begins (Yamada et al. 2004). It was hypothesized that changes in sea-surface temperature (SST) in the spring relate to the distribution and abundance of prey fishes in the following season. To examine the effect of spring SST on the dynamics of the regional-annual sand lance catch, we used monthly mean SST data for April for an area of 60×100 km around Rishiri Island (Area C in Fig. 1), to index ocean temperature. The SST data for this sector from 2001 to 2009 was obtained from Hakodate Marine Observatory; it was based on merged satellite and in situ global daily SST (MGDSST) data collected by the advanced very high resolution radiometer (AVHRR) sensor on US National Oceanic and Atmospheric Administration (NOAA) satellites and the Japanese multi-functional transport satellite (MTSAT).

5) Statistical analyses

To examine the effects of the sand lance catches on the total number of nests which includes both active and empty nests, we employed General Linear Models (GLM). The GLM contained the total number of nests which included both active and empty nests as a dependent factor. Similarly, so as to examine the effect of the catches on the number of empty Black-tailed Gull nests, we employed the same GLM containing the proportion of the number of empty to total nests (%) as a dependent factor. All the GLM were simplified using Akaike’s information criterion (AIC)-based model selection. We compared the AIC of the two models which included either the regional-annual or local-temporal catch of sand lance as an independent factor, and selected the model with the smallest AIC as a best adequate model. A best adequate model was selected only if the model had...
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an AIC >2.00 lower than the others (Burnham & Anderson 2002). After the division of the colony of Black-tailed Gulls in 2010, at Shinminato egg-laying date was delayed and empty nests increased in the new colony compared with previous years at Oiso, independently of the food conditions (Kazama et al. 2014, also see Fig. 2). Although the reasons for this difference are unknown, it is possible that gulls in the novel environment of a new colony take longer to choose a nest site, and easily give up egg-laying. Therefore, considering those effects of the shift in the colony, analyses were conducted only for data from 2001 to 2009, i.e. before the division of the colony. To examine the relationships between monthly SST in April and regional-annual catch of sand lance, we employed linear regression models. All analyses were conducted using R ver. 2.12.1 (R Development Core Team 2010).

RESULTS

Sand lance catch and numbers of gull nests varied greatly among years (Fig. 2a, b). In 2009, the number of empty Black-tailed Gull nests exceeded active nests (Fig. 2a).

The minimum adequate models showed that both the total number of Black-tailed Gull and Slaty-backed Gull nests increased significantly in parallel with the regional-annual catch of sand lance (Fig. 3), but not with local-temporal catches (Table 1a and b). The proportion of empty Black-tailed Gull nests to the total nest number decreased significantly with the local-temporal sand lance catch (Fig. 4), but not with the regional-annual catch (Table 1c). The monthly SST in April was significantly negatively correlated with the regional-annual catch of sand lance ($r^2=0.456$, $t=-2.422$, $n=9$, $p=0.046$, Fig. 2c).

In 2007, all 24 pairs observed formed nest cups in their breeding territories, but four pairs (16.7%) did not lay eggs. In 2008, one of the 24 pairs did not form a nest cup, although they mated repeatedly in the territory during the mating period (late April to mid May). In 2008, five of the 23 pairs that formed nests (21.7%) did not lay eggs.

DISCUSSION

1) Total number of gull nests and regional annual stock size of sand lance

The numbers of nests built by both Black-tailed Gulls and Slaty-backed Gulls varied strongly in response to variations in the regional annual sand

![Fig. 2. Annual dynamics of a) gull nesting numbers, b) sand lance catch data, and c) monthly sea-surface temperature (SST) in April at Rishiri Island. The dynamics of the numbers of active (with eggs) and empty (without eggs) nests of Black-tailed Gull (indicated by a solid line) and total nests of Slaty-backed Gulls (indicated by a dashed line). Since after 2010 (indicated with an arrow in a), part of the Black-tailed Gull colony moved to a new site and divided into two areas, data for Black-tailed Gulls in 2010 and 2011 (indicated with diamonds) were excluded from the analyses (see Methods).]
The Japanese Sand Lance is the most important prey species of both gulls during the nesting and egg-laying periods possibly because it has a higher energy density (5.5–6.7 kJ/wet g) than other prey species (e.g. Euphausiids: 3.1–5.5 kJ/wet g, Davis et al. 1998; Sebastes and Greenlings: 4.8–5.0 kJ/wet g; Cephalopods: 3.4 kJ/wet g, Watanuki 1987; Takahashi et al. 2001).

The regional-annual stock size of the Japanese Sand Lance was greater in years with lower SST in April. Generally, regional stocks of pelagic fishes are affected by large-scale marine physical events such as SST fluctuations and by biological responses such as migratory movement (Coelho 1985; Montevecchi & Myers 1996). The Japanese Sand Lance occurs

Table 1. Results of General Linear Models selection examining the effects of sand lance availability in short-term local spatial scale and long-term broad spatial scale on: a) the total number of active and empty nests of Black-tailed Gulls, b) the total number of active and empty nests of Slaty-backed Gulls, and c) the proportion of empty nests to total nests of Black-tailed Gulls on Rishiri Island. The model with the smallest Akaike’s Information Criterion (AAIC < 2) was selected as the best adequate model (indicated in bold).

<table>
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<tr>
<th>Factor</th>
<th>AIC</th>
<th>ΔAIC</th>
<th>Estimates±SE</th>
<th>χ²</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>a) Total number of Black-tailed Gull nests (2001–2009)</td>
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<tr>
<td>Regional-annual catch of sand lance</td>
<td>188.9</td>
<td>0.0</td>
<td>1.14±0.45</td>
<td>5.85</td>
<td>0.016</td>
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<tr>
<td>Local-temporal catch of sand lance</td>
<td>194.4</td>
<td>5.6</td>
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<tr>
<td>b) Total number of Slaty-backed Gull nests (2003–2012)</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Regional-annual catch of sand lance</td>
<td>85.5</td>
<td>0.0</td>
<td>0.010±0.002</td>
<td>13.61</td>
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<tr>
<td>Local-temporal catch of sand lance</td>
<td>90.6</td>
<td>5.0</td>
<td></td>
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<tr>
<td>c) Proportion of empty to total nests of Black-tailed Gulls (2001–2009)</td>
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<td></td>
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<tr>
<td>Local-temporal catch of sand lance</td>
<td>66.3</td>
<td>0.0</td>
<td>−0.016±0.003</td>
<td>16.35</td>
<td>&lt;0.001</td>
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<tr>
<td>Regional-annual catch of sand lance</td>
<td>82.5</td>
<td>16.2</td>
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Fig. 3. Relationship between annual stock size of Japanese Sand Lance and the total numbers of Black-tailed Gulls (solid line) and Slaty-backed Gulls (dashed line).

Fig. 4. Relationship between current local availability of Japanese Sand Lance and the proportion of the number of empty to total nests of Black-tailed Gulls.
widely in coastal areas of Japan. Their feeding habits, breeding performance, and stock sizes vary among locations (Okamoto et al. 1988). Although little information is available on the species' habits in our study region (Okamoto et al. 1989), it is considered to prefer cold water and to migrate to the region to spawn in spring, preferably when the surface water temperature is below 6.0°C (Fisheries Research Department of Hokkaido Research Organization 2013). Therefore, it is presumed that in years with lower spring SST, more adult sand lance immigrate into the region. Tomiyama and Komatsu (2006) found greater recruitment of the species at lower water temperatures in Ise Bay, central Japan, probably because of the lower mortality of larvae. This fact supports our results.

The total numbers of gulls nests, which reflected the numbers of individuals establishing breeding territories and building nests, increased in relation to the regional-annual stock size of sand lance, but not with local-temporal availability. Generally, the foraging range of seabirds is broader during the pre-breeding period, including nesting period, than during other breeding periods because of the lack of central place foraging constraints such as incubation or chick guarding (Hedd et al. 2014). During the nesting period, the study gulls may also forage spawning-migratory sand lance (determined by stock size; see above) broadly and flexibly without any constraints. Thus the decision of the study gulls to build a nest or not, may be in response to broad changes in the annual stock size of the Japanese Sand Lance.

In general, seabird populations tend to vary only gradually over time because of their relatively long lifespans and low adult mortality (Furness & Camphuysen 1997), and variation in food conditions in one year might not be followed by changes in breeding numbers in that year or in subsequent years (Thompson & Ollason 2001). However, the total numbers of gull nests, including empty nests, during our study on Rishiri showed considerable annual variation in response to the regional annual stock size of sand lance in the current year. This might be the result of considerable flexibility in the decision of parents whether to breed or not. In some long-lived seabirds, individuals skip breeding during one or more years under conditions where breeding is likely to heavily negatively impact upon their future reproductive potential, for example when fewer prey are available (Stearns 1992). The Black-tailed Gull frequently skips breeding (Kazama et al. 2013), and the same is likely in the Slaty-backed Gull as it also happens in other closely-related species (Calladine & Harris 1997). Although adult gulls typically do not return to the colony in the years in which they skip breeding, they do return in subsequent years (Kazama et al. 2013). The flexible breeding behavior of adult gulls, such as skipping breeding but returning in subsequent years, may strongly contribute to the drastic annual variation in breeding numbers in response to the annual stock size of sand lance in the current year.

2) Empty nests of Black-tailed Gulls and local temporal availability of sand lance

In 2007, the proportion of Black-tailed Gull pairs giving up egg-laying after nest building was 16.7%, whereas in 2008 it was 21.7%. This accounted for a large part of the proportion of the number of empty nests in both years (27.3% in 2007 and 33.6% in 2008, Fig.1a). The proportions of deserted nests were consistently smaller (about 11%) than the proportion of empty nests in both years. At the study colony, crows (Jungle Crow Corvus macrorhynchos), frequently take Black-tailed Gull eggs during the early phase of incubation (Kazama 2007). In addition, parent gulls sometimes stop incubating and abandon their clutches when the weather changes abruptly or becomes severe, such as when there are long spells of rain, or when there is intensive disturbance by predators or humans. Such abandoned eggs are usually depredated by crows or conspecifics immediately after they are abandoned (Kazama et al. 2014; K. Kazama personal observation). Although the empty nests counted during this study may also have included those depredated or abandoned after egg-laying, that proportion was likely to be relatively small (11%) and consistent among years. Thus, fluctuation in the number of nests deserted before egg-laying seemed to be a main cause of variation in the proportion of the number of empty nests.

The proportion of empty Black-tailed Gull nests was correlated with the local availability of food just before egg-laying (May and June). In seabirds, the decision whether to lay eggs or not, the timing of egg-laying, and the clutch size, are proximately affected by female body condition just prior to egg-laying (Giudici et al. 2010; Goutte et al. 2010). Thus more parents might give up egg-laying after nest-building in years with lower local-temporal availability of sand lance.

The annual variation in the local-temporal avail-
ability of Japanese Sand Lance was not synchronous with changes in the annual regional stock size (Fig. 2b). Sand lance sometimes form small, dense, and transient schools in surface water (Robards et al. 2000), and both fishermen and seabirds target such ephemeral schools (Götmark 1986; Mizushima & Shimazawa 2003). The temporal detectability and catchability of these small fish schools may be affected by local and short-term oceanographic conditions, such as tide and wave height, and/or meteorological ones such as wind speed, possibly causing a mismatch between the variation in the long-term regional catch and the short-term local catch.

Although the total number of nests was not small in 2009, the number of empty nests was very large (Fig. 2a) because the local-temporal availability of sand lance was extremely low despite the normal (average) level of the stock size that year (Fig. 2b). These results suggest that egg-laying Black-tailed Gulls require, not only a larger annual stock size, but also higher local availability, just during the egg-laying period. In 2009 few gulls reared fledglings at the study colony (Kazama et al. 2014; K. Kazama personal observation). In long-lived seabirds, individuals tend to change their nest-sites when they failed to breed in the previous year (Naves et al 2006). A mismatch between prey availability at different spatio-temporal scales might be one of the causes of the collapse of the Black-tailed Gull colony, leading it to move to a new location.

Although the breeding parameters of seabirds are used as bio-indicators that reflect on the state of the marine environment and fish abundance, most researchers do not consider breeding population abundance of seabirds, such as colony size, to be a good indicator because the time scale involved is usually long term (Furness & Camphuysen 1997; Thompson & Ollason 2001; Thompson & Grosbois 2002). However, our results indicate that the breeding population abundance of seabirds exhibiting flexibility in their breeding decisions can be sensitive indicators of the annual prey stock size in the current year. Seabird nests can, generally, be counted easily during single or short-term investigations, whereas collecting other ecological, physiological, or behavioral data requires long-term and intensive investigations. Therefore, the nest numbers of certain seabird species can be convenient and useful marine bio-indicators.

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