BEACHED BIRD SURVEYS IN LITHUANIA REFLECT MARINE OIL POLLUTION AND BIRD MORTALITY IN FISHING NETS

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SUMMARY

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We report the results of beached bird surveys on the Lithuanian coast of the Baltic Sea during the winters 1992/93 through 2002/03. The purpose of the present study was to establish baseline oiling levels for beached birds in the eastern Baltic. We also attempted to evaluate the influence of bird mortality in gillnets on the results of beached bird surveys. The coastal gillnet fishery, which was initiated and expanded along the Lithuanian coast over the course of our study period, caused an increase in waterbird mortality. The presence of mostly unoiled, gillnet-drowned birds among beached birds may have lowered the observed oiling rates and considerably affected beached bird species composition by increasing the proportion of diving birds. Nevertheless, we conclude that minimum oiling rates were high (27%) on the Lithuanian coast during our study, and this finding indicates the presence of chronic oil pollution in the area. We also concluded that beached bird surveys have limited value in studying bird bycatch issues. Beached bird surveys help to identify the existence of bird bycatch, the geographic scope of the problem and the bird species involved, but they do not allow for determining bycatch rates, fishing gear involved or the precise locations and circumstances of birds drowning—that is, the basic questions to be answered when analyzing fisheries bycatch.
Key words: Eastern Baltic Sea, waterbirds, gillnets, bycatch, oiling rates, Lithuania, beached birds, winter season

INTRODUCTION

The Baltic Sea is an enclosed body of brackish water that lies along the major bird migratory route in northern Europe, hosting internationally important staging areas (Skov *et al.* 2000). About nine million waterbirds reside in the Baltic Sea during winter (Durinck *et al.* 1994). At the same time, the Baltic is one of the most urbanized seas in the world, with nine countries sharing its shoreline and about 85 million people living within its catchment area (HELCOM 2003). This degree of urbanization has led to a diverse array of human activities, some of which may adversely affect waterbird populations.

One of the most prominent consequences of human activity in the Baltic is the potential for marine oil pollution. Birds are recognized as good indicators of marine environmental health (ICES 2003), and beached bird surveys are widely used in countries around the world to monitor trends in marine oil pollution (Camphuysen & Heubeck 2001). Results of beached bird surveys triggered inclusion of oiled bird monitoring as a distinct component in the Helsinki Commission (HELCOM) monitoring program and the European Marine Strategy, with implementation scheduled in the near future (ICES 2005). Beached bird surveys were initiated along the coast of Lithuania in 1991 to monitor trends in marine oil pollution (Vaitkus *et al.* 1993).

Lithuanian coastal waters are internationally recognized as important wintering and migrating habitat for waterbirds (Raudonikis 2004, Skov *et al.* 2000). Thousands of Velvet (White-winged) Scoters *Melanitta fusca,* Long-tailed Ducks *Clangula hyemalis,* Goosanders (Common Mergansers) *Mergus merganser,* Goldeneyes *Bucephala clangula,* Great Crested Grebes *Podiceps cristatus* and Red-throated Loons *Gavia stellata* aggregate in the area every winter. The intensity of industrial activity in the Lithuanian coastal zone has been increasing since the early 1990s, with recent developments including the construction of a new B¯uting˙e Oil Terminal with offshore mooring facilities, the advent of a nearshore gillnet fishery and the intensification of sea traffic with associated sediment dredging and dumping. Recently, an oil rig (D-6) was constructed in Russian territorial waters adjacent to Kursiu Nerija National Park, designated by the Lithuanian government as a Special Protected Area (Natura 2000 code, LTKLAB001) for the protection of migrating and wintering waterbirds, and by UNESCO as a World Heritage site (Curonian Spit). The purpose of the present study was to establish baseline beached bird oiling levels in the eastern Baltic and to evaluate bird bycatch in fishery gillnets as a factor affecting beached bird surveys.

METHODS

Study area

The 92-km portion of Lithuanian coastline monitored in this study is located in the eastern Baltic (21°06′E, 55°44′N; Fig. 1). Approximately half of the coastline extends along the mainland and half along the Curonian Spit. The shoreline is characterized primarily by sand and gravel beach exposed to prevailing westerly winds and intense wave action. Astronomic tides are absent in the Baltic Sea, where water levels fluctuate only 0.6 m depending on wind direction. Beach width in the study area ranged from 20 m to 100 m. The study area was subdivided into three sections for analysis (Fig. 1): Lithuanian mainland coast (L1), Klaipėda seaport zone (L2) and Curonian Spit outer coast (L3).

Commercial nearshore gillnet fishing, which affects beached bird survey results, was considered in the study. This activity is a relatively new on the Lithuanian coast, initiated in 1992. Fishing effort grew rapidly during the first several years, but has been relatively stable since 2000. The variety of fish species being targeted means that varying types of nets are used, with mesh sizes ranging from 16 mm to 120 mm. Fishing intensity is highly variable, depending on local conditions such as wave height and the presence of sea ice. For a more detailed description of the nearshore fishery on the Lithuanian coast see Dagys and Žydelis (2002).

Data collection

The design of beached bird surveys for the Lithuanian coastline was established in the early 1990s (Vaitkus *et al.* 1993, 1994), adopting standards suggested by Camphuysen (1989) and Camphuysen and van Franeker (1992). Our protocol consists of 23 parameters, ranging from a description of survey and environmental conditions to details about bird carcasses and oiling (Vaitkus *et al.* 1994, Žydelis & Dagys 1997). Typically, a survey was conducted by a single observer walking the beach and recording all bird carcasses detected from waterline to foredune.

In the present study, we analyzed data collected during the winter seasons from 1992/93 to 2002/03. We included data from October through April, when waterbird numbers in the study area were highest. Surveys were scheduled to occur at least once per month, but some could not be completed because of stormy sea conditions, extensive snow cover or ice floes obstructing the shoreline. When environmental conditions permitted, we attempted to survey at least 50% of each coastal section (L1, L2, L3). Counted bird carcasses were removed from the beach or marked to avoid recounting.

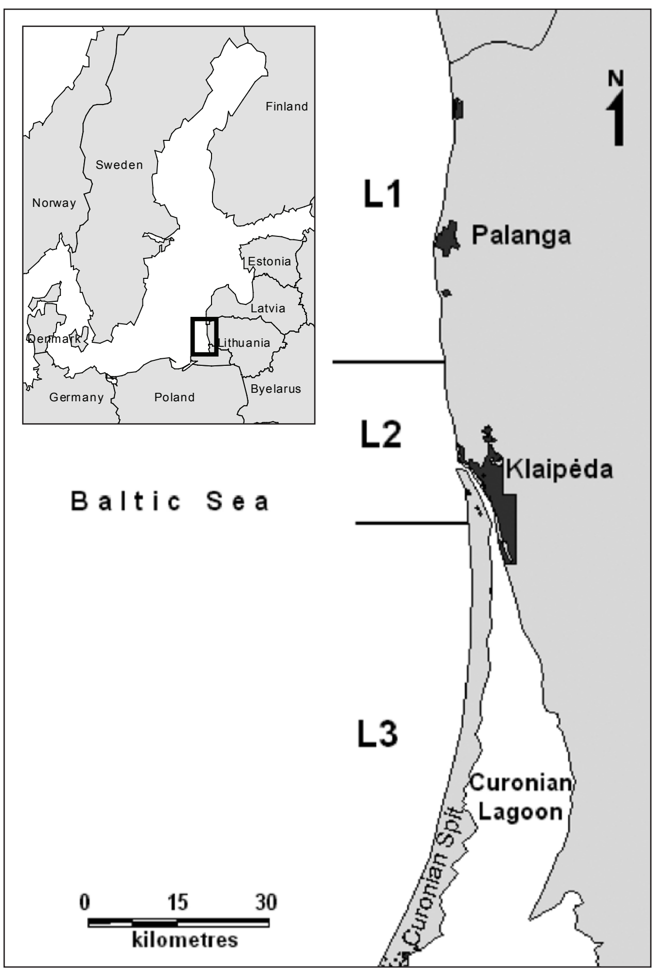

Fig. 1. Map of the study area with indicated sections of Lithuanian mainland coast (L1), Klaipėda seaport zone (L2) and Curonian Spit coast (L3).

Following suggestions of Camphuysen and Heubeck (2001), material collected after known oil spill incidents was analyzed separately. Survey effort following oil spills tends to be of higher intensity than at other times, and inclusion of the unadjusted data can have an undue effect on beached bird density and oiling rate estimates (Camphuysen & Heubeck 2001). Also excluded from analyses were land bird carcasses encountered during the beach surveys.

Data analysis

Each survey conducted by a single observer (or observer team) along a continuous stretch of the coast was treated as a sampling unit in the analyses. The length of individual surveys ranged from two kilometers to 38 km, averaging 13 ± 0.5 km (standard error). In total, data from 185 surveys, covering 2408 km of coastline, were used in this study.

Beached bird densities were calculated as the number of carcasses detected per linear kilometer of shoreline. Oiling was assessed only for complete carcasses, which were defined as those with >75% of the bird's body intact. The oiling rate was summarized as the proportion of oiled carcasses per season. In addition to oiling rate, the proportion of birds for which mortality was attributed to bycatch in fishing nets also was assessed. Evidence of drowning in fishing nets included remains of net material on a carcass, characteristically tousled feathers, broken or cut limbs, and bleeding from lungs. It is likely, however, that the number of bycaught birds was higher than that tabulated, because carcasses could have lost any of the above mentioned features because of damage by scavengers or simple disintegration. Following Camphuysen and Heubeck (2001), oil vulnerability indices (OVIs) were used to contrast oiling rates with vulnerability scores for the most common beached bird species. The OVIs for various species were adopted from or developed following the criteria described by Camphuysen (1998), wherein a species' anticipated vulnerability to oiling is a function of its distribution and behavior. Highly vulnerable species—characterized by much time being spent on the water, by restricted habitat ranges or by a high degree of range overlap with areas of potential oil pollution—have high OVI scores.

Statistical calculations were performed using the SAS software (SAS Institute 1994). Species OVI scores were compared with oiling rates using the Pearson correlation. All proportions were logit transformed before statistical trend analysis. Trends were measured using logistic regression, and therefore χ^2 and P values are presented instead of the R^2 used in simple regression. Standard error accompanies all reported means.

RESULTS

Beached bird densities

A total of 679 waterbird carcasses were found during regular winter beached bird surveys during 1992/93–2002/03. Of these, 390 carcasses (57%) were complete and qualified for assessment of oiling rate. Beached birds were detected during 63% of all surveys, with at least one bird suitable for oiling assessment in 49% of the surveys. The overall mean density of beached birds was 0.32 ± 0.04 birds/km. Beached bird densities differed between coastal sections (Kruskal–Wallis analysis of variance: $\chi^2 = 32.66$, df = 2, $P < 0.0001$), with high densities detected along the mainland coast (L1) and in the seaport zone (L2) and lower densities on the coast of the Curonian Spit (L3) (Fig. 2).

Beached bird species composition

We found carcasses of 28 waterbird species. Long-tailed Duck was the most commonly detected species (37%), followed by Herring Gull *Larus argentatus* (17%), loons (8%), Velvet Scoter (6%), Common Gull *Larus canus* (6%), and Steller's Eider *Polysticta stelleri* (5%). The remaining species each constituted less than 5% of recovered carcasses. Species composition varied between the study years, with a significant increase in the proportion of diving birds (loons, grebes, sea ducks and alcids) occurring over the study period ($\chi^2 = 5.41$, df = 1, $P < 0.05$; Fig. 3). Conversely, the proportion of gulls among beached birds decreased during the study period ($\chi^2 = 6.70$, df = 1, $P < 0.01$).

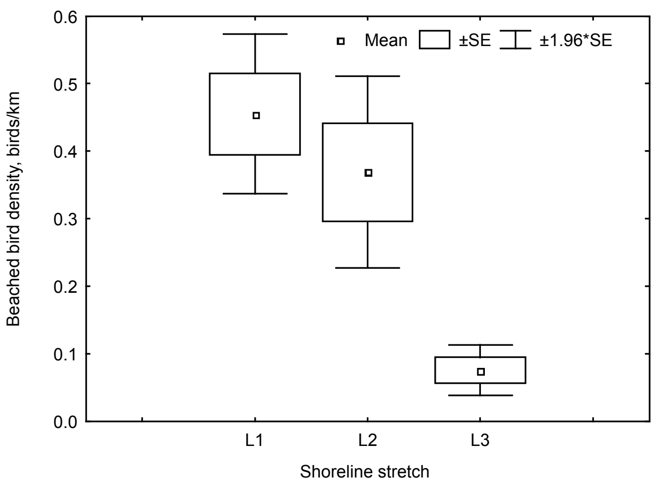

Fig. 2. Average beached bird densities on three sections of the Lithuanian coast of the Baltic Sea during 1991/92–2002/03: mainland (L1), seaport zone (L2) and Curonian Spit (L3).

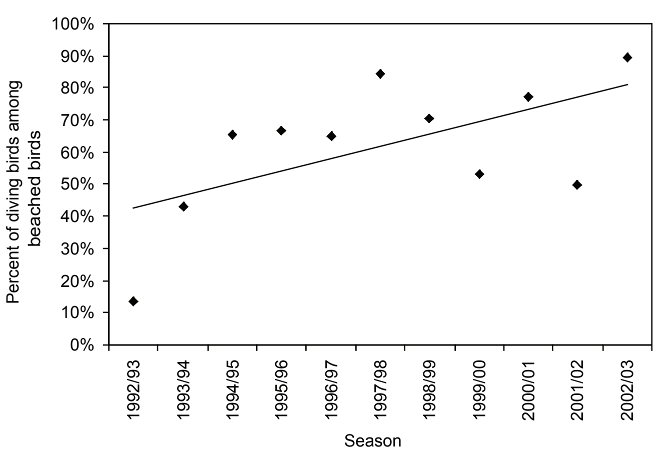

Fig. 3. The percentage of diving birds (loons, grebes, sea ducks and alcids) among beached birds on the Lithuanian coast of the Baltic Sea during 1992/93–2002/03. The positive trend is significant at $P < 0.05$ ($\chi_1^2 = 5.41$, df = 1).

Oiling rates

Oiled birds were recorded on 17% of the 185 winter surveys included in the study. Of 390 complete carcasses used for oiling rate assessment, 107 (27%) were oiled (Table 1). Oiling rate ranged from 0% to 56% across years, with no evidence of a trend ($\chi^2 = 1.23$, df = 1, $P > 0.1$; Table 1). Differences in oiling rates between species were considerable (Table 2), but the correlation between oiling rate and oil vulnerability index (OVI) for the most commonly found bird species was nonsignificant ($R = 0.19$, $P > 0.1$). Beached bird oiling rates varied among coastal sections ($\chi^2 = 7.53$, df = 2, $P < 0.05$), with rates in the seaport zone (38%, n = 143) being much higher than on the Curonian Spit (14%, n = 36; $\chi^2 = 4.21$, df = 1, $P < 0.05$) and the mainland coast (23%, n = 211; $\chi^2 = 5.08$, df = 1, $P < 0.05$). Bird oiling rates did not differ significantly between the mainland coast and the Curonian Spit ($\chi^2 = 2.74$, df = 1, $P > 0.05$).

Beached birds after oil spills

Two spill-related mass waterbird mortalities were recorded during the study period. Mass stranding of oiled birds occurred in February 1995 and January 1997, with locations, sources, and amount of oil spilled remaining unknown.

Following the incident in February 1995, 276 waterbird carcasses were detected. Long-tailed Ducks were the most abundant of the beached birds, comprising 65% of the total. Other victims of note were Herring Gulls and Common Gulls (14% and 5% respectively). Based on plumage oiling estimates, 84% of beached birds were oiled. Following the January 1997 oil spill, 439 beached birds were detected on the Lithuanian coast. Velvet Scoters and Long-tailed Ducks dominated among beached birds, comprising 79% and 16% of all birds, respectively. All recorded beached birds (100%) had oiled plumage.

Three incidents of oil spilling into the sea have been reported at Būtingė Oil Terminal: December 1999, March 2001 and November 2001. Mass mortalities of waterbirds were not observed following any of those incidents.

TABLE 1
Number of waterbird carcasses collected during regular beached bird surveys and bird contamination with oil in 11 winter seasons on the Lithuanian coast of the Baltic Sea

Season	Total bird carcasses (n)	Complete carcasses (n)	Oiled carcasses (n)	Oiling rate (%)
1992/93	44	36	14	39
1993/94	72	60	12	20
1994/95	26	18	8	44
1995/96	21	11	2	18
1996/97	43	27	15	56
1997/98	102	61	7	11
1998/99	95	52	8	15
1999/00	98	65	21	32
2000/01	97	39	19	51
2001/02	14	6	1	17
2002/03	67	15	0	0
Total	679	390	107	27

Birds drowned in fishing nets

Drowning in fishing gillnets was the other common cause of waterbird mortality identified during beached bird surveys. Of 390 complete carcasses detected during the study period, 126 (32%) were identified as having drowned in fishing nets. The proportion of beached birds drowned in fishing nets increased during the study period, although the trend was not statistically significant at the 0.05 level ($\chi^2 = 3.51$, df = 1, $P < 0.1$; Fig. 4). Gillnet victims were almost exclusively diving birds, dominated by sea ducks (60%) and loons (23%). Correlation between the proportion of beached birds associated with gillnet mortality and the proportion of diving birds found among beached birds was positive, but marginally nonsignificant ($R = 0.59$, $P = 0.1$). Among birds identified as gillnet victims, eight carcasses (6%) also had signs of oiling.

DISCUSSION

Results of our beached bird surveys along the Lithuanian coast of the Baltic Sea contain valuable information about the causes of waterbird mortality and the species most affected by human activities. They also provide a baseline for future reference. Although densities of beached birds were low, the proportion of recovered birds that had been oiled was relatively high. The oiling rate we observed (27%) is remarkably high when compared to a recent report from the Baltic coast of Poland (south of Lithuania), where bird oiling did not exceed 2.8% (Meissner *et al.* 2001). Bird oiling on the Polish coast exceeded 50% in the 1960s and 1970s, but decreased sharply starting in the 1980s (Meissner 1992). On the neighboring coast of Latvia (north of Lithuania), beached bird oiling rates were 5% in 1992 and 53% in 1993 (Kurochkin 1993).

A decline has occurred in beached bird oiling rates along the coast of the North Sea. In the Netherlands, for example, Camphuysen (1998) reported a drop of 50% (from 76% to 38%) in the average bird oiling rate between 1977 and 1997. A similar change was observed along the German coast of the North Sea (Fleet & Reineking 2001). In contrast, increasing and consistently high beached bird oiling rates are reported for the coast of Newfoundland and Labrador, Canada, averaging 74% in recent years (Wiese & Ryan 2003). In general, beached bird oiling rates vary widely depending on location, season and species (reviewed in Camphuysen & Heubeck 2001).

TABLE 2
Total number, oiling rates, Oil Vulnerability Indices (OVIs) and number of birds drowned in fishing nets for the bird species most frequently found on the Lithuanian coast of the Baltic Sea

Species[a]	Complete carcasses (n)	Oiled carcasses (n)	Oiling rate (%)	OVI	Bycaught birds (n)
Steller's Eider	17	2	12	56	7
Loons	44	6	14	49	29
Mergansers	12	2	17	44	6
Herring Gull	65	15	23	42	0
Great Black-backed Gull	13	3	23	52	0
Common Gull	17	5	29	36	0
Long-tailed Duck	135	44	33	48	57
Velvet Scoter	25	10	40	52	11
Swans	15	6	40	28	0
Great Crested Grebe	17	8	47	45	6
Alcids	10	7	70	63	2

[a]Species listed in order of increasing oiling rate.

The other important cause of bird mortality identified in this study was drowning in fishing nets. Indeed, the number of beached birds for which mortality was associated with bycatch exceeded the number associated with oiling. The proportion of beached birds that had drowned in fishing nets was undoubtedly higher than detected, because it was often difficult to determine whether a bird had been entangled and drowned or died from other causes. Cause of mortality was undetermined for about 40% of complete bird carcasses, some of which may well have died in fishing nets. The proportion of beached birds associated with bycatch increased during the study period, as did the proportion of diving birds in the sample. Those trends corresponded to an increase in fishing effort by commercial gill-netters in the nearshore zone (Dagys & Žydelis 2002). Drowning in fishing nets also was identified as the main cause of bird mortality along the Baltic coast of Poland in 1998–1999, accounting for up to 76.5% of beached marine birds (Meissner *et al.* 2001).

In general, reports of beached bird surveys rarely mention mortality attributable to bycatch, a study by Forsell (1999) along the Atlantic coast of North Carolina and Virginia, United States, being one of the few exceptions. The author analyzed waterbird mortality in coastal gillnets, using beached bird surveys to assess geographic scope and the bird species involved (Forsell 1999). However, beach surveys are not sufficient to document bird bycatch in detail, because the method does not allow accurate determination of bird bycatch rates, the fishing gear involved or the location and circumstances of bird drownings—basic questions to be answered when analyzing fisheries bycatch. Assessing bird mortality in fishing gear typically requires direct communication with fishermen and observer programs to monitor the bycatch.

Added bird mortality attributable to bycatch, which began and increased in Lithuania during our study, appreciably affected

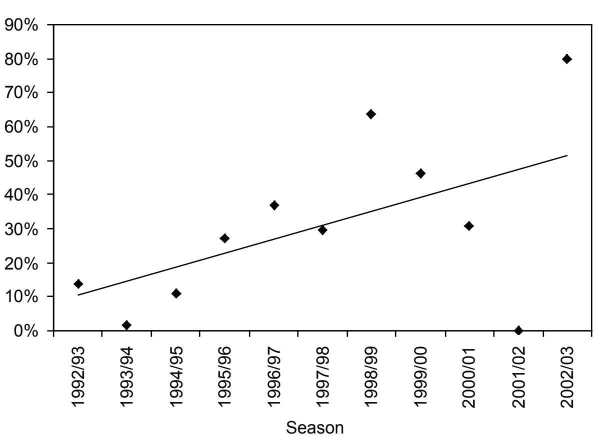

Fig. 4. The percentage of beached birds identified as bycatch victims of gillnetting on the Lithuanian coast of the Baltic Sea during winters 1992/93–2002/03 ($\chi^2 = 3.51$, df = 1, $P < 0.1$).

the species composition of beached birds and probably biased oiling rates, lowering them to an unknown degree. Therefore, the calculated oiling rates should be considered minimum values for the study area. Bird mortality attributable to bycatch may be responsible for the absence of a correlation between species oiling rates and OVIs in this study, which contrasts with strong support for such a correlation documented elsewhere (e.g. Williams *et al.* 1995, Camphuysen 1998, Wiese & Ryan 2003). If we exclude records of beached birds for which mortality was associated with bycatch, the mean oiling rate on the Lithuanian coast was approximately 40%. However, this figure suffers from the same unknown quantity—the actual proportion of beached birds drowned in fishing nets. High variability of fishing effort and bycatch rates (Dagys & Žydelis 2002), and the varying habits of fishermen in dealing with drowned birds [throw overboard, bring and leave on shore, or take along (pers. obs.)], did not allow us to assume constant bycatch or its even representation among beached birds.

CONCLUSIONS

The coastal gillnet fishery, which was initiated and expanded along the Lithuanian coast during the study period, caused an increase in waterbird mortality. The presence of gillnet-drowned, mostly unoiled birds within the sample of beached birds may have lowered the observed oiling rates and considerably affected our estimates of beached bird species composition. We suggest that the observed oiling rates represent the minimum levels actually occurring in Lithuania. At the same time, beached bird surveys have limited value in studying bird bycatch issues in detail.

Despite the complicating effect of bird mortality attributable to bycatch, we can safely conclude that oiling rates were relatively high on the Lithuanian coast during this study, indicating the presence of chronic oil pollution in the area. Larger-scale oil spills had acute effects on wintering waterbirds, causing mortality of hundreds and presumably thousands of birds.

This study provides background data for future beached bird monitoring locally and regionally, specifically in relation to the potential effects of the newly constructed oil rig D-6 in the vicinity of the Curonian Spit, southeastern Baltic. Clearly, additional causes of bird mortality, fisheries bycatch in particular, must be carefully considered for their influence on assessments of oil pollution and waterbird mortality.

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