The impact of the 1991 Gulf War oil spill on bird populations in the northern Arabian Gulf - a review

Peter Symens & Abdullah Suhaibani

Abstract: The Arabian Gulf is of international importance for breeding and wintering seabirds and wintering and migrating waterfowl. Following the massive oil spill which occurred in 1991, a monitoring scheme to assess possible damage was initiated. During the first months more than 30,000 wintering grebes and cormorants, including the endemic Socotra cormorant (Phalacrocorax nigrogularis) were killed by oil-fouling. This represents from 22 % to more than 50 % of the regional populations of the different species. Large numbers of waders were oil-fouled between February and May 1991. The affected intertidal zone along the Saudi Arabian coast was virtually abandoned for the following two years. Although some mortality has occurred, the records indicate that most waders had dispersed from the affected intertidal habitats and that at least a proportion of the oil-fouled waders survived. Since the autumn of 1992, large numbers of waders have reappeared on the previously oiled intertidal areas indicating that recovery is proceeding. The internationally important breeding colonies of terns on the offshore coral islands escaped any serious impact from the oil spills in 1991. The following year a major decrease in breeding success was caused by a lack of prey fish stocks. At the time of writing it is not clear whether the reduction in prey fish populations and the resulting decrease in the terns' breeding success is attributable to the Gulf War oil spill, or caused by natural fluctuations in fish populations.

تأثير بقعة الزيت الناتجة عن حرب الخليج عام 1991م على مجموعات الطيور في شمال الخليج العربي، مراجعة

بيتر سيمز وعبد الله السحيمي

خلاصة: يعتبر الخليج العربي ذا أهمية عالمية بالنسبة لتكاثر وإنشاء الطيور البحرية وإنشاء الطيور المائية المهاجرة. وعلى أثر بقعة الزيت الكبيرة التي حدثت عام 1991م بدأ العمل في برنامج مراقبة لقومي حجم الأضرار المحتملة التي يتعرض عد ذلك. وسجلت الأحصائيات خلال الأشهر الأولى توقع أكثر من 3,000 قروذ من طيور العطاس والغاف، بما في ذلك الفالكون السوطي Phalacrocorax nigrogularis المستوطنة وذلك من جراء التلوث النفطي. وتبعت هذا النتائج نسبة تزاوج من 42% إلى أكثر من 50% من المجموعات المحلية للأنواع المختلفة. كما أصاب التلوث أعدادًا من الطيور الحواض في الفترة مارس وأبريل ومايو 1991م. وأصبحت منطقة ماين المد والجزر المتأثرة بالتلوث على أعداد الساحل السعودي من الخليج مهجورة تقريباً خلال العامين التاليةين. وعلى الرغم من حدوث بعض حالات تلوث لا أن مشاهدتنا تشير إلى معظم الطيور الحواض قد انقرضت بعيدًا عن منطقة ماين المد والجزر الملوثة وأنه على الأقل هناك نسبة من الطيور الحواض المتوترة بقيت حية. ومن حزين 1992م رجعت أعداد كبيرة من الطيور الحواض إلى مناطق ماين المد والجزر التي سابق أن تعرضت للتلوث مما يشير إلى أن استعداد هذه المناطق لاحتفاظها مستمرة.

أما مستعمرات العمران الهشة ذات الهمة العالية على الجزء المرجاني البعيد على الساحل فقد كانت متأثرة على تأثير الحطام لبقعة الزيت عام 1991م. ولكن حصل انخفاض كبير في نزاع موسم التزاوج خلال العام التالي بسبب النقص في أعداد الأضماك التي تتغذى عليها هذه الطيور. وليس من الواضح في الوقت الحاضر ما إذا كان النقص الملاحظ في مجموعات الأضماك والطيور النادرة عنه في نزاع موسم التزاوج لطيور البحرية مرتبطًا إلى تأثير بقعة الزيت أو إنه نتيجة للتغيرات الطبيعية في أعداد مجموعات الأضماك.
INTRODUCTION

Although previous quantitative studies on bird populations in the Arabian Gulf are scarce, this region is known to be of international importance for breeding seabirds (e.g. GALLAGHER et al. 1984, ZWARTS 1987, BUNDY et al. 1989) and for wintering and migrating waders (e.g. SUMMERS et al. 1987, ZWARTS et al. 1991). When massive quantities of oil were released into the northern Arabian Gulf in January 1991, it was feared that these important bird populations would be diminished to such an extent that a full recovery would be impossible. At an early stage following this disaster it became apparent that a complete damage assessment was not possible due to the lack of data on the pre-war situation. Therefore a long-term monitoring programme was initiated to gather more baseline information on these bird populations along the northern Gulf coast in Saudi Arabia and to try to assess the long-term effects of the Gulf War oil spill. This paper gives an overview of the results that were obtained between February 1991 and April 1993.

RESULTS

Wintering seabirds: The first obvious victims of the oil spill were wintering seabirds. Counts of dead birds at 82 sites, covering nearly 200 km of coastline between al-Khafji in the north and Jubail to the south, from February to April 1991 revealed a total of 10,243 oil-fouled bird carcasses (SYMENS & SUHAIBAN in press). The majority of these dead birds were: great crested grebes (*Podiceps cristatus*, 20.7 %), black-necked grebes (*P. nigricollis*, 26.6 %), great cormorant (*Phalacrocorax carbo*, 22.8 %) and Socotra cormorant (*P. nigrogularis*, 25.9 %). The remaining 4 % included (in decreasing abundance) gulls, waders, ducks, terns and herons. Extrapolation of this number to the entire affected coastline of Saudi Arabia and Kuwait suggests that at least 30,000 pelagic seabirds died as a direct consequence of oil-fouling in the northern Gulf between February and April 1991. This total number includes a large proportion of the wintering populations of grebes and cormorants of the northern Gulf, as well as important numbers of birds which winter further south in the Gulf and which were caught by the oil while migrating northwards along the Gulf coast to their breeding areas.

It is difficult to define how significant this mortality is at species level, since no accurate pre-war population estimates for wintering seabirds were available for this region. During the winters 1992 and 1992-1993 counts of wintering grebes and cormorants were made along the entire Saudi Gulf coast. These counts indicated that a minimum of 3500 great crested grebes and 5000 black-necked grebes wintered in this area. Whereas the great crested grebe is only a scarce winter visitor to the southern Gulf, the winter distribution of the black-necked grebe reaches the Gulf of Oman and the Arabian Sea (e.g. GALLAGHER & WOODCOCK 1980, BUNDY et al. 1989, RICHARDSON 1990). If the numbers that winter in these parts of the Gulf are similar to those of the Saudi Gulf coast, then the total wintering population of great crested and black-necked grebe in the western and southern Gulf can be estimated at 7000 and 10,000 birds respectively. It is estimated that the Gulf War oil spill killed more than 50 % of this wintering population of grebes. The great cormorant occurs as far south as Oman (GALLAGHER & WOODCOCK 1980, RICHARDSON 1990), though in smaller numbers than in Saudi Arabia. The wintering population of great cormorants along the Saudi Gulf coast was estimated at 15,000 birds in 1991-1992 and 12,000 in 1992-1993. Assuming that this represents half of the population that winters between Kuwait and Oman, then the Gulf War oil spill may have killed 22 to 34 % of this population.

The Socotra cormorant (Plates 1-2) is an endemic bird to the Arabian Gulf and the Arabian Sea. In the northern Gulf, breeding takes place in the late autumn and winter, after which the birds disperse, but the extent of these dispersive movements is poorly understood (e.g. BUNDY et al. 1989). Based on a survey of all breeding colonies of this species in Saudi Arabia, the total population in the Kingdom was estimated at 30,000-35,000 birds in the winter 1992-1993 (SYMENS et al. 1993). Thus the mortality caused by the Gulf War oil spill would represent more than 25 % of that population.

Waders: ZWARTS et al. (1991) tentatively estimated that 260,000 waders winter on the Saudi Arabian Gulf coast and up to four million in the whole Arabian Gulf, and on this basis judged the intertidal zone of the Gulf coast to be one of the world's five major wintering areas for waders. SUMMERS et al. (1987), reviewing the information on status, population size and migration of waders along the West Asian Flyway, showed that all waders wintering in eastern Africa and the majority of those in southern Africa pass through the Middle East on migration, and concluded that the intertidal zone of the Arabian Gulf coast was probably one of the most important stop-over or 're-fueling' areas for migrant waders in the whole West Asian Flyway region.
Plate 1: Adult specimens of the Socotra cormorant (*Phalacrocorax nigrogularis*) on Judhaim Island.

Plate 2: Juvenile Socotra cormorant on Judhaim Island.
Table 1: Number of nests of four species of terns on the northern Arabian Gulf islands in 1991 and 1992.

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
<th>Harqus</th>
<th>Karan</th>
<th>Kurain</th>
<th>Jana</th>
<th>Juraid</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td><strong>S. bergii</strong></td>
<td>1991</td>
<td>17,80</td>
<td>196</td>
<td>1250</td>
<td>3</td>
<td>0</td>
<td>3229</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>15,00</td>
<td>170</td>
<td>2100</td>
<td>2</td>
<td>35</td>
<td>3807</td>
</tr>
<tr>
<td><strong>S. bengalensis</strong></td>
<td>1991</td>
<td>16,00</td>
<td>10,154</td>
<td>8710</td>
<td>37</td>
<td>0</td>
<td>20,501</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>12,00</td>
<td>14,000</td>
<td>10,000</td>
<td>0</td>
<td>2800</td>
<td>28,000</td>
</tr>
<tr>
<td><strong>S. repressa</strong></td>
<td>1991</td>
<td>0</td>
<td>2310</td>
<td>0</td>
<td>5650</td>
<td>930</td>
<td>8930</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>0</td>
<td>4800</td>
<td>0</td>
<td>6000</td>
<td>1050</td>
<td>11,850</td>
</tr>
<tr>
<td><strong>S. anaethetus</strong></td>
<td>1991</td>
<td>0</td>
<td>11,160</td>
<td>3180</td>
<td>6930</td>
<td>12,730</td>
<td>34,000</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>0</td>
<td>17,370</td>
<td>2400</td>
<td>5000</td>
<td>10,000</td>
<td>34,770</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1991</td>
<td>3380</td>
<td>23,820</td>
<td>13,140</td>
<td>12,660</td>
<td>13,660</td>
<td>66,660</td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>2700</td>
<td>36,340</td>
<td>14,500</td>
<td>10,022</td>
<td>12,885</td>
<td>78,427</td>
</tr>
</tbody>
</table>

During the first year following the oil spill, the numbers of migrating and wintering waders in the polluted intertidal zone, representing some 50% of the total intertidal zone of the Saudi Gulf coast, had decreased by up to 98% compared to estimated pre-spill levels as given by ZWARTS et al. (1991). This was due to the oil pollution in the intertidal zone and the subsequent loss of food supplies (EVANS & KEIJL in press). LARSEN & RICHARDSON (in prep.) showed that waders disperse away from oiled areas to more sheltered sites and that oiled waders often appear segregated or isolated from non-oiled birds. This behaviour was frequently noted along the Gulf coast where heavily oiled curlews (Numenius arquata) were regularly observed singly or in small groups 1 to 5 km inland in the sand dunes, where they foraged on tenebrionid beetles. Large concentrations of waders were only found at non-intertidal wetlands such as temporarily rain-flooded sabkhas and sewage evaporation ponds. Within these flocks, large numbers of birds were oil-fouled, indicating that many of these birds had dispersed away from the oiled intertidal zone. At the sewage evaporation ponds of Jubail in Sabkhat al-Hasa up to 1000 Mongolian plovers (Charadrius mongolus) were present in April 1991, of which more than 90% were oil-fouled (EVANS & KEIJL in press). In April 1992, the maximum count of Mongolian plovers at this site was only 365, none of which were oiled.

Until the autumn of 1992, no concentrations of waders were observed along the affected coast north of Jubail. The only concentrations of waders in the area occurred at the sewage evaporation ponds in Sabkhat al-Hasa in Jubail, where at times nearly 20,000 waders, mainly Calidris and Charadrius species, were counted between October 1991 and May 1992. These birds spent their entire stay in the region at this site, where they were feeding mainly on the larvae of various chironomid salt flies and ostracods, such as Heterocyclops salinus.

In October 1992 the situation suddenly changed. Large numbers of autumn migrants reappeared at Sabkhat al-Hasa, but only during daytime. In the evening, all waders left from this site to the oiled intertidal area of Dawhat ad-Dafi where they foraged during the nocturnal low tide and from which they returned to Sabkhat al-Hasa in the early morning to remain there during the diurnal high tide. This change in behaviour indicated that the intertidal fauna in that area was recovering, as was confirmed by WATT et al. (1994). In mid-November 1992 and mid-January 1993, only two years after the oil spills occurred, the total feeding density of waders on the mudflats of Dawhat ad-Dafi reached maximum values of 35 and 32 waders per hectare, representing 76 and 70% of the pre-war densities recorded by ZWARTS et al. (1991). The recovery for smaller species like dunlin (Calidris alpina) and little stint (Calidris minutus), which mainly feed on smaller invertebrates such as polychaetes, reached up to 90%. For species such as redshank (Tringa totanus), grey plover (Pluvialis squatarola) and curlew, which feed on the larger invertebrates such as crabs, the recovery ranged only from 10 to 34%. This rate of recovery of wader densities on intertidal areas after the oil spill corresponds very well with results from similar studies on other oil spills. When more than 100,000 barrels of diesel crude polluted 3250 hectares of intertidal flats and salt-marsh at the Medway Estuary in the U.K., wader densities dropped significantly but recovered very well 15 months after the incident (HARRISON & BUCK 1967, 1968; HARRISON & HARRISON 1967). Similarly, CHAPMAN (1985) reported a recovery period of one
Table 2: Numbers of oil-fouled adult terns on Karan, Saudi Arabia, in 1991 and 1992.

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>lightly oiled</th>
<th>moderately oiled</th>
<th>heavily oiled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>16420</td>
<td>3.8%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>1992</td>
<td>11780</td>
<td>0.6%</td>
<td>1.1%</td>
<td>1.4%</td>
</tr>
</tbody>
</table>

to two years for waders and their food supplies on sandy beaches in the Gulf of Mexico after the Ixtoc I oil spill in 1979.

During the initial months following the oil spills, levels of oiling were particularly high in the populations of Mongolian plover, grey plover, broad-billed sandpiper (*Limicola falcinellus*), curlew and Terek sandpiper (*Xenus cinereus*) (EVANS & KEIJL in press; pers. obs.). However, it is impossible to estimate the number of waders that died as a consequence of this oil-fouling. Although dead waders were only rarely found in the affected area, it is assumed that many oiled birds may have died along their migration routes. Ringing studies indicated that oil-fouled waders had significantly lower body weights than unoiled birds, both at the oiled zone in spring 1991 (EVANS & KEIJL in press) and near Riyadh in autumn 1991 (pers. obs.). This decrease in body weight was mostly due to reduced fat reserves and was severe enough to make successful migration and breeding impossible that year. However, birds initially colour-marked at Sabkhat al-Fasl while they were heavily oil-fouled in November-December 1991, have been re-sighted totally clean the following winter (1992/93), indicating that at least a portion of the oil-fouled waders survived.

**Breeding seabirds:** Breeding seabirds were another important bird group of concern. The offshore islands in the northern Gulf in Saudi Arabia are known to be of international importance for breeding terns, particularly for lesser crested tern (*Sterna bengalensis*) and bridled tern (*S. anaethetus*) (e.g. GALLAGHER et al. 1984, ZWARTS 1987, BUNDY et al. 1989), while swift tern *S. bergii* and white-cheeked tern (*S. repressa*) occur in numbers of regional importance (Plates 3-5). During the breeding seasons of 1991 and 1992 the numbers of pairs of the four breeding species of terns were estimated on the islands Harquas, Karan, Kurain, Jana and Juraid, following the methods used by ZWARTS (1987) in 1986 (see also SYMENS & EVANS in press). The results of this census are shown in Table 1. The colonies of lesser crested tern on these islands are the largest and densest found in the world, and the breeding population on these islands must represent a significant part of the total world population of this species. The large breeding population of bridled terns place the islands among the five most important breeding areas in the world.

It was feared that the terns and their breeding activities could be severely affected by the oil spill. Large numbers of adult terns might be killed through oil-fouling. Oil could be transferred to the eggs by incubating adults and kill the embryo. Research has shown that 10-20 µl of fresh oil on a freshly laid larid egg is enough to kill the embryo (WHITE et al. 1979, LEWIS & MALECKI 1984). Stranded oil on the shore can severely affect the chicks as they gather on the beach. Oil spills can also affect seabird populations through the food chain by damage caused by toxic hydrocarbons to the ecosystems where food resources are produced. Disruption of the breeding cycle of prey fish species could cause a drastic decline in the terns' breeding success. This indirect impact may only become apparent over a longer period.

In both years a large number of adult birds on Karan was checked for oil-fouling. The degree of oil pollution was scored visually as lightly oiled (0-5% of the total body smothered by oil), moderately oiled (6-33% of the body) and heavily oiled (more than 33% of the body) (SYMENS & EVANS in press and Table 2). During the summer of 1991 only small numbers of oiled adult terns were recorded while the few dead oil-fouled terns that were found represented less than 0.2% of the total adult population. These low numbers can be explained by the fact that the oil from the Gulf War oil spill had disappeared from the open sea and had stranded in the coastal bays by April when the terns returned from their wintering grounds in the Indian Ocean to their breeding areas in the northern Gulf. The larger number of lightly oiled terns in 1991 was probably the result of contact with tar balls while the birds were plunge-diving to catch their prey. Little oil spots were regularly found on all parts of the body, including the underwings and upperparts. In 1992 most of the tar balls of the Gulf War oil spill had stranded and the number of lightly oiled terns
Table 3: The breeding success of terns on Karan, Saudi Arabia, in 1991 and 1992 (n.a. = not available).

<table>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S. bergii</td>
<td>76</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>33</td>
</tr>
<tr>
<td>S. bengalensis</td>
<td>95</td>
<td>n.a.</td>
<td>86</td>
<td>n.a.</td>
<td>82</td>
<td>46</td>
</tr>
<tr>
<td>S. repressa</td>
<td>93</td>
<td>45</td>
<td>77</td>
<td>0</td>
<td>72</td>
<td>0</td>
</tr>
<tr>
<td>S. anaethetus</td>
<td>94</td>
<td>47</td>
<td>97</td>
<td>37</td>
<td>91</td>
<td>33</td>
</tr>
</tbody>
</table>

decreased correspondingly. The increase in numbers of moderately and heavily oiled terns that year probably reflects the usual, chronic oil pollution that occurs in this region. Moderate and heavy oiling is mostly caused by contact with fresh floating oil. In 1991 there was no floating oil around the islands during the summer, because the oil industry in Kuwait and the northern Gulf was not operational due to the damage caused by the war. In 1992, this industry was again operational and accidental leakage, spilling and transport-related pollution might have caused an increased oil-fouling of terns.

The low number of oil-fouled adult birds resulted in virtually no oiling of eggs by incubating birds. In 1991 a number of chicks were oil-fouled by the tar on the beach rock on Karan, Jana and Juraid, but in general this did not prevent them from normal development to full-grown juvenile birds. Furthermore this problem was very localised so that it had a minimal effect on the total breeding success.

Table 3 gives an overview of the breeding success per species on Karan in 1991 and 1992 (for methodology see SYMENS & EVANS in press). In this table hatching success represents the percentage of eggs from which a chick hatched, fledging success represents the percentage of the total number of chicks that eventually fledged, and breeding success indicates the percentage of eggs that resulted in a chick that fledged. The overall high breeding success in 1991 showed that there was no impact of the oil spills on the breeding activities through poisoning or reduction of their food resources (young pelagic schooling fish, mainly sardines and anchovy). The tempering effect of the soot clouds of the Kuwaiti oil well fires might have had a positive effect on the terns' breeding success by reducing heat stress on adults, eggs and chicks (SYMENS & EVANS in press). In 1992 however, the breeding success was greatly reduced, ranging from only 46% in lesser crested tern to a complete failure in white-cheeked tern.

The following changes were recorded:

1. many incubating birds abandoned their eggs before they hatched;
2. the growth rate of the chicks was much lower than in the previous year, resulting in a much higher chick mortality;
3. the swift terns preyed upon the chicks of white-cheeked terns to such an extent that not one single chick of the latter species survived for more than three days after hatching;
4. there was a significantly reduced amount of fish brought in by the parents to the chicks;
5. there was an important increase in inter- and intraspecific aggression between birds returning with fish to the colony.

In longer-term monitoring studies on breeding seabirds in other parts of the world, all these phenomena have been attributed to a shortage of prey stock (e.g. DANCHIN 1992, FURNESS 1982, MONAGHAN et al. 1992, UTTLEY 1992). From this it is concluded that in 1992 there was not enough food available for the breeding terns in the northern Gulf to raise their chicks successfully. At the time of writing it cannot be determined whether this shortage is caused by a delayed effect of the oil spill, a decrease in sea temperature due to the soot clouds of the Kuwaiti oil well fires, attributable to the extremely cold winter of 1991-92, a natural cycle in fish populations, or to a combination of these factors.

CONCLUSIONS

The scarcity of pre-war data on distribution, population size, natural fluctuations of populations in space and time, and the lack of base-line data on the ecology and migration strategies of waterfowl populations in the Arabian Gulf region, made any detailed damage assessment of the Gulf War oil spill on these important bird populations virtually impossible at an earlier stage. Surveys on wintering grebes and cormorants during the two winters following the oil spill revealed that the mortality repre-
Plate 3: White-cheeked tern (*Sternula repressa*) near Jana Island.

Plate 4: Bridled tern (*Sternula anaethetus*) on Karan Island.

Plate 5: Part of a breeding colony of the lesser crested tern (*Sternula bengalensis*) on Karan Island.
sent from 22 to 50 % of the regional populations. However, the presence of extremely large numbers of juvenile great cormorants during these winters indicate that the populations are recovering.

Initially, virtually all waders disappeared from the oiled coastline and many birds were oil-fouled, but our observations indicate that most waders dispersed from the affected zone rather than died. Whereas previously it was assumed that most, if not all, heavily oil-fouled waders would die as a consequence of the oil pollution, our observations have proved that at least a proportion of them managed to survive. A strong increase in feeding densities of waders on the affected intertidal areas of Dawhat ad-Dafì since the autumn of 1992 indicates that these traditional feeding grounds are recovering.

Whereas the breeding colonies of terns on the offshore islands escaped any major impact in 1991, a drastic decline in breeding success was noticed in 1992. At present it is not clear whether this decrease can be attributed to the oil spill.

Further monitoring will be necessary to see if any long-term impact of the Gulf War oil spill on these internationally important bird populations occurs and whether full recovery to the pre-war situation can be reached.

REFERENCES


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