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VIEWPOINT

Seabirds at Risk around Offshore Oil Platforms in the North-west Atlantic

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Seabirds aggregate around oil drilling platforms and rigs in above average numbers due to night lighting, flaring, food and other visual cues. Bird mortality has been documented due to impact on the structure, oiling and incineration by the flare. The environmental circumstances for offshore hydrocarbon development in North-west Atlantic are unique because of the harsh climate, cold waters and because enormous seabird concentrations inhabit and move through the Grand Banks in autumn (storm-petrels, *Oceanodroma* spp), winter (dovekies, *Alle alle*, murres, *Uria* spp), spring and summer (shearwaters, *Puffinus* spp). Many species are planktivorous and attracted to artificial light sources. Most of the seabirds in the region are long-distance migrants, and hydrocarbon development in the North-west Atlantic could affect both regional and global breeding populations. Regulators need to take responsibility for these circumstances. It is essential to implement comprehensive, independent arm's length monitoring of potential avian impacts of offshore hydrocarbon platforms in the North-west Atlantic. This should include quantifying and determining the nature, timing and extent of bird mortality caused by these structures. Based on existing evidence of potential impacts of offshore hydrocarbon platforms on seabirds, it is difficult to understand why this has not been, and is not being, systematically implemented.

Keywords: offshore platforms; seabirds; oil; monitoring; Grand Banks; North-west Atlantic; flares.

Introduction

Seabirds are conspicuous marine organisms and relatively easy to survey. Their distributions and abundances are influenced by physical and biological processes such as oceanographic variation, weather, season, food availability and human activities such as fishing, vessel traffic, pollution, artificial lighting and large offshore structures. Seabirds have been frequently used as monitors of the marine environment (e.g. Furness and Greenwood, 1993).

Offshore oil exploration in areas of high seabird abundance in Atlantic Canada is expanding. Concerns about the impacts of these activities on seabirds have frequently been raised, yet no scientific assessments of the situations have been carried out. Here we present a literature review relating to seabird attraction to offshore platforms, recommend research designs to monitor and quantify seabird attraction and associated mortality and propose ways to mitigate possible detrimental effects.

Attraction to Offshore Oil Platforms

Seabirds are attracted to large offshore structures such as hydrocarbon drilling and production platforms. Causes for this attraction include structural stimuli (Tasker *et al.*, 1986; Baird, 1990), food concentrations (Carlisle *et al.*, 1964; Klima and Wickham, 1971; Shinn, 1974; Duffy, 1975; Sonnier *et al.*, 1976; Ortego, 1978; Wolfson *et al.*, 1979; Tasker *et al.*, 1986), oceanographic processes (Fedoryako, 1982) and lights and flares (Terres, 1956; Imber, 1975; Bourne, 1979; Sage, 1979; Hope-Jones, 1980; Crawford, 1981; Verheijen, 1981; Wallis,

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1981; Reed *et al*., 1985; Reed, 1986). Bird observers, boat and platform personnel, and researchers have noted associations between seabirds and offshore installations, though few have attempted to quantify them. Tasker *et al*. (1986) noted that birds were seven times more dense (birds/km^2) within a 500 m radius of a platform than birds in the surrounding waters. Baird (1990) found similar results in the Bering Sea, where bird densities at rigs were six to seven times greater after 'spudding' (i.e. commencement of drilling) than before. More recently, seabird concentrations around offshore oil platforms on the Grand Banks were 19–38 times higher than on survey transects leading to it (Wiese and Montevecchi, 2000).

Platform structures concentrate both seabirds and their prey in their immediate surroundings. Availability of roosting refuge at sea and increased food availability may be the most important reasons why birds persist at offshore oil platforms following initial attraction. Oil platforms create artificial reefs and augment levels of benthic flora and fauna, zooplankton and fish (Carlisle *et al*., 1964; Klima and Wickham, 1971; Shinn, 1974; Duffy, 1975; Sonnier *et al*., 1976; Ortego, 1978; Wolfson *et al*., 1979; Baird, 1990; De Groot, 1996). The discharge of human wastes at offshore platforms 'fertilizes' artificial habitats and might attract birds directly in much the same way as sewer outlets. For some seabirds, such as shearwaters, offshore oil platforms have become sites where otherwise patchy or scarce prey is more concentrated and predictable.

Seabirds are highly visually oriented organisms. A large vertical structure with a brilliant source of light in an environment which is otherwise flat and dark at night presents a conspicuous visual cue and a sharp contrast against nocturnal darkness (Weir, 1976; Bourne, 1979). Flares may be so intense that they can be individually detected using satellite imagery (Muirhead and Cracknell, 1984). Storm-petrels and other procellariforms forage at night on vertically migrating bioluminescent prey and are, therefore, naturally attracted to light of any kind (Imber, 1975). Large attractions and mortalities of birds have often been documented by lighthouses, ceilometers, communication towers, office buildings, navigational lights, and oil platforms, mostly during overcast nights with drizzle and fog (Weir, 1976). The attractive effect of lights during cloudy nights is enhanced by fog, haze or drizzle because the moisture droplets in the air refract the light and greatly increase the illuminated area.

Anthropogenic Mortality of Birds around Offshore Oil Platforms

Regardless of the processes that attract and hence concentrate marine organisms at offshore oil platforms, their presence near the structure may lead to immediate or long-term detrimental impacts on their lives. An obvious negative influence around oil platforms is the intermittent presence of oil on the water. The hydrophobic nature of oil causes plumage to lose waterproofing, insulation and buoyancy, resulting in death due to hypothermia, exhaustion and starvation. Oil is ingested and inhaled while preening feathers (Birkhead *et al*., 1973; Stout, 1993) or by ingesting contaminated prey (e.g. fish around oil platforms, Davies and Bell, 1984), reducing survival and lifetime reproductive success (Leighton, 1990; Khan and Ryan, 1991; Frink and Miller, 1995; Hartung, 1995). The resultant increases in mortality and decreases in recruitment rates create potential effects on population trends.

Hibernia, the largest permanent offshore oil platform on the Grand Banks, reported 60 spills between November 1997 and December 1999, with a median of 10 l per spill (D. Burley, Canada Newfoundland Offshore Petroleum Board, pers. comm.). Depending on environmental conditions, such a quantity can cause slicks large enough to kill many seabirds; there is no direct relationship between the volume of oil spilled and the number of birds killed (Burger, 1993). Rather it is the timing and location of a spill that largely determines the extent of the mortality.

Lights and flares attract birds, especially storm-petrels (*Oceanodroma* spp), dovekies (*Alle alle*) and shearwaters (*Puffinus* spp), and as Weir (1976) pointed out, 'nocturnal kills are virtually certain wherever a lit obstacle extends into an air space where birds are flying. The time of the year, location, height, light and cross-sectional areas of the obstacle and weather conditions will determine the magnitude of the kill'. Documented mortality is higher during migration periods when large numbers of birds are forced to a lower flight path or to the surfaces by inclement weather (Terres, 1956; Weir, 1976; Sage, 1979; Hope-Jones, 1980; Crawford, 1981; Verheijen, 1981). Most birds that migrate at night climb to their migrating altitude almost immediately after takeoff and begin a gradual descent shortly after midnight (Weir, 1976). Similarly, the numbers of Leach's Storm-Petrels (*Oceanodroma leucorhoa*) visiting colonies near lighthouses peaks after midnight (Bryant, 1985). This pattern might help explain the much larger numbers of birds at tall, illuminated, man-made structures in the latter part of the night. In addition, evidence suggests an influence of lunar phases on bird mortalities at lighted structures (Crawford, 1981; Verheijen, 1981; Reed *et al*., 1985).

Whether by instinct or learned capacity to associate light and smell with food, seabirds have been known to circle platforms and the flare for days eventually dying of starvation (Bourne, 1979). Storm-petrels often fly directly into lights (Terres, 1956; Weir, 1976; Crawford, 1981; Verheijen, 1981; Reed *et al*., 1985) and flares (Bourne, 1979; Sage, 1979; Avery *et al*., 1980; Wood, 1999), resulting in death or injury by impact or burning (Hope-Jones, 1980; De Groot, 1996).

Production licenses for offshore oil operations in Canada stipulate that surplus gas be burned at sea only with the consent of the regulating authorities. For economic reasons alone, it is better to re-inject gas into the sea-floor or store it in reservoirs for later transport ashore (De Groot, 1996). Unfortunately, this has not been the case on the Grand Banks until recently, although production began in 1997. Between November 1997 and June 2000, 1.13–2.5 million m^3 of gas were burned daily on the Hibernia platform (Canada Newfoundland Offshore Petroleum Board, 1998, 1999, 2000), creating flares up to 20 m in height. The height of flares, total numbers in an area and consistency of flaring are likely the most critical factors increasing the volume of illumination attracting birds (De Groot, 1996). As the number of flares from exploratory rigs and permanent platforms in the North-west Atlantic increases, high flaring during initial phases will continue to be common practice (Schael, 2000), making bird mortality at flares more than just a short-term localized problem.

Need for Systematic Quantitative Data Collection at Platforms

Despite the attention these negative impacts of oil platforms on birds have received and their mention in past environmental assessment reports, the extent of these problems has not been quantified for this region and baseline data available on seabirds at sea for the study area are sparse and inadequate. The only documented and published information on bird mortalities at oil platforms comes from the North Sea, focuses on flares, and dates back 20 years. Results from these studies vary and it is noteworthy that mortalities involving large numbers of birds can be very difficult to detect at sea if mortality events are episodic and observation periods are short. Sage (1979) witnessed, reported and compiled information of several occasions where hundreds, sometimes tens of thousands of birds, were killed by flying into the flare, whereas Hope-Jones (1980) and Wallis (1981) did not observe fatalities directly due to flares. These differences may have resulted from the reduction of flare sizes after the first study but no information on this is available; comparable data have not been collected in the North-west Atlantic. Avian species killed in the North Sea were mainly songbirds during spring and fall migration but also included storm-petrels. Reports from boat and platform personnel in the North-west Atlantic indicate the regular occurrence of storm-petrels flying into the lights of boats and the platform and of thousands of dovekies (*A. alle*) circling in the Hibernia lights for hours on end (D. Taylor Hibernia Management and Development corporation, St. John's, Newfoundland; U. Williams, Terra Nova Development Project, St. John's, Newfoundland). Despite any existing skepticism toward early reports of large bird kills in the North Sea, a critical difference between the predominance of songbirds in the North Sea, versus storm-petrels and other seabirds off eastern Canada, needs to be emphasized. We simply do not know the actual effects of offshore platforms on seabirds in the North-west Atlantic. Storm-petrels are strongly attracted to light and have been killed at platforms, and diving birds (auks) that occur seasonally in large numbers around platforms are the most vulnerable groups of birds to oil (Montevecchi and Tuck, 1987; Camphuysen, 1989; Wiese, 1999; Wiese and Ryan, 1999). Auks, shearwaters and storm-petrels occur in the North-west Atlantic in enormous numbers (around 40 million, Brown, 1985; Chardine, 1990; Lock *et al.*, 1994), and the world's largest colony of Leach's Storm-Petrels (~9) million birds) occurs on Baccalieu Island on the east coast of Newfoundland (Sklepkovych and Montevecchi, 1989).

The goal of future research is to minimize unnecessary, avoidable seabird mortality. With this in mind, two monitoring systems are proposed and outlined below: first, to quantify the timing of association of different seabird species with offshore oil platforms, and second, to quantify the nature and timing of seabird mortality caused by offshore platforms.

Quantifying Seabird Associations with Offshore Oil Platforms

A combination of simultaneous platform-based and vessel-based surveys is the most comprehensive and systematic way to assess bird attraction to offshore platforms. Vessel surveys rigorously test the hypothesis that birds occur in above-average density in the vicinity of the platform through comparisons within the transect route (Fig. 1), among different surveys on the same route and with the surrounding ocean. However, they only provide a restricted view around the platform, as tender vessels stay outside a 500 m safety zone and often up to 3.5 km away from the installation when not unloading or loading.

Surveys conducted from the platform determine timing and degree of association of seabirds with platforms as well as species composition at different times of day and year around hydrocarbon platforms (Tasker *et al.*, 1986). Identification of species composition as well as quantification of total numbers is essential to determine species-specific vulnerability to different types of disturbances. It is also the only means to conduct night observations (see 'mortality').

Timing is a crucial aspect of every monitoring system. In the first instance, the seasonal occurrences of different species around platforms need to be determined. To do this properly, observers need to remain on the platform for 7 days per visit, and surveys need to be carried out during each month of the year. Delineation of seasonal occurrences will indicate times of highest risk for seabirds and clarify periods of major bird movements through the area, such as shearwaters in spring, storm-petrels in autumn and dovekies and thick-billed murres (*Uria lomvia*) in winter. An observer should additionally be on the platform continuously for 2 months during

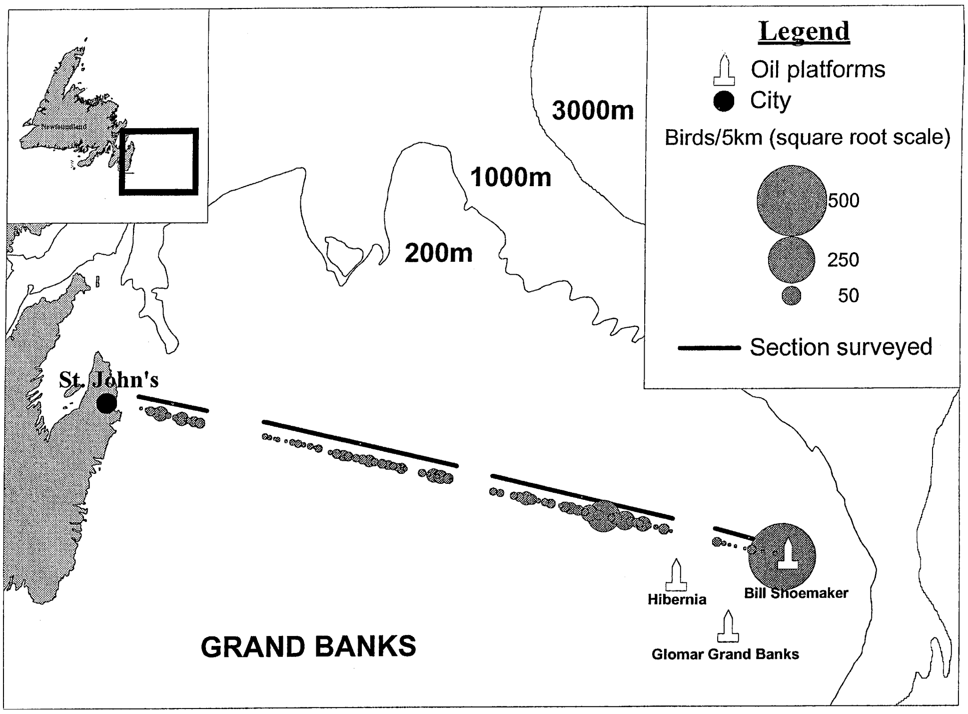

Fig. 1 Typical seabird distribution pattern observed during seabird surveys conducted between St. John's, Newfoundland and offshore oil platforms on the Grand Banks. Surveys were conducted in the summers of 1999 and 2000.

April/May, September/October, and January/February. Air and water temperatures, salinity, wind speed and direction, visibility, sea state, and lunar phase, as well as speed and direction of ocean currents should be recorded during all surveys. Over the long term, this survey design will permit the necessary comprehensive analysis of interseasonal and interannual variation in the timing of seabird species occurrences and abundances at offshore platforms.

Quantifying Seabird Mortality at Offshore Oil Platforms

In the case of an oil pollution event, effective direct monitoring may be possible only during daylight hours. Immediately upon occurrence of a spill at a platform, observers should carefully record species-specific information on: (a) behaviour relative to the oil (attraction, avoidance, indifference, escape techniques after contact, etc.), (b) number and percentage of oiled individuals, (c) time individuals spend preening oiled feathers, and (d) number, percentage and timing (elapsed time after spill) of dead birds. Dead individuals should be collected and autopsied.

Nocturnal surveys should begin at the onset of darkness (i.e. 30 min after sunset), last for 30 min and be repeated every hour until dawn.

Surveys will quantify species- and time-specific mortality due to oiling, drilling fluids, produced water, collisions and incineration in flares at platforms. However, experimental studies are needed to investigate effective means of minimizing mortality. Experiments using red filters in front of floodlights on tall structures reduced avian casualties by 80% (LGL Limited, 1972). Simple light-on/light-off experiments at a television tower demonstrated that within 2 min after lights were turned off, birds circling the tower departed, while 2 min after relighting, the same or other individuals returned (Cochran and Graber, 1958). Elsewhere ceilometer beams, outfitted with filters that permitted only the emission of ultra-violet (UV)-light, greatly reduced the number of large bird kills. Airports that shut off ceilometers when alerted of large migrating flocks in the area reduced bird mortality (Terres, 1956; Weir, 1976). It is crucial to shield lights rather than reduce brightness (Reed *et al.*, 1985). Upward shielding of lights reduced the attraction of shearwaters and two species of petrels by 40%. In contrast, filtering UV and short visible wavelengths reduced brightness by 75% but did not reduce attraction. Finally, many seabirds that occur around platforms (e.g. fulmars, shearwaters, storm-petrels, dovekies) feed on small plankton and fish offal (e.g. Montevecchi *et al.*, 1992; Montevecchi, 2000). Current practices of discarding macerated grey water provide a direct food source for these birds and fertilize the artificial reef created by platforms. This must be avoided.

The following experimental and mitigative manipulations at offshore platforms are recommended:

1. Schedule flare shutdowns for maintenance during critical periods of migration and systematically record the incidence of birds at the platform before, during and after flaring.

2. As an experiment, stop discarding waste into surrounding waters for one month and systematically record the incidence of birds at the platform before, during, and after cessation of waste discharge.
3. Shield all outside lights (except navigation lights) towards the sky and systematically record any incidence of birds at the platform before and after shielding.
4. Turn off all unnecessary outside lights and close blinds of all windows of the living quarters 30 min before darkness.

Experiments and mitigative actions of this kind have been carried out at platforms elsewhere and are essential, as birds are attracted primarily to light sources rather than the areas they illuminate (Reed *et al*., 1985). Together, surveys and experimentation will make it possible to identify critical times of the year (e.g. migration from September to November) and times of night and allow the development of effective forms of mitigation.

Conclusions

Despite occasional documentation of negative impacts of offshore oil platforms on birds, and the documented association of birds with offshore hydrocarbon platforms in eastern Canada, the nature and timing of seabird mortality at platforms have not been rigorously and systematically studied. Up to 40 million seabirds vulnerable to anthropogenic impact occur throughout the year, and anecdotal knowledge suggests a potentially large problem. The need for baseline information in eastern Canada cannot be overstated.

Given the intense work loads of platform personnel, nature of boat operations, rigorous design of the proposed study and the necessity for consistency in the observations, it is impossible to carry out an effective monitoring programme without skilled and dedicated observers (Tasker *et al*., 1984; Webb and Durinck, 1992; Montevecchi *et al*., 1999). Public confidence in the adequate protection of the marine ecosystem is best ensured if observers are independent, 'acting at arm's length' from the petrochemical companies responsible for platform operations. A reasonable model for such an arrangement is the fisheries observer programme that is required in Canadian waters.

To initiate this process, offshore operators have to be convinced or mandated to allow independent, arm's-length observers on platforms. Despite the identified concerns and repeated recommendations and suggestions from local and international seabird experts (Montevecchi *et al*., 1999) in a report and at a workshop sponsored by the Canadian Association of Petroleum Producers, offshore hydrocarbon operators are not allowing independent observers on their platforms. We recommend that the use of independent observers on platforms be mandated by law; we look to the Canada Newfoundland Offshore Petroleum Board to resolve this issue expediently and effectively.

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