and technology hearing evidence concerning the EEC proposal to reduce pollution by the titanium dioxide industry. At present Britain is the only member of the European Community to oppose the proposal. Two plants on the Humber estuary are believed to discharge a total of more than 60 000 m³ of acidic waste daily.

Japan

Writing in *Earthscan Bulletin* (Vol. 6, No. 8) marine biologist Katherine Muzik has drawn attention to a threat to a coastal reef on the Japanese island of Ishigaki posed by plans to build a new international airport. The airport, designed to handle jumbo jets, will be extended out into the sea and will result in the destruction of at least 3.6 km of reef. Island residents have organized opposition to the plan, arguing that, while the airport is designed to allow more tourists to visit the island, destruction of the reefs will remove one of Ishigaki's chief natural attractions.

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VIEWPOINT

Viewpoint is a column which allows authors to express their own opinions about current events.

Oil Pollution Dangers on the German Coast

G. VAUK

Dr Gottfried Vauk has been leader of the Island-Station of the "Institut für Vogelforschung, Vogelwarte Helgoland" since 1956. He also is chief of the project group on Seabirds and Seals in the German research working association of oil accidents.

Even before the first World War, Hugo Weigold, the former head of the bird observatory Helgoland, called attention to the threat to seabirds of oil pollution. At that time he did not think that the subject of oil pollution would still preoccupy the bird observatory in 1983.

Seabirds which arrive as oil victims on the beaches of Helgoland have been counted since 1960. To begin with, these counts were published at infrequent intervals (Vauk & Pierstorff, 1973; Vauk & Reineking, 1980), but more recently they have been published annually (Vauk, 1981, 1982a, 1983). Until recently there was no summary of the historic development of the oil pollution and its effect on seabird populations. Therefore we wrote a book, which combines our own experience with Anglo-American literature (Reineking & Vauk, 1982).

Helgoland—Centre of Oil Pollution Research in West Germany

The geographical position of Helgoland in the German Bight (54.11 N; 07.55 E) has favoured seabird research and the exploration of the flight paths of migrant birds. Helgoland waters are a vital wintering area for seabirds of a variety of species, especially in very frosty winters. The island is also the site of the only large breeding colony in Germany of the Common Guillemot *Uria aalge*. Because of this, researchers at the bird observatory have concentrated on this group of birds in respect to the problem of oil pollution.

In 1928, Drost published the following analysis "The island of Helgoland presents a great possibility of studying oil pollution of the sea. As long as the discharge of waste oil and oily water is not completely avoided, large amounts of oil will continuously get into the sea. Therefore the danger to the marine life, especially seabirds, increases." This correct prediction became more important after oil exploration started on a large scale in the North Sea and the oil ports of Rotterdam and Wilhelmshaven were expanded. Helgoland presents the possibility of determining the extent and the effect of the oil pollution of the North Sea, since it is placed in the point of intersection of important steamship routes and also oil slicks drifted by the north-west winds along the German Bight including Helgoland (Fig. 1). Seabirds are indicators for the quantity, the type and the temporal distribution of oil.

Increase of Oil Pollution in the German Bight Since 1960

The evaluation of the results indicates that in the years 1960–1979 the number of oil victims was under 100 a year. Since 1979 an extreme increase has been observed, reaching a temporary peak of about 350 oil victims in 1982. 1983 will show a further heavy increase. Altogether more than 650 oil pollution victims have been found until 31 March 1983 (Fig. 2).

With regard to the time of year, it is evident that the number of oil victims increases in the winter (October to April), whereas during the summer the numbers are small. A significant correlation exists between the air and water temperatures as well as the number of the days with strong wind on the one hand and the number of oiled birds on the

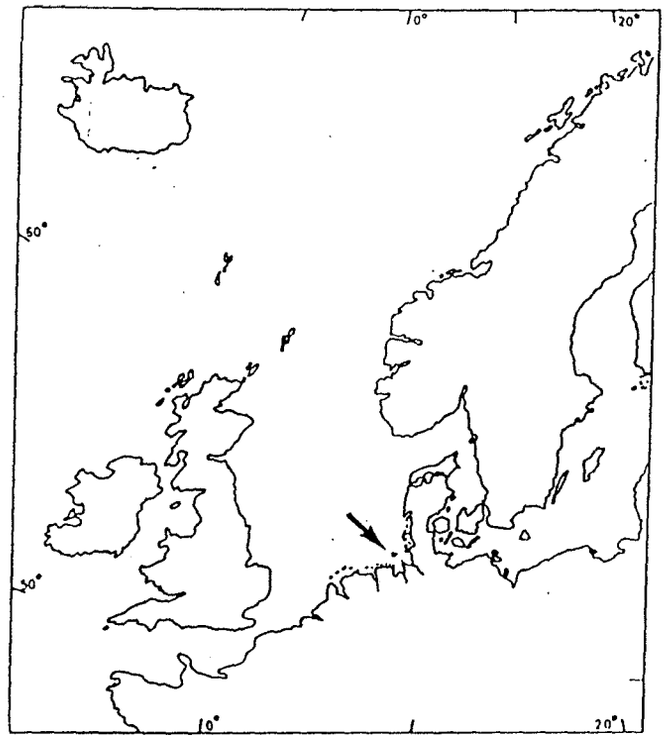

Fig. 1 Geographical situation of Helgoland in the German Bight.

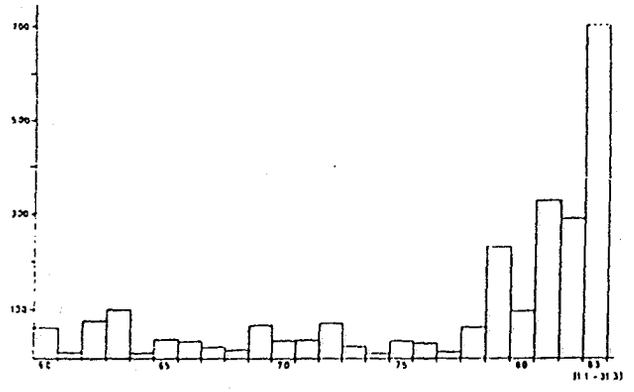

Fig. 2 Number of dead seabirds resulting from chronic oil pollution, Helgoland 1960 to March 1983.

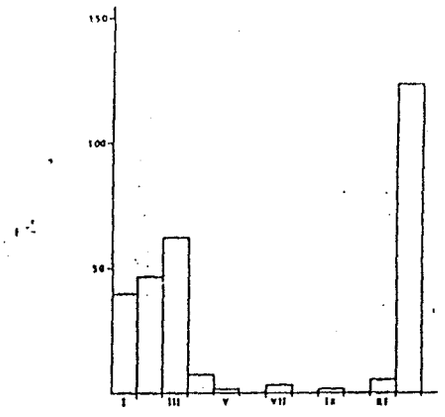

Fig. 3 Oil pollution victims in 1982.

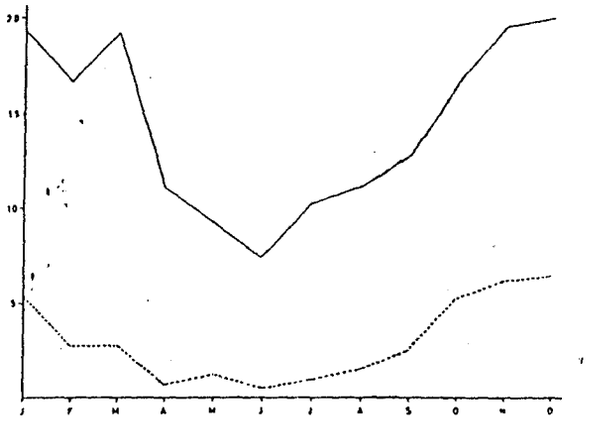

Fig. 4 20 year average of days with windforce 6–8 and more in Helgoland.

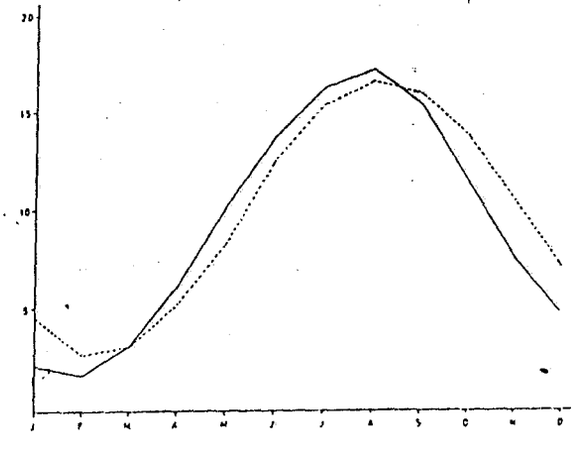

Fig. 5 20 year average of the air and water temperatures at Helgoland.

other (Figs 3 and 4). Several factors explain this relationship:

(a) In the winter, there are more birds in the German Bight.

(b) In winter, biological degradation of oil is slower because of low air and water temperatures (Fig. 5).

(c) During the winter, the strong north and north-west winds drive oil into the German Bight.

(d) Due to bad visibility conditions at the sea during the winter months it is easier for captains to discharge old oil and to clean ballast and fuel tanks near the coast.

(e) Rough sea leads to an increased number of small accidents to ships, platforms and pipelines, resulting in an increased oil loss into the sea.

The increased number of oil victims since 1979 is a significant signal for growing oil pollution. We have therefore been searching for the producers of this creeping oil pollution. The only way was the analysis of oil taken from the feathers of the oiled birds. With this method it was possible to determine which were from crude oils, waste oils and treated oils. In addition, the origin of the crude oils could be determined rather exactly. The results show the following tendency: either old oils or crude oils constitute a considerable part of pollution and the source of the crude oil is mainly the North Sea.

Dangers to the Marine Ecological System

It is necessary to distinguish between several different negative effects of the increasing oil pollution.

(a) The seabirds in the marine area, in the Wadden Sea and at the coast;

(b) The other marine life-forms in the area of the open sea and in the Wadden Sea;

(c) The beaches and the coasts in connection with tourism.

A bird which is contaminated with oil suffers seriously and frequently dies. The constant stress, produced by repeated cleaning with the disarranged behaviour which that entails, leads, in combination with the harmful effects of ingested oil, to hypothermia and damage to the internal organs, leading to a situation in which the bird dies. Alternatively the bird may reach the beach in such a totally exhausted state that no rehabilitation is possible – a racking end. Single birds, especially gulls, can survive oil pollution, either in nature or after appropriate care, but it is to be assumed that these animals suffer lesions later (Clarke, 1978; Vauk, 1980).

The question is whether the seabird populations of the North Atlantic are damaged by the creeping oil pollution and decimated in numbers. It is well known that the number of breeding birds, for example the Common Guillemot *Uria aalge* and the Common Kittiwake *Rissa tridactyla*, in certain colonies at Helgoland, have increased in spite of known losses from oil pollution (Figs 6, 7), but little is known about the origin of this increase (Vauk, 1982a,b).

But it is likely that the reason for the decrease of the populations of Common Scoters *Melanitta nigra* in Scandinavia has been oil pollution, because this decline of the last twenty years proceeded in parallel with the continuous rise of oil pollution in the North Sea and Baltic (Cramp *et al.*, 1977; Joensen & Hansen, 1977). It seems that seabirds like the Common Scoter and the Eider *Somateria mollissima*, which stay in a relatively small area near the coasts of Denmark and north-west Germany during the winter, suffer greatly from oil pollution. In comparison to this, seabirds like the Kittiwake and the Common Guillemot are rarely in touch with smaller oil patches in the open sea.

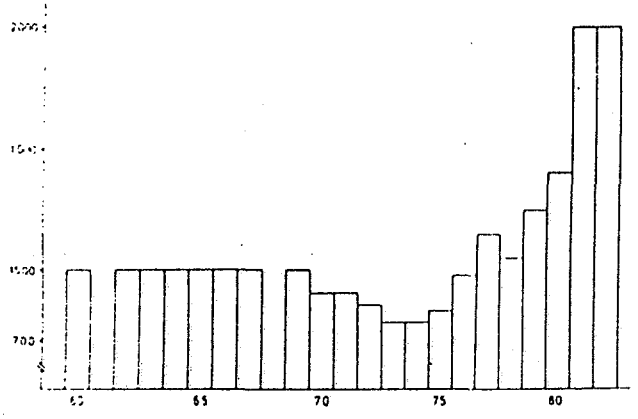

Fig. 6 Development of the breeding population of the Common Guillemot, *Uria aalge*, on Helgoland.

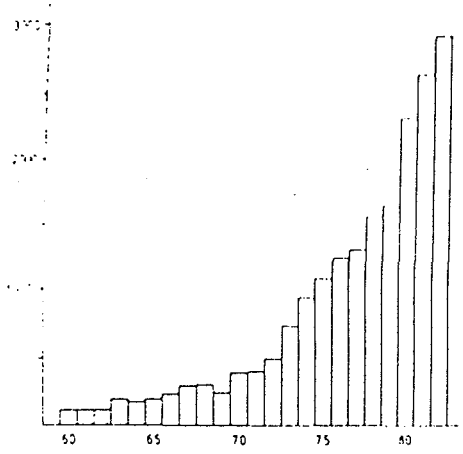

Fig. 7 Development of the breeding population of the Common Kittiwake, *Rissa tridactyla*, on Helgoland.

Though this situation is not alarming, Helgoland, the only German colony of seabirds, is in acute danger. At present, five pairs of Razorbills (*Alca torda*) and 15 pairs of Northern Fulmars (*Fulmarus glacialis*) breed in addition to Common Guillemots and Kittiwakes. Even now, a small oil slick drifting near Helgoland could cause high losses to such small populations, which would then disappear or be heavily reduced. This danger increases in the months of February and March because, from experience, the most oiled seabirds are concentrated in the sea area near Helgoland or already at the breeding rock at this time. However, it is absolutely imaginable that smaller oil pollutions can appear during the breeding time. Fortunately this has not happened so far. If this was to happen, the most important and last colonies of terns on the north-west coast would be in acute danger. The terns have only a few breeding places on some smaller islands protected and guarded by nature conservation associations in the area of the German Wadden Sea coast which is densely populated and heavily used by tourists. Then, especially, the Sandwich Terns (*Sterna sandvicensis*) would be in danger, breeding only in large numbers on the islands Trischen and Scharhorn in the Elbe-mouth and Norderoog at the west coast of Schleswig-Holstein. A driving oil slick in the Wadden Sea near these colonies, of which the Elbe mouth seems particularly threatened, could lead to the end of the population, particularly in May and June. A slight oil contamination of the eggs could lead to brood losses, which could be alarming to the existence of the population. With a crash, decades of protective work, carried out by nature and bird conservation associations in the last retreat areas of the terns, could be destroyed at once (Schneider, 1980; Temme, 1967).

Most of our knowledge about oil pollution damage relates to seabirds. Our knowledge about the effect of chronic oil pollution on plants and animals of the marine area and the Wadden Sea is much less. There are very few publications of results with regard to the damage to marine organisms caused directly by oil. Nothing is known about long-term change caused by slight oil damage. It is possible that such damage in the open sea is unlikely at present, but in the sublittoral and littoral habitats degenerative effects of relatively trifling but recurrent oil pollution are to be expected. In the winter of 1982–83 the effects of oil pollution were visible in the area of the Wadden Sea, and also on the beach and adjacent dunes of the coasts of Schleswig-Holstein. On the island of Amrum large parts of the beach and *Amnoghila arenaria* to a height of 10 cm were covered with oil. Equally large regions of limited dyke-foreland and of the Wadden Sea were covered with oil or tar masses of various sizes. Fortunately some weeks ago the bulk of oil was washed out by an extraordinary

strong tidal wave. Repeated oil pollutions of this manner led inevitably to enduring damage to the flora and fauna of the beach and shallows.

It is widely believed that oil residues which become tar-balls are without any risk or consequences to the environment. In my opinion, this assumption has not yet been proved. If this is so, tar-balls, although finally reduced to a size at which they are no longer visible, could lead to serious stress of the beaches and the Wadden Sea. It has already been proved that after some time of water and weather influence buried oil residues can be re-exposed and can expand their harmful effects to the environment.

From what has already been said, chronic oil pollution leads to beach pollution, which has unpleasant consequences for tourists seeking recreation. A beach soiled by oil puddles could lead to the interruption of the stay of guests or their disappearance altogether. In consideration of the large economic importance of tourism on the whole German coast, it is conceivable that serious results could follow further oil pollution of the coasts and beaches. It is time that administrations of coastal resorts authorities and politicians recognize dangers which may one day threaten a prosperous sector of the economy. This problem cannot be solved indefinitely by constant beach cleanings, because smaller and/or invisible oil patches cannot be cleared away. In addition, the common financial burden of the communities increases constantly.

Can Oiled Seabirds be Rescued and Rehabilitated?

When oiled birds appear on the coasts this question will be asked every time and will be answered in different ways. In principle one has to differentiate two aspects of this problem: the biological–ecological and the human aspects.

Biological–ecological aspect

Especially in the USA and Great Britain, there have been attempts to clean oiled birds, rehabilitate them and reintroduce them into free-living populations. From the published reports it is evident that amateurish efforts to clean birds are merely cruelty. The results of professionally supervised cleaning stations and rehabilitation centres are extremely small. Assuming the most favourable conditions, 0.8% of all birds affected by oil can be rescued. The proportion of birds successfully cleaned varies with the species, but in most cases it is species, the rescue of which has no impact at the population or ecological level which are most easily cleaned: gulls, swans, some species of geese, coots, etc. The percentages of survivors are small for genuine pelagical seabirds. After the ringing and release of these birds the rate of recovery, i.e. the death rate, is higher than in the normal case. Also injury to the feathers and the interior organs as a result of the oil pollution (and possibly the cleaning?) must be assumed. Furthermore, the natural behaviour of the captured animals is disturbed. Therefore they become outcasts and this rarely allows a reintegration into a free-living population. Cleaning and rehabilitating birds involves large costs and for these reasons attempts to clean oiled seabirds have to be regarded as absurd.

The human aspect

To the human and ethical point of view, cleaning of oiled seabirds appears differently. One can hold that man, who has raised difficulties by his civilizing–technological actions to other creatures, has to help these creatures in every possible way. Under these circumstances, the use of financial resources and human work cannot play a part any more than the fact that the chances of rescue are small and that the few rescued birds are insignificant to the existence of the wild population. This connection gives the idea of establishing a reproductive captive population from rescued birds (Bourne, 1970).

It is necessary that the cleaning and rehabilitation actions, if they are not to change from humanity to cruelty to animals, are carried out by specialists (veterinarians, biologists and animal-keepers) in adequately equipped rehabilitation centres. These rescue activities demand a lot of money and human work, which cannot be covered by the nature conservation association itself. With priority the meagre funds and possibilities of the nature conservation associations have to be used for the maintenance of existing, tolerably normal living spaces (breeding, shelter and feeding places for the seabirds) and their wild populations. In addition the nature conservation associations should carry out and stimulate scientific and educational work, which could support their aims. So the cleaning experiments of the oiled birds have to be performed and financed by organizations that feel bound themselves to such tasks. In West Germany these are predominantly animal conservation associations.

What Precautions are Needed to Remove the Chronic Oil Pollution?

This account shows that the cleaning of oiled seabirds is not a priority task but the determination of the polluters is; this aim can only be reached by the international control of the North Sea. At the same time international laws are needed with very severe punishments for the polluters. Without doubt a national and international supervision of the North Sea is needed. The first priority is an overall air-supervision, already practiced with success in the Netherlands. In addition a comprehensive control of the production platforms is required. These are now extending to the west coast of Schleswig-Holstein, where the first test drilling has been productive. Finally, in the interest of the maintenance of the health of the North Sea, science and nature conservation associations should put pressure on enforcing international laws and corresponding punishments, in order to end the chronic oil pollution of this sensitive marine ecological system.

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Heavy Metal Content and Lithological Properties of Recent Sediments in the Northern Adriatic

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Heavy metal (Hg, Pb, Cd, Cu, Cr, Ni, Co, Zn and Fe) concentrations, textural characters and mineralogical compositions have been determined on 246 surface sediment samples from the Northern Adriatic Italian sea area. The relationship between the heavy metals content and the pelite (< 63 μm fraction) percentage has been studied. All the metals resulted accumulated in the fine fraction with the following percentages (Hg, 95%; Zn, 86%; Pb, 82%; Cu, 79%; Cd, 74%; Ni, 70%; Cr, 65%; Co, 65% and Fe, 64%). The specific surface area has been measured on 44 samples and correlated to metal values. A fairly good (50% and more variation explained) linear correlation coefficient has been found for Ni and Cu in the entire area, less significant correlation for other metals. In order to discriminate between natural and anthropogenic origin the metal concentrations on the whole sediment has been normalized on the basis of the pelite percentage. In the areal distributions drawn with the corrected values, zones contaminated by industrial discharges have been identified mainly in front of the lagoon of Venice.

In a previous work (Donazzolo *et al.*, 1981) we published the heavy metal concentrations, the textural characters and mineralogical compositions of sediments collected in front of the Lagoon of Venice. High levels of Zn, Pb and Hg were found in areas facing the Lido and Malamocco port entrances, mainly due to waste materials from industrial processing of zinc minerals. The study has been then extended to the Italian Adriatic sea area from the Po di Levante to the Isonzo rivers mouths. Preliminary results concerning Hg, Pb and Cd have been presented at the Symposium *The Adriatic Sea-Characteristics and Perspectives* Rovinij, Oct. 1982 (Donazzolo *et al.*, 1983). Whereas a significant correlation between the sediment fine fraction percentages and the Hg and Pb concentrations was observed in the entire area, Cd showed a similar behaviour only in a restricted zone.

In the present paper we discuss the contents of Hg, Pb, Cd, Cu, Co, Ni, Fe, Cr and Zn in terms of the grain-size and mineralogical composition and of the specific surface area. Our aim is also to define a proper method for normalizing the heavy metal concentrations in order to distinguish natural origins of these elements from anthropogenic inputs.

Experimental

Study area

The studied area extends for about 2500 km² within the Italian territorial waters from Isonzo to Po di Levante rivers (Fig. 1). In this part of the Adriatic Sea the prevailing water currents run counterclockwise parallel to the coastline. The eight main rivers flowing into the sea drain waters from heavily industrialized and intensively cultivated districts; on the inner border of the two main lagoons, i.e. of Venice and Marano connected with the sea through channels or port entrances, the industrial zones of Marghera and Aussa-Corno are located, respectively.

Sampling and analyses

In this area 246 surface sediment samples have been collected by a modified Van Veen grab sampler aboard the R.V. *U. D'Ancona* of the Italian C.N.R. during three cruises in 1977, 1978 and 1979. The density of the sampling grid has been increased in front of the lagoon of Venice port entrances and of the Po di Levante, Adige and Brenta river mouths which were supposed to be the main sources of pollutants for the Italian Northern Adriatic Sea.

The sample handling and the chemical, sedimentological and mineralogical analyses were carried out following