

Seabirds in Conditions of Local Chronic Oil Pollution, Davis Sea, Antarctica

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Simple Summary: Oil spills are rare in Antarctica. They happen in the ocean and on land. The purpose of the study is to determine the total number of seabird species interacting with oil at the Mirny Station and around it, to assess the extent of pollution and to identify the most important sites of interaction. Observations carried out at the beginning of the 21st century at the Mirny Station revealed significant oil pollution in its territory. This pollution had affected the coastal ecosystem for more than 60 years. Five bird species were found to have been in contact with oil. The least affected by pollution were Wilson's Storm Petrels (*Oceanites oceanicus*) and skuas. Most petrels did not interact with oil. Adélie (*Pygoscelis adeliae*) and Macaroni (*Eudyptes chrysolophus*) penguins were found to be vulnerable to oil pollution. Hot spots have been identified where penguins' interactions with oil occur most frequently. Mechanical cleaning of rocks in hot spots can reduce the impact of pollution on local fauna. This information can be useful in assessing the health status of marine vertebrate populations and in preserving the marine biodiversity of Antarctic ecosystems.

Abstract: Oil spills are rare in Antarctica. They threaten flying birds and penguins. This is the first report on the interactions of seabirds with oil in the area of the Mirny Station (East Antarctica). The purpose of the study is to determine the total number of seabird species interacting with oil in and around the Mirny Station, to assess the extent of pollution and to identify the most important sites of interactions. Oil pollution is found on the ground, on the continental ice and, on the seawater surface, both directly in the Mirny and beyond. Five species of seabirds were in contact with oil. Oil pollution threats have been identified for breeding and molting Adélie Penguins (*Pygoscelis adeliae*) and vagrant Macaroni Penguins (*Eudyptes chrysolophus*). Less affected by oil pollution during the breeding season were tube-nosed bird species and skuas. The most important places of interaction of seabirds with oil are at Cape Mabus, on the islands of Zykov, Tokarev, and Stroiteley. Evidence of long-term oil pollution of the environment is indicative of the chronic nature of the impacts on the coastal ecosystem.

Keywords: oil; fuel; spills; pollution; seabirds; penguins; Mirny; Haswell archipelago; Antarctica



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1. Introduction

Major oil spills are rare in the Antarctic [1]. However, according to estimates by I. Snape et al. [2], 1 to 10 million m³ of soil in Antarctica is considered to be contaminated with oil. Land spills most often occur in ice-free coastal areas with high marine biodiversity, where populations are isolated and vulnerable, and where the environment is of high aesthetic value [3].

Direct fuel leakage mainly occurs at Antarctic stations and along road networks [3,4]. In the second half of the 20th century, significant diesel fuel spills (tens of thousands of liters) occurred both in West Antarctica (for example the Bahía Paraíso vessel, which ran aground and subsequently sank near the Palmer Station) [5] and in East Antarctica (for example at the Davis and the Casey stations) [2,6,7]. Significant oil pollution is present at the Mirny Station [8–11]. Small-scale local oil pollution was recorded at the Edgeworth David Station, Bunge Hills [12].

Oil spills threaten flying birds and penguins. In addition, oil spills along the coast and coastal areas are the most damaging to the environment due to concentrated biodiversity and the complexity of clean-up [3]. Penguins are particularly vulnerable to oil spills and are more likely to be exposed to them [13–15]. They must keep their plumage in good condition [15]. The main effects of oiling on penguins are loss of the waterproofing and insulative properties of the feathers [13]. The body weight of oiled penguins decreases rapidly, since increased metabolism counteracts low body temperature [16].

African Penguins (*Spheniscus demersus*), Magellanic Penguins (*Spheniscus magellanicus*), and Little Penguins (*Eudyptula minor*) were exposed to massive oil pollution [1,7,13,17]. The extent of oiling of other penguin species varied from one (King Penguin (*Aptenodytes patagonicus*)) or several individuals up to several dozen and hundreds of individuals, for example Adélie (*Pygoscelis adeliae*), Macaroni (*Eudyptes chrysolophus*), Gentoo (*Pygoscelis papua*), Chinstrap (*Pygoscelis antarcticus*), Rockhopper penguins (*Eudyptes crestatus*), and possibly Humboldt Penguins (*Spheniscus humboldti*) [1,7,13,18,19]. Petroleum pollution has killed thousands of penguins in South America, Africa, Australia and New Zealand, and even Antarctica [1].

The Haswell archipelago supports an abundance of life [20]. It is home to tens of thousands of seabirds that breed here annually on fast ice (Emperor Penguin (*Aptenodytes forsteri*)) as well as snow and ice-free rocks (Adélie Penguin, tube-nosed birds and skuas) [21,22]. This is one of the few places in East Antarctica, where the abundance of seabirds is concentrated in a spatially limited area. With the advent of human activity in the study area and the construction of the Mirny Station, oil pollution has become a problem for seabirds. The purpose of the study is to determine the total number of seabird species interacting with oil in and around the Mirny Station, to assess the extent of pollution and to identify the most important sites of interactions. The article contains general information about oil pollution in the coastal ecosystem of the Davis Sea. For the first time, this information fills a gap in our knowledge of the problems and interactions of seabird species with oil in one of the sectors of East Antarctica—in the area of the Haswell Islands. This information can be useful in assessing the health status of marine vertebrate populations and in preserving the marine biodiversity of Antarctic ecosystems.

2. Materials and Methods

2.1. Study Area

The work was carried out on the Haswell archipelago (66°31' S, 93°01' E) off the coast of the Davis Sea (Queen Mary Land) in the Indian sector of the Southern Ocean based at the Russian Mirny Antarctic research station (66°33' S, 93°00' E) (Figure 1). This report summarizes the historical and recent information accumulated by biologists during their work in Mirny and the adjacent islands. The author's year-round observations in 2012/2013 and 2015/2016 also formed the basis of this report. The collection of data on oil pollution was not targeted. The information was collected along with other programs for the study of vertebrates. All the islands (17) and nunataks (Komsomolsky, Radio, Morennyy, and Hill of the Winds) of the studied area, as well as the coastal water area, continental and fast ice were examined by the author at least once. The total area surveyed was about 17.5 km². Hot spots of interaction of birds with oil (Figure 1) were visually identified by the author during a visit to the islands of Zykov, Tokarev, Stroiteley, and Cape Mabus. The boundaries of contamination of a relatively extensive zone of continental ice to the southwest of the Mirny nunataks were determined from a high-resolution satellite image (Figure 1). This area is dangerous for polar explorers, as it is located in the zone of ice cracks. The visit to this territory was very limited. The author surveyed a part of the territory, mainly along the edge of the mainland. Hiking trips to the islands were carried out on fast ice from April to December in groups of 2 or more people. In the wild, seabirds were observed visually with or without binoculars. Whenever possible, the birds were photographed, and the images were analyzed in the laboratory. A total of 14 species of seabirds have been recorded in the area of the Haswell archipelago [9,20–23]. Of these, 9 bird species breed (Emperor and

Adélie penguins, Southern Fulmar (*Fulmarus glacialisoides*), Antarctic (*Thalassoica antarctica*), Snow (*Pagodroma nivea*), and Cape (*Daption capense*) petrels, Wilson's Storm Petrel (*Oceanites oceanicus*), South Polar (*Stercorarius maccormicki*), and Brown (*Stercorarius antarcticus*) skuas); and 5 bird species do not breed (Chinstrap and Macaroni penguins, Southern Giant Petrel (*Macronectes giganteus*), Pomarine Skua (*Stercorarius pomarinus*), Kelp Gull (*Larus dominicanus*). Chinstrap Penguin, Pomarine Skua, and Kelp Gull were not observed by the author during the work on the archipelago.

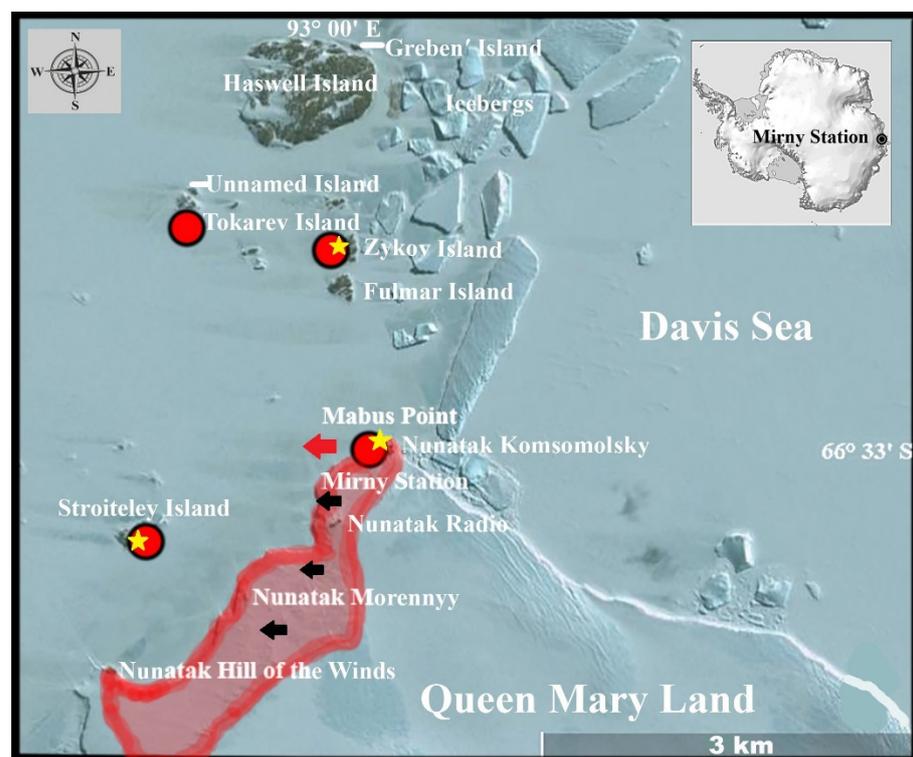


Figure 1. Distribution of pollution in the Haswell archipelago (in the inset in the upper right corner is the location of the Mirny Station). Satellite image Google Earth. Image © 2021 Maxar Technologies Image U.S. Geological Survey Image NASA. 28 October 2011. The names of the objects mentioned in the text are shown in white on the map. The territory of a garbage dump and old equipment containing oil pollutants is highlighted in pink. Red circles indicate hot spots where the greatest threats of oil contamination to birds, especially penguins, are present. Yellow asterisks indicate the sites of observations of the oiled Adélie Penguins. The red arrow shows the direction of movement of the oil film on the surface of the seawater from the source of contamination. The black arrows show the direction of movement of oil pollution on the surface of the continental ice during the summer period (explanations in the text).

2.2. Study Material

Birds were photographed if they could come into contact with oil. In conditions of good visibility, a Canon 60D digital camera and Sigma 50–500 mm and Canon 70–200 mm long-focus lenses were used. Images of objects in conditions of insufficient visibility were obtained by a portable digital camera Sony Cyber-shot DSC-WX220 Black. Digital images obtained by the author on islands in bird colonies, in open water, and on fast ice were analyzed in the laboratory. Binoculars ($\times 8$) were used daily. The author visually distinguished the natural pollutants of bird feathers (droppings, soil, algae) from oil pollution. The identification of pollution sites mainly occurred in the austral spring and summer, when the maximum surface areas of the land were free from snow and ice.

To identify birds contaminated with oil as well as for other purposes, 174 South Polar and 5 Brown skuas and suspected hybrids were captured in the study area from 13 January 2012 to 30 November 2012. From 28 January 2015 to 5 March 2015, 99 South

Polar and 1 Brown skuas were captured. The captured birds were marked with a numbered metal ring and a colored plastic label with a unique number or a combination of a set of colored rings. This made it possible to identify each individual separately. The mentioned marking was used only if the individuals had not been previously marked. The weight and age of birds, morphometric characteristics, and the state of the feather cover were also recorded. Special attention was paid to the damage to the webbing on the legs of South Polar skuas [24]. From 22 November 2012 to 17 December 2012, 72 clutches of South Polar skuas containing 136 eggs were examined on the islands of the archipelago. Two nests of mixed pairs between Brown and South Polar skuas were also found. One of them had 2 eggs on 30 November 2012, and 2 chicks on 14 December 2012. In another nest on 12 December 2012 there were 2 eggs. On 17 December 2015, 33 clutches of South Polar skuas containing 57 eggs and 2 clutches of mixed pairs between Brown and South Polar skuas containing one egg were examined. All captured skuas, their egg clutches and chicks were visually examined and photographed. The term “oil” in this article is used in a broad sense. It includes diesel fuel, gasoline, kerosene, fuel oil, lubricants, and oiled rags. The use of this term removed the difficulties of identifying contaminated surfaces, which could simultaneously include different types of fuel, used lubricating oil and oiled rags, as well as impurities of non-oil-exclusive origin.

3. Results

3.1. Oil Pollution

3.1.1. Oil Pollution of Islands and Nunataks

Oil pollution was found on Tokarev and Zykov islands and the largest of the Stroiteley islands, as well as on the Komsomolsky, Radio, and Morennyy nunataks (Figure 1) [9–11,22]. In the southern part of Tokarev Island, a section of oil-contaminated surface was found. This site was located outside the Adélie Penguins colony. On the island of Zykov there is a dump of rusty barrels, brought here, apparently several years/decades ago. Most of the barrels are empty, but some still contain fuel. During the summer, fuel from the barrels enters the ocean. Stroiteley Island is the most polluted with oil, garbage, and rusty machinery. In addition, fuel leaks from the tanks where it is stored may occur on this island. There is a persistent smell of oil near the tanks. Among the four coastal nunataks, no oil pollution was found on the Hill of the Winds nunatak, although rusty barrels and other debris were present. The surface of the rocks of the Morennyy nunatak is polluted with oil. This nunatak is used annually, but infrequently throughout the year when pumping fuel from stationary to mobile tanks for transport to the tanks of the diesel power plant at the Komsomolsky nunatak. The extent of oil pollution is apparently significant on the Radio nunatak, but it is difficult to identify for most of the year. The most oil polluted is the Komsomolsky nunatak, especially Cape Mabus.

3.1.2. Oil Pollution of Marine and Continental Ice

Sea ice surface—fast ice and icebergs are free from oil pollution. At the same time, the continental ice on the territory of the Mirny Station and in its environs is subject to strong oil pollution. Oil pollution of the Mirny and its nearest surroundings, according to preliminary estimates, was found on an area of up to 3 or more km² (Figure 1). In this area, oil pollution does not form a continuous coating and is represented by spots of various sizes—from 1–2 m² to tens and even hundreds of m².

Seasonal vertical and horizontal oil migration has been detected on the continental ice. It is observed annually in the summer in the Mirny and its surroundings. Vertical oil migration is established on the mainland ice east of Cape Mabus, where the lower horizons of oil pollution are submerged in the ice thickness of more than 10 m. At a vast landfill of garbage and broken equipment southwest of nunatak Radio, oil-contaminated surfaces were observed submerged to a depth of at least 6–7 m. Oil that has sunk into the thickness of the continental ice at the edge of the Antarctic barrier enters the ocean as part of pieces of icebergs that have broken away from the continental barrier, which are subsequently

added to the drift. Horizontal migration of oil to the ocean is intensified with seasonal warming, surface melting of mainland ice, snow cover, and ice on the surface of rocks. Masses of snow and surface ice melting in summer form a runoff that comes into contact with oil-polluted areas. Oil enters the ocean with melt water and is transported by the sea circumpolar current in a westerly direction (Figure 1). Thus, spreading from the place of the primary source of pollution, oil covers significantly large areas of the surface of the mainland, continental ice, and ocean. The scale of pollution significantly exceeds the area of primary oil pollution.

3.1.3. Oil Pollution in Coastal Waters Free from Fast Ice

From 1999/2000 to 2015/2016 field seasons, a thin slick of petroleum products was observed annually on the surface of the seawater near Cape Mabus in late January and February. It was formed as a result of the summer snowmelt on the Komsomolsky nunatak and on the surface of the continental ice in its vicinity. The collapse of the oil-contaminated edge of the ice barrier east of Cape Mabus may also have contributed to this. At this place, meltwater interacts with oil spills and carries them into the ocean. By wind and sea current, the oil slick spreads westward to the coastal part of the Davis Sea (Figure 1). The extent of pollution has not been established, but the width of surface pollution of seawater near the shore usually does not exceed 50 m ([9,10,25], unpublished author's data). During the absence of fast ice, the water surface at Cape Mabus is used mainly by swimming Adélie Penguins. Here, during the breeding season, the number of birds interacting with the oil slick can reach several hundred individuals.

3.2. Oil Pollution Effects on Seabird Species

Although oil pollution of the study area has been documented since the middle of the last century [8], there was no published information on oil pollution in relation to seabirds and mammals. Pollution undoubtedly took place in the Mirny in the second half of the 20th century, although during the Soviet period this problem was not given due attention. From 1999/2000 to the 2015/2016 breeding season, oil pollution was documented by biologists and had an effect on birds [9–11], unpublished author's data]. Among 14 seabird species of the Haswell archipelago [21–23], 5 bird species—Adélie and Macaroni penguins, South Polar and Brown skuas, Wilson's Storm Petrels interacted with oil. Oil contamination of the plumage and legs was found in the most widespread breeding species of birds of the archipelago—Adélie Penguins and non-breeding vagrant Macaroni Penguins. Breeding or non-breeding South Polar and Brown skuas as well as Wilson's Storm Petrels had signs of foot contact with oiled rock surfaces. Their plumage was not oiled, and mortality from oil pollution has not been established.

The first evidence of the interaction of Macaroni Penguins with petroleum products was obtained in 1999/2000. From 20 to 26 February 2000, a single adult Macaroni Penguin was observed at Cape Mabus, heavily contaminating its body with oil products, up to golden feathers on its head [9]. In the period of 7–11 February 2012, a young single Macaroni Penguin was also sighted at Cape Mabus. During five days in the Mirny, the penguin stained the legs and abdomen with oil products. Both vagrant Macaroni Penguins left the station [23].

The first evidence of the interaction of Adélie Penguins with oil was obtained in 2009/2010—a highly oiled individual was found dead on the ice in the Mirny area on 15 January 2010. In an unpublished report of the 54th Russian Antarctic Expedition, it was noted that “on Cape Mabus, Adélie Penguins molt annually, some of which die as a result of oil contamination of the plumage” [10]. In 2012/2013, more than 100 Adélie Penguins molting at Cape Mabus (Komsomolsky nunatak) had oiled plumage and legs. In 2015/2016, oiled Adélie Penguins were also observed molting at this location, but their number was not determined. The maximum number of simultaneously molting birds on the Komsomolsky nunatak was observed on 03 March 2012 (231 individuals) and 11 March 2015 (201 individuals). On 22 November 2012 on the Zykov Island in one of

the subcolonies of Adélie Penguins, oiled individuals were found sitting on nests. Their number was not determined. On 27 October 2012, 2256 adults were counted on Zykov Island. 17 December 2012 on the largest of the Stroiteley Islands, a single Adélie Penguin was observed with an oiled brood patch, to which the shell of a broken egg had stuck (Figure 2A). On the same island, adult Adélie Penguins warmed oiled egg clutches in at least four nests (Figure 2B). On 4 November 2012, 3450 adults were counted on the Island of Stroiteley ([11], unpublished author's data).



Figure 2. Oil contamination of Adélie Penguins (*Pygoscelis adeliae*) in the Haswell archipelago area: (A) Shells from a broken egg adhering to the oil-stained lower body of an adult (Stroiteley Island, 17 December 2012); (B) The brooding spot of an adult and the surface of the egg shell stained with oil (Stroiteley Island, 17 December 2012); (C) A molting adult soiled with oil (Mirny Station, Cape Mabus, 20 February 2015). Photo by the author.

Some Adélie Penguins, having dropped their old contaminated plumage, stain the fresh plumage with oil again. The feet of most of the penguins that molted in the Mirny were also stained with oil. The birds had contamination ranging from mild (small spots of oil on the feathers) to severe, when most of the body feathers of individual penguins were oiled (Figure 2C). On the body of penguins, dirt is clearly localized on the chest, abdomen, sides of the body, legs and tail, rarely on the head. In the Mirny, the penguins encounter oil pollution in the late austral summer and autumn, while on the islands of Zykov, Stroiteley, and possibly Tokarev—in the spring, summer, and probably autumn during molting. Deaths from pollution among penguins were not recorded in 2012/2013 and 2015/2016. Nevertheless, the facts of death of clutches of Adélie Penguins from oiling of roosting spots of adult birds and the surface of egg shells were established. Oil pollution was the sole cause of the death of a single adult Adélie Penguin in 2010 [10].

Of the 273 test cases of South Polar Skuas and 6 cases of Brown Skuas captured in 2012 and 2015, no skuas were found to have oiled feathers. A total of 193 eggs of South Polar skuas, as well as 6 eggs and 2 chicks hatched from hybrid pairs of skuas, did not have oil on the shell surface or plumage during their nest survey in 2012 and 2015 breeding seasons. In the 2012/2013 breeding season, one adult and one juvenile of the South Polar Skua were found dead, in 2015/2016—two adults. The causes of death of skuas were not related to oil pollution.

4. Discussion

The habitat of seabird species in the area of the Mirny Station and its immediate environs has been contaminated with oil for a long time. Below is a somewhat more detailed discussion of information on the state of pollution of seabird habitats on the territory of the archipelago, as well as the nature of interactions of birds of different taxonomic groups with oil. Petroleum pollution is a threat to the avifauna of the Haswell archipelago. Five bird species (35.7% of the total abundance of the archipelago's species) came into contact with oil. The greatest threats of oil pollution are identified for breeding and molting Adélie Penguins, as well as vagrant Macaroni Penguins. The least affected by oil pollution were Wilson's Storm Petrels, South Polar and Brown skuas. Breeding

populations of Emperor Penguins, Antarctic, Snow, and Cape petrels, as well as Southern Fulmars, did not interact with oil.

Penguins are probably less able to detect and avoid oil pollution than other seabird species [14]. They were the most vulnerable to oil vertebrates in the area of Mirny. The fate of the oiled penguins is unknown. They were not found in the Haswell islands after winter migrations in the following breeding seasons. There is a possibility of death of oiled penguins in their wintering range. In Antarctica, oiled Adélie Penguins have been recorded on Cape Bird, Ross Island, Cape Hallett, Ross Sea, and Macaroni Penguin on Heard Island in the Southern Indian Ocean [7,26]—one of the closest islands to the Mirny in the Subantarctic.

Penguin mortality from oil is a long-term and large-scale geographical problem [1]. It is well known, for example, that oiled Magellanic Penguins often die [27]. Moreover, many oil-contaminated penguins are likely to die at sea and go undetected [15]. Finally, oiled penguins themselves can be the distributors of pollution in ecosystems. Oil contamination of adult Adélie Penguins and the death of their egg clutches negatively affects breeding success. In 1986, a pair of Magellanic Penguins was observed in Argentina at Punta Tombo, whose eggs were covered with oil through contact with the incubating parent and subsequently did not hatch [27].

In the Southern Ocean, cases of oil pollution by tube-nosed bird species have been established [7,28,29], but they seem to be rare. On the territory of the Haswell archipelago, breeding populations of tube-nosed bird species, with the exception of Wilson's Storm Petrels, are located mainly on the islands of Haswell (Antarctic Specially Protected Area No. 127) and Fulmar [21,22,30–33]. These islands are free of oil pollution. From 2009/2010 to 2015/2016, minimal breeding of Cape Petrels and Southern Fulmars was found on Zykov Island and an unnamed island near Tokarev Island, as well as possibly on Greben' Island ([9], unpublished author's data). However, in the new breeding grounds, the birds did not interact with oil. With the exception of Wilson's Storm Petrels, other tube-nosed bird species transited the Mirny and the islands, but did not come into contact with oil-contaminated rock and ice surfaces ([34], in the press).

Long-term year-round observations in the Mirny area in the 2012/2013 and 2015/2016 for the tagged South Polar and Brown skuas with oiled legs did not reveal a negative effect on the birds. Traces of oil were absent on the surface of the shell in the clutches of eggs, as well as on the plumage of chicks hatched by that time during a total survey of all nests of both species of skuas on the islands of the archipelago in 2012/2013 and a partial survey in 2015/2016 breeding seasons. Some South Polar and Brown skuas with oiled feet returned to the Mirny after wintering last season and bred successfully on Haswell Island. However, deaths of adults or chicks of South Polar Skuas from direct contact with oil are known [35] for the western sector of Antarctica.

Oil pollution is not a native phenomenon of the territory under consideration. Supplies of diesel fuel, kerosene, gasoline, and oil for the needs of the stations were replenished outside of Antarctica. The annual delivery of fuel supply to Antarctica to maintain the continuous operation of the Mirny Station, and (in the past) for the drifting continental Vostok Station, was carried out by ship. The earliest oil impact on the coastal ecosystem of the Haswell archipelago probably occurred in 1956 during the first Complex Antarctic Expedition. During the unloading of equipment from the ship to the fast ice near the Mirny, one of the tractors was unintentionally flooded under tragic circumstances. Currently, the volume of cumulative oil pollution in the Mirny and its immediate surroundings is very significant. They can amount to tens of tons or more. The extent of the contamination has not been determined.

The difficulty in determining the amount of oil pollution in the study area is that the oil on the surface of the continental ice gradually sinks into its near-surface layers and becomes visually inaccessible even in summer, during the warmest period of the year. Moreover, the "summer" volumes of annual oil supply from the mainland to the ocean are also not established. In this regard, in this work, we had to limit ourselves to visualizing

the boundaries of the spatial distribution of oil pollution on the surface of the mainland and island surface (Figure 1). In the future, the boundaries of the distribution of pollution on the map can be adjusted, and the pollution itself can be detailed.

There is no penguin rehabilitation center in the Mirny and there is no way to free the plumage of oiled penguins from oil. Therefore, the primary and effective conservation measure should be the mechanical cleaning of rock surfaces from oil pollution in the breeding and molting sites of penguins—in “hot spots” (Cape Mabus on the Komsomolsky nunatak, Stroiteley Islands, Zykov, and, possibly, Tokarev islands (Figure 1)), where birds oil their plumage every year. Mechanical cleaning should be done before or after the breeding and moulting season of Adélie Penguins. It will allow to realistically and significantly reduce the risks of oil pollution in relation to penguins in degraded habitats. Despite the fact that the results presented in the article are not so significant, the program for monitoring the health of Antarctic fauna and the current state of the coastal ecosystem of the Davis Sea should be further developed with the mandatory consideration of the proposed conservation measures.

During the Russian period, cleaning of the territory of the Mirny Station from pollution (mainly solid waste—scrap metal, wood) occurs annually. The cleaning of the Nunatak Komsomolsky from debris began during the Russian Antarctic Expedition and continued at least until the 2015/2016 season. In the 2009/2010 season, for the first time, debris removal work was carried out at Cape Mabus [10]. However, petroleum pollution on the rock surfaces continued to be a threat to molting penguins.

Perennial runoffs of pollutants into the ocean, including seasonal oil runoffs, are a chronic event and a major threat to marine ecosystems. Chronic oil pollution can cause much more damage to wildlife than a single disaster [1]. Control, prevention, and maintenance of facilities and facilities that ensure the storage and movement of oil through the station at a higher level can and should become an effective tool for containing potential oil pollution in the Mirny area.

5. Conclusions

The source of oil pollution of the environment is the long-term continuous human activity in the Mirny. Oil pollution covers the entire territory of the station and its immediate surroundings. Long-term and annual oil pollution of the environment indicate the chronic nature of the oil impact on the coastal marine ecosystem. Human activity at the Mirny Station is the most important and possibly the only source of oil pollution in the Davis Sea basin. Although this work is pioneering for the Mirny area, there is a large gap in determining the exact size of the population of any bird species exposed to oil and the survival rate of oiled individuals. Special efforts should be made to study more deeply and comprehensively the interactions of birds with oil. In this regard, assessment methods that allow conclusions to be drawn without reliance on reliable scientific evidence are not scientifically sound [36].

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