

Anthropogenic impacts in Antarctica

Impacts can be divided into three categories by source:

- 1. Research stations**
- 2. Tourism**
- 3. Introduced species from both of the above**

External impacts cannot be ignored either—atmospheric changes and loss of ozone, long-distant movement of pollutants and pesticides (e.g., DDT, Hg), global warming.

We've already covered some of the atmospheric effects, impacts of research stations, and introductions on subantarctic islands

Tourism in Antarctica



Tourism in Antarctica: good or bad?



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In 1910, when Scott was starting his last expedition south, the Thomas Cook agency in London advertised a tourist expedition, but this was cancelled after Scott's tragedy

First 'tourists' to Antarctica can be traced back to the 1920s when a Falklands mail ship brought paying passengers to whaling stations in the South Shetland and South Orkney Islands

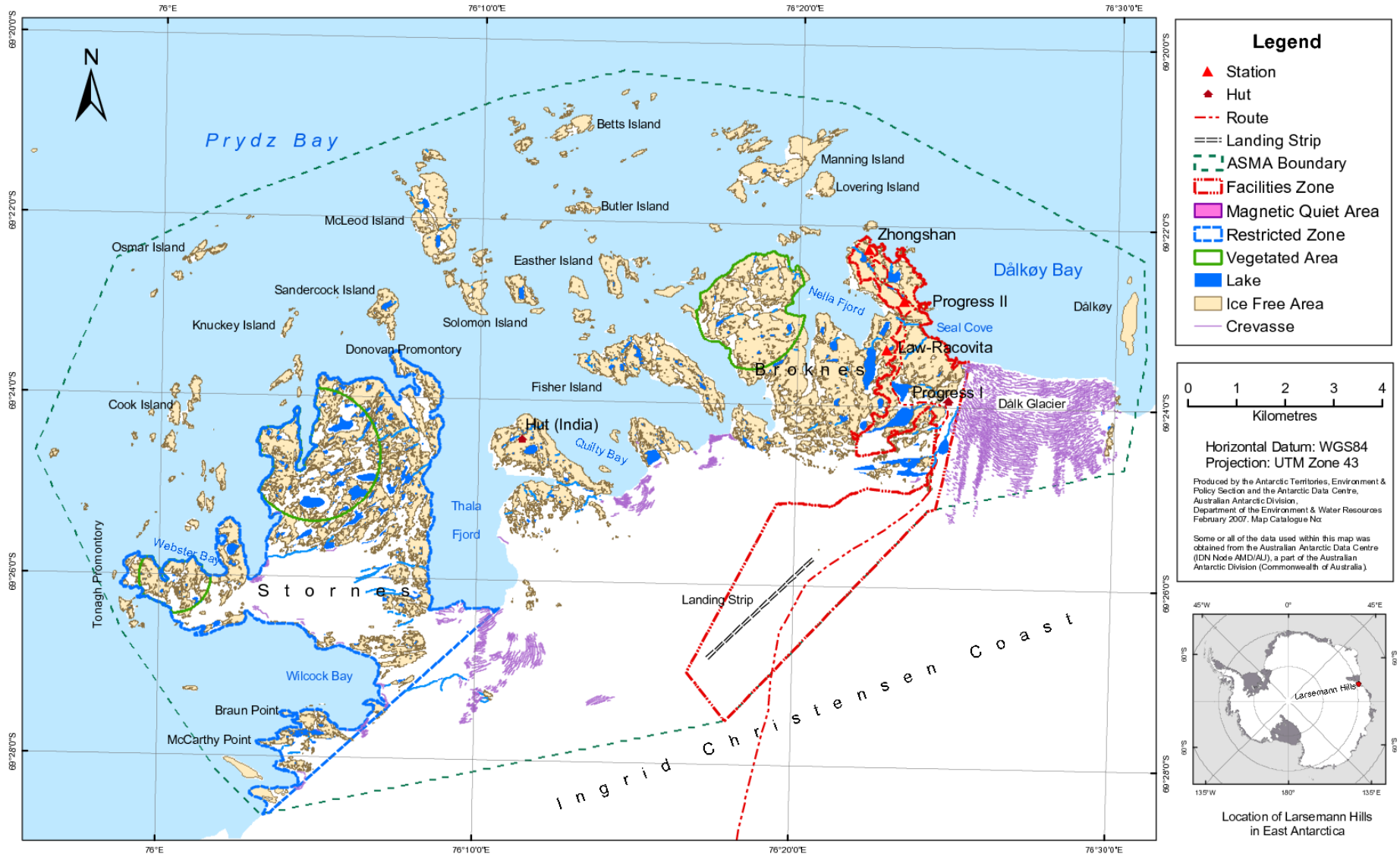


In 1930, the New York Times advertised a 142-day luxury cruise to the Antarctic, but it never succeeded

In 1931, the first woman to see Antarctica was Ingrid Christensen on resupply vessels to East Antarctic whaling fleets. On a later visit, she landed near where Davis Station (AUS) is now located on 30 Jan. 1937



Map B: Larsemann Hills Antarctic Specially Managed Area, Ingrid Christensen Coast, Princess Elizabeth Land, East Antarctica Management Zones and Ice Free Areas



Edith 'Jackie' Ronne, first American woman with Jennie Darlington to visit Antarctica and first to winter over.



1919 - 2009



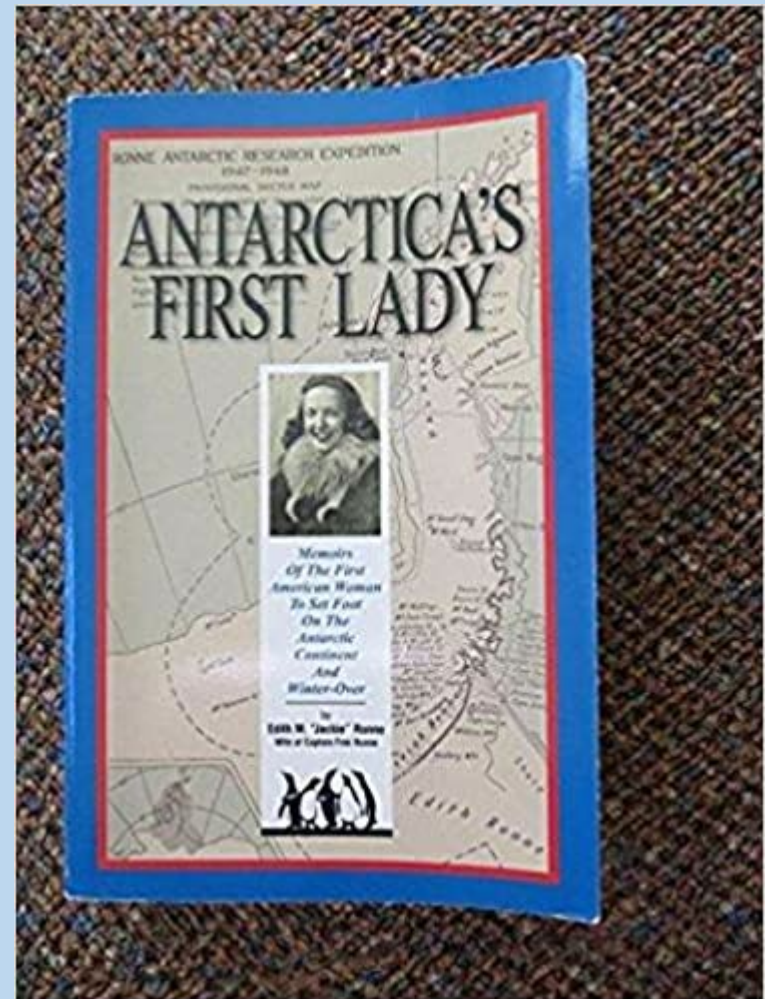
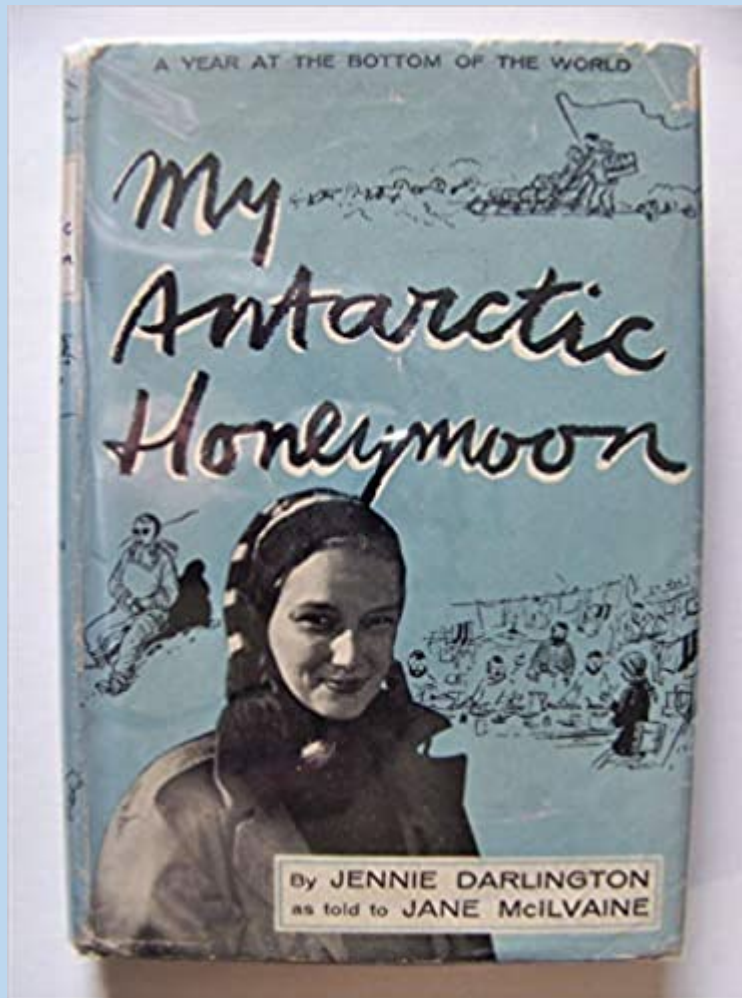
Jackie and Finn Ronne

**Ronne Antarctic Research Expedition, Stonington Island,
Weddell Sea and Antarctic Peninsula, 1947-1948.**

Surveys, mapping of region

Ronne Ice Shelf named for her

http://www.ronneantarcticexplorers.com/ronne_antarctic_research_expedition.htm



Women in Antarctica

In the U.S., the National Science Foundation did not allow women to apply for grants for Antarctic research until 1969

First woman to receive funding was in 1970 to study penguin behavior

First woman to winter over at the South Pole was not until 1979

Today, McMurdo Station has over 1/3 women as scientists and support crew

See history and reference to books on women in Antarctica at:

<https://annex.exploratorium.edu/origins/antarctica/people/women.html>

In 1956, Chile completes the first tourist flight over the South Shetland Islands with 66 passengers

In 1957, a Pan American flight from New Zealand lands at McMurdo Station in the Ross Sea, the first commercial flight to land in Antarctica

More land-based tourism began in the IGY when Chile and Argentina started bringing tourists to the South Shetland Islands, but they never started a formal tourist operation

Up to now, though, impacts from research and tourism had been minimal in Antarctica

--garbage from ships dumped into sea

--garbage around stations and huts

--some debris on ocean bottom from sunken ships

The IGY increased impacts considerably, especially at military bases and large research stations

Considerable amounts of waste, abandoned vehicles, garbage left in dumps or thrown into the sea

Despite the 1998 Environmental Protocol, this is still a problem at crowded areas such as King George Island



Ship-based tourism has been growing annually since the first tour company, started by Lars-Eric Lindblad, launched the MS *Lindblad Explorer* in 1969



Great experiences, scenery are guaranteed on these trips

Also, most of these tourists are wealthy, can become good ambassadors for Antarctica and conservation



The *Explorer* made every effort to visit new places every year in Antarctica, but went aground in 1972 and again in 1979 requiring passenger rescues by Chilean and Argentinean naval vessels

In 1989, another tour vessel from Argentina, the *Bahia Paraiso*, hit rocks and sank near Palmer Station, Anvers Island, in the AP

Fuel spilled from this damaged the local marine environment and caused some impact to nearby penguin and skua nesting areas



Some ships took risks and some passengers died



Meanwhile, air tourism picked up in 1977 when Qantas and New Zealand began summer tourist flights over Antarctica

Five flights in 1977, 16 by next year, and 17 in 1978-1979

Antarctic Treaty meeting in 1979 passed a recommendation for concerns that there is no air traffic control or search and rescue possible for these flights

In 1979 an Air New Zealand flight crashed into Mt. Erebus killing all 257 aboard, effectively ending air tourism in Antarctica



Where the crew of TE901 thought they were flying — along the computer track used by the previous sightseeing flights.

Where TE901 was actually flying — following the changed computer track. It looped down to 1500ft through a gap in the clouds.

Ross Sea

McMurdo Sound

Shackleton's hut

Scott's hut

Mt Bird

Mt Erebus

ROSS ISLAND

Lewis Bay

Mt Terror

Ross Ice Shelf



Graphic: MICHAEL MULHERON

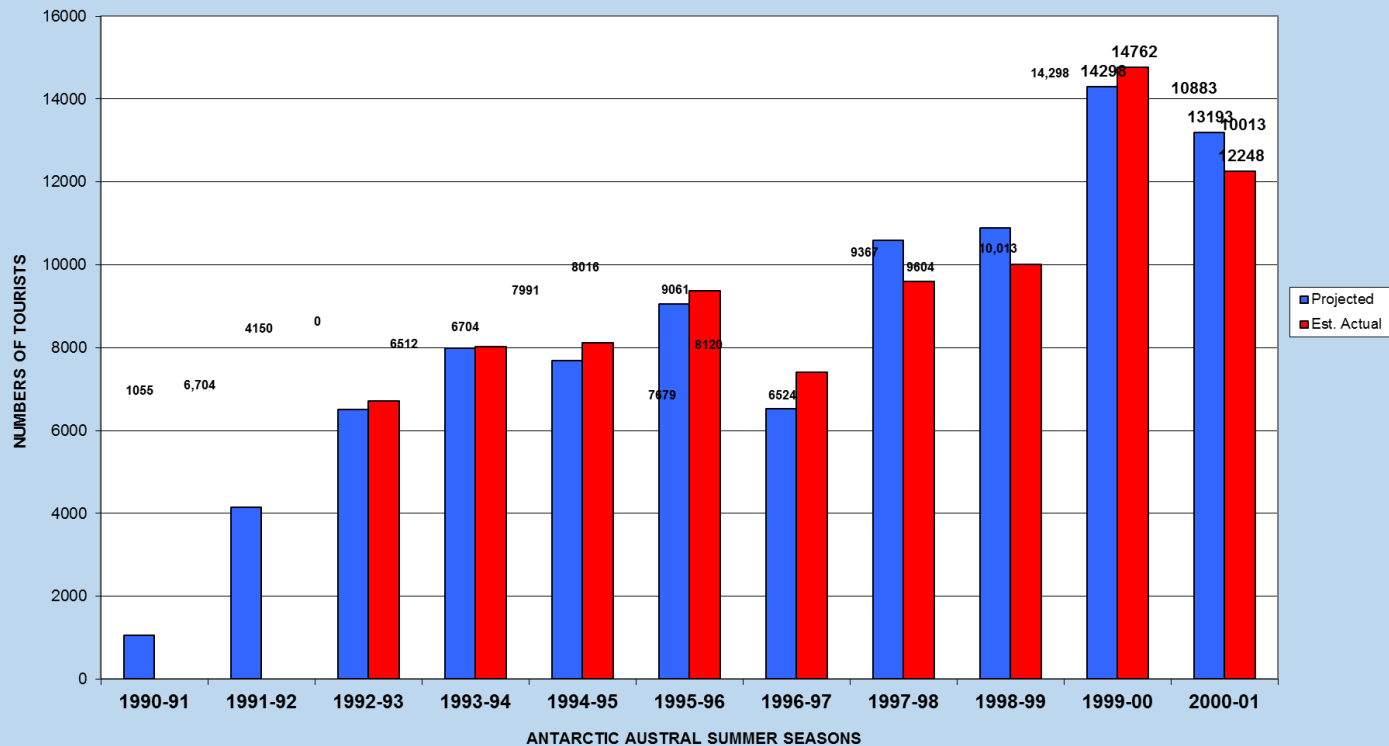
However, Qantas started flights again in 1994 and they continue today:

<http://www.antarcticaflights.com.au/>

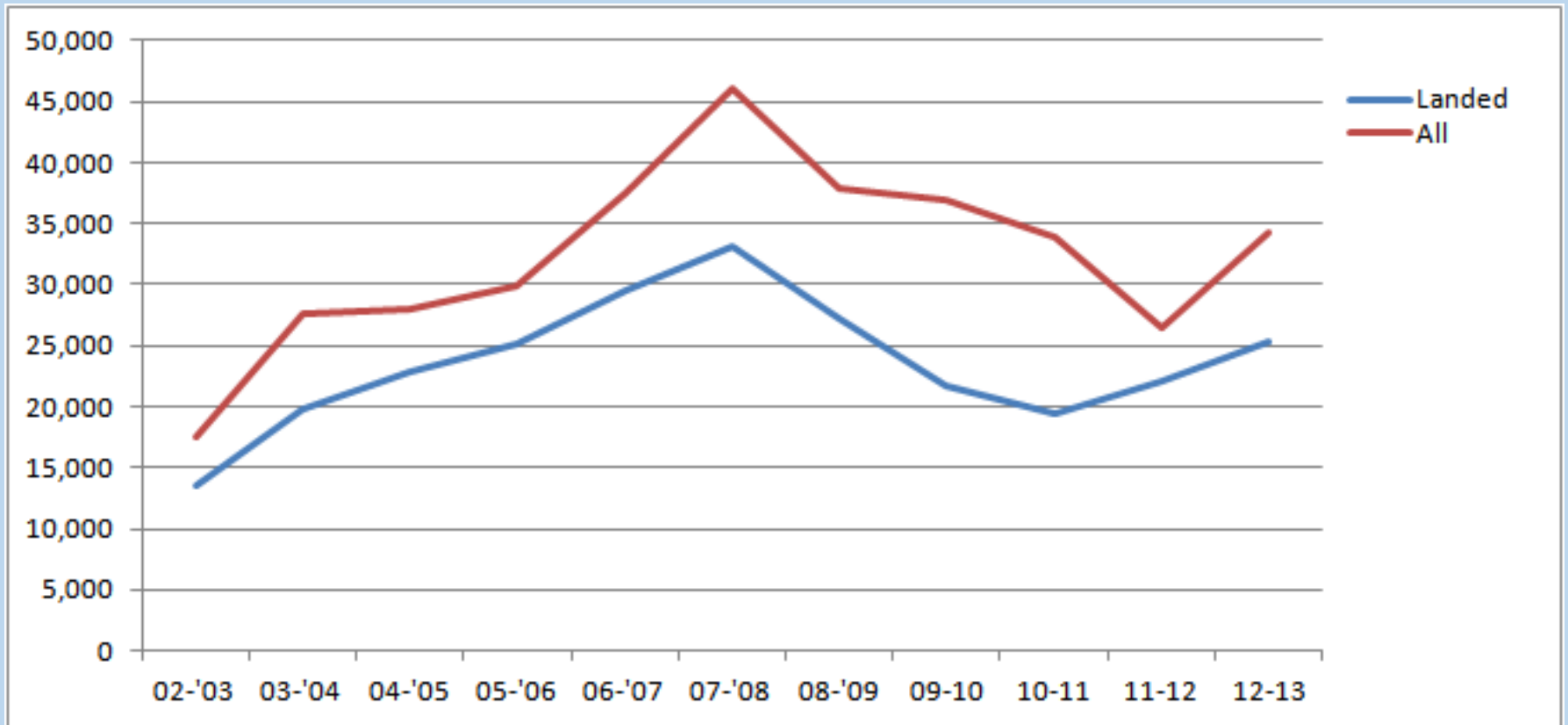
Ship tourism continued to increase, from 1055 tourists visiting Antarctica in 1990-1991, to a peak of over 45,000 in 2007-2008

1992-2001 ANTARCTIC TOURIST TRENDS

[Includes Ship and Land-Based passenger numbers. 1997-98 onwards includes commercial yacht activity]



37,405 in 2013-2014
36,702 in 2014-2015
38,478 in 2015-2016
44,367 in 2016-2017
51,707 in 2017-2018
55,534 in 2018-2019
55,614 in 2019-2020



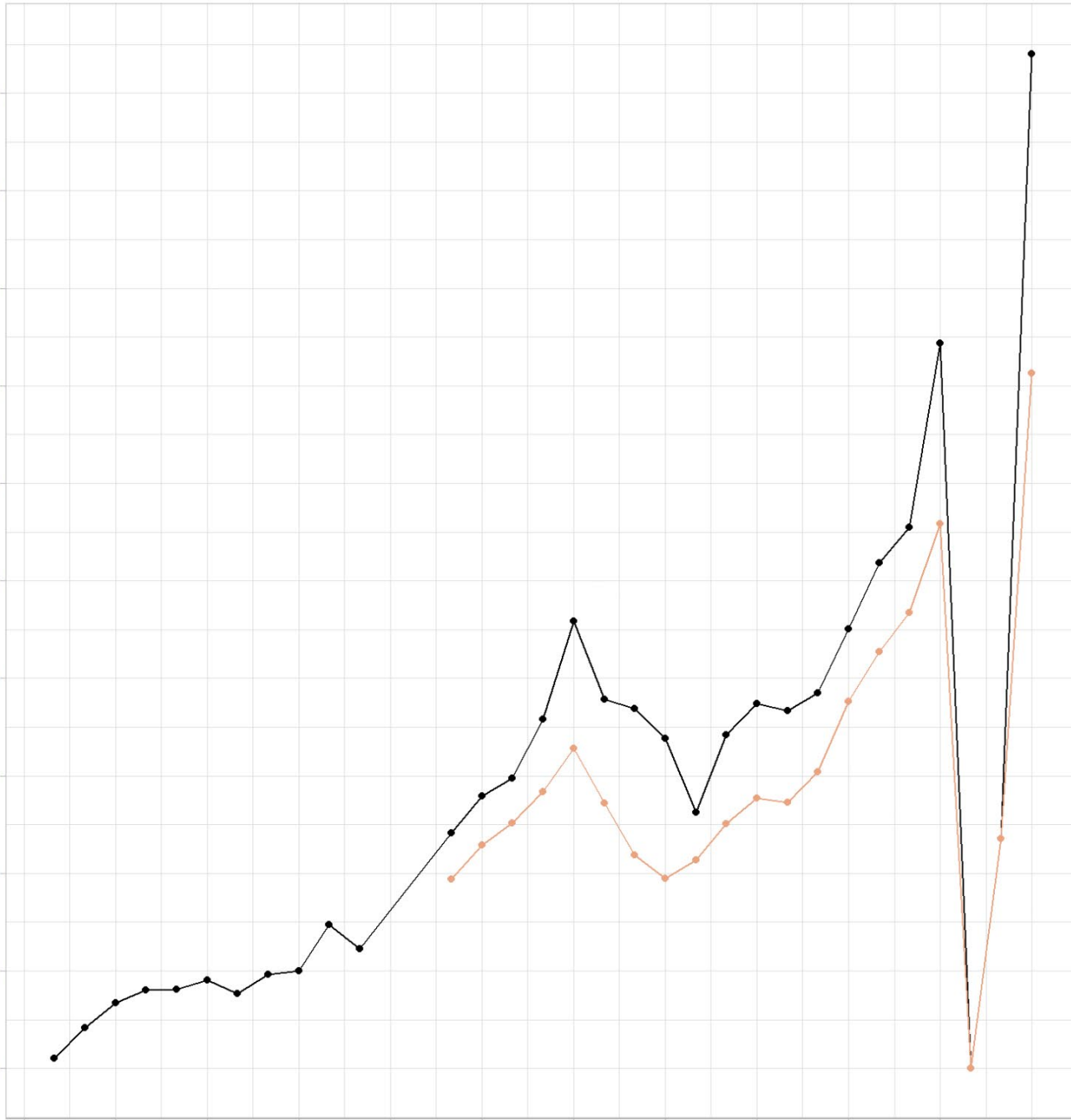
Number of Tourists

100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0

1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022

● Total Tourists
● Landed Tourists

Pearson 2023



In 1991, the International Association of Antarctica Tour Operators (IAATO) was founded “to advocate and promote the practice of safe and environmentally responsible private-sector travel to the Antarctic”

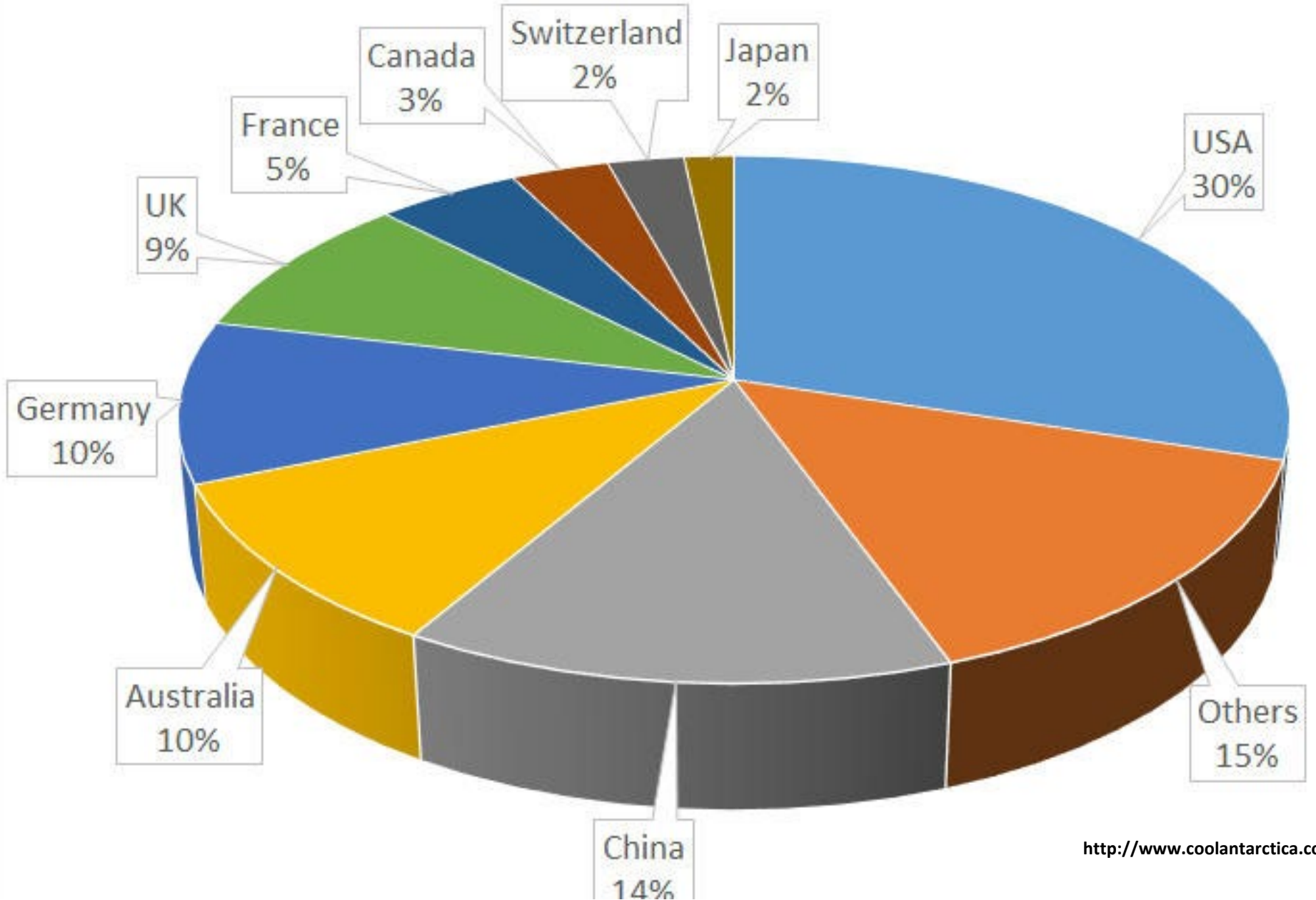
Over 100 tour companies agree on protocols to protect Antarctica in line with Antarctic Treaty guidelines, share data, limit visits and overlapping tours to sensitive areas, and to prevent unnecessary disturbances to wildlife

Also lecture and help prevent introduced species and recently banned the use of drones by passengers in 2015-2016

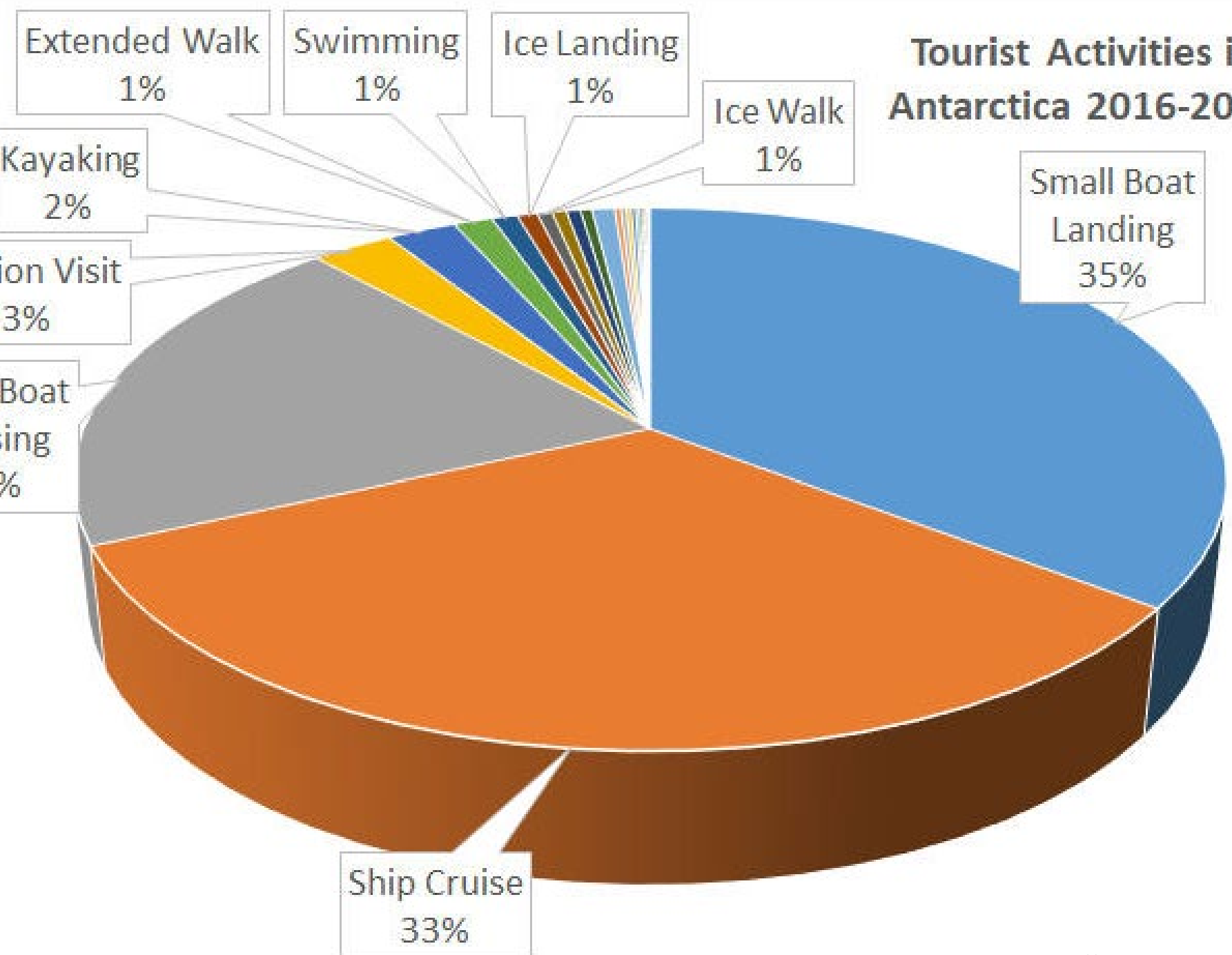
<http://iaato.org/home>



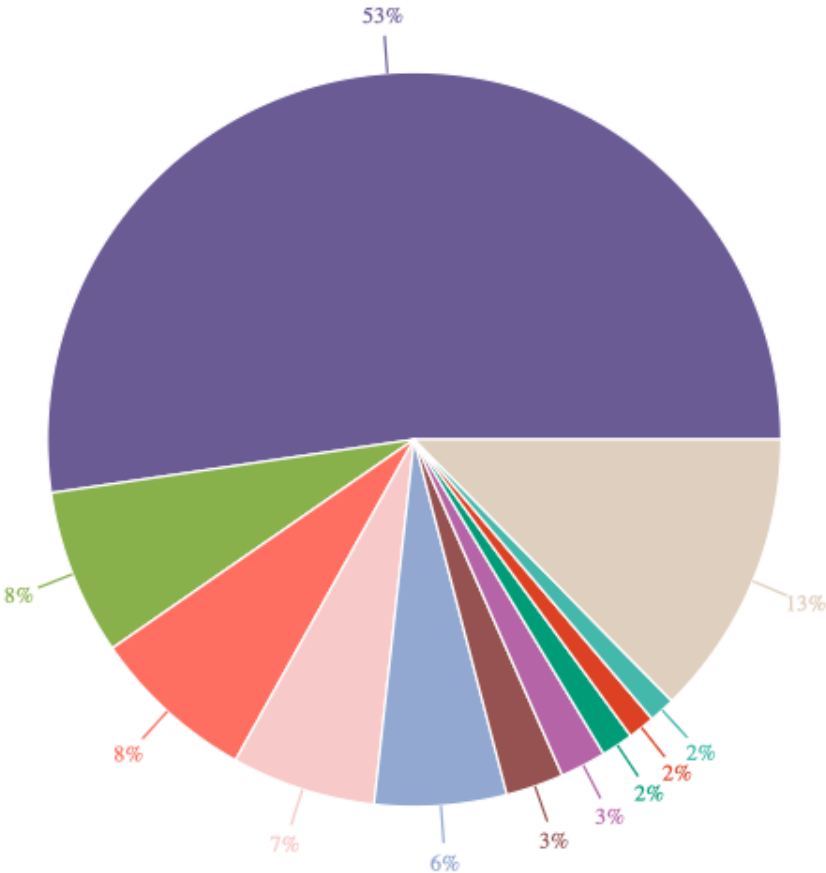
Tourist nationalities in Antarctica 2016-2017



Tourist Activities in Antarctica 2016-2017



2022-2023 IAATO Visitors by Nationality, **Vessel**



- USA (54416) (53%)
- United Kingdom (7585) (8%)
- Australia (7571) (8%)
- Germany (6606) (7%)
- Canada (6044) (6%)
- Argentina (2646) (3%)
- France (2106) (3%)
- China (1464) (2%)
- Switzerland (1234) (2%)
- Netherlands (1198) (2%)
- Others (13118) (13%)
- Total 103988**

On 23 Nov 2007, the MS *Explorer* hit ice that punched a hole in its side and it sank near King George Island

All passengers rescued, and subsequent fuel leaks dissipated with open water and currents

The potential for worse disasters remains



Due to increasing tourism concerns, member nations at the Antarctic Treaty meetings in 2009 passed a resolution to restrict visits:

No ship with 500 or more passengers can make landings

No more than 100 passengers may land at one time

One guide per 20 passengers on landings



Do tourists have an impact on Antarctic wildlife?

Only if they cause major disturbances, but viewing from a distance may generate increased heart rates in penguins and seals, but no impact on reproductive success



Other impacts by tourism:

Trampling of sensitive vegetation and erosion

Inadvertent carrying of small seeds, bacteria, algae on boots within and outside of Antarctica



Citizen Science in Antarctica

Ross Sea Jan. 2023



Extreme tourism a growing problem in Antarctica

- impacts in remote areas
- rescues may be needed
- debris from camps, crashes





<https://www.swoop-antarctica.com/adventures>

In 2022-2023, four passengers on tour ships died:

two from flipped zodiac

one from rogue wave

one from fall on ship

Injuries on ships in rough seas are common

[https://en.wikipedia.org/wiki/List_of_disasters
in Antarctica by death toll](https://en.wikipedia.org/wiki/List_of_disasters_in_Antarctica_by_death_toll)

Introduced Species

Most introductions are on subantarctic islands where climate is more favorable for successful invasions by plants, animals

In the Antarctic, marine species from ship's ballast or attached to hulls can colonize bays

Insects and seeds of terrestrial species of plants can be easily transported accidentally

Overall, the properties of the Antarctic Circumpolar Current, cold ocean waters, and harsh terrestrial conditions prevent many introductions from being successful

Natural introduction: Cattle egret, only species to have reached all 7 continents



From Africa, reached Brazil in 1930s, Florida in 1940s, now widespread in Southeast

The endemic benthic fauna on the Antarctic continental shelf represents a food web that could collapse with introduced species

Decapods like the King Crab are close to reaching this zone as ocean temperatures warm

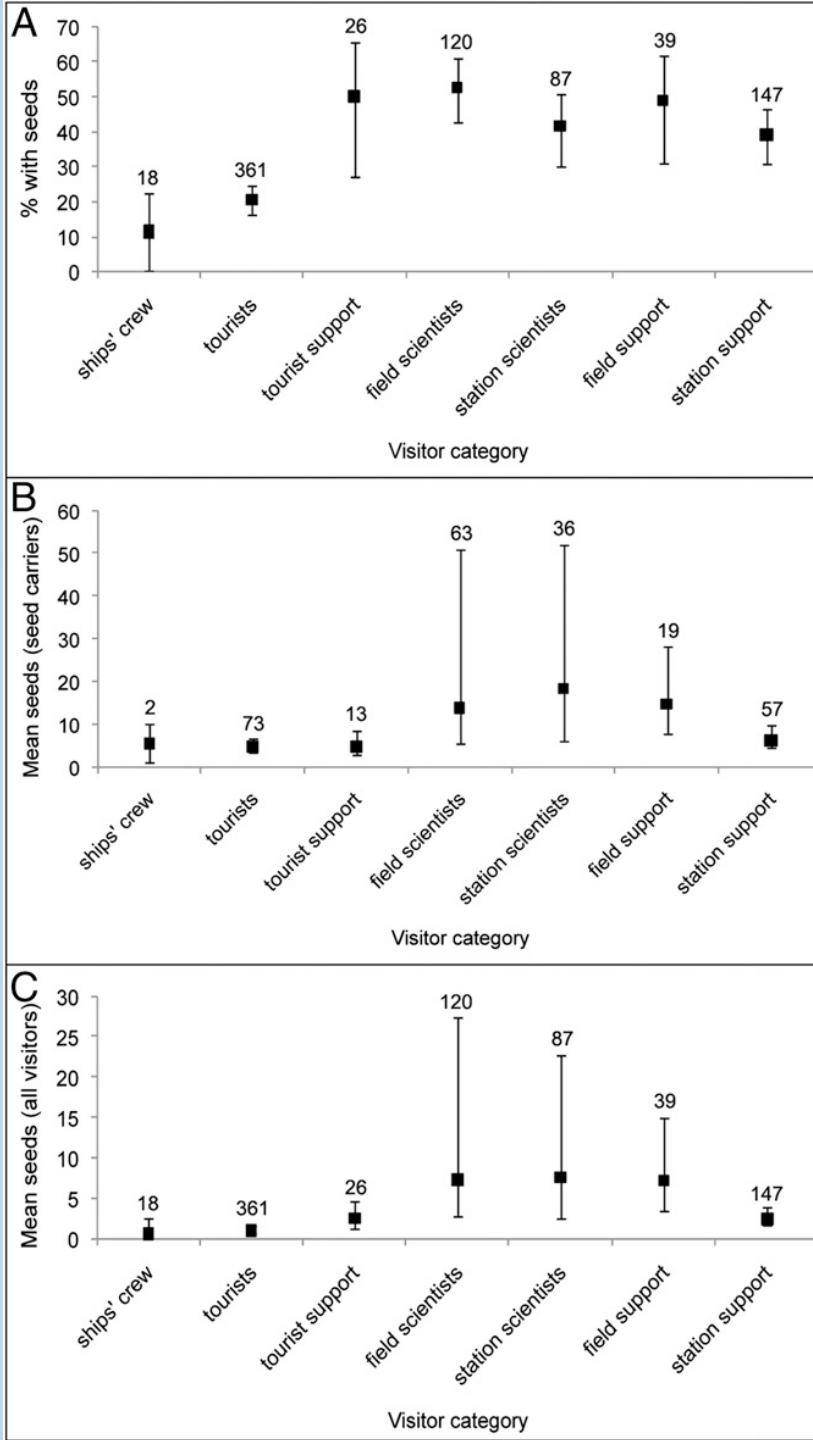
Possible invasive copepods have been identified in the northern Antarctic Peninsula, perhaps carried by ships

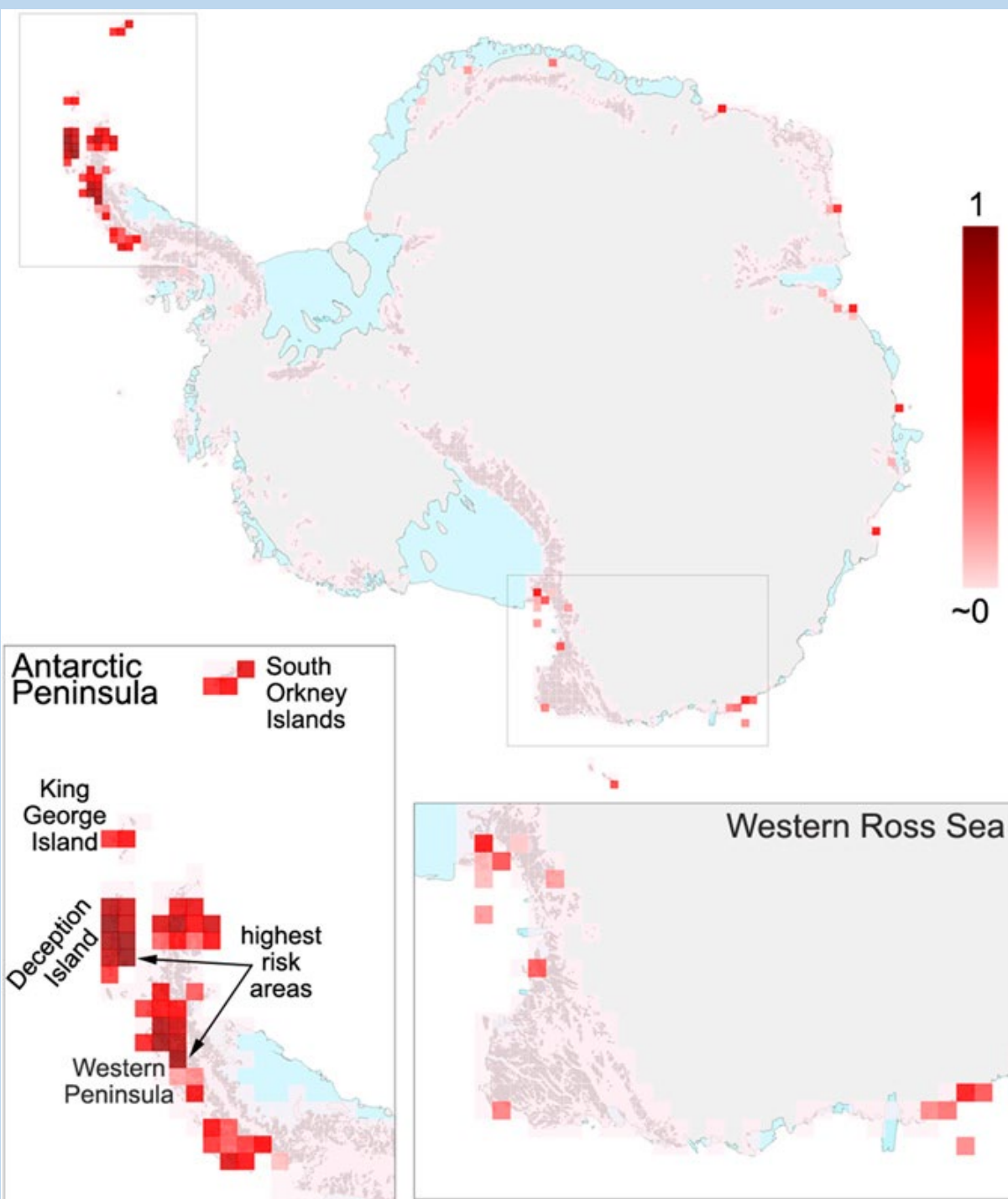


A recent study of seeds found on different kinds of visitors to Antarctica in one season (2007-2008) shows that researchers carry more per person, but tourists are more numerous and stop at more places

**33,054 tourists made 223,095 landings
7,085 scientists and support personnel,
mainly at McMurdo and AP**

Fig. 1. Proportion of visitors carrying seeds, number of seeds per visitor carrying seeds, and number of seeds per visitor across all visitors. (A) Proportion of visitors (mean and 95% bootstrapped CI) carrying seeds within each of the visitor categories. (B) Mean (and 95% bootstrapped CI) number of seeds per visitor by category for those visitors carrying seeds. (C) Mean (and 95% bootstrapped CI) number of seeds per visitor by category for all visitors (i.e., those with and without seed loads). Sample sizes are given above all bars.





Areas of greatest risk are sites frequently visited by tour ships, and research stations

Fig. 3. Relative risk of alien vascular plants establishing in Antarctica. Visitor- free, ice-free areas are allocated a small value to represent the minor chance of establishment in the absence of visitor landings. Insets show risk index detail for the Antarctic Peninsula and the western Ross Sea. Ice-free areas are shown in dark gray, continental areas in light gray, and ice shelf/ice-tongue areas in light blue.

It's also possible for established species to spread to less visited areas

***Poa annua* bluegrass on King George Island is spreading from the Polish station where it first appeared**

It also has independently arrived at three other stations along the western AP



Two other vascular plants from South America have invaded Deception Island, as well as two springtail species

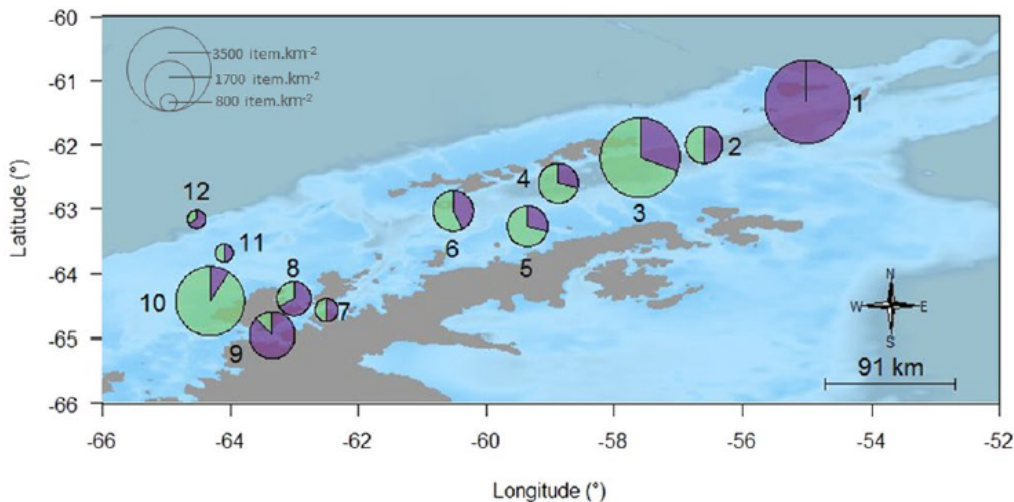
As climate warms, especially in the AP, the risk of additional alien species gaining a foothold increases



Plastics in Antarctic now a growing problem

Plastics in sea surface waters around the Antarctic Peninsula

Ana L. d. F. Lacerda^{1,2}, Lucas dos S. Rodrigues¹, Erik van Sebille³, Fábio L. Rodrigues⁴, Lourenço Ribeiro^{5,6}, Eduardo R. Secchi¹, Felipe Kessler⁷ & Maíra C. Proietti¹



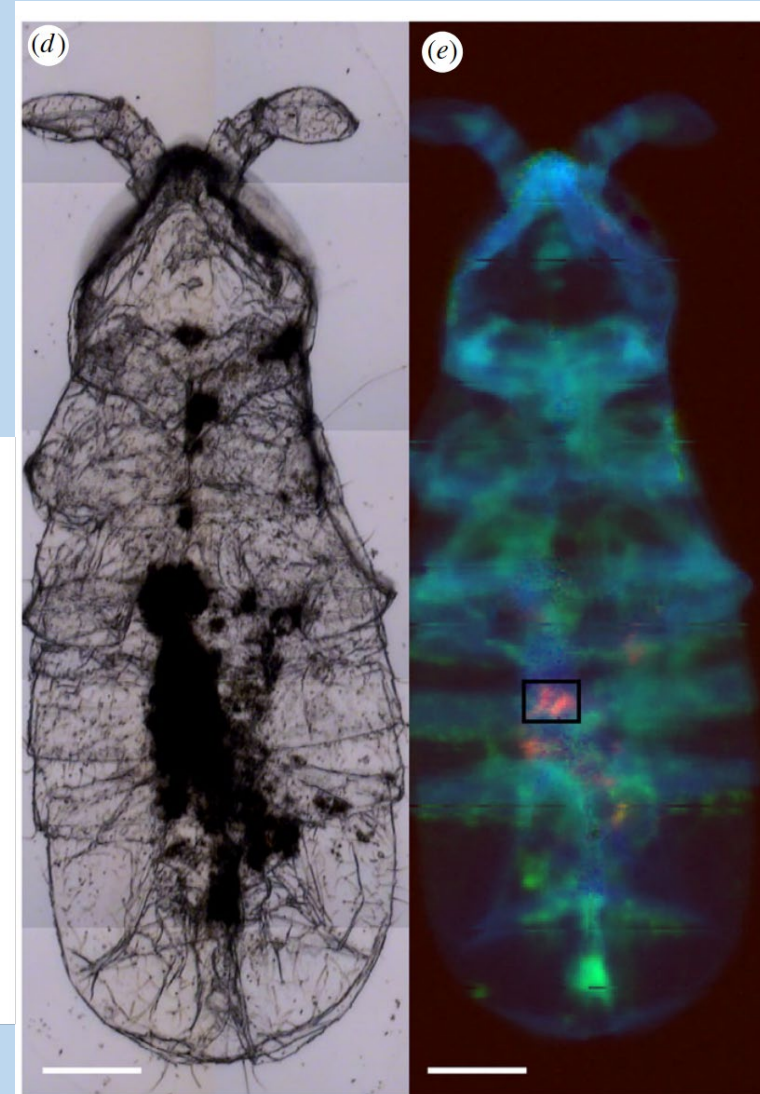
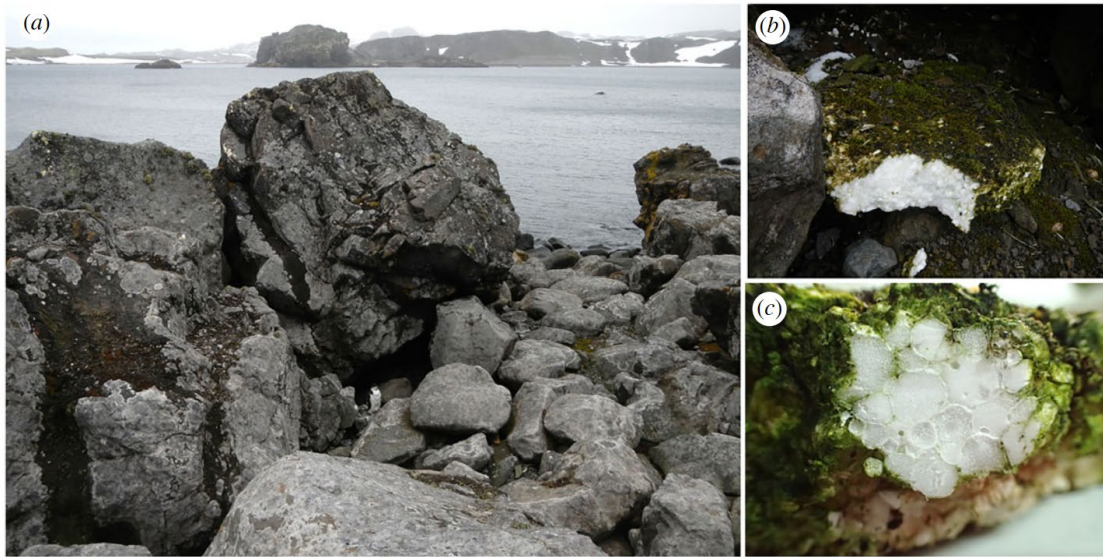
2019

Figure 1. Abundance of micro (purple) and mesoplastics (green) per sampling point in Antarctic waters. The map was created using the *marmap* package and graphics were inserted using the *mapplots* package and *add.pie* function on R 3.5.0 (<https://www.r-project.org>).

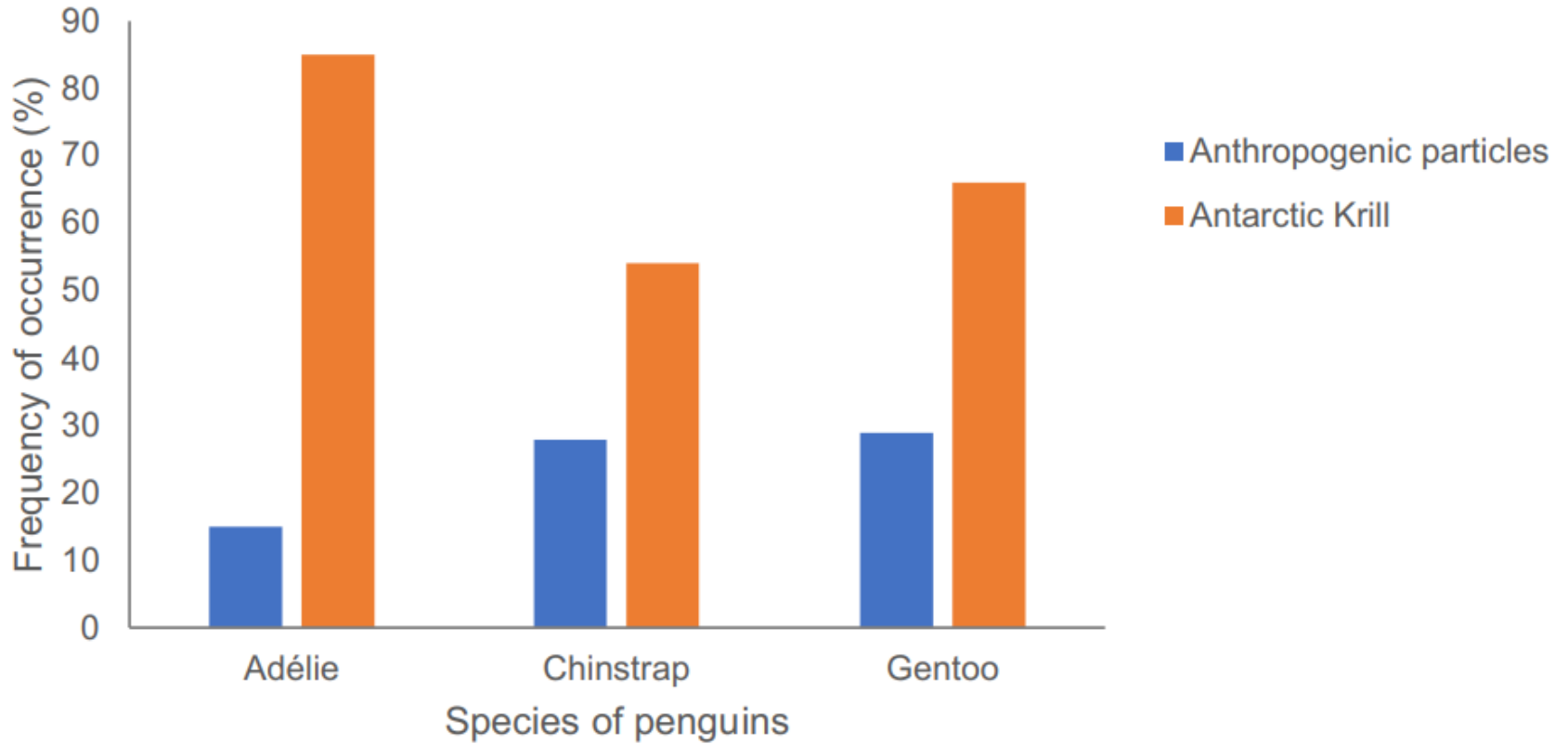
Plastics everywhere: first evidence of polystyrene fragments inside the common Antarctic collembolan *Cryptopygus antarcticus*

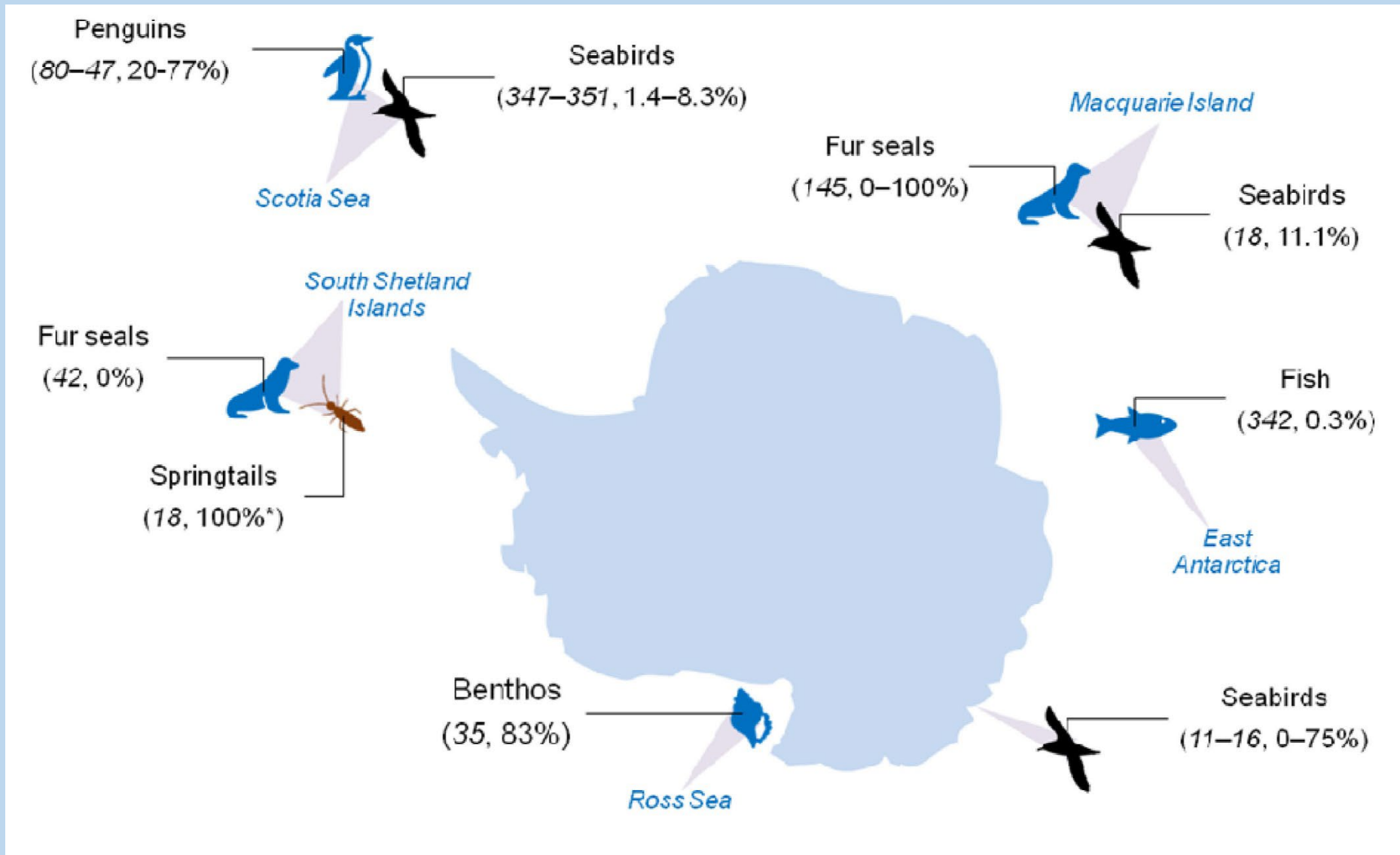
Elisa Bergami¹, Emilia Rota¹, Tancredi Caruso², Giovanni Birarda³, Lisa Vaccari³ and Ilaria Corsi¹

2020



Microplastics in penguins





Avian flu and seabird colonies



Herring Gulls in Scotland



23 October 2023

British Antarctic Survey Report:

Highly Pathogenic Avian Influenza (HPAI) has been confirmed in brown skua populations on Bird Island, South Georgia – the first known cases in the Antarctic region.

20 November 2023

Naturalist on the National Geographic *Explorer* just left South Georgia Island and reports the avian flu is now impacting skuas and fur seal pups. Many sites closed to tourist visits, impacts to penguin chicks expected next

Quiz

1. What are three main areas of anthropogenic impacts to Antarctica and which is worse?
2. When did tourism begin in Antarctica and who were the first women to step on the continent and winter over?
3. What have been the trends in ship and air-based tourism in Antarctica since the 1960s?
4. What is IAATO and their primary mission?
5. How have introduced species been impacting terrestrial and marine environments in Antarctica and how do tourists vs researchers compare in bringing in exotics?

IDEA Survey

Log into: <https://uncw.campuslabs.com/eval-home/>

Please provide comments on need for textbook in class?

Also, usefulness of in class 'quizzes'--helpful or not?