Seabird and Plastics Slide Show Script

1) A black-footed albatross inspecting a balloon in the productive waters of central California using its beak to check things out.

2) Marine debris comes in many shapes and forms. Highlight the definition (underlined) and go through the examples.

Marine debris can include very strange objects – like the famous "duckies" that fell from a container ship in the middle of the North Pacific 12 years ago and have been running loops in the gyre ever since. The photo shows two sets of these toys: notice that after 12 years they seem pretty intact, except that the colors of the yellow duckie and the red beaver faded.

3) Currents transport marine debris around the ocean. This funny story provided oceanographers with valuable information about the currents of the North Pacific and their residence time (how long water and debris stays within different gyres). Notice that the little arrows in the map converge (point towards) the "garbage patch" area. That is the area where floating debris accumulates. Once materials gather at the garbage patch, they stay there for about 50 years.

4) Marine debris is found everywhere in the ocean and affects many ecosystems and organisms, from those that live near the bottom (benthic) to those that live in the water column (pelagic).

5) These plastic pieces were all retrieved from Laysan and Black-footed albatross boluses, or were fed to the chicks by adult birds. The adults travel over vast areas of the North Pacific and ingest these floating pieces of plastic, which they then bring back to the chicks at colonies.

6)There are three different ways that seabirds feed: they collect food items from the surface, they plunge to capture submerged prey, and they use their wings and feet to fly or swim underwater. The foraging methods of seabirds influence their ability to gather different types of prey and debris (e.g., floating versus sinking). It is important to highlight that items that float on the sea surface, may float deeper down in the water column. Thus, not all the debris that sinks at the surface ends up in the bottom of the sea. When a sinking piece of debris reaches a layer of water whose density that matches its own, it becomes neutrally bouyant (not sinking, but merely floating suspended in the water column). Therefore, this debris drifts passively in the water column, where diving turtles and seabirds can encounter it.

7) When we look at an entire community of breeding seabirds – in this case in Alaska – and contrast divers (red dots) and surface foragers (blue dots), we see interesting comparisons. The upper figure shows the proportion of birds with plastic in their bellies during an EARLY (1969-1977) and a LATE (1988-1990) period. Each point represents one species. Some species never ingest plastics, and others ingest a lot. Notice that in particular, the northern fulmar (NOFU), the fork-tailed storm-petrel (FTSP) and the red-faced cormorant (RFCO) ingest lots of plastics. In these three species, more than 50% of the individual birds the researchers looked at contained plastics. By repeating this study 15 years apart, the researchers were also able to determine if there has been an increase or a decrease in the amount of plastics ingested by seabirds.

They looked at birds of the same species from the same breeding sites in two time periods, and compared how many individual birds of each species contained plastics in their bellies. The results are plotted in the lower graph. The white bars are for diving species and the black bars are for surface foragers. For these two foraging guilds, the figure shows the change in the proportion of species that had more / less plastic in the LATER time period.

8) Seabirds come in many different sizes. Different sized birds eat different sized prey. It makes sense: if you have a small mouth, you cannot eat a huge piece of food. The size of the pieces of food (fish / squid) and debris they ingest is determined by the size of their beak. For example, while albatrosses eat debris items that are 2 – 10 cm large, shearwaters eat debris items that are 2 – 4 mm large.

9) Because seabirds come in many sizes, they ingest a great variety of debris, ranging from tiny pellets / scraps (in the small-size storm-petrels – which have a wingspan of about 30 cm and a weight of about 40 g) to larger items like lighters and light sticks (in the larger albatrosses – which have a wingspan of about 180 cm and a weight of about 3200 g). In spite of their size differences, both species feed in the same way: by picking up food at the surface.

10) In turn, the size and shape of the debris ingested by seabirds determines their health impacts. Larger items (especially those with sharp edges) can injure the chicks by cutting their stomachs. Large items can also obstruct the digestive system of the birds: stuffing them so they cannot eat any more. Small items (like these industrial pellets used to transport plastics – which are melted and molded into plastic products) are not as damaging mechanically, but they present other problems. Because the smaller items have a large surface area / volume ratio, they degrade in the stomachs of the birds faster and leach poisonous chemicals found in the plastics. PCBs are a main example of these leached compounds, which can affect the health of the birds and are also known to impact the thickness of the egg shells.

11) This is a photo of the Earth at night. The lights show densely populated areas of the world. Can you find Los Angeles and San Francisco? The boxes highlight two contrasting locations: the heavily industrialized and polluted North Sea (in red) and the sparsely-populated and pristine New Zealand (in green). So, we would not expect to find a lot of plastic in New Zealand seabirds, right?

12) Well, in fact, surface-feeding seabirds that breed in the North Sea (northern fulmars) and in New Zealand (royal albatross) are both full of plastics. How is this possible?
Think about currents and think about the far distances some of these seabirds travel to find food. Ocean currents (like we saw previously with the example of the duckies) transport debris over large areas.
Because many seabirds travel very far, they can breed in a very pristine location, but go to feed to another region of the ocean where debris concentrates.

13) Royal albatross from New Zealand, for instance, ingest large amounts of floating plastics – including lighters, pieces of floats, and bottle tops.

14) This is the same photo of the Earth at night, showing two very distant islands (in the middle of nowhere) where breeding seabirds are ingesting large amounts of plastics. The point of this slide is to highlight that marine debris reaches the farthest points of the planet, even Inaccessible Island is accessible to plastic.

15) These next two slides illustrate the two reasons why birds ingest debris.
The debris looks like the food they naturally eat. In this case, prions eat krill (orange crustaceans) and orange plastic pellets.
The black and white photo shows some of the items eaten by these birds. Notice that they are small / irregular pieces, not the industrial pellets shown previously. Therefore, these were likely broken off pieces from larger plastic debris items. Notice how small they are: the larger one is about 1/10 of an inch.
In 2001, researchers documented plastics in the diets of seabirds from Heard Island – in the Southern Indian Ocean – for the first time.

16) Seabirds also ingest plastic by mistake: either because it is concentrated with their prey (e.g., floating fish egg masses) or because it is ingested by their prey. For example, when a skua (predatory gull) eats the prions that were ingesting plastics, many of the pellets are in turn ingested by the skua.

The two bottom pictures show the contents of skua castings: packets of indigestible material that the skuas throw up every once in a while. These castings include feathers, bones, and sometimes plastics. Researchers have studied these castings to monitor plastic in the ocean. The proportion of castings with plastics, and the average number of plastic items in a casting are great indices of plastic availability to seabirds. Researchers have documented increases in the plastic ingested by seabirds at Inaccessible Island in the South Atlantic Ocean.

17) In the North Pacific Ocean, two species of Hawaiian albatrosses ingest large amounts of plastics. Even though these species breed on islands very far away from large cities and ports, they are somehow finding these plastics in the ocean. How are they doing that?

In 1998, there was a satellite tracking study of two albatross species that breed on Tern Island, at the end of the Hawaiian chain. This is a very remote location: 3200 km from the Aleutians, 4500 km from California, and 4300 km from the Kamchatka peninsula in Russia.

18) Satellite tracking technology allows researchers to map the voyages of albatross in search for food for their chicks back at the colony.

This slide shows six foraging trips (black lines) by the same **black-footed albatross,** breeding in Tern Island, Hawaii. The trajectories of the bird are superimposed over maps of sea surface temperature (color lines) measured from satellites. Because the foraging behavior of the albatrosses changes depending on the period of the breeding season, each stage is shown in a separate maps. Panel A shows the brooding period, when the parent albatross take turns staying in the colony with the chick. During this period, which lasts 18 days, the parents do not travel very far: 150 – 300 km from the colony, and stay in the warm subtropical water (warmer than 20 degrees C). Panel B shows the rearing period, when the chick is old enough to be left alone, and the parents go on very long trips – which they alternate with short forays. During the rearing period, these albatrosses go all the way to California, about 4400 km away from the colony.

Notice that during the rearing period, this albatross went on a short trip (663 km from the colony), in between two trips to California.

19) This slide shows six foraging trips (black lines) by the same **Laysan** albatross, breeding in Tern Island, Hawaii. The trajectories of the bird are superimposed over maps of sea surface temperature (color lines) measured from satellites. Because the foraging behavior of the albatrosses changes depending on the period of the breeding season, each stage is shown in a separate maps. Panel A shows the brooding period, when the parent albatross take turns staying in the colony with the chick. During this period, which lasts 18 days, the parents do not travel very far: 250 – 1500 km from the colony, and stay in the warm subtropical / transition zone waters (warmer than 15 degrees C). Panel B shows the rearing period, when the chick is old enough to be left alone, and the parents go on very long trips – which they alternate with short forays. During the rearing period, these albatrosses go all the way to the subarctic water, up to 3500 km away from the colony.

Notice that these two albatross species go to different places in the ocean to look for food, even though they breed in the same place.

20) This slide summarizes the different North Pacific latitude bands (and regions) where the tracked albatrosses spent their time at sea. The upper panel shows where black-footed and Laysan albatrosses foraged, during the brooding and the rearing periods (see two previous slides). Notice that the Laysans went farther to the north – into subarctic waters. The bars for a given species do not add to 100% because the birds spent a bunch of time in the low latitude waters north of the colony (south of 35 degrees W).

The bottom panels shows the average density (number of items found in one kilometer squared of ocean surface) of small and large plastic for the same North Pacific Ocean regions. Notice that there is a lot more small plastic (pieces smaller than 25 mm) than large plastic (pieces larger than 25 mm) in the ocean. Why do you think that is the case?

Also notice that the subtropical regions have the most plastic, the subarctic regions have intermediate levels, and the Bering Sea has the lowest abundances. Why do you think that is the case?

21)The currents play a very important role determining where plastics end up in the ocean.
When albatross go to the ocean in search for food, they also encounter floating debris, which is transported and concentrated by ocean currents.

This map shows the major currents, the location of Tern Island (red dot), and the areas where Laysan and black-footed albatrosses go to look for food during the rearing period of the breeding season (the two blue blobs). The green blob shows the location where Capt. Charles Moore surveyed for plastic debris. He discovered a large area – the size of Texas – with high densities of floating debris. If you collected the floating plastic with a net, every time you cleaned an area the size of a basketball court, you would collect 1.4 pounds. Just imagine how much plastic is out there: Texas is the size of 2.4 billion basketball courts!!!

22) Satellite tracking has allowed researchers to track the movements of albatrosses tagged in Cordell Bank National Marine Sanctuary (red star) during the summer (July – October) of 2004. Seven out of the nine black-footed albatrosses tracked off California entered the "eastern garbage patch". On average, the birds spent 14% of the time within the garbage patch, with two birds never entering this region. Notice however, that two birds spent over 1/3 of their time at sea inside of this region.

Note: 5 birds were tracked with transmitters that operate continuously, and 4 were tracked with transmitters that operated on a duty-cycle, with alternating 24hr ON : 24hr OFF periods. These birds were analyzed separately.

23)What are the effects of plastics on seabirds?
They depend whether you consider the immediate (short-term) effects and the protracted (long-term) impacts.The size of the items influences whether they really harm the birds. Big pieces can cut and obstruct the stomach. However, it is difficult to conduct studies to determine how bad ingesting plastics is, and what these effects are.

24)The long-term impacts of plastics are related to the leaching of poisonous chemical, as the debris breaks-down in the stomach of the birds. The key question is whether the levels of pollutants found in seabirds are related to the amount of plastics they ingested. The answer is not clear, but here are some clues from several studies.

25)This slide shows the results of a study where researchers compared the amount of plastic ingested by albatross chicks that died at the colony in 1987.They compared the causes of death for chicks that had LARGE or SMALL amounts of plastics in their bellies. They used 22 cm 3 as the threshold for LARGE / SMALL: which corresponds approximately to the volume of the highlighter shown in this slide.

The researchers looked at the two albatross species (black-footed and Laysan) and recorded the cause of death of the chicks. None seemed to have died due to starvation or due to obstructions of their stomach with plastic. Most birds died of unknown causes and dehydration.

Then the researchers compared the survivorship of the chicks with LARGE (red font) and SMALL (green font) amounts of plastics, they did not find a statistically significant difference. In other words: the chicks with more plastic did not seem to die more frequently than those without as much plastic in their bellies.

26) These researchers then looked at other possible effects of plastic ingestion, like the weight of the chicks and the growth rates. They thought that perhaps chicks that had been fed lots of plastics may grow slower or be skinnier.
Once more the chicks with LARGE (red font) and SMALL (green font) amounts of plastic in their bellies are compared, for each species separately.
The results showed that Laysan albatross chicks were impacted by plastic: birds with LARGE amounts were skinnier and grew slower.
For the black-footed albatross the researchers could not detect any impacts from plastic ingestion. What could this mean?

27) Because Laysan albatross chicks seem to be impacted by ingesting LARGE amounts of plastics, now we focus on a different study where the researchers contrasted the amount of plastics and the condition (body mass and the amount of fat) in chicks that died of natural causes (red font) and were killed accidentally (e.g., hit by cars). The idea is that if plastics are not killing the chicks, then those that died in accidents and those that died naturally should have the same amounts in their bellies.
The results showed that the chicks that died naturally had more plastic in the stomach and larger items (weights are shown).
These chicks had lower body masses and a lower fat index, though the numbers were very similar.
These results suggest that chicks that eat a lot of plastic have trouble, and are in worse condition.

28) Another really important part of this story is what happens to the chicks when the parents have a really difficult time finding food – during a “bad year” of poor food availability in the ocean.
When researchers compared the causes of Laysan albatross chick deaths in 1987 (good year) and in 1986 (bad year), they noticed that in the bad year – when chicks were dying of starvation – some chicks also died because they had too much plastic in their stomachs and they became obstructed.
Overall, the survivorship (how many of the chicks that were born survived to leave the colony), declined from 76% in the good year to 54% in the bad year.
Therefore, even if only 2,2% of the chicks died due to plastic impaction in 1986, that effect affected a much larger proportion of the chicks (46% died that year, compared to 23% in a good year). The chicks were twice as likely to die during the bad year.

This result suggest that plastic ingestion – as we saw in the previous slide – affects the overall condition of the chicks, making them more skinny and causing them to grow more slowly. When the chicks are faced with a bad year of low food, the stress from the plastic ingestion seems to make things much worse for them.
What is not known is whether parent albatrosses feed their chicks more plastics in “bad years” where there is less food around.... or whether the stress of not having food – combined with the stress of ingesting plastics – are too much and the chicks die. In good years, these chicks would still survive because the stress of ingesting plastics is not enough to kill them.

29) Chicks regurgitate Boluses before leaving the nest . The bolus contains indigestable matter, including many plastics. On Kure Atoll in the Northwesten Hawaiian Islands, 144 Boluses were analyzed and plastic was found in every single Bolus, comprising 60% of the Bolus's individual weight.

30)Some statistics about bolus contents:

- 88 Laysan boluses analyzed – 20% of them contained large plastic items – lighters and light-sticks

56 black-footed boluses analyzed – they did not contain lighters and light sticks, but had more than twice as much plastics on average than the Laysans.

31) These researchers also looked for plastic debris in carcasses of dead chicks. Plastic was found in every single one. 3/9 boluses contained red lighters. Colorful items seem to be attractive to these birds.

32) A fun pop quiz to reinforce some of the lessons:

Answers:

Dead whale: We defined marine debris as human-made items not normally found in the ocean.
Therefore, only the dead whale is not marine debris.

90%: because plastic is used and is pervasive throughout the world

3) 95%. It's sad, isn't it?

33) So, What can you do about this? quotes on slide from New Zealand.

34) One of the most effective things we can do is not too litter, but obviously it travels from many sources through watersheds to the beaches and out to sea. We can get involved no matter where we live by getting involved in trash pickups, beach cleanups, river cleanups, stream cleanups etc.

34) Slide not for students, contains all the references for plastics/seabirds.