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Whale You At? The Influence of Solar Storms on Frequency of Whale Strandings in the North Sea

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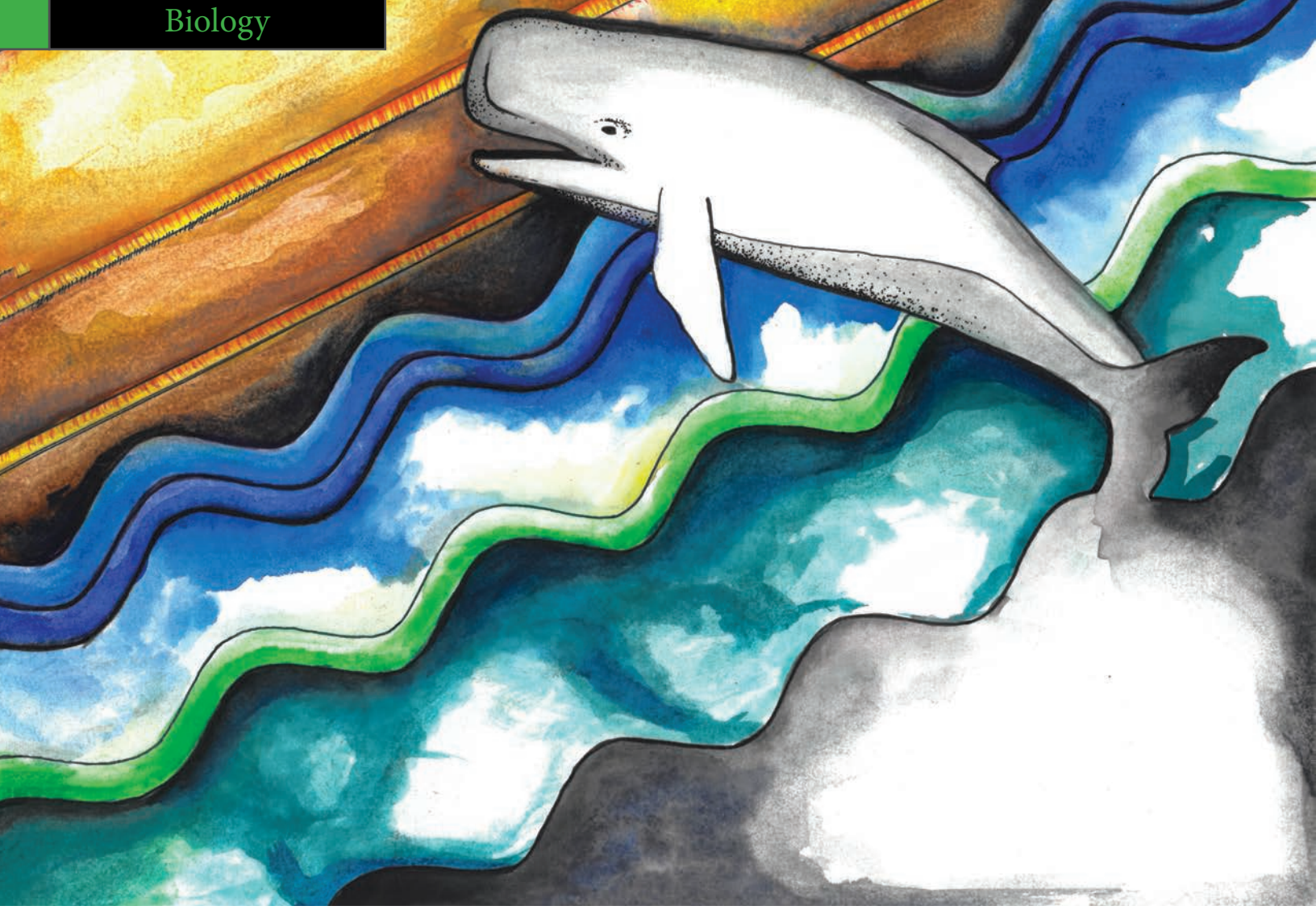

Whale You At?

The Influence of Solar Storms on Frequency of Whale Strandings in the North Sea

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You are driving down a road when you hear "Turn left in 500 feet" come from your GPS. This small device directs your every turn and should ultimately get you to your desired destination. Suddenly, that great new song comes on the radio, you start jamming away, and you miss the left turn. What you should do now? You think about turning around at the next opportunity, but then the GPS tells you to "Continue for 1 mile and turn left at the next road." You are lost no more. We are lucky to have such remarkable forms of technology that at the touch of a button will take us from Point A to Point B, and even redirect us when we happen to get lost.

Animals like whales don't necessarily have a GPS for guidance, yet they manage to migrate immense distances while rarely getting lost. Migrating species have a remarkable ability to follow specific routes during migration season despite the long periods of time that pass between seasons. However, what happens when whales get lost and, rather than enjoying a burgeoning supply of kelp, end up stranded on beaches miles from their desired destination? Whale beachings, or strandings, are a mysterious phenomenon that has puzzled whale lovers and scientists alike. In trying to understand incidents of whale beachings, there is definitely a biological and an environmental aspect to explore.

In February of this year, New Zealand faced one of its worst whale beachings in history, which resulted in the deaths of 250 pilot whales. According to a piece in The New York Times, 50 whales did eventually swim back out to sea, but 90 whales re-beached themselves that same afternoon. As the article mentions, a consistent factor that researchers believe contributes to whale beachings is navigational mistakes, which can occur when the whales are escaping predators or chasing prey. The severity of these events lies in the fact that whales have immense social bonds and swim in packs. When the leader of a pack happens to go off-course, everyone following is in jeopardy of getting stranded.

Navigational mistakes can be quite problematic for whales. A recent report in *BBC News* extrapolates on this phenomenon to examine what could be causing whale beachings hundreds of miles away in the North Sea. Researchers believe large solar storms play a role in whale beachings, specifically those of 29 sperm whales in the North Sea in early 2016.

In response to the sperm whale stranding in the North Sea, researchers published a study in the *International Journal of Astrobiology* to examine the influence of solar storms on sperm whale strandings. They explain that there is a connection between migrating species and astronomical interrelations that exist between magnetic fields, particle flows, and radiation. In essence, species like whales that migrate into northern regions rely on magnetism for orientation.

Through mechanisms of echolocation and magnetism, whales are able to communicate with one another and navigate along their migratory routes. It can be said that whales are equipped with their own biological GPS system. Earth has superimposed magnetic fields which whales learn to use to determine where they are and where they need to go. But, similar to the case of an electric GPS, these systems can become uncalibrated, sending the driver or whale onto an unmarked path.

Geomagnetic anomalies, like solar storms, can potentially cause these biological GPS systems to become uncalibrated. A mixture of changes in ocean depth and geomagnetic anomalies, such as an unexpected major solar storm, can cause an overabundance of information that interferes with whales' internal magnetic senses. As a result, whales can become disoriented and accidentally take a wrong turn that leads them into shallow waters.

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The scientists who published the study in the *International Journal of Astrobiology* hypothesize that the sperm whales were thrown off-course because of interferences within geomagnetic fields which consequently disrupted their internal magnetic 'compass'. They predict that an increase in solar storms at the end of 2015 led to such shifts in geomagnetic fields. Moreover, given that this is an unfamiliar route, sperm whales may have experienced greater difficulty with advancing through more treacherous waters. Some of the added difficulty lies in the fact that many of the packs of whales who travel along this route are composed of young whales, otherwise known as "bachelor groups". Thus, inexperience with shifts in geomagnetic fields characteristic of the North Sea is another contributing factor. Sperm whales spend much of their early life in lower latitudes, where magnetic disruptions such as solar storms are not as easily felt. Young whales are unaccustomed to dealing with shifts in geomagnetic fields and may be more easily disoriented by shifts in magnetic fields in the North and Norwegian Seas. They are unable to adopt "alternative navigation systems" and thus the consequence is an increase in the frequency of whale strandings.

Given that whales already rely on geomagnetism to navigate along migration routes, the problem arises when there is an excess of geomagnetic information. Whales, like the sperm whales in the North Sea, may not be capable of discerning this additional and often faulty information. What results is confusion, and the whales inevitably follow a path that does not really exist and end up stranded on beaches. Some whales, typically older and more experienced, are capable of reorienting themselves, or as a GPS would tell you when you get off-course: "Recalculating...recalculating". However, "bachelor groups" have not reached this point of experience and so recalculation is not an option. In addition, one must consider how solar storms impact a whale's ability to potentially recalculate.

One way in which species can "reset" their internal magnetic system is by using the sun. However, as noted in the study, the two solar storms that aligned with the sperm whale strandings were so strong that disruption of the geomagnetic field made it harder for such whales to re-calibrate. The study adds that the "disruption of the geomagnetic field by a solar storm at the crucial time of magnetic adjustment at the sea surface could result in the whales following a wrong course for a whole day."

During solar storms, there is a major flux of charged particles and radiation coming from the sun and reaching Earth's surface. With such a flux of high-energy particles, Earth's magnetic field can shift, causing inclination. Inclination is an important navigational parameter used by other migrating species, and so there is a possibility that it is also used by whales. Essentially, solar storms can alter geomagnetic field lines in relation to their geographic conditions. Inclination is characterized by the angle formed by a compass needle when it is held vertically. So, it is essentially an angle of intersection with the reference point being Earth's geomagnetic fields. In the case of the solar storms that occurred in December 2015, the inclination fell in the North Sea during the first storm and then rose during the second. These changes in the angles of inclination cause deviations in latitude and, depending on how long these effects last, can have monumental consequences on migrating species that may be in the area.

As sperm whales migrate north, they are met by magnetic field lines that have a higher vertical component. That is, the angle between a vertically held compass and the presupposed geomagnetic field lines is large—in the range of 70 degrees. Older whales are more likely to have experienced the effects of solar storms and thus are more knowledgeable about how to deal with shifts in their magnetic sense. Young whales migrating on their own, however, are more prone to disorientation because they are not able to rely on a second navigational system nor do they understand the geomagnetic shifts they encounter. They then end up stranded in shallow waters as they veer off-course.

Results from the study in the *International Journal of Astrobiology* show that there is no definitive causal relationship between shifts in solar activity in and around the North Sea on whale strandings. However, the study did conclude that the 29 sperm whale beachings could have been triggered by strong solar storms that took place in December of 2015. As the researchers note, there are a number of issues that contribute to positive correlations between environmental changes and the frequency of whale strandings, so further study of this phenomenon is necessary.

Whale beachings have become an ever-pressing phenomenon to understand, especially in the realm of conservation. And, as the study mentions, shifts in Earth's magnetic field because of geomagnetic anomalies have an impact on many migrating species, whether they be honey bees or homing pigeons. Animals are not afforded the great privilege of having GPS systems that are safe from the effects of solar storms. While we may be able to "recalculate," whales and other migrating species could face more catastrophic consequences than just simply making a wrong turn; they may never end up at their destinations and instead be stranded on a beach, unable to get back to their native habitats. There is still a lot left to study concerning the phenomena of whale beachings, like the effect of climate change and variations in solar activity on the warming of ocean waters, and the effect this may have on frequency of whale strandings.

If you'd like to learn more about whale strandings and solar storms, see Matt McGrath's article "Northern Lights linked to North Sea whale strandings" from the September 2017 issue of *BBC News*.