Slide 2: Jackie was so excited…

She had always been obsessed with whales. As a small child, her first memorable toy had been a stuffed humpback whale and her favorite family vacation had been to San Francisco for whale watching. She had worked hard through high school to be accepted into the Oregon State University marine biology program. Now, as an undergraduate student she had been selected to participate in a research expedition to Antarctica. She was going to be able to use real data to finish her senior honors thesis!

Slide 3: Jackie was aware of the perilous situation of current whale populations. Baleen whales (blue, fin, humpback) were almost entirely extirpated through commercial whaling. It broke her heart that over 2 million whales had been killed over the last century. She also knew, thanks to her ecology class, that this affected the polar ecosystem by creating a void of krill predators.

Slide 4: polar food web with humpback whale

Slide 5: Jackie was also very concerned about the changing polar ecosystem. The average winter air temperature has increased by 5 degrees on the Antarctic Peninsula over the last 50 years. This has decreased the sea ice cover to less than 80 days annually and made “heavy ice” years infrequent. She wanted to observe, first hand, how this was affecting her beloved humpbacks. (Ari slide 18)

Slide 6: Ari slide 19 Questions #1 and #2

What is happening to the sea ice coverage around Anvers Island?

1. It is increasing.
2. It is decreasing.
3. It is not changing significantly.

What is happening to the sea ice coverage south of Margaeurite Bay?

1. It is increasing.
2. It is decreasing.
3. It is not changing significantly.

Slide 7: Question #3

Hypothesize what Jackie will conclude from the data her expedition is collecting?

1. The humpback whale population is decreasing.
2. The humpback whale population is stable (not increasing or decreasing).
3. The humpback whale population is increasing.

Slide 8: Objectives (Ari slide 22)

Slide 9: Question #4

There are generally 4 questions/stages of study in marine mammal movement. Put these in the most logical order.

1. How does their distribution and behavior change over time?
2. Where are the animals? What are they doing?
3. What are the consequences of global change on animal distribution and behavior?
4. Is their behavior related to environment?
5. 1, 2, 4, 3 c. 2, 1, 4, 3
6. 1, 3, 4, 2 d. 2, 4, 1, 3

Slide 10: Four stages of marine mammal movement with stage 1 highlighted.

Slide 11: Jackie was on the boat going out looking for whales to tag… These tags were so cool! Not only did she love the bright colors but the information they would collect over 48 hours was amazing. They contained 3 axis accelerometers, magnatometers and gyros to measure time, depth and temperature for each whale tagged. They could even transmit gps coordinates, audio and video to the scientist’s laptops. This data would give her tremendous incite into predator foraging behavior. (insert video of tagging)

Slide 12: Question #5

Which of the following is LEAST likely to affect predator foraging?

1. Physical constraints of predator
2. Timing, behavior and constitution of prey
3. Plasticity in appetitive behaviors
4. Mating behaviors of males

Slide 13: Finally, Jackie had some data to analyze… She had been chosen to participate based on her acute analytical skills honed over the last 3 years of college. Her role in the expedition was to combine video and movement data such as depth pitch, roll and heading so that a team of graduate students could create a track of the tagged whale’s movement. This plotted track would help the team visualize the maneuverability and feeding behaviors of the whales.

Slides 14 and 15: Data and questions #6 and #7

Question #6

What is happening at time 16:24.25 sec in the given graphical data?

1. The whale is rising to the surface and rolling.
2. The whale is rising to the surface with no change in pitch.
3. The whale is diving and rolling.
4. The whale is diving with no change in pitch.

Question #7

What is happening between time -8 and 0 seconds in the graphs above?

1. The whale is speeding up and diving.
2. The whale is speeding up but not rolling.
3. The whale is speeding up and heading in one direction.
4. The whale is speeding up and rising toward the surface.

Slide 16: Jackie knew exactly what was happening with the given data. This whale was feeding! Of course this was just a tiny portion of the 48 hours of data she was going to sort through over the next several months. And… this was just one of many whales tagged. What a huge undertaking this was going to be for her. She was ready for the challenge!

Slide 17: Jackie was finally back on dry land spending endless hours in the lab while still finishing up her last semester of classes. She knew her social life might suffer slightly but it was totally worth it! The techies were using a program called trackplot (similar to a cool app she had found called tag data) to produce a 3D track of the movement for several whales they had tagged.

Slide 18: (Ari slide 33)

Slide 19: Jackie was in awe of the finished products the tech people had produced using the trackplot program. This could make someone a lot of money as a really popular video game. Of course every whale is different so quanifying the feeding behavior would require audio and other data. (Ari slide 39) (link mp3 of whale movement)

Slide 20: Jackie even saw a novel feeding behavior for Antarctic humpbacks called bubble net feeding, normally seen in other populations. Was this a sign of communication between populations separated by vast distances? This would need to be a whole different experiment… maybe grad school? (Ari slide 38)

Slide 21: Jackie was also able to review the results of the other group working on prey mapping. They used echosounders to determine distribution, abundance and density of krill. (Ari slide 42)

Slide 22: Question #8

What can you deduct from the two images given?

1. Whales feed all day long as the krill abundance is fairly constant.
2. Whales feed mainly during the day as the krill abundance is highest then.
3. Whales feed mainly during the nighttime as krill abundance is highest then.
4. Whales rest too much to have any predictable feeding pattern.

Slide 23: Question #9

Using the image of long-term satellite telementry showing the movement, distribution relative density of whales across the Western Antarctic Peninsula, which of the following is the best conclusion to make?

1. Whale feeding is relatively evenly distributed across the peninsula.
2. Whale feeding is not evenly distributed across the peninsula.

Slide 24: Jackie was fascinated with the satellite images showing a very unequal distribution of whales along the peninsula. Why would this occur? Of course, it had to be the food… predators follow the prey!

Slide 25: Four stages of marine mammal movement with stage 2 highlighted.

Slide 26: Jackie had finally finished her honor’s thesis using the multitude of data collected in Antarctica and was ready to graduate. But, the lab she was working for had moved on to the second stage addressing change over time. Fortunately, the primary investigator had a little extra money and could hire her as a lab assistant for the summer before she started grad school at Rutgers in the fall. Her first task was to analyze monthly dive patterns and foraging rates.

Slide 27: Question # 10

Using the following data, when are the foraging rate more uniform across individuals? (Remember: Antarctica is in the southern hemisphere so winter is June, July, August!)

1. Summer c. Neither
2. Winter d. Both

Slide 28: Jackie thought that wasn’t too difficult. She was really getting good at analyzing data. She also had access to pictures of long term whale tracking data showing individual whale migrations from Antarctica to the south pacific.

Slide 29: Question #11

Using the images above, at which month have all the whales migrated away from Antarctica?

1. February c. June
2. April d. cannot be determined

Slide 30: Jackie was surprised by the fact that some the whales were staying longer and foraging more during the winter. She had read in her college classes that whales didn’t stay in the Southern ocean over winter. What might be changing in the environment to account for these results?

Slide 31: Four stages of marine mammal movement with stage 3 highlighted.

Slide 32: Jackie decided it was time to search the research literature for possible answers to her question. She found images produced by Acoustic Doppler Current Profiler (ADCP) backscatter showing the density of krill and whales in Wilhemina Bay.

Slide 33: Question #12

What can be concluded from the images of density for 2009 versus 2010?

1. The whales are feeding closer to shore in 2009 over 2010.
2. The whales are feeding closer to shore in 2010 over 2009.
3. The whales are not showing any difference in feeding behavior between 2009 and 2010.
4. The whales are leaving Antarctica completely between 2009 and 2010.

Slide 34: This information further confused Jackie. She pulled up the krill lifecycle table from her marine biology text. (Ari slide 51). The whale feeding behavior was heading away from shore looking much like a spring krill bloom.

Slide 35: This implied that the changing (warming) environment was actually beneficial to the Antarctic humpback population. Usually a biological disturbance (especially a human influenced disturbance such as climate change) was detrimental to the species experiencing the disturbance. Was this not the case for humpback whales? And if so, what did this mean for the ecosystem as a whole? (Ari slide 54)

Slide 36: Four stages of marine mammal movement with stage 4 highlighted.

Slide 37: Jackie needed validation that the warming temperatures and reduced sea ice in Antarctica was beneficial to the humpback population. She once again got online and found images of whales where body size and mass were measured. (Ari slide 56)

Slide 38: Question #13

Using the images above, what is the most logical observation of whale size and mass?

1. The whale is bigger and heavier in the summer.
2. The whale is bigger and heavier in the fall.
3. There is no noticeable difference between the summer and the fall.

Slide 39: Image of mother and baby

Slide 40: Jackie wondered if the increased size would correlate to increased population. Doesn’t increased resources translate to increased reproduction and survivability? Back to the library research data base for supporting evidence.

Slide 41: Question #14

Finally, she found a study that had taken small biopsy samples (while tagging). This allowed the researchers to test for pregnancy of female whales. Using the data accumulated, what would you expect to be happening to the humpback whale population?

1. The humpback whale population is decreasing.
2. The humpback whale population is stable (not increasing or decreasing).
3. The humpback whale population is increasing.

Slide 42: Question #15

How does your answer to question #12 compare to your hypothesis at the beginning of the case study?

1. It supports my original hypothesis.
2. It refutes my original hypothesis.

Slide 43: Jackie was elated to conclude that the humpback whale population was on the rise. Of course this did not mean that the environmental disturbance (increase temperature due to climate change) was overall beneficial to the polar ecosystem. Penguin populations continue to significantly decline as the redistribution of krill does not align with their feeding behaviors! (Ari slide 55).

Slide 44: Jackie also hoped the data from her Antarctic research adventure (and all the data she had discovered through online research) would be used to further protect her favorite animal. She knew krill fisheries were economically important in Antarctica and was cautiously optimistic that they would correlate krill harvesting with areas of high whale foraging. (Ari slide 64)

Slide 45: Jackie was now ready for her next chapter in life… graduate school and more whales!