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Well, the work I've done on penguins has been pretty diverse. It started with the diving physiology and it's evolved now to the point where I'm trying a special way of doing a census of penguins. It's almost all been on Emperor Penguins although I've done some work on King Penguins and other species as well.

What's important about penguins? It's hard to say. It depends on the species and the investigator that's working on them, I suppose. But Emperor Penguins I think are not just a special species of penguin; they are a special vertebrate. And I say that because of their characteristics and they're the only one that winters over in the Antarctic. The Emperors face it head-on, and so, to me, in many ways they are the closest thing that we have to a higher form of life that's an alien to this planet.

Well, Emperors, as an indicator species, is one of the ideas that I've been trying to work out now, and that is that they are the most ice-dependent vertebrate that I know of. We know that there are animals that are dependent on the sea ice as far as the undersurface is concerned and we know of other examples of that. But Emperors have to have sea ice; they can't get along without it. They are probably the only species that may never set foot on land, and that's because they don't need to. In fact it's a big inconvenience to them and they are very awkward in their walking and so they would have a hard time moving around on a rough terrain. Nevertheless they have to breed on it and they have to molt on it, and they feed in the pack around it. So where the ice goes, so go the Emperor Penguins.

As far as Emperor Penguins are concerned, I've only worked on them for a little over 20 years in the detail that I've been conducting now on a long-lived species like this. As far as any population trends, one difficulty is actually getting the counts. That's why I'm working on ways of doing that in a very broad way, but as far as other changes with the birds are concerned, I can't say that I've really seen any except for the sudden impact occurrences like this giant iceberg that broke away in 2000. Then it (the iceberg) came and drifted into the (Emperor Penguin) colony area in the Western Ross Sea, and we're actually working on a report for that at the present time. That was a significant effect. We believe it killed a lot of adults from the results of it and the colony had failed completely the first year that it (the iceberg) arrived and it hasn't done well since then.

Well, it's (climate change) more a potential than what are known effects as far as I know. Now there is one study that Defense did at Dumont DeVille, where they have hypothesized that the colony declined in the middle seventies because of changes in sea ice conditions and it's never recovered (fully) from that. They recovered to some degree, but they've still persisted. It's really unknown, though, as to how much that occurs.

As far as migration of the birds, adapting to a new habitat rather than sea ice, I don't think that's possible for a variety of reasons. As far as moving to new sea ice conditions, there's potential for that, but that potential might be that there are more southerly distributions and the colonies in the Northern Rim would fail.

As far as climate change and the limits of food, that's a more difficult one because of course all their food is marine food and it's hard to assess what those populations are experiencing. And Emperors, I think, are fairly catholic feeders in the sense that they feed on squid, fish and krill, so they have a number of options there and they also stay in the water column which is the reverse of what the smaller penguins do. They range from feeding right under the ice surface down to deeper than 500 meters, so they've got a large three-dimensional column or environment to live in whereas smaller penguins are feeding generally about 20 meters.

Well, why should we care about Emperor Penguins, what's happening to them? You can answer that in a variety of ways. If you've worked with them and lived with them as I have, there's a good reason. There's an attachment to them. The planet itself would be a much more sterile place (without them) and that's an important issue.

As far as being an indicator species, that gives us a wake-up call for certain things. I think they are an icon that we attach to as well. I think that the publicity of the Emperor Penguin is as great or greater than what has happened recently about the rediscovery of the Ivory-Billed Woodpecker, which they call a Holy Grail bird. It's the Holy Grail. I'm not quite sure what I would call the Emperor Penguin that. But I think it would catch the attention of the world, essentially, if we suddenly started to discover that some of the things that we are doing may cause the loss of this pristine aspect of the Antarctic environment.

How do we make people more aware of the Antarctic, or the ocean environment? I would say, keep doing what we're doing only maybe doing it in a broader way. Most scientists, as far as our responsibility is concerned, need to expand their horizons beyond the technical reports that they do and work in other media as well, just as I'm doing right here in this interview. But I think those are important because we have species that do capture the attention. I mean, everyone knows about whales and they know about killer whales in particular and they certainly know about Emperor Penguins, especially with this new movie that's out now. But I think that's perhaps what we can continue to do.

It is a good-news story in the sense that there are populations that are declining for one reason or another but in general the Antarctic penguins and particularly the Emperor Penguin right now is a good story. I've been working in the Antarctic and around there with penguins for forty years in one way or another and the good news is that the changes are fairly small, in fact they are miniscule compared to what's happening around the rest of the world. So when I go to a study site that I attended or went to forty years ago, it's very much the same, the distributions of populations are pretty close to the same. Whereas if someone goes to a site in say, Central Africa, for example, where they worked

on gorillas or whatever. I mean, we're talking about gorillas disappearing in the next twenty years, and so we don't have that kind of scenario as far as the Antarctic is concerned at the present time. Thank Heaven!

Well, a typical day in the Antarctic, my favorite day, is when we're in the field. And the field means that we're in a remote camp, which is a necessity if you work on Emperor Penguins. In only a couple of instances do (the colonies) occur near bases and so our camp is 200 miles away. So we're on our own. The typical day is that we're doing our own cooking and all the other camp needs that you have to do. There's no support whatsoever.

We're very weather-dependent. If it's blowing and visibility is low, then the day is going to be spent inside doing some kind of work there. And if it's a great day or a good day in the Antarctic, we're outdoors. And we're doing whatever we've set up for that time. A lot of it occurs in the colony where we may be doing weights and measures of the birds or attaching instruments for remote monitoring or we may be doing some census work. If we do that, it means that we're climbing a bluff that's about, I'd say four to six hundred feet high. It's very close to vertical, so it's a very vigorous kind of effort. If we're not doing that, we're doing work at the ice edge. That's always a very exciting aspect because we are essentially in a pelagic environment. So while we're there almost anything could go by, from beaked whales to numerous Emperor Penguins or Adele Penguins. And there's a lot of action that goes on at that time.

Why are Emperor Penguins in the most remote and perhaps the harshest place to live on the planet? Well, that's really a good question and the evolution of that probably took a long time to get worked out.– and just how remarkable is that, there's probably 9,600 species of birds! Emperor Penguins are the only ones to over-winter and breed in the wintertime in the Antarctic. But they are the only ones there. There are no predators. If they can deal with the severity of the environment then they have no competitors, they have no predators and they have a pretty peaceful environment. And that says a lot for the bird. As I said, they are very clumsy on land and so if there were any land predators around, they wouldn't survive that kind of predation. So their breeding area, if they can hunker down and tolerate it – and they can, they are very well adapted to cold environments – it's not so severe for them.

Well, why should we care about Emperor Penguins? What can they tell us? I think they can tell us a number of things, and one was this example that they are the only species that are down in the Antarctic winter and it tells you one thing about extreme adaptations to cold. And that's something that we're dealing with in almost any endeavor we do, people that live in Minnesota or Wisconsin are thinking about that any winter. But we're also thinking about it for space flights or whatever when they're in severe cold and the insulation of those suits have to be very effective. Well, how do Emperor Penguins do it? And the example is, they have no baggage. They have nothing. They're out there with just what they've been adapted for, which is an extremely good coat of feathers and

probably some blubber for insulation beneath them, and they can go through a lot of winter. And they do that while not eating for most of that time.

If you put a human out in that environment, naked – which is all they have as far as their adaptations are concerned, he (or she) would probably last a couple of minutes before freezing. So we get an idea of an extreme that way. I already mentioned one earlier and that was that they dive to 500 meters, water that's 28 degrees Fahrenheit. It's just below the freezing level of seawater, that's the reason why ice doesn't form at that depth. In any case, while they're going to that depth, they're holding their breath for ten to fifteen minutes. Well, they're a small bird, about 25 kilos – small compared to humans. Well, they're undergoing an extreme hypoxic event, an extreme event without oxygen and we can't do that. So the idea of how they adapt, what their cardiovascular effects are to respond to those hypoxic events are medically very important to us as well. And we are studying that both in Emperor Penguins and other diving birds and mammals.

When the Emperor's breed, they are facing average temperatures of minus thirty, minus forty degrees Centigrade, and frequently there are winds that are over forty or fifty miles an hour and may get up as high as 100 miles an hour. And a beautiful example about Emperors is the cooperative aspect of that; their need for survival, they do not defend territories. They do not have nests that they defend vigorously against other individuals. They actually have survived by cooperation and huddling together. And by doing that they conserve body heat. They turn their individual bodies into one large mass. And at that point it's so effective, that within these huddles, the temperature may get up as high as 80 or 90 degrees Fahrenheit. And the average temperature in those huddles is about 70 degrees. So here they are sitting in an environment that is minus-40, say, and they're sitting in a place where certainly in the center of that huddle they're probably getting too warm!

When they're in those huddles like that, they do move around. The huddles are actually fairly fluid and so they are opening up and closing and moving around. And if there's a strong wind blowing then the birds on the windward side will be moving to get in the lee of the huddle, so there's a constant motion that way. It's all very slow motion. If you were to watch that going on it would be difficult to see who's moving where because of the way they sort of shuffle along, but it just keeps happening. And the huddle keeps rotating.