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Historical Perspectives

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(Born 6 June 1959)

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Lessons from 40 Years as a Marine Scientist: Advice to a Young Lisa

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Is anyone ever ready for a "perspectives" piece? It hints a transition from a life focused at looking ahead to a retrospective look back. In my case, I'm far from ready to stop looking forward, but I do believe that time brings a special kind of wisdom that only comes through experience; and I will cede that I have racked up years of experience. After all, it has been 47 years since I left high school. Back then, there was no e-mail, a single computer took up an entire room, the Endangered Species Act was just five years old, and commercial whaling was still legal. I've learned a lot in those 47 years. I've survived a lot of challenges and made a lot of mistakes. What would I tell a young Lisa were I to have the opportunity to provide advice? That list of "what I would do if I had it to do all over again" is at the end of this piece for those of you who wish to jump ahead. How I learned those lessons is the theme of my perspectives piece.

My University Years

I grew up in a very small, science-focused town (Los Alamos, New Mexico). My father was a scientist; and my mother was a self-educated renaissance mind who believed strongly in life-long learning and fact-based paradigms. From my earliest memory, I knew I would be a scientist. My undergraduate degree at a large and prestigious R1 university provided entry into a vast and incredible world of knowledge, albeit largely through formal coursework and perfecting my performance in the game of grades. I never questioned the next step of graduate school, even as I had little practical knowledge about what one actually did there.

My master's degree changed all of that. It was during that time that I learned how to think (as opposed to memorize), how to ask questions, and how to formulate plans to answer them. Those years I spent learning and practicing these skills in an environment with that as the sole purpose changed my life. I published two papers from my thesis research on bottlenose dolphins (*Tursiops truncatus*; Ballance, 1990, 1992), and I had a fantastic time. I wanted more.

So, I went on for my Ph.D. With my basic skills acquired from my master's degree, it was during this time that I learned how to contribute to the world's knowledge and how to advance paradigms. It was challenging. I changed universities after my first year, changed advisors after my second year, went through a crushing series of personal break-ups with partners, and lost my dream advisor to AIDS during my fourth year when that disease was still a stigma and hidden. (Professor Bryan S. Obst was an astonishingly talented scientist and among the finest humans I have ever known. He was gay. I, and as best I know, his other graduate students and colleagues, were unaware of this until his death.) Despite the challenges, my doctorate experiences were also exhilarating. I learned how to work as part of a large team aboard National Oceanic and Atmospheric Administration (NOAA) research vessels thousands of miles from land, how to work alone on a tropical island filled with seabirds, and how to test theories and synthesize disparate data streams. I fell in love with my future husband and lifelong colleague, and I published two more papers on seabird ecology (Ballance, 1995; Ballance et al., 1997). (A third is still patiently waiting to be revised and submitted.)

I learned a great deal during my graduate years, especially about the value of a master's degree, the critical role of advisors (and mentors), the hurt that harsh feedback can bring, and the complexities of what constitutes excellence. (I write more about these lessons at the end of my piece.) I had shaped my future around a professor position at a university as so many (most?) graduate students do. After all, that is our universe; it tends to be all that we know. So, it is not surprising that our sights are set on academia. However, for me, my career took a sharp and unexpected turn.

National Oceanic and Atmospheric Administration

My applications to universities were largely met with invitations to interview, but it did not take long for me to clearly see that oceanic work on biology and ecology of marine megafauna requiring large ships, essential for my research, was the purview of the U.S. government. (Academic research fleets seemed to spend most of their ship time and money on research pertaining to physical, chemical, and biological oceanography, and biology at low trophic levels.) By then, I had shaped my CV so well for academia that my supervisor at NOAA was pushing me out the door. Looking for a professional home, it was an awkward and frightening time. Ultimately, it was networking and serendipity (and yes, qualifications) that gave me my first real job.

NOAA is an agency of the U.S. federal government; it is large, complex, and famous for predicting the weather. But NOAA does a lot more. I had landed a graduate research associateship with NOAA for my doctorate career through a chance meeting at a scientific conference. This meeting led to a post-doctorate with the National Academies' National Research Council at the same NOAA laboratory. I worked at the Southwest Fisheries Science Center in La Jolla, California, one of six science centers scattered throughout the United States. I spent considerable time on the deep ocean, mostly in the tropics, hundreds to thousands of kilometers from land. That work led to an offer to be leader of the center's Dolphin Ecology Program, then on to Chief Scientist of our Tuna-Dolphin Research Program, and finally to Director of the Marine Mammal and Turtle Research Division. I had not intended to spend my career there, but I ended up with 31 years at NOAA and many extraordinary experiences. Two stand out as intensely challenging, intensely rewarding, and intensely impactful—professionally and personally.

I will characterize the first experience as "The Tuna-Dolphin Problem"—the name commonly used to refer to an extraordinary spectacle of nature and a thorny management problem (reviewed in Ballance et al., 2021). In the eastern tropical Pacific, an area of open ocean one-third larger than the continent of Africa and containing waters under the jurisdiction of 12 nations plus the high seas, multispecies aggregations of dolphins, seabirds, and tunas group together in a single assemblage. These are large (tons of tunas, hundreds of seabirds, and thousands of dolphins), prevalent, and near the surface. The tunas are dolphin-sized, reaching 50 kg or more; the association between dolphins and tunas is strong—the tunas remain with the dolphins even when they run, and these aggregations are highly visible at the surface (Figure 1).

Although the composite species are mostly pantropical, the co-schooling of dolphins and tunas is a hallmark of the eastern tropical Pacific, and is more predictable and prevalent there than in any other tropical ocean in the world.

These aggregations form the basis for what has been the world's largest yellowfin tuna fishery. In what are known as dolphin sets, fishers use high-powered binoculars (and, in later years, helicopters) to locate dolphin schools and seabird flocks. Speed boats are then lowered into the water, and they and the helicopter chase the dolphins into the net. Because the bond between dolphins and tunas is so strong, the tunas follow the fleeing dolphins into the net. These are huge purse-seine nets between 1.5 and 2 km long, and up to 250 m deep. It's a widespread and intensive fishery (Figure 2).

Of course, the unintended consequence was dolphin bycatch mortality, termed so because the intent of the fishery *was* to capture the dolphins as bycatch. The unintended consequence was mortality. And that mortality was high, greater than 600,000 in some years during the 1960s and early 1970s, down to 20,000 in the early 1980s, spiking to 100,000 in the mid-1980s, and down to about a thousand per year by 1995 (Figure 3). By 1992, it was estimated that more than 6 million dolphins had been killed in this fishery (National Research Council, 1992). For some perspective,

Figure 1. A mixed school of spotted and spinner dolphins (*Stenella attenuata* and *Stenella longirostris*, respectively) with seabirds is a highly visible signal of the associated yellowfin tuna (*Thunnus albacares*) co-schooling below the sea surface (Photo courtesy of Robert L. Pitman)

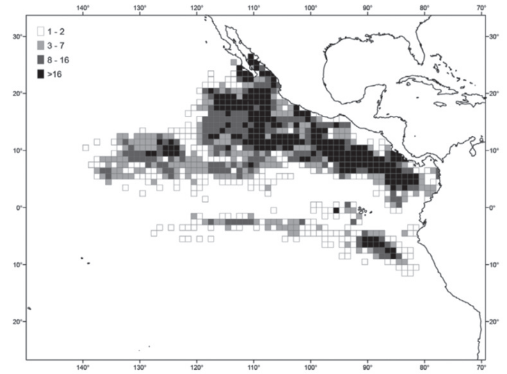

Figure 2. Distribution of purse-seine sets on dolphins during 2010 in the eastern tropical Pacific. A total of 11,645 sets are shown. (*Source:* Inter-American Tropical Tuna Commission [IATTC], 2015)

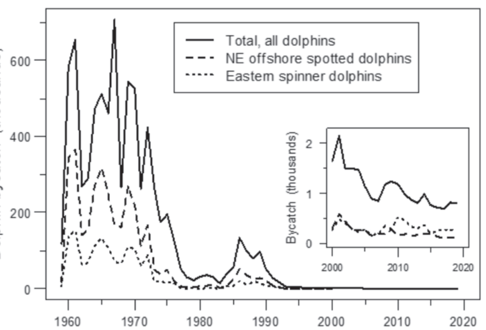

Figure 3. Estimated number of dolphins incidentally killed annually in the eastern tropical Pacific tuna purse-seine fishery. Shown are the total for all dolphins and separately for the stocks of the two dolphin species with the highest number killed (Wade et al., 2007; IATTC, 2015). The inset graph has an expanded vertical scale to show details from 2000 to 2019; notice the change of scale on the y-axis. (Reproduced from Ballance et al., 2021)

the number of whales removed from all oceans of the world during the 80-year period of industrial whaling has been estimated to be half that, 3 million (Rocha et al., 2014).

Because early mortality was almost entirely caused by the U.S. fleet, the U.S. government was charged with addressing the problem. NOAA research vessel surveys began in the 1970s. They became systematic in 1988 and ran through 2006. I joined these surveys as a seabird observer in 1998 and became Chief Scientist of this effort in 1999. I went to sea every year they were conducted for as often as 120 days each year.

We used a multidisciplinary approach on these surveys. A major focus was to estimate dolphin abundance. We used high-powered binoculars and trained observers to detect and identify cetaceans, as well as a helicopter to calibrate observer estimates of school size with aerial photographs of those same schools (Figure 4; Gerrodette et al., 2019). We conducted a suite of biological projects to clarify population structure, study behavior, assess health and condition, and learn about acoustics. And to provide context for our research on dolphins, we studied the ecosystem from top to bottom, including other apex predators (as competitors and commensals), low and mid trophic fishes and invertebrates (as the prey base), and physical and biological oceanography (defining habitat). This program represents the most intensive research effort on marine mammals in the world (Figure 5; Kaschner et al., 2012).

Through this unprecedented research effort, we made some amazing discoveries. We resurrected a previously described species of seabird, the Nazca booby (*Sula granti*), based on distinct bill color, breeding colonies, at-sea distribution patterns, and morphology (Pitman & Jehl, 1998). We made the first field identifications of four cryptic species of cetaceans. When we began our research, the dwarf and pygmy sperm whales (*Kogia sima* and *Kogia breviceps*, respectively) were distinguishable from one another only when live-stranded or from dead specimens on the beach. The same was true for melon-headed and pygmy killer whales (*Peponocephala electra* and *Feresa attenuata*, respectively). Our at-sea surveys revealed field characteristics that could reliably be used to identify them in the wild. The pygmy beaked whale (*Mesoplodon peruvianus*) was first described from skeletal specimens in 1991 (Reyes et al., 1991), but it was our research at sea that described its field characteristics and distribution throughout the eastern tropical Pacific (Pitman et al., 1987; Pitman & Lynn, 2001). And for almost 100 years, *Indopacetus pacificus* was known only from two worn skulls found in Australia and Somalia. It was our surveys that finally made the link between a cryptic beaked whale in the tropical Pacific and this species (Pitman et al., 1999), and sightings are now not uncommon because we know what the live animal looks like. We learned about oceanography, ichthyoplankton, flyingfishes, marine turtles, seabirds, and the influences of climate on species assemblages (e.g., Pitman & Ballance, 1992, 2002; Ballance et al., 1997, 2006; Spear et al., 2001; Fiedler & Lavín, 2006; Eguchi et al., 2007; Vilchis et al., 2009; Fiedler et al., 2013; Van Noord et al., 2016).

We also learned about dolphin abundance and trends—the primary focus of the research. Our results were sobering. Bycatch mortality was associated with a massive decrease in abundance so that in 1993, two dolphin stocks were listed as depleted: (1) northeastern offshore spotted dolphins (*Stenella attenuata attenuata*) were down to 19% of pre-fishery abundance (Wade, 1993a), and (2) eastern spinner dolphins (*Stenella longirostris orientalis*) were down to 44% (Wade, 1993b). By the early 1990s, changes in fishing gear and fishing practices had lowered reported mortality by an astounding 99% (Ballance et al., 2021). This led to an expectation of recovery, and, indeed, there was a general increase in estimates of abundance after 1998 but with substantial uncertainty so that the 95% confidence intervals of growth rate included zero (Gerrodette et al., 2008). As of 2006, our research indicated that dolphins were not recovering as expected. The question was why.

We conducted a lot of research on that question. Our ecosystem studies did not support the hypothesis that ecosystem shifts had occurred to the extent that previous population levels could not be supported (Wade et al., 2007). So, we turned to focused research on the dolphins. We found that the proportion of calves in dolphin schools reflected exposure to purse-seine sets (Cramer et al., 2008). Our data came from aerial photographs of dolphin schools (Figure 6). These allowed us to quantify the number of calves in a school. We applied a spatially explicit index of purse-seine set intensity and found that the number of calves in a school decreased as the number of sets increased.

We also found that the proportion of pregnant females in dolphin schools reflected exposure to purse-seine sets (Kellar et al., 2013). Our data came from skin and blubber biopsy samples from female spotted dolphins, some 12% of which were pregnant. The spatial pattern in pregnancy rates reflected exposure to purse-seine sets so that greater exposure to sets was correlated with lower pregnancy rates.

Further, we found that dependent calves were missing from schools encircled in the nets (Archer et al., 2001). The dataset came from dolphins killed in purse-seine sets. Up to 95% of lactating females in the nets did not have their nursing calves with them. The missing calves accounted for up to 8,300 animals per year, 14% higher than

Figure 4. The NOAA research vessel *David Starr Jordan* conducting a visual line-transect survey for cetaceans in the eastern tropical Pacific. This photo was taken from the helicopter used to photograph dolphin schools for calibration of school size estimates. (Photo courtesy of the Southwest Fisheries Science Center, NOAA)

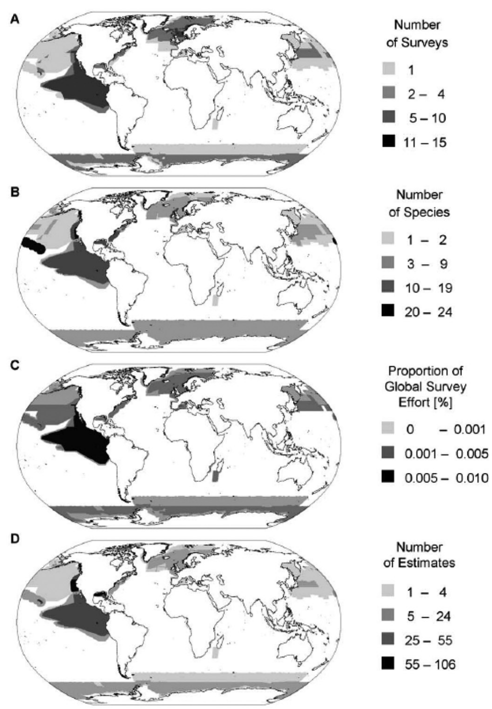

Figure 5. Global coverage of line-transect surveys for marine mammals. The eastern tropical Pacific is clearly visible in terms of highest number of surveys, species, proportion of global survey effort, and abundance estimates. (Reproduced from Kaschner et al., 2012)

Figure 6. Aerial photograph of mixed species school of spotted and spinner dolphins. The circle shows a female–calf pair, easily identified by the difference in length of the two individuals and the echelon swimming position of the smaller animal. (Photo courtesy of the Southwest Fisheries Science Center, NOAA)

observer-reported dolphin kill. Another suite of projects quantified the benefit of echelon swimming in dolphins and found it to be energetically beneficial to calves and costly to mothers (Noren, 2008, 2013; Noren et al., 2008). This research had implications for potential separation of females from their calves during the chase prior to the set of the purse-seine net (Noren & Edwards, 2007).

Taken together, our conclusion was that the practice of setting on dolphins had population-level effects beyond the direct kill recorded by observers on fishing vessels, possibly explaining, at least in part, the apparent lack of recovery.

The remaining story of the tuna–dolphin problem is more complicated, multifaceted, and fraught with well-intentioned efforts that resulted in failures, and some successes (Ballance et al., 2021). One of these successes was modifications in fishing methods and gear so that by 1975, about 95% of dolphins captured were being released during backdown. Less clear in terms of success was the effectiveness of U.S. legislation and international agreements. Increasingly harsh regulation through the U.S. Marine Mammal Protection Act led to a decline in the number of U.S. vessels in this fishery but an increase in the international fleet. This, in turn, led to import regulations, and lengthy and bitter litigation. Finally, video footage of graphic dolphin kill obtained undercover prompted creation of the U.S. "Dolphin Safe" label, but that was followed by other labels and certifications, each with their own unique definitions, which created confusion for tuna consumers.

With the "Dolphin Safe" label in place and the U.S. fleet no longer setting on dolphins, U.S. federal government science and we in NOAA moved on to other things. Meanwhile, the number of sets on dolphins by vessels from many other countries continues, and the situation pertaining to the status of the impacted dolphins remains as complex as ever, and many would say unresolved.

During my time as an ecologist and Chief Scientist of this research, I learned much about the complementarity of applied and basic research, the extent of profound impacts (direct and indirect) by anthropogenic activity in even the vastest of oceans, how research may be overshadowed by politics, and the strengths and pitfalls of advocacy in science. More on this below. But first, the second of my intensely challenging, rewarding, and impactful experiences during my years with NOAA: the vaquita (*Phocoena sinus*).

The vaquita is relatively new to formal science. It was first described in 1958. The species is endemic to a tiny portion of the northern Gulf of California in Mexico. Among the earliest known photos of the vaquita was of four individuals incidentally killed in a gillnet (Figure 7).

We in NOAA were involved in research on vaquitas with Mexican colleagues from the late 1980s, including conducting a series of visual surveys and estimations of abundance (Barlow et al., 1997). The uncertainty around these point estimates was typically high, but Bayesian methods indicated an 89% probability of decline between 1997 (n = 567 vaquitas; 95% confidence intervals 177, 1,073) and 2008 (n = 245 vaquitas; 95% confidence intervals 68, 884; Gerrodette et al., 2011). The obvious cause of the decline was bycatch. Documented since the 1950s, by 2008,

Figure 7. One of the earliest known photographs of vaquitas (*Phocoena sinus*). All four of these animals were incidentally entangled and killed in a gillnet. Note the fetal folds on the smallest animal, indicating that it was a newborn calf. (Photo courtesy of Alejandro Robles)

when I was Director of the Marine Mammal and Turtle Research Division (and immediately following the extinction of the Yangtze River dolphin [*Lipotes vexillifer*], which had a profound effect on me and so many others in my profession; Turvey et al., 2007), the vaquita was the most critically endangered marine mammal in the world. In addition to abundance estimation, we collaborated on a series of projects focused on competition with fisheries, inbreeding depression, habitat degradation, and pollutants (Rojas-Bracho & Taylor, 1999; Taylor & Rojas-Bracho, 1999). None of these were found to be significant threats, prompting this strong recommendation, in collaboration with our Mexican colleagues:

> We further conclude that more surveys or estimates of bycatch mortality will not provide useful information needed for the conservation of this critically endangered species. Instead, resources would be better invested in a comprehensive program to eliminate entangling nets from the range of the vaquita through a buyout program or other system of compensation to affected fishing communities. (Jaramillo-Legorreta et al., 2007)

There followed a series of headlines in the news. In 2013, an illegal trade in fish bladders was uncovered. Vaquita bycatch in that fishery was high. The black-market price of these bladders was so extraordinary that Mexican drug cartels became involved. Two years later, Mexico's president announced a new vaquita refuge and funds for a new abundance survey. That survey estimated that 60 vaquitas were all that remained (Jaramillo-Legorreta et al., 2019).

In 2017, an unprecedented project spun up. Vaquita CPR (Conservation, Protection, Recovery) was a multinational, multidisciplinary effort with a goal of capturing the last remaining vaquitas and placing them in semi-captivity to buy more time to address the bycatch problem

(Rojas-Bracho et al., 2019). We were an integral part of Vaquita CPR. Incredibly, we were able to capture a juvenile animal (Figure 8), but it exhibited extreme stress after just a few hours so we had to release it back at the capture site. Our second capture was an adult female. She died from capture myopathy in less than 24 hours, and we had to stand down. The following year, the abundance estimate totaled less than 19 animals (Jaramillo-Legorreta et al., 2019).

It was during this time that Sea Shepherd Conservation Society (SSCS), a nongovernmental organization, perhaps best known then for placing zodiacs and their crews between Japanese scientific whaling vessels and their target whales in Antarctic waters, spun up an effort with a different focus. "Operation Milagro" placed vessels in the core of the known vaquita range where gillnets were illegal and dragged the water column, removing and destroying fishing gear. They did this at great personal risk; and in a conflict between an SSCS vessel and a local fishing panga, one fisher was killed. At this writing, Operation Milagro is still in effect, though the focus has shifted to science support, including providing funding and a vessel for the most recent vaquita surveys of which I have been a part. It's an odd and extraordinary partnership, one that has changed the face of conservation science.

The Mexican Navy has also played a quiet but critical role by placing a grid of gillnet-deterrent structures inside the Zero Tolerance Area (where gillnets are illegal) in 2022. Each of 193 m^2 concrete blocks are embedded with two 3.5-m-tall iron rebar hooks protruding from the top that have proven extremely effective in entangling gillnets as they drift by. Many of us believe that these blocks, and ongoing efforts by SSCS, are the only things standing between the vaquita in its tiny core range and extinction.

My experiences with vaquitas strengthened lessons I had already learned about the devastatingly profound impacts of indirect anthropogenic activity. Vaquitas also taught me how ineffective science can be in hyperpolarized situations, especially if those most directly involved are left out of discussions pertaining to solutions. And finally, vaquitas taught me about the challenges and the consequences of choosing between truth to self and blind faith in the system. More on that below.

High Risk/High Reward

In 1955, a mass stranding of killer whales (*Orcinus orca*) was recorded in New Zealand (reviewed in Pitman et al., 2011). Mass strandings are always newsworthy (and distressing) events. This one was particularly significant

Figure 8. A vaquita calf live-captured as part of Vaquita CPR, a multinational effort to save the species from extinction (Photo courtesy of the Mexican Secretary of Environment and Natural Resources)

because the killer whales were so peculiar. They had tiny eye patches and oddly shaped dorsal fins and heads. Because killer whales live in matrilineally related groups their entire lives, these oddities were attributed to a genetic defect. Then, in 2004, almost 50 years later, a school of 10 killer whales photographed on the other side of the planet showed the same distinctive features; and in 2011, a paper was published based on seven sightings all around the Antarctic continent that established Type D as a distinct ecotype (Pitman et al., 2011). In January 2019, I joined five other scientists from four countries and a crew of three aboard the 24-m charter research vessel *Australis* to find Type D killer whales and collect a biopsy sample to resolve its species status through genetics (Figure 9).

Our destination was the subantarctic waters south of the Drake Passage. These latitudes in the Southern Hemisphere, the "roaring 40s and furious 50s," are widely considered among the most inhospitable of the world's oceans because of the high winds and heavy seas that build as they circle around the globe, ringing the Antarctic continent to the south (Figure 10). We had funding for three weeks of research from an anonymous philanthropist, and most of that time was spent at anchor, hiding behind a tiny islet south of Tierra del Fuego in 50 knot winds.

Finally, we bashed our way east for 18 hours in hopes of catching a six-hour weather window. We got it at 6:00 AM the next morning. And astonishingly, there they were—Type D killer whales. Remarkably, they approached our vessel (and in retrospect, we realized this behavior was likely because they regularly depredate longliners in that area), and we were treated to amazing looks, collecting photographs (Figure 11), video, and three biopsy samples. The latter formed the basis for a paper documenting the distinct genetic makeup of the Type D killer whale, which is almost certain to be described as a new species (Foote et al., 2023).

One week after I returned from that expedition, I interviewed for the position of Director of the Marine Mammal Institute at Oregon State University (OSU). It was a huge risk for me to leave NOAA, my professional home for my entire career (and my personal home for 35 years). My work was immensely fulfilling. I believed deeply in NOAA's mission and mandates. I respected and admired the people I worked with; the leadership team I cultivated was among the best collection of applied marine mammal and turtle scientists in one location on the planet. I spent considerable time on my weekends and evenings with my job because of this passion. I expected to spend the duration of my career right where I was. And yet, I was increasingly aware that I had more to give than that position allowed. So, on the heels of the exceedingly high-risk nature of our Type D killer whale expedition, and the high reward outcome that resulted, I accepted the offer from OSU and moved my career and my small family from the federal government and San Diego to academia and coastal Oregon.

Figure 9. Our research team and crew aboard *Australis* in Antarctic waters (Photo courtesy of Jared Towers)

Figure 10. Habitat of Type D killer whale (Photo courtesy of Jared Towers)

The five years I have been with OSU have been a career high for me. They have given me the chance to build a center of excellence in marine mammal science, to initiate new programs and policies designed to facilitate success of the best in the field, to develop new courses with trans-disciplinary elements to train the next generation of professionals, and to maximize my impact in what I now know I love to do best—be a force multiplier.

My previous lessons about the impact of science in a vacuum, the role of advocacy in science, and truth to self have been reinforced. And I've learned a few more things—about government vs. academia, publishing, and stress.

A Career's Worth of Lessons Learned

My career is, I hope, far from complete. But here are the lessons I have learned to date. They form advice for a young Lisa were I to have had the chance to receive it at the beginning of my scientific journey:

- *Master's degrees* – Among the best decisions I have made was to learn how to *do* science before the expectation of significantly contributing to science. If you are seeking an advanced degree and have the privilege (time and resources), invest in a master's degree.

- *Advisors* – Aside from your own motivation and capabilities, your advisor is the most important ingredient for graduate success (and much more important than the pedigree of a university). Spend time researching your options. Choose as though your career success depends on it. (And if you are pursuing a career not dependent on a graduate degree, make it a priority to look for mentors. We are out here. We want to help you.)

- *Feedback* – This is (and should be) an inherent part of science. But it is not always given constructively. Do not let harsh feedback destroy you; spin it to your advantage. Use every bit of feedback to improve your ideas, your products, and your approach.

- *Excellence* – Know that not all extraordinary scientists are extraordinary people. Be prepared to meet this truth. Search for and surround yourself with individuals who are both. They are out there.

Figure 11. Type D killer whales in the Southern Ocean (Photo courtesy of R. Wellard)

- *Serendipity and networking* – Of course you must have talent and back it up with accomplishments to succeed. But building and maintaining your networks will bring opportunities through serendipitous encounters that may change your life.

- *The Anthropocene* – It is tempting to wish we could exclude humans from the oceans to solve problems associated with anthropogenic impacts, but practically, this is impossible. To restore ocean ecosystems, we must embrace the humans that depend on them. We must include all stakeholders in efforts to find solutions toward sustainable use.

- *Impact* – In the face of what often feels like overwhelming problems, focus on the small wins and what you can do in your own sphere of influence to make the world a better place. Small wins add up.

- *Advocacy* – Is it ok for a scientist to be an advocate? I have thought about this question since I was in graduate school, and I still do not have a clear answer for myself. What is clear to me, however, is that as the world is increasingly changed by anthropogenic activities, scientists are often the most informed advocates.

- *Be true to yourself but beware* – Speaking truth to power can be costly.

- *Government, academia, and nonprofit organizations* – The ingredients for scientific and operational excellence are the same for all three: a "How can we make this happen?" approach, a core focus on innovation, and a willingness to take risks. Seek out institutions with people in positions of authority who espouse these qualities; they are the world's true leaders.

- *Publish. Now.* – Science is a process, a never-ending search for pattern and truth in an always evolving environment. Make your work a part of that process.

- *Stress* – So much of stress is about attitude. Learn to control it. We are so privileged to be in this field. Enjoy the ride.

And more personally:

- *Work–life balance* – It is critical not to work yourself to the point of burnout. But if your career is your personal passion, and your partner is your colleague, the line between work–life balance is fat and a thousand shades of gray. For me, living my passion through my work has been a dream come true.

- *Privilege* – The world is full of inequity that has mostly to do with luck. If you are lucky to be born with privilege, as I was, realize that it comes with responsibility. Use it wisely; share it. You will make the world a better place.

- *On being a female scientist* – I've written elsewhere about some of the trials I have been through in this context (Ballance, 2020), so I will not repeat those experiences here. I will mention choices, particularly in the context of having children. Truly, no one can have it all. Be prepared to choose between competing priorities. And be at peace with your choices.

- *Confidence* – Combine it with humility but have confidence. Believe in yourself.

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