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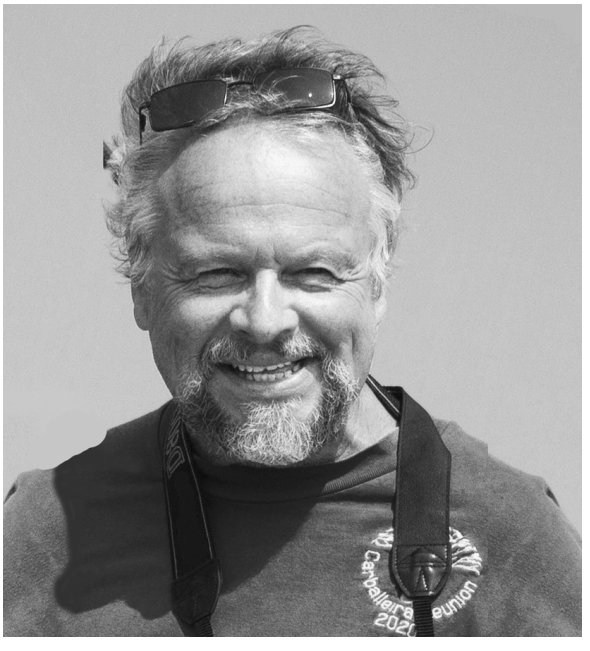
Historical Perspectives

Bernd Würsig

(Born 1948)

Bernd Würsig has degrees from Ohio State University (B.S., 1971) and Stony Brook University (Ph.D., 1978); spent two years as a National Institutes of Health and two subsequent ones as a National Science Foundation postdoctoral fellow at University of California Santa Cruz (1978-1981); and spent eight years going through the professor ranks at Moss Landing Marine Laboratories (1981-1989). He came to Texas A&M University in summer 1989, and is now Regents and University Distinguished Professor (Emeritus since November 2016). He has taught courses in Marine Bird and Mammal Biology, Marine Vertebrates, Bio-Statistics, Behavioral Ecology of Cetaceans, Evolutionary Biology, and Study Abroad courses in Spain, Mexico, Greece, and New Zealand. Würsig has published 190 peer-reviewed papers, book chapters, and seven books; he has been senior advisor to more than 60 graduate students; and he has made 14 movies on nature interpretation. He was nominated for an Academy Award for an IMAX movie on dolphins. He, his students, and postdocs have studied marine mammal and sea bird foraging, sexual behavior, and social ecology on all continents; and he is presently working on the social strategies of dusky dolphins in New Zealand and Indo-Pacific humpback dolphins in Hong Kong. Recent books are *Dusky Dolphins; Master Acrobats off Different Shores* (with Melany Würsig, 2010) and *Encyclopedia of Marine Mammals*, 3rd ed. (Senior Editor, 2018), both with Elsevier Academic Press. He and his wife Melany enjoy their gardens in New Zealand, the Arizona desert, and coastal south Texas—three marvelously different biomes.



Bernd Würsig, Galaxidi, Greece, 2014 (Photo by Silvia Bonizzoni, with permission)

Shoulders

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Abstract

There were several wonderful figurative shoulders that lent inspiring views to my life. A select few belong to, in order of appearance, my papa Gerhard Würsig, Roy Tassava of Ohio State University, Charlie Walcott of Cornell University, Roger Payne then of Rockefeller University, and Ken Norris of University of California Santa Cruz. The shoulder that has been ever-present these past 50 years is that of my wife, Melany Carballeira Würsig. I thank them all. For you readers who may be in your approaching twilight years, I suspect you have similar mentors on whose shoulders you have relied for your own successes. If you are yet young (you lucky devils!), you will appreciate those shoulders ever more as time progresses all too rapidly. Let us now hope that the persons we have relied on will engender ever more shoulders to be relied on, of each gender, race, background, and belief relative to what culture, science, education, and philosophies of humanity may have to offer.

Early Life

People with apparently rewarding jobs tend to be asked, "How did you first get into this?" or some such. It is a good question, for thinking about it may lead the one questioned into a short path of self-discovery, and could even generate, I suppose, a broader insight to what early influences towards specific careers may best lead to formative experiences and—perhaps—lifelong ways (there may be at least one M.S. or Ph.D. thesis/dissertation out there with such questions linked to professions with a decent sample size). I've been asked this question of early influence through the years, and my standard (and honest) answers have been along the lines of "First, reading the popular works of Hans and Lotte Haas (Haas, 1954) and, second, Jacques Cousteau, for a love of marine biology (Cousteau & Dumas, 1953); and after that, John C. Lilly for an early—albeit misguided (Würsig, 1979a)—belief of high dolphin intelligence (Lilly, 1961)." I was a bit younger than 10 for the Haas/Cousteau marine biology influence and a bit older than that for the dolphin one. It was only in the later teens that I read the lovely anthology that showed that *science* could be afoot in a love of whales and dolphins (Norris, 1966).

Someone recently asked this question of personal career formation, and I reflected a bit more. A love of nature came first, as it probably does for most (all?) field biologists. In those early formative years in the 1950s, Mama, Papa, brothers Klaus and Gerd, and I lived in a small green shack adjacent to a forest in a village (Stedden) not far from the beautiful medieval city of Celle in Lower Saxony, northern Germany (https://en.wikipedia.org/wiki/Celle). We had a hand pump for well water in front of the cabin and an "outhouse" bathroom in the farmer's barn (Figure 1). When Mel and I visited

Figure 1. Bernd Würsig (in middle), with cousin Peter and brother Gerd (left and right), 1953 (Photographer unknown; use courtesy of Würsig family)

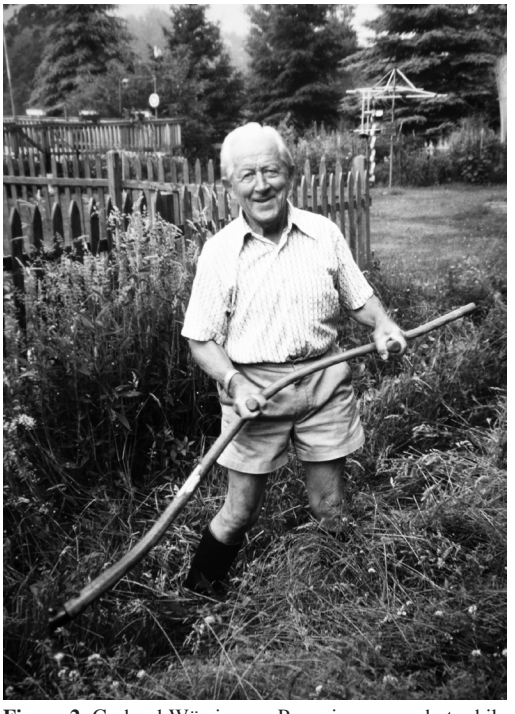

Figure 2. Gerhard Würsig, my Papa, in cameo shot while mowing lawn on his Pennsylvania land with an old-style hand-scythe, 2001 (Photo courtesy of B. Würsig)

the village 13 years after the Würsigs left, the cabin had been converted to an auto garage, and the old Mercedes Benz in it barely fit. My parents and Klaus (the "before the war" child) came to western Germany as refugees from that part of former Germany—a part of Silesia (Schlesien)—whose borders were shifted into Poland after the Second World War (https://en.wikipedia.org/wiki/Silesian_German). They had lost land, their home, and possessions back there, and faced the need to start anew in middle age. We received coveted "green cards" of immigrant status to the United States in 1956 under a family refugee visa, and we moved to Ohio that summer (https://en.wikipedia.org/wiki/Bernd_Würsig). It was a wonderful—magical, really—transition, but never mind all that for now.

While still in Germany, the family used to take walks in the woods behind the cabin—favorite memories of childhood—and one day one of us brothers (it might have been me, the most nervously rambunctious; never far from trouble) thoughtlessly bent a maybe 2-m-long and 1.5-cm-thick limb from a small deciduous tree, swinging from it perhaps (I fancy it may have been a European ash [*Fraxinus excelsior*]), and snapped it off. I can still hear the snap, and Papa gently scolding whoever did the dirty deed. He went home and got a paring knife and length of twine, took us back to that tree, and after cleaning the jagged edges, showed us how to bind (or graft) the limb back onto the tree just so—with cambium of tree stock and broken limb tightly touching—to give it a chance to regrow onto the tree. No tree salve; no fancy explanations. I did not know the word *cambium* but did learn that a tree is a living entity to be honored. We visited that wounded life numerous times in the next months (for a year or so), and finally Papa took the string bandage off to show us a healthy regrown limb with a knobby callus, the response of healing around the grievous wound. He was not schooled in biology or grafting, and I never asked how he knew what to do. I was (and am still) in awe (Figure 2). It may have been that event and deed that helped to engender a deep, lifelong respect for nature; and respect and love tend to go hand-in-hand. So, perhaps a life as a biologist was sealed before the age of 7, but who knows?

I'd best get to the science part (or bore us all to death) but have one more tangential comment: It is an ancient canard, perhaps earliest stated by Bernard of Chartres (https://en.wikipedia.org/wiki/Bernard_of_Chartres; MacGarry, 1955) that "We stand on the shoulders of giants," and this is often (somewhat) true, but I'd like to change that to "We stand on the shoulders of others." We can at times see far only because we are seeing a bit further than those before us, and so it goes. OK, so Papa allowed a glimpse into the window of nature (and Mama was also cool; no further detail here), but it seems that along every step of the way of life's trajectory, we are confronted with the (happy) realization that we could perhaps see a little bit further only because someone lent their shoulders for that added bit of height, that glimpse of new wisdom as it were. For a related analogy, we might think of science as building a wall, with each of us lucky to add another brick or two to what has already been built and by whom. It is only when we get to the greats, Ptolemy (https://en.wikipedia.org/wiki/Ptolemy), Jing Fang (https://en.wikipedia.org/wiki/Jing_Fang), ibn al-Haytham (https://en.wikipedia.org/wiki/Ibn_al-Haytham), Isaac Newton (https://en.wikipedia.org/wiki/Isaac_Newton), Charles Darwin (https://en.wikipedia.org/wiki/Charles_Darwin), Albert Einstein (https://en.wikipedia.org/wiki/Albert_Einstein), and many more come to mind, that an entire new wall (or at least new façade!) may be added. OK, OK, the wall building analogy has come to some question (Crandall & Sherman, 2016), and perhaps a better analogy of proper progression of science is the solving of a puzzle, or of inter-related puzzles (Tullett & Vazire, 2018). I stick with the wall idea but also emphasize that this is not a wall built to keep others

out (as seems all the rage these days); it is a wall that is part of a house of understanding and can also be thought of as a rather wide bridge leading to the wisdom of accumulated knowledge.

Each of the great scientists and philosophers mentioned above would probably aver that they also stood on the shoulders of others, and we know that at least Isaac Newton ("If I have seen further, it is by standing on the shoulders of giants"; https://discover.hsp.org/Record/dc-9792/Description#tabnav), Charles Darwin (1887), and Albert Einstein (Buchwald, 2015, as an example), three "recent" western thinkers, expressed this in their writings. But back to the run-of-the mill scientists, i.e., me: It was due to so many past (by reading about them) and direct (by them being role models) connections to wonderful people that made any "successes" in science that I may have had possible. This expression is not one of these "I am being humble" moments—it is a true reflection of life, probably felt by most of you. There is no such person as a "self-made" woman or man; whether we appreciate it or not in real time, we all need and accept help (or help us!).

The single most influential person in my life, who lent her shoulders oh so many times, and graciously continues to do so today, is Melany Anne Carballeira Würsig (Figure 3). "Oh no!" you might say. "Not another 'my soulmate and muse' story!?" You would be correct—that genre has been worked to death, and I am loathe to hear another colleague attribute his or her life's fortunes to "their soulmate/muse." Enough already with muses. We met as server (Mel) and cook (Bernd) at the Cedar Point resort on Lake Erie in Ohio in the summer of 1978 (and recently travelled back there for our 50th year celebration of that fateful meeting), and she showed then, and shows now, that she understands me, respects me, but knows well when to reign me in and when to lend a supporting mind or hand. Not only did she support the two of us financially through those meager hand-to-mouth years of being a grad and post-doc student (she was first and foremost a most efficient and kind attentive waitress, then insurance claims adjuster, then food server again, then realtor, then grade school teacher), but she was always a curious, excited, eager, dedicated partner for my final years of undergrad school in Ohio; grad school on Long Island, New York, and fieldwork in Argentina; post-doc in California and Hawai'i; going through professor ranks from assistant to full at Moss Landing Marine Laboratories; and becoming a field associate after Patagonia and Hawai'i in central China, the Canadian Arctic, Russia, the Peruvian Amazon, Gulf of Mexico, and—above all—the south Island of New Zealand. Woof (Würsig, 1999)!

Without Mel, I probably would be "a nothing"; maybe still a reasonably functioning human being (*Homo sapiens*), but certainly not as a successful (or unsuccessful, as the case might be) scientist. So, the "soulmate" and "muse" labels fit this once, and be damned the triteness of the designations. We published about a dozen science papers and two books together (Norris et al., 1994b; Würsig & Würsig, 2010)—she without a degree in biology but an M.S. in science of reading. Always transcribing, collating, tabulating, questioning, thinking ahead, suggesting this or that collaborator, incorporating ideas from other realms, and, oh yes, keeping the finance books. Kind criticism and gentle but firm guidance. Muse.

At Ohio State University in the late 1960s was a wonderful zoology professor, Roy A. Tassava (Figure 4). I was an inexperienced upper-level undergrad who somehow had managed to finagle an "honor's stipend" to study anything in Zoology that I wanted to study, and I chose Roy Tassava's amazing RNA/DNA limb regeneration lab. Or maybe he chose me; I'm hazy on this. At any rate, this was the first time I was immersed in *real science* and got to collect eastern newts (*Notopthalmus triturus viridescens*) with hip boots and nets in the Hocking Hills of southeast Ohio; put the little critters in a freezer; and at the right time, warm them up to do dastardly limb regeneration

Figure 3. Melany Carballeira Würsig, surfacing from a dive in Hawai'i, 1979 (Photo courtesy of B. Würsig)

experiments to study RNA-type incorporation into their blastemal new limbs. This was exciting novel research and is one of those things that led to our understanding of developmental and regeneration chromosomal biology. Roy was one of the pioneers (Tassava et al., 1974; Christensen et al., 2002). He was the perfect mentor—maybe only 10 or so years older than I yet more wise and experienced, gently explaining and re-explaining, showing how to cut a limb, store it in liquid nitrogen, prepare the gel, run it, read it, analyze it, think, write. After about 6 months with him, he offered a fully paid, 4-year National Institutes of Health (NIH) career doctorate, and I declined—not because of the exciting science but because of the mostly lab component. I simply could not see myself in a lab for the rest of my life (a personal failure, I know). He was a bit hurt maybe, and it is a regret having hurt this fine mentor. He got me started in science. Thank you, Dr. Tassava!

In that academic senior year (1970-1971), I was rejected from graduate education by plenty of schools (take note those of you young-uns reading this; you NEED to select an advisor, and she or he needs to accept you before applying to that school where that potential advisor works!). There (finally) came an acceptance letter from Stony Brook University to their wonderful (but short-lived) interdisciplinary program where we had advisors from the schools of Marine Sciences, Ecology and Evolution, and Neurobiology and Behavior. As an aside, while that experiment at Stony Brook did not last, perhaps due to lack of coordination/communication among entities, 38 years later I was fortunate to be the inaugural chair of an interdisciplinary program in Marine Biology at three campuses of Texas A&M University that HAS survived these past 10 years and is thriving (www.tamug.edu/marb/Graduate). It can work; it just needs will and the hard work of communication and integration (and the will and capability to find funds).

There were many wonderful potential mentors at Stony Brook, but the most amazing ones were the evolutionary thinkers George Williams (https://en.wikipedia.org/wiki/George_C._Williams_(biologist) and Larry Slobodkin (https://en.wikipedia.org/wiki/Lawrence_B._Slobodkin) in Ecology and Evolution, both now deceased; and Charles "Charlie" Walcott, a most amazing scientist and human being (http://nbb.cornell.edu/charles-walcott), in Neurobiology and Behavior (Figure 5). It was Charlie who took me on as a young Ph.D. student and sent Mel and me to work with Roger Payne on right whales (*Eubalaena australis*) in southern Argentina.

Charlie taught numerous grad students how to properly solder electronics to make simple

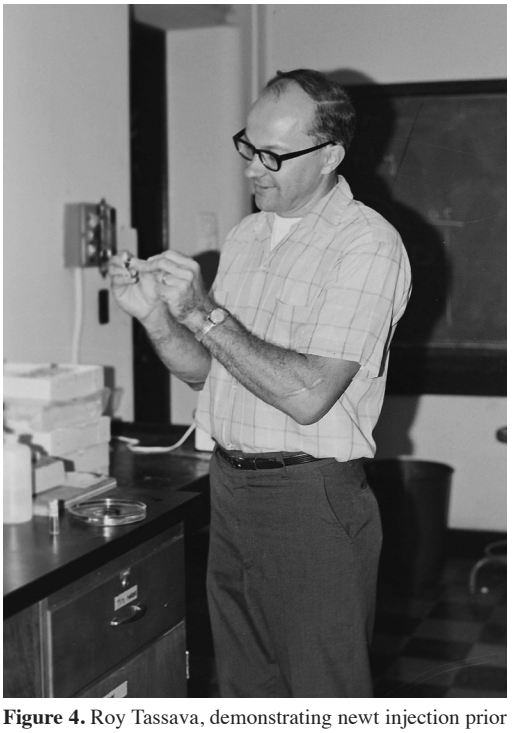

Figure 4. Roy Tassava, demonstrating newt injection prior to MRNA experiment, 1968 (Photo courtesy of B. Würsig)

Figure 5. Charlie Walcott, tracking pigeons with a directional radio antenna, 1972 (Photo courtesy of B. Würsig)

but effective small radio transmitters for homing pigeons (*Columba livia domestica*) to study how they might find their way back to the loft (Walcott & Green, 1974). It turns out pigeons have a large assortment of sensory tricks available, including sense of smell, visual directional cues, magnetic compass and map capabilities, and a prodigious memory for such a small bird brain (Walcott, 1996). Charlie taught some of us to build our own "Heathkit" radios (he made me build the "ham" radio receiver/transmitter I used to communicate with him once per week when Mel and I were ensconced in southern Argentina); to become a licensed radio operator (back in the 1970s we needed to receive and transmit Morse Code at a minimum of 13 words per minute for that license); and to dream to follow in his footsteps in becoming an airplane pilot, which he is, and which I emulated a few years after meeting him. As he had used his airplane piloting skills to study bird navigation, I then used mine to help track and behaviorally describe bowhead whales, but that saga is for another time.

Above all, Charlie imbued us with a sense of what it is to be a scientist—somebody who enjoys nature, is willing to explore the at-times scary unknown, and can at the same time remain grounded in the realities of grubbing for funds with another research grant application, meeting those grant writing and university obligations and grad student degree edits in a somewhat timely manner, and trying to keep a level head (somewhat "above water") and hopefully a decent sense of humor at the same time. Charlie excelled in all of these and thrived; we mere mortals simply survived. He went on to do ground-breaking work in other biological behavior realms, including the study of common loon (*Gavia immer*) calls (Walcott et al., 1999). Years after working with Charlie, Mel and I dedicated a book to him (Würsig & Würsig, 2010), a tiny thank you for leading us to a life of science, adventure, fun, and fulfillment. Charlie is (among other duties) Professor Emeritus, University Marshall, and University Ombudsman at Cornell University, where he received his Ph.D. 60 years before. As a scientific hobby, he makes instructional videos that beautifully illustrate research at Cornell University, available to all and at no cost on his website (http://nbb.cornell.edu/charles-walcott).

Charlie introduced us to another "giant shoulder," and this was the amazing Roger S. Payne (Figure 6). In 1972, Roger was an adjunct professor at Rockefeller University (in the lab of Donald R. Griffin, the "Father of the American School of Behavior," discoverer of bat echolocation, describer of bird songs, and the man who in later years of his life exhorted us to crack open a window of potential understanding of the minds of non-human animals [https://en.wikipedia.org/wiki/Donald_Griffin]). Roger had carried out his bachelor's degree at Harvard and his Ph.D. at Cornell. Among other findings, he described the amazingly acute directional hearing of barn owls (*Tyto alba*) that allows for precise localization of prey (Payne, 1971). In the 1960s, he and Scott McVay first discovered the complex songs of male humpback whales (*Megaptera novaeangliae*) and a bit later wrote this up in one of the most logical, clear expositions we have in biological science (Payne & McVay, 1971); and Payne and colleague Douglas Webb hypothesized (correctly, it turns out) that the infrasonic sounds (below our level of hearing; i.e., below 20 Hz) of fin and blue whales (*Balaenoptera physalus* and *B. musculus*, respectively) could signal and be heard by conspecifics for many hundreds of kilometers, across deep ocean basins (Payne & Webb, 1971). In that year, Roger and his then wife Katharine ("Katy") Payne also started the longest running study of whales, the southern right whales of Patagonia, Argentina, still going to this day. If you noted the year date (above) when several of these seminal ground-breaking papers came out, you might say (and you would be correct if you did) that 1971 was a good year for Roger Payne. Because of Roger's publications, it was a good year for behavioral and marine mammal biology as well, and for the laying of numerous, solid, well-founded bricks in the wall of behavioral science.

Somewhat tangential (as I tend towards), Katy Payne was apparently (as described by both Roger and Katy, pers. comm., October 1973, by both; interviewed separately) the first to discern the "music" in the sounds of humpback whales that allowed for that 1971 publication on song. And, years later, she was one of the major discoverers and describers of infrasound communication in elephants (Payne et al., 1986; Payne, 1998). It turns out that both African (*Loxodonta* sp.) and Asian (*Elephas maximus*) elephants use infrasound to

Figure 6. Roger Payne communing with southern elephant seal pup, 1972 (Photo courtesy of B. Würsig)

"rumble" communicate over several kilometers distance, quite separately evolved from the infrasound of those other behemoths in the ocean, the blue and fin whales that Roger described some years earlier. Katy provided another shoulder from which to see communication; she provided several more bricks in that wall.

Roger Payne went on to champion much of the beginning fieldwork on whales by advising a cadre of graduate students who have become "famous" for cetacean work in their own right. Chris Clark studied right whale acoustics (more about this fine scientist a bit later) and—among other groundbreaking work—bowhead whale (*Balaena mysticetus*) acoustics (Clark & Johnson, 1984; Würsig & Clark, 1993). He is now Professor Emeritus at Cornell University. Sara Taber and Peter Thomas studied right whale calf development (Taber & Thomas, 1982). Peter went on to (presently) lead the U.S. Marine Mammal Commission as Executive Director after a distinguished career championing multiple coral reef and other conservation initiatives (see also Thomas et al., 2015). Sara Taber wrote a sublime book on living in the field (the *campo*) in Argentina, with descriptions of lovely nature and the human inhabitants of this barren-seeming—but teeming with plant and animal life—beautiful land (Taber, 1992). Peter Tyack started as our field assistant in Argentina while at Harvard University, and then he did his Ph.D. on insightful acoustics/behavioral work with humpback whales in Hawai'i (Tyack, 1983); he is a professor at St Andrews University in Scotland (after having spent most of his life at Woods Hole Research Institute) and is one of our foremost thinkers of marine mammal sound, ocean noise, and conservation. He has a wonderfully informative TED talk accessible for viewing (https://www.youtube.com/watch?v=mKe3QKcta-8). There are many more such fine colleagues whose early influence was Roger. Do forgive me for not mentioning all.

Roger Payne is also probably the most influential scientist on Earth to have stopped large-scale factory ship whaling during the 1980s. To help engender an urge for ocean conservation and cessation of whaling, he used the power of his voice and his excellent cello playing capabilities to duet with the recorded songs of humpback whales and infrasounds of fin and blue whales in huge auditoriums, as well as the popularity of his records of humpback whale song. (There is even a bit of that recording included on *Sounds of Earth* sent out on a gold-plated LP record placed aboard Voyager 1 that may or not be found by others far from Earth and years from now.) He is still active, still attending and hosting conservation conferences as president of his nonprofit organization Ocean Alliance, and still leading expeditions in oceans and gulfs worldwide to document macro and micro pollution (https://en.wikipedia.org/wiki/Roger_Payne). A life well spent.

Charlie recommended Mel and me to work in the field with Roger and Katy. They interviewed us in a lovely old-style barn ("The Payne Lab") behind their house in the Lincoln, Massachusetts, woods just south of Concord, and a few days later we were given the go-ahead to join this august team. I am rather convinced that the only reason "I" got the job of being a boat operator and diving assistant (both weak qualifications) was because Melany spoke impeccable Spanish, having grown up in Venezuela and Colombia (of U.S. citizen parents) and could help navigate Argentina's bureaucracy with that skill, as well as teach the Payne kids (four of them; all now successful adults) in Spanish but also as a day-to-day home-schooler for math and English and such. So, the "I" was really the package of a team. Thank you, Mel.

It was austral spring 1972 when Mel and the Paynes left for Patagonia (I joined them a few weeks later), a lovely dry windswept land with plenty of domestic sheep (*Ovis aries*) and fewer but still numerous lowland llamas, the guanaco (*Lama guanicoe*); the second largest rodent on Earth, the Patagonian cavy or mara (*Dolichotis patagonum*); a small underground mouse-like burrower, the tuco-tuco (genus *Ctenomys*); the poisonous Patagonian lancehead pit-viper, with the lovely Spanish name of *yarará ñata* (*Bothrops ammodytoides*); black-browed albatross (*Thalassarche melanophris*) and giant black petrels (*Macronectes giganteus*) sailing the shore-lining cliffs (or *barrancas* in Argentine Spanish); South American sea lions (*Otaria byronia*); the ubiquitous but difficult to find and track Burmeister's porpoises (*Phocoena spinipinnis*); dusky dolphins (*Lagenorhynchus obscurus*) and common bottlenose dolphins (*Tursiops truncatus*); and majestic killer whales (*Orcinus orca*) cruising past the *barrancas* (and scaring the bejeebers out of right whales, sea lions, and dolphins). Harris (1998) provides a beautiful guide to the birds and mammals of this realm. We newcomers were enthralled and realized why the Paynes had fallen in love with the shores of Patagonia during their trip there the year before.

From Roger and Katy, we learned how to recognize the distinctive v-shaped blow and broad black back of right whales, how to get to know individuals of these huge animals by their distinctive head-borne keratin patterns called callosities (only right whales, the genus *Eubalaena*, have them), and how to listen to their underwater moaning/groaning-like sounds (Figure 7). One of Roger's assistants and a lifelong colleague for him and me since, Christopher ("Chris") Willis

Clark and his wife Janie Clark, later described some of the meanings of these sounds by using sophisticated new ways of telling from where an underwater sound comes (Clark & Clark, 1980). We learned to tell whether males were attempting to mate, the distinctive belly-up stance of females making it difficult for the males to gain access, the boisterous mating groups where up to a dozen males compete to mate with a single female (later recognized as a multi-mate or polygynandrous society, where multiple females and males mate during one sexual period, with apparent sperm competition made possible with huge testes sizes; Brownell & Ralls, 1986), how mothers kept their calves out of danger from boisterous males and hungry killer whales, and that different proportions of ages and the two sexes are distributed differently around the shores of the peninsula (Payne, 1983; Rowntree et al., 2001).

At the same time, we learned techniques of study that have stood the test of time, now used by hundreds to thousands of marine mammalogists the world over. We learned how to photograph and thereby photo-identify individual whales (see Payne et al., 1983) with a shore-bound, heavy tripod-mounted lens 1 m long (i.e., 1,000 mm in size!); to plot their movements with a surveyor's transit or theodolite (Roger Payne's first use with marine mammals, now ubiquitous; Würsig et al., 1991; Gailey & Ortega-Ortiz, 2002; Piwetz et al., 2018, this issue; Figure 8); to record their underwater sounds with a modified set of sonobuoys that sent signals back to camp, and even eventually taught us much about whale communication (Clark, 1982); and to take meticulous notes, as in proper Joseph Grinnell style (Herman, 1986), often with hand-held, portable, battery-powered tape recorders that required many hours of transcription into our field data sheets and daily logs. The techniques and results are excellently described in a set of papers edited by Roger (Payne, 1983), and in a captivating book of Roger's early life with whales (Payne, 1995).

Figure 7. Southern right whale surging forwards, showing the head callosity patterns that allow for distinctive individual recognition, 1974 (Photo courtesy of B. Würsig)

Middle Years

While the whales were (and are) inspiring, Mel's and my lives moved inexorably towards the smaller odontocete cetaceans, the porpoises and dolphins of shore-lining Patagonia (blame J. C. Lilly). Besides the occasional (and well-recognized) killer whales (Lopez & Lopez, 1985) that would frighten all marine mammals in the area as they sauntered by, we came to know and study three species: (1) the secretive Burmeister's porpoise on which Mel and I wrote our first-ever scientific paper, with Mel as first author (Würsig et al., 1977); (2) the world-renowned common bottlenose dolphin with which we first realized (due to Roger and Katy Payne) the incredible power of recognizing individuals (Würsig & Würsig, 1977; Würsig, 1978; Wells, 2014; Figure 9); and (3) the small wonderful dusky dolphin, which has become a staple of understanding the manners in which social systems adapt to their environment (Würsig & Würsig, 1980, 2010; Würsig et al., 1989; Pearson et al., 2017).

By being in the right place at the right time, we learned "lots." Burmeister's porpoises are ubiquitous throughout much of the southern part of South America—on both Atlantic and Pacific coasts; they are difficult to study because they surface silently

Figure 8. Roger Payne and Melany Würsig "duel with" two Kern DKM theodolites to inter-calibrate them for increased accuracy, November 1974 (Photo courtesy of B. Würsig)

and are visually unobtrusive. Mel was the only person I know who could reliably and repeatedly sight and track them from shore, and she did so most successfully in calm seas with nary a ripple on the surface. This takes a keen eye and, above all, patience. Recent research has taken advantage of their underwater sounds to find and track them with much more accuracy than we could have dreamed of 45 years ago, with potentially large conservation implications to this at least regionally endangered species (Clay et al., 2018). As a slight but important aside, the closest relative of Burmeister's porpoise is the diminutive Gulf of California harbor porpoise (*Phocoena sinus*), vaquita ("little cow") in Spanish, critically endangered in northern Mexican waters (Jaramillo-Legorreta at al., 2016) due to being caught in set nets for a large scianid fish, the totoaba (*Totoaba macdonaldi*), to satisfy a lucrative Asian market for the erroneously believed health benefits of their swim bladders. Vaquita may be doomed to extinction as I write this mid-2018, and that is sad and unforgivable of the human community. Burmeister's are doing a bit (but not much) better.

From early photo-identification, we learned that bottlenose dolphins have a fission-fusion society, with individuals of groups separating and aggregating on almost hourly bases, depending on how they were feeding and socializing, and perhaps as well due to mere "whims" of societal connections (Würsig, 1978; Gowans et al., 2008). We also learned that at times—and only occasionally—they change social affiliations with animals very far away (Würsig & Würsig, 1977; Würsig, 1978), seen also in spinner dolphins between distant atolls (Karczmarski et al., 2005). It appears that dolphins of a society know each other well and do not need immediate manifestation of physical presence. Instead, they align themselves with other individuals per apparently most efficient numbers and kind for feeding, socializing, sexual aggregations, and taking care of young. A human example might be parents and offspring gathering for breakfast, kids then being totally differently aligned during daytime school, as are also mom and dad for their various activities and jobs, with cohorts of relationship. In the dolphin case, now and then, one society may become "too large" for a particular area, and some individuals split off to join another society. Others may leave the second society and join the first. In this larger scale fission-fusion, we simply do not know how much coercion may be by one set of animals "running off" another one, how social/sexual relations play into this game, and what else may be going on. Reasonable comparisons may be human beings migrating due to habitat depletion (Bates, 2002; Black et al., 2011) because a society becomes too large for individuals to know each other well enough to socially network efficiently (Hill & Dunbar, 2003), or due to being forced out by others as we see all too often even in our modern societies (Wood, 1994; Figure 10).

Dolphins tend to a polygynandrous (multimate) society, where several males mate with several females, and the reverse is also true. Horrors! Females and males mating with more than one mate! Yes, and they do so by the male assiduously attempting to mate with a female by approaching her from below while she is at or near the surface; the surface might be thought of as an unyielding "bed." The female "invariably" (we are not certain this is always true) makes it difficult for the male to penetrate her by gyrating and rolling at the surface, and often rapidly sprinting ahead. Usually, more than one male is involved; and it appears that it is the most agile, perhaps also the most persistent and vigorous, male that eventually gets to mate with the female. Thus, it is likely that the female is choosing "the best" male (i.e., the one who is most healthy and fit, perhaps) in

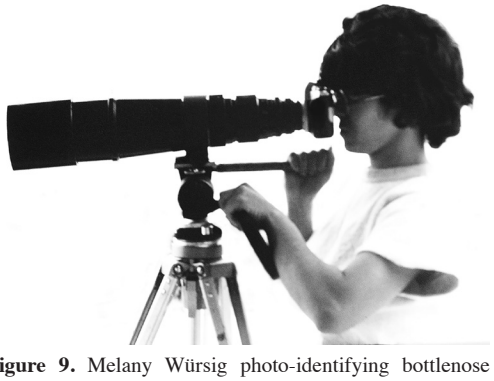

Figure 9. Melany Würsig photo-identifying bottlenose dolphins from shore, with 500 mm lens, strongly backlit by the early morning sun, 1973 (Photo courtesy of B. Würsig)

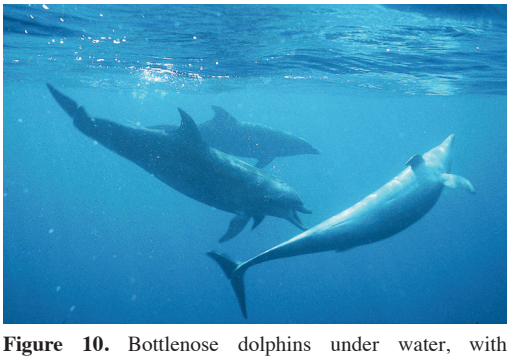

Figure 10. Bottlenose dolphins under water, with aggressive "biting" that probably helps to create distinctive marks in the thin, easily tattered trailing edge of the dorsal fin (Photo courtesy of B. Würsig)

this game of scramble competition (Figure 11). However, we see multiple penetrations by multiple males in one such mating bout, and large testes are at play for favoring a particular paternity; this is sperm competition similar to the right whale case mentioned above (see also Kenagy & Trombulak, 1986). My recent Ph.D. student Dara Orbach described dusky dolphin mating in more detail and put it into context with aspects of evolutionary thought (Orbach et al., 2015b, 2017).

When sexually active, males make a great deal of sperm—each little sperm a potential dolphin if it meets the right egg at the right time—and can inseminate "lots of" females. Females can be inseminated by "lots of" males. Even so, remember that while the male can have multiple paternities in one mating season or year, the female has only one ovulation, one egg, one fetus, and one calf—not just for that one season or year but, since she is putting her all into gestating (about 1 year) and nursing (> 1 year) her calf, only one offspring per two years at a minimum (Cipriano, 1992) and usually longer than this. Thus, females and males have very different reproductive life strategies (and potentials). It makes sense that the males are not choosy and that the females are very much so, perhaps not all that dissimilar from elephant seals (*Mirounga* spp.) where the loud squawking by females being mated with attracts other males to her, and a larger more robust male may be able to displace the original mating attempt (Cox & LeBoeuf, 1977). In mammals that mate in water, the male's success may go to the one who is most maneuverable, not the largest, and therefore we expect to see—and do see—little sexual dimorphism (males and females are pretty much the same size, shape, and color) among these water-mating polygynandrous societies.

Above all, we learned that dusky dolphins have a daily fission-fusion society related to feeding on fish schools—"bait balls"—of southern anchovy (*Engraulis anchoita*). Our radio-tracking studies (Würsig, 1982; Würsig et al., 1989) showed that dusky dolphins can undergo large movements in a few hours to longer times, traversing in one day or two days from the nearshore shallows of < 60 m depth to the (in Argentina offshore by about 200 km) continental slope of 500 to 1,000 m and more of depth, feeding (we later learned) in very different ways in the shallows than in deep oceanic waters.

For the Ph.D. work in Patagonia, Argentina, in the 1970s (Würsig & Würsig, 1980), we caught up with dusky dolphins in the shallows nearshore and saw them (1) resting very close to shore at night, in small groups of 10 or so animals, so with up to about 30 small groups spread out in very shallow water nearshore; (2) one (or two) small groups finding aggregated anchovy prey in early daytime, and other small subgroups coalescing to herd those prey towards the surface; (3) as dolphins coalesced from many small groups, they joined in one large melee of activity that seemed to tighten the fish-ball prey and drive it towards the surface; and (4) after coalescing, at times into a school of up to 300 dolphins, and after having fed, dolphins socialized (with much sex as well), displaying exuberant-seeming acrobatic leaps.

There is a progression of levels and types of activity in bait-ball feeding: the first phase (#1 above) was rather inactive, with the dolphins' eyes largely closed and a small amount of inter-individual sounds. They were traveling in small subgroups of about 10 individuals, surfacing and diving synchronously in shallow waters nearshore. They were heavily resting, what passes for sleep in dolphins (one side of their brain can be shut down in "sleep," and the other side can be moderately active at that time; a good evolutionary trick if you are a voluntary breather who needs to come to the surface to do so). Our radio-tracking studies showed that those small nearshore groups rested the entire night, presumably close to shore to stay away from shark predation and to be able to hide in the surf zone when killer whales came by (Würsig, 1982).

The second phase (#2, above) was marked by individuals of any one of those subgroups initiating "head-first" leaps as dolphins worked to contain prey at some moderate depth (say, 20 m); and then individuals leapt to the surface, overshot the surface, breathed, and used the weight of their bodies to rapidly again take their place in the coordinating society of animals herding fish into a tight ball. In other words, the head-first re-entry leap was designed to breathe and get dolphins back to what was (is) important at the time—herding and feeding. This second phase was marked by subgroups aggregating; and while the leaps are designed to

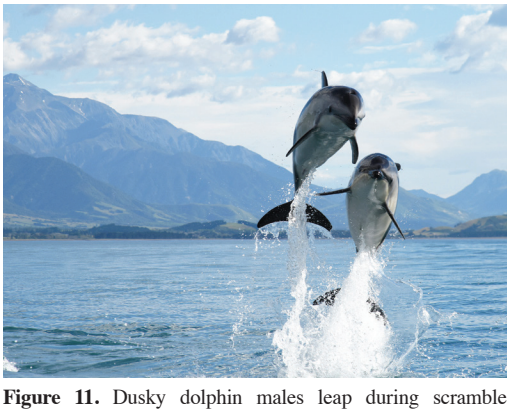

Figure 11. Dusky dolphin males leap during scramble competition for evasive females (Photo courtesy of B. Würsig)

efficiently herd fish deep below, they also attract other subgroups from up to 8 km away. It may even be (this is still a hypothesis) that the leaps are partially designed to attract those other subgroups to the one subgroup that has found food: "Come help us herd." Indeed, we showed statistically that a large number of dolphins (fused subgroups of the previously resting fissioned ones) will engender larger and more bait balls brought to the surface over time until all dolphins of that part of the shoreline (on some days only) are aggregated with about 300 dolphins in bait-ball feeding mode for up to and at times over 2 hours duration in one anchovy-rich spot (Würsig & Würsig, 1980).

The third phase (#3 above) involved the fish ball—tightly balled indeed so that we humans could at times dip our hands into the ball and fill the palm with 10 to 15 small 10-cm-long juvenile anchovy (which seems to indicate that fish were suffering from oxygen depletion, and perhaps sensory overload as well, as they were so tightly balled and constrained). Close to the surface, dolphins from numerous aggregated subgroups tightly wound underneath and to the sides of the ball, and then individual dolphins sliced past the periphery with their mouths close to the fish ball, taking one, sometimes more, prey from this tightly packed clump (Figure 12). This phase was most often attended by surfacing dolphins side, back, and belly slapping with loud percussive rather omnidirectional sounds broadcast in air and under water. The "percussive leap" is probably mainly intended to help frighten fish into a tight ball and perhaps to call other dolphins from nearby groups.

The fourth phase (#4 above) was a bit different and juxtaposed along with the third one for those dolphins that seemed to still need to snack. The fourth phase was one of "exuberance," of dolphins leaping in highly acrobatic forwards or backwards somersaults with twists left or right—spins not quite as amazing as those of spinner dolphins (*Stenella longirostris*) but spins nevertheless. This fourth phase had a "party atmosphere," with much socializing and sex, and the exuberant leaps and rapid swims were probably a part of an expression of "We have coordinated to herd and feed; let us reinforce social bonds" (Würsig & Würsig, 1980). I'm just guessing, but social play (and sex) are important parts of bonding in social mammals (De Waal, 1982, on common chimpanzees [*Pan troglodytes*] is but one of numerous examples), and this guess may not be far off the mark.

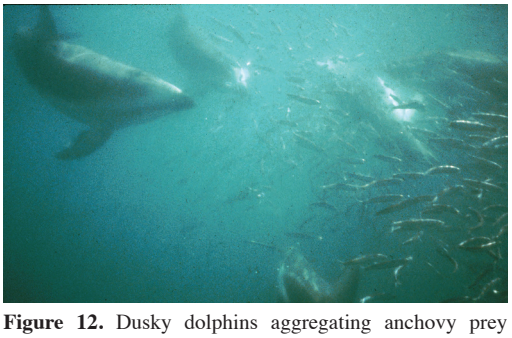

Figure 12. Dusky dolphins aggregating anchovy prey under water (Photo courtesy of B. Würsig)

Our descriptions of the leap sequence—head-first re-entry, then percussive noisy slap, then acrobatic—were statistically significant relative to stages of feeding (Würsig & Würsig, 1980) and facilitate hypotheses of leaps aiding in inter-dolphin communication (i.e., social facilitation) and in prey herding/prey capture. However, leaps not associated with fission-fusion duskies while foraging and feeding on bait balls can have a bewildering array of reasons not yet fully understood. For example, some forward-facing clean leaps are structured to efficiently travel rapidly with in-water propulsions and in-air leaps (Au & Weihs, 1980), while other leaps may help to change the direction of a traveling group (Markowitz et al., 2010a). Coordinated leaps in a small group may represent multiple males jockeying for position to mate with a single female (Orbach et al., 2015a). In spinner dolphins, spins serve at least in part as an important social facilitation mechanism of getting others to join in an elevated group awareness or "awakeness," often related to a group entering a bay in the early morning or leaving it in the late afternoon (Norris et al., 1994a); however, in these and perhaps other dolphins, even acrobatic leaps and spins are at times attempts to dislodge remoras from the leaper. Pearson (2017) and Würsig & Whitehead (2018) provide summaries of some of the known and hypothesized reasons for leaps.

After daytime feeding by many aggregated subgroups that rested individually nearshore the night before, and after the social sexual "party" post-feeding, dolphins again fission into small subgroups and rest nearshore for late evening and night, not at all with the same partners of the previous night (except for mothers and young calves, and perhaps a few other close associates). Again, they do not need physical manifestation of togetherness to function as a social unit. This latter point is quite unlike the human situation mentioned above in which mom, dad, and the kids get back together as the same family unit at night after their different lives during the day. Dolphins—apart from moms and calves and somewhat rare "friends"—are not formed into families.

With Argentine bottlenose dolphin fission-fusion society and dusky dolphin foraging descriptions, we youngsters (Mel and I) "made a mark," and with publications in *Science* (Würsig

& Würsig, 1977, with a cover photo), interviews by the *New York Times* and the *Long Island Post* in that same year, and articles in *Scientific American* (Würsig, 1979a) and the venerable Woods Hole publication, *The Biological Bulletin* (Würsig, 1978), our view of social organization and societal strategies relative to habitat were becoming appreciated. There were doubters, and I was "heckled" at a marine mammal conference in San Diego in 1977, with several researchers expressing that it was impossible to recognize dolphins without freeze-branding or otherwise tagging them, and that our descriptions of fission-fusion societies must be bunk since everybody knows that dolphins live in tight family groups (sigh). Remember, this was in the 1970s, and all we had of scientific field descriptions were the (amazing) insights of humpback whale song as gained not from being in the field but from Navy sonobuoy recordings (Payne & McVay, 1971). We also had tidbits of spinner dolphin sociality (Norris & Dohl, 1980), Michael Bigg's descriptions of the matriarchal societies of killer whales (Bigg, 1982), and Susan H. Shane's separate discovery of photo-identification of dolphins in the mid-1970s during her Master's degree work off Texas (Shane, 1980), which also showed fission-fusion society in dolphins, but none of these new insights were published until later. It is no wonder that there were doubters. Ours was a renaissance of a few humans immersing themselves in the study of cetaceans in nature, and Mel and I are happy that we were a part of it. The discovery was "ordained" by the Zeitgeist of the times, and it would have happened without us dabbling with dolphin research in Argentina. So it goes, and it is lovely to be a part of new and expanding paradigms 48 years later.

The Ph.D. field quest was accomplished. Mel and I said fond farewells to our (dolphin and human) friends in the Patagonian desert of Argentina and promised to come back—for a post-doc and for more work on duskies and bottlenoses. This is a promise we are sorry was not kept. We went to other areas and climes, but the pull of Patagonia and what could have been long-term research projects there are always a wee bit of an ache in my soul.

Nevertheless, let's (virtually) travel back to the Patagonian wilderness again: sitting in a pup tent far from home, at Punta Norte (the northeastern cape) near the famous South American sea lion loberia (or colony) of Península Valdés. It was winter, and I'd been wrestling with the smaller directional adcock loop antenna giving sporadically poor readings of dolphin radio track positions, making it difficult to know when to trust and not trust the positional triangulation data. It was cold and raining, and had been so for several days. Camp rations were almost gone, yet I needed to stay as long as there was a chance to acquire data from the dolphin in radio range. I counted radio bleeps of dolphin surfacings, plotted directional bearings, and felt sorry for myself.

Several years before, I'd become aware of a very great man, a professor at the University of California at Los Angeles, who was then in Hawai'i for extensive studies, and since 1972, at the University of California at Santa Cruz. Kenneth S. Norris had discovered jaw hearing for echolocating bottlenose dolphins (Norris, 1974, presents a delightful account); described nasal plug generation of click, burst-pulse, and whistle phonation (Norris, 1967); and encouraged others to look at intelligence and cognition in a systematic, experimental, and operant (positive) conditioning fashion (Norris & Schilt, 1988). Dr. Norris (I did not know him as "Ken" until quite a few years later) had published a lovely edited book called *Whales, Dolphins, and Porpoises* (Norris, 1966) a few years earlier, and I had one of the original in print versions of this book that was soon out of print. He was my overall greatest "marine mammal hero," and I suppose I wanted to ingratiate myself with him.

So, sitting in that wet pup tent, writing Dr. Norris a letter on thin light blue air-mail paper, I introduced myself, explaining what we had been trying to do with theodolite tracking, photographic recognition, and the latest—radio tracking. I told him what we hoped to be learning and how frustrating it all was. Little money, equipment failures, storms, and road wash-outs. I do not remember the exact verbiage, but I'm sure I tried to brag a bit about what we had learned in the past two years or so, with a generous degree of self-pity included. I sealed the envelope and, in due time a week or two later, mailed it from Puerto Madryn during a food and toilet paper restocking trip from our main camp.

The letter was forgotten among the daily chores of maintaining camp, the daily data gathering when the wind did not blow, and the nightly journal writing to try to keep a written hold of a bit of the newly discovered. But a letter DID come back. Ken Norris, the famous one, had read my somewhat childish ingratiation and words of pity (in retrospect), thought about them, and written the best possible response a striving and unsure beginning student of science could ever wish to receive. He told us how important this kind of diligently gathered new information on dolphins was; how difficult he well knew it was to wrest such things from animals in the field; exhorted us to stay the course; and invited us to visit him in Santa Cruz, California, at any time to share what we'd learned, ask for help relative to analysis and interpretation thoughts, and more.

The return missive came typed on what later —as Ken's post-doc, then colleague and friend —I came

to recognize as a vintage, small field typewriter, with letters askew, up and below an imaginary line, way before word processing and handsome and efficient editing and re-editing. The great Kenneth S. Norris had answered lowly me and had told me that what we were doing was of necessity hard, as these ways had not been cleaved before, but was useful and appreciated in the greater scheme of a new era of field biology. He asked us to keep working in the face of at times adversity and discomfort, to not give up (Figure 13).

A later realization was that this letter so special to Mel and me was not special to Ken in the writing at all. This is the kind of advice he gave to his students and to others each and every day—hunched over the old typewriter—to young and old alike, far and wide, every night into the wee hours when the southern star made its low rise in the south in Kealakekua Bay, Hawai'i; when Orion stood proudly in the top of the sky off Cabo San Lucas, Mexico; at his sheep farm back home, at the edge of the scrub oak and the redwoods where it was difficult to see the stars in the sky for shading by coastal fog and towering trees; and when we searched and found for the first time ever the little beleaguered Gulf of California harbor porpoise, the vaquita (that he discovered for science; Norris & McFarland, 1958) in the upper reaches of the Sea of Cortez (Wells et al., 1981). This is what he did to maintain science and to help to breed a new generation of wide-eyed ones who simply needed some grounding, some guidance, and a few kind words to let them know that an interest in nature and the ways of cetaceans need not be a dead-end road or a ticket to oblivion.

Figure 13. While we have dozens of photos of Kenneth ("Ken") S. Norris "in action" with science, I rather prefer photos of him relaxing, here singing/playing his guitar to a young upcoming scientist on the research vessel *Regina Maris*, January 1979 (Photo courtesy of B. Würsig)

The skies turned sunnier, the winds seemed to abate or blow less often, and the next 18 months were a good time of collecting data from boat and shore. And, as happens to all grad students with time, a self-reliance and pride of ownership and capability came to the fore. I now never fail to marvel at the amazing strides a young field biologist makes in those first two to three years immersed in nature. They are different human beings, different creatures, going out than when they came in. I would not deny that for me, Ken had much to do with this. There were those several other wonderful mentors in life, kind and thoughtful nature appreciating Gerhard, Melany, Roy, Charlie, and Roger. I refuse to compare them for all made amazing contributions to who I am or hope to be today. But, yes, Ken stands out, and his thoughtful voice echoes in my mind as we try to understand the social lives of dolphins and whales.

During the final Ph.D. year of study, I obtained an NIH post-doctoral fellowship to study dolphins to gain insight into aspects of "human child rearing and human development" (this WAS the late 1970s, the hippy era, that might compare dolphin calves with human babies) and chose to work with that wonderful mentor Kenneth S. Norris. Mel and I crossed the U.S. from Long Island, New York, to Santa Cruz, California, in a classic, highly used, and rusted red and white VW van, with all belongings tied to the front, back, inside, and on top (my burgeoning library of books came separately by U.S. Post book rate in 35 boxes); our 4-month-old child Kim travelled in a special shoebox propped just right among the mountains of effects. The transmission went out going up into the Rockies, causing a one-week hiatus while it was replaced. We had to make a major detour to avoid the coastal mountains near San Francisco, but finally approached Santa Cruz after a climb up those mountains from San José at a speed of 1 to 3 miles per hour, with much honking of traffic behind.

We lived for free in the Felton Forest north of Santa Cruz on the Ken and Philly Norris farm at the edge of the coastal redwoods (*Sequoia sempervirens*), with domestic sheep and geese (*Anser anser*) roaming underfoot, in a 28-foot Boston Whaler boat (the *Nai'a*, Hawaiian for "dolphin"), parked under California live oaks (*Quercus* sp.),

which boat we would later use to find vaquita in the Gulf of California and work with spinner dolphins off Kealakekua Bay, Hawai'i (with an intrepid and amazing colleague, skipper Randy Wells, who was a Ph.D. student of Ken's then and is now the preeminent dolphin biologist of our time, with the longest running study of common bottlenose dolphins—now 50 years—on Earth; Wells & Scott, 2018). At any rate, this was a lovely natural venue to prepare several Ph.D. papers for publication, and to gear up for the designated post-doc of studying spinner dolphins on the coast of the Big Island of Hawai'i. While I had a postdoc for salary, we needed funds for the work; and Randy and I—with Ken's blessing—wrote a proposal to the U.S. National Marine Fisheries Service (NMFS) and National Science Foundation (NSF), both of which fortunately were funded. Mel, Randy, several undergrad students, and I made it to Hawai'i in Spring 1979 and pretty much stayed there until early 1982, with only several short jaunts back to California to take care of bits of bureaucracy as there always will be.

In Hawai'i, we learned that spinner dolphins spend their times in and near bays of the island during the daytime (see also Norris & Dohl, 1980) and feed on elements of the Deep Scattering Layer (DSL) offshore at night. In other words, the dolphins were using the protective shallow coves to rest ("sleep") in daytime away from the dangers of deep water shark predation, in small groups of variable sizes, and then aggregating with other daytime, nearshore resting dolphins to form a cohesive large school of up to several hundred dolphins that then fed in open waters at night. This was a revelation to Mel and me as we recognized that dolphins can adjust their daily/nightly behavioral resting/feeding/socializing regimes relative to the habitat available to them. Note that their day/night activities are reversed from those of the coastal shallow water duskies of Patagonia. While, again, we "learned lots" from Hawaiian spinner dolphin regimes (the book Norris et al., 1994b, seems a fitting hallmark for this), we learned this lesson of behavioral flexibility with habitat above others and were able to apply it to social strategies with multiple species and in many places (Figure 14).

Spinner dolphins of far-apart atolls do not have a fission-fusion society on a daily basis simply because there are not other dolphins available nearby (Karczmarski et al., 2005); bottlenose dolphins may have fission-fusion societies on hourly bases depending on their foraging/social/resting/mom and calf care-giving requisites (Wells & Scott, 2018); and Amazon River dolphins (boto, *Inia geoffrensis*) may have a fission-fusion society more aligned to polygyny, or even at times monogamy, than the general polygynandrous societies that seem the common fate of the taxonomic Family Delphinidae (Best & da Silva, 1984). Societies form themselves for greatest efficiency of inter-individual affiliation, be it for food aggregation, safety while resting, foraging and feeding, sexual interactions, or mother–calf associations (Gowans et al., 2008).

Back in the 1970s, Mel and I hypothesized that dusky dolphins form nearshore fission-fusion societies that in daytime allow them to most efficiently forage for and corral prey, then feed on same (Würsig & Würsig, 1980). But this was a hypothesis only as we simply did not know whether dolphins were truly aggregating prey by their behaviors, nor whether it was efficient for them to herd prey to the surface. It was not until a remarkable grad student, Robin Vaughn, studied duskies in both New Zealand and Argentina in our haunts from (then) 35 years before that we learned that the hypotheses were confirmed and that duskies really do surround prey balls in a manner to move them towards the surface, tighten the prey by their actions (i.e., "herd"), and are more efficient at such tightened feeding than otherwise (Vaughn et al., 2010, 2011, 2013).

We started out in the shallow waters of Argentina, describing bottlenose and dusky

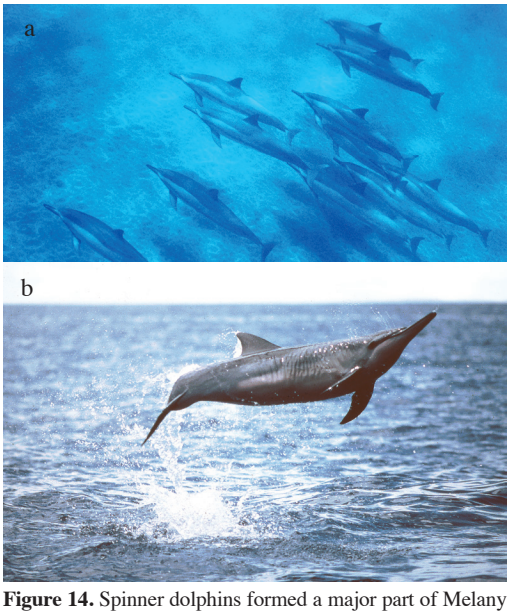

Figure 14. Spinner dolphins formed a major part of Melany and Bernd's formative science, here with (a) spinners at rest as a "carpet formation" subgroup in the mid-day shallow waters of Kealakekua Bay; and (b) a spinner dolphin spinning horizontally as an indication of the end-of-rest afternoon, just before social/sexual activities and leaving shore for deep-water feeding at night. (Photos courtesy of B. Würsig)

dolphin fission-fusion societies. After a stint with spinner dolphins in the shallow and nearshore waters of Hawai'i (night-time feeding only, on deep scattering related prey only available near the surface at night!), we then went to the deep waters of New Zealand to describe duskies acting in very different ways from those of shallow water feeding in daytime in Argentina. They were now feeding at night in the deep Kaikoura Canyon on mesopelagic prey, just like spinners! This switch in foraging and attendant social behaviors was a revelation then but now is reasonably well understood—again, an adaptation to habitat. To understand this further, we were fortunate to have two students—Tim Markowitz and April Harlin—explore dusky dolphin lives in other areas of New Zealand, and they found a shallow water place reminiscent of Patagonia, Argentina, in Admiralty Bay, Marlborough Sounds. There, duskies fed in daytime, aggregating prey into tight balls, just like in the shallow waters of Argentina (Markowitz et al., 2004). Fine. We now knew about behavior vs habitat shifts. BUT, due to their copious photo-identification work in both Kaikoura and Admiralty Bay, Tim and April showed that some of the same dolphins that fed at night on deep scattering layer prey off Kaikoura migrated seasonally (in winter) to Admiralty Bay and changed their day/night regimes to feed on schooling pilchards (*Sardinops sagax*) in daytime, in "proper" nearshore shallow water prey aggregation fashion (and then returned to Kaikoura to adapt to that regime once again for spring-summer; Markowitz et al., 2010b). As well, it tended to be the same individuals, largely males, that made the migration year after year (Harlin et al., 2003). Such behavioral flexibility was new for us then in dolphin biology but is not all that surprising. A "human comparison" might be someone who works on a farm for a part of the year but moves to another area for city factory or mining work to make ends meet while the farm is not as productive (Rademacher-Schulz et al., 2014). Only some (the brave ones?) make this seasonal migration, while others simply wait out the lean times. I may be off on this dolphin-to-human comparison but rather like it as a present working hypothesis.

Later Years

I need to cheat a bit by strongly abbreviating the next 35 years. We spent several years (1979-1982) in Hawai'i working with spinners (Norris et al., 1994b), then started NSF-supported comparison studies in 1983 to study dusky dolphins in the deep waters of New Zealand rather than the shallow ones where bait-ball feeding prevails in Argentina. These studies have now spanned well over one dozen graduate students and about 50 or so research papers, and continue to this day. In short, we know more about social strategies of island-living and otherwise nearshore dolphins than we did 45 years ago, but we also know that there is much more that needs to be known (Würsig & Würsig, 2010).

At times, with and without Melany, I spent many months away from home (still a regret while our lovely kids Kim and Paul were growing up), studying Peruvian Amazon River dolphins, the boto (*Inia geoffrensis*; Wang et al., 2001), 1992 to 1989; Chinese Yangtze River dolphins, the baiji (*Lipotes vexillifer*; Würsig et al. 2000b), 1987 to 2003; spending summers of 1981 to 2007 in Arctic and near-Arctic waters describing bowhead whale (*Balaena mysticetus*; Würsig & Clark, 1993) and endangered western gray whale (*Eschrichtius robustus*; Gailey et al., 2007) behaviors and problems relative to oil and gas exploration and development; and in Hong Kong sporadically from 1992 and still to this day attempting to help solve some of the myriad problems of Indo-Pacific humpback dolphins (*Sousa chinensis*) in beleaguered human-degraded waters (Würsig et al., 2016). This latter work has largely been with former student and now lifelong colleague Thomas "Tom" Jefferson, a wonderful collaborator and human being (see Jefferson, 2018, this issue; Figure 15).

During those years in the 1980s to 2010s or so, I flitted about here and there for conferences and for shorter research stints in Hawai'i, Mexico, Belize, the Bahamas, Hong Kong, Canadian Arctic, Russian far east, California, South Africa, Europe, Argentina, Brazil, and several other places that would need to be looked up to recall place and time. (Many of you active researchers who read this can well-empathize, I know.) Much of this does seem a blur yet I think can only be called "science" if a student, colleague, or I progressed it with research by publishing results in peer-reviewed journals. Science is not science unless it sees the properly reviewed light of day. Not all of mine (nor some of my students' work) did. And M.S. theses and Ph.D. dissertations without being published in peer-review journals or book chapters do not count.

Mel, the kids, and I moved from Moss Landing Marine Laboratories (a lovely, nurturing scientific and educational environment) in 1989 to Texas A&M University at Galveston (ditto there on the above), and I am now a professor emeritus (i.e., retired) but still with a tiny office to call home. Texas A&M provided a huge host of other research opportunities, and one of these was studying the marine mammals of the Gulf of Mexico, which we did with expensive boats and gear, and, despite the complications of the various

large-scale projects (1992 to 2007), managed to learn much new about the 20+ cetaceans and one manatee residing there (Würsig et al., 2000a; Davis et al., 2002; Würsig, 2017).

All is not perfect. Despite the amazing shoulders I have used, and the several folks (I fancy) who have used my shoulders, there are those who simply want to walk alone; and after 20+ years to this day, they pretend that they are the ones who invented "all," and that they do not, or have never needed, a shoulder from which to see more clearly. I think of a very few (thank goodness, only a few) colleagues, grad students, and post-docs who have produced good work and will continue to do so but who will never be "greats" simply because they cannot see the other bricks in the wall that are making their own recent bricks possible. They believe, it appears, that they are the ones who invented the wall and are making all the bricks to extend this wall even further. As well, they at times seem resentful of anybody who might have been a "mentor." This is a shame, I think, as we all need to rely on others and will not accomplish all that much without those reliances. Greatness itself does not matter. It only matters that we may have made a difference, or at least seriously tried. It also matters that we thank those who helped us to try for it shows that we are working from others' shoulders' view and, thereby, perhaps will help guide the next generation in how to accept those shoulders.

There are scientists who may have somewhat correctly (but only somewhat) avowed that they were "higher" than all others, and I think of the great physicist Isaac Newton. He eschewed comparisons to himself, did not believe anyone was his equal before or then, and vehemently castigated anyone who might have disagreed (summary by Hawking, 1988). As mentioned earlier, he also—perhaps in a weak moment—thanked colleagues for lending shoulders from which to see. In stating that he was the greatest, he was right, of course—he WAS the greatest; but we mere mortal marine biologists must not assume to be likewise. We are but pawns in this chess of life (trite phrase alert) and hope that our own pawn may be worthy to last and not be cast aside with the wisdom of the future. And, if it is cast aside, we should be scientists and honest thinkers enough to realize that this is, or was, for the best. It would be oh so good for an ego or two to be laid aside here and there, and overall our science and fledgling attempts at conservation would be the better for it.

Four years ago, I was asked the following by a well-known researcher lauded in this manuscript, but I will not name names here: "So, Bernd, what have you really accomplished in life?" That person may have meant this as a simple request for personal reflection, but also possibly as a bit of an accusation, "Hey, I do not think you have accomplished all that much, compared to some others and to me." That was fair of course, but it also left me nonplussed as I had until then rather fancied that I had accomplished the pleasant tasks of adding several solid bricks to our world of marine mammal (of science?) wall of knowledge, perhaps helping to solve a puzzle or two. I mumbled something about "We all muddle along," but it is true that I could not clearly elucidate a world-set of accomplishments. I've thought about this since then (agonized on it, even) and could now give a much better answer to what I may have done or might take mild credit for helping to do: formulating/developing tools of benign research, describing social strategies and environmental adaptations of social animals, explaining how beleaguered dolphins and whales might be helped by this or that proper reduction of noise influences and changes of other environmental perturbations, recommending and having accepted several strict regulations that I believe have and will help certain societies of marine mammals and their ecosystems survive, and helping to school over 60 of my graduate students to hopefully do likewise, and do better. Above all, understanding a bit more about social mammals in the oceans than we knew before, although "my bricks" (the puzzle pieces) are only several of many.

Due to enforced reflection, I can begin to answer the question of "What have you accomplished in science?" better now than four years ago. So, I also ask each of you science/conservation/education

Figure 15. An Indo-Pacific humpback dolphin, also termed Chinese white dolphin by our colleagues in Hong Kong and the People's Republic of China; its coloration changes from dark as a calf to white-light pink with spots as an adult as described by T. A. Jefferson. (Photo by T.A. Jefferson, with permission)

readers to ask yourself this question (as by my "anonymous" inquisitor) each and every day (OK, once per month), and hope to have not merely a smooth and satisfying answer but a solid and deeply meaningful one as well. If you cannot do so now, then strive for it. Recognize and defend your life's goals, your mis-steps and accomplishments, your visions for the future. It is this kind of reflection that can lead us to think and act more purposefully in our lives. We do not merely want to drift along, meeting this or that deadline of proposal, of contract or grant report, of book chapter, of next needed lecture. A life spent in the pursuit of knowledge and education of others—as well as, I am adding here, a quest for better strategies of conservation—is a life well spent. This "life well spent" is not another notch for your twig of ego; it is only a gauge of what impact on science and conservation we may have had and how to use our accumulated "wisdom" to help better this Earth.

There exists a personal expression of regret and loss. In 1979, Ken Norris, Randy Wells, and I were the first researchers to document the in-field occurrence of the little-known elusive and rapidly declining vaquita in the northern Gulf of California (Wells et al., 1981). Ken had first described the species from skull bones about 20 years earlier (Norris & McFarland, 1958). Today, the vaquita hangs on by a tenuous thread that threatens to break any month now (Thomas et al., 2017). A few years after our seeing vaquita in the Gulf of California, Mel and I studied baiji in China (Würsig et al., 2000b). The baiji is now gone (Turvey et al., 2007). Wow, to have seen and studied the only two (yes, the only two) cetacean species to be so in danger of going and to have gone extinct in our times! This is a sadness and a burden, and it engenders a personal feeling of failure. What could I have done to make this not happen? I have no answer (Figure 16).

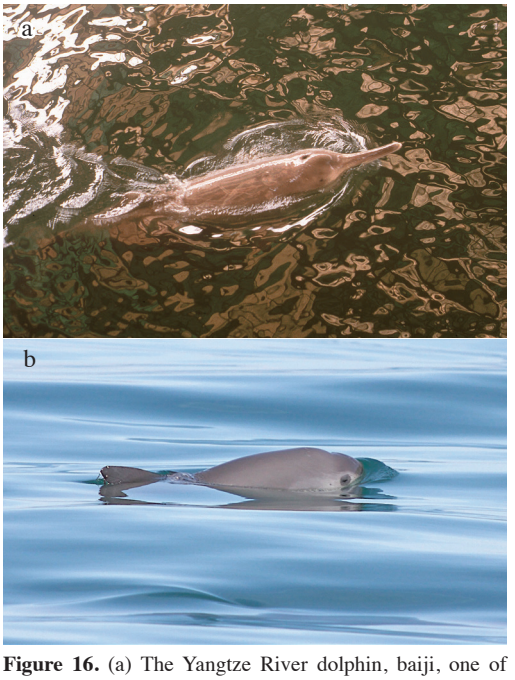

Figure 16. (a) The Yangtze River dolphin, baiji, one of the last of its kind photographed in the late 1980s (Photo courtesy of B. Würsig); and (b) the vaquita, or Gulf of California harbor porpoise, hanging on by a figurative thread as a species (Photo by T. A. Jefferson, with permission)

Many of us oldsters who do "reflections" on our lives make much of the fact that devices for study and analysis, and accessibility of data from others, are much more sophisticated now than 10, 20, and more years ago. We used paper and pen in the 1970s; clunky, battery-powered tape recorders; and analog ("film") cameras. The Paynes' (and, therefore, also Mel's) theodolite was a beautiful Swiss Kern Model DKM-1 but had an upside-down image so that views of dolphins were of them going left to right instead of the real right to left (for example), and leaping down instead of the correct up (Mel and I still insist that the world is upside down). Instead of pushing a computer button to record x and y coordinates that these days immediately translate to latitude and longitude as well as distance from the theodolite operator, speed of movement from the preceding reading, etc., the Kern theodolite had an internal circular slide rule (look this up if the term is too ancient) that needed swift and experienced eyes and hands to "vernier adjust" each and every reading to the closest circular second. We did so rapidly, and could obtain subsequent position readings just about as fast as with modern computer-connected digital theodolites that do give all those amazing readings in real time. We now speak into voice recorders that add data points to an *Excel* spreadsheet matrix; and we burn digital high-resolution images into a tiny storage device without needing to change film cartridge each 36 pictures. Instead of putting large radios onto animals and tracking them with "yagi-uda" (Uda & Mushiake, 1954) antennas, we use tiny digital devices, gathering place and other data uploaded to satellites and beamed back to the lab (Laplanche et al., 2015). Instead of filling out little cards to ask a colleague for a mailed copy of the latest paper, we e-mail her and ask for a pdf, or we look her work up in Google Scholar or some other scientific search engine. Instead of choosing the proper statistical technique "from a book" of such techniques (I was brought up on Sokal & Rohlf, 1969, and was a teaching assistant for Bob Sokal "way back when"), there are modern techniques of using sophisticated forms of statistics (Buckland

et al., 1993; Whitehead, 2008) to give us accurate approximations of numbers of animals in a society and of social groupings in that society (respectively to these references). We can even craft statistics to be adapted for each particular problem, depending on the "normality" or any other distribution—or non-distribution—of the events recorded (https://www.r-project.org). The world of science and knowledge is at our fingertips.

Yes, today's devices and information accessibility are a far cry from those of a generation or two ago. Information gathering, transfer, and analysis/application can travel more rapidly now, not a doubt. **But**, the basics of science have not changed. *Reality check:* We still need to read the literature and know enough to ask what the next important questions may be, and how we might go about answering them. We still adhere to the scientific method (see Nuzzo, 2014, for a cautionary view). We need to know not just the nearest shoulders that helped us see further but those shoulders who helped our mentors see further and—when possible—so on down the generational line. Without such perspective, we might be led to believe that "our generation" has invented all that is important. I am a bit dismayed (Old Person Alert!) by youngsters who do a Google Scholar search for the latest papers and do not cite (or even know about) what led to that latest paper, that latest insight. Charlie Walcott, my Ph.D. degree mentor, is one of but many who has an amazing "academic pedigree," with physiologists, entomologists, psychologists, and developmental biologists as mentors for six scientist "Academic Fathers" through the 20th and 19th centuries; and while looking at that background, I stopped at the 7th ancestor, who was the wonderful American philosopher Ralph Waldo Emerson, 1803-1882 (https://en.wikipedia.org/wiki/Ralph_Waldo_Emerson). Now, I'm not arguing that we should know seven generations of academic mentors (especially due to the lauded "six degrees of separation" phenomenon; https://en.wikipedia.org/wiki/Six_degrees_of_separation), but without at least some healthy long-term perspective, we lose sight of how important it is to have new perspectives, and how tenuous our own "newness" may be. I think of the axiom, "Those who do not know history are doomed to repeat it" (mostly, but perhaps unfairly, attributed to Santayana, 1906). The Würsig Corollary might be "Scientists who do not know their history are doomed to not fully understand their science." You may quote me on this.

There is another reflection after alluding to several amazing "shoulders" I have used—Gerhard, Mel, Roy, Charlie, Roger, and Ken. There was only one woman in that line-up, and she was not an academic scientist *per se* (but with a good scientific mind), my wife, who helped also to fund us along the way with various and sundry odd jobs. What the heck?! Could I not have chosen more women of science and perhaps also more people of color in expressions of accolade? Trust me, as far as direct use of shoulders, I could not have, and this is a regret, but we (in marine biological science) are doing at least a bit better now in the diversity department. While teaching at Moss Landing in the 1980s, there was no woman scientist on the faculty; presently, the teaching and research faculty is about 50% each gender, a wonderful improvement. When I started at Texas A&M University Galveston in 1989, we were an all male faculty of 13, and it was a personal source of embarrassment that we could not muster even one woman scientist for a professor position! Now, almost 30 years later, we are also at 50% each gender, and the largely younger, vibrant female faculty members are reaching new heights in marine biology research, education, and conservation-related service. This was not due to

Figure 17. A major part of our research entailed looking at dead rather than live animals to learn about aspects of whaling history, reasons for incidental strandings, and potential ways to help endangered cetaceans: (a) Mel and Bernd measure a stranded fin whale in Patagonia, Argentina, 1974 (Photo by Charlie Walcott, with permission); and (b) Mel and southern right whale skeletons in Imbituba, Santa Catarina, Brazil, taken by small-village whalers in the late 1960s, photographed 1973 (Photo courtesy of B. Würsig)

purposefully selecting women; it was due to (1) a concerted effort to not be biased against women (finally!); and (2) more women entering the marine biology field, perhaps as our overall appreciation of all human beings came to the fore (Pinker, 2011). The males are doing fine as well, of course.

I have a personal aside and may be chastised for it. While each individual human should (and must) be taken "as to their past and promise," I have a bit of a soft spot for females in field research and lab settings; on average, they seem to do better than males at being patient, observing with least possible bias, analyzing in similar fashion, and carefully thinking through tricky problems. I have no idea whether this perception is due to a construct of inherent sex/gender capabilities, a part of our western upbringing, both, or a product of my fevered mind. It is utterly amazing as well, how many (many!) male scientists of earlier generations are now known to have had "secret side-kicks" who often did much of the work, and even at times much of the thinking and writing, and they often were women. Watson and Crick received the 1962 Nobel Prize in Physiology or Medicine (along with Maurice Wilkins) for discovering the helical nature of DNA (Watson & Crick, 1953), but their insight was largely due to Rosalind Franklin's meticulous X-Ray work (Franklin & Gosling, 1953), and, although she has been lauded in other ways, it seems wrong that she did not receive higher acclaim (she could not have been eligible for the 1962 Nobel Prize as she died before then), and we do not normally speak of the Watson/Crick/Franklin discovery of DNA. It would have helped if their 1953 article had been by Watson, Crick, and Franklin.

Even in the ancient Anglo-Saxon epic poem *Beowulf*, monster Grendel is portrayed (at least in modern translations; see Tolkien, 2014; but the actual translation was done in the 1920s) as strong and proud, while his (much more?) un-named (!) accomplished warrior mother is portrayed as a "hag" or "fern-hag" (Heaney, 2000). Very recent modern writers may do better as perhaps exemplified by Maria Dahvana Headley (2018), who herself is promising to come out with a new transliteration of the ancient epic in the next year or so and "set words straight." So, we (at least socially and societally) advance.

"Our" (I think this means "western society's") advances in gender equality (and there are amazing women in our small field of marine mammalogy, e.g., Williams et al., 2016) are welcome, but we still need to help make room for persons of color—that is, those who are not of the Anglo-Saxon white heritage. There are some but still too few scientists and educators in our fields of biology, marine science, and marine mammalogy who are not "Anglo-Saxon white," at least in Europe and the U.S. Diversity is the name of the successful game, I say, and let us hope that as more former graduate students attend upper-level disciplines and receive degrees, the future of our hallowed halls of learning, government wildlife management entities, business-related biologists, and nonprofit societies will be not only gender-equal but also race and background non-specific. It is a hope that will eventually be realized when our students and faculty look somewhat like the 1970s bridge crew of the Starship Enterprise (but see Kapur & Wagner, 2011). As societies, we advance, diversify, and become better we hope (Pinker, 2018). To become better is our only hope.

We live in a dangerous time. The Earth is warming, and no matter what other prattle you may hear, it is largely due to us, humans, over-enjoying wholesale carbon burning that we discovered millennia ago but have only gotten really good at exploiting in the past 150 years or so—REALLY good (Hartmann et al., 2013)! Now here we are, with polar bears disappearing due to their ice, snow, and dens melting (Stirling & Derocher, 2012); amazingly rapid shifts in marine mammal distributions worldwide (MacLeod, 2009); and wholesale impacts on marine ecosystems (Hoegh-Guldberg & Bruno, 2010). It is enough to make a person cry. Never mind (here) the positive vibes of humans getting better (again, Pinker, 2018); we have not yet learned to stop the juggernauts of atmospheric carbon build-up and ocean acidification. Until we do so, we seem to be in a perilous cycle of wishful thinking with a huge dose of denial. Good people and governments are attempting to reduce carbon use and get us, a bit belatedly, back to a more sustainable system; but there are just about as many (it seems) people and governments who believe that it is more important to save the livelihoods of coal miners for this generation than it is to save our planet for this and future generations of humans. Now, each and every coal miner is important; and if their way of life dies out, we need to be ready to support them with retraining, social enhancements, etc. But to prop up a dying industry that is helping to cause the death of our ecosystems, and therefore also us, makes no sense.

It is dissatisfying to end on a pessimistic note. Scientists should lead the way to help solve problems, darn it. After all, we now recognize that we are but part of intricate webs of survival at multiple socio-ecological levels (Machovsky-Capuska et al., 2018, provide a clean marine system example). As an (eternal) optimist, I believe that we CAN "come around" and use wind, solar, water, wave, and other energies instead of the one that has and will get us into more trouble. We can and must do so on an individual level ("bottom up"), with reduced use of gas-guzzling automobiles, use of roof-mounted solar energy where possible, recycling of water resources, and reduction of carbon-made products such as plastic bags and worthless trinkets (an ecologic

Figure 18. Bernd and Mel Würsig in "Big Glasses" phase, late 1980s (Photo by Charlie Walcott, with permission)

analogue might be Kominoski & Rosemund, 2012). On the upper-scale level ("top down"), the European Union has made great strides in helping to curb climate change (https://ec.europa.eu/clima/policies/eccp_en); and even presently developing but powerful up-and-coming nations such as India (https://www.preventionweb.net/english/professional/policies/v.php?id=28137) and China (https://unfccc.int/news/china-meets-2020-carbon-target-three-years-ahead-of-schedule) are getting into the act of reducing use of fossil fuels. In the U.S., which has been primarily responsible for a worldwide fossil fuel addiction, we may yet wean ourselves and become a leader once again, but this will take much concerted human action by scientists, grassroots activists, students (maybe YOU), companies, and government agencies. All is not lost but may soon be. Please help (*Union of Concerned Scientists*, 2018); your help is needed now more than ever before.

Acknowledgments

A personal retrospective is indeed personal and may not be aided much by viewers near and far. Nevertheless, I thank Melany Würsig for being a wonderful intellectual companion through Life and for acknowledging that as far as she knows, I have not lied in this manuscript (Figure 18). Thanks also to Randy Davis, who conceived of this Festschrift; Kathleen Dudzinski, senior editor of *Aquatic Mammals*; and Tom Jefferson for guidance. I thank Roy Tassava, Charlie Walcott, Roger Payne, and Ken Norris for being splendid mentors, with nary a thought for themselves but instead care for their students and science. I thank > 60 fine human beings (about two-thirds women, and a too-small dash of non-whites) who have been my grad students in this journey through life. My goodness, what wealth of wisdom you have provided—on personal and scientific, and on moral and philosophical, grounds. You are the present and the future, and you (and yours) are our main hope of getting out of that climate change and wholesale destruction of habitat conundrum. I sense that you are up to the challenge, and thank you for this.

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