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# Historical Perspectives

## Louis M. Herman

### Preface

Today, there are clear, well-defined paths to becoming a marine mammal scientist: specialized academic programs, graduate assistantships, internships, a supportive professional society, dedicated scientific journals, job opportunities with government and private institutions, and much more—all help to prepare and guide the student toward a career as a marine mammal scientist. But in the 1960s, when I began my career, almost none of these opportunities or structures existed. The paths to becoming a marine mammal scientist were poorly defined at best, and sometimes it was only through a confluence of chance sprinkled with a little choice that one arrived at that goal. What follows then is the story of the meandering path I took toward that goal, a route whose final destination could not have been foreseen.


**Figure 1.** Lou Herman and the dolphin Phoenix at the KBMML pools (*ca.* 1985)

# Birthing a Dolphin Research Laboratory: The Early History of the Kewalo Basin Marine Mammal Laboratory

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## The Harbor

Turning left off of busy Ala Moana Boulevard, I steered my '57 VW beetle into Kewalo Basin Harbor. I enjoyed that little bug: ten years old, a stick shift, and almost maintenance free. And with a soft-vinyl sunroof that slid all the way back so that when I wanted to try my novice hand at surfing, I could prop my Hobie inside. I wasn't on my way to surfing, though. I was on the hunt for a dolphin laboratory—not an existing one, but a place where I might create one with the funds promised me.

Kewalo Basin Harbor is nestled snugly between Waikiki and downtown Honolulu—a smallish rectangular harbor of about 55 acres built in the 1920s to accommodate lumber schooners, now long extinct, as is the lumber trade. Now the harbor was filled with an assortment of small- to medium-sized boats. As I drove parallel to Ala Moana Boulevard along the *mauka* side (mountain-facing side) of the roadway that wrapped around the harbor, I passed by a fleet of small charter fishing boats. One had Ahi flukes pinned to its signboard offering the promise of big game fish. The irony struck me—using a fish to lure a person. Many of these charter boats had flying bridges: The captain could drive and scan from the heights for the shadowy forms of fast-swimming mahi or yellow-fin tuna. Several larger-sized tour boats were there as well. Their enclosed lower deck and open upper deck gave tourists the choice of basking in the sun or enjoying a cold beer below as they looked forward to their first view of Pearl Harbor or of Diamond Head from its ocean side. A sign read, "Join a dinner cruise and dance with a Hawaiian band—6 pm."

Looking south across the harbor to its *makai* ("ocean") side, sheltered from the waves by a sloping rock wall, I could see a few old wooden Sampan fishing boats. These trolled for Aku (skipjack tuna) using poles and live bait, a technique on its way out at that time, displaced by the steel-hulled long-liners moving in and monopolizing the fishery. A worker armed with a bristle brush was challenging the rust on one of these boats.

A rank odor from the Hawaiian Tuna Packing Plant at the harbor's west end now invaded my open windows, carried on the gusty Kona winds that at times displaced the northeasterly trades. I continued along the east side of the harbor, passing by a large marine supply store, a sail-maker's shop, a net-drying shed, a hole-in-the wall eatery, a small marine fuel station, and finally paused next to a long fence of overlapping redwood slats at the harbor's southeast corner. The fence was perched atop a three-foot-high concrete wall that wrapped around a large rectangular enclosure I estimated to be more than 100-feet long. Curious as to what this place might be, I exited my car and peered through a knothole. Inside, I could see two large, circular concrete structures that seemed to fill most of the enclosure. Okay, it's worth asking, I thought, remembering, though, how many other promising places I had looked at and asked about to no avail—either not suitable or not available. I walked over to a small hollow-tile building fronting the north end of the enclosure and knocked on the door, thinking, "Wela, this wild-goose chase is all your doing."

**Figure 2.** Aerial view of Kewalo Basin Harbor and vicinity, *ca.* 1982; the twin pools of the Kewalo Basin Marine Mammal Laboratory are near the center of the photo. Ala Moana Beach Park lies immediately to the left (east) of the lab and the harbor to the right (west).

## Sharks

A middle-aged gentleman dressed "Hawaiian-style" in khaki shorts, flowered Aloha shirt, and "slippahs," answered my knock. I told him about

my search and asked about those concrete structures I had spied. He invited me in. I could see now that they were twin circular pools, quite large, arranged along the length of the facility but separated from each other by about ten feet. I strolled over to the nearer pool. The walls rose about three feet above the surrounding concrete deck and about two feet below. I expected to see water inside, but it was completely dry; strewn about the floor were large mooring lines, buoys, anchors, and a variety of other marine equipment, as if the pool was simply a large, open-air closet. I turned to my host with a questioning look. "This place," he explained, referring to the entire enclosure with a sweep of his arm, "is simply a convenient office and storage space for the University of Hawaii ship operations berthed just outside."

"And what about these two pools?" I asked.

"That's an interesting story," he said, smiling.

He began by telling me the facility was built in 1959 to exhibit sharks to paying visitors. The owner collected the sharks locally by setting large baited hooks at night just outside the harbor entrance, near "Point Panic," a favorite bodyboarding spot for many "locals." In the morning, any hooked sharks still alive were placed in the pools. My host pointed to an old pump room at the rear of the facility, saying, "Seawater was pumped into the pools directly from the ocean." He then continued, saying that business wasn't good—folks were not likely to come back a second time to see sharks simply swimming about. So, to spice up the show, the owner approached young surfers passing by on their way to the Kewalo's surf break and asked if they'd like to earn a few bucks. All they'd have to do, he'd say, was "take a swim." That challenge seemed hard for an adrenalin junkie surfer "dude" to resist and business picked up—temporarily. But the sharks were at times true to their kind and the word soon spread that you do *not* want to take a swim there.

My host pointed to stairs leading to a small, dilapidated hut set atop a shed at the south end of the facility. "It's a great view," he said. I climbed up. The ocean was not more than 30 feet away, wrapping around this southeast corner of the facility and fended off by a low rock wall. Southward, the ocean extended to the horizon, punctuated only by the waves breaking across the shallow Kewalo's reef some 100 yards offshore. To the east, the ocean blended into a kilometer-long channel that once served as the entranceway to the Ala Wai Yacht Harbor about a mile away. The channel's sheltered waters were now a popular swimming and canoeing site accessible from the adjoining Ala Moana Beach Park. Beyond the yacht harbor, farther yet to the east, lay the broad sweeping arc that was Waikiki Beach, still relatively unmarred by hotel development. And in the distant east rose the iconic image of Diamond Head, the historic gateway to Honolulu for arriving ships. I turned and looked west toward the harbor, its potpourri of boats, the large seafood restaurant bordering the harbor's west end and named after Fisherman's Wharf in San Francisco, and again caught a brief whiff of the pungent odor from the tuna-packing plant.

I recall vividly how the story ended: Without the draw of the surfers, the owner went bankrupt and one day, quietly and unannounced, he left the facility, the sharks, and the islands. Later, when the smell of decaying flesh drifted over the fence, the Harbor authorities broke in, found the site abandoned, and eventually turned it over to the University of Hawaii for their ship support. "That's us," my host said.

He then surprised me by saying that the ship operations would soon be relocating to Pier 18 at the far side of downtown Honolulu. "We're out of here then," he said.

Almost afraid to ask, I said hesitatingly, "Does that mean this place will be available?"

"I suppose it does," he said, but then added that I should contact the Hawaii Institute of Marine Biology as he'd already had inquiries from them about using the facility for shark studies.

I thanked him for the tour, the story, and the exciting news, and left the facility smiling and excited, thinking what an ideal location for a dolphin laboratory. Outside, I looked again at the harbor, the bordering ocean, and the silhouette of Diamond Head in the distance. I strolled over to Ala Moana Beach Park whose sands butted up against the southeast side of the facility. I studied the quiet waters of the channel that ran the length of the kilometer-long beach all the way to a manmade spit of land called Magic Island, and I thought how perfect it would be to be able to swim there every day—if this facility were to become my dolphin lab. And then I thought again about Wela and how I had gotten to this point.

### Sea Life Park

There's a high bluff in east Honolulu, situated where the south coast of Oahu bends to the east and catches the gusty trade winds. A marine park is perched on top, gazing out at the nearby Pacific waters that create vistas of bottled-water-clear-ocean above pristine white sand. The dark shadows of coral reefs stretch their tongues into the virgin sand creating stark contrasts with the white sandy bottom. About 1,500 meters offshore lies a strikingly shaped rocky islet known as Rabbit Island, or *Manana* in Hawaiian. To me, its shape mirrored the profile of a giant male sperm whale

resting at the surface, its huge head protruding high out of the water and its body tapering rearward and downward to a small dorsal hump and finally to a submerged tail. It should be called Whale Island, I thought. But I once swam out to that island together with others from our ocean swim club, and there *were* rabbits.


**Figure 3.** The entrance sign to Sea Life Park, Oahu (current)

**Figure 4.** Rabbit Island off of Sea Life Park with its profile resembling a male sperm whale resting at the surface

Inside the Park, I watched four dolphins rise in lockstep synchrony out of the waters of Whaler's Cove, curve their bodies at full height into graceful arcs, and pierce the water on reentry with their snouts, leaving behind only the faintest of splashes—a perfect ten with a degree of difficulty worthy of Greg Louganis's best. I took in a deep breath at this display of power and grace and at the realization that I would soon be working with a dolphin like those. I wondered how it would go—my first venture into dolphin research. But there was little time to ponder that question, for I was about to be introduced to the young lady who would be my dolphin collaborator in research. Her name was *Wela*.

It was the summer of 1967, and I'd just completed my first academic year as a new Associate Professor of Psychology at the University of Hawaii. Accompanying me to Sea Life Park were four student volunteers from a graduate seminar I had been teaching that spring on research methods. We stood together in the Park's training area watching Wela, a female Pacific bottlenose dolphin of perhaps 8 to 10 years of age, glide effortlessly about her large oval-shaped seawater pool. Each time she swam by, she peered up at us with a sidelong glance from a large dark eye. We couldn't resist waving at her as she passed by.

**Figure 5.** Wela's pool in the training area at Sea Life Park, the site of Lou Herman's first dolphin study

A small cache of our research equipment stood ready nearby: sound generators, amplifiers, underwater speaker, digital logic boards, and customized apparatus and stimuli. Now Wela was at the far end of the pool, and we gently lowered the apparatus into the water, marking the beginning of a scientific project on dolphin intelligence that I thought would be but a single summer's fling into that exotic topic. I never imagined that, instead, it would mark the beginning of a 36-year journey with dolphins and whales and a new career as a marine mammal scientist.

### An Unintended Career

As we placed the apparatus in the pool, I was literally and figuratively entering new waters for I was not yet a marine mammal scientist. Instead, I was specialized through graduate training, research, and work experiences in a field then called human information processing—the study of how we filter and choose among the stream of stimuli

that constantly reach our senses; how we allocate our limited processing resources to the selected inputs; how we encode, store, and retrieve information from short- and long-term memory; and how we select and organize responses and achieve skill in performance. It was a new field that emerged in the late 1950s and early 1960s built in part on concepts borrowed from communication theory as pioneered by Claude Shannon at Bell Laboratories (Shannon & Weaver, 1949). My dissertation, completed at Penn State in 1961, examined how humans process information in the face of competing demands from two concurrent auditory tasks, each needing real-time responses.

I had arrived at Penn State in the fall of 1957, dragging a U-Haul trailer behind my seriously underpowered '53 Plymouth all the way from Atlanta and across the challenging Allegheny Mountains. Before that, I had spent nine months in Atlanta at Emory University, assisting in studies of concept learning by Rhesus monkeys as part of my training toward a Ph.D. in Experimental Psychology. I enjoyed a student's life in Atlanta, living in a small studio apartment with my dog Buster. But when the Psychology program slashed the stipends for graduate students in half (to $700 per year), I decided to look elsewhere. Without the stipend, I had only the Korean GI Bill for support, earned after 45 months in the Air Force during and after the Korean War, plus a little extra cash working as a weekend lifeguard at an Atlanta country club. I applied to several graduate programs, and when Penn State offered more than twice the amount I had been receiving at Emory, I gladly accepted. At summer's end, I said a sad goodbye to Buster, who I left in the care of a good friend, and began my travel north.

I had spent most of my Air Force career as an Intelligence Officer at Maxwell Air Force Base in Montgomery, Alabama, assisting a civilian specialist, Albert Biderman, in debriefings of repatriated Air Force pilots shot down over Korea or Manchuria. We were seeking to decipher the "mysterious" Chinese methods of "brainwashing" that had coerced some into false confessions of germ warfare. We carried out extensive interviews and related research, and ultimately concluded that the methods were not mysterious at all. Instead, they were mainly conventional interrogation techniques: social and physical isolation, total control of the prisoner's every action, debasement, and eventual dependence on the interrogators for every physical and social need (see Biderman, 1963). After the project ended, I considered continuing in the Air Force and applied for transfer to another unit where I heard that advancement in rank was reportedly swifter. I was disappointed when the transfer was denied, and I applied for release from service with the intention of beginning graduate work in experimental psychology. Things moved quickly after that—on January 6, 1957, I was an Air Force Officer on active duty, and on January 7, I was a graduate student at Emory University.

I never regretted transferring from Emory to Penn State, an oasis of learning and culture in the mountainous, sparsely populated middle of Pennsylvania. I met my future wife, Hannah, there, a fellow graduate student. In the fall of 1961, after I completed my degree and after Hannah and I were married, we said goodbye to our friends and to the little town of State College with its one movie theatre, two diners, and three bars, boarded my now well-powered '59 Pontiac, and motored westward, enjoying the journey, the sights, and the freedom. I did need a job, though, and so we meandered about the country, stopping at various places that had expressed interest in interviewing me for a position in "human factors engineering," a field that seeks to optimize the performance of the human operator in a man-machine system such as the complex of a pilot and his aircraft. At Columbus, Ohio, the human factors branch at North American Aviation offered me a position, starting almost immediately. I was to help devise methods for improving a sonar operator's ability to correctly classify echo returns as "submarine" or "whale," a task of surprising difficulty at that time, and even for years afterwards (see Herman et al., 1964). To me, at that time, a whale was just a fuzzy blip on a sonar display. I had no prescience that the study of whales, together with the study of dolphins, would eventually define me as a marine mammal scientist.

### Getting to Hawaii

In 1962, as I sat at my desk at North American Aviation contemplating sonar displays, the loudspeaker blared out my name, saying I had a call from Washington, DC, and it was from John Kennedy! Excited and puzzled, I picked up the phone, said my name, and heard a loud voice exclaim, "Congratulations!" The caller then identified himself as the executive director of the American Psychological Association, saying, amusedly, "I'm often confused with that *other* John Kennedy." After I calmed down, he explained that I was the winner of the first Creative Talent Award from the American Institutes for Research for the best dissertation in Psychology (see Harlow et al., 1962). Moreover, he continued, the award carried a prize of one thousand dollars! I had to calm down again and then remembered that my thesis advisor, Dr. John Corso, had graciously nominated my dissertation for the award months earlier, rather casually mentioning that to me.

Later, I began to think about the significance of the award and wondered whether it might be a signal to take a path into more basic research, something that could be done best in an academic setting. The next spring at the regional meeting of the Eastern Psychological Association at which I gave an invited address on my award, I inquired about academic positions, interviewed for several, and was offered an Assistant Professorship at Queens College in New York City at $8,500 for the academic year. That was several thousand less than I was making at North American. Nevertheless, I accepted the offer, and in early September of 1963, Hannah and I resumed our travels in the '59 Pontiac, but headed eastward this time to Queens College.

My time at Queens College lasted three academic years, ending abruptly when a vote for the department chair went wrong. I had arrived at Queens College during a period of growth together with four or five other new Assistant Professors of Psychology and was assigned to teach courses in experimental psychology, statistics, and a graduate seminar on information theory. The department chair for the past 20 years was a prominent psychologist born and educated until the age of 20 in Russia, and specializing now in Russian Psychology, from Pavlov onwards. As if true to his roots, he ran the department like a Czar over-lording his subjects, or so the "old guard" who had been there all those years whispered to us novices. The spring of 1966 came, and it was time to elect a chair for the next three years. The old guard whispered again that if we all voted together, we could elect a new chair. Naively, we bought into it, and when the "secret" ballots were counted, the alternative candidate had won—except for one small detail not whispered by the old guard. The vote was but a recommendation to the College President. He promptly reappointed the old department chair, who, like an omniscient Czar, seemed to know exactly who had voted how. Suddenly, almost all the "newbies," all untenured, were out of a job. Dismayed, and with the spring semester almost ending, I realized there were few job opportunities this late in the academic recruiting season. But, posted on a bulletin board, was a notice that Hawaii was seeking an experimental psychologist. The image of Hawaii at that time, in the mid-1960s, at least to us Easterners, was that of the prototypical Caribbean Island—warm sun, white sand beaches, sparkling blue-green water, palm trees, and not much else except maybe grass skirts, Ukuleles, and Arthur Godfrey. Hannah, who was working at a Queens College education clinic, was advised by the "sophisticated" clinic staff, "Hawaii? You don't *live* there. You only visit!"

Nonetheless, I applied for the job, flew out for an interview, was surprised by the mountains and by the bustling city, and thought, "Well, I could stay here a few years until something else turns up." I was offered an Associate Professorship and, in August of 1966, Hannah and I again began a trek westward, now in our 1966 Dodge Dart, all the way to San Francisco, stopping everywhere along the way, enjoying the dramatic parks of the west and northwest, and finally camping in the bowels of a giant redwood in Marin County before making our way across the Golden Gate Bridge to San Francisco. There, we shipped our car to Hawaii on a Matson liner and sent ourselves there on a Pan Am jet. The research equipment I had gathered at Queens College under a National Institutes of Health (NIH) grant to study information processing and human performance would come separately, and the grant itself would be transferred to Hawaii.

Hannah and I settled temporarily in a small walk-up studio in east Waikiki, an area then referred to as "The Jungle," a jumble of old cottages, cheap rentals, and a lot of 1960s' "free-spirits." From there, it was only a short walk to Kaimana Beach where I could swim in the ocean or in the 110-yard-long natatorium built as a memorial to those who served in World War I. Swimming there, I felt I was in the spiritual presence of Johnny "Tarzan" Weissmuller and Buster "Flash Gordon" Crabbe, both Olympians and movie stars, who once raced each other in that very pool in the late 1920s.

Swimming and beaches were a significant part of my own natural history, and their lure was a factor leading me to Hawaii. I had spent many boyhood summers at the south-shore beaches of Long Island in New York. In high school, I joined the swimming team, and when it came time to choose a college—it had to be tuition-free because of our family's limited finances—I enrolled at the City College of New York in upper Harlem, an hour and a half of jostling subway ride each way, rather than attend the more conveniently located Queens College, because CCNY, not Queens, had a pool where I could continue my swimming career. And, during my college summers, I worked as a New York City lifeguard at Rockaway Beach, the City's largest, busiest, most challenging, and most social ocean beach. It was natural, therefore, for me to seek out swimming opportunities in Hawaii, and soon after our arrival, I joined that ocean swim club that took me out to Rabbit Island off of Sea Life Park. I suspect that my fondness for the ocean and swimming was part of what eventually attracted me to dolphins and whales.

### Rats and Dolphins

At the University of Hawaii's Department of Psychology, I was assigned to teach undergraduate and graduate courses in experimental psychology and was allotted a small laboratory space in the basement of the Psychology Building where I resumed my research into human information processing. Additionally, given my background with Rhesus monkeys, the Department Chair assigned me to teach a new undergraduate laboratory course on animal learning in which students would be familiarized with the principles of classical and operant conditioning. During the weekly laboratory section of the course, each pair of students was provided with their very own white rat and a "Skinner box," and they attempted to apply the techniques I taught them to train their rats in both simple and complex behaviors. The students loved their rats, petted them, gave them cute names, and cheered their progress. But, in a way, it was those same rats that led me to dolphins.

During the spring semester of 1967, I was teaching a graduate seminar in experimental design and methods. One student, whose eyes always seemed to glare with special intensity, stopped me in the hallway between classes, asking once again, "Dr. Herman, why are you working with rats in Hawaii? Why aren't you studying dolphins?" Then, with that intense glare ratcheted upwards even more, he said, "Dolphins are very intelligent! I've read John Lilly's books! Why isn't anyone studying them in Hawaii? Why don't *you* do it?"

Eventually, I began to think, "Why *not*?"

For the last phase of that graduate seminar, the students were to design an experiment collectively. One day, I walked into class and said, "For your project, let's all design an experiment on dolphin intelligence!" Everyone liked the idea, and we began to review the literature on animal intelligence and how it had been studied. We soon learned that valid scientific experiments on dolphin intelligence were almost nonexistent or, in some cases, were suspect. I said, "We have the opportunity now to design a *proper* experiment." Of course, there was soon sentiment to actually *do* a study and not just design one. There was a lot of talent in that class, and I was confident we could do a proper study if only I could manage to convince Sea Life Park to let us work with one of their dolphins for a summer project.

It seemed simple enough—convince Karen and Tap Pryor, the recent developers and owners of Sea Life Park and the associated Oceanic Institute (Pryor, 1975), to lend us one of their dolphins and one of their pools so that we could carry out a scientific study of dolphin intelligence. Karen, in her mid-30s (like me), and a devotee of B. F. Skinner and his principles of reinforcement, was a self-taught trainer as well as the curator of mammals at Sea Life Park. It was evident that much of the early success of the Park was a reflection of her managerial skills. Further, Karen was keenly interested in research. A few years after my visit to the Park, Karen was to publish a seminal paper called "The Creative Porpoise" (Pryor et al., 1969). It was easy to understand, then, why she welcomed our project, but she cautioned that I would have to get permission from Tap as well.

Tap was a multitalented innovator and entrepreneur, also in his mid-30s, and of seemingly boundless energy and ideas. Following a stint in the Marines as a Naval Aviator, he enrolled in the graduate program in marine biology at the University of Hawaii. Frustrated by the lack of local facilities to complete his study of sharks, he decided to develop a research and public display facility for marine life that would include dolphins. He designed a park (together with Ken Norris), raised the funds to develop it, and in the early 1960s, Sea Life Park was born. Tap later went on to develop many other projects, from undersea habitats and submersibles to shrimp farms. I've never been sure why Tap was at first reluctant to authorize my research project, given his own research background and the mission of the Park, but, nevertheless, I did not take his initial "no" as his final word. Almost daily, I sought him out, spelling out my case. One day I heard he was visiting Coconut Island, located in Kaneohe Bay on windward Oahu, and I made my way out there. I think he was startled to see me when I caught up with him as he strolled along one of the wooded paths through the island, but somehow the setting, or my arguments, or more likely the nuisance factor I was creating, swayed him, and he said "yes." He would give me a window of three weeks for the study. Not enough, I thought, but a start.

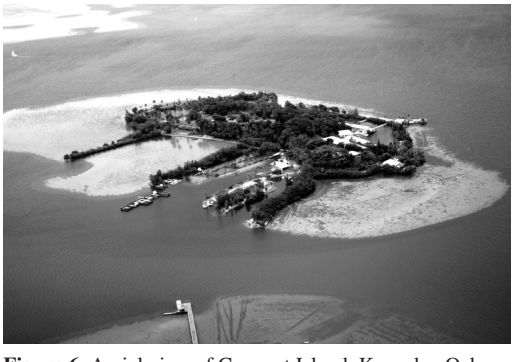

**Figure 6.** Aerial view of Coconut Island, Kaneohe, Oahu

"Come back next week," Karen said after hearing of Tap's assent, "and I'll let you take a

swim with Wela." I can still recall my emotions during that first swim—an insoluble mixture of elation and anxiety. I treaded water in the center of the pool while Wela, excited by a stranger in her waters, dashed about at an alarming rate of speed, churning up waves, and coming uncomfortably close at times. It almost seemed that she was testing *me*. Finally, Wela slowed down and as she glided close by, I reached out and let my hand slide along her flank, feeling for the first time that smooth wet-innertube-like skin that allows the dolphin to slip through the water so easily. Wela lifted her head out of the water at my touch and I heard the *whoosh* of her breath as her blowhole opened for a moment and closed again. But her eye caught mine, and I sensed she accepted my presence. I exited the pool, dripping seawater, but with a smile on my face as broad as a dolphin's. Karen smiled, too, at my dolphin baptism and said we could begin our study anytime.

### The Question of Dolphin Intelligence

My studies of human information processing were in keeping with the paradigm shift sweeping over psychology in the 1960s, forcing the field of theoretical psychology away from the restrictive tenets of behaviorism in which unobservable concepts like mind, memory, and consciousness were scientifically taboo subjects, to the revolutionary science of cognition that arose to address such issues.

The 1960s witnessed not only the birth of the *cognitive revolution* in psychology and in many other fields like neuroscience, artificial intelligence, and philosophy, but also saw the unfolding of a banner decade for the laboratory study of dolphins. Much of what we now take for granted about dolphin behavior saw its genesis and development during that decade, setting the agenda for much of what was to follow. A sampling of topics initiated or developed during that decade, briefly noted in Box 1, gives a flavor of the exceptional productivity of those times.

Harrison Matthews (1966), the eminent large-whale biologist, attributed much of that surge of research to the emergence of marine parks. In his opening remarks as the Chair of the First International Symposium on Cetacean Research in 1963, he stated, "The greatest revolution in the study of the Cetacea has come with the possibility of keeping living cetaceans in oceanariums. . . . Now the living animal is accessible at close quarters for the study of functional anatomy, physiology, pathology, reproductive activity, behavior, and even psychology" (p. 4). To that assessment I would add a further critical factor: the emergence in the early 1960s of the Navy's marine mammal program, which provided funding for both in-house and outsourced research on dolphins and sea lions (see Wood, 1973; Evans, 2008).

The question of dolphin intelligence also emerged in full flower in the 1960s with the publication of two books by John Lilly (1961, 1967) and the advent of the *Flipper* film and television series during that time. Lilly's popular works took their inspiration from descriptions of the large and apparently complex brain of the bottlenose dolphin, which Lilly likened to the computational power of a computer that increases with size and complexity (number of processing elements). Noting that the brain of the bottlenose dolphin was well over 1,000 grams, the minimum size, Lilly (1961) contended, for language, he hypothesized that dolphins might communicate with one another through a language of their own, and "being without benefit of hands or outside constructions of any sort, they may have taken the path of legends and verbal traditions, rather than that of written records" (p. 68). In his 1967 book, Lilly pushed the computer metaphor further, wondering what transcendent mental capabilities lay within the brain of the sperm whale, by far the largest brain on the planet. Not surprisingly, these speculations raised the eyebrows of many scientists. F. G. Wood (1973) wrote, "In moving into the unfamiliar fields of behavior, bioacoustics, and linguistics, Lilly seemed to lose whatever critical acumen and scientific skepticism he possessed" (p. 92). The noted biologist E. O. Wilson (1975) put it more bluntly: "Lilly's books are misleading to the point of bordering on irresponsibility" (p. 473). On the several occasions that I met Lilly, including an occasion when he visited my lab, I always found him to be personable, respectful of my work, and with an obvious keen interest in spiritual and transcendental matters.

Although these criticisms of Lilly by Wood and Wilson were expressed several years after our

**Box 1.** Examples of dolphin research productivity during the 1960s

- Types of vocalizations (Lilly & Miler, 1961a; Lilly, 1962; Evans & Prescott, 1962; Evans, 1967)
- Signature whistles (Caldwell & Caldwell, 1965)
- Vocal exchanges (Lilly & Miller, 1961b; Lang & Smith, 1965)
- Echolocation (Kellogg, 1961; Norris et al., 1961; Evans & Powell, 1967)
- Hearing thresholds (Johnson, 1967)
- Visual discrimination and problem solving (Kellogg & Rice, 1964)
- Creativity (Pryor et al., 1969)
- Reproductive and social behaviors (Tavolga, 1966; also Tavolga & Essapian, 1957)
- Care-giving behavior (Caldwell & Caldwell, 1966)

**Figure 7.** John Lilly (*right*) visits Lou Herman's lab, *ca.* 1985

little group gathered at Sea Life Park, I was aware through my own readings that Lilly's pronouncements on dolphin intelligence and language were highly speculative and without strong scientific foundations. Yet, during this same 1960s period, there were several well-executed empirical studies completed or underway by various investigators seeking to understand dolphin vocalizations, communication, and the possibility of dolphin language. One suite of studies attempted to correlate dolphin whistle vocalizations with behavior to search for any language-like systems resident within those sounds (e.g., Dreher, 1961, 1966; Dreher & Evans, 1964; Lang & Smith, 1965). However, a careful review of these studies suggested to me that there was insufficient variation (information content) in the whistles to plausibly allow for an extant language with properties akin to human language (Herman & Tavolga, 1980).

Two other studies, one by Jarvis Bastian and the other by Dwight Batteau, both respected scientists, directly tested some implications of a linguistic ability in dolphins, if it existed. Bastian, a professor of psycholinguistics at the University of California–Davis, wondered whether one of the key design features of language, its *openness* or capacity for creating symbols to represent new events or objects, could be demonstrated by dolphins if a situation were structured that required it (Bastian, 1967). Bastian's key question was whether one dolphin could inform another about an arbitrary event, something not in the dolphin's natural or learned repertoire. For that, he chose the state of an out-of-water-light as flashing or not. Initially, a male and a female dolphin maintained in the same pool but in separate halves (a small mesh net separated the pair) could each see the light and each learned to press one of two paddles in its half of the pool contingent on the state of the light but with the male having to press his first. Only if both responded correctly was the pair rewarded. They learned this sequence and which paddle to press almost perfectly. Later, in a series of gradual steps, an opaque net now separated the pair, obscuring the male's view of the light, but not the female's. In theory, the male now had to depend on the female for information on the state of the light or which paddle to press. Surprisingly, the pair continued to respond almost perfectly, and vocalizations were heard from the female at the start of most trials. Rather than accept this apparent groundbreaking finding as proof of the transmission of arbitrary information by the female, perhaps through some linguistic structure, Bastian initiated a series of control measures, such as removing the opaque barrier, thus allowing the male to again see the light, and finally removing the male altogether from the pool (Bastian et al., 1968). The key finding was that the female's vocalizations and her previous behaviors continued unchanged and unabated. The authors concluded that the female was not intentionally (knowingly) transmitting information to the male but that chance factors allowed the pair to succeed in the task. A likely cue was the spatial position of the female while vocalizing, which differed depending on the state of the light. The male might have used his ability to sense those different locations acoustically as cues to which paddle to press (for further discussion, see Evans & Bastian, 1969; Wood, 1973; Herman & Tavolga, 1980).

During the late fall of 1967, I was happily escorted to Coconut Island by David Alices, the talented "local-style" head trainer at Sea Life Park. David was taking me to view an ongoing study initiated by Dwight Batteau that was attempting to communicate with dolphins through an artificial whistle language. I followed David to a small tree-lined lagoon occupied by two dolphins, *Maui* and *Puka*. A small houseboat was moored at the edge of the lagoon, and on its sheltered lanai sat several relay racks filled with electronic gear. Batteau, a physicist and mechanical engineer at Tufts University, had constructed a "man-to-dolphin translator" to convert spoken Hawaiian-like phonemes into whistle-like sounds that were then broadcast into the lagoon though underwater speakers (Batteau & Markey, 1968). The whistle sounds controlled various dolphin behaviors, some 12 or 13 different behaviors altogether by the time the study ended some three years after its inception. In one of those tragic circumstances that shouts of irony, the end occurred prematurely when Batteau drowned while swimming in the ocean near Sea Life Park. When I arrived at the lagoon with David Alices, Batteau's assistant, Peter Markey, was wrapping up the research. What I was able to witness, however, as demonstrated by David, and as described in the Batteau and Markey report, were responses of the

dolphins to a few simple whistle commands. For example, one whistle sound commanded a dolphin to "hit the floating ball with your pectoral fin." That single sound thus acted to release a sequence of behaviors. I could see that this was unlike the linguistic structure of human languages in which a unique sound stands for a unique semantic element such as a particular object (e.g., "ball") or a particular action (e.g., "hit"). In Batteau's "linguistic" system, therefore, there was no way to dissociate a complex instruction into its semantic elements to create a new instruction such as "hit the hoop (rather than the ball) with your pectoral fin" (for a more detailed analysis, see Herman, 1980). Batteau's system thus lacked *productivity*, a design feature of human language that allows for new meaning to be constructed through recombinations of old words (Hockett & Altmann, 1968). I concluded that some other approach would be needed if dolphin language-learning ability were ever to be tested again.

### My First Study

So, it was in that delicate and conflicting context—of raised eyebrows by some in the scientific community at mention of dolphin language or intelligence contrasted with a burgeoning interest by others in resolving those issues through objective scientific study—that our small group now gathered at Sea Life Park lowered our apparatus into Wela's pool. At this time, our focus was not on language or on intelligence *per se* but on testing a dolphin on an existing comparative learning task that seemed to order terrestrial species along a continuum consistent with their relative brain development. This was the very same concept-learning task I had been applying to Rhesus monkeys during my stay at Emory University. Various investigators by now had shown, for example, that Rhesus monkeys were more efficient learners of this type of task than were spider monkeys, which were more efficient than cats, which were more efficient than rats (Warren, 1965)—results that correlated well with the brain sizes and development of these species. Our goal was to see where a dolphin would fit within that menagerie of tested animals. We would give Wela a series of simple problems, all of the same type, each solvable by the same strategy or rule. We would then track her learning efficiency, that is, her progress toward discovering and applying the rule to each new problem as she gained experience with previous problems.

Wela's actual task was quite simple. We displayed two different plywood shapes side by side under water and asked her to choose one or the other at random by pushing on it to trip a microswitch. We used our preplanned schedule to determine whether that initial (Trial 1) choice would be rewarded (with a brief underwater sound and a thrown fish) or not. Thereafter, on Trial 2, and on successive trials with that pair, she should continue to choose the rewarded object, or if her initial choice was not rewarded, switch to the other pair member, a strategy succinctly called "win-stay, lose-shift." After six to 12 trials with a particular pair of shapes, a new pair was introduced, and Wela once again had to uncover the rewarded member. Would she become increasingly more efficient at solving new problems (show an increasing level of success on Trial 2 over blocks of problems) as her experience grew? Typically, animals tested in this paradigm are given hundreds, even thousands, of problems to determine when, of even if, a successful strategy develops. Rhesus monkeys, after experiencing many hundreds of problems, improve steadily and eventually often learn to choose the correct object consistently after only a single trial with a new pair. Rats, in contrast, show little improvement even after thousands of problems.

Finally, that moment came when we lowered the apparatus into the water for the first time and our test of Wela began. We tested her each day, carefully following our planned protocol and dutifully recording our results. The three allotted weeks passed quickly, and we had not yet been able to complete a sufficient number of problems. I asked Karen for more time. "Sure, continue," she said, implying that it was okay with Tap as well. By early fall we had given Wela 80 different two-choice problems, still a small number as compared with the numbers given to other species tested, and were wrapping up the research. Fall classes had begun, and my teaching duties were resuming, as well as classes for the grad assistants. However, Wela had reached a level of performance similar to that achieved by Rhesus monkeys given comparably few problems, but it was still not good enough to conclude that she had mastered the win-stay, lose-shift strategy. The dolphin's place among the species tested in that paradigm remained unresolved (see Herman et al., 1969). It would be up to someone else, I thought, to take the issue further. Feeling disappointed that we hadn't achieved more, but without the means to continue, I decided I would get back to my studies of human information processing and remember this experience as an interesting and fun summer.

### The Navy

As we neared the concluding days of our project, a small group from the Navy's marine mammal program, recently relocated to San Diego from Point Mugu, California, visited Sea Life Park and wandered over to where we were testing

Wela. The group was led by Bill Powell, who in another year's time was to become the manager of the newly developing Navy dolphin program at the Marine Corps Air Station at Kaneohe Bay. As the group watched, I gave a running commentary on what we were doing and why. They seemed impressed by our well-controlled procedures and intrigued by a study that was attempting to establish a dolphin's place in a comparative learning paradigm. After hearing that our time at Sea Life Park was ending, Bill asked whether the University had a place where I could continue this work. I shook my head—there was no place. After a few moments of reflection, Bill astonished me with an offer to provide two dolphins and modest funding if I could find a place to continue this research.

"Seriously?" I asked

"Seriously," Bill replied.

I was excited by this intriguing prospect. Wela had been an adventure and a challenge, and I was sure I could do better next time, as could a dolphin. But where could I find a place? And, pressing ahead would require a large commitment of time, and I wasn't yet willing to abandon my human research. Perhaps I could parallel process the two projects, I thought. After all, I reasoned, my dissertation was a study of multitasking, and I had determined it could be done relatively efficiently.

I looked back at Bill, and said, "Okay, I'll give it a try!"

After the Navy team left, I wondered what I agreed to so impetuously, but *doing something* rather than *doing nothing* was both my strength and at times my weakness, as the thrill of impetuousness can at times morph into the regret of action. Of course, it would be hard to find a place. But, it was the late 1960s, and Hawaii was not yet in its full building-boom frenzy, having achieved Statehood only some eight years earlier. There were still open places. Over the next weeks and months, I carried out a search, feeling at times like a frustrated Ponce de Leon seeking his fountain, driving throughout the island in my '57 bug every chance I had, exploring sites, experiencing disappointments, and wondering what Wela had gotten me into, until, finally, I made that left turn from Ala Moana Boulevard into Kewalo Basin Harbor.

### My First Dolphins

After leaving the former shark facility, functioning then only as an office and storage locker for the University ship operations, I followed the advice of my host there and contacted Phil Helfrich, the Associate Director of the Hawaii Institute of Marine Biology (HIMB). Phil said that Albert Tester, a distinguished shark researcher and a professor in the Department of Zoology at the University of Hawaii, was scheduled to use one of the pools for shark research. Dr. Tester at that time was leading a shark eradication and research program funded by the State, initiated after a shark attack on a young surfer. There were no plans for the second pool, however. I told Phil of the Navy offer and that some of the money could be used to help defray costs of the needed renovations. Phil was supportive and agreed to include the dolphin project in HIMB's renovation plans. I then paid a courtesy call to Dr. Tester. He was comfortable that the arrangement could work—dolphins in one pool and sharks in the other. It was a deal. I then contacted Bill Powell, reporting I had found a place and that it could easily accommodate two dolphins. I explained my plans for the facility and my ideas for research. I said I hoped he could provide young dolphins as that would be the best time to start their education, track their development, and test their intellectual potential. Bill replied that it all sounded good. He then asked me to prepare a proposal and a budget. "Keep it to about $10,000," he said.

With the help of HIMB and some of the Navy funds that had come through as Bill had promised, the facility was readied—dolphins in one pool and sharks in the other. The sharks arrived first, sandbar and gray reef species caught locally and maintained in the south pool. Dick Wass, one of Dr. Tester's doctoral candidates, would carry out a study over the next two years on their growth rate. Vic Faughn, one of Tester's assistants, was charged with setting hooks at night to provision the pool with new sharks, an ironic reincarnation of the method used by the original developer of the Kewalo shark facility. Occasionally, Vic returned with a dead tiger shark, its appearance as a corpse almost as menacing as when alive. One day, working on a dock just outside the lab, Vic extracted the entire jaw of a 13-foot tiger with its rows of teeth still intact. He opened the jaw wide, passed it to me, and said, "Try it on!" I was able to circle my body with it, passing it downward from my head to my feet like a hula-hoop, without any tooth touching me. When Vic nodded toward Point Panic at the Harbor's entrance, saying that's where he hooked the shark, several onlookers, apparently ardent body-boarders at that popular spot, said they might take their surfing elsewhere.

Early in the afternoon of March 4, 1969, a Navy truck pulled up to the large double doors of the facility. From inside, I swung the doors open and saw three Navy personnel bending over two dark forms lying on stretchers on the truck bed. I shouted to my graduate assistant, Frank Beach, that the dolphins were here. First one dolphin and then the other was lifted up, still on its stretcher, carried inside, and with typical Navy aplomb,

**Figure 8.** The first year of the lab (1969); the dolphin pool is in foreground, with shark tank in rear covered in a sunshade. A redwood-slatted fence separated the dolphin pool in half, but the fence could be folded back on itself to increase the available area to Kea and Nana.

each stretcher was hoisted above the pool wall and tilted sideways, the dolphin rolling off into the pool and landing with a loud splash about a foot below. There must be a better way, I thought.

The two dolphins now swimming about in the clear waters pumped in from a new seawater well drilled adjacent to the facility had traveled a long way. The first leg of their journey was by Navy plane from the Florida Keys to the Navy's marine mammal facilities at San Diego. A month later, they continued again by plane to the recently constructed Navy marine mammal facilities at the Kaneohe Marine Base, where they spent another month. Finally, after traveling by truck across the *pali* ("cliff") from Kaneohe, they were here, the initiates of my Kewalo Basin lab. We named one dolphin *Keakiko* (*Kea*, for short) because of a "white spot" on her tail, and the second *Nana*, the Hawaiian word for "to look, observe, or see," for her engaging habit of rising up to watch us as we passed by.

Both Kea and Nana were female Atlantic bottlenose dolphins, wild born in Florida's coastal waters. Kea was collected by Santini's Porpoise School in Grassy Key, midway down the peninsula defining the Florida Keys. Milton Santini, a local fisherman, founded the school. His first dolphin, *Mitzi*, was the star of the 1963 film, *Flipper*, that added greatly to the dolphin's aura. Flipper, represented not only by Mitzi but later by other dolphin "stand-ins," became an icon, made famous not only by the film but by the television series that was to follow the next year and continue through to 1967. When Mitzi passed away in 1972, Santini reportedly was heartbroken. He sold his facility and never worked with dolphins again. The "Porpoise School" then went through several management and identity changes, eventually morphing into the Dolphin Research Center, still active today. A statue of a dolphin stands prominently outside the entrance to the Center. A small plaque reads, "Dedicated to Mitzi. The original Flipper."

Kea was about three years old, a good age to begin her education. It was obvious, though, that she had suffered a horrific shark attack sometime in her young life in those Florida waters, where as many as half the dolphins bear shark scars (Wells & Scott, 2009). A long, dark, arcing scar ran down Kea's right flank from behind her dorsal fin to the white coloration of her belly. Her left flipper was partially bitten away, leaving a stunted, irregular profile rather than the gracefully tapered edge typifying her species. I wondered how she could have survived that attack, but here she was, looking at me with that indelible dolphin smile.

Nana, about 12 years old, was dark in coloration with large, bright eyes that gave further credence to her name. She was older than I had hoped for and I wrote to Forrest Wood, then head of the Marine Bioscience Facility of the Naval Undersea Warfare Center in San Diego, to inquire about her. "Woody" responded apologetically, saying that only one of the young animals obtained from Santini was available for my project. As a substitute, they had obtained a dolphin at Key West from Bob Bailey, the noted animal trainer. That was Nana. Bob told Woody that Nana had been at Key West since April of 1968 but had undergone no training. She arrived at my lab burdened with many small, ulcer-like pits covering about a fourth of her body surface. Termed "pinhole lesions," there was no known cause and no known treatment.

I had designed the dolphin pool so that it could be divided into two halves by a slatted redwood fence that ran across the diameter of the pool, rising from just above floor level to about four feet above the water surface. The fence was hinged at its center and could be folded back about $135^0$, opening up the pool but leaving a small pie-shaped wedge accessible through a gate in the fence. Later, I used that area as a temporary holding pen for stranded green sea turtles and a small school of tilapia.

The Navy contract that had been awarded was for slightly over $10,000. I had specified that we would complete two different types of concept-learning studies, one to follow up on our initial work with Wela and the second to examine a simpler learning paradigm. The work was to be completed by October 1969 and would serve not only to satisfy the contract by obtaining data on dolphin comparative learning, but would also satisfy Frank's dissertation requirements. Frank and I worked feverishly throughout the summer

and early fall of 1969 and finished the project on time. Both Kea and Nana solved the simpler problem in which the reward values of the two members of a fixed pair of underwater sounds reversed unpredictably and the dolphin must learn to reverse her choices, too, again using the win-stay, lose-shift strategy. Few species are capable of rapidly reversing their choices in this paradigm, but both dolphins, Kea especially, learned to rapidly reverse in synchrony with the changing reward values of the pair of sounds (Beach & Herman, 1972), much like what had been found in studies of chimps and Rhesus monkeys. The second test, similar to the type given Wela but using many different pairs of sounds projected under water rather than pairs of shapes, continued to be problematical. Puzzled by this difficulty, I donned scuba gear and sat on the pool bottom listening to the sounds that Kea was dealing with, adopting the dolphin's "point-of-view." The problem soon became obvious. Playing the two different sounds simultaneously, one at each underwater speaker as I had been doing, apparently resulted in some mutual acoustic interference. Instead, I needed to sequence the pair of sounds, presenting one after the other in random order and randomly determining which sound appeared at which speaker. This change worked like magic, and Kea soon was able to solve new problems after a single trial, using the win-stay, lose-shift strategy, a level of performance that rivaled the best reported for chimps or monkeys (Herman & Arbeit, 1973).

Those who have worked closely with dolphins understand how emotionally bonding the connection between human and dolphin can become. Early one December morning in 1969, we found Nana lying unmoving on the pool bottom. Our veterinarian, John Allen, arrived soon after, and his examination, then and later during necropsy, showed no evident trauma or systemic failure. However, over the nine months that Nana was with us, the pinhole lesions gradually spread across her body despite efforts by John and other veterinary consultants and laboratories to diagnose and treat them. The necropsy report read, "Approximately 90% of her skin surface was covered with various stages of lesion described as 'pinhole lesions' in *Tursiops*." Veterinarians would eventually classify pinhole lesions as one of several manifestations of poxvirus occurring in both captive and wild dolphin populations (Geraci et al., 1979). I wondered whether the extensive lesions might have compromised the integrity of her integument, possibly leading to an electrolyte imbalance she could not overcome.

Nana, despite her poor health, was a bright and responsive animal that we looked forward to seeing each day. She never showed signs of discomfort from her skin lesions, and she greeted our arrival warmly each morning, squealing excitedly on seeing us and urging us, I suppose, to hurry up with breakfast.

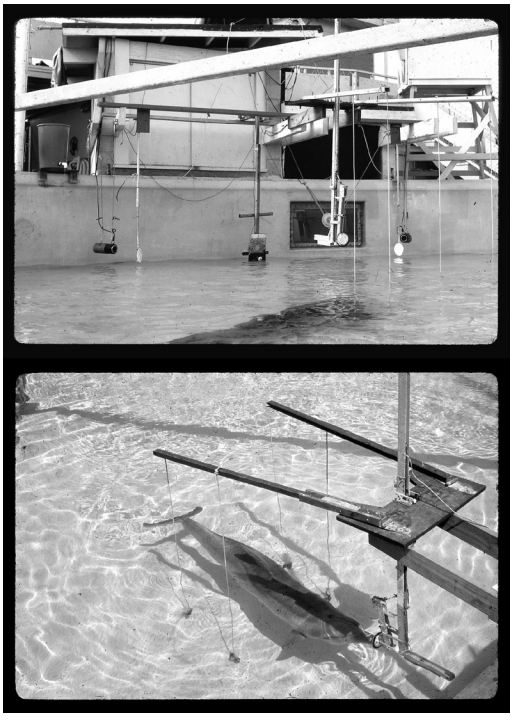

**Figure 9.** *Top:* View of initial apparatus used to test Kea's auditory learning and memory abilities; the water has been lowered for pool cleaning. The left and right J9 underwater speakers can be seen, each with a response paddle nearby. A channel of suspended ropes defines the "listening" area, with a "start" paddle at the channel's end. Just beyond the start paddle is a centrally located speaker that may play a "sample" sound. The two alternative sounds, one of them a "match," later appear at the J9 speakers, one at each speaker. *Bottom:* Kea enters the rope-channel listening area and presses the start paddle to begin a trial.

### The National Science Foundation

By the middle of 1971, although the research was exciting and going well, the future of the lab was uncertain. I had received a second Navy contract to continue my work with Kea, now my only dolphin, but further Navy funding seemed unlikely, and my current funds would soon run out. We were scrambling to cut costs, obtaining needed equipment and supplies from Navy surplus, and remaining heavily dependent on volunteer help. Of course, there was no compromising on dolphin food or health. Frank Beach, my graduate student, had received his Ph.D. for his work with Kea and Nana and was

now employed as a research scientist by the Navy dolphin program at Kaneohe Bay. A new graduate student, Bill Arbeit, and I were working together on several studies with Kea. We had completed one study showing Kea's acute sensitivity to small, almost minute, degrees of frequency modulation (Herman & Albeit, 1971a) and had completed a report for the Navy of her sensitivity to various types of sounds, not only frequency modulated sounds but pure tones and pulse modulated sounds (Herman & Arbeit, 1971b). We used the findings from the latter study to guide our selection of sounds for the successful Herman and Arbeit (1973) study. Additionally, together with another graduate student, Judith Gordon, I was designing a test of Kea's memory for new sounds that would later appear in publication (Herman & Gordon, 1974) and would attest to the remarkable auditory memory of the dolphin. In addition, Mike Yunker, an undergraduate honors student, and I had planned and were carrying out a study of Kea's sensitivity to temporal differences in sounds that also was later published (Yunker & Herman, 1974).

It was a thrill to see Kea performing so well, and I felt we were on our way to discovering much about the sensory and cognitive world of dolphins. However, I cautioned my students that unless I could find reliable long-term funding to continue our dolphin research, I would have to end the research, close the lab, and return full time to my work in human information processing. I knew that message was disappointing to the students, but I realized that the odds of securing long-term funding were slim. Nevertheless, I submitted a comprehensive research proposal to the National Science Foundation titled *Sensory and Learning/ Memory Processes in the Bottlenosed Dolphin*, and I asked for five years of support at an average of $54,000 per year. That seems modest funding by today's standards, but it was July of 1971 and $54,000 could buy a nice single-family home in Honolulu, a home that might cost at least ten times more today. In the proposal I stated,

> The major goals of the research are the fuller realization of the auditory capacities and specializations of [the bottlenosed dolphin] . . . and their comparative evaluation with documented capacities and specializations of primates and other selected vertebrate representatives.

More generally, I stressed that the comparison of dolphin and primate on intellectual traits could help answer some nagging questions about the evolution of intelligence. Nonhuman primates (particularly the chimpanzees) bear a close evolutionary and genetic relationship to humans, and their study is sometimes viewed as a window into the origins of human intellect. But, I wondered, is the primate line of evolution an obligate path for advanced intellect or are there divergent routes that can lead to that same result? I wanted to examine whether these two mammalian groups, primates and dolphins, though characterized by different brain architecture, sensory specializations, morphology, and ecology, and representing millions of years of divergent evolution, might nevertheless show convergences in cognitive characteristics and skills. I reasoned that such convergences, if demonstrated, would eliminate all those just named factors—architecture, sensory specialization, morphology, ecological niche, and evolutionary history—as uniquely necessary for the emergence of advanced intellect, and would point the way instead to other common root causes for the emergence of such skill. What commonalities might remain? One, I thought, might be social pressure. In a later publication (Herman, 1980), I wrote specifically of this possibility. We now know, for example, that chimpanzees and bottlenose dolphins both live in fluid, complexly structured societies where individual recognition and selective inter-animal associations and communication are paramount (see, e.g., Connor et al., 2000). This so-called social intelligence hypothesis has become today a major theory for the evolution of advanced intellect (e.g., de Waal & Tyack, 2005).

In late December of 1971, NSF gave its answer, awarding the full five years at the requested level of annual support. Bill, Mike, and I clinked celebratory glasses together, and Frank Beach drove across the island to join us. Now, all we had to do was carry out our ongoing and planned studies. We would examine both auditory and visual sensory processes, working-memory, comparative learning, and, eventually, the understanding of language-like symbolic systems.

Nearly coincident with the award of the NSF grant, Dick Wass completed his dissertation work on sharks, Dr. Tester had no further need for the shark pool, and the entire facility was then turned over to me for dolphin research, though the property still resided under the authority of HIMB. With this new funding and its guarantee of at least five years of stability, I felt it was time to give the facility an official name. I proudly commissioned and posted a large wooden sign on the harbor-facing side the hollow-tile building that now housed our offices. It read, *Kewalo Basin Marine Mammal Laboratory.*

## Epilogue

*Puka Arrives*

Under the NSF grant, the dolphin *Puka* arrived in 1972 to join Kea in our research program. This was the same Puka that was one of the two dolphins being studied by Dwight Batteau in that lagoon on Coconut Island. Puka became our visual specialist, and our studies with her revealed definitively that bottlenose dolphins have good visual acuity both under water and in air (Herman et al., 1975). We also showed that dolphins, though lacking color vision, are most sensitive to the blue end of the visible spectrum, which is in keeping with the photic characteristics of their underwater world (Madsen & Herman, 1980). Carolyn Madsen, who had arrived at the lab in 1972, received her doctorate for her studies of dolphin vision.

*Kea's Memory*

Kea went on to demonstrate further the remarkable fidelity of dolphin auditory short-term memory, including memory for whole lists of sounds (Thompson & Herman, 1977; also see Herman, 1975, 1980). Roger Thompson, who also arrived in 1972, earned his doctorate through these memory studies. For me, the most pleasurable part of the research at this time was watching Kea solving problems—patient, confident, alert, investigative, and immensely gleeful when successful, which was most often. I can still replay in my mind a remarkable scene featuring Kea in an auditory matching-to-sample paradigm. She is waiting patiently in the listening area between two underwater speakers. A to-be-remembered sound (the "sample") has already played. Soon, a sound will appear at each speaker and she will have to choose the one that matches the previous sample—a test of her short-term memory. As Kea waits, a large green sea turtle, an escapee from its pen in Kea's pool, now swims lazily by in front of her. Kea shakes her head up and down vigorously and pops her jaws with a loud clap, both serious dolphin threats, but she remains in the listening area, waiting. Finally, the two sounds play and Kea dashes to the speaker to her left and presses the adjacent paddle, correctly choosing the sound she had heard before. Then, instead of returning eagerly to her trainer for her fish reward, she races after the turtle, places her rostrum on top of its shell, and with vigorous strokes of her tail surfs the gasping turtle across the pool and back into its pen. Satisfied, Kea spins about and swims to her trainer at high speed for her well-earned fish reward. I trot over to the pen and close the turtle's gate, inadvertently left open, thinking what a marvelous animal Kea is.

*The Humpback Whales of Winter*

In 1975, there were so few humpbacks wintering in Hawaii that few residents, outside perhaps of the Maui community, were aware of their presence. Hawaii humpbacks were part of the North Pacific population that had been whaled mercilessly throughout their habitats until finally coming under the protective umbrella of the International Whaling Commission (IWC) in 1966. At that time, it was estimated that there were perhaps only 1,000 to 1,500 humpbacks remaining in the North Pacific (Rice, 1977). On hearing the "rumor" that there were humpback whales in Maui waters, and being keenly interested in expanding my studies to include field observations of marine mammals, I chartered a helicopter, flew over the Auau channel that runs between Maui and Lanai, and together with Hannah verified their presence. The next year, 1976, I launched all-island aerial surveys using three small Cessna aircraft to document the distribution and abundance of the whales, including the presence of calves.


**Figure 10.** Whale study: Hannah and Lou Herman in front of a Cessna 182, preparing for an aerial survey of humpback whales in Maui waters (1977)

Additionally, from a vessel I chartered, we approached and photographed whales at close hand to identify individual animals through the unique markings each carries on the underside of its tail flukes, visible when the whale dives. We also made underwater observations during which I noted the common presence of a third whale trailing below and behind a mother-calf pair. I dubbed that whale the "escort," a term now commonly used to refer to male humpbacks accompanying females (Herman & Antinoja, 1977).

During the winter/spring of 1977, working with Ron Antinoja and with my new graduate student, Paul Forestell, I set up a field station on the north shore of Lanai Island from which we launched small inflatable boats daily to capture photographs of the whales and to record behaviors. Paul continued on with me in both the dolphin and whale studies through to his Ph.D. in 1988. Additional

students of marine mammal behavior were attracted to the whale project, and during the winter/spring whale season of 1978, Randy Wells and Giuseppe Notobartolo di Sciara worked with me as field assistants. Scott Baker joined the project in 1979, and we worked closely together during the following years, both in Hawaii and in Alaska (the summer home of many of Hawaii's whales), until he completed his dissertation in 1985. Scott went on to establish a distinguished career in whale research.

**Figure 11.** View of humpback whale field camp at north shore of Lanai Island at Halepalaoa Landing, 1977; an inflatable Avon craft and a kayak are on the beach, and a spotting scope on a tripod is visible in the distance.

**Figure 12.** *Left to right:* Lou Herman, Paul Forestell, and Ron Antinoja on Maui during the 1977 humpback whale season

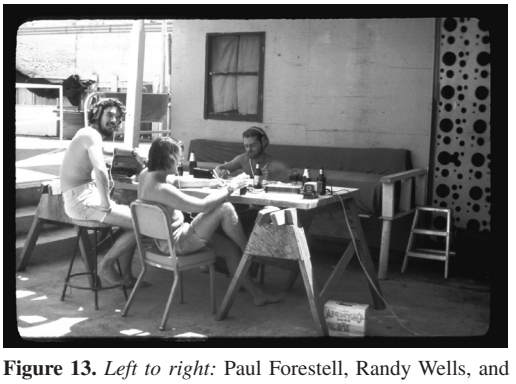

**Figure 13.** *Left to right:* Paul Forestell, Randy Wells, and Giuseppe Notobartolo di Sciara at the Kewalo Basin Marine Mammal Laboratory, 1978, reviewing whale data

My studies of the humpbacks, together with many students and field assistants, have continued every year since that initial foray, right up to the present, culminating most recently in a paper on the life histories of individual Hawaiian humpbacks that, in some cases, we have sighted in Hawaiian waters over spans of 30 or more years, though not in every one of those years (Herman et al., 2011). Today, humpback whale abundance in the North Pacific is estimated at 20,000, with more than half coming to Hawaii each winter (Calambokidis et al., 2008), a remarkable success story and a conservationist's dream.

Our daughter Elia, born in 1979 and nurtured on dolphins and whales throughout her youth, later also joined in the whale studies. During several years when she was a researcher for the Remote Imaging Department of National Geographic, she and I worked together to apply cameras (Crittercams) on to the backs of whales in competitive groups (E. Herman et al., 2008). And, in the circular trajectory that life sometimes takes, Elia, who began her whale "career" in 1980 as a one-year-old accompanying her parents in the lab's research boat, is now the State of Hawaii co-manager of the Hawaii Islands Humpback Whale National Marine Sanctuary.

**Figure 14.** 1980 humpback whale team standing by University of Hawaii van in front of rented condominium apartment in Maalaea, Maui. *Left to right:* Scott Baker, Barb Kuljis, Joe Mobley, Loren Davis, Lou Herman, and Tom Freeman.

**Figure 15.** Hannah and Lou Herman and seven-month-old daughter Elia on whale boat, 1980

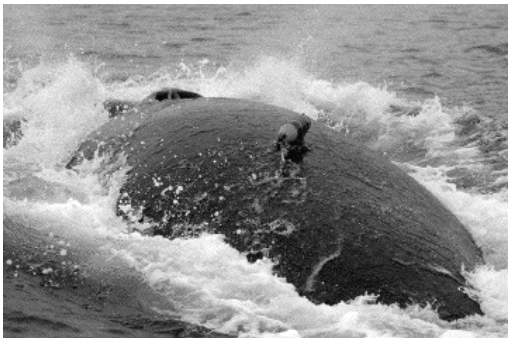

**Figure 16.** Humpback whale in a competitive group wearing Crittercam during collaborative study between the National Geographic Remote Imaging Department (Elia Herman, field director) and The Dolphin Institute, 2005-2006

I greatly appreciate the support for the whale work given by grants or contracts from the NSF, the National Oceanic and Atmospheric Administration (NOAA), the Marine Mammal Commission, Sea Grant, and the National Park Service (for work in Alaska). As I noted, many graduate students joined in the research over the years and many went on to establish careers in marine mammal science after completing graduate degrees at the University of Hawaii, including Paul Forestell, Scott Baker, Gordon Bauer, Joe Mobley, Hillary Maybaum, Adam Frankel, Chris Gabriele, Dave Helweg, Alison Craig, Scott Spitz, Adam Pack, Mark Deakos, Alison Stimpert, Siri Hakala, and Kira Goetschius, listed, more or less, in the temporal order of their first appearance in the whale research program.

*The Theft of the Dolphins*

On May 29, 1977, in the dark hours before dawn, two former students serving as pool cleaners and who I had discharged only two days previously took Kea and Puka bodily from their pools, placed them on the floor of an old VW van, and motored them 40 miles to a remote part of the island. There they abandoned the pair in the ocean to somehow suddenly make it on their own in this strange place. The two dolphins separated from each other immediately and neither was ever recovered, though we tried for many days. I believe both perished within a short time, victims of starvation, dehydration, or sharks. I sometimes think about the fear Kea must have felt, alone in that dark ocean with its unfamiliar sounds and with perhaps the memory of her earlier shark attack still ghosting about in her mind. The two perpetrators were eventually convicted of first-degree theft, though neither served any jail time. It was a terrible time for my students, my staff, for Hannah, and for me as we mourned the loss of Kea and Puka and weathered the stress of the long criminal trials and the labor of the rebirth of the lab. I will always be grateful during those dark times for the support of Ken Norris and Bill Evans.

*Rebirth of the Lab*

After 14 months of staring at two empty pools, each as dry as the day I first saw them in 1967, the

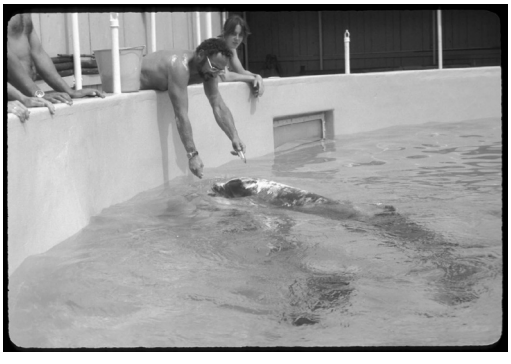

**Figure 17.** New arrivals Akeakamai and Phoenix, both still sporting zinc oxide applied during transit, being hand fed by Lou Herman on July 8, 1978

**Figure 18.** Lou Herman, Paul Forestell, and Hannah Herman enjoy a beer in celebration of the new arrivals, July 8, 1978.

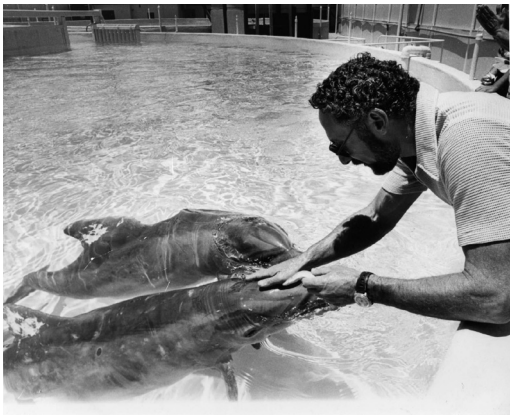

**Figure 19.** Lou Herman shows Ake and Phoenix to a press conference called to introduce the new dolphins and mark the rebirth of the lab, July 9, 1978.

**Figure 20.** Close up of the youngsters Ake (*lower*) and Phoenix (*upper*), fall 1978

arrival in July 1978 of two young female dolphins, *Akeakamai* (Hawaiian for "lover of wisdom") and *Phoenix* (named in honor of our rebirth) marked the renewal of the lab. It was a joyous occasion for our little group that had held together during those difficult months—Ron Antinoja, Paul Forestell, Hannah, and me.

With this new pair, and together with my new post-doctoral students, Doug Richards and Jim Wolz, we were able to show that dolphins are capable of understanding the semantic and syntactic features of the special gestural or acoustic languages we created (Herman et al., 1984). It was groundbreaking research, the first convincing evidence of syntactic processing by an animal. The research program was broad in its scope, and, over the ensuing years, it also revealed the remarkable capability of dolphins for vocal mimicry of arbitrary sounds (Richards et al., 1984) and for understanding the gestures or sounds as symbolic references to real-world objects, much in the way an arbitrary name in human languages comes to stand for or refer to a real-world object (Herman & Forestell, 1985).

**Figure 21.** Doug Richards and Lou Herman (*in water*) introduce Ake and Phoenix to a J9 underwater speaker, fall 1978. Phoenix is at the left and Ake at the right.

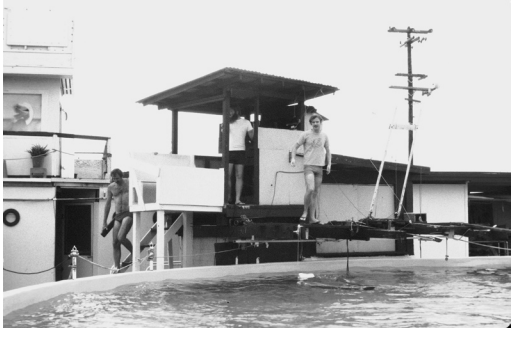

**Figure 22.** Preparing for instruction of Akeakamai and Phoenix in the language comprehension paradigm, fall 1978. *Left to right:* Gordon Bauer descending the tower steps to take his position at pool side as the dolphin instructor; Jim Wolz inside the tower—he will be operating a remote keyboard to control the sounds the dolphins will hear; and Doug Richards atop outriggers preparing to lower the stationing apparatus and the J9 underwater speakers into the water.

**Figure 23.** Language comprehension study. *Top:* The experimental configuration at the start of a comprehension trial; there are pairs of basket and pairs of Frisbees to Ake's left and right temporarily held in place by assistants until the trial begins. Also visible is a freely floating surfboard and a ball. Out of sight are additional floating objects. All objects, as well as several tank fixtures have gestural "names" that are understood by Ake. *Center:* The trainer has signed a five-word gestural instruction: "Right Basket Left Frisbee In," which means "Place the Frisbee on your left inside the basket on your right." Ake has just retrieved the Frisbee on her left. Note that the assistants are all standing erect with hands behind their back and looking straight ahead to avoid giving any social cues. Similarly, the trainer is wearing opaque goggles. *Bottom:* Ake has reached the basket that was initially to her right and is placing the Frisbee inside.

**Figure 24.** Lou Herman gesturally signing "Surfboard Question," asking Ake whether there is a surfboard in her pool; she answers "No" by pressing the paddle on her left or "Yes" by pressing the paddle on her right. The ability to understand symbolic references to absent objects is evidence that Ake understands the gestures as representing those objects as does a spoken object's name for us.

*Hiapo and Elele Arrive*

In 1987, with the support of a contract from the Office of Naval Research and a continuing NSF grant, as well as continuing grants from the Center for Field Research, the young female *Elele* (Hawaiian for "ambassador") arrived together with the young male *Hiapo* (Hawaiian for "first-born son"). The pair joined Akeakamai and Phoenix in the newly renovated pools that were now connected together through a wide channel.

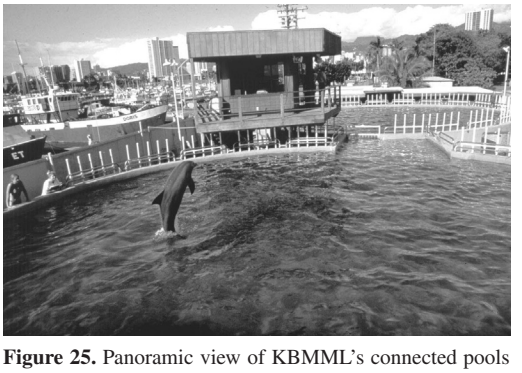

**Figure 25.** Panoramic view of KBMML's connected pools and new observation tower constructed in 1985-1986 in preparation for the arrival of the two young dolphins, Elele and Hiapo, who would be joining Ake and Phoenix.

The accomplishments with these now four dolphins included demonstrations of their remarkably facile behavioral mimicry, not only of other dolphins but of humans as well (Xitco, 1988; Herman, 2002); an understanding of television images as representations of the real world; and that these images may be acted on in the same way as real-world events (Herman et al., 1990).

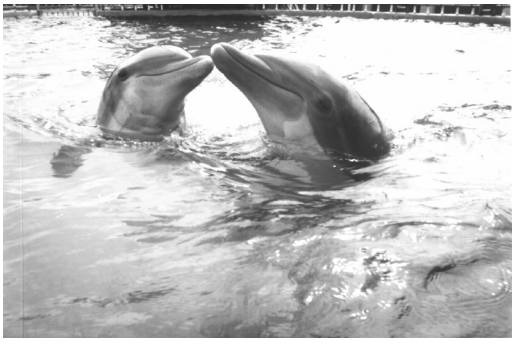

**Figure 26.** Elele (*left*) and Hiapo (*right*) at KBMML

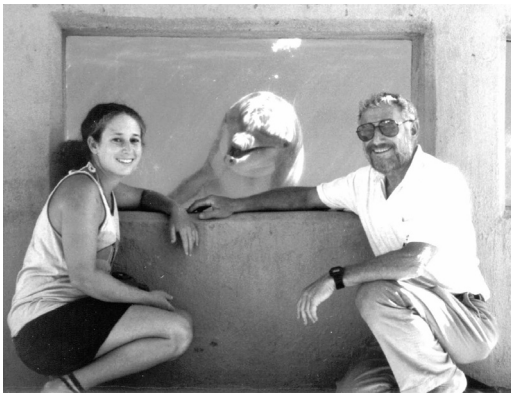

**Figure 27.** Elia and Lou Herman and Ake at one of the new pool windows (*ca.* 1996); Ake has just blown a bubble.

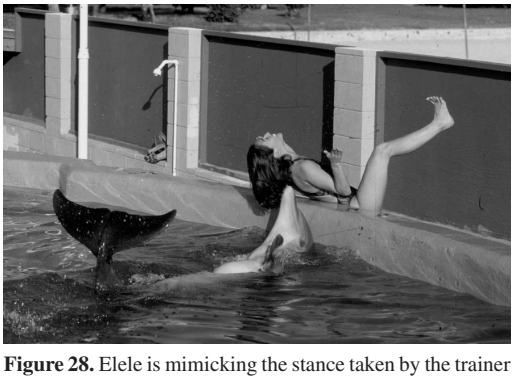

**Figure 28.** Elele is mimicking the stance taken by the trainer Amy Miller, in effect creating analogies between her body plan and that of Amy's.

**Figure 29.** Ake at underwater window watching gestural instruction being given on the television screen by a trainer being filmed live in the television studio; a camera in the window allows the trainer to see the dolphin at the window.

**Figure 30.** Dolphins understand the indicating function of the human pointing gesture. *Top:* Lou Herman uses a brief cross-body point to refer to the surfboard to Ake's left. *Center:* Lou has just signed the action command "pec-touch." *Bottom:* Ake touches the surfboard with her pectoral fin.

Our studies also showed the understanding of the directing intention of the human pointing gesture (something that is not within the natural capabilities of chimpanzees) (Herman et al., 1999) and the demonstration of self-awareness as manifested in conscious awareness of their own body parts (Herman et al., 2001) and in conscious awareness of their own behaviors (Cutting, 1997; Mercado et al., 1998; Herman, 2006).

We also showed that dolphins have an innate capacity for creating images of objects through echolocation that apparently are analogous to the

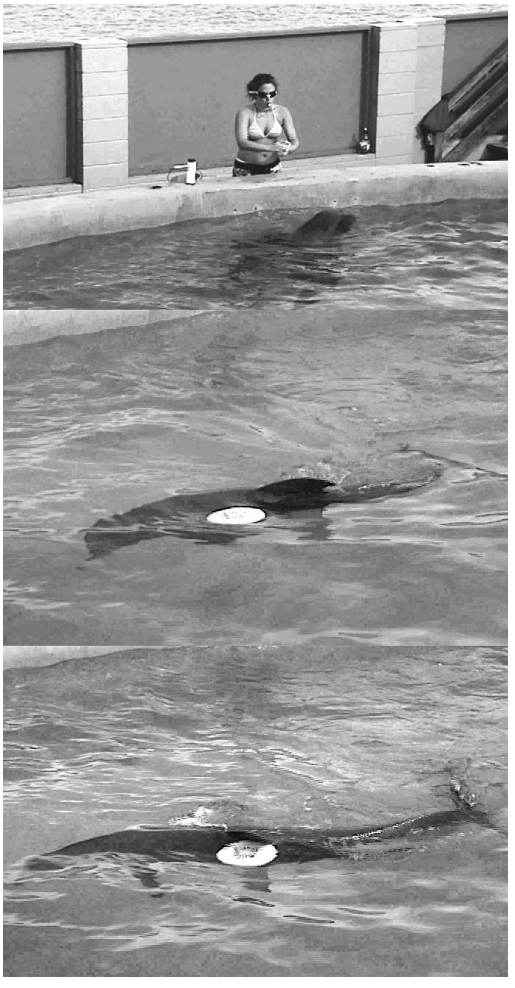

**Figure 31.** Body-part understanding. *Top:* Elele is given the three-word gestural instruction "Frisbee. Dorsal fin, touch," a novel instruction that requires Elele to have conscious awareness and conscious control of her body parts. The trainer (Elia Herman) is just completing the gestural sign for "dorsal fin." *Center:* Elele approaches the floating Frisbee with her body cocked sideways. *Bottom:* Elele lays her dorsal fin squarely on the Frisbee and holds there until she hears a whistle signifying "Correct."

images constructed through vision, as determined through cross-modality matching studies (Herman et al., 1998; Pack et al., 2004).

*The Research Legacy and People*

Altogether, during its tenure from 1969 to its closure in 2004 when the last dolphin, Hiapo, passed away, the lab produced over 160 scientific publications and reports on dolphins and whales, plus 41 theses and dissertations. Among those who worked closely with me in our dolphin and/or whale studies were Ron Antinoja, Bill Arbeit, Scott Baker, Gordon Bauer, Brooks Bays,

**Figure 32.** Vision-echolocation cross-modal matching. Elele has been shown an object in air to her visual sense and must find a matching object in one of the three visually opaque but acoustically transparent partially anechoic boxes, using her echolocation sense. Most often, Elele is able to locate the matching object or, alternatively, she may press a "none of the above" paddle if she determines that there is no match.

Frank Beach III, Krista Berkland, Brian Branstetter, Stacy Braslau-Schneck, Lea Carsrud, Becca Cowan, Alison Craig, Amy Cutting, Mark Deakos, Paul Forestell, Adam Frankel, Chris Gabriele, Kira Goetschius, Judith Gordon, John Gory, Siri Hakala, Dave Helweg, Elia Herman, Hannah Herman, Esme Hoban, Alana Hobbs, Matthias Hoffman-Kuhnt, Greg Hunter, Daisy Kaplan, Deirdre Killebrew, Leah Kissel, Karl Langton, Naomi Macintosh, Carolyn Madsen, Dave Matus, Hillary Maybaum, Eddie Mercado, Amy Miller, Joe Mobley, Jean Osumi, Adam Pack, Mike Peacock, Chris Prince, Susan Reeve, Cathy Ritchie, Scott Roberts, Susan Rodenkirchen, Kathy Sdao, Melissa Shaw, Melissa Shyan, Scott Spitz, Bill Stifel, Alison Stimpert, Brian Tarbox, Kristin Taylor, Roger Thompson, Robert Uyeyama, Dave Weller, Erin Williams, Amy Wood, Mike Yunker, Mark Xitco, and Kathy Zagzepski, as well as post-doctoral colleagues Gary Bradshaw, Mark Holder, John Hovancik, Stan Kuczaj, Jim Ralston, Doug Richards, and Jim Wolz. It was truly a collaborative effort of the many students, interns, and staff who worked with me in this research marathon, together with nine remarkable and

unforgettable dolphins, and hundreds of photo-identified humpback whales who offered us the underside of their tail flukes as they dove.

*The Road's End*

Today, the place where the lab once stood, at the southeast corner of Kewalo Basin Harbor, is now but a parking lot, reminding me of that sad song that speaks of paving paradise. Altogether, though, it was a fine adventure while it lasted, and I am grateful that I could share so much of it with my wife Hannah and daughter Elia, who always offered their support and wisdom. When I look back over all those dolphin and whale years, as well as the years that came before "my unintended career," it seems as if my path was somewhat like that of a wanderer going nowhere in particular along an open highway, but stopping curiously at every location where a sign read, "Viewpoint ahead." Often, the views were spectacular.

**Figure 33.** Phoenix and Lou Herman in a close moment at the KBMML pools (*ca.* 1985)

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