# Introduction

*Kenneth S. Norris*

This book is the result of a 25-year-long attempt to learn about the lives of wild dolphins. From the late 1940s to the 1960s, a scattering of behavioral observations of captive bottlenose dolphins accumulated (McBride and Hebb 1948, Tavolga and Essapian 1957, Tavolga 1966, Bel'kovich and Yablokov 1963, 1969). The conclusion from these studies was that dolphins are social mammals exhibiting a variety of patterns known from terrestrial species. They do not behave like fish but instead have set up reasonably typical mammalian societies in captivity.

Although captive studies allowed consecutive and detailed observations over long periods of time, they still left the behaviorist to wonder what it was truly like to live in a wild dolphin school. The degree to which the captive environment had warped natural patterns remained unassessed. What, we wondered, was it like for a dolphin to live in a society of many dozens of animals, to swim many kilometers a day, and to dive a dozen times an hour to depths of 100 m (330 ft) or more? Who were the dolphin's enemies and how were they dealt with? How did wild dolphins catch food, sleep, communicate, give birth, mature, and die out in the ocean? How did they use both their vision and their echolocation at sea?

The captive studies could not include observations in the deep water where most dolphins live, nor the external dangers that must have been central in shaping their societies.

In the late 1960s, I became convinced that while we could learn much about dolphins from captive studies, somehow observers had to go to sea with the animals if we were ever to learn how they structured their societies. At the time, it was unclear if this could be done to any useful degree.

My home base at the time was Hawaii, so I sought a place around those islands where I could hope to find the same animals over and over again in a workable stretch of sea. I began by attempting to follow radiotagged schools from a shore-based triangulation station located on Oahu's Waianae Mountains. At the same time, I constructed my first dolphin-viewing vessel, which was officially named the *Mobile Observation Chamber (MOC)* but came to be called by one and all the "semisubmersible seasick machine" (or "SSSM") (see chap. 3).

We did spend much time with the dolphins along that coast and we made some preliminary findings, but the animals proved to be wary of people and boats and the area of calm water was small. Although we could often see the dolphins' backs and fins above the water as they rose to breathe and we did learn a little of the structure of their schools, nearly all that they did beneath the sea surface remained hidden to us. In the end, the vagaries of weather and the need for extensive vessel time made the effort prohibitively costly.

But like most such observational puzzles—whether the scientist is attempting to learn about orangutans or dolphins—once the uncertainties are brushed aside and one begins to search for opportunities to observe, one finds them. In time, we found ways to identify many individuals in a school and we could sometimes sex them. Our best opportunity for observation, to our surprise, proved to be the Hawaiian spinner dolphin *(Stenella longirostris),* a member of a mostly open ocean genus. Some of its populations were found to frequent the clear water coves of the various Hawaiian Islands on a daily basis. This discovery allowed us to do the first phase of this work (Norris and Dohl 1980*a*). We found a population of these dolphin along the extensive lee shore of the largest of the Hawaiian Islands, the island of Hawaii (see Appendix B).

These spinner dolphins did something else for us. They allowed small craft and even swimmers in their midst, and they usually swam in clear waters (clearer than we usually found along the shore of Oahu) where they could be identified, photographed, and observed underwater. Other studies of wild dolphin behavior had lacked, or nearly lacked, this underwater observational dimension. This chance allowed us to observe them in the context of a wild school, complete with predators, food sources, and the physical world of the sea. We could see the dolphins' reactions to the topography of deep island slopes and to sandy-bottomed coves where we learned their schools came to rest.

This penchant for coming into shallow bays gave us our only truly bias-free chance to watch them. From the nearly vertical lava bluffs backing Kealake'akua Bay, we could see and track wholly undisturbed schools as they swam over a white coral sand patch located at the deepest part of the bay (see fig. 1, frontispiece).

We soon learned how extremely sensitive spinner dolphins are to intruders. We learned that our underwater work with swimmers and viewing vehicles did indeed influence the schools we watched. At times when the dolphins had not yet settled into deep rest, the intrusion of a boat or swimmer caused them to inch away. If pursued tenaciously, they sometimes moved out of the rest cove altogether. At first, this effect was not clearly evident. On the water, we did not easily perceive the reactions of the entire school relative to us. But from the clifftop, their edginess toward one of our teams on the water was clearly observable against the dimension of the entire bay. In time, even from close up these reactions became obvious.

Nonetheless, especially when the spinners were active, they swirled around our observation vessel and sometimes peered through the windows at us. We finally came to understand that the spinners' descent into rest is a touchy time when they seem to be making the decision of whether or not to remain in a given rest area. But once the die had been cast, our intrusion seemed to be of much less concern to them.

Awakening proved to be a very interesting time. Repeatedly, we saw the dolphins' activity state change in a few minutes from deep rest to high activity. By classifying the aerial patterns of the spinners, we were soon able to judge the activity state of such dolphin schools. A hierarchy of different aerial patterns proved to be arrayed along a gradient of increasing activity.

Mother–young pairs cruised by our viewing capsule on a frequent basis. Sometimes we could hear their vocalizations in the context of their lives at sea. Jody Solow of our team was able to attract some active dolphins to her and exchange play objects with them as she swam along with their schools.

It is probably fair to say that more than in any study to date, we came to know the detailed cycling of the daily activity patterns of wild dolphins with some confidence. Much intimate school behavior began to fall into a broad contextual framework. For example, we could eventually match the frequency and kind of sound emissions against our knowledge of the daily patterns of spinner dolphin life. It is quite another matter to assign specific meanings to these sounds, although a speculative framework for the context of some of these signals is erected here. It is presented as a template for other workers to consider when they probe beyond the limits of our work.

What we did is what I call *natural history*. That is, we attempted to look at a single species from as many viewpoints as we could contrive to understand what the totality of the dolphin's life is really like. To me, this approach provides the ultimate in intellectual excitement that one can derive from field biology. Everything one sees is worth thinking about.

Then one can extend beyond these observations to consider a larger view of the animal's life and evolution, as I attempt to do here.

Animal behaviorists working with terrestrial animals can sometimes sit quietly watching their animals for long periods, but almost always, we dolphin watchers had to be content with brief encounters. We were seldom granted the chance to observe even modestly long sequences of behavior except from the cliffside (and there we could not see any details of underwater activity). Instead, we had to piece together behavior from film clips that typically lasted from just a few seconds to about a minute in length. The dolphins, always on the move even during rest, simply faded into the blue murk beyond the limits of our vision. This happened no matter how unobtrusive we tried to be in following them. They had dolphin business to do and we were not part of it, and furthermore, we could not easily follow them.

We began our work by determining the daily progression of behavior, which ultimately put our short behavioral sequences into context. But before events could be related contextually, they had to be seen over and over again. Surely, we have just scratched the surface because new insights came as fast when we were packing up our camp as they did when we first began.

We came at our spinners from every observational and conceptual angle we could devise. This book, as a result, outlines the broad aspects of a school-dwelling mammalian society living in three-dimensional open space. It ties spinner dolphin behavior to the ecology of a marine environment, and it begins to sketch how sounds, respiration, locomotion, and vision are used by these dolphins.

But it is also, in part, an "old man's book." I began my work with marine mammals four decades ago and I will not attempt any effort such as this again. At about my age, people begin to fall off of boats. As I wrote, I found I wanted very much to spell out how I had come to view dolphin life. This seemed especially urgent in view of the popular myths that had built up around dolphins. As the reader will find, dolphins are regarded here as a perfectly reasonable twig on the mammalian tree, albeit one that extends the group's range of possibilities in certain directions.

By the time I wrote my part of this book, years of rumination were behind some of the constructs we present here. I wanted to spell out the most important of these constructs while I had the chance (for example, I have been thinking about how dolphin schools work since I was a graduate student). The bulk of the long term piling of fact upon fact was work done by my younger colleagues who operated our field camp and could stay there all the time. Most of the inevitable routine work and most of the statistical tests are theirs.

Members of my team and I sometimes had quite different ways of extracting information from nature, and the work is much better for this diversity. My usual method is to spend time (often months or years) observing, hypothesizing, and checking my hypotheses against nature before I begin real quantification (beyond the normal run of daily field notes, which are full of little quantifications). I built up an overview of the dolphin's patterns and then began to ask pointed questions. I depended a great deal on this knowledge of my animal and upon this slow hypothesis building, testing, and retesting. It can be an almost magical experience to watch the structure of nature unfold as one comes to see more and more deeply into how things work. From chaos at the start, one can sometimes come to see meaning in most events. My method lets me refine my personal biases as I shape and reshape them. It works because nature is not reluctant to point out my mistakes, and because I have trained myself to discard fallen hypotheses. But one must reconcile oneself to creeping up on truth through a thicket of these fallen hypotheses. Most of the time the process is mental and observational and, only at the last, statistical. Statistics becomes a method to validate your conclusions for others.

Others in my team took a radically different route. They sought to quantify what was in front of them at the outset, to build up anonymous data sets free of the inevitable personal biases implicit in my method. Then, with these "true" numbers before them, they looked for patterns in the data sets. What emerged from these two methods performed side-by-side was, I thought, fascinating. We tended to see different things. The statistical search could uncover things I could not see with just eyes.

My method allowed us to set the events of breathing, spinning, schooling and school structure, and the progress of acoustic behavior throughout the 24-hr cycle in a contextual framework subject to further testing and refinement by other observers at other times. The method of quantifying at the start showed unexpected things: the relationship between departure from rest coves and day length, the fluid nature of dolphin society, and the necessary erection of an offshore superschool as a larger unit of organization at the island of Hawaii. In short, this book benefitted because we used both paradigms in its construction.

Our study, like any piece of fieldwork, raises more questions than it answers. Intriguing questions about the balance between kinship and cooperation beyond family boundaries in an extreme of mammalian social order are implicit in what we found. It seems true that no other mammalian species (including birds and treetop monkeys) exists all its life in an open three-dimensional world to the extent that these and other oce-

anic cetaceans do. For this reason, how schools work as protective systems is a major question in dolphin behavior and an important focus here.

Not surprisingly, we feel that this work is preliminary. It has been primarily an attempt to outline the basic behavior patterns of a dolphin species so that later, more sophisticated questions can be asked. Our efforts to relate spinner dolphin life to the important theories of sociobiology and behavioral ecology are preliminary. Instead of plunging directly into such questions, we first had to learn how to sex dolphins, to understand their mating system, to define the memberships and boundaries of the groups we saw, to make some broad sense of the babble of sounds they emit, and to see, first hand, how their schools were arranged.

My earlier and even more preliminary study with Thomas Dohl (Norris and Dohl 1980*a*) showed only the outlines of what we could expect to learn about spinner dolphins. We did the work during our spare time while we both worked at the Oceanic Institute, on Oahu, Hawaii. Between that work and this present study, I had returned to my mainland post at the University of California. Thus, any new work became, perforce, a real expeditionary effort and not something that could be pieced together on weekends spent at the island of Hawaii. So my first effort for this work was to build a team (fig. 2).

I had learned of a pair of promising young workers from cetologist Roger Payne. Bernd and Melany Würsig had worked for three years at Payne's right whale camp at Golfo San José, Argentina, living in a generator house because the main camp was too crowded. The two of them had taken Roger's innovation of tracking marine mammals from shore with a surveyor's theodolite and had made it into an art. Preeminent among a small handful of workers, they had advanced the art of photo-identification of individual cetaceans into a major tool for the analysis of cetacean populations and movements. Their work and that of Dr.'s Michael Bigg and John Ford, and to a minor extent my colleague Thomas Dohl and myself, had begun to demonstrate during the early 1970s that if one were persistent, it was possible to learn a considerable amount about any dolphin school by scars and marks on backs and dorsal fins. Then, over time, the social structure of a dolphin society could be unraveled bit by bit.

Bernd and Melany Würsig did another thing that attracted me to them. Among behavioral cetologists, more than anyone preceding them, they put numbers on everything they saw. Their papers were peppered with probabilities that let the reader assess the validity of their assertions. Because of them and a few others, cetacean science leapt from the anecdotal to the verifiable. I wanted that hallmark on this new work.

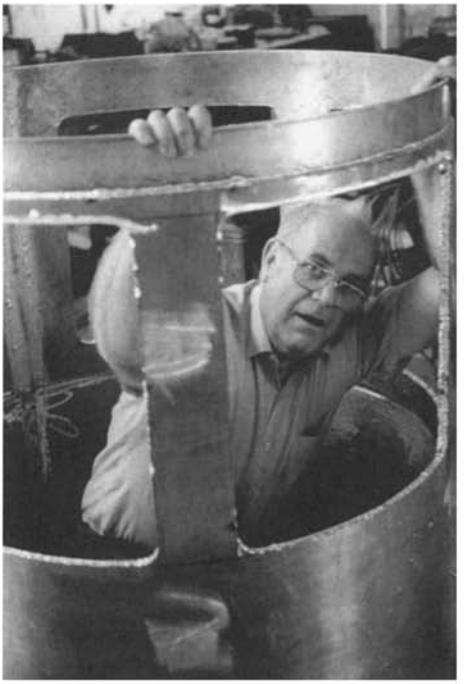
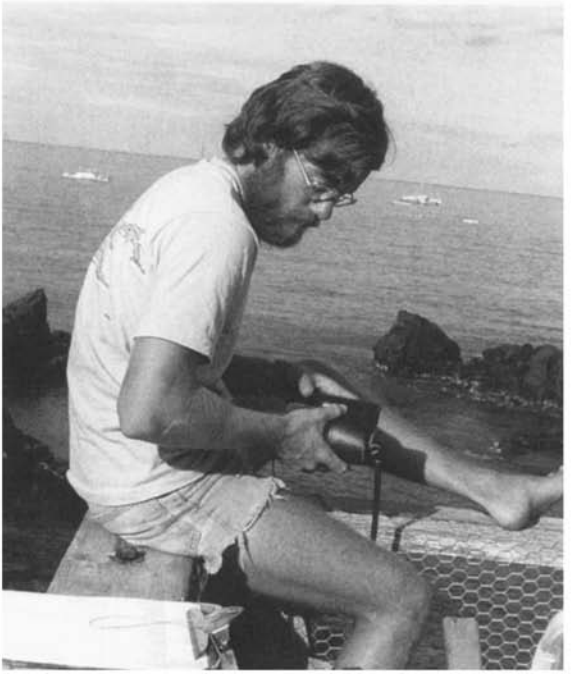


Figure 2. The Hana Nai'a research team. Above: Kenneth Norris, Bernd and Melany Würsig; page 8: Randall Wells, Shannon Brownlee; page 9: Christine Johnson, Jody Solow.




I had initially corresponded with Bernd when he wrote from storm-swept Patagonia, Argentina, asking for advice on how best to begin his behavior studies on dusky and bottlenose dolphins. Four years later, as he was writing his Ph.D. dissertation, we laid plans for them to join the spinner dolphin team.

Bernd became my team leader. He was involved in nearly everything we did. He and Melany took as special tasks the establishment and operation of a theodolite tracking station one-third of the way up the 150-m Kealake'akua cliff. They led the enormous task of assembling,

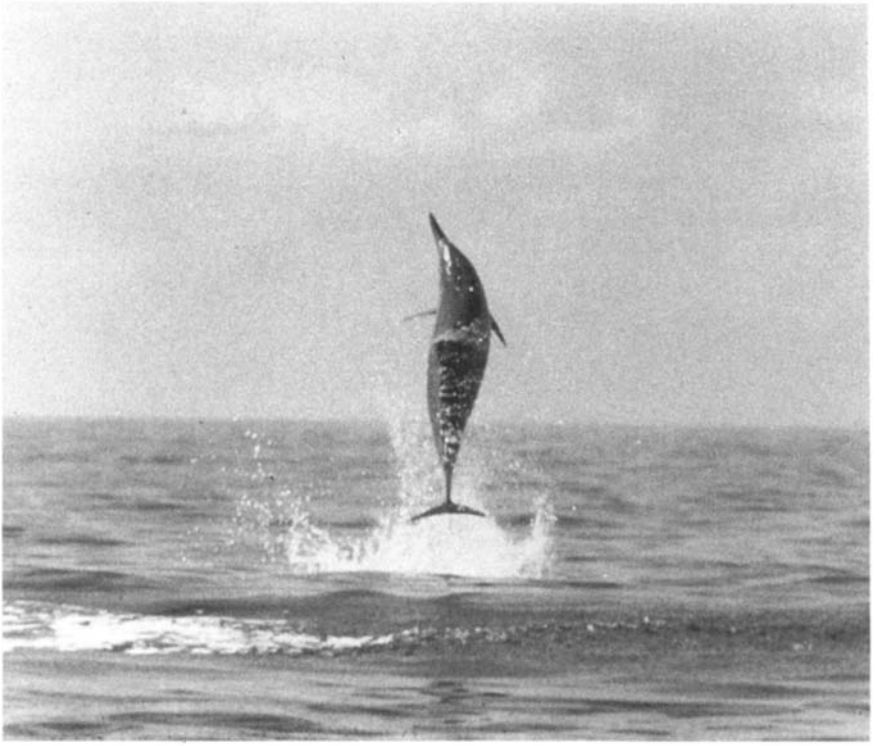


Figure 3. A spinner in a spin at Kealake'akua Bay.

cataloguing, and interpreting the nearly 20,000 individual identification slides on which this work is based. Bernd spearheaded the hourly watch over Kealake'akua Bay from the dock at the field station that went on continuously for the first 12 months of the study. This chronicled the comings and goings of the dolphins into and out of the bay, their numbers, and their behavioral states. We learned to gauge behavioral state by observing the kinds and intensities of aerial behavior. An adult spinner is shown demonstrating its trademark spin in figure 3.

Bernd also made everything work, from pick-up trucks to electronic equipment. I had not bargained for that skill, but I found that I had brought into our camp one of the most skillful adjudicators with the mechanical world that I have ever met. This was fortunate because I am one of those in whose hands instruments and automobiles quickly disassemble following the second law of thermodynamics.

I met the other part of my field leadership team on board the old square-rigged whale research vessel *Regina Maris* as my wife Phyllis and I sailed along the outer coast of Newfoundland. I was on board to teach

and help with observations of humpback whales along that rugged shore. Also on board was knowledgeable, organized Randy Wells. He had come aboard as part of a team attempting to radiotrack a humpback whale that had been released from a nearby pound net. As experienced as Bernd, from a decade of studies of bottlenose dolphins in Florida, he had yet to complete his degree. So he joined both my doctoral program and the Kealake'akua effort at the same time, and the spinner team leadership was complete. I could not have asked for better.

Randy had worked extensively with a population of bottlenose dolphins living along the Florida coast, among other projects. He knew a great deal about programs and boats and all it takes to run them safely, and so he had much to do with making our sea effort go. He also emerged as an excellent photographer. He and Bernd became a well-oiled team when photography of wild dolphins was needed. They balanced on opposite rails of our vessel's bow, and their motor-driven cameras soon caught every animal that surfaced. He designed and led the flight program that allowed us to locate, count, and resight schools around Hawaii. He traveled every two weeks to Oahu Island to take blood samples and observe behavior from a captive spinner population so that we could pin down the annual hormonal cycle of spinners. He and Bernd captured and radiotracked dolphins and obtained underwater films of their schools. Together they kept the entire complex operation going in every aspect of its accounting, logistics, and science.

There is nothing that pleases me more than seeing the talents of some young person unfold when opportunity is provided. So I had much to do with populating the Kealake'akua camp with promising students who I thought could help with key parts of our program or who wanted to try new things. Here I mention the four who share the masthead with the Würsigs, Randy Wells, and myself. Many others who had lesser roles, some of great importance to our effort, are acknowledged later.

I had known Shannon Brownlee for a long time, in fact, since she was a young child. Years later, she became one of my students at the University of California, Santa Cruz. By then, she was an artist of skill and style much like her father, but I did not fully understand that she had also developed powerful analytical, mathematical, and writing skills. The task was placed in remarkably capable hands when I suggested that she attempt the difficult task of unraveling the daily cycle of sounds of spinner dolphins.

The second student, Jody Solow, joined us to see if a swimmer could make friends with a dolphin school, just as Jane Goodall had done with her chimpanzees. Jody is as fearless as any fieldworker I have every known, which was necessary because swimming with a warm water dolphin school also means swimming with their attendant sharks. Jody ap-

plied her inventive mind and great empathy for animals into an effort that came close to succeeding. Her work contributed important insights about how dolphins live. Spinner dolphin schools proved to be vital to their members to a far greater degree than to dolphins of shallower or more enclosed waters. They would not lag behind their traveling schoolmates for long to play with a plodding human. But they swam with her repeatedly, if only briefly, even allowing her in the midst of their schools at times, but they always continued on their way.

I met Christine Johnson as one of the many young students interested in dolphins who have passed through my office. She showed special mettle in a long observational study of two Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) at Steinhart Aquarium in San Francisco. I found her to be a student of exceptional theoretical capability and one wholly devoted to learning about the minds of animals and people, an ability we now lump under the term *cognitive science*. When I met her, I had begun to edge my own interest over in that direction. I, too, wanted to learn in cognitive terms how dolphin societies work. So Chris became a explorer with me of the intricacies of dolphin behavior as seen from underwater. More than anyone else, she spent her days down in the viewing compartment of the *Maka Ala*, our underwater observation vehicle, watching the dolphins of Kealake'akua Bay. The bulk of what we say in this book about that effort evolved between us. It is still an incomplete effort, a reconnaissance, but it clearly shows the value of underwater observation for learning about the societies of wild dolphins. In fact, I venture to say that the new frontier in wild dolphin behavioral studies lies in such underwater efforts.

Nearly everything we saw from the *Maka Ala* was new. What Tom Dohl and I had done earlier, and what others such as Bill Evans with his viewing vehicle *SeeSea* had produced, were really just snapshots. The *Maka Ala* study reported in this book is a little better, even though the vessel was uncomfortable and unable to negotiate even modest seas. It was also very difficult to keep her ports clean, and only occasionally could we sex a dolphin through her downward-sloping windows. Nonetheless, she showed us what a better vessel could teach us.

After the Hana Nai'a camp was closed down and we had returned to Santa Cruz, Randy and I began to design a new and better viewing vessel with a hoistable chamber, bearing in mind what we had learned from the *Maka Ala*. My doctoral student Jan Östman joined us and took a major burden in the construction and early operation of this new craft, which is described in chapter 3. Jan has the new vessel at sea off the Kona Coast as I write. We have found that we can easily hoist the observation cylinder up into the hull, go 12 knots into a reasonable sea until we find dolphins, lower the cylinder down into its coaming through the hull, de-

scend a ladder into it for observations, and when done, hoist it again for the trip home. Sexing dolphins is no longer the difficult problem it was in the present work because one can look upward through the vertical windows of the cylinder and see the genitalia of the animals swimming diagonally above.

Much unraveling of the details of spinner dolphin life lies ahead with this new craft, which Jan, a Swedish national, has given the almost unpronounceable name of *Smyg Tittar'n,* which he says means "tiptoeing looker" but which we Americans translate into "tiptoeing peeping Tom."

My part has been to shape all this, to share in the field experience, and to watch my young professional colleagues go about their work, doing much of it better than I could. I have also thought hard about the trove of information we have assembled and have tried to make a coherent story of it.

As it turns out, I chose my colleagues well. Dr. Bernd Würsig is now a major worker on wild dolphins and whales, directing a large marine mammal program at Texas A&M University, Galveston, Texas. Melany raises their two children and helps, as she always has, with Bernd's various projects. Dr. Randall Wells is now the world authority on the structure of wild bottlenose dolphin schools and a staff behavioral ecologist at the Brookfield Zoo, Chicago. Shannon Brownlee has won two national awards as a science writer and is now Senior Editor for Science at the magazine *U.S. News and World Report* in Washington, D.C. Jody Solow is a Ph.D. candidate in cultural ecology at Cambridge University, England, and in the field in the Solomon Islands. Christine Johnson has completed a doctoral program in cognitive psychology at Cornell University in New York and teaches that subject at the University of California, San Diego.

We live in an exciting time. This century, this decade, this year, legions of scientists around the world probe into "the way things are," seeing aspects of how our world works for the first time in history. It is breathtaking to have been a tiny part of this great uncovering. This book includes the first attempts by scientists to learn about oceanic dolphin lives underwater, at sea, where this lineage of animals has lived for several times as long as the human race has existed.