Recollections of the Scripps Kelp Program
(July 1958 to July 1961)
by Jay C. Quast[1]

An important part of my future arrived that summer afternoon; striding through the open door of my graduate office in the ichthyology section of the Biology Building at the University of Los Angles (UCLA). It was the familiar stocky form of Carl L. Hubbs,[2] icon in the world of ichthyology – world famous and senior professor at the Scripps Institution of Oceanography at La Jolla (about fifty miles south of Los Angeles). This gentleman commanded my respect – a "grey eminence" who in one way or another influenced just about all lives of researchers working on fishes at Scripps or UCLA.[3] I had finished most of my graduate requirements, was well into my Ph.D. research, and Carl, of course, was on my Ph.D. committee. And, of course, he was highly deferred to by Boyd Walker, my senior professor at UCLA, as well as other faculty there.

Contrary to what one might expect of such an eminent personality, Carl's manner was typically beyond pretension. If you encountered him on the street and didn't know who he was, you could easily think he was either some small haberdasher on a errand or a school teacher on the verge of retirement – plain-vanilla Midwestern, the ilk of Harry Truman. He wore his black hair in a "butch" cut and characteristically regarded we mere graduate students gruffly and with a rather bored expression. His wit was sharp, though a bit rustic, his insight penetrating, and his knowledge of fishes and their lives encyclopedic. Nuance, however, was not a strength – this man usually enjoyed coming directly to the point. He was on one of his periodic visits to UCLA (Scripps was administratively a part of UCLA then).

Taking a chair, Carl asked if he could have a few words, apologized for being in a hurry, and immediately came to his subject. He had two questions, the second depending on my response to the first: Would I be interested in joining a team at Scripps doing a special study on the kelp[4] forests of Southern California, including their fishes? (The Kelp Program had been established to assess the effect of commercial kelp harvesting on the kelp itself and the kelp-inhabiting fishes, and had already run four of its seven years.) Second – if I could join the Program soon, which meant I would undoubtedly have to move south to La Jolla – would Rosemary and I be interested in

house-sitting his home (and, it turns out, extensive flower garden) for several weeks while he and wife Laura visited the eastern U.S.?

The first question amounted to an offer I couldn't refuse. Foremost, it was a golden opportunity to become a professional in the life-work of my dreams. I would be paid not only to discover new information about fishes but work with them in their environment. I could start using the tools I had gained in my classes on fish identification, fishery science, botany, physics, and statistics. And I could use the physical fitness, training. and skills I had developed in several years of free ("skin") diving.[5] High on the list, was that this work probably would put me on the track for scuba training and entry into the underwater world being popularized by Jacques Cousteau. Not only would I be able to spend countless hours in that world, but would be paid and scientifically recognized for doing what I had for years longed to do. That night, spouse Rosemary shared my excitement at the offer, and next day I called to accept and say we would be glad to house-sit the Hubbs' beautiful home. Although these were the right decisions, perhaps my enthusiasm would have been tempered slightly had I asked important questions during the visit. For example, as I soon discovered, the Kelp Program had already employed a first-rank ichthyologist for several years, so why was I needed? And what would my relationship to this person be?

California sport fishing organizations, represented by their irascible spokesman, Ray Cannon, had become alarmed by the development of kelp harvesting in the inshore waters. The beds occur along much of California's southern shoreline and were favored sites for a large sport fishery. For the most part, the kelp industry took only the uppermost part of the plant, mainly a foot or two of the upper columns where the fronds bend and float just below the surface, sometimes extending laterally for yards. Harvest was by mechanized barges with front-mounted toothed mechanisms similar to a hay-mowing machines. The cut fronds were stacked via conveyor belt on the barges to be processed ashore for alginic-acid content.[6]

Many sport fishermen were convinced that such harvesting adversely affected the fish populations living in the beds. This was a reasonable assumption because research had already shown that several non-sport fish species depended on the giant kelp for food and shelter, and it required no great a leap in logic to think that sport species such as kelp

bass, sheepshead, and rockfish might be dependent on the kelp as well. The harvesting companies, however, believed that because they were just taking parts of fronds at or near the surface, enough of the plants remained after harvesting for good kelp survival and adequate fish habitat. Confident they were a threat neither to the kelp nor sport fishery, the companies volunteered to subsidize research on the issue through the California Department of Fish and Game. The state agency then contracted (for seven years and $200,000) with the Institute of Marine Resources (IMR) within the Scripps Institution of Oceanography.[7] IMR itself also contributed.

The Kelp Program was aimed at throwing enough light on the subject to put these question to rest. It would examine what might be the critical needs of the kelp forests and their fishes. Greatest emphasis was to be on the kelp plant itself and secondary emphasis on fishes, particularly sport species. Third were the invertebrates, many of which were known to be important in the food chain of the fishes, such as shrimp, snails, and mysids living within the tangled holdfast of the kelp plants or associated with the stipes and fronds.[8]

During its prime years the program employed about fourteen scientists and numerous part- and full-time technicians. For most of my three-year tenure I worked most closely with Wheeler North's group, in fact almost "lived" with them as we shared one of the small "T" (temporary) frame dwellings – surplus housing from some military establishment nearby that were moved onto the campus for additional office space. Wheeler, a scuba-diving botanist, was the program's leader and major investigator. Along with his diving technicians, he studied the gross characteristics (e.g., distribution, weight, height and growth rate) of the plants. He also analyzed their ecology (e.g., effects of water temperature and grazing by the small red sea urchin). A resident of La Jolla most of his life, Wheeler knew its kelp beds well.

A month or so after my enthusiastic response to Carl's offers, Rosemary and I moved to the Hubbs' house in La Jolla. Only a couple of years old, it was Spanish-style, spacious, and stood on a large lot on a high terrace that sloped toward the sea. It seemed like a palace after the cramped rental quarters we had occupied in Los Angeles. The building was C-shaped, with the two wings extending into an upward slope, enclosing a central, private, lawn. The middle portion had a handsome living room dominated by a

large fireplace. The north wing, which viewed a cul-de-sac that served the house, was made up of a fine dining area, big kitchen, utility room, and spacious two-car garage. The south wing had a large office (opening to the middle portion by large glass doors), then the bedrooms. Both office and living room looked westward through large plate-glass windows onto a panoramic view of the Pacific Ocean.

Although its availability greatly facilitated our move south, the offer of their house by the Hubbs was as practical (for them as well as for us) as altruistic. Up the hill from the two wings and enclosed lawn was, without doubt, a major motivation for their invitation – a large garden of flowering plants and shrubs that were phenomenally thirsty in the warm and arid Southern California summer. Near the end of each wing were erect hose bibs from which long hoses had to be dragged along several pathways for a goodly amount of daily hand watering (principally Rosemary's job). We also found the garden to be unique in that one section, farthest removed from street, was devoted to natural statuary chosen by Carl – pieces of forked beach driftwood, each embedded in the ground with fork upward, suggesting a human crotch.

We slept in the Hubbs' bed and found that Carl's side was set on boards. I sympathized because I too suffered from back trouble. As a result of his strategy, I adopted slab beds for the rest of my life. I also learned that Carl always took a cold shower on arising but lacked the strength of character to follow suit. The grand home did warp our sensibilities a bit. On moving out we occupied a small three-room rental in nearby San Diego constructed on a concrete slab and bordering a hot, noisy alley. It sported termites.

While Rosemary watered, I of course was finding out about my new position at Scripps. An early discovery was that this mere graduate student was not particularly welcomed with open arms by the then senior ichthyologist on the Kelp Program who was supposed – in the beginning at least – to be my supervisor. David E. Davies, visiting professor from South Africa, was a handsome, capable scientist, probably in his forties, with a good international reputation. But, among other things, from the start we had a cultural conflict – I found him overly demanding of deference, stand-offish, and quite old-world authoritarian. To my view, a product of California informality and equalitarianism, the tall good-looking South African, who often wore campaign shorts,

high stockings, and brightly polished shoes, resembled the archetypical army officer depicted in films of the old English Empire. I fully expected him to break out a swagger stick at any moment. Although Davies had the same mandate as I did, he seemed both unhappy and insecure with his place in the program. Although I was strongly oriented to working in the kelp beds directly with the fishes and all aspects of their biology, his time seemed to be mainly devoted to analyzing reports in a statistical study of sport fish catch versus kelp harvesting.[9] Although Davies was said to be scuba-capable, during the year or more that he had worked with the Program prior to my arrival he had made few if any field studies, and he made no dives after I joined the Program. Not only did he seem reluctant to use scuba, I never saw him associating with the other diving scientists or technicians. During my first days there I never heard his name mentioned among the diving scientists and technicians that were to become my close associates. He seemed a "loner." I recall that Davies walked with a slight limp, which may have indicated a physical problem. Now I realize there must have been much more going on behind the scenes that I didn't know about. But at that time I was preoccupied with bringing myself up to speed and didn't worry about it.

In those first days Davies and I shared a singular "office" on what I believe was the second story of the Ritter Building – the main structure (then) on campus. The room was amazingly small – more like a long obscure coat closet than a workplace. Opposing counters, separated by a narrow aisle, occupied its length except for the single door opening. Sash windows filled one side, and one on a narrow end gave a peek northward at other buildings on campus. The space was barely big enough to accommodate two persons and some rudimentary equipment such as typewriter, calculating machine, one or two file cabinets, and microscope. Its provenance was obvious, it had been made by closing off the farthest end of a standard laboratory room, through which we had to traverse to reach our office. The laboratory was shared with a physiologist working on arguably the world's most disgusting creature, the hagfish.

At this time, however, there was so much that was new and I was so naive professionally that the vast inadequacies of those meager facilities relative to my eventual research needs didn't enter my mind. I was overwhelmed with the excitement of starting research (spearing a few kelp-bed fishes and analyzing their stomach contents), trying to

adapt to Davies, getting acquainted with the Hubbs' house and garden, scuba training, and getting my Doctoral thesis into final form.

My first task on joining the Kelp Project was learning the craft of scuba diving. I was already an accomplished swimmer and had built stamina during several years of skin diving with a snorkel along the rocky coastline off Los Angeles. In order to qualify for training, prospective Scripps scuba divers had to show they had the strength and endurance to swim "once around the pier" – from the beach along the length of Scripps pier then back along the other side to the beach. The swim involved about a quarter mile of ocean swimming without the aid of flippers, and entering and exiting through the surf. My test was administered by the internationally-famous Conrad Limbaugh, known to all as "Connie," Scripps' chief professional diver. Connie followed my progress from the top of the pier, carrying a ring-style life preserver to throw to me, and ready to dive from the pier if I encountered trouble. I had no serious problem but found the test more difficult than I expected, and the time taken to round the pier considerably longer than I thought it would take. The exposed sandy-beach surf was stronger than I had experienced in my free-dives off Los Angeles, where the seas are moderated by the Channel Islands offshore. I missed the assistance of large flippers, which I had always used when free diving, and a floating inner tube on which I could hang and rest. Here, if I panicked there would be only lacerating mussel- and barnacle-encrusted pilings to embrace while tossing in the four-foot waves. But my test went well except at the very last where I had to land through the boisterous shallow surf on the beach. Despite having had little experience catching waves and none doing so without flippers, I tried to catch one small wave, planning to relax while I body-surfed in. The combination of misjudgment and showing off resulted in my disappearance in turbulence and foam for fifteen seconds or so (I remember being upended and surrounded by gaily dancing bubbles) before locating the bottom and getting to my feet to walk ashore. I had been in no danger but Connie said I had given him a frightening moment (and it would have been dangerous for him to dive from the high pier into such shallow water). I passed.

Connie became my mentor, not only for diving, but also, to a considerable extent, Scripps' and La Jolla's rich culture as well. He was a talented, intelligent, lovable bull of a man – liked and respected by all.[10] Principally self-educated in the physics of diving

and oceanography, he had gained sufficient expertise on the region's fishes to author, aided by Carl L. Hubbs, an early, highly regarded book on the fishes of the La Jolla kelp beds. Although prematurely bald for a man otherwise appearing to be in his mid-thirties, he had a strong sexual appeal to women. As a late teenager and young adult he was a self-styled "beach bum," hanging out on the Southern California beaches and supporting himself by life-guarding and odd jobs. I believe he may have started junior college but lost interest – professors and books couldn't compete with the lure of the beaches and their freedoms, beautiful girls, parties, wonderful sunshine, and ocean swimming and surfing. As an example of his earlier beach-bum days, he described how he once gave himself the assignment of having sex with a different woman every night for one week (but said he missed by one night). His interest and expertise in ocean activities led to experiments with early versions of Cousteau's Aqua Lung and work for Scripps as a specimen collector. Collecting and association with research biologists, particularly the inspiring Carl L. Hubbs, stimulated Connie's interest in the biology of the region, especially the fishes, and he became an expert observer and respected scientist.

Connie had been an active participant in the dawn of scuba diving, precipitated by the breakthrough developments of inexpensive foam-rubber suits and the popular scuba apparatus called the "Aqua Lung." Inexpensive heat-retaining suits were important because of water's high specific heat, making it an efficient heat remover when in direct contact with the skin. For bare swimmers, even mid-sixty temperatures can be uncomfortably cold and possibly dangerous with long exposure. Although La Jolla is located in so-called "sunny Southern California," average surface water temperatures even in June may be only in the upper sixties and may frequently drop into the lower fifties (and much lower at diving depths of only thirty feet). When Connie began experimenting with early scuba gear, the only practical protection from heat loss was long underwear – ridiculously minimal at best.[11] (About its only benefit was a slight slowing of cold water circulating over the skin.) Although the free diver can warm himself with the energy expended in diving as well as returning to and lingering in the warmer surface layer and it's sunshine, the scuba diver minimizes energy expenditure to conserve air and remains in the cooler depths. Water-tight two-piece Latex suits, worn over long underwear, soon became available, but were expensive, had poor insulating

qualities (the air layer trapped in thinly compressed underwear), and were easily punctured. They involved considerable effort to don and doff. It was the inexpensive foam rubber suit that gave the real boost to scientific and recreational diving in cooler and cold waters. It was called "wet" because it allowed some water to work between the foam layer and the diver's skin, which didn't really matter because the water quickly warmed to near body temperature. By the time I joined the Program, all Scripps divers wore foam.[12]

The swimming-pool part of my training, also personally given by Connie, went well. It included swimming considerable distances under water without a breathing aid and practice with the Aqua Lung in the shallow part of the pool. I learned the technique of "buddy breathing," whereby one diver shares his mouthpiece with another who supposedly is having trouble with his breathing apparatus (I pool-practiced this with another trainee who came down with infectious mononucleosis while we were in the training – fortunately I suffered no serious consequences). There was time spent on the diving tables, which relate depth of dive to bottom-time available without reaching nitrogen saturation in the blood (and being vulnerable to the bends). I learned about, and later experienced, carbon dioxide buildup, usually expressed by a strong dull pain in the back of the head, suffered by a diver who doesn't ventilate properly (easily done when concentrating on a task). There was the art of proper weighting (a weight belt is needed to help a diver submerge because of his natural buoyancy and that of his diving suit, but the diver becomes heavier with depth because air in insulating materials will compress). I learned the parts of the Aqua Lung and their functions (for many years the earlier models had a pair of corrugated hoses that lead around both sides of the diver's head to the mouthpiece). We learned the importance of ventilating one's lungs generously when rising to the surface to avoid air-pressure buildup in the lungs and possible air embolism (deadly air bubbles circulating to the brain). There were the "squeezes" – ear, sinus, and face-plate[13] – which I would sometimes experience and see in others. And there was the lore: For example Connie's story about recovering the body of a novice abalone diver from deep water – the man had made the fatal mistake of wearing an over-weighted weight belt *inside* his Latex diving suit. As a result, the heavy belt couldn't be jettisoned

when the diver lost buoyancy with depth and harvested a heavy sack of abalones. The victim, dead four hours and in rigor, still retained a vice-like grip on the sack.

The scuba training took a considerable amount of my time the first month, but I did manage to begin spearing fishes in the La Jolla kelp beds and analyzing stomach contents. Davies and I began adapting to each other somewhat but there was no friendship developing. Most of my office time was spent identifying and tallying invertebrates and he wrote or operated the mechanical calculator.

The first overt friction between the two of us developed on publication of the project's first monthly report after I joined the Program. Since Davies was the senior person (by far) in our party of two, he wrote and submitted the report. As my contribution, I furnished him with a summary of my findings, which I believed to be quite interesting. Possibly because I was not available at the time, I had no opportunity to review what he had written before submission. Later, when I read what had been published and circulated by the California Fish and Game, I found that the report had been well done and that it included many of my data and conclusions. However, my name appeared nowhere, particularly not in regard to my contribution – the only one appearing was "David E. Davies, Project Leader." Perhaps his lapse was inadvertent; or perhaps it was accepted practice in South African academic hierarchies not to give named credit to the work of subordinates; possibly, also, I was overly thirsty for recognition. Anyway, I tried to diplomatically take the matter up with him, pointing out that I felt that fairness demanded that progress worth mention should be accompanied by some recognition, particularly since this research was begun and carried out under my instigation. This incident apparently sealed the end of our relationship.

Almost by magic, shortly I was moved from the isolation, loneliness, and closeting with someone I couldn't get along with – as well as the nearby hagfish – to the wonderful extended-family atmosphere of Building T-4. This was the office home of Wheeler North, the active scientist and Program Director for the Kelp Program, most of his staff and, best of all, a large office I shared with Conrad Limbaugh.[14] (Connie, however, was not a member of the Kelp Program). This homey office overlooked, and stood just a small street's width from, Scripps' beautiful white-sand beach and surf. Soon afterward I learned that Davies was leaving Scripps to return to South Africa.[15]

T-4 had a small front porch leading into a large space that probably once served as the cottage's living and dining area. Wheeler and his secretary, Lois, occupied what may have been a kitchen, breakfast nook, and pantry to the left. Straight ahead and to the left was a large former master bedroom, now the office Connie and I shared, with attached bathroom. An enclosed back porch furnished a large sink, counter, and attached storeroom. The walls had functional inset electric heaters, and we were serviced by phone lines, water, and electricity. Numerous sash windows let in an abundance of sunshine, giving a soft, informal, and wonderful ambiance – without doubt it was a working space vastly preferable to the many-storied, modern, honeycomb, concrete structures that now grace the campus.

In contrast to the isolation, bureaucracy, and hierarchy I had experienced when closeted with Davies, in T-4 I found friendliness, collegiality and the atmosphere of LETS GO! Everyone enjoyed and respected Wheeler. Of average stature, thin and wiry, he had tremendous drive yet was soft-spoken and self-effacing. He suffered from a chronic and severe back problem caused by an accident he suffered several years previously on the cliff in front of his shoreline house. Often visible when he was suiting up for a dive, his spine was contorted into an S shape. I understood he often, possibly always, needed pain medication. He combined a bright mind with a sunny, supportive disposition. Wheeler wouldn't hesitate to let you know when he disagreed, yet would seem to almost apologize for having a different view – sometimes I actually felt guilty when I found I must express a differing opinion. About the strongest language I ever heard him use was "Shucks." He was a hands-on leader and despite his severe physical handicap dove incessantly for his research.

Wheeler was from a socially prominent La Jolla family and a long-time resident of that seashore community. As already mentioned, Conrad Limbaugh was also a long-time resident of Southern California, but "from the other end of the beach," so to speak. Over the two years I shared the office with Connie I found him to be a rich source of anecdotes about La Jolla's (and early Scripps') social intrigues (including some involving Connie himself).[16] One was an amusing story (I have been unable to confirm) about a cocktail party that Wheeler and his wife, Nancy, had once thrown . Attending were many

socially-prominent La Jollans, and the Norths had decided to serve martinis. In order to avoid the tedium of last-minute preparation, Wheeler mixed several gallons in glass pitchers a day or more in advance, and stored them – to get "good and cold" – in his deep freezer. When most of the guests had arrived and had started munching canapés, Wheeler went to the martini mix and was surprised to see the pitchers coated with ice inside. Paying little heed, he decanted the mixture into cold glasses and served the drinks, confident they should be especially good. Indeed, the freeze-dried martinis did go over well – so well that some guests quickly downed several. However, formation of the ice had boosted the alcohol concentration, and very soon the denouement struck. Guests began staggering and slumping into chairs or to the floor. The party came to a close when a prominent La Jolla matron collapsed face downward into a plate of canapés before staggering to her feet with globs of pate's, deviled eggs, and cream cheese, complete with adhering crackers, stuck to her face.

With the help of Connie and the other experienced divers and biologists, now my office companions, I was able to start extended field research on fishes. I chose three approaches: one, to establish what species normally exist in pristine kelp beds, along with their numbers – i.e., the "standing crop" of fishes; two, to establish the species and their numbers found in cut beds; and three, to try to determine the habitat requirements of the kelp-inhabiting species (for example whether they thrived in regions where giant kelp was absent) and their food specialties. For the standing crop estimates of pristine versus cut beds, I picked two methods: first, one that could be easily accomplished by two divers working from a skiff – namely swimming transects through the kelp beds and counting the species occurring within a set distance of my course – and second, use of a "wall" net to physically close off a part of a bed so that all of the fishes within the enclosure could be collected. This special net had been designed and begun by David Davies and was nearing completion when he left the Program. We all presumed the wall net would give greater precision and detail in estimating the fish standing crops than other methods, but knew it would be impractical for widespread use because of the large number of divers and other resources that would be required for each set. For the third approach – the habitat preferred by the various fish species, especially their foods, I

utilized the fish transects made in the various habitats, and stomachs of specimens taken in the wall-net collections, by spear fishing, and from sport fishing boats.

As anticipated, transects were my most frequently used method. Here, I swam a compass course, usually close to the bottom (in water too deep to see the surface I usually ran another near-surface transect as well), while my assistant followed, unwinding a line of standard length. Over this distance I tallied occurrences of fish species and other data within a band of standard width on a large white Fiberglass slate which included a spherical diving compass in its top. Early on, it became apparent that my transect needs for accompanying technicians could not be satisfied by the existing divers with the Kelp Program, and a woman diver, Jean Kauanui, was hired. Together, Jean and I swam transects in cut and uncut beds all over Southern California, as well as in northern Baja California, Mexico.

For fish collecting, the old-fashioned pole spear, a straight wooden pole about seven feet long with five-tined spear at one end and a loop of surgical rubber tubing at the other, was the implement of choice. You could swim with this spear "cocked" – that is with the surgical tubing stretched to your hand (the loop anchored between your thumb and forefinger) while you gripped the forward part of the shaft. On releasing your grip, the shaft would shoot forward to impale the target on the spear's tines. A different spear more favored by skin divers, probably because of its lighter weight and easier maneuverability, was the Hawaiian sling. It used a steel shaft about five feet long that was propelled by a loop of surgical rubber attached to the back of a wooden hand grip with a hole drilled down its center to accommodate the shaft. A conventional door hinge at the forward end of the handle held the metal shaft from flying forward by jamming it until you pulled on a trigger to straighten the hinge and release the shaft. The Hawaiian sling could shoot farther than the pole spear, but would often go completely through a fish without killing it, with subsequent loss of the fish. Also, the spear was easily lost because it traveled free for a considerable distance, often out of sight in water of limited visibility. Our specimens were usually attached to a fish stringer worn on our weight belt.[17]

Collecting fish stomachs on the sport fishing boats was successful and especially enjoyable. One boat in particular, the Seabiscuit, skippered by a delightful character,

Chili Troester, was willing to accommodate Rosemary, serving as my secretary, and me just about any time. Chili looked like a movie pirate, with wild red hair, thin build, and gold ring in his left ear. In his early thirties, he talked a blue streak. The Seabiscuit had a deck hand, equally a character, who in addition to his other chores dispensed live-anchovy "chum" at the fishing sites. The deck hand bragged that he once convinced a boatload of customers not to smoke because of the danger of starting a kelp fire. The third crew member was a jolly, matronly, middle-aged women who managed the boat's galley. I still savor the thought of munching her juicy hamburgers during a beautiful morning at sea.

The Chili Troester boat show yielded a rich assortment of stomachs of kelp-bed species. Typically the boat made a morning half-day voyage, leaving San Diego around eight. Once out of San Diego Bay, we would head north in warm air and bright sunshine along the white beaches of northern San Diego and La Jolla's scenic coastline. Chili had his favorite fishing spots, usually in kelp beds, and on approaching a site would circle while the deck hand tossed live chum from a live-bait tank . (Often you would see fish chasing the anchovies at the surface, a sure sign of good fishing.) We would then anchor or drift slowly over the chosen "hole." As fish were taken by passengers, I would, with their permission, identify and gut their catch (I had no refusals) then tie a numbered tag around each stomach before dropping it into a container of preservative. Meanwhile, my "secretary" would enter each tag number and corresponding species name, size, and other collecting information in an information log. The system worked well except under one circumstance – days, usually glassy-calm, when well-separated very regular and pronounced swells ("long-period" – with crests separated by tens of seconds or more) moved through the kelp beds. Known locally as "oily swells," they originated from large Pacific storms, usually at great distances. Under these conditions, the ship rolled violently and incessantly "in the trough." Then I could count on my secretary disappearing below decks to one of the cots. We tried over-the-counter seasickness medicines – but then she became so sleepy she wouldn't be of much use either.

Chili had a favorite fishing spot off northern La Jolla, just a mile or so south of Scripps. The place was about a half-mile out from the shoreline and the ocean surface was featureless here (no rocks visible or anchored kelp). Chili would orient the boat by

shore features and then cut his engines so that the boat would slowly drift across the spot. He would warn the passengers beforehand to lower their gear to the bottom but watch their fishing poles because at any moment they could get the strong strike of a large fish. This often happened when Rosemary and I were aboard – after a few minutes of drifting, several fishermen would have good strikes and land large fish. The spot intrigued me, particularly when I discovered from the Seabiscuit's fathometer that the water was only sixty-five feet deep here, well within scuba diving range. Judging from the evidence, it was probably a rocky reef projecting from the flat, sandy bay bottom. On one trip, I found linear range markers (streets that pointed in my direction and shore features such as trees or poles that aligned) in La Jolla city. Several days later I shared my information with Jimmy Stewart, the Program's chief diving technician, and on one fine day soon afterward we lowered a skiff from the Scripps pier and motored to the site. On anchoring and meeting on the bottom after descending along the anchor line, we first found a featureless empty, white sand plain stretching to the limit of visibility in all directions. There were large ripple marks and the moving dappling of sunshine refracting through the clear water above. We chose to swim towards shore. Soon the view ahead took on the diffuse darkness of something large lurking just beyond visibility distance. We kept on our course (my heart started pounding) – then suddenly, a magnificent structure of boulders and bedrock emerged, the pile topped by a large slanted stone slab. There were fish everywhere, some quite large. Entire fishing poles, corroded reels still attached, lay scattered where they had been suddenly pulled from their mounts as fishing boats had drifted into the concentrations of big fish living there. Jimmy and I swam about the site for about ten minutes admiring the scene (Jimmy wore gray cloth-and-leather work gloves and while he peered closely among the boulders a foot-long rockfish grabbed one glove and had to be shaken loose). On examination, we found the reef had once been a point of rocky shore line, probably during lower ocean levels during a glacial period. The shoreline had then been eroded back by the ocean to separate this point. Afterward, all had been submerged by the rising postglacial seas. The formation was within easy range of scuba as well as expert free divers (later one free diver reported seeing a large black sea bass sheltering under the projecting stone). I initially named the place "slant

rock" but was pleased to hear the site is now called Quast Rock and has became part of a small marine sanctuary

The Program's completed wall net was an example of reality impacting supposedly well-laid plans – no matter how carefully the uninitiated prepares for a complex interaction with nature, procedures will almost always be challenged in unforeseen ways. The basic idea behind the net was simple: build a big net of fine mesh that reached from the ocean surface to the bottom, lay the net in a closed circle in a kelp bed, poison the fish in the enclosure with rotenone (harmful only to fish because it acts on their gills) pumped from a skiff, and then pick up the dead and dying fish with divers using hand nets. We had the boats to lay the net, either the Program's 21-foot power cruiser Macrocystis (generic name of the kelp plant) or the larger Scripps buoy tender. We practiced maneuvering in a circle while laying the net, which turned out to be unexpectedly complicated because the pull of the net feeding off the stern tended to straighten the boat's course (an incompletely closed net would allow valuable fish to escape). We anticipated we would need calm, sunny weather and a slack tide (to avoid currents), and assumed that Southern California would have an abundance of both. The net taught us, however, that a prediction of slack tide by the tidal tables did not insure lack of currents in the beds.[18] We found that unexpected currents would not only deform the net circle, making it difficult to estimate the area and volume enclosed, but that even slight currents would displace rotenone-treated water from the net downstream to cause mayhem outside while fishes on the up-current side within the enclosure were unaffected. In one instance currents threatened to bend the net over so badly that the fine netting became a hazard to divers operating inside (whose clothing and scuba gear offer endless opportunities for mesh entanglement). The operation had to be aborted. A wall-net operation, off Punta Banda, Baja California, Mexico, got off to a nearly disastrous start when we belatedly discovered our rotenone-pump wouldn't work – that solvent from a previous use had completely disabled the centrifugal pump's plastic impeller. Fortunately, we had brought an abundance of plastic bags, so the divers could spread the rotenone by hand. We found retrieving the net from a supposedly smooth bottom, even one thought to be quite free of rock outcrops, to be unexpectedly difficult because, inevitably, the fine mesh along the lead line (bottom of the net) would snag on rocks we

didn't know about. Then divers had to go down to try to disentangle the net, obviously a hazardous procedure. If that was not successful, we had to pull the net loose from the surface, resulting in extensive tearing of the mesh.. As a result of these and other difficulties, only three wall-net collections were sufficiently trouble-free to be regarded as successful.

We hoped the wall-net collections would yield glimpses of the entire fish community in prime uncut kelp beds, data not available by other methods.[19] For the bulk of the population estimates, however, the transect method was by far the most useful. In total I spent over a hundred hours underwater surveying from Gaviota, Southern California, to off Turtle Bay, about one-half the distance down the Pacific side of Baja California, Mexico. Wheeler's studies required visiting the extent of the kelp distribution in Southern and Baja California, and each of his forays was an opportunity to obtain data on the fish populations as well.

An important aspect of Wheeler's research was determining the standing crop of kelp growing in various habitats and under different cutting conditions. It required removing entire plants and floating them ashore for length and weight measurements of holdfasts, stipes, and fronds, a daunting task because of the weight (amounting up to hundreds of pounds) and length (up to 100 feet) of some plants. But this was only a portion of the task. Once ashore, the long stipes needed to be separated, labeled, and then stuffed into five-gallon wide-mouth cans with formaldehyde preservative for detailed measurements later in the laboratory. The work was labor intensive and would have been expensive if done by paid technicians. However, Wheeler, with his usual creativeness, devised an excellent low-cost solution – a summer program for junior and senior honor high-school students in La Jolla and San Diego.

In this scheme the Kelp Program sponsored camping expeditions lasting several days – food and transportation included – to various study sites along the coast of Southern California and Baja California, In exchange for a few hours of easy labor here and subsequently in the laboratory, the students enjoyed a free camping trip to the sea shore as well as an able introduction by a marine expert to coastal biology and scientific research. The scheme was a success, and the students participating, a dozen or so, were almost entirely teen-age girls.

During my work on the Program I saw little of Wheeler's student helpers because when on campus they usually worked in a different building. On expeditions I was fully occupied by my studies and the students had a separate camp. In two instances, however, I had noteworthy contact with members of the honor group.

The first occurred early in my work when I shared the cramped office with David Davies in the Ritter Building. It was a late-summer morning and the door to our office was open as well as the door from the laboratory outside to the hall. Suddenly we were alarmed by loud shouting and screeching coming from the hall. We dashed out and found the commotion coming from the laboratory immediately across from ours, a room used by Wheeler's group for storing and examining the five-gallon cans of preserved kelp that had been collected in the field. We were passed at the doorway by a technician rushing out with an open five-gallon can held at arms length. Inside the room was an overwhelming stench. People were shouting and running about, some frantically opening windows. It took a while for the place to settle down and for us to find out what had happened – a harmless but monumental mistake had been made on one of the field trips. As a background, when the students were included in a trip, customarily they occupied a separate camp with its own latrine and, since a large store of empty five-gallon wide-mouth cans was always available on such trips, it was the custom to use one or more of these cans for that purpose. Normally, on becoming full or on breaking camp, these cans were sealed and stored separately to be deposited in a garbage fill near San Diego. However, one such can had been sealed and accidentally placed in the truck with the preserved kelp, ending up in the stack of cans with preserved materials in the room. This day the stored kelp was being processed and the latrine can was opened, to everybody's immediate anguish (possibly the lid was almost ready to blow off from pressure of the fermenting contents, anyway).

The second instance happened a year later and on a quiet afternoon at T-4. It was also in late summer – I believe just before the secondary-school year was scheduled to start. Wheeler and secretary Lois were absent, and only three of us were present – myself, Jimmy Stewart, and George Snyder, who was analyzing fish stomach contents from our collections. One of Wheeler's student helpers, a short willowy attractive girl of about eighteen, entered the building, greeted George and Jimmy (I was in my office and

didn't see her enter, although my door was open) and shortly went into a bathroom off Wheeler's office. Moments later, she appeared, this time clothed only in brief pink brassier and panties. She seemed aroused sexually and went from one of us to another, chatting, laughing, and sitting closely nearby. She did not proposition us in words, but I am certain that given the chance she would have had sex with anyone present, perhaps everyone. We did not reproach her but, after acknowledging her presence, went on with our work. Soon, presumably with her sexual storm subsiding, she returned to the bathroom, dressed, and left the building, untouched.

The glories of body surfing at noon on the beautiful beach during summer and early fall must be mentioned. Many buildings there front on acres of clean white sand just a few steps from offices. The spot is a most attractive place to have a quick lunch before body surfing for the remainder of the break. Water temperatures generally were at 70 F. or higher from June through September so protective suits were not needed – besides, foam suits rob you of the delightful sensation of water and bubbles rushing across your skin. The giant flippers, Duck Feet, standard for our scuba diving then, vastly improved catching and riding a wave as well as powering back out through the turbulence.[20] The basic procedure of body surfing involves entering the surf from the beach by wading backwards through the shallow wash zone with your flippers pointing towards shore. When you reach swimming depth you turn and spring your body forward through the tumbling broken water and foam, kicking strongly and adding a breast stroke when needed for additional power or stability. You meet the waves head on, not by trying to swim over them but by powering straight through them. Once you have reached swimming depth, it is amazing how a large ferocious-looking wave rapidly moving towards you, sometimes with foaming water roaring down its face, can be easily transited merely by sticking your head into its base and letting it roll over you. When you move through such a wave in clear water (the usual summer condition), you will get a quick glimpse of the sandy bottom below (with little curlicues of sand rising from the passing disturbance). You swim outward through the breaking waves until you reach the zone where they gain pointed crests prior to breaking. Then you wait, allowing them to move over you until one appears you wish to catch. Just before it arrives, you turn toward the beach kicking strongly, possibly adding several breast strokes to gain speed. You will

then feel the wave lift your feet and body and it is time for a delightful slide on the wave's front face as you race toward the beach. You form a flat surface by holding your legs and flippers together, straight and stiff. Your arms are held at your sides to increase your planing surface. You keep your body on course by slightly canting your arms and hands in the smooth rushing water under you. Soon the wave breaks with a roar and for a few moments you glide before foam (under some surf conditions the top of the wave curls roundly leaving a long tunnel inside, which you may admire until all commotion breaks loose). Before you reach the shallow wash on the beach, you tuck your body (make a ball by reaching down and grasping your folded legs). You will do a quick effortless somersault under your wave and quickly emerge facing the rapidly receding crest and the beach. But don't linger, it's time to turn and swim back to sea through the next wave. If you wish to ride a wave onto the beach, you do not tuck but stay on the wave – just be certain you are not riding into rocks or other obstacles.

The vast majority of my transect surveys occurred in Southern California because I needed repetition to derive data of adequate reliability. However, I also made a number of trips, usually but not always initiated by Wheeler, south of the Mexican border to survey pristine kelp beds or fish populations away from kelp. Among the latter was one noteworthy five-day expedition to Guadalupe Island arranged by Carl Hubbs. The island interested me especially because, although lacking *Macrocystis,* it has many of the same fish species found in the Southern California beds. Volcanic, small, and precipitous, it lies approximately 275 miles southeast of San Diego and 165 miles off Baja California. Hubbs arranged for the trip, both to census a herd of sea elephants that used the beach on the northeast end of the island and to give the twenty students in his large-mammals class valuable field experience. Also invited were Scripps scientists interested in sampling sea-elephant blood, and Jimmy Stewart and myself. Our research platform was Scripps' converted high-seas tuna vessel, the Hugh M. Smith. Despite being in the month of January, we had calm seas and beautiful weather. On arrival, the Smith anchored off the main colony, which was in normal raucous turmoil with roaring bulls and yapping cows clearly heard from our anchorage. The mammal researchers were able to easily land on the beach. The big males progressed like one-ton maggots among their harems, stopping occasionally to pull themselves fully erect and threaten other males or the human visitors.

While the teams of mammal scientists and students worked the colony on the beach, Jimmy and I swam fish transects along the boulder-strewn shores. Every now and then we would encounter a sea elephant in our transects, but they posed no threat and were never belligerent. (Sea elephants feed mainly on squid taken in the deep ocean – probably the individuals we encountered were young males that the colony harem-masters[21] would not allow on the colony beach).

Our transects were uneventful except for unexpected wave-surge, poor visibility (thirty-five rather than the one-hundred foot visibility noted by other divers visiting Guadalupe Island), and encounters with the huge mammals. But on the morning we were scheduled to move to an anchorage at the south tip, the Smith suffered a mishap. On weighing anchor preparatory to moving, the anchor chain kinked in the haws pipe and snapped, and the loose anchor and section of chain reentered the bay with a big splash. Shortly afterward, the captain ordered the other anchor lowered. After a long conference between the ship's officers and Hubbs, Jimmy Stewart and I were asked if we could dive and attach a buoyed line to the lost anchor so it could be retrieved at a later date. According to the marine chart and the ship's fathometer we were anchored on slightly-sloping bottom at a depth of about 130 feet. It would be a mild decompression dive, but Jimmy said "no problem" and I assented but with some misgivings.

Now our roles would be reversed. Jimmy, the experienced professional diver, was in charge and I would assist. Although I was unpracticed in decompression, the hazard should be slight since only a few minutes decompression would be required. Nevertheless, the request put me in a dilemma because I had never been interested in diving to depths requiring decompression and was psychologically unprepared.[22] My goal was to learn all I could about the shallow zone, down to around eighty feet, which included almost all kelp-bed depths. Perhaps I could have justifiably refused but was under considerable peer pressure – a shipload of crew, scientists, and students. I assented. Although we planned making only one deep dive that day, we ended up making two.

Our plan was to take down a long line, carried by Jimmy, to tie to the lost anchor. We would then unwind the line as we returned to the surface where attendants waiting in a skiff would attach a small buoy. For the search, we would descend the good anchor

chain to the bottom and space ourselves out on a radius from the chain ten to fifteen feet apart (distances that we thought would give complementary circular search areas we could easily scan).[23]

Around 9:30 A.M. we entered the water from the boat-landing platform and swam on the surface to the heavy vertical (good) anchor chain. Jimmy promptly disappeared down the chain. I followed his waving flippers through his clouds of silvery bubbles. As mentioned previously, if weighted properly for depth at the start of a dive the diver must swim down against his own buoyancy when near the surface.[24] As the diver presses deeper, particularly on a deep dive, he is assaulted by a host of strong physical and psychological sensations. The danger of such an environment, despite adequate training and equipment, quickly manifests itself. As we gained depth, the surrounding void darkened from a cheerful sunlit greenish-blue to dark green and then a menacing dark-olive nothingness – this darkest point not indicating a drop into a frightful dark abyss but rather merely nearing a dark bottom.[25] With descent and increased water pressure, the familiar sigh of your breathing apparatus moves to higher pitch and seems "tighter." You swallow regularly to pressurize your inner ears (because of constrictions in my eustacean ducts I would hear entering air as a loud squeak). At around 100 feet your body senses the pressure without distinctly feeling it and despite the sighing of your breathing apparatus you feel immersed in cold inhospitable silence. Here, a wrong move or panic could subject you or your buddy to quick death or a lifetime of pain – there is no sunny surface nearby to quickly dart to. Then the surrounding nothingness reaches its darkest and vague features emerge from the gloom below.

I was unprepared for the scene. In my shallow diving I had become accustomed to well-illuminated sandy or rocky substrates. Here, the bottom appeared to be mainly big, automobile-sized, boulders, similar to the ones we had run surveys over in shallow water, but now covered with a thick blanket of black silt. The anchor chain we had descended now turned horizontal and leveled off, partly buried, into the gloom. Here and there rocks protruded through the silt to support dirty short tufts of seaweed. Scattered ghostly translucent-white sea pens, four or so inches tall when fully expanded, emerged from the black muck. Litter from countless boats using the anchorage over countless years was everywhere – beer cans, bottles, paper boxes, a helmet liner, broken pottery,

and paper towels. But most spectacular and macabre were bodies of huge sea elephants – in all stages of decomposition from nearly lifelike to mere lines of dirty, partly buried, skull and backbone within faint outlines of what was once their proud bodies. Welcome to The Valley of the Dead.

We quickly spaced ourselves along a radius of the circles we planned to search. Although I had expected to find cold clear water here, if anything the visibility was poorer than we had in the shallow surveys – it appears that despite our depth we were still in the same water mass as at the surface (on descending we encountered no noticeable thermocline[26]). Now we were subject not only to poor water transparency but also attenuated illumination, giving even less visibility distance – probably under twenty-five feet. Beyond that, the stygian scene dissolved into repulsive funeral emptiness. Except for the constrained sighing of my AquaLung, there was an ominous silence about the place – and the constant awareness of great pressure.

In retrospect, our search tactics contained two serious flaws, each augmenting the other: First, we had not anticipated the clouds of silt we would stir up on nearing the bottom. Second, we chose a starting point (center of our search circle) on the lowest part of the vertical section of chain when we should have followed the terminal horizontal part extending across the bottom to the good anchor and then use the good anchor as the center of our circle. As a result, when we completed about one-third of our circle and encountered an anchor, with flukes and part of anchor shaft protruding from the muck, the drifting cloud of silt had obscured most of the horizontal chain. Not visible was whether the chain was broken near the anchor or not, the critical difference between attached and lost anchors. We used up valuable time deciding, via hand signals, to swim along the chain and check it despite the dense drifting cloud. Although this stirred up even more silt, we soon discovered the chain was solid when finding it starting to lift off the bottom – obviously we had been following the good anchor chain. Now we were nearing the limit of our bottom time and were forced to cease operations and ascend.

It was still fairly early in the morning when we arrived back on the Smith. We decided that after lunch and the mandatory surface rest period (to rid our blood and tissues of excess nitrogen) we would return to the bottom and continue our search. This time, however, we decided that Jimmy would lead the search in a somewhat circular path

downslope of the point of anchor-chain contact (the bottom sloped gently deeper to near the contact and slightly steeper beyond). On this circuit we penetrated to a depth of 160 feet but found no trace of the lost anchor.

Next morning the Smith moved to the island's south anchorage to allow for more mammal and shallow-water fish surveys. The water was beautifully clear here. In the afternoon, Jimmy and I dove near Morro Sur, a spectacular headland, on one of the most beautiful dives I have ever encountered. Sheer rock cliffs dropped straight down through crystal-clear water to a depth of forty or fifty feet where they met a steeply-sloping rock slide composed of house-sized boulders which continued down to about eighty feet. The rocks were densely covered with colorful carpets of red and green algae and groves of short seaweeds. Beautiful schools of colored fish were everywhere.

Late in the day we departed the island for our return to San Diego. The afternoon was warm and beautiful, with a sea surface like faintly undulating glass. We had not gone far, probably only several miles, when we heard the ships engines slow, then idle, then completely shut down. On deck we joined a crowd lining the starboard side, anxiously looking ahead. We were drifting into a pod of resting or sleeping sperm whales. The big creatures were hanging motionless and nearly vertical in the clear water, individuals spaced perhaps sixty feet apart. The blunt forward part of each whale hung just below the surface and periodically a snout would barely emerge for a breath. There was no wind and we drifted slowly through the pod – there must have been around sixty animals. After about twenty fascinating minutes we left the beautiful monsters in peace.

Already mentioned, the Kelp Program's secretary was named Lois. She was well liked. And there was Pat, a tall, lanky technician specializing in motion and still photography. Both were Caucasian, probably in their mid-thirties, and they became romantically involved. It was spring, and time for the Mexican holiday Cinco de Mayo, which is widely celebrated in the Latino population of Southern California. Pat and Lois were invited to a large party at a friend's house and asked to bring another couple as guests. They invited Rosemary and me. It was an impressive affair held at a large private home and included about thirty guests. There were abundant Mexican specialties, including the traditional item for a Cinco de Mayo celebration, the highly decorated pottery container, called "Tinaja," hung by cords from the ceiling and stuffed with candy.

The big event in such celebrations is the breaking of the Tinaja, whereby the candy is scattered over the floor to be scrambled for by the guests. Typically, a lady in the party is asked to allow herself to be blindfolded and then given a stout wooden broomstick about four feet long. She then is supposed to swing blindly at where she thinks the Tinaja might be while the other guests joyously gather in a circle around her, out of swinging range, and shout instructions, misleading or not.

Lois, as Rosemary and I, had never attended a Tinaja party, and Lois was chosen for the position of honor – that of Tinaja breaker. It was Pat's role to blindfold his lady, point her in the right direction, and then step back a safe distance while she swung after the pottery vessel. Pat did the first part of his role well. He didn't, however, step back very far, possibly underestimating the will and vigor Lois would display. She started her swings mildly at first but then, encouraged by the shouting guests, began haphazard slices of surprising force and reach. Perhaps Pat had stepped slightly forward to better align Lois, but on one generous follow-through from a particularly wild swing she brought the staff down and well behind her, squarely swatting Pat in the testicles. Pat yelped in agony before doubling up, clutching his groin. He collapsed back into the crowd of shouting participants and was hardly noticed in the tumult. Lois, unaware she had grievously disabled her boyfriend, continued her wild swings and finally located the Tinaja. She gave it a solid thrashing and it broke. In the following commotion of guests scrambling for candy, we could not determine whether Pat participated or not.

For me, another of the more noteworthy expeditions of the Kelp Program was to Turtle Bay, which was shallow, protected, and on the Pacific side of Baja California, about one-half way down the peninsula. Several sparse kelp beds grew on several low reefs just outside its entrance to the Pacific. At that time there was a small town on the bay's northern shore with about a thousand inhabitants, living mostly in driftwood shacks and served by a decrepit pier and a nearby gravel landing strip.[27] Our lead party had set up camp on the eastern bay shore, well removed from town, and the fifty-foot Scripps' T-Boat, serving as our base of operations, anchored off the camp. Wheeler and Art Kelly, a graduate student and former veterinarian, and several others rode the T-boat down from San Diego. Because of the sparse kelp beds there, I only joined the expedition to conduct my surveys over its last several days, flying south from Ensenada

I had visited the town many times before and had always found it enjoyable, picturesque, and quite clean. This time, however, it was saturated daily by what could only be called the Big Stink – a powerful smell wafting from the harbor on the prevailing westerlies from a port-improvement project. A sardine cannery, which had dumped potent waste into the harbor for years, had recently been deprived of its avenue for disposal by a new encircling breakwater. The result – tons of semi-liquid sardine effluent piling up in what was now an enclosed lagoon to boisterously bubble and ferment in the warm sunshine.

I had originally planned on spending only a single night in Ensenada before catching a Aerocargo C-46 flight to Turtle Bay. However, I ended up spending three nights in the stinky town before being able to make the trip. Aerocargo's fleet consisted of two aged C-46s – cargo craft with only a few metal bucket seats in an otherwise nearly empty big aluminum fuselage. On the rough gravel airfields and landing strips, takeoffs and landings were somewhat like being towed over a gravel road in a tin can.

The attempt at flight the first morning was a bust – despite earlier assurances, there were "scheduling difficulties." I was told to come back the next morning. The next morning we did take off – it was very noisy, with no sound suppression from the twin radial engines and flying gravel from the airstrip bombarding the fuselage underside. But after about twenty-five minutes in the air, we abruptly banked and returned to Ensenada. This time, the right engine was "very bad" and needed to be replaced by one from another battered airplane parked nearby. It would take at least another day. Finally we did manage the flight to Turtle Bay where I was set down with my barracks bag on a naked gravel strip between sand dunes. Otherwise the landscape was absolutely empty. A dirt road paralleled the airstrip on one side but I didn't know which way to walk so carried my bag to the road and awaited developments. Soon, a rickety truck loaded with Mexicans came rattling past in a cloud of dust, and I was able to hitch a ride to the bay shore near the town. It happened to be the beach I wanted – the T-Boat was about a quarter mile offshore and soon a skiff beached nearby to pick me up.

I spent the first night aboard the T-Boat. Next day I helped unload materials from the boat to the beach, managing during the morning to run one fish transect in a small

kelp bed near the bay entrance. Since the boat had more people than it could comfortably sleep, I volunteered to spend that night on the beach with several other members of our party from our camp nearby. (I had brought a sleeping bag in my duffel, along with a cheap inflatable plastic air mattress, and there were extra folding canvas cots at the camp.)

That evening those of us that needed to were taken ashore where we proceeded to set up our cots well above the high-tide line on the gently shelving beach. I inflated my air mattress and rolled out the sleeping bag. The evening had few insects and the six-inch waves lapped softly. A beautiful glow filled the western sky and bay below and I crawled into the bag. Damn, the air mattress had leaked and was nearly flat. Since it had leaked before, I now carried a patching kit, but would have to locate the leak first. The answer was simple – there still seemed to be enough light to wade with the partially inflated mattress and submerge successive parts, watching for telltale bubbles.

Everybody on the trip had been warned about the hazard of sting rays, particularly in shallow shore water, and we were constantly on our guard. The shore looked like perfect habitat for the small round *Urobatis* stingray, whose diameter, wingtip to wingtip, is usually less than one foot. During the afternoon we had transferred equipment here and had been careful to shuffle our feet on the bottom, which we believed would root possible stingrays from the area before we could step on them and be hit with the lacerating spine on the top of their tail. The precautions seemed to work well and after many barefoot trips through this area no one had been hit. However, evening conditions for stingrays are different. As illumination drops, the small rays become less cautious about venturing into shallow water. As I waded I did slide my feet along the bottom. This time, however, instead of frightening the stingray off I felt my foot slide onto a firm slippery back and, simultaneously, a sharp spine hit the top of my foot.[28] There was nothing I could do but wade ashore and use a flashlight to signal the T-boat for help.

Enter Art Kelly – physiologist, veterinarian, and all-round knowledgeable good guy. Art was housed on the T-boat and soon made his appearance, seated in the stern of a skiff manned by a crew member. In the beam of my flashlight, Art, with his overweight frame, appeared a bit like Captain Bligh being set adrift with some of his loyal crew members in the old movie *Mutiny on the Bounty*. He emerged to the beach loaded down

with a big copper kettle and a box of Epsom Salt. A table, lantern, gasoline camp stove, and several folding chairs were brought from our nearby camp and Art was soon brewing a hot mix of Epsom-Salt in seawater. Meanwhile he worked at cleaning the wound. I sat for the next hour or so glumly soaking my injured foot in brew so hot I thought it might cook off at the ankle. Right there I gained an affection for that big selfless man which would last the rest of my life. I hesitate to even think of the problems I could have faced had Art not been along.

A repeat of the hot soak occurred the next morning before I was rowed to the T-boat and made comfortable. The boat was scheduled to sail for San Diego that day and I enjoyed a leisurely sea trip home. Next day at La Jolla the wound seemed to be healing well and my foot had been neither red nor swollen. Within several days I thought I was out of danger and had started walking tenderly and more or less normally but in a week or so it began to redden, swell, and ache. My doctor concluded that, despite the skin having healed over the wound, bacteria had survived Art's treatment and the foot was infected. A single course of antibiotic did the trick.

One further expedition should be mentioned. Once again, it used the T-boat and involved nearly the same set of characters as the Turtle Bay trip. Lasting a week, it nearly got us in serious trouble with the Mexican authorities. It put us in waters regularly traversed by killer whales, gave me one of the most fascinating undersea topographies I have ever seen, and afforded my first experience with a panicking would-be diver. The place was the San Benito Islands, an isolated set of kelp-girded rocks about seventeen miles northwest of Cedros Island, which lies just off the large northwestward-projecting point roughly halfway down the west coast of Baja California.

We arrived at the anchorage, near a small Mexican village on the larger island, at 6:30 in the morning on an evenly overcast and calm February day. The water here was entirely oceanic – beautifully clear with entire kelp columns in view, reaching down to the rocky, velvety, algal-covered bottom some thirty-five feet below. Our work here promised to be particularly enjoyable – principally collecting fish by spear around the kelp columns to improve our data on fish foods. We used the trusty pole spears, fanning out ten or fifteen-feet apart to sweep for fish, with a small launch from the T-boat as our diving platform. In order to prolong our collecting time, we wore paired air bottles but

remained in the vicinity of the launch and mother ship. As we were working back toward the launch with full stringers, intent on emerging anyway because we had used most of our air, we heard the launch's motor running. But the sound did not strike us as unusual. On surfacing near the launch, however, people were shouting at us from both boats to "Get the hell out of the water, there are killer whales nearby." And at the T-boat we found that people there had been firing rifle shots, attempting to frighten the Orcas away. We had not seen a sign of the Orcas underwater but as I stood on the T-boat's fantail a few moments later, I was startled by a big killer whale rapidly emerge from transiting the length of the boat. It was swimming rapidly on its side with one eye looking directly up at the boat. I swear we made eye contact.

During the rest of our stay the whale pod became a daily sight as it toured the island group. Although we believed we were probably safe in the water near them, we took no chances and picked our diving times and places to avoid the Orcas as much as possible. We also made sure there was always a lookout on the launch to start the motor and pound on the bottom if the whales appeared nearby while we were under water. One morning we were presented with a particularly spectacular display. We watched five of the whales (two males, two females, and a calf) move nearby with dorsal fins out of the water, sometimes in a close group and sometimes swimming in different directions. During one five-minute period one female, apparently the one with a calf, jumped out of the water and broached repeatedly, making large splashes. One viewer claimed he saw the calf hurtling (being thrown?) backwards out of the water.

Because of a stroke of good luck, the second incident at the San Benitos Islands didn't have serious consequences. However, for a while it seemed very serious. And before the matter was cleared up we wasted two days of valuable time. On the afternoon of our second day at the anchorage we were surprised by a resident of the nearby settlement, claiming to be a Mexican official, boarding our vessel to announce that he would have to report us to the Mexican government. Yesterday, he reported, someone from our boat had visited a small colony of sea elephants nearby and had shot four animals. (The fact that he had not reported the incident to the mainland but said he would "have to" implied he felt in a position to extract a hefty bribe.) If his claim were true, and were reported, this could have caused a minor international incident, including

confiscation of our vessel and payment of large penalties. We did a hasty check of all passengers and crew and found that indeed the claim was true – the vessel's young assistant engineer, known as "Junior," confessed that yesterday he had taken his 22-caliber rifle and the T-boat's pram, had visited the group of sea elephants, and had shot one animal. However, he insisted that he killed only one, shooting it through the eye, in contrast to the Mexican's claim that four had been killed. A hasty conference between Wheeler, the T-boat's skipper, and Art Kelly ensued and soon they invited the Mexican into the cabin. After about five minutes the Mexican emerged, somber-faced – followed by three relieved-looking Americans – and left the vessel. Although apparently true in the main, the situation had been resolved – by good luck Art Kelly had obtained a collecting permit before the trip which entitled him to take five sea elephants. We had agreed to flesh out the specimens and take their skulls and visceral samples for scientific study.

All hands spent most of the next day up to their elbows and knees in sea-elephant blood, blubber, and intestines. In addition, we discovered we had another task – capturing and carting aboard the T-boat (probably for the San Diego Zoo) the half-grown sea-elephant cub that had been orphaned by Junior's gunshot. Painstaking examination of the skulls revealed that only one had a bullet hole, in support of Junior's claim. The remaining three turned out to be starting decomposition sufficiently that they had without question died well before our vessel reached the San Benitos. It was nearly dinner time when we rolled the last heavy skinned carcass across the rough rocks back into the sea.

On one of the following days, we made an interesting dive in sparse kelp off the northwest tip of the largest San Benito island. Here I swam enthralled over an extensive stretch of rocky shoreline with all appearances of a drowned landscape. As I moved toward deeper water, small winding sand-bottomed channels with vertical solid-rock walls became larger and had coarser sediments in their bottoms – fine sand, then coarse sand, then small pebbles, then larger pebbles, and so on. These in turn grew and joined other channels into larger passages to finally form large deep ones with imposing vertical walls and cobble bottoms. In places the channel sediments were sorted, as in sections of terrestrial streams, and at least one wall appeared to be undercut. At first I thought I was swimming over a terrain that had been eroded terrestrially (above sea level) during an

earlier glacial period. However, when looking over the region as a whole I concluded I had been exploring surge channels formed by huge Pacific seas impacting this exposed location. What impressive crashing and turbulence must occur here when massive storm seas arrive unimpeded from the vast Pacific stretching to the west. Understandably, fish were scarce here.

The final incident contributing to the noteworthiness of the San Benito trip happened on a calm sunny afternoon. I volunteered to take the T-boat's skipper scuba diving in a shallow cove of the anchorage. The short, chubby man claimed to have had part of a Navy course, and Wheeler and Jimmy Stewart had given him appropriate gear – foam-rubber suit, flippers, weight belt, etc. We easily swam to an area about 100 yards from the ship where we stopped and I indicated we should dive to an attractive rocky bottom about twenty-five feet below. I moved to the bottom and waited, but when the skipper didn't appear, looked up to see him splashing and bobbing at the surface. Apparently he was badly under weighted because he would repeatedly submerge several feet and then bob back up. As I moved short distances over the bottom to spear several fish he struggled to follow me above, clumsily grasping at floating fronds of kelp plants. I decided to surface and tell him he was too lightly weighted and that we should return to the ship, but when I arrived nearby found him still struggling, red faced. He kept mumbling through and around his scuba mouthpiece that he couldn't find the pull tab of his flotation jacket. I tried to help him but was unfamiliar with his brand of jacket and, with his constant struggling, could not locate a tab. I could not make the panicked skipper realize he had nothing to worry about because he was already as buoyant as a cork and would have no trouble breathing if he would just take the mouthpiece out of his mouth. Finally, I grabbed his arm and further buoyed him (I was wary of getting so close that the panicked man could grab me, so approached him at arm's length from the rear), forcefully told him to just relax, and called over to the ship for someone to bring the skiff. When the skiff arrived and the skipper was capably supporting himself by grasping the stern I was surprised to find we had difficulty removing his tank and getting him aboard because he still would not let go of his mouthpiece. He was fine, but a little blue in the face, when we got him back to the T-boat

In the summer of 1960 my field work came to an end and it was time for the long, involved process of data analysis and write-up. I moved back to the Ritter building, this time into a spacious office on the ground floor. However, that spring before my move, all of Scripps, especially we of T-4, were touched by a tragedy that was particularly close to me. My office mate, the capable, talented, broadly-respected, and likeable Conrad Limbaugh, was lost in a diving accident on France's Mediterranean coast. It took several weeks for the basic facts to develop – bits and pieces relayed by Wheeler, and I never saw a full and final description. The following is to a considerable extent speculative, in effect fleshing out the bones of what I believe may be certainty.

I remember the day when everyone in T-4 was excited about Connie being invited by the famous Jacques Costeau to join him on the *Calypso* to dive with the Costeau team in the Mediterranean off southern France. Not only was this an honor for Connie but a public-relations boost for Scripps. After Connie left for France with everyone's best wishes, all of us looked forward to his return and accounts of his experiences. For me, the week or so between his departure and the first news passed especially quickly because I was busy starting the complicated process of analyzing my data and sketching outlines for the series of papers I would need to publish my results. Next I remember a solemn-faced Wheeler announcing to all of us that apparently Connie had gone missing while on a dive off southern France.

By way of introduction, southern France has a limestone coast, rock of nearly pure calcium carbonate. It had been laid down in huge layers, miles in extent and sometimes hundreds of feet thick, and represents shells and skeletons of organisms that once inhabited ancient seas. Limestone has a distinctive characteristic that makes it an important agent for a particular land form known as karst topography – it readily dissolves in acid solution. Because acid is in groundwater just about everywhere (commonly the result of plant decomposition), terrestrial limestone deposits typically erode into pinnacles, surface and subsurface channels, and sinks the world over. Interior channels, the earliest manifestations of erosion, grow to form the limestone caves which humans love to explore, and may form complex networks miles in extent. In time, if the conditions continue and the channels are not too deep in the limestone, the biggest channels may grow sufficiently to weaken their roofs, which may then collapse to cause

sinkholes at the surface, each marked by a conical pile of limestone rubble below the collapse point in the cavern below.

After the formation of the limestone caves at the margin of the Mediterranean – probably during the most recent Glacial Epoch, when the oceans were lower than now because much of the earth's water was tied up in glaciers and ice caps – the climate warmed, much of the ice melted, and the seas rose. As a consequence, the limestone channels and caves that had formed were flooded with sea water, putting a stop to their development. These caves, their entrances now submerged, probably lay largely undiscovered and unexplored until the advent of Costeau's scuba, and would be exciting attractions to venturesome divers. Apparently, Connie became interested.

On the morning of that fatal day, Connie and his French guide arrived by skiff at the chosen spot, a short distance off the coastal limestone cliffs. They anchored, donned scuba gear, including underwater flashlights and probably a single tank each (because of possible narrow dimensions in the cave), and upended into the water. The guide, who possibly had taken clients to this cave many times before, swam directly to the cave's underwater entrance with Connie following. I expect the guide entered the dark entrance and after moving a short distance, turned on his flashlight and waited for Connie to follow. Connie then arrived with his light turned on and the guide proceeded deeper into the entrance tunnel with Connie following. I would guess the cave had no stalactites or stalagmites, which form in later stages of limestone-cave evolution and require air exposure, but principally represented a solution channel in the form of a rough tube of unknown extent. Some distance in, possibly around a hundred feet, the entrance tunnel expanded into a much larger chamber with a conical pile of limestone rubble from parts of the roof that had caved in, the area possibly being illuminated from a sink hole above. This large chamber probably would have contained abundant air in the roof cavity even if a full sink hole had not developed as yet. Here, Connie and his guide probably stopped tandem swimming and wandered the chamber separately, circuiting the rubble pile and possibly spending considerable time inspecting the chamber walls. The guide possibly felt that separate movement was permissible here since the chamber was circumscribed and that Connie would wait to contact him, possibly near the exit, before either attempted to leave.

Now other factors came into play. A large chamber is not the inner end of a solution cave but may mark only the outer end – the channel continues deep into the limestone mass, narrowing with distance (possibly very slowly in this example). For some reason, Connie and his guide did not meet at the exit prior to moving out – perhaps after some waiting, Connie became confused and thought his guide had already departed; perhaps there was no such agreement; or perhaps the guide spoke English poorly and Connie had not understood his instructions. Whatever the reason, Connie probably decided to leave but chose the wrong tunnel, swimming inland rather than out. The guide, in turn, may not have left and, after waiting for Connie, had made the circuit around the debris cone once more, looking for him. Finally, getting low on air, the guide would have exited the cave. He would not have known for certain that Connie was missing until surfacing by the anchored skiff. Possibly, even then he waited until he was sure that Connie, if still in the cave, would be out of air. Even then, there would have been a good chance that Connie was still alive because he might have surfaced in the air chamber above the debris cone – yet was unable to exit because he was not sure of the exit and lacked sufficient air. Very possibly the guide had not brought extra air so the two would be isolated from each other. The guide could do nothing but hope for the best and leave to summon help.

Probably a primitive rescue effort was mounted quickly on the chance that Connie was stranded in the big chamber. However, once it had been established that he was not there, the only chance for his survival would have been that he had found a stray air pocket somewhere deeper within the limestone mass. But very likely this was unknown territory to all, and divers with only a single tank and light would be reluctant to search more than a short distance inland of the chamber for fear of becoming stuck in a narrow passage or also becoming lost. But all early attempts failed to locate Connie, and it was not until days later that a team from the *Calypso* laid a string of lights into the inner cave and searched to its extremities. First they located flipper marks in the mud indicating Connie had first moved into – only into – the inner reach. Then, much further in, they found his body – now headed outward, but with the air tank empty. Scuba mouthpiece firmly gripped between his teeth, he bore a look of grim determination.

It is easy, from the vantage of an office chair and 20-20 hindsight, to ask insightful questions and make wise speculations. But framing such responses at least helps control a mystery. A basic problem in going into a dangerous unfamiliar environment under guidance of a stranger is the host of assumptions carried by each that may not have been communicated to the other. Even a minor language barrier tremendously complicates the problem. A luminous compass would have been essential but Connie must not have been so equipped. If he was, possibly he made the second common error of forgetting to take a general orientation reading before entry. Was Connie shown a map or sketched layout of the cave and the region to be visited? Was it understood the neither person should leave the round chamber without the other? Finally, is there a chance that a previous night "on the town" may have dulled Connie's senses so that he didn't fully understand what briefing he did receive, or have the mental acuity to recognize danger and circumvent it.

Most of us terminated our field work for the Kelp Program in the summer of 1960, setting aside a year for data analysis and writing research results before the program's scheduled end in the summer of 1961. At first, allowing a "whole year" for these tasks may seem like a generous allotment. However, each step of this procedure nearly always turns out more complicated than even seasoned scientists expect, and each step can be a mine field of unexpected delays and surprises.[29] In my own example, I ended up with six papers and could not finish the writing, submission, and rewriting until 1962 and 1963. Production problems included the sheer volume of writing involved and delays due to having to communicate by mail (from Alaska) with the artist doing the complicated figures, tables, and graphs. Fortunately, my new employer (then the U.S. Bureau of Commercial Fisheries, in Auke Bay, Alaska) believed in the worth of the papers and allowed me the time.

The last big event for the terminating Kelp Program was presentation of the results to the sponsors and other interested parties at a gathering at the California Department of Fish and Game at Terminal Island, California.[30] The meeting was held in a large conference room and I was surprised to see more Kelp Program scientists and Fish and Game representatives present than sport fishermen and other interested persons, such as environmentalists. Ray Cannon, however, the irascible sport fishermen

representative and principal instigator of the research program, did attend – and his body language indicated, as expected, he did not like what we were going to say.

Our results indicated, convincingly we felt, that harvesting on a healthy kelp forest – the only kelp beds the companies said they were interested in harvesting – had no detectable deleterious effect on either the kelp plants or the fish populations. Wheeler summarized the harvesting effect as "about like mowing your lawn." I found that since the harvesters only removed portions of the canopy, the few fish species (not of sport fishing interest) that might be somewhat dependent on kelp usually had adequate time to escape to the intact plant below. Further, I found that many of the sport species commonly taken by fishermen in and about kelp existed in abundance where the giant kelp did not exist. I also noted that the only places where populations of fishes seemed to be shut out of kelp beds were a few among those whose canopy had *not* been harvested. Here, the canopy had grown so dense that it blocked most light to the deeper parts of the bed, including plants and animals on the sea floor.

As expected, Ray put on a tirade of incredulity. But we had shown there was little scientific support for his assertions over many years. Finally, probably in an effort to save face, he accused us of bias since our research had been supported mainly by the kelp companies. Within several years all of the research had been published – fully in the public domain for everyone to see. As far as I know, there have been no meaningful challenges.

In reality, we all should have given this gentleman a vote of thanks. His original doubts were reasonable and he had the perseverance to see that the matter was thoroughly investigated. As a result, we now know a lot more about an important part of our world and how to manage it. And it led a lucky few of us through several years of wonderful, rewarding work, including launching me on an exciting and fulfilling career.

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[2] I have dropped the "Doctor" appellation from the names of all non-medical scientists with Ph.D.s appearing in these recollections. Usually their scientific stature should be evident from accompanying narrative.

[3] Marine mammals as well. Hubbs, an indefatigable scientist, also became an authority on Eastern Pacific mammals. When supposedly confined to bed during a serious illness, he became bored and climbed onto his roof in La Jolla to make daily counts of grey whales moving along the coast. As a result, he was able to seriously challenge accepted theory on migrations of this species.

[4] The plants that make up the giant kelp (species Macrocystis pyrifera) beds in Southern California are unlike any large plants in the terrestrial environment. (They are probably more closely related to mushrooms than flowering trees, shrubs, and herbs). Kelp plants are composed principally of rod like haptera and leaf like blades. The haptera are translucent dark green, around a quarter-inch in diameter, can be many yards long, and are of the consistency of a pickle – that is, they will snap when sharply bent. At the plant's base, the haptera intertwine into a root-like bundle, the holdfast, that is weakly attached to the ocean bottom, which can be rock or sand. Normally, the holdfast is sufficiently attached and heavy to anchor the plant whose structure above the holdfast consists of long fronds composed of alternating blades, each blade with a float, reaching for the sunlit ocean surface. Unlike most trees, shrubs, and fleshy plants in the terrestrial environment, kelp plants do not reproduce with flowers or seeds, but rather by releasing motile eggs and sperm from narrow reproductive blades above the holdfast directly into the surrounding water, somewhat in the manner of ferns. Kelp beds somewhat resemble forests underwater because the columns of tangled fronds extend upward like tree trunks, sometimes as much as 100 feet or more. In clear water, the towering columns reaching toward the sunny surface, often interspersed with slanting moving schools of colored fishes, can be an unforgettable sight.

[5] Probably the term "skin diving" originated to describe breath-holding ocean swimmers who made short dives from the surface. Goggles and flippers were soon added to improve the underwater visibility, and then faceplates and snorkels. With the development of latex suits worn over long underwear and then foam rubber suits, which cut loss of body heat tremendously, the sport penetrated much colder waters, even sometimes being used around ice in arctic regions. The name crossed over, however, despite the loss of nearly all skin exposure, and is still widely employed.

[6] Alginic acid is valuable as a commercial softener and preservative, as well as a biologically neutral constituent used in diverse products such as ice cream, bakery goods, and cosmetics. Recently (2004) it has shown promise for use in tissue regeneration.

[7] Scripps' Institute of Marine Resources (IMR) was established as a subsidiary of Scripps Institution of Oceanography to handle more "applied" aspects of oceanographic research in contrast to the supposedly more "basic" orientation of the mother Institution. This is an important distinction that, deservedly or not, can profoundly affect the prestige, lives, income, and research of participating scientists. Supposedly, "basic research" places its emphasis on pure need for information with little heed paid to direct practical application, while "applied research" emphasizes science of direct commercial application – on the one extreme the elite "deep thinker" untroubled by the everyday world, and on the other a dependent practical technician following scientific recipes set

down by others. In practice, however, this distinction is often more apparent than real, and blanket application can by downright misleading, even harmful. Consideration will show that in many cases both lines of emphasis can be addressed in the same research and that neither form can have the monopoly on skill or brain power.

[8] One invertebrate, a small red sea urchin, became of special interest when it was found to graze heavily on the holdfasts, sometimes causing the death of entire kelp plants.

[9] In retrospect, it now appears that overseers of the Kelp Program, both at Scripps – for example Carl Hubbs – and in the California Fish and Game, were concerned about Davies' apparent reluctance to conduct intensive work directly on the fishes (an obvious critical need for the program) and had belatedly decided to add someone who was more field-oriented to the program.

[10] Well, nearly all that is. Connie, early in life a child of Southern California's beach culture who had gone through a reformation when he started working as a diver at Scripps, had somehow become involved in the divorce and subsequent remarrying (to Connie) of the wife of a distinguished Scripps faculty member. Needless to say, this caused quite a scandal at the fledgling university. Despite Connie's subsequent development into a good citizen and respected diving-scientist, he was never forgiven by some faculty.

[11] However, as with marine mammals, a generous layer of subcutaneous fat and robust metabolism help to preserve body temperature, and Connie with his burly-muscular build and active life was generously endowed with both. Standing near Connie's bald head when he looked through a microscope was like being near a warm fire.

[12] Minor problems with foam suits, however, were that they lost both thermal insulation value and buoyancy with depth. For example, a ¼ inch foam suit at the surface is under one atmosphere of pressure but at 32 feet is subject to two atmospheres and will be only 1/8 inch thick, thereby having lost one-half of its thermal-insulating value. Similarly, it would have lost one-half of its buoyancy, meaning that a diver that was neutrally buoyant at the surface would now be over weighted. At depths of around 64 feet (three atmospheres) and deeper, the suit would feel like tissue paper when felt at the wrists.

[13] Face-plate squeeze occurs when a submerging diver fails to exhale sufficient air through nose or mouth into his face plate to equalize the pressure building outside. Without this equalization, the pressure on the diver's body (and blood supply) becomes much higher than the pressure of the air pocket within his face plate, with the consequence that the eye capillaries burst outward, filling the sclera with pools of blood. The diver realizes "something" has happened when his entire field of view turns pink. The visage presented to others will be shocking but the eyes will clear in a week or so.

[14] Our desks were placed in the middle of the room and faced each other. As a result Connie and I could easily converse and I benefited enormously from his ideas and experiences. He was particularly interested in the habits and ecology of the juvenile kelp-bed fishes. His calls home to check on the welfare of his children were an education in juvenile psychology conducted by a loving father.

[15] Davies probably completed his statistical study of kelp-harvesting records versus sport catch records after leaving Scripps. His work, which generally agreed with my research, was published in the collected works of the Kelp Program.

[16] In a few respects, such as his love of life and women, his strong body build, his drifting youthful days along the beaches, his fascination with marine life, his love of science, and his intellect, Connie reminded me of Ed "Doc" Ricketts popularized by John Steinbeck in *Cannery Row, Sweet Thursday,* and, in particular, the biographical appendix of *The Log from the Sea of Cortez.*

[17] However, you couldn't always assume the specimens were safe on the stringer hanging from your side. Once when Jimmy Stewart and I were collecting fishes for stomach analysis in shallow water just off La Jolla's surf zone, I watched as a harbor seal cautiously approached Jimmy from behind and below to try to detach the end fish from his stringer.

[18] Predicted tides are based on mathematical models that cannot account for transient effects such as storm or local winds, surface waves moving surface water toward or away from shore, or large slow deeper-water (internal) waves that cause large-volume subsurface horizontal oscillatory movements. A slack tide in the tables may signify nothing more than a probable near-zero net water movement when the actual situation at some points may be opposing currents running side by side.

[19] In addition to the larger fishes of interest to sportsmen, the kelp beds abound in smaller species important to the kelp community, often serving as important links in the food web. Many of these, and several infrequently-occurring larger species as well, hide in the tangles of kelp holdfasts, or rocky crevices and small caves, or within the mass of kelp fronds, so their numbers cannot be accurately estimated by the transect method. Also there are some small exposed species that are so cleverly camouflaged to be difficult to recognize, let along correctly identify and count. For these, the wall net was invaluable for obtaining estimates of kinds, life stages, and numbers.

[20]Scripps divers were encouraged to swim and body surf to stay in peak physical condition, needed for their work. The oversize flippers put large demands on your legs, but once you built up the necessary muscles they gave you tremendous power, so much so that your arms actually were in the way unless held to your sides. The activities greatly enlarged my thigh and calf muscles and I remember one summer day when Rosemary and I walked a sidewalk in Arcata, Calif. I wore shorts and we were amused to notice people turning around after passing us to stare at my super-developed legs. In modern times I would have been accused of being on steroids.

[21] The term applies to big virile males that have taken over a group of females and successfully chase other males away.

[22] Most scuba divers I have known seem to fall into two general categories – carefree or apprehensive. The carefree appear to pay little heed to imagined dangers and may actually seem to enjoy stretching the bounds of caution. I have seen them toss themselves into, what seemed to me, the most ominous hole without apparent second thought As a result, they seem relaxed and at home in a wide variety of situations. But they may have a downside in carelessness and complacency. Opposing characteristics apply to the apprehensive type – in all but the most innocuous situations, exaggerated concerns for safety may actually contribute to hazard and rob enjoyment. I suggest that scientists, particularly creative and imaginative ones, tend to fall generally in the apprehensive category. As with their research, they may be prone to apply imagination and creativity to elaborating on possible hazards, particularly in unfamiliar situations. I

belong in this second group. Further, perhaps in part because I did not undertake scuba diving until around the age of thirty, I found that I could not shift over to the carefree type even with extensive experience – on the contrary, I could never shake an overlay of apprehension which may have actually intensified gradually over the years. This helped me give up the practice after about two decades.

[23] Now, some fifty years later, I realize that Jimmy and I used a version of the "chain contact" system whereby a series of individuals space themselves within visibility distances of each other to form a visual chain leading from a stationary feature. This enables those farthest out to orient to the feature even when well beyond visibility distance of it. This technique, noted in one of my Kelp Program publications, is apparently used by schools of the blacksmith (*Chromus punctipinnis*) for feeding about fixed objects such as a rocky prominence. The blacksmith is a so-called "demersal" species that is always associated with some fixed bottom feature such as a rock pinnacle or pile of rock. I became curious when I noted that I would sometimes see blacksmith feeding near the surface, well out of visibility range of any bottom feature or kelp plants. (Usually on descending one does not encounter demersal fishes in the water column until the bottom becomes visible.) On inspecting such schools I discovered I was seeing the top of a column of fish leading up from a bottom feature, in other words they appeared to be cooperating to form a visual chain linking the topmost members with the feature. By this means a schooling demersal fish can greatly expand the sweep of its feeding without fear of drifting out of a territory. Years later when watching fathometer records in the Gulf of Alaska I noticed schools of Pacific ocean perch (*Sebastes alutus*) formed plumes over the tops of submarine features such as mountains and pinnacles. This species is also demersal but feeds heavily on pelagic krill.

[24] As the diver gains depth, however, you become neutrally buoyant and must ease your power or else descend at too rapid a rate. Near the bottom, you actually may be over weighted – in such case you become aware that you no longer tend to float upward, only sink and, particularly on a deep dive, might find the loss of such "fail-safe" buoyancy a bit unnerving.

[25] Except in very clear water where the bottom may be visible from the surface, the visible hemisphere below a diver is usually blank and luminous because of the scatter and reflection of light from minute particles. However, when the diver is closing in on a dark-colored bottom and arrives near visibility distance of it, the darkness will suppress back scatter of light and for a moment the hemisphere below will take on a menacing universal gloom. Usually this indicates that bottom features will shortly be visible. Thus pleasurable salvation – gaining visibility contact with the goal – may be immediately preceded by psychological repugnance.

[26] A thermocline is an abrupt change in temperature with depth, usually from a warmer strata of water to a colder one. It is common in lakes and oceans. Usually, also, the shallower, warmer, layer has poorer visibility because of animal and plant plankton as well as myriad sources of suspended sediment locally. In contrast, the colder water below the thermocline often is much clearer because of the absence of plankton and surface sources of sediment – often along the coast of Western North America the deeper layer may be upwelled from the deep ocean and originate from such distant sources as the Antarctic Convergence and the Sea of Okhotsk, off Siberia.

[27] Wheeler had talked with the "Mayor" of the village and was told that the economic support of Turtle Bay came from canning abalone, and that in earlier years the Japanese had a factory operating there. However, one year the Mexican government informed the Japanese company it would have to start paying taxes. At this point the Japanese had a large party, burned the factory to the ground, and left for Japan.

[28] The Little Round Stingray (*Urobatis halleri*) has a sharp, bony, dagger-shaped spine, about 1½ inch long, on the upper side of its tail. Lateral serrations intersect both cutting edges and the spine is loosely covered by a skin sheath. The ray lies flat on the sand or mud, sometimes partly buried, and moves over the bottom by wave-like undulations along the margins of its wings. If stepped on, or grabbed from above, the ray quickly curves its tail over its back and rams the spine forward, driving it into the offender. In the case of hitting something soft, such as skin, the ray will then withdraw the spine, leaving a long, deep, pocket-like wound. If the offender has more resistant skin, such as that around the mouth of a shark, the spine may remain imbedded, breaking loose from the ray's tail.

Although looks superficially clean, it represents a biological zoo of bacteria, slime, and other noxious materials that take their toll in the neat little pocket cut into your foot. Prompt treatment is important. Fortunately, this small species does not seem to have a venom (however, there are records of crewman dying from falling into nets with large sting rays in the Gulf of Mexico).

[29] The surprises can be devastating, for example when a scientist gives a final research report to a gathering of peers and discovers there that his analysis, possibly representing years of work, was statistically faulty and does not support the conclusions he supposed. In another common example, a researcher passes local reviews and submits his or her paper to a scientific journal for publication, which then sends the manuscript out for review by appropriate authorities. After months of anxious waiting by the author, the review results are finally sent and state in effect that the paper is not worth the paper it is printed on. It must be mentioned, however, that the review process cannot be perfect and that occasionally, for a variety of reasons, a paper that represents even a scientific breakthrough can be unjustly refused.

[30] Preliminary results had of course leaked out from a variety of sources. For example, our quarterly reports to the California Fish and Game were readily available to the public.