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OCEANOGRAPHY: THE MAKING OF A SCIENCE  
*People, Institutions and Discovery*

Transcript of the Videotape-Recorded Interview with  
JAMES RONALD STEWART

Conducted at  
Scripps Institution of Oceanography  
The University of California San Diego  
La Jolla, California  
February 10, 2000

Interviewer: Ron Rainger



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JAMES RONALD STEWART

February 10, 2000

Ron Rainger,  
interviewer

[Note: Volume level on Ron Rainger's microphone is extremely low.]

**Ron Rainger:** This interview is being conducted by Ron Rainger. The interviewee is Mr. James Ronald Stewart, chief diving officer at the Scripps Institution of Oceanography.

**James Stewart:** Chief diving officer, emeritus.

**RR:** Emeritus. At Scripps Institution of Oceanography. Today is February 10, 2000, and this is at the Scripps Institution.

I wondered if you could begin by telling us how you became interested in diving and oceanography.

**Stewart:** Well, as I indicated to you a little earlier in our conversation, back in the thirties, the Scripps pier was then open to public fishing and it was open until, actually, about the beginning of World War II. My Dad would take part of his vacation and we would come and camp out on the beach, down in what is now Kellogg Park right down below us here. He'd come out and fish

on the pier and I'd go out with him, and when he'd catch a fish, I would take a look at it and run up to the old Scripps aquarium and see what that fish was. Little did I think I would spend fifty years of my life here.

But as far as the diving aspects of that, I lived in National City, which is down south of here, and on Memorial Day of 1941, I got courage enough to ask a girl to come out to the beach with me, and we rode the bus out. Lo and behold, a kid I was in junior high school was in the La Jolla Cove and had a face mask. Prior to that, I'd been through all the Red Cross swimming classes and I was kind of a pool rat. He said, "I can see under water." I said, "Nah, you can't see under water." I put his mask on, and I could see under water. Well, the next week I had me a face mask, and that's how it all started.

**RR:** I read that you were an early member of the Bottom Scratchers. I wonder if you could tell us a bit about that. I gather there's quite a test you have to go through.

**Stewart:** Well, prior to my induction into the Bottom Scratchers, five of us in high school started a little club called the Monterey Club, and we started at probably '42. And being a little older than some of the people into our club, I was drafted at the end of World War II. When I got out two years later, most of the other kids were then being inducted into the military. So I started diving with the Bottom Scratchers, who were the only other divers practically around. I started with them in '47 and I was inducted in '51.

The test that they put you through--and I was the last one they did that to--required that you dive to a depth of thirty feet and retrieve three abalone from the bottom, and without the use of swim fins. When I started diving, we didn't have swim fins and we didn't have wet suits, and we didn't have anything but a face mask, so that was a great challenge. Well, those guys, in their infinite wisdom, had moved every abalone off the bottom except two, and so I about killed myself trying to find that third one.

So then they had a bunch of buoys and flags out, and I had to go out on the second buoy, I had to go down. Well, they put three abalone down there, but they'd hammered them to the bottom, and the darn things had been down so long that they'd all migrated away. So that was a little challenge unto itself.

Then you had to get a lobster over ten pounds, which in those days was no big deal, and grab a shark over six feet long by the tail. Well, that shark, of course, if you were really clever, didn't have teeth, and kind to beat you to death, but at least they didn't bite you. So that was kind of the induction ceremony. Then I had to stay out with my little pole spear until I got enough fish to make a nice cioppino. So then I became one of the boys.

**RR:** Quite an elite club.

**Stewart:** Well, the Bottom Scratchers is, in fact, the oldest club in the world. It was formed in 1933. There are still five of us in San Diego, and of that five, I'm the only one still diving. Most of the guys that started are now in their mid-eighties. I'm only seventy-two, so it worked well.

**RR:** It sounds like sports fishing and sports diving and diving for sport and diving for fish is kind of the main objective [unclear].

**Stewart:** Well it certainly was. It was long before I got into college, or just as I was getting into college, but what it gave me was an appreciation for the ocean and what the body of water can do to you if you don't understand it. And it gave me really a good first-hand look at the plants and animals that lived in this environment here, and really got me turned on to oceanography. I'm not sure I knew the term "oceanography" in those days, but marine biology, marine botany, and those kinds of things. If you've ever swum through a kelp bed, it's kind of like swimming through a forest, one of the more beautiful places you'll ever be.

Well, just to go back, when I was in college--well, go back even further. In 1946, California Fish and Game--I think it was '46. Either '46 or '48, California Fish and Game passed an ordinance that you could not spear fish. Well, what they were thinking of were people standing on piers or on bridges and spearing sharks and skates and then just walking away and leaving them there. And so the Bottom Scratchers were able to add that change, so what it says

is you may spear fish if you're totally submerged. So that allowed the skin-diving aspects, spear-fishing aspects to continue.

**RR:** Did you continue, when you went off to college, I've read that there was some additional [unclear].

**Stewart:** I went to junior college here in San Diego first, and my thought was that I'd probably go into the state park or national park or Forest Service as a naturalist or as a botanist, so that was my early field of study. My dad was with the California Water and Telephone Company, San Diego South, and 1945, prior to the time we got the first barrel of Colorado water in here, we had a three-month supply of water left in San Diego. Period.

And so it always seemed--back up a minute. When we studied in junior college, the only green place around was Balboa Park and the San Diego Zoo. You have tropical animals, you have tropical plants to feed them, put them in that environment. Well, it always seemed to me rather ludicrous to landscape essentially a foggy desert with tropical plants. You know what the water usage for that. So I was one of the early people to suggest that we might just possibly landscape with California native plants, and I undertook that at kind of an early age.

When I went to Pomona [College], it was the same kind of thing. I was in dry land botany, essentially plant ecology. During one of my summers--well, even before that, in 1950, we had the first national spear fishing championship. It was held in Laguna Beach, up north of

us here, and three of us from the Monterey Club participated in that. There were thirty-three clubs, and it was obvious that we were being legislated out of the water by the hook-and-line fisherman. They thought we were scaring their fish and doing all this.

So we formed something called the Los Angeles Council of Diving Clubs. Well, I'm from San Diego, so being the youngest kid on the block, it was my charge every month to go up to L.A. to this meeting. Some other guy from San Diego who was there, who turned out to be Connie Limbaugh, who had just come down from UCLA as a graduate student, and he and I started riding back and forth together. He knew that I was a diver. We'd go out and chase halibut around on the weekends and got to be fast friends.

Then I spent a summer at the Kirkoff Marine Lab, which was owned by Caltech, but Pomona College had the summer session there. A fellow by the name of Will Pequegnat and I started scuba diving. I had scuba dived before, but I didn't have a continuous kind of a thing. So he kind of got me into it. I learned more in that six-week session about plants and animals, we'd go out and collect and we'd talk about things as we saw them--how do you do this, and what is that, and where do they live, and the interactions of these plants and animals. That really gave me a lot of perspective.

I applied to graduate school and I was accepted at SC and Hawaii. So I started at SC in marine botany. Lo and behold, about halfway through that first year, my major professor died of a heart attack, so I transferred out to Hawaii.

I'd been doing transects at Eniwetok, primarily Eniwetok Atoll, between the bomb tests. I'd go in and see what we'd done with a friend of mine who was out there. So then I started at Hawaii and I worked there for a couple years, a year and a half, went back and forth between the coast and out there. And then he died.

So by that time, I had a couple of kids and decided to have time to go to work. So I went out to San Diego State and picked up a general secondary teaching credential. When I got my credential, it was in, I guess, February of 1958, and I had already committed myself to go out to Eniwetok on Operation Hardtack, so I couldn't sign a teaching contract. Being as secret as it was, I didn't have a clue when I'd be back.

So when I came back from that test, our charge was to install instruments and collect tsunami data as a function of the blasts. Bill van Dorn was kind of the person in charge of that project. So we came back, and I was about to go out and find myself a teaching job, and lo and behold, they had just started, had been funded to conduct a big kelp bed study, by the state and by the Federal Water Quality Control Board. So I was asked to take on the field project managership of that under Wheeler North. I did that until 1960 and we dived all over.

I guess I should go back just a bit, because in 1957, during the International Geophysical Year, we were still in the throes of really doing a lot of testing on some of the Navy shark repellent. Connie and a couple of other guys went down to Clipperton Atoll. We'd also done some tests out here. Doug Fayne took his group out to Jaluit Atoll in the Marshall Islands and looked at shark repellent, which didn't work and we all knew it. It was in a packet about that

long and about that wide and about that thick, and everybody wore it on either their person or their life jacket. Right on it, it said "shark repellent," with great big, bold, yellow letters. Well, physically it did nothing, but psychologically it was a big crutch, so we all chuckled about that.

Anyhow, the kelp program started. We were able to dive every major point on every island between San Diego and La Paz in the Gulf of California trying to figure out what is a kelp bed. What will it support? And so we worked essentially from Monterey this way. Our northernmost point that we usually worked was Santa Barbara. So this whole southern California bite, including some of the islands. We gathered an awful lot of data.

In '59--it had to be later than that. It had to be '61, because I had already taken the diving officer slot. Connie died in a cave diving accident in either March or April of '60, and I was asked by then the director of the Institute of Marine Resources, Admiral [Charles C.] Wheelock, if I would take a sabbatical from what I was doing and run the diving program. I said, "Sure. Why not."

No one had ever really done that on a full-time job. My first task was to run a statewide class on a Santa Barbara campus, because at that point, Scripps was the epicenter of diving within the University of California, and we trained and certified for all the other campuses, and there weren't many in those days.

We also, just prior to that, I guess in '52, the university lost two people. There were no formal training procedures, there were no equipment standards, there were no air standards, so the Board of Regents said, "Ladies and gentlemen, come up with some realistic training and

certification procedures, or get out of the act.” So the people here on this campus, like Connie and some other folks, put together a rough outline of how to, what to do, and whatever.

Concurrent with that, we developed some of the overhaul and maintenance procedures for the old aqua lung, and developed the equipment to go with it. So there were lots of things that went into that early period.

In '64 or '65, I was asked by the university president's office if I would put together a document under which all of the branches of the University of California could operate. We were all paid by the same company and insured by the same company. It was nice to have the same training procedures, equipment procedures, recordkeeping, physical exams, and all that, so we could, in fact, have reciprocity. That really worked pretty well.

So I created a little document that I don't think anyone else has many copies of, and we called it the *University Guide for Diving Safety*. That became the backbone. Each campus then worked under that and was able to put together their own campus manual that addressed ecologic considerations in their area or whatever, and then that document was spread around quite a lot in 1963.

Prior to that, '62, I developed a diving program for Fish and Wildlife, and then in '63 I was approached by the National Park people and I developed a program for them. I trained over 150 National Park rangers, naturalists, and whoever. Over the years--well, I guess in '67 I was contacted by [Office of] Polar Programs to see if I would either evaluate or train anyone, regardless of nationality, who wanted to work under the auspices of National Science

Foundation, in either the Arctic or Antarctic. Sitting behind my desk in La Jolla, I said, "Sure. Why not."

Well, the next year, they said, "Well you ought go down there and see what you're training them to do." So I've been running back and forth down there for the last thirty years.

But a lot of things happened. In '71, I just happened to be living in the same building with our Sea Grant [Program] folks here, and they took a look at that university guide. By this time there were quite a few programs that had started, and they asked me if I would put it in a format that could go around the country and around the world and act as the backbone for scientific or research diving programs. So I did that.

Along with that, I developed a little section on shipboard diving, and I did that because no one had ever done it, number one, and in 1967, we were out for sixty-two days in the Pacific on an ONR [Office of Naval Research]-funded trip. I believe it was ONR, called Carmosel.

One of the things that happens, you always told the captain and the chief engineer when you're going to put people in the water so they didn't turn anything over. Well, we put the boat up on a rock, a very sharp pinnacle. This is a volcanic island, and really, the only thing we had to work with were Japanese charts, and some of them weren't very good. We're going into this beautiful bay and the water was as flat as this rug, just a deep, deep blue. We're standing on the bow looking around. All of a sudden this pinnacle was right in front of us. We kind of slid the boat along that. Fortunately, it didn't poke any holes in it, but two of us jumped over the side to look at it.

About the time we get down in this really blue water mass, the mess cook dumped the steak bones from the night before. And guess who came to dinner? It's not hard to jump out of a boat, but it's sure hard to jump back into one, but two of us did that. A lot of things went on in those days.

**RR:** That's great. I'm going to back you up a little bit and explore a couple of things in more detail. I wonder if you can tell me a little bit more about the early diving group at Scripps that included Connie Limbaugh and Andy Rechnitzer.

**Stewart:** Connie and Andy and Bob Huffer and Bill Bascum and Hugh Bradburn and Bob Dill, Joe Curry, a lot of the kids who were there, who had come here early, Walter Munk and some other folks. That was quite a group diving here. When I took over the diving officer's slot, or, actually, I created the title of diving officer for the university, I had fifty-eight people who were diving. Of course, in those days, during the summer we'd have a whole bunch of kids working with us on the kelp program. Doug Inman's group and Fran Shepard's group had diving groups. Bill Fager in ecology had divers.

Of course, that wartime oceanography bit was just starting to phase out, so we lost a lot of the people who had been involved in that, Saxe Montgomery and Bill van Dorn and some of those folks. So there were just all kinds of studies conducted.

Connie worked for Carl Hubbs, and so did Andy. Connie, under the Institute of Marine Resources, did one of the first kelp bed ecology studies. That's up in the library, really a complete document. That was published in '58, I think. But Chuck Fleming, Earl Murray, Frank Snodgrass. Frank worked up here with Walter Munk. We did all kinds of things, all kinds of studies.

One of the things early in our diving background here, Fran Shepard had a diver by the name of Frank Haymaker, and what is now our diving locker down here used to be the duck garage, where we had that amphibious duck, and that was their diving platform.

When I started here, no one had ever really looked at the submarine canyon. We did the first 200-foot contour, Connie and Wheeler North and Ray Garladi and myself and Earl Murray, Chuck Fleming. We'd go out in a foursome, and three of us would dive and we'd go to 200 feet and stay there for fifteen minutes. While we were on the bottom, somebody's take a sextant and shoot horizontal sextant angles, like a transit for surveying, so we could come back and physically pinpoint where we'd started, where we'd come up.

I can recall the first dives we made. We found things that were endemic to Monterey because it was still cold down there. We were all taking these grandiose notes, and we got up and we couldn't read what we'd written. So then we came out with a pretty sneaky little checklist, so all you had to do was make a mark and identify the plants and the animals. So the submarine canyon surveys were one of the early things that we really contributed to.

**RR:** I was going to ask you at that time in the early fifties, [unclear], there was this ONR-funded and National Research Council-funded work on undersea warfare and underwater swimming.

**Stewart:** Right.

**RR:** Can you tell me to what extent that had on any sort of impact on what was going on here at Scripps?

**Stewart:** Well, a lot, because a lot of the projects were funded by ONR. I can't give you the specifics, but ONR made a major contribution at that time to what we were doing. Early on, there were only two groups of us diving, ourselves and the underwater demolition, in its original configuration, were surface swimmers. They were essentially snorklers. And then Doug Fayne's group, called submarine operations, sub ops, were the people who used aqualungs and ultimately rebreathers, and that kind of group ultimately became the SEALs. Well, there were only two groups of us diving, us and them, so we did a lot of things in common.

In 1955, we developed a program for the Naval Electronics Lab. I'm not sure what they call it now, but the old Naval Electronics Lab. We had our ships tied up there, had our sea-floor studies group there. Then when we got our own dock, we kind of moved out of there and people went their own ways. So, OR had a significant role.

One of the things that was kind of funny, I guess one of the summers I was in college, people knew I was a diver. When they were putting in housing projects, they'd lay pipe and then they'd always flush the pipes out and they'd just simply chlorinate them, and flush the chlorine out of the line. Well, they turned on a fireplug one day and blew out a duck. Now, that has to tell you that the screen on the intake in that reservoir is not on. So I went out. That was Sweetwater Lake, and in those days MPL [Marine Physical Laboratory] had a barge out there, ultimately ended up at San Jacinto.

Well, I went down and I found that this one intake was not quite lined up on this, it must have been a four- or five-foot-diameter pipe, that's why it moved around and got it back on there. I kept hearing this click, kind of a "ping, ping ping." I moved around behind this big concrete weir and I couldn't hear it.

Came back out, and it turned out that these guys were testing their sonar out on the barge. I swam over and talked to them, and they said, "Would you do that again? We can hear your swim fins." And they called it the swimmer signature study. So we inadvertently participated in it. We tried all kinds of fins and all kinds of kicks to see if we could sneak up on them, but really didn't work well. Lots of things that went into the beginnings of this.

**RR:** I know that you've said that ONR contributed a lot to the physiology [unclear].

**Stewart:** Well, the two people in my lifetime that I dealt with were Sid Galler, who had biology, and Leonard Lieber, who was in physiology. They were always interested in what we were doing. They funded a lot of the exercises and a lot of the kinds of fieldwork that we were doing. We were developing techniques and we were also looking at the physiology of man, not specifically ourselves, but what we were doing was fed in to other folks.

One of the big programs was, of course, the testing of this shark repellent and others.

In '62. we had kind of an interesting happening that was secondary to ONR, but in those days they'd just come out with the big purse sein nets for commercial fishing. Bureau of Commercial Fisheries got a call--whoever they are now, NOAA [National Oceanic and Atmospheric Administration], got a call, National Marine Fisheries, in those days it was Bureau of Commercial Fisheries, got a call from the fishing industry saying, "Come up with something that will deter sharks in large numbers, because we wrap a school of fish and the sharks take our nets apart."

So we took this standard Navy shark chaser down to the Revillagigedo Islands down south of Cabos San Lucas, took a small wet submarine down, tethered it aft of the ship, and we would dump in gallons of this repellent. You'd thrown a piece of fish out and the sharks would come right straight up through that and eat the fish. We knew that, but academically you had to test it to be sure.

So we went from there, two of us got in this wet submarine with a camera, and I think one of the highlights of my oceanographic career was, we were siphoning this repellent out with a

hose, and I have a picture someplace, a shark has this garden hose in his mouth and repellent's streaming out through his gills.

Well, I showed that in London at the Second World Congress of Underwater Activities, and when I came back through Washington, I stopped back at the experimental diving unit and showed them that. They weren't extremely happy about that. By the time I got back here, the president of the shark chaser corporation had threatened to sue to University of California for belittling its product. So we had a seminar here, and he showed his movies and I showed mine, and kind of ended that battle. So there have been a lot of fun things that went into this as well.

**RR:** What was the shark repellent made of?

**Stewart:** I think it was just a copper acetate, bluestone and nigrosine dye, neither of which do much. They probably put some other stuff in it, too. I think those were the two main components.

**RR:** I know that ONR and the Navy also had a lot of interest in psychological or sort of human factors aspects of diving. I wondered if you could comment on that and how your work [unclear].

**Stewart:** Well, kind of self-screening. We didn't do any great psychologic testing when a person wanted to dive. It was more of a one-to-one thing, where you watched that person and you made that decision whether that person was comfortable in the water or now. And if they weren't, then they didn't dive. I mean, it was very simple. You had to have a mind-set where you stuck with your buddy. Essentially, ultimate responsibility for safety lies within the diver himself, because no one can tell you what to do underwater or how to react. And if you have two people, then if you swim together and somebody has a problem, you've got a redundancy. You've got a backup.

One of the things that's happening now, people are going back to solo diving. The thing that I tell them is that if somebody is dependent upon your insurance to stay alive, and there's no body, there's probably not going to be any insurance, because no one knows if you went to Mexico or where. And so the statute of limitations may be a very long wait period. So anyhow, those are some of the kinds of things that happened. We initiated the buddy system, and that's really carried out very well for us.

**RR:** And what about tasks [unclear]?

**Stewart:** Well, the underwater work aspects, everybody had a job, and you just went down. On the deep stuff we did, we'd lay it out here on the lawn and make a dry run on it. You never took a wrench with you that you had to adjust, because it was always too large or too small, so you

found out what the dimensions of the nuts or bolts or whatever you had to replace or take off, and you took that specific wrench, and you always had it secured to your person in some way so that you didn't drop it, because that was one of the major problems. You're out in blue water and you drop your wrench, then you've got to go all the way back to the surface and get another one. That's not only time-consuming, but potentially dangerous. [Interruption.]

I can recall the psychological testing that was done to us before we went to Nome, Alaska, at the end of World War II. I spent two years up there in the Air Corps and then later when I got into Office of Polar Programs. Anyone that goes south to spend any amount of time, especially the winter-over group, would go through the same battery of psychologic tests that our nuclear submarine folks do, so they're screened by people who are in the business. End either they go or they don't go.

From our particular standpoint here, the kind of diving we do, as I indicated earlier, is determined by the person who certifies them. After the first few dives--they have to make two dives with members of our Diving Control Board, if not me as an instructor who authorizes them, they have to be signed off by two folks. If they're not happy with them, then we sit down and discuss it. So that's how our psychologic testing happens.

ONR was responsible for the first 1,000-foot open-water dive made. In 1959, we heard about a young Swiss schoolteacher by the name of Hannes Keller. Keller had made a 450-foot dive, and we said, "What?" He got together with a physiologist by the name of Buehlman, and approached the French Navy for some free time in their experimental dive unit, and they

conducted dives down to about 600 feet. Well, that had never been really done before, water stuff.

So he came to the United States in 1963, summer of '63, and conducted a--or it may have been earlier than that, '62, because I had just gotten bitten by the shark in '61, so maybe it was the summer of '61. We went back and he made a 710-foot dive, in which he did physical work. This was all in a pressure chamber. He was given a grant by ONR to develop and conduct four dives, 300 feet for an hour, 600 feet for twenty minutes, I think 820 for ten minutes, and 1,000 feet for four minutes. This was conducted up off Avalon in Catalina.

The protocol was fine, but, unfortunately, two people died, the fellow that was in the bell with him and then one of the standby guys. I made the last dive on that bell, and we made it to 175 feet. In order for them to get it aboard, I had to cut off a big eight-cylinder motor block that was used as a weight. When I caught that block off, it registered on their strain gauges and they sucked that bell off and we got sucked up in the water mass that came up with us. I've got just a shirt, a wetsuit shirt on, probably no lead, set of twin 70-cubic-foot air cylinders, and we came up so fast that my face mask was squished clear down around my nose and I was hanging onto my mouthpiece.

We came out of the water. I came out of the water up to my bathing suit, like a rocket, and our ascent rate was about sixty feet a minute and we exceeded that by some. We came up from a 175 feet in probably ten, fifteen seconds.

So the Keller technique worked out. He was using a variety of different gases as he went up and down through the water column, and it worked. That's of course, the process and procedure that's used throughout the commercial diving industry now. That gave Sealab a kick.

**RR:** And he didn't die?

**Stewart:** No, no.

**RR:** [unclear]. Let me take you back a little bit again to [unclear] mentioned a little bit earlier, and that is working in the Marshall Islands in the fifties, [unclear], Eniwetok. Can you talk a little bit more about what the objectives were there, the dives that you did?

**Stewart:** Well, I'll look at Eniwetok primarily. Our stuff at Bikini was pretty minimal. We had a chance to dive the old wrecks, the *Saratoga* and the *Arkansas* and the *Nagato*. But most of our work was in Eniwetok. We had twenty-one stations across the lagoon, and we were looking at plant life primarily, collecting plant life and then evaluating it from a radiation standpoint. Along with that, we were collecting both plants and animals, primarily for the University of Hawaii for their collections. Later on during the tests, as I indicated, we were collecting tsunami data. We'd put in an instrument that would record the pressure spike as a tsunami wave went by, and we learned a lot.

**RR:** How soon after the blasts [unclear]?

**Stewart:** Probably our instruments were distanced from the ground zero, but we were putting in an instrument for another blast and we got a Mayday call, "Is anyone out there with any diving gear?" We went out to this boat, and they were about to put in another device, put in something that they had lost a little gadget over the side, worth about a million dollars. Fortunately, they put a line on it, and two of us dropped down. We'd already been at fifty feet for a while, so we dropped to 175 feet. What they hadn't told us, it was at the bottom of a three-day-old crater, so we got a little warm, but they hosed us right off. I tell people that's what turned my beard white, but I don't think they believe me anymore.

**RR:** So the Navy wasn't real big on [unclear] and that sort of thing?

**Stewart:** Well, I mean, for a million dollars, you're probably apt to do most anything. There were no Navy divers aboard that one. Just us.

**RR:** But most of the work was prior to the blast [unclear]?

**Stewart:** Then we'd go in and get them. Once in a while we'd have our--one particular shot, we had three destroyers and an old Liberty ship and the submarine *Bonita* all in an array, and we had about a 500-foot armored cable, about like that, tied it up to the buoy, to which the ground-zero ship was attached. And we were told, "It's going to be hot. You won't be able to get in for several days." Turned out it wasn't hot. They towed the *Mike Moran*, this Liberty ship, out the next day. We got to watch them sink it with gunfire, and that was kind of fun.

But couldn't find our instrument. When they pulled out the ship, they pulled out the buoy, snapped our cable, and we had a team of eight Navy divers working with four of us, and we searched for that thing for about fourteen days before we finally found it. Here it's in an area that you knew exactly where it was, because the other ships were still there and here's this hole and clear water. And how we missed that thing for fourteen days with a very thorough search pattern, I will never know. Suddenly there it is. Six-foot diameter lead faring [?] standing on its edge with 300 foot of cable wrapped around it. Strange things happen.

**RR:** The Navy didn't say, "Don't worry about radioactivity" or any of that? [unclear]?

**Stewart:** Water's a pretty good buffer.

**RR:** And so these were diffusion studies, too, diffusion of radioactivity?

**Stewart:** Well, they did that in the coral, some of our graduate students, and I'm sure they were funded. I don't know if they were funded by AEC [Atomic Energy Commission], by ONR, but Ron Lam and Tom Dana were two of our graduate students. The last time I went out there was '71. I went out kind of to babysit them, and I took my counterpart from UCLA with me, Glen Eckstram [phonetic]. And went out, we did a lot of diving. That's what they were doing, was looking at percolation rates of water in coral, among other things. And along with that, doing some measuring of what was in there, radioactivity. Of course, that was quite a few after we'd done our last shooting out there.

**RR:** You went back in the sixties again [unclear]?

**Stewart:** We did that twice. Once was on this project to change out the tsunami recorders. At the end of the blasting, at the end of the atomic era, if you will, in the beginning we had, I think, fifty-two tsunami recorders scattered around the Pacific. We didn't have a clue what those waves were going to do. It turned out they didn't do anything, except really locally. So we took all of those tsunami recorders out but four, and those four were on islands that were unshadowed by any other landmass. We had one on Johnson Island, which is about 1,100 miles out of Hawaii, one on Canton, which is about 2 degrees south, one on Wake, and one on Corror [phonetic]. So we got unshadowed information in the Gulf of Alaska, Japan, Indonesia, and

South America. So we'd go in about every year and change those out. In '61 we had done this, and that's when I had my little encounter with the shark on Wake Island.

**RR:** [unclear]. Well, go ahead, tell us now.

**Stewart:** Well, I think after all the shark work we'd done and all the time we'd spent in the water, all of that, you couldn't get into the Pacific in those days. I mean, no way to get there. So all of our experiences with sharks were putting in instruments, taking them out, sitting on a decompression stage under the ramp of a boat, and we always had somebody up there with mop or a pole or something. We had never been in their feeding territories. These reef sharks, now we know have feeding territories. Johnson wasn't bad. Canton was awful. You had to go out about 100 yards over a reef flat and then down to 110 feet, and that was like being in a shark tank at Sea World. We always had somebody with us with a piece of pipe to keep them away. We got chased out a couple of times.

We went to Wake and we saw three sharks in three days, which is like us sitting here now. Most of those islands, if you don't see fifty sharks on a dive, then you're in the wrong place. So Ron Church was my partner, and we had taken out the recorder and had it back out on land, and Saxe Montgomery was in charge of the group, three of us out there.

So Ron and I took a jackhammer out and a compressor out one day, we were going to put in a piece of inch-and-a-half pipe across this reef flat so we could [unclear] our cable out because

it was being chafed on the reef, armored cable. So we did that, and we pulled the cable through and were piling it up at the head of this channel. Now, if you can imagine these atolls, on the outside they're kind of like your hand. You have a ridge and then a groove, buttresses and grooves. We were [unclear] our cable up through this groove, and Ron happened to have a camera with him, so at the end of that, we took some pictures of what we were doing, and some land fish that were in there, for our lectures here. A rook current developed coming out this channel and we couldn't swim in against it. It was bringing all this detrital material off the reef. Our visibility in the top five or six feet went down to very close.

As we're coming in, the waves were breaking about where my knuckles are, and this is about twenty-five feet deep here. I'm coming in here, Ron's here, and that's probably as wide as this room is long, and we were right in contact. Mask, fins, and snorkel, that was it, and we had wetsuits. We came in and Ron yelled at me, "Hey, a little shark got ahead of you." I think by being ahead of Ron, I had turned that animal into the channel between us, but rather than going out, the animal started to mill around, and it came at me the first time, I had nothing in my hand, so I dived straight at him, and he went at Ron. The only person that ever had a picture of the shark that bit him, Ron got really a good picture of the shark, not while he was biting me, we were too busy at that time.

But then as the animal went away, he was going down on that angle and he did something that I had never seen, he put his nose up in the air, all sharks drop their pectorals, it just says, "Hey, I know you're there." Well, this guy did that and then he puts his nose in the air, gets a

big hump in his back, and it looked like he had a hinge in his middle, he just undulated, almost no net movement forward. Nobody had ever described that.

So then the animal went out and he went into some things that I had seen, and I wasn't very happy with, he went in, he just swam erratically and he was snapping his teeth. By that time, I'm just getting a little concerned. Now, all this is one breath, so we're talking thirty seconds maybe.

And all this is now still going down and away, and then he went into some other things I had seen, he'd swim along and he'd go [demonstrates]. When they set their teeth, they saw a chunk out. And then he rolled right back up over his shoulder, now he's on that angle, about like that, and probably twenty-five feet away from me, still going away, and he rolled right back up over his shoulder and he ran for my left side. When he got right on me, I flipped to my right, and just the time it takes me to do that, I met him right there with his mouth open. I couldn't do that, all I could do was shove my arm up and, of course, he took a pretty good chunk out of my elbow. Then he turned around and swam away.

I looked down and saw a nice shiny joint capsule and a couple of arteries [unclear] a lot of bleeding without them, so I got to the bracheo pressure point and shut them off. Ron helped me back in over the reef. We had no transportation. So we flagged down an old dump truck, and about twenty minutes back into the infirmary, the doctor had gone to Guam for the day, so the nurse filled me full of Demerol and whipstitched me back together and they flew me--

[Begin Tape 1, Side 2]

**RR:** How long were you [unclear]?

**Stewart:** Well, I came back and Gordon put a split skin graft on it, and took a piece about eight-by-eleven off my knee. A split graft just indicates you're splitting the skin. It was like a huge pavement burn and, of course, you had gauze on it and you had to sit in the bathtub and soak all that off. That wasn't very pleasant. I asked him why he took that much off and he said, "Well, I took enough off to make you a wallet." But I've never seen the wallet. I went to his seventy-fifth birthday last Saturday. So he and I have hunted and fished and dived and whatever together for years.

I've been guaranteed a stiff elbow out of it, and it's really difficult to drink a cold beer or a cup of coffee with a stiff elbow. There's all kinds of things that go into your thinking. At that time I had an old GMC pickup with a four-speed transmission, and each day I backed a little further off of second gear. It took me about two years to get that darned thing straightened out. It worked. That's great physical therapy.

**RR:** So you were back diving again [unclear]?

**Stewart:** Oh, I don't know, probably eight months before I got back in the water. But I really hadn't been in the water with sharks until Carmosel, and this was this trip where we joined this ship in Guam. Fran Shepard was the principal investigator, but we had Josh Tracey of the [U.S.] Geologic Survey, Norm Newall, the New York Aquarium, and a bunch of our people from here, Art Bloom from Cornell.

We were the first ship to be allowed in the Trust Territories. Joined the ship in Guam, on the *Old Horizon*, had a recompression chamber board, we had a ship doctor, and we went south. We were the first people to ever dive the Truk Lagoon. There was no way to get there. We went in there because we had the tail end of a typhoon and we needed a place to hide. So we ran in there, and just happened to anchor in the old Japanese harbor, masts sticking out. We went out and looked at that, and there were all kinds of artifacts on the bottom. That was fun.

One of the things we did on that trip, the purpose of the trip was to look for higher stands of sea level than we have today, because theoretically this is the highest that we've ever had. There were some nips, two-meter nips, on the rocks at places like Guam. It became obvious the island was coming up, and the water hadn't been up there.

Going to the atolls, there were some platform reefs that had been described, that were just two meters. What does that really mean? Are they really coral reefs or what are they? We had a portable drilling rig with us and we put it in on the islands and we drilled down the coral atoll or primarily rubble coral thrown up by storms, then a mangrove floats by and a coconut floats by, and pretty soon you have instant island after some years.

Well, we were boring some holes on one of these little sand islands at Truk Lagoon. We were bringing this drilling rig up ashore, had an old sixteen-foot flat-bottom skiff and I was running it, they were putting it together. It was a hot day and I had my face mask. I had been running up the same groove that I'd cut in the sand. I rolled out of the skiff and I was making a landing from about me to the end of your nose, when a great big Japanese horn mine. I immediately moved my docking spot. [Laughter]

But that was a good trip. We really did a lot. And what we found was that the average coral atoll was about twelve feet high. That's about what it will tolerate and then it gets washed over and starts again. We bore down to platform coral, reef-building coral, and at Jolly Wood Atwell [phonetic], we went down to the Carolines and we had really some fun times. We'd dive Truk, so what the island of Ponope [phonetic], and it's spelled differently than it was then, and it's in the southern end of the Caroline Islands, dive there, and we were collecting coral samples in a river, where it doesn't grow. Obviously the water would come up. We're getting ready to go to another island, the island of Kusai, and a native comes out in a red, white, and blue outrigger, said *Gemini XIII* or something, and he says "Have you guys been diving the old wrecks?"

We said, "What old wrecks?" We got back in the water, and it turned out to be three Yankee whalers that were sunk by the Confederate gunboat *Shenandoah* in 1865. I didn't know there was a Confederate gunboat in the Pacific. Apparently built in England, sailed around the Horn, and shot the hell out of the Yankee whalers out there. I guess the last shot of the Civil War was shot in the Pacific when they sunk the *Shenandoah*.

Anyhow, we got some things off the *Shenandoah* and then we went to the island of Kusai, two other little islands, Mokil and Pingalap. Those islands are probably a mile in diameter. They're big. And you could lie on the reef and you could look straight down, just like looking down that wall, and there was just nothing--blue. Went to Kusai, and at Kusai again we were anchored in a river mouth and we were running vertical transects up and down these coral reefs. We had gotten our small boats aboard, and it was kind of dusk, and a native schoolteacher came out and said, "You've been diving the old wreck?"

"What old wreck?" Put a boat back in the water. We were anchored right on the last of the pirate ships that plied the Pacific. It was 105-foot four-gun brig called the *Leonore*, skippered by a bad guy by the name of Bully Hayes. We were ultimately able to run it down to Cook, this bad guy, the last of the pirate ships, the last of the slave traders and all-around bad guys. Apparently there were a couple of whalers in there in front of him and he had a typhoon pick up and they got their yards crossed and got out, and he, by the time he got his sails up, one of the cannons broke loose and demasted him before it broke up. He got ashore and the natives took care of him very quickly.

Well, the cook got away and ultimately ended up back in London. There's a little book called *Reuben and the Devil*, and this occasion is written up in that. And of all things, Jim [James] Michener was here and did some work sometime ago, I was talking to him about that, and we found another section on this book in the little book he wrote called *Rascals in Paradise*.

So I had a chance to talk to him about that and said that we'd used his book actually as a historic document. So we had a lot of fun on that trip.

Came back from there, ran over to the Marshall Islands, and in Jaluit we were on our way home, we were coming to Kwajalein to fly out of Kwaj, and just one of these idyllic days, and we thought, "Well, let's stop and just make one dive for ourselves." So we did and we found this little coral reef, 100-foot visibility, and we were all carrying--by this time we'd seen a few sharks, but nothing serious. And we had five-tine pole spears. We cut them off so that they were manageable, probably four-foot poles on them, and we'd just hit the bottom and here came this little gray shark. He went into the same kind of posturing that I had seen, and I really wasn't very happy with that. As a matter of fact, I was behind somebody. And we looked like a sea urchin with all of our five-tines pointed out. So finally this little shark swims away, and I breathed a sigh of relief. Here came its mother, a big gray shark, and it was right on our face. Finally we just said, "Enough of that stuff," and we got in the boat and went home. But that was an excellent trip.

But we found the coral, we found the platform coral at Jaluit. Picture taken in 1958 had showed this platform reef, and we showed it to one of the natives and he said, "Oh yes, that's right over there. It happens after every hurricane." Breaks all the coral up, throws it up into a platform, and over the years, with the rain on it, it simply leaches out and essentially becomes concrete. But when you look at it, here's coral, not in a growth position, but upside down and

killer clams with two halves of the shell [unclear] one way or another. So that ended that theory.

But it was a good trip.

**RR:** I'm going to shift gears a little bit and ask you about diving as a scientific tool, because you play an important role [unclear]. Could you describe either your own contributions or just how diving [unclear]?

**Stewart:** Well, when you look at all the years that we didn't have scuba, we either had to go down on the end of a hose or simply skin dive, when the first aqualung came here, the first two aqualungs were--and there are two stories, Doug Inman's story, or [Jacques] Cousteau gave these to Shepard, and Bob Dill told me that they were in fact purchased by ONR through Bob Dietz, that Bob Dietz got the first two. You'll have to get those two guys get together and let them talk it out sometime with their two stories.

Anyhow, we ended up with two in 1948, because the first aqualungs came into the country in '48. At the same time, Connie and Andy were at UCLA and they conned their major professor into buying two of them up there. Then they bought those two to Scripps, then we had four. I got here in '52 and I think we had six or eight by that time.

But what the aqualung and what scuba did for us was give us a means of transportation. But it wasn't really the aqualung that made diving practical; it was a concurrent development of the wetsuit by Bradner that really made it possible. All an aqualung did was allow you to go

deeper, stay longer, and get colder. So with a wetsuit and iterations thereafter, it really made diving a tool. So you could actually take the human mind and eye, as Rick pointed out yesterday--and I wrote a little one-pager for a diving officers' meeting we had here in 1976, University Diving Officer meeting. I said, "Why man? What can we do that instruments truly aren't able to do?" And what Rick said was really basically what I said, but put a few more things in there with it.

But the old mind and eye under water can do a lot of things. You can synthesize what you see, and you've got two of the best manipulators in the world right there. I wrote a paper on the use of the tactile sense under water one time. If I'm working, if I'm in really dirty water doing something, most of the time I shut my eyes. I'm working on a vessel or I'm putting in an instrument or if I'm doing something that I know what I'm doing, it's much easier for me to shut my eyes and feel, because all of my senses are dedicated right there, and it really works well. With a light, it back-scatters in your face in dirty water and you can't see anything. You're essentially blinded. So, just the development of those things.

We've been able to do so many things. It gives you the ability to go in and out of the surf, to get out of a small boat, go off a large ship, and be mobile in three dimensions: up, down, and sideways. I think that being able to just go down on the bottom and sit there and look around and watch what's happening, I think you become more of a naturalist when you've been at it as long as I have. My background's in kelp medicology, I'm a plant person, but over the

years, you learn the plants, the animals, the ocean, sand movement, and things all in the relation to each other. Ecology, if you will. I can't tell you how many people I've trained.

**RR:** I was going to say, I know Menard and [unclear].

**Stewart:** Sure. Oh, yes. Bill Menard and, of course, Fran Shepard and those people were-- Shepard, I don't think ever had a lung on. If he did, I'm not aware of it. But certainly Bob Dietz, Bill Menard, that whole group. Actually, they had something called geologic diving consultants, Bill Menard and Joe Curry and Bob Dill, and a bunch of other guys, and they did a lot of the early geologic surveys for the oil companies up in the Santa Barbara Channel. That's how they made their Frosty money. We had a similar kind of thing where a group of us in biology did biologic work for people who couldn't give it to the university. Made ourselves a buck or two doing that. If you're working for the university, you don't make a lot of dollars, or you didn't in those days, anyhow. [Interruption.]

**Stewart:** Well, one of the studies that was funded by ONR went to Westinghouse, and we did a swimming study out here off the end of the pier. We had a pin in the ground an eighth of a mile off the end of the pier, and off the end of the pier we had 100-foot line, polypropylene line, and every ten feet we had a riser with a float on it, and they were numbered. They wanted us to trim ourselves out neutral, and we made several runs. You trim yourself out neutral on the first run,

and the tact was to say twenty feet in a thirty-foot water column. Swim a course of 000, due north, and see where you came in at the end of an eighth of a mile. It was kind of fun, because then we swam three, six, and nine pounds negative. We had a device on us that monitored air consumption every four seconds, I think, and once we trimmed neutrally buoyant, then they gave us a three-pound weight. Well, a three-pound weight is nothing. You can control that with a breath. Six pounds, you noticed that you were doing this. Nine pounds, your body was going through the water like this and your air consumption went exponentially up. So what they were doing was trying to find out where it was best to carry a weight. [Interruption; correct spellings of names are discussed.]

**RR:** We were talking about training of Menard and those people. I saw in the file for your retirement-- [Interruption.]

I had seen in the retirement film that there was a woman swimmer named Thea Schultz. I wondered, where there a fair number of women that you also trained to dive during those years?

**Stewart:** Oh, certainly. As we speak, I think probably a third of our divers here are women, if not more. Some of our early--it's kind of an interesting thing. There's a lady by the name of Xael Perry, she was a heroine on *Sea Hunt*. She and Mike Nelson. Well, Xael, they did a publicity stunt and she made a dive to, I think, a booming 210 feet out of Catalina. And Marge Reidel, who was diving as well, had a 200-foot [unclear] and we were diving to 225 or 200 every

day, never thought anything about it. Then they had this big whoop-de-do about Xael making this monstrous dive, so I harass her about that quite often.

**RR:** Were there also women scientists at Scripps?

**Stewart:** Certainly.

**RR:** In the fifties or sixties?

**Stewart:** Yes. I'm not sure how many. Marge Reidel and Nan Limbaugh both worked with us in the kelp program during the late fifties. A lady by the name of Jean Kowanui--and how you spell that, I don't know, but she worked with us for years, an excellent diver. And then every summer when we hired these kids in to work with us, they were usually NSF [National Science Foundation] kids who came in on an NSF program, and we'd run it through our diving program and they'd go to work for us on the kelp program as divers or as beach people.

**RR:** Not for the Navy program?

**Stewart:** No.

**RR:** [unclear].

**Stewart:** It's kind of funny--when we wrap this thing up, I'll tell you a couple of sea stories.

**RR:** You can now, if you want.

**Stewart:** Well, we've talked about the interaction between ourselves and ONR in general, and I'll just tell you two stories. For years, we just had this really beautiful operational interchange between ourselves and the guys in UDT [underwater demolition team] and the guys at NEL [Naval Electronics Laboratory]. When we developed a program for them in 1955, a fellow by the name of John Biggles was their diving officer, my counterpart. I think we ought to put something on this about why the term "diving officer" came into being. The Navy has always had the title of diving officer, and my title was, I was a principal marine technician, and then ultimately I was a principal environmental health and safety technologist, essentially health and safety officer.

Well, if I had a pressure-related problem in those days and picked up the phone and called one of the submarine tenders where they had the recompression facility, "This is Jim Stewart. I'm principal environmental health and safety technologist," they're going to put me in touch with somebody I don't want to talk to. So I said, "What the heck. I'm the diving officer. This is Jim Stewart. I'm the diving officer," they'd put me through to the people that I wanted to talk to, and that's how that started.

But we just worked together for years and years. We can't dive with the Navy now. And just to show you how bad that is, I hammered on that admiral up there last night, or day before yesterday, told him the story. I got a call from the fellow who was then the technical director of NEL, Howard Blood [phonetic]. He said, "Do you guys still have your 200-foot certification?"

I said, "Sure."

He said, "Well, we have a sensitive torpedo at 186 feet of water out of Mission Beach, and the Navy doesn't have a diver in San Diego qualified below 130 feet."

So I said, "Okay, I'll send a couple of guys down. They'll tie it off for you."

They went down. They wouldn't let them get on the Navy boat to go out and recover their torpedo. So we launched a sixteen-foot whaler from the end of the pier and went out and tied it off for them.

Then one of Doug Inman's groups--actually, Clint Wiment [phonetic]--had two current meters, one on either side of the Straits of Gibraltar. They had developed the equipment, tested the equipment, installed the equipment, went over to pick it up, and the Navy wouldn't let them dive from a Navy vessel to recover the Navy's gear. Those guys had to ride a Navy vessel out and they had to wait until Woods Hole [Oceanographic Institution] *Noor* [phonetic] came in, swim over and touch the *Noor* and then make their dive. I actually got up at two in the morning, called the admiral in charge of whatever that area is, and said, "Mr. Stewart, I know who you are and what you want and the answer is no."

"Okay." So Brad Mooney was at NRL [Naval Research Laboratory], the admiral in charge of that, and I had known him since the *Trieste* days. He was a bathyscaphe sailor. ONR's office was right down the hall from where mine was, and I caught Brad walking down the hall one day. He was just on his way out as the admiral in charge of that, so nothing ever progressed, but, you know, it was ludicrous to have a funded program and then the guys won't let you use their hardware to get off. So I was a little upset about that, needless to say.

**RR:** So that's the main problem with the Navy, that they just won't let [unclear]?

**Stewart:** No, not really. It seems to be only from a diving vein and I can't get that through my thick head as to how that whole thing works. It's the old CYA [cover your ass] thing, you know. "I can't allow that to happen on my watch." So, anyhow.

**RR:** I was going to ask you a bit about Antarctica [unclear].

**Stewart:** Well, I got a "blue sky call" from Polar Programs in '67, asking if I would either train or certify anyone who wanted to dive under their auspices. I said, "Sure." They sent me some guys out, had them in on my Christmas class of '67, who were going down south in '68, ran them through. Then the next year, they asked me if I'd go down and take a look at the area and make recommendations, and I did. So from that time until the present, I have been doing that for them.

What they do is they send me a copy of the proposal, anyone who wants to use divers, and I evaluate it with equipment and safety program, equipment and procedures. If it looks good to me, I sign it off. Meanwhile, they've sent the scientific part of that for peer review. If they get signed off from the science end of it, then they select the folks they want to physically do the diving. That may be the PIs [principal investigators]. Again, they send me a list of their qualifications and I review those qualifications, and if I have any questions, then I pick up the phone and call them.

Now with the American Academy of Underwater Sciences in place, the crazy old document, this *University Guide for Diving Safety* became the background and the boilerplate for the American Academy of Underwater Sciences. Our program here was noted in the *Federal Register* as being the program to follow when you set up a diving program, so we got freebies out of that.

What else?

**RR:** I don't have any other questions unless you--

**Stewart:** I'm just trying to think what I do for Polar Programs, and that's really what I do. I go down there and I usually hold a meeting of the folks on the ice, and I go out to the field camps and take a look at what's going on, review the equipment, take a look at all of the maintenance and overall records, compressor, filter changes, all those things, as I would here. I've set them up

a Diving Control Board of people like myself who are knowledgeable in polar work, and that really works well. I don't have to run back and forth unless I want to, because I've got guys down there who can do it as well as I can. So why spend their money on something I don't need to, if somebody's going to be there anyhow. So I've done that for them.

**RR:** What I'm wondering in a way, too, [unclear], I'm assuming nowadays there are sort of adventurers, not necessarily Navy people, but various individual or private firms that want to dive in those kinds of areas.

**Stewart:** Anybody can dive down there. They just can't use our facilities.

**RR:** Right. What I guess I'm wondering is, do the studies that you make for the Navy, does the Navy classify those kinds of things, or does it get out into the literature so that people know about safety before going into the Arctic?

**Stewart:** Well, I wrote a little thing called *Guidelines for Conduct of Research* for polar programs. Wally Jenkins had done one many years ago for the Navy, on polar diving, and I just took what he had and brought it up to speed and then put in some of the rules and regulations under which scientists dive, and that worked out pretty well. But all of that goes in and, of course, after Sealab, starting three or four years after Sealab, we started having these Sealab

reunions where we'd get together. What we've done is, every other year we're back at the experimental diving unit, or Panama City, Florida. This year it will be here, and next year it will be back there. So what I do, is share with them the information I collect on diving and on regulations, because we've got more cold-water experience than they have, by far. We do it. That's just what we do. Scientists go do that. And they have to go find someplace to do it.

The irony is that for years, the Navy flew airplanes, until this last year. The VXE-6 was headquartered up at Point Magu, flew our C-130s, and the Navy backed out of it. But they had all of the reason in the world to send people down there and play with our toys, and I never got much feedback from them. But we share our data with them, I'll put it that way. There's nothing classified about it.

**RR:** Tell me about Project 600, the [unclear].

**Stewart:** Well, when we came back from Carmosel, I had a call from--I don't know who I had a call from. One of the people who had been on Sealab, had later gone to work for Westinghouse, and so they got my name and knew I was kind of active in diving and whatever. They gave me a call and asked me if I'd like to be one of the scientists on that particular project.

So a kid by the name of Rick Cheshire [phonetic] was my partner, and we had five commercial divers and we lived in a house about seven feet in diameter and it was dual recompression chamber actually, habitat. It was on the deck of a barge and we were fifty-two

miles out off of the mouth of the Mississippi, and we were supposedly working with the *Deep Star 4000*, also a Westinghouse boat. Fran Shepard was supposed to be in the submersible, and I was going to be locking out at 600 feet and doing things and handing him samples and whatever. They blew a solitate [?] converter on the machine and had to go home, so we did it by ourselves.

We were saturated at a depth of equal to being 350 feet under water, breathing a mixture of 95 percent helium, 5 percent oxygen, and you learn to speak in helium. [Demonstrates] Well, all of our food was locked in from the outside, Styrofoam cups, somebody locked me in a cup of coffee, the cup being about that size, when I opened the hatch to get my coffee out that, foam cup had been compressed to a point where it was about that high and about that big around. I had coffee all over the lock. So we learned about that. And when they'd lock hot food in you for dinner, in that helium environment, it was cold in about two bites. You just never think about those things.

I took my wetsuit in, I was going to use my wetsuit and we were using hot-water suits, and they hadn't developed the technology to pump hot water 600 feet down yet, so they pumped cold water over us and we got that off in a hurry. I took my wetsuit in, and it had compressed to a point where it probably fit about a five year-old kid. And then when we came out, of course, it got back to size.

We had unlimited time at 350 feet, and we were able to make hour excursions, what they call a vertical excursion to 600 feet. At that point we were breathing 97-3 helium-oxygen, and then they changed the mix on the way back up to the house.

One of the things that did happen, you're academically aware of the heat transfer problems with helium, but till it happens to you, you don't know. Our house was on the deck of a barge in August, off New Orleans. Hot. The inside of our house was kept at 95 degrees in order for us to have the same degree of body comfort that you would have in 70 degrees air. The temperature center went erratic and dropped us to 85, and I was so cold, I hurt. When you're looking at a thermometer that says 85 degrees and breathing helium, I mean, you're giving off deep-core temperature with every breath, and you can put all the blankets on you you want, and that doesn't help you a bit. We learned a lot.

From a psychologic standpoint, they ran psychologic tests on that one, because being in a closed compartment with six or seven other guys, it worked out fine. Nobody had any problems.

**RR:** This was before Sealab?

**Stewart:** No, it was just after. Well, it was between Sealab 2 and Sealab 3. One was in '64, 2 was in '65, and then 3 was supposed to be in '67 or '68.

**RR:** [unclear].

**Stewart:** Yes, it was [unclear].

**RR:** ONR has always been big on submersibles, *Trieste* and *Alvin* [unclear]. I guess some people might think that submersibles are a replaceable for the human diver. I wonder what your view is about the role of submersibles and ONR's support.

**Stewart:** Well, submersibles are a means to an end. They take you deeper. We've had people I think as deep as 2,600 feet. But from what we know now, that's probably not the best approach. Submersibles are a means of transportation. Many of them have diver lockouts, so that if the manipulators on the machine itself won't perform the task at hand, then you can lock a diver out in reasonably shallow water and let him work, and come back in and decompress him on the way home.

I think probably one of the more innovative things that's come out, a fellow by the name of Phil Nugent, who was an old abalone diver out of Santa Barbara years ago, got a Ph.D., now I think he's president of the Can Dive [?] or something like that, one of the big commercial firms, developed a one-atmosphere diving dress. That had been done by the Degaze [phonetic] firm in Italy back in the forties, but I think it weighed about four tons and it wasn't very good.

Then the Navy came out with something called the Gym suit, and again it's a one-atmosphere suit, the Gem and the Wasp. The Wasp, you're kind of in a tube and it's got propellers that move you around, which you could actually do some work, it had manipulators. You could take a dip net and scoop something up. Then we started putting slurp [unclear] on the

submersibles so you could slurp up an animal, and you saw what the people up at Mobare [phonetic] are doing.

But this one-atmosphere suit, Sylvia Earle made a dive on, I guess it was *Star 2*, took her to 1,200 feet. She did that. It, again, was very heavy. I think it was sixty pounds in water weight, negative.

Then Phil came out using a composite suit, the same kind of thing we build aircraft out of now, and it's neutrally buoyant, essentially. He's got one, and what he was able to do was reinvent the wheel, if you will, where rather than the water compressing a joint, it actually expands the joint, and I put my arm in the sleeve of that thing when he was first making it, and I could reach around and scratch the back of my head. He said, "It works the same way under water."

And he's got one that'll go to 2,000 and one that will go to 450. The one that goes to 450, carry it around in two suitcases. I mean, you can put it on, go out and walk the axis of our canyon there, come back out, take it off, have a beer, and go home. Where if I did that, I'd spend about six days decompressing.

I sicced NASA on him for that. I put together a national committee to go back and evaluate the swimming pool in which they were going to build the Space Station. I did all the open-water work with the early Shuttle crews.

We went back to Johnson and redesigned a big swimming pool, 225 feet long, 175 feet wide, 60 feet deep. They were going to build a Space Station in that. Well, sixty feet, and the

suits they wear have, I think, four pounds' internal pressure. So you add that to sixty feet, puts you on the seventy-foot table, or maybe it's a little more than that. But they would have decompressed for hours.

So we redesigned that tank so that thirty feet underground, thirty feet above ground, they'd lock out at thirty-three feet, go into a pressure chamber and breathe oxygen for two hours and go home. Because when they're in the Shuttle, you know, when you lock out in the cargo bay, you've got a soft suit on. Well, you're cranking along at 17,500 miles an hour, more or less, and you run into a chip of paint that's only going 15,000 miles an hour, it's like getting hit by a rifle bullet, so you go to explosive decompression. And by pre-breathing oxygen in the airlock before they go out, they pre-breathe oxygen for two hours, lowers the body's nitrogen level down to a point where it wouldn't be as serious as if you hadn't done that.

**RR:** One question that's, in a way, kind of a wrap-up for us is, what do you view as your major contributions to the [unclear]?

**Stewart:** Gee, I don't know. I think probably evolution of diving programs. I mean, I've spread that thing throughout the United States and throughout the world, done a lot of training for the various agencies, and I've been a resource. I think that's the best term I can use. I've been a resource. Really, to the University of California, we're a resource. I'm willing to share what I

do. Nothing's classified about what I do. I'm willing to share that with anybody who wants to ask.

I've given more talks, I think, for the University of California than anyone. You can imagine what happened when the movie *Jaws* came out. Imagine what happened to my correspondence and my phone mail. It went ballistic. Finally I had to write a little crib sheet to say, "The information that you need may be found in the following publication," get that out to them.

I really think that the development of these kinds of things, no one had ever done it before, and I think that probably is as much of a mark as I can make. They say I'm a consultant to everybody in the world, it seems like. Unpaid consultant. Actually, Polar Program supports my office.

When I retired, I'm the only nonacademic at Scripps to have the Board of Regents appoint them emeritus. So I have my office as long as I want it and I get to play with the big kids when I want to. I do a lot of trout fishing and things like that.

The reason I've stayed in San Diego all my life, and I could have gone other places, including Washington D.C., but I've looked around the world for some place that I could go surfing or diving or swimming in the morning, and an hour and a half I'm on top of a 6,000-foot mountain in the pine trees and I can walk a couple of hundred yards and look 4,000 feet down in a desert, and if I don't like it where I am up there, in another hour I can be there and still be home in two hours. That's a tough place to beat, and I don't tell people that.

There's just been a lot of things that we've been able to do, I think just kind of uniting the research community. OSHA grabbed us in '81. Federal OSHA grabbed through a working fluke, and Glen and I went back in '76, went back to Washington D.C., for a meeting, and some people that claimed they'd been hurt by the commercial diving industry had filed for some kind of special orders to be created governing commercial diving. So we packed up all our manuals and all of our data and all our log sheets whatever, and went back, and they said, "We don't want you guys."

Well, the next year a couple of other guys went to a meeting in New Orleans, and the next thing we knew, we'd been grabbed. It came out in a wording fluke. It said, "Any diving in which there is an employee/employer relationship, you're a commercial diver." We don't do the things that they do. It's a means of transportation to us. Well, it took us about 110 meetings from '76 until '81, and then we went through an administration change and we had to reeducate OSHA, and finally they gave us an exemption.

Now, the exemption, that was one that was printed in the *Federal Register* that cited our program as a means of conducting business. The day that exemption was given to us, the Carpenters and Joiners Union, who control the commercial diving industry, filed a suit against Federal OSHA for giving us an exemption. It took us three more years to get out from under that.

So we're under the gun here at Scripps because we're cited in the *Federal Register* as being the way to do things. Let me tell you, we do things. I mean, the way it ought to be. And

those guys can walk in at any time and check our records and everything else and it's right there. So I think that's one of the things I did well.

Just as a second to that, when we started gathering data, in those days I think I had 165,000 dives here at that time, we'd had one death, and that was Connie's, when he swam the wrong way in France. Now we have probably 250,000 and we've had one other death and that happened in the Antarctic, a kid who came in as a volunteer. That's about it. With that kind of numbers behind us, we've done something right. I think just putting these things together, it's done well for us.

In collecting our data for this OSHA presentation, in those days I trained about 95 percent of the people who were then running scientific diving programs. So I could call them and say, "Get me your data." And we were able to generate three-quarters of a million dives, and within the commercial diving field in those days, there was about one case of decompression sickness for every 2,000 dives. Within the sport diving industry, there was one in every 10,000, and ours was 1 for every 100,000. So I feel that that's one of the contributions I've made, was putting that whole thing together and making sure that it worked.

**RR:** That's a wonderful record. Thank you very much.

**Stewart:** My pleasure.



**RR:** This has been wonderful.

**Stewart:** Good.

[End of interview]