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Brainard, Rusty ~ Oral History Interview

Edward Glazier

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Voices from the Fisheries
166 Water Street
Woods Hole, MA 02543

Interview with Rusty Brainard by Edward Glazier

Summary Sheet and Transcript

Interviewee

Brainard, Russell 'Rusty'

Interviewer

Glazier, Edward

Date

July 27, 2016

Place

Honolulu, Hi

ID Number

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Use Restrictions

Biographical Note

Dr. Rusty Brainard began work for NOAA on the first day he graduated from Texas A&M University in May of 1981. Shortly thereafter he was assigned as Station Chief for the Geophysical Monitoring for Climatic Change Station at the South Pole, Antarctica. From 1984-2002, he was based at the Southwest Fisheries Science Center in Monterey, California studying coastal fisheries and climate variability from Alaska to Chile. He joined the Pacific Islands Fisheries Science Center in 2002 where he did his Master's Thesis on how currents that flow around seamounts affect fisheries in the Northwestern Hawaiian archipelago. He earned his Ph.D. at NOAA's Pacific Marine Environmental Lab working on the physical oceanography of El Nino.

In 1994 he became the Commanding Officer of the research vessel *Townsend Cromwell* for a record 39 months and did approximately 300 dives in the Northwestern Hawaiian Islands. He was then assigned to the ecosystem and oceanography investigation at the Pacific Islands Fisheries Science Center in Honolulu, where he works today as a supervisory oceanographer. He is the founding Chief of the Coral Reef Ecosystem Division (CRED). From 2005-2010, Rusty was co-PI of the Census of Coral Reef Ecosystems project of the Census of Marine Life developing tools to systematically monitor the biodiversity of coral reefs. Since 2010, Rusty has served as NOAA's Technical Lead for the US Coral Triangle Initiative's Ecosystem Approach to Fisheries Management (EAFM).

Scope and Content Note

Interview contains discussions of: fisheries management, climate change, seamounts, coral reef ecosystems, ecosystems-based fisheries management, ocean acidification, technology changes impact on science, autonomous reef monitoring structures (ARMS), biodiversity, genetic sequencing, acoustics and ocean soundscapes

In this interview Rusty discussed his long history working for NOAA on a variety of complex issues related to fisheries management, climate change, flow topography of seamounts, assessment of coral reef ecosystems, technological advances in genetic and acoustic research related to fisheries, the challenges faced in doing research in the Pacific Islands Region, and the national and global efforts to shift from single species stock-assessment-based fisheries management towards ecosystem-based fisheries management.

He has conducted his research in many parts of the globe including the Western Seaboard of the Americas, Antarctica, and the Pacific Remote Islands.

He discusses how fisheries scientists are trying to improve predictions on how the global oceans are changing due to climate change and acidification, and how these changes affect food security, changes to livelihoods, and changes to other societal benefits coming from the ocean.

Indexed Names
Andrews, Kacky
Boehlert, George
Bush, George
Clinton, Bill
DeMartini, Ed
Johnson, Jeff
Murawski, Steve
Obama, Barack
Parrish, Frank
Polovina, Jeff
Pooley, Sam

Transcript – RB-001

Edward Glazier (EG): This interview is being conducted as part of the Voices from the Science Center Project funded by the Northeast Fisheries Science Center. It is also part of the Voices from the Fisheries project supported by the National Marine Fisheries Service Office of Science and Technology. My name Edward Glazier and today, July 27, 2016, I'm speaking with Dr. Rusty Brainard at the Pacific Islands Fisheries Science Center in Honolulu. Rusty has had a long career with NOAA Fisheries and is presently Supervisory Oceanographer for the Coral Reef Ecosystem Program. Rusty, I thought we could talk a little bit about your career, so maybe start at the beginning and then we'll work our way through a variety of issues. Rusty?

Rusty Brainard (RB): Yeah. So, I actually started working with NOAA the day I graduated from college. I actually I got commissioned into the NOAA Corps at my graduation ceremony, so that was in May of 1981 and immediately got sent to New York for training and then got sent straight to a ship, the NOAA ship *Discoverer* working in Alaska for, you know, part of that deployment, and then also the equatorial Pacific which was fascinating work.[1] And then while I was actually on the Equator, I got this, this was pre-email and stuff, I got a Telex message out at sea, you know we were on a 35-day cruise or something, got a telex message that I've been selected to go to South Pole, Antarctica for a year. You know, so after I got off the ship, and then got sent to Colorado for a bit to train for an assignment at South Pole Antarctica to be Station Chief for what was then called the [NOAA] Geophysical Monitoring for Climatic Change Station [South Pole Observatory], which was essentially monitoring all of the various parameters that influence climate change. The most notable one is CO_2. Ozone – this was kind of in the peak of the ozone hole years – and so we were literally at 90 degrees south, about 10,000 feet of altitude. The warmest it got for the year was about 30°F below, and the coldest it got was 106°F below, so kind of the mean was around 60°F below, so it was a very different environment.

EG: Summer in Antarctica?

RB: Yeah.

EG: Where did you go to college?

RB: I went to Texas A&M [University at Galveston] for my undergraduate.

EG: I was going to trace that back. OK. I knew some folks who did some small social group research it at the pole. Years ago.

RB: Oh. We were actually… there were 20 of us that wintered over at South Pole and we were part of some psychiatric evaluation studies on us essentially.

EG: Yeah, that may been Jeff Johnson.

RB: I don't remember who. They had us see psychologists before going and then when we all came back, all individually, and so you know we were part of some sort of experiment as well. Never really heard what…. and I think that was an ongoing long-term thing with each of the winter-over parties.

EG: I think NASA had a hand in it.

RB: Yeah right, trying to prepare for…

EG: Small group interaction in space.

[1] Narrator Clarification: Rusty Brainard entered NOAA Corps Service on May 8, 1981 whereupon he immediately shipped to New York to undergo the NOAA Basic Officers Training Course (BOTC).

RB: Yeah, very similar to it. Yeah, it was kind of like being on a different planet there, because it was dark literally at South Pole. The sun went down once and we had actually had a 17-hour green flash, you know, where I'd been at sea a lot and I used to really enjoy watching the green flash which is usually a flash. It's…you know, a fraction of a second and most of my colleagues at the South Pole had never heard of it because they weren't seagoing types, and then I got them all excited to watch this thing and the South Pole was all flat, you know being on a large glacier, and you're kind of, "It's happening!" you know, and it kept happening because it [the sun] just went around…it was just essentially setting going horizontally around the entire horizon. And so we watched it and watched it and then people started getting bored with it.

EG: I never knew. I've seen the flash before once or twice.

RB: It was kind of right at that particular place.

EG: Interesting.

RB: And then after South Pole I went to my first fisheries assignment, so I went to actually what then was part of the Southwest Fisheries Science Center, but I was in Monterey which was the Pacific Fisheries Environmental Group, actually then it was just the Pacific Environmental Group, where we were looking at mostly global datasets on kinds of interactions between oceanic forcing of fisheries. At that point, I was working mostly on coastal fisheries all the way from Alaska to Chile, and the influence of ocean variability like El Nino. You know so this was back in 1984 to 1986 when very little was really known about El Nino.

EG: So quite relevant now.

RB: Yeah, yeah. So it's still… so I mean so we were kind of doing some of the early stuff on the interactions between fisheries and climate variability.

EG: From Monterey, so Southwest was La Jolla.

RB: La Jolla. In fact, the Honolulu lab used to be part of the Southwest Center. Right, and until 2002. In fact, then was also my first engagement with the Honolulu Laboratory which is now [part of] the Pacific Islands Fisheries Science Center [PIFSC] for my Master's [research]. While I was in Monterey working at Pacific Environmental Group, the Laboratory Director from Honolulu, who was George Boehlert at the time came, to our lab seeking oceanographic assistance on some seamount work at the Hancock Seamounts [in the Emperor Seamount chain] at the far end of the Hawaiian Archipelago, and then that evolved into becoming my Master's research looking at flow, the way the currents flowing around topography, like seamounts, actually change the hydrodynamics and it creates very special environments for fisheries. So, there were very tight aggregations of certain fishery resources they were trying to understand, that had been heavily exploited in a very short period of time.

At that point it was pelagic armorhead, a fisheries species that went from…you know, when they first started the fishery at Hancock I think it was something like 80 metric tons per trawling hour

that they were just essentially mowing the lawn on the top of these seamounts, and within like three years that had dropped to 0.4 metric tons [per trawling hour], essentially just taking all the fish off the top of it. And then they closed the fishery and I'd say, as far as I know, it's never been reopened…but it hasn't recovered. Probably the last time…we [the Honolulu Laboratory] then were surveying for a number of years following [the closure], and now it's been probably 15 years since there's been a re-survey of it, so maybe at this point there's been some recovery. But the last surveys that were done, it hadn't recovered. Anyway, that was my first engagement with what became PIFSC and that became my Master's thesis looking at the flow interactions that were influencing that fishery.

EG: Particularly at Hancock, or did you do work at Cross Seamount or any of the others?

RB: At that point, no, it was just that there was a big focus because NMFS had shut the fishery at Hancock and the project was to monitor, really, why was it so productive, and would it recover in monitoring that. So…

EG: Yes.

RB: But kind of the physics [of flow/topography interactions] would be the same, you know, I mean, you know

EG: Vertical forcing.

RB: Yeah, yeah. Essentially, actually what we were looking at is when flow, kind of in laboratory experiments, and now in computer experiments, you see you can have flow and you have a seamount there and then that creates something that's called a Taylor column where there's this kind of central region where the flow kind of goes around and there's this kind of hole there that kind of keeps larvae and a bunch of things trapped there which was one of hypotheses that was helping drive this fishery. And that would apply kind of anywhere where there's flow and topography interactions, the same physics would apply. And at that point, as part of my Master's work, I actually came out on the *Townsend Cromwell* a couple of times to go on those cruises to Hancock even though I was at that point still working at the Monterey lab. But after that, I came to the *Townsend Cromwell* as Operations Officer, so then I kind of got very involved with all aspects of the Honolulu laboratory seagoing science missions which included, you know, protected species work with monk seals at the time. There's a lot of field camp work. So we reported…

EG: Even at that early date?

RB: Yeah, and that work started I think in 1978, or maybe it was 1982, and I was kind of there from 1987 through 1989 so was a very central part of what we were doing. We also were doing the annual lobster survey cruises in the Northwestern Hawaiian Islands, and some bottom fish survey crews was in the main Hawaiian Islands and during that period, we did the very first of experiments with monofilament longlining. You know, so I was kind of onboard when we were first learning how to longline aboard *Townsend Cromwell* which was really exciting, and from a ship driver perspective, longlining and lobstering are particularly fun because you're continually

[maneuvering the ship], for your entire watch, you don't have a second where you can relax, you're having to, you know, continually pay attention to the gear because the gear is, at least in the case of lobstering, is attached to the bottom. You don't want to be dragging that gear so you're trying to maintain the ship, you know, permanently above this while they're pulling pots and likewise with a longline it's, you know, 20 miles of line and you're essentially, you know, maneuvering the ship up this line, and trying to do it very rapidly and then when there's a bunch of fish on, if there's tangles or something, you've got to stop the ship immediately. Lots of interactions. From an enjoyment perspective, those were interesting times. Those are my first kind of real interactions with seagoing fisheries, I mean that's what we were doing. We were fishing, and trawling. Whether we were longlining, we were bottom trawling, we were bottom fishing and we were lobster fishing, so I was getting a really broad exposure to the operational aspects of what fishermen do from a…although it was from a research vessel which is often very different in configuration from a fishing vessel. We were trying to do all of these different types of methods from one platform on different cruises so that was very enjoyable. Almost three years of my life was kind of being a non-commercial fisherman. [laughs]

EG: And that led to your dissertation at some point?

RB: No, then I went after that, I did my graduate work where I did my research for my Ph.D. at NOAA's Pacific Marine Environmental Lab which then I kind of went back to the climate side. I was working on kind of physical oceanography of El Nino, again that was, you know, becoming more and more of a dominant driver of variability that was influencing all…various sectors of the economic…you know, it was affecting fisheries but it was also broadly affecting agriculture and climate all over the globe. You know so the parts that I was doing there were trying to understand again the physics of what was [going on] so we could better model it, so we could do better climate predictions. And then from there I was selected to be Commanding Officer of *Townsend Cromwell*, so I came back to Hawaii, and I've been here ever since. So that was in 1994.

EG: Wow.

RB: I came back to Hawaii to be Commanding Officer of *Townsend Cromwell.* That was, I think, the longest Commanding Officer tour, at least up until that point. I was extended multiple times as Captain and so I think it was 39 months as Commanding Officer which typically is 24 months, is what a typical command tour is.[2] And I was loving every minute of it. I mean we were doing these fascinating missions, you know, and then we were doing a lot of longlining both down by the Equator as well as in the North Pacific at the subtropical frontal zone. We were still doing the annual lobster survey cruises. We were still supporting the monk seal work. We'd started then doing reef fish surveys for one of the projects with Frank Parrish and Ed DeMartini and between those surveys where I got involved as one of the support divers, and then as part of a monk seal diet study, they're needing to collect something like seven [specimens] of like eighty different reef fish species, they were wanting seven specimens of, so they can do fatty acid analyses, you know, so they can test from the fatty acids what was in the monk seal diet, which is very much a fishery issue because there was a controversy at the time on… there was a declining population of Hawaiian monk seals, a critically endangered species. At that point, there was, in

[2] Narrator Correction: Rusty Brainard spent 40 months as Commanding Officer of the R/V *Townsend Cromwell*.

the 1980s, a rapid increase in the lobster fishery and there was a lot of finger pointing--

EG: I remember that.

RB: --on whether the monks seal decline was caused by competition for resources.

EG: Right.

RB: So there were some that were saying that, you know, by taking those lobsters, they're taking part of the diet of the monks seals, and so that's what that study was about. My involvement wasn't on that end. It was really just to be a fish collector. And that's, you know, that kind of background between those support missions, I think while I was Commanding Officer I think I did some 300 dives up in the Northwestern Hawaiian Islands--

EG: Fantastic.

RB: --and that became kind of the foundation which later came to what I've done for the last 16 years that after my time as Commanding Officer on *Townsend Cromwell*, I was assigned to, and this as still as a NOAA Corps Officer, I was assigned to the Ecosystem and Oceanography Investigation here at Pacific Islands Fisheries Science Center. Again at that point, it still Honolulu Laboratory working with [Dr.] Jeff Polovina, so I was actually doing some bigeye tuna work and some work in the Northwestern Hawaiian Islands on flow topography interactions and how that influenced fisheries. But I think a lot because of how much work I'd done in the Northwestern Hawaiian Islands, in 1998, President Clinton signed the Coral Reef Protection Executive Order which said that the federal agencies needed to do more to understand and protect coral reef ecosystems.

At the time in the Pacific Islands Region there really wasn't any mapping assessment or monitoring going on. There was just starting [to be]...the University of Hawaii was just starting for the main Hawaiian Islands, some coral reef monitoring, but in all of the other areas…American Samoa…. there wasn't any monitoring in the Marianas and Guam. There wasn't any monitoring in the Northwestern Hawaiian Islands. There wasn't any monitoring or mapping, you know, so I spent a few years there, kind of working with a lot of colleagues in Washington and around the nation and developing some proposals and some plans to fill this gap of knowledge, where we were now needing to protect the coral reef ecosystems. We didn't have maps of where they were. We didn't know what species were on most of them. We didn't know the abundance, we really didn't know anything.

That led to in 2001, actually in 2000, we did our first *Townsend Cromwell*-based reef ecosystem survey cruises which the very first one was actually supported by the [U.S.] Fish and Wildlife Service to go to Howland, Baker, [and] Jarvis [Islands] and Palmyra [and Kingman Atolls], what are now the Pacific Remote Island Areas to do the first assessment surveys of those locations. All that had been done in many of them like Howland, Baker and Jarvis had been some snorkel surveys, just at the landing sites where they were mostly doing terrestrial work where somebody would jump in the water, who knew their fishes, and would make a species list, and that was kind of the extent of what we knew for most of those places, so we did kind of those first years in

2000, 2001, 2002, we were really pioneering the first time SCUBA had ever you've been used at these locations, and any of the mapping, you know, those places were only ever surveyed during World War II, and they were with sextants, so they were literally a couple miles off of the locations on the charts and there were no depths on the charts like the shallowest soundings were like 260 fathoms and then nothing in the near shore to show what was actually there . So we really… and most of the Pacific Islands were kind of in that state as recent as 2000 and 2001.

So that's what we've been doing really ever since, is we established the Center. Well, we became the Coral Reef Ecosystem Investigation in 2001 and then in 2002, we became Pacific Islands Fisheries Science Center, so each of the investigations became research divisions, so we then became the Coral Reef Ecosystem Division from 2002 until last year. Then really the core of our work has been to map, assess, and monitor and do kind of applied research to allow us to better manage the fishery resources and the coastal resources for all of the U.S. Pacific Islands which includes, you know, the main Hawaiian Islands, the Northwestern Hawaiian Islands, the Pacific Remote Islands, all of the islands in the territory of American Samoa, the waters of the territory of Guam, and the waters of the Commonwealth of the Northern Marianas. So that's kind of been the core for the last 16 years is that ongoing research program.

EG: These are massive ocean areas.

RB: Huge. Yeah.

EG: I often wonder how and whether you get sufficient resources to be able do what you would like to do. Would you say that it deserves additional fiscal resources and time and money? I mean is it we're going in the right direction today?

RB: Well it's been fairly level funded now since we started. What's really made it much more difficult is level funding is really a decline. We've had very significant cost increases for cost of living increases, overhead increases, so our, you know, with level funding, we've actually seen about a 40 percent reduction in ability to get the work done.

EG: Right.

RB: So I think we are…

EG: At a time when these places are becoming monuments and protected areas.

RB: Well, I think actually, you know, from a from a conservation perspective, I think…so little was known in the Northwestern Hawaiian Islands. The first of these reef assessment cruises in 2000 in the Northwestern Hawaiian Islands, essentially kind of raised the visibility mainly to the non-governmental organizations and same with the Pacific Remote Islands and same with the Northern Mariana Islands. We suddenly had information that these were actually really special ecosystems that we were starting to document that the difference and diversity and abundance particularly of the fishery resources, the abundance between these remote areas and the populated areas was like an order of magnitude of abundance and decreases in fish biomasses in the populated areas. You know, so we essentially provided the background information that led

to political decisions mostly through Executive Order to establish this series of remote monuments because the…again, mostly from pressure from the different environmental NGOs [non-government organizations] who are saying these are very special places. They're not being utilized now. Let's protect these places. They made petitions to the Presidents. And you know now there's been multiple presidents. The first one was Clinton who declared Northwestern Hawaiian Islands [Coral Reef Ecosystem Reserve in 2000/2001]. President Bush then built tremendously on that [in 2006 establishing the Northwestern Hawaiian Islands Marine National Monument], and then President Obama has built on that [in 2009 establishing the Pacific Remote Islands Marine National Monument, the Marianas Trench Marine National Monument, and the Rose Atoll Marine National Monument].

EG: And we're presently seeing a desire for expansion.

RB: Yes, so there's, you know and again we weren't actually part of any of the decisions at all. We didn't advocate for any of these measures.

EG: Right.

RB: But it's clear to see that those measures all started happening once we actually documented, you know, the resources and the uniqueness of those places.

EG: That's exciting. And your work has some impact.

RB: Yeah, and again it's an indirect impact that I don't think many of these things would necessarily have happened if there wasn't information to show these differences.

EG: Right. So how large of a vessel is the *Cromwell*?

RB: Well, the *Cromwell* is, or I mean it was retired in 2002. So we haven't used the *Cromwell* in quite a while, but it was a 163-foot vessel. It got replaced by the NOAA ship *Oscar Elton Sette*, which is 224 feet.

EG: OK.

RB: It is the primary vessel for the Science Center for the work that my program does, the coral reef work. In 2003, the *Sette* came on line in 2003, and the NOAA ship *Hi'alakai*, which is kind of a sister ship of *Sette,* they were both former Navy surveillance vessels, both got converted for different purposes. The *Sette* was a multi-disciplinary fisheries research ship, the *Hi'alakai* was modified very much to support our mission. I mean it's capable of carrying five boats and has a recompression chamber. I mean, it is almost like the perfect platform for us to use and it carries 22 scientists, and since we're trying to do ecosystem surveys, we have fish biologists on board, we have coral biologists, and algal biologists, and invertebrate biologists, we have chemical oceanographers and physical oceanographers, and mappers, you know, and trying to really look at ecosystems, [that] requires lots of different types of expertise. So we have 22 scientific births and every single one of our reef assessment cruises every birth is filled, as we're trying in this snapshot of time, document the status and how these systems are changing across taxa, from

where we are right now with lots of partnerships. Right now we are in partnership with academic partners. We're actually monitoring from the microbes which generally aren't [of] direct interest from a fisheries management perspective, but have tremendous [importance]. That's where most of the function is going on, and much of evolution is kind of driven at that level, all the way up to the apex predators. We're kind of monitoring the biological life, both the benthic community structure and the fisheries community structure across the ecosystem, and this is in response to kind of national efforts and really global efforts to shift towards ecosystem-based management, which is kind of one of the fundamental shifts that our field is going through, is going from single species stock-assessment-based fisheries management to more of an ecosystem-based fisheries management approach.

EG: Which is clearly of great interest to many people now, but also leads to many challenges. What's driving the research end? I mean, this kind of work is being done around the country but how do the decisions come down to where to send the *Sette*, or the other vessels? And what to do. It's really a process of coordination.

RB: It's a significant coordination process with, you know, many different interests, but the decisions are made primarily at the center leadership, and at national leadership. There's competition between all of NOAA to use the NOAA ships, you know, so there's a competition of priority, you know, a prioritization process of how can we get essentially the most bang for the buck really for the American people. What are those questions that need answers most importantly? The Fisheries Service gets a lot of sea time because we have to make management decisions, we're a regulatory agency. We make those decisions based on the best available science, and you need to access these places, these ecosystems, these fisheries, in order to have that best available information. So that's really kind of how the process goes. Of course, there's always more science we would like to do, and always will be. In particular at the ecosystem level, we are really at are infancy and really understand, understanding how these fisheries operate…how these ecosystems operate.

Again, you know, for most of fisheries management for the last couple of hundred years or thousand years, mostly the real challenge was just assessing how many of the species were there, and for temperate fisheries, there's usually very large abundance of a relatively small number of fish [species], and those are the target fisheries, and, you know, a lot of effort goes into getting stock assessments, reliable estimates of the abundance of the population so they can they then establish a quota for how many can be taken from that system. When you get to, you know, Pacific Islands Region, there, particularly for reef systems, there's very high diversity of low abundance species, and almost all of those species are taken at the subsistence level, at the community's level. You know, so that approach becomes a stock assessment to actually meet the true mandates is a very expensive undertaking. To try to do that for many hundreds…I think we have, some five or six hundred management unit species in our region, of which for the coral reef species, we've now done 21 stock assessments of those 600 or so species, and 19 of those were just done last year for the first time.

So we're, you know, that approach is incredibly challenging to apply that across the board for all of those managed species, you know, in some ways an ecosystem approach, one it makes more sense because the whole system is coupled together. It's integrated together. You know, but it's

also more cost effective to see how the system is doing, how certain indicators, how fish assemblages are doing, trophic assemblages are doing, and different functional groups, and then come up with, you know, which is hard scientifically but it's more doable than trying to do a robust stock assessment every year for every one of those species.

EG: That's interesting.

RB: I mean we just can't do it. We, I mean the amount of effort we spend a tremendous amount of time at sea as it is, and we're very far from being able to reach that. Then again, internationally and nationally we're coming to realize that that we really should be managing the whole of the ecosystem uses, and trying in an ecosystem-based management at the end of the day is really trying to achieve a balance between human wellbeing, the societal uses of these marine systems, and ecological wellbeing so it will be sustainable. You know, is reaching that balance through good governance, and that good governance we believe needs to be based on sound science, of both the people side, and the ecological side. And so much of the [ecosystem] function is in, and again, traditionally we've focused on just the fish that we take and eat, so everything has been based on that part of the ecosystem which is those highest trophic levels. And kind of everything below that we've mostly not done much about, and we haven't been basing any of the management of what's at the lower trophic levels or the environment that's forcing those things. Now it's becoming more and more [important to acquire a] common understanding [of] just how much climate change and ocean acidification these, you know, the planet and the ocean as we know it, is different now, and is going to continue to be changing over time. We need to better understand how the whole of the ecosystem which includes the environmental variability, the physical properties of the ocean, the chemical properties of the ocean, how those are changing and how those are going to be affecting all the way down to the microbes. The things that are mostly going to affect immediately are going to be at that fine level, and that's where everything kind of goes up from there, to the things that more fisheries, and more of the people care about at those higher trophic levels, but those can't be maintained without the foundation of all of those lower trophic levels below that. We're now trying to understand those linkages so we can better manage those upper trophic levels, if that makes sense.

EG: Oh absolutely.

RB: And the role of people in interacting.

EG: So we're at the top of those human and political influences.

RB: Yeah, yeah. And then I guess the other part of that is we've tended to manage fisheries in isolation from all of the other ocean uses, and coastal uses that need to be managed. You know, so often, you know, agriculture or things particularly for the near shore system, there's lots of things that are going on land that sometimes have a greater influence on say coral reefs, or coral reef fisheries, or near shore fisheries, than fisheries alone, and yet we're managing those things independently of each other or in some places like the Pacific Islands Region, our region, from an economics perspective, the economic value of tourism in our region which mostly people come to for [enjoyment and recreation], because of our ocean environment, because of beaches, because of water quality, for diving, for snorkeling, for various things. There's numerous studies

of the value of these near shore [eco]systems economically, and often those values are much greater than the economic values of those near shore fisheries. You know, so it's trying to reach what is the best societal benefits across all of these sectors and being able to maintain ecological well-being, so that those are sustainable services that, you know, and then kind of taking all of those sectors, you know, into the management decisions concurrently, and that's very, very challenging.

EG: It really is.

RB: But I think that's really kind of where we're going as a global community and certainly within National Marine Fisheries Service. We've recently issued our first ecosystem-based fisheries management policy statement. There's currently a draft road map for how we are actually going to implement that, and a lot of it is just what I'm talking about, is how do we incorporate these other aspects into the way we manage fisheries.

EG: You've walked us through a long history and process of increasingly complex issues. I often wonder if the human resources are always going to be available to keep this tradition of research work to understand these systems going. Do you feel like the new crops are coming in to take on this kind of work?

RB: I mean, I think certainly the next generation of scientists are well prepared, I think, and are becoming well prepared. They're very interested. There's been a shift in needing to understand this. Whether the resources will be available to do that kind of research over the long term, that's really a political process and at the end of the day, I think there will be research, because society depends on us making effective decisions to conserve these resources. We've seen fishery after fishery around the globe collapse, and with that is the collapse of the societal side. You know, the jobs associated with it, the food that's produced. We know we need to do a better job, and I think again from a scientific perspective, we think these ecosystem approaches are the right way to do it. And again, I would argue, and often people say oh you, in fact there's often this kind of myth and there has often been this resistance towards ecosystem-based management because they think you have to know everything about everything before you can do anything. We like to actually see it completely differently. You still have to know, I mean you only have as much information as you have. You still have to make the best decisions towards ecosystem-based management that you can with the information you have. You can, moving forward, you can restructure how you're gathering information for the same amount of money to take any good consistent information, like, I mean right now we're required to do stock assessments of all species. We're not able to do that, we don't have the resources to do that as I mentioned. We instead are focusing all of our resource on doing stock assessments, and not effectively enough again for these very diverse coral reef systems or near-shore systems. We could do that differently by doing it through ecosystem indicators for the same amount of resource. It's very, very complex science and, you know, how we do it is very different than obviously from a science perspective, we think we can do it much better with more resources, but we can't rely on there being more resources. We think we can do a better with the resources we have if we re-prioritize the use of those resources.

EG: I see. Gotcha. You know I wanted to ask you about some of your most interesting work.

Any specific projects that you might think about as emblematic of your career?

RB: As you've pointed out, my career has kind of gone in many different directions. That what we were just talking about ecosystem-based fisheries management, and it is something I found very interesting and over the last five or six years, the science that my program has been doing, or has been trying to do, the ecosystem science to support that for a long time, but over the last five or six years, I was assigned by NMFS's leadership to be NOAA's Technical Lead for an ecosystem approach to fisheries management for the Coral Triangle Initiative, an initiative between six countries in the Coral Triangle Region which include Philippines and Indonesia and Malaysia, Timor-Leste, Solomon Islands, and Papua New Guinea.

So that was kind of an entire shift for me, and one of the things that provided me was an opportunity is not really only look at the science side, because NOAA Fisheries doesn't have any management or regulatory authority in those areas. I was able to be much more involved with the policy side in that world, and again my role was to be a technical advisor on how, you know, what kind of information you need, and that sort of thing, but it really helped me open my eyes to how would you actually do this. How would you achieve this balance between ecological and human wellbeing, and kind of thinking of it from not just the science perspective is how would you actually do it in that part of the world, you know, a country like Indonesia has 260 million people and like 80% of them get most of their protein still from ocean resources in their backyard, and in that part of the world there's just major, major threats to their fisheries. So it's just that the challenges they face are just, you know, huge. And many of those are developing countries very, very poor people, you know, if they just still have to find a way to feed their family every day, they're going to do whatever it takes to get a fish from the ocean, and as resources become scarcer and scarcer, they become more and more desperate.

So the challenges... again what was very eye-opening to me is the importance of doing this and helped rethink kind of the science that we need to actually inform management more. You know, so less from an academic perspective and more from a practicality perspective, which is kind of where NMFS is anyway. I mean, we're not in the academic sector. We've always been much more applied. That just kind of helped refocus a little bit closer to where the rubber meets the road.

EG: How did this arrangement occur through NOAA, for you, given that these are…?

RB: Well, it was primarily the Coral Triangle Initiative was between the six countries. They came together and signed an agreement for ocean governance that the six countries would work together through the U.S. State Department and USAID, U.S. Agency for International Development. They committed for five years to the U.S. Coral Triangle to help get those six countries started, so the Coral Triangle Initiative came up with five priority goals, one of those goals was to implement an ecosystem approach to fisheries management. USAID and the U.S. committed something like $45 million to help with three of those goals. One of those goals that the U.S. committed to assisting with was an ecosystem approach to fisheries management because NOAA Fisheries handles management of fisheries in the United States. Most of the partners within that partnership of U.S. Coral Triangle Initiative were NGOs and contractors, but they wanted NOAA to be involved because we actually have the management responsibilities in

the United States, so they reached out, USAID reached out to NOAA then an agreement came, and then it was for different themes they identified folks, and actually [Dr.] Steve Murawski was the Chief Scientist for NOAA Fisheries at the time and Kacky Andrews was the Program Manager for NOAA's Coral Reef Conservation Program. They essentially talked to the Center Director and myself and came to the conclusion that I should be that guy.

EG: Lucky you. Interesting.

RB: Although, actually at the time, I said I don't know how I would have time to do that, and [Dr.] Sam Pooley, our Science Center Director at the time, said Rusty doesn't have time for that, and nevertheless the decision was made this that I was going to be that guy.

EG: What happened to your other duties in the meantime?

RB: Fortunately, by that point, we, as a program, were much more mature. I mean, in the early years the day-to-day thing, management of everything, I was very involved in. We were then kind of 10 or 11 years into our history. Most of what we do is…. we had mature teams. So we have a fish team, and a benthic team, and an ocean and climate change team, and each of those had much more developed and established leadership. The program didn't need as much day-to-day interaction to sustain itself during that period. Yeah, yeah. People filled the void. You know I don't think things suffered, and in fact, again, I think it turned on a bunch of lights in my head of how we could actually do our day job of managing U.S. fisheries better through that engagement. Because we were working closely with the UN FAO [Food and Agriculture Organization of the United Nations], their fisheries side more on international things, and there were several large marine ecosystem projects, the Bay of Bengal large marine ecosystem project, I got very involved with.

So, we started learning from people, experts around the globe, who are facing the same challenges of overfishing, destructive fishing, land-based source of pollution, climate change. You know, everybody around the globe is suffering these things. It became a very good opportunity to really work side-by-side with these other global experts and I think we were there, I was there, my team was there primarily to provide technical assistance and help build their capacity, and I think we did that in a significant way. But I'd be the first to admit I think learned more in that entire process than probably any individual that I was there, as you know, to assist. And I think our whole team did, and I think that now is, in fact as I've been part of the NOAA Fisheries, the NMFS Ecosystem Based Fisheries Management Working Group. I mean we've been coming up with this [EBFM] policy statement, this [EBFM] road map. I've been on various of these things [working groups] and part of that was because I'm able to bring in [the] kind of experiences for how other parts of the world are doing that through this last five years of that interaction. Some of that is coming home to help us make that [transition], I mean we were also in this transition of how do we actually transition from single species stock assessment-based fisheries management to ecosystem-based fisheries management, so it's I think it's actually been very beneficial both to the countries overseas that we were there to assist, but also in then bringing lessons learned home.

EG: Did anyone write up lessons learned from that process? Is there anything?

RB: I mean, there's multiple documents. So we've published like guidelines for EAFM [ecosystem approach to fisheries management, EAFM] for that region. We've developed like a week-long curricula [on an EAFM], published [that] curricula as an FAO document, and so those are kind of formalized ways [to share] lessons learned. There hasn't been kind of an equivalent of what specific lessons were learned from there that are transferred to here. It's more kind of engagement in what we're trying to do here and bringing those into those discussions, but not kind of a specific document.

EG: Sure.

RB: I would say that right.

EG: But, practical advice and knowledge.

RB: Yeah yeah, and being on these different working groups, now that's a whole other insight that that gets brought into those discussions [with NOAA Fisheries], and I think that's been beneficial.

EG: I did want to hit a bit on the technological changes that have occurred in your career. Boy it's really changed if you think back just 15 years ago.

RB: Yeah.

EG: You really have a lot more going on now, a lot of ways to see the world and communicate that just weren't there, so I would think remote sensing developments have been really incredible for you in your career. Anything in particular?

RB: Well, I mean…[I] kind of think the three big kind of categories that have fundamentally changed, really the first is computing technology that is enabling ecosystem models, and climate models, and much more robust ability to understand and to predict from what we were able to do a few decades ago. I completely agree with the satellite remote sensing as well as some other technologies for observing the ocean that didn't used to exist, I mean satellites give us a continuous global picture of what the ocean surface is doing from many different perspectives. And the models give us ability to kind of predict on a global scale what's going on in the ocean, but there's other tools in addition to those. I think those are the most fundamental changes.

But another one in kind of the biological area is just genetics. It's not just been in the marine field but it's carried over, it's mostly been in the medical fields, the ability to understand all the way down to the genetic level differences between organisms and relationships. You asked earlier about what kind of projects that have been really foundational for me in my career, another one that I was asked to be a PI [principal investigator] on from 2005 to 2010 was part of a global Census of Marine Life Project. There were 17 different projects under the Census of Marine Life. I was one of the co-PIs with two others on a Census of Coral Reef Ecosystems [CReefs] project which was really [aimed at understanding biodiversity of coral reefs]. Most of the diversity of life in the ocean we don't know. It's [been] estimated that we only have

documented 15 to 20 percent of the organisms that live in the oceans. For coral reefs, it's estimated that a quarter of the species that live on the planet… in the [global] ocean occur in coral reefs which are like 0.1 percent of the area of the ocean, so they are highly diverse systems. So as part of that project [the CReefs]…and there's not enough taxonomists on the planet and probably never will be, [documenting biodiversity of coral reefs have] been underfunded.

So, we developed a tool, in fact that's what one looks like up there -- an autonomous reef monitoring structure [ARMS] -- to have people all over the globe systematically use the same collecting device, so that we could have kind of a standard which, in the biological realm, we didn't have a standard. So we developed here [at PIFSC], these ARMS, the acronym is for ARMS and now they've been deployed all over the globe, and they've become a standard collecting device. At the end of the day, we take everything that settles in that [the ARMS unit] over three years, and we can then [molecularly] sequence that. An ARM is that big [gesturing]. [The S unit, has] plates [that] are nine inches by nine inches and there's ten plates. It just becomes a settlement [plate]…a home…it becomes a fake reef that we can remove after three years and put another one down and we can look at how much diversity and abundance there is of all these small things that live in a reef that we mostly know nothing about. I mean we know something about some of the crabs and some of the worms and some of the snails. But in an ARM[S unit] like that, we're now finding through this molecular sequencing, that we're typically finding [something] like 1,500 species in something that small. There are [about] 31 known phyla of life on the planet. We've seen as many as 28 phyla in a single ARMS [unit]. Almost all of them come up with like 20 phyla. I mean it's just…[the diversity is amazing] and that genetics have become a tool that enables us to document for the first time this diversity of life. We are actually keeping it partially funded through things like the ocean acidification research that we're leading. There's very significant concerns with climate change and with ocean acidification, that the diversity of life in the ocean is going to fundamentally change.

EG: Right.

RB: And that's what's happened in these past extinctions events. Kind of the best research now suggests that almost…[or possibly] each of the five [global] mass extinction events has also been ocean acidification event. Mass extinction is when we've lost 50 percent or more of the life on the planet, and these are becoming a tool to document for the first time what we actually have and all those things that are really difficult to [sample and document], the things that live within the reef, so our traditional reef surveys miss almost all of that. We count the fish. We do a pretty good job of that. We can count the coral. The macro algae we can assess, but all of those together are less than one percent of the diversity. That other 99%, and this [the ARMS] doesn't capture all of it, but [ARMS] systematically give us a measure of the diversity that was completely unknown, and that's now being adopted by colleagues all over the world. And so the technology though, to kind of bring it back to that, is [that] we still wouldn't be able to [document biodiversity. ARMS is] just a tool to collect it, but the real technolog[ical] advance is to be able to sequence it, otherwise we'd still need thousands of taxonomists sorting through all of this stuff, and we'd still like that because, you know, the genetics doesn't [tell us what every organism is]. Until you kind of barcode an individual thing [or organism] you still need to describe that thing once, and then have a sequence of it so that once you see that any other time anywhere in the world you'll know, "Oh, that's that guy." We still don't [know]…in many cases

we don't know [most] of those 1,500 [species], you know, it's only like 15% or actually less than that, it's like 3% have actually been barcoded and described at the same time. So it's just this amazing amount of life in the ocean that we know nothing about. Yeah. But that's actually been exciting.

EG: How have they been, you know, given to other colleagues, through just informal agreements, or through programs?

RB: It's mostly through kind of collaborative partnerships, so it's like actually…

EG: Social networks of scientists basically?

RB: So yeah, there's an increasing recognition of the need, in fact, you know, it's been somewhat scary for actually…for some of my staff. I've been kind of really pushing to get these replicated around the globe, even though we didn't have all the sequencing capability. We started developing these in 2005, started deploying them in 2006, and we started putting them all over the Pacific, and then with partners, we put them all around Australia. They went in the Indian Ocean, and they've gone all over the globe. We still didn't have the method all the way worked [out]. Literally a few weeks ago, we had the first sequencing from 100 ARMS [units] and it's fundamentally, if it holds up, it's fundamentally changing what we thought we knew about coral [reef] diversity – not coral diversity…diversity of marine life. The Coral Triangle is defined based on the number of coral species. It's highest there. There's like ten times as many coral species there as say Hawaii. It's kind of a very linear gradient and reef fish are also kind of that same gradient, and the only other thing we knew was kind of the macro mollusk kind of have that gradient of the highest diversity there and the lowest the further you radiate away from that [the Coral Triangle]. From the ARMS samples, and we do it [sample and analyze] in different size fractions [and] we're seeing the opposite pattern [of diversity]. We have no idea why that would be. But again, those things that we knew about are less than one percent of the diversity and we kind of are…you know…because those things did that, we just have all of the entire communities, well that's just the way it is, and there's been all kinds of theories of why that have been competing, you know, it may be now that we have different technologies that [might show that the expected] pattern isn't universal. It's for some groups but not all groups. And if so…

EG: A paradigm. Yeah.

RB: It could be a paradigm, and it may be that we find that there's some underlying bias or there's some underlying problem, you know, so it will probably be several years before we can say whether that's actually definitive or not, but [the preliminary findings are] just totally shocking to us.

EG: That's exciting.

RB: Yeah. It's exciting, like whoa, that's not supposed to happen, you know.

EG: Right, indeed.

RB: Those are kind of some examples, and actually another kind of technology is acoustics. You know, so you can use both active acoustics, where from a ship, or even from a buoy or something you can send out sound waves and then they bounce off of things in the water, and that's often how fisheries use echo sounders a lot to find out where fish are in the water column. So that's the tool that's advanced a lot. But also passive acoustics is just listening to the oceans, getting ocean soundscapes, and a lot of organisms make sounds…just like birds, you know. I mean forest diversity, we know much more on the terrestrial literature. You can actually see shifts in biodiversity just from the soundscape, and you know kind of for about a 10-year period, about an 8-year period we were starting to use some things called ecological acoustic recorders -- kind of a great acronym is EAR. We were listening to the ocean, and we were starting to develop these soundscapes that ended out in 2010. We lost the funding for that, but I think that the tool itself, you know, that's one of the things we need more resources for because right now when we survey coral reefs and fishery resources, because of the remoteness of the Pacific Islands region, and the vastness of the Pacific Islands region, we visit each of the islands every three years. We have about five days on any one of these particular islands, where we do almost all of our work using dive surveys. We can only do that during daytime hours, so we have about eight hours a day for about five days, and we document the status of that place, the fish, the corals, the algae, now, you know, all the crypto biota, the little small things, the temperature and I think we do a great job documenting it during those five days. Then, 1,100 days later, we go back and take this snapshot.

EG: Right.

RB: The acoustics we can just leave in place, and we can get the other 16 hours of a particular day of what sounds the critters are making. We get seasonal cycles. We can get changes with El Nino, La Niña. But when we're only going every three years, we miss so much of this variability that we just don't know how much is there, so the acoustics becomes this technology that we can deploy pretty cost effectively all over the place to get, you know, an indication of what's going on the rest of the time.

EG: Yeah, very interesting.

RB: And we could, you know again it costs a lot more money, but we could even get that transmitted back. I mean it's like an order of magnitude more to get it real time versus just collecting them, and downloading, and whether to do real time or not depends on whether management needs it in real time if it's going to cause [changes in management decisions]. I'd rather, from a science perspective, I'd rather have ten times as many recording devices out there unless management was saying we will use that tomorrow if you can give us yesterday's information. If we can get to that point, then that real time becomes very beneficial. At this point I don't think we're far enough along, we are just actually…getting that understanding of that variability would be huge and then we may learn enough to say [what it means], actually if we had this in real time we could do this. We could make, you know, on the spot management decisions, or our sooner than kind of picking them up every three years.

EG: Fantastic. You know, again, you know you're building these time series of different data, and I keep thinking about how awesome it is to have all this data, you know what does the future

hold? Or, are we going to be able to sustain these tools over time? What's your vision of the future for all this?

RB: Well, I mean one of things we've been trying to do with things like the ARMS and you asked earlier how do we network that out where other people use them? So, one example of that is we've been asked through the IOC which is the [United Nations] Intergovernmental Oceanographic Commission for the Western Pacific Region. We've [my team at PIFSC] been kind of monitoring the ecological impacts of ocean acidification on coral reefs for about a decade longer than others. We started in kind of 2005, and many other parts of the world are just now kind of doing that from ocean observations. Most of what we know about the effects on coral reefs of ocean acidification are from laboratory experiments, where you take a coral, or some species in question they want to look at, and then you put a bunch of control tanks with that species in it, and then you have some others where you change the chemistry of the seawater to what's going to happen a century from now, or 1,000 years from now, or something, and you see what happens to that that critter.

EG: Yeah, so experiment.

RB: Yeah so it's an experiment, but we don't have any of those observations in nature. We were kind of the first to kind of, well what do we need to add to what we were already doing for coral reefs, the chemistry clearly, but also what's going to happen to biodiversity, and then what's going to happen to production and removal of calcium carbonate, the reef structures. So through IOC, they asked us to help the countries of that [Western Pacific] region come up with that. So what we're trying to do is have these methods standardized all around the globe. And that's what the ARMS are becoming is a standardized tool that everybody can use to better understand not what's happening in their favorite reef, but what's happening all over the place, and I think that… I mean they're adopting it very readily, and trying to have technologies that aren't, you know, [an] incredibly expensive thing. I mean, that's just PVC, you know, a couple bolts holding it together because something that all of these…I mean the sequencing, that's another thing, is the genetics, the cost of the genetics, is plummeting just like the cost of computing. In fact, it's actually been going down faster than the cost of computing has been going down per calculation, you know, per, you know, base pair calculation. When we started the development the ARMS, there was about $20,000 to do a sequencing run for [an] ARMS [unit]. Now it's about $200. That's from 2005 to now, you know, by, you know, who knows whether it will be, you know, by 2030 or something, it will be just inconsequential. The expensive part will still be to get the sample out of the water.

EG: Is that a function of expertise or technology?

RB: It's technology. Yeah. And again it's part of this. I mean a lot of that was kind of feeding from like the human genome experiment where billions and billions were spent, and nobody was spending a bunch of money on any of this kind of stuff, but that technology to do that, mostly for medical research that has more direct human benefits, these other fields are then benefiting from those things.

EG: Well, your day is clearly… we're hearing some things on your telephone, huh? Umm,

maybe one last point, what might you say that makes this region particularly unique, in terms of….

RB: The Pacific Islands Region is, I mean, for particularly like a Washington crowd, I often present it on a globe, like now we have science on a sphere, but know actually for in a PowerPoint sense, I've sometimes done, you know, actually a rotating globe. I've actually had it start in Washington D.C. and then rotate and then stop, you know, with kind of from a satellite's view over the Pacific, and you can barely see a little bit of land along, you know, North America over here, and see a little bit of Australia over here, but from a vantage point just above us all you see is ocean. The world we live in, the Pacific Islands Region, is an ocean world of which there's a little bit of land which is very, very different. You know, and many of these islands are low islands, climate change is going to have just a huge impact on these places from things like sea level. Some of these islands are likely to disappear in our lifetime. Certainly within our children's lifetimes.

EG: I think the EEZ of Tuvalu is a million square miles, and the land area is 70 square miles or something?

RB: Yeah, I mean that's very typical of the whole of this region. It's some specks of land, you know, with just huge ocean areas. So the challenges we face, are also [vast].

EG: They're ocean challenges really.

RB: Yeah, there are ocean challenges and the challenges of doing science to do that are huge. Whereas for us to do our work in the Marianas, to get the ship to the Marianas, it takes 15 days for the ship to get there, and then 15 days back. You know, same with American Samoa, it takes, you know, like 10 days to get to American Samoa and back. It's just this vast region, and if we can't get to them, we have no idea what's going on, so at a very minimum we need to know just how they're doing, how they're changing, so that management can know whether current management actions are sustaining things, or whether additional management actions need to be to be made. That with things like climate change and acidification occurring, the global ocean is changing. We're trying to best understand how it will change so that we can best inform human adaptation to changes in food security, changes to livelihoods, and changes to other societal benefits coming from the ocean. Right now, you know, we know that these changes are coming. There's been some studies, but all of them have very large error bars of concern, and our job is to greatly improve those predictions, so, you know, if something isn't going to change in a certain way, we don't want society spending a bunch of resource, of limited resource, to change something that isn't going to really happen, so we want to continue to do a better job of making those predictions so that people can make better decisions for how to utilize fisheries as well as other, you know, aspects of these ecosystem services.

EG: Right. Fantastic. It really is a laudable mission. Thank you so much Rusty. I really appreciate your time.

RB: Thanks Ed.

EG: Thank you.

RB: Yeah. Obviously, I can ramble on for a pretty long time.