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Waples, Robin ~ Oral History Interview

Maggie Allen

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Voices from the Fisheries
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Woods Hole, MA 02543

Interview with Robin Waples by Maggie Allen

Summary Sheet and Transcript

Interviewee
Waples, Robin

Interviewer
Allen, Maggie

Date
August 8, 2016

Place
Northwest Fisheries Science Center
Seattle, Washington

ID Number
VFF_ST_RW_001

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Biographical Note
Robin Waples was born in Berkeley, California. He received a Bachelor's degree in American studies from Yale University and his Ph.D. in marine biology from Scripps Institution of Oceanography. In 1986,Waples joined the Northwest Fisheries Science Center as a National Research Council Research Associate. From 1997 to 2000 he was the Director of the Conservation Biology Division. In 2001, he became the center's Senior Scientist. His research interestsinclude population genetics of anadromous and marine fishes.

Scope and Content Note
Interview contains discussions of: salmon, population structures, Endangered Species Act, habitat degradation, impacts of dams and culverts on salmon spawning, genetic testing, mixed stock genetics and hatchery fish.

Indexed Names
Utter, Dr. Fred

Transcript—RW_001

Maggie Allen: This interview is being conducted as part of the Voices from the Science Center's project, funded by the Northeast Fisheries Science Center. It is also part of the Voices from the Fisheries project that is supported by the NMFSOffice of Science and Technology. I am Maggie Alan and today I am speaking with Dr. Robin Waples at the Northwest Fisheries Science Center in Seattle Washington. It's August 8, 2016 at 10:30 a.m.

Dr. Robin Waples was born in Berkley, California and he received a Bachelor's of Arts in American Studies from Yale University and his Ph.D. in Marine Biology from Scripps Institute of Oceanography. In 1986, Robin joined the Northwest Fisheries Science Center as a National Research Council Research Associate. Then from 1997 to 2000, he was the Director of the Conservation Biology Division. And in 2001, he became the center's Senior Scientist. His research interest revolve around population genetics and conservation genetics of anadromous and marine fishes. Alright, so thanks for being here, Robin. Do you mind just telling me what inspired you to pursue a career in marine biology, and kind of where you went from there?

Robin Waples: Well I didn't start out working or really much interested in science. My bachelor's degree was a liberal arts degree, it was mostly sort of a combination of sort of history and literature. But it allowed me to take courses in all sorts of interesting subjects. So…but my first job after college was in Honolulu, Hawaii where I was teaching seventh and eighth grade English. I also coached water polo because I have always been a competitive swimmer. So I ended up actually spending a lot of time in the ocean. Body surfing, skin diving, things like that. Eventually I moved to the outer islands. And I traveled quite a bit, living in Australia for a few years. I spent as much time as I could diving on the Barrier Reef and so that's how I really got interested in marine biology. So eventually I decided I was interested in going to grad school but I hadn't taken any science courses in college except I had one course in astronomy to meet the science requirement. So I had to go back, I took two years of science courses-undergraduate science course at the University of Hawaii. And at that point then I applied to grad school. So it was kind of roundabout way that I got interested in science and marine biology and fish. Really from spending lots of time in and under the ocean.

MA: And why did you chose Scripps for your Ph.D.?

RW: Well, it was a leading institution in the field. You know, I lived in California,had gone to high school there. Even though after, when I was really young, we moved to the Midwest. I went to school on the east coast. I'd lived in California and so it was…San Diego is a little warmer than most places so I had gotten used to tropical climates. So it was a bit of a step back toward the mainland. But not too to dramatic in that respect. So, at Scripps I still spent a lot of time in the ocean. My thesis involved collecting lots of species of shore fish, California shore fish, in mainland and also offshore islands. So I was still diving and fishing a lot. It was part of my thesis.

MA: And then why-how did you end up here at the Northwest Fisheries Science Center, like what was your path after you got your Ph.D.?

RW: Well, NMFS has a program affiliated with National Research Council and it’s still going. It provides post doctorate opportunities for people at NMFS labs. And so there was an opportunity here with Fred Utter, who was one of the founders of the whole field of fishery genetics. So that's how I ended up coming to Seattle and before long there was an opening so I got hired. So that's how that happened.

MA: And then, so what was that like you said tropical...you had been in tropical place for a while or at least San Diego. And then you moved up here, so how was that shift?

RW: Well, we like Seattle a lot but yeah, at San Diego the ocean is actually cold most of the time. They still have quite a bit of an upwelling on most of the West Coast. It warms up in shore by the end of the summer. But for diving any time more than ten or twenty feet below the surface, it's still pretty cold. So it's all wetsuit diving. So I got used...I got used to that. But Puget Sound is much colder, much murkier. My...Scripps had insisted that you use their diving gear. I had all my own diving gear but after six or seven years of really not using it, it wasn't really feasible to use anymore. And my wetsuit had pretty much, I barely made it through- it was popping at the seams every dive. So it really, I would have needed all new equipment when I got to Seattle to dive, in much different conditions. And the job here didn't require me to do that.

I started working on salmon and my research with them was in fresh water dealing with studying mostly juvenile fish. So we did a lot of collecting in Idaho, Oregon, eastern Washington, and Oregon. So one of the major things changed, I stopped diving as a regular thing. I still snorkel if I go to a warm places and so on. But that hasn't been part of my research here. But in Hawaii, and California, and Australia I was interested mostly in marine fish. Here, there is some work on marine fish but most of the work at this Center historically has been on salmon, so the vast majority of my work since I came here has been on salmon, which obviously spend quite a bit of time in the ocean but that’s…much less is known about their ocean ecology. It's much easier to study them in fresh water. And it's important also because in fresh water that's where the spawning occurs so that's where the local population structure is. So it's important to study their reproductive units or populations. So that's a pretty big change.

MA: Yeah.

RW: Just dictated mostly by the life history of the species.

MA: Okay, so that's why you kind of got into that area. Because you wanted to study…they were studying salmon so you just kind of went where the interest was?

RW: Yeah, when I first came most of the work supporting…most of the funds supporting the genetics group here were from analysis of mixed stock fisheries. So one of the big management headaches for salmon is, even though they spawn in fresh water, that's where local populations are. And so they may, you know…sort of be Oregon fish or Idaho or Washington fish. Or theremight be populations that are on tribal lands or they have United States and Canada fish spawn in different areas. When they are in the ocean, they tend to be mixed up. So, they migrate widely. So you can have fish from Columbia River migrating up to Alaska or across the ocean to just off Asia. So there is huge management problems of harvest that are…most of the commercial harvest is done in the ocean. A lot of the sport harvest is too. Or sometimes in the lower parts of major rivers. And there you can have lots of major populations mixed up.

So if they want to set the harvest rates so that they maximize, say, catch of U.S. fish and minimize catch of Canadian fish, or maximize the catch of abundant populations and minimize the catch of threatened or endangered populations. If they want to focus on hatchery fish and minimize take of wild fish, then you have to know when all of these different populations are migrating and at what time. And so on. And so it turns out that that can be done with [physical]tags but it's very costly and expensive and very time consuming.

So it turns out that salmon have intrinsic genetic marks that are passed down from generation to generation. If the populations are different enough in their different streams, then you can use genetic methods to figure out what the composition of mixed stock fisheries are. And so, for example,if you find out that the endangered salmon eitherare migrating through a fishery in an early part of the season, or the later part of the season, or they are more to the east of the catch area or [more to] the west, or something like that, then they [managers] can shape the harvest in space or time to try to minimize catch on the fish they don't want to catch and maximize[catch of the targeted populations]. So that's…there has been funding for a long time for that through the PacificSalmon Treaty.

So that's how most of my work started out. And it turns out [that]even though in conceptit's fairly simple, inapplication [it can] be very complicated. Because the salmon don't have…they don't have something like [a situation where] one population just has blue eyes and the next population just has brown eyes. You know? If it were that simple, it would be pretty easy. What they have is slight differences in the frequencies of different genes. But if you get a lot of different genes that are genetic markers, then statistically you can start to tell populations apart and make good inferences about the composition of the catches. So there is quite a bit of complicated statistical analysis and sampling issues and so on. So there's...there's still ongoing [work], trying to continually incrementally improve that process.

So that's what I initially worked on largely, but it turned out, around 1990 our agency received petitions to list several populations of salmon under our Endangered Species Act. So what that meant was thatthey were not being petitioned as a whole species like Chinook salmon orCoho salmon. Because those…all of the five species of pacific salmon that occur here in NorthAmerica also occur in Asia. So there is no question there were [at least some]healthy populations of all the species. But individual populations were clearly in trouble and some had already disappeared. They had been blocked totally by dams, or over harvested, or [suffered the effects of]habitat degradation, things like that. It turns out the Endangered Species Act allows listing of what they call distinct populations segments. That's how grizzly bears and bald eaglesand [other species] in the United States have been listed even though they are more abundant in a place like Alaska.

But nobody knew what a distinct population segment of salmon might be. Would that be the 50 salmon that always spawn in your uncle's stream, in his back yard, you know? Or would it be all the salmon in the Columbia River Basin? Or something in between? So that was a huge sort of unanswered question, like a Pandora's Box [containing] all sorts of possibilities. Whether they would end up getting listed on the Endangered Species Act depended on, to a large extent, how these units would get defined, their distinct population segments. So I ended up spending a lot of time after that working on issues more related to conservation. But a lot of the same tools that were used for mixed stock genetic methods or used for mixed stock fishery analysis were also useful for conservation, to help describe the patterns of how different the populations were. What are the most distinctive populations? What are the natural groups of populations, if you had to group populations into groups where they are pretty different from each other? And how do you do that? And what sort of groups do you end up with? All those sorts of questions became important and some of the tools that have been developed for other methods were very useful for those.

So starting about 1990, I spent a lot of time, probably almost…the vast majority of my time for about 15 years was spent on endangered species stuff for salmon. And so we used genetics but we didn't only use genetics. We combined it with life history information like the age of the salmon, what seasons they migrated in as juveniles and as adults. Also ecology: What are the distinctive features of the habitat that might promote different adaptations? Like, do salmon from this population have to migrate a long way to get to their spawning areas? Or do they have to go over big waterfalls that might select for specific kinds of fish that are really strong enough to do that? So we combined lots of different types of information in doing these Endangered Species Act evaluations. So it turns out our agency was responsible for implementing the Endangered Species Act for salmon and also all marine fish and marine mammals like whales, sea lions, and so on. It turned out that the scientific information produced by our group here at the Center has had a huge influence on what our agency has done with endangered species listing, determinations, and recovery planning for salmon, as well as things like killer whales, humpback whales, green sea turtles.

MA: And how was that a challenge to like translate the science that you were doing into policy that kind of affected the EndangeredSpecies Act?

RW: Yeah, it was challenging and also quite interesting. Because like most acts [or laws], the Endangered Species Act dealt with some biological and scientific issues but it used a lot of terms like distinct population segment. I mean, population is a biological term but it's not a real specific term. A population could be either bigger or smaller depending on what your context is for thinking about it. And distinct population segment, that's not a biological term. So there was no- you couldn't look even in a biological dictionary and find a definition of that. So we had to develop ways we thought was consistent with the legislative and legal history of the Endangered

Species Act to define salmon distinct population segments. And it was largely a process of deciding how much lumping or how much splitting to do. So extreme splitters would say, like I mentioned before, "every little stream" because salmon are legendary for their homing capability. Most of them come back to the same steam they were born in. So maybe that's a distinct population segment. But if so, then you have hundreds or thousands of them for each species. Hundreds or thousands of distinct population segments. And each distinct population segment under the ESA gets treated as if it were a separate species. So that's like having hundreds or thousands of each of the biological species of salmon: pink salmon, chum salmon, Coho salmon, to deal with under the Endangered Species Act, and for each one of those you would have to determine is it threatened or endangered. And then if it's threatened or endangered you have to have all sorts of protective measures, people need permits and you need recovery plans for each individual[species]. It would be a nightmare to do that. So day-to-day salmon management[whichis]done mostly by states, tribes, and local groups, focus[es] on those small units. But for the purpose of the Endangered Species Act, we thought we really had to get something that people worry about…[and they] really worry about extinction which is a permanent process. It means you can't get something back – it’s gone. We thought we needed to focus on bigger units.

So we ended up with units...oh like Puget Sound Chinook salmon, that's what we have called a distinct population segment. And there is quite a bit of diversity within Puget Sound Chinooksalmon. Thereare probably 30 or so…20 or 30 populations or stocks [of Chinook salmon within Puget Sound]that would meet most people’s definition. So they should probably be managed separately but collectively they are all pretty similar to each other. And they are different in many ways from all the salmon on the Washington Coast, or all the salmon in the Columbia River or up in British Columbia, so that they do form sort of a natural unit. So we ended up with these [relatively large]distinct population segments.We call them evolutionarily significant units or ESUs…because we think they represent major chunks of diversity within the species as a whole that are important to save.

And so they [the salmon ESUs]tend to be fairly large like that. But when you go through the five species of Pacific Salmon, plus we did steelhead (which are anadromous rainbow trout – rainbow trout that go to sea and come back), that's 6 species. We ended up in the lower 48 states with about 50 ESUs or DPS's. So it was somewhere…5 to 15 or a few to 15 [ESUs]per species. Some[salmon species] are distributed more widely geographically and others, pink and chum for example,have a[mostlynorthern distribution and] they don't go very far south. So they didn't have as many units. Now about half of those [ESUs]are now listed under the Endangered Species Act. So people at this Center here have been heavily involved and still are in recovery planning, for example, developing biologically sound recovery plans. And then working with stakeholders and mangers to develop[recovery plans]. Well, basically we spent quite a bit of time in the process trying to set biological meaningful goals for recovery. Like, how many populations have to be at what level of viability for the whole distinct population segment to be delisted? That's largely a biological question because it talks about extinction and it's complex because you have to think about interactions of lots of different populations over time and space. But once you decide on the goals, then the emphasis shifts to the stakeholders and policy because there are lots of different ways you might achieve recovery. If some…For example, the only way you can achieve recovery of this population is if you move Seattle east of the Cascades. Well that's not going to happen. A different option that would put more emphasis on different populations would probably be one that would be chosen by policy people. Sothere were some parts of the process that were largely scientific, some that were largely policy [based], and then there were quite a few that involved a lot of science policy interface and interactions.

MA: What do you see for the future of salmon in the northwest, you know the anthropogenic effects and general predictions that you have?

RW: Yeah. Well, there is…I think there's both reason for a pretty substantial optimism and pessimism. I mean the pessimism is easy to see. It's…Most of the bad things that salmon face are caused by humans or [are] exacerbated by humans. So just about everything we do does not help salmon. If they just stayed in one place, it would be much easier but they don't, they need lots of abundant cool clean water, and fresh water. They need to have unimpeded migration corridors, both as juveniles and adults. And they have to have the ability to migrate thousands of miles in the ocean and come back. So just about everything that we do related to urbanization, agriculture, forestry, road building, just about all of those things are not good for salmon. There are ways to shape them so the activities aren't as bad, so there is a lot of work in that respect.

But a lot of it is just a function of the number of people. The number of people continues to increase. It's easy to find predictions about how many more people there will be by 2050 or 2100, so there is no question of there being increasing pressure in addition to all the issues raised by climate change. Climate change in general for…certainly for salmon in the lower 48, probably isgoing to be a net detrimental effect because the water is so warm. Droughts might increase but it's not going to be totally uniform. Some populations will probably do even better just because of local changes, so it's quite complex. In the far North and Alaska, some populations may do better because areas that are really just frozen or too cold for salmon to really thrive much will become more sustainable for salmon.

So the picture for the species as a whole – all of the species – isn't necessarily terribly gloomy with respect to climate change, but there is no question [that] individual populations are going to[be stressed].Some individual populations (maybe lots – particularly in the lower 48 near the southern extent of their range) are going to suffer. You are going to see lots of changes there. So anyway there is plenty or reason for pessimism.

But on the other hand [there are] lots of reasons for optimism too because salmon are such [an] iconic resource in the Northwest and pretty much every place where they occur. There's a lot of interest in the salmon conservation. Lots of people have become much more knowledgeable about salmon biology. There's lots of grass roots efforts to improve things. There's some really good collaborations. They do surveys you know. People…If they ask people how much they care about Spotted Owls you know, it's usually like 5 or 10% of the people care at all. But when they do the same surveys and ask people about salmon or maybe even ask them "Would you be willing to pay more in taxes if it would help salmon?" They get, you know, 70-80-90% of the people say yes and so that part is really encouraging.

So it's still kind of an open question how it's going to pan out. I think we have lots of populations that are stressed now…I can say about half that are left.We did a paper about ten years ago where we tried to estimate how many populations were around, say 200 years ago when major European settlements started. And we concluded that across all the species, at least in the lower 48 states, about a third of the populations that used to be here are gone. A lot of those were [the result of] blockage by impassable dams like Grand Coulee Dam or Hells Canyon Dam or the dams in the Sacramento San Joaquin – big dams injust about all the tributaries that blocked access for a long time to open areas. So a lot of that has been caused by that.

Of the two-thirds of the populations that are left, about half are listed[under the ESA]. So if we have…If we manage to conserve most of the populations that are listed now, then we've still got a pretty good chunk of the original diversity I think. I think that would allow the species…all [of the salmon]species to be sustainable into the future. But if half of what's left are – [those] that are at risk nowthat are [listed] under the Endangered Species Act – if we lose most or all of those, then we are looking at really a tattered fabric of diversity where you have big chunks of salmon diversity lost. It's sort of like a house of cards or that Jenga sort of thing. If you pull enough pieces out, at some point the whole thing could collapse. Cause salmon are very good [at] homing. Like I said, they are legendary for that sort of thing. But some do stray and so they are good at re-colonizing areas. Usually if you have new habitat that's opened up, because a glacier receded or they removed a landslide that was blocking a stream or something, salmon generally will re-colonize that very quickly. When the Elwha Dams were taken down,[it was] really fast (within the same year) [and] they had fish pushing up stream. So those are the encouraging parts, but that requires having robust populations somewhere nearby to produce the recruits that are, you know, sort of checking out new areas. So if everybody is sort of losing populations here and there, at some point the whole system can sort of fall apart. But what that point would be nobody really knows. But I think we wouldn't like to get close enough to there to find out.

MA: So the fish ladders, do those help? Do you know, has that been...from the increased public awareness that you were talking about. Like the culverts and the fish ladders does that help too? Those little measures, or do you think we need more...bigger?

RW: Well, the fish ladders…there is no question they've helped, I mean they do have...Take the fish that go up the Snake River – steelhead, sockeye and Chinook salmon. They all go as far as almost 1,000…900 miles up the Columbia and Snake Rivers. They spawn in central Idaho and in some areas,they're at 6500 feet elevation. It's just unbelievable where they get to. To do that those[populations], as juveniles, have to go to through eight main-stem dams. And as adults they have to come back up through 8 main-stem dams with fish ladders. Whereas[in]Hells Canyon, three dams there do not have fish ladders, so they are a complete block. So everything…all the salmon [populations]upstream of there were extirpated – same as [what occurred with salmon above]Grand Coulee Dam. So it [fish ladders] does make a big difference, but still at every dam the fish are delayed. Some of them don't do it. And it's quite a selective mechanism too. So you used to have fish thathad to swim upstream against a real strong river like the Columbia. And now they have to be able to find a fish ladder in a huge dam and then they go swim through a lake...those reservoirs, so it's a string of[fish ladders and lakes]...So it's [a]very different[experience for adult salmon], very different selective pressures[they experience]. So we are selecting for different types of fish. So the sort of salmon that make it up to central Idaho aren't quite the same as they used to be.

Be interesting to see [what happens]if they ever take the dams out.What…you know as people are talking…For some of the dams there are still groups that are militating to take out the lower four Snake River Dams which don't produce a lot of electricity, to help boost survival[of salmon]. Cause it is…There’s no question that having fish ladders and good juvenile bypass [systems]definitely can considerably help. But it's not the same as having a totally free flowing river. So whether it's in the long run going to be sustainable to just leave it the way it is or whether you really have to take dramatic measures[such as taking the dams] out. There’s still a difference of opinions among biologist and the general public and the courts on that issue.

But the issue of culverts is pretty interesting, because the big dams are easy to focus on. You can see how many hundreds of miles are blocked by this. But collectively, every place you go, people build culverts, you know. There's roads, and streams, and everything. And so, large numbers of the culverts…they may look okay to us but for some subtle reasons, they just don't provide for fish passage. So, for example, you know, salmon can jump pretty big waterfalls, but to do that they need a deep pool below that so they can go deep and get a big run up so they can leap high. And you can have a small culvert that's only, you know, a two or three foot drop. But if it's just a shallow[pool] – if it's just splashing on concrete or something – there is no way a salmon can get any momentum or leverage. It needs to really, you know, do some radical things with its tail from deeperwater to make a jump. So a little two foot thing[or culvert] could be a complete block for a salmon. And those happen pervasively across the landscape. So a lot of habitat could be opened up if there were…if you could push a button and remove all of the culverts. There are thousands and thousands...probably tens of thousands of them. So that would be a huge collective thing. But each one is just a little bit. But that's why it's important to have local groups that are interested. Because that's the only way those are[going to be dealt with]. There’s no giant federal group that is going to come in and restore 10,000 culverts across the West Coast. That has to be done on some sort of local, very local[basis]. So that requires, again, broad based public support and interest. So anyway, both the little things collectively (e.g., culverts) and the big things (e.g., dams) can be important.

MA: And so what has been a project that you have worked on that you are most proud of or have most enjoyed?

RW: Um…well there areindividual projects that, you know, are pretty interesting. But collectively the biggest one I think was this whole salmon Endangered Species conservation. We spent about a decade going through all of the species on the West Coast and doing comprehensive status views. We first had to define the population structure and the DPSs [distinct population segments] and then for each we had to determine whether they met the criteria to be threatened or endangered. Then they had to develop…we had to help develop recovery teams [and plans]. This involved not just us but lots of other really good scientists from throughout the region. To try to develop the scientific basis for recovery planning. And then work out ways to communicate that information to stake holders and[the broader public].So that whole process took about a decade and a half and it's still ongoing. I pretty much handed off my role by about 2003-2004. I mostly handed my role in that stuff off to other people. But it's had a hugeeffect on how salmon conservation has been applied all over the West Coast.

MA: And what's the biggest challenge, I mean you mentioned some challenges but what's the biggest challenge you think of working in the scientific field? Or in the government in general?

RW: Um, well[in]any government you've got to deal with bureaucracy. So there is plenty of that to deal with. But, you know if you think of scientific careers,sort of the other major avenue would be through academia. So I've got lots of friends in academia. And it's certainly not the case that they don't have bureaucracyand all sorts of headaches. They're different and some are similar, but I'm not sure they are greater or lesser, one place or the other. But it is true that in recent years, it seems that the bureaucratic red tape [and] administrative issues you have to deal with in the government have just increased pretty dramatically. They haven't affected me as dramatically because I managed to step down from most of my supervisory and administrative responsibilities. I used to be head of a division and now I don't supervise anybody. So I have avoided most of those. But I know lots of people here have been really discouraged by just…it's the death by a 1,000 cuts sort of stuff that just saps your time. So that's a real challenge.

And it's related to thepublic's perception of science and government. They are mixed up. As is obvious, there is a pretty strong difference of opinion in the public sec– you know, of the voting public and the parties about usefulness of the government. And so…also the role of science. So those are…those issues are more discouraging I think, than when I first came. So that's a…that's a pretty big challenge.

On the other hand, I have to say our agency has…[I've] really been impressed with the commitment our agency has given to science. So they don't…It's not the case [and] I certainly wouldn't advocate for itthat scientists should be making policy decisions. Policy people should be making those decisions, but they should be considering the best science…the best possible science before they make those decisions. And if they make a decision that really is at odds with the science, they should be able to explain and should be expected to explain why they are doing that. And our agency has been, I think, really good about, first of all, putting a high emphasis on science. They created conditions where, as much as possible, we can do the work. And we worked out ways to try to present scientific information to them, in ways [where]we're not trying to tell them what they should do. We're trying to just say, "Here is our best cut atwhat the science says." Together with our best ability to characterize a degree of certainty or uncertainty associated with it. And then it's up to them to make the decisions.

So I think our agency has been really, really good at that in spite of the fact that lots of the scientific conclusions we came to were not convenient for the agency. I mean, a lot of the salmon stuff (e.g. ESA listings)caused easily billions and billions of dollars of economic consequences…the ESA listings have had…We never had our agency tell us, "Here is what the answer should be" or "That's not the right answer. Go back and bring us the right[one]." Or really aggressive fiddling with the science or something once it leaves here. So we worked out [an effective process]. It's not done 100% like this all throughout the agency, but pretty much we have on the west coast worked this out. Pretty much always we have a stand-alone scientific product produced by the science centers that says, "Here is our best cut that we think the science says on these key questions." And then there is some policy, or legal/policy overlay.Okay here is what science says, here is also what it says in these regulations, in these acts, in this guidance we have…And here also is how much money we have and these other things. And given all that here is what we are going to do. So that's how it tends to work out.

They had some pretty egregious meddling in the Department of the Interior – the Fish and Wildlife Service – for example, in the Bush administration. They had some people back in headquarters [and] they were literally fiddling with the science. They were changing what the science [documents]said.Anda few people in the end finally did get sacked as a result of the investigations, for real gross interventions and stuff. So the good news is, I never saw anything like that in our agency. It also made it much easier to hire people if I could tell them, "What you do here is going to make a difference."They're not going to fiddle with the science. You're not going to be told what you can and can't say – at least in scientific[terms]. If you want to make big policy statements about what people should do, that's not really a scientist's role. As a private citizen, you can have those opinions, but...

MA: Yeah.

RW: But what that meant was we ended up finding, say by the mid-nineties when we were doing all of these ESA status views and people were seeing that we were doing good science and it was definitely having an impact, we started getting…When we had new jobs to offer, I started seeing that we had really top people.People coming out were top of their graduate class that could easily get tenure-track [academic]jobs anywhere. And they wanted to come here because they knew they could make a difference. They wanted todo work that made a difference in the world. And so that's still true. So that's the most optimistic part.

MA: I was going to ask, speaking about of academia, you have taught as well, do you teach still sometimes at the University of Washington?

RW: Yeah, I help the last time probably… Oh, I give guest lectures pretty frequently. I am on various grad students' committees here and other people... I'm affiliate faculty over there. But I don't get paid by the University of Washington, so usually I don't teach specific classes there. Although two years ago I helped teach…co-taught with another guy, like a seminar on endangered species issues. So I do have a hand in teaching, yeah.

MA: And do you prefer doing research over teaching generally?

RW: Yeah I think the important thing is to have a balance. And when I first came as a post-doc, I didn't have any management or supervisory responsibilities so there was a gold mine of tons of genetic data and really interesting questions. So that was a good time for research and then I ended up being a head of this endangered species group that was small, but then ended growing up into a whole division of 40 people or more. So between all the endangered species stuff and running the division and everything else, that was taking 150% of my time. For most of that decade and a half, I didn't…I had very little time for research. It was mostly nights and weekends. So that's why I now, wouldn't be that eager to spend most of my time teaching because I already deferred research for so long.

So it's important, I think, for people to have the right balance in an agency like this. If all you do is work with the science support stuff, waiting for the regional office to call with [problems like], "Well, we have this new [crisis] or some senator in D.C. wants the answer to this question by tomorrow afternoon, you know…" Everybody has to do some of that stuff but if you don't get to do research as well, then the research [expertise]will decay and before long you won't have kept up your field and you won't be as credible and everything... So the key is really finding the right balance between that, and that's hard. It was out of balance, no question, for much or the '90s, at least for me and a lot of people working on this stuff, because we had…well, we had all sorts of legal deadlines and too much to do. But it's actually…we have hired some more people in recovery planning and they've got better balance. Recruited more people, got a broader base of people involved.

MA: And how has technology changed over time since you have been here and how has that affected your work?

RW: Well, one way is faster computers. So that's not just for…I mean computers were fast enough for word processing and stuff like that but...So there's been a big change in computer modeling, being able to do simulations. This is true not just in genetics but certainly to lots of genetic methods now require very sophisticated modeling that are very computationally intensive. They're dealing with problems that you can write down on paper, but the equations are so complicated that you can't solve them analytically. You have to solve them[with computers]. They may have a huge multivariate space and there are some peaks in there that sort of have the best answers [or most likely solutions]. But finding those peaks, it's just a gigantic space to search. So what ends up happening is that people develop computer algorithms for searching.

There are so many billions and zillions and quadrillions of possible combinations of things to consider that even fast computers cannot consider them all. So they have to have searches that sort of go around and sample the space. And what's happened is with the vast increases in computer technology, they have been able to attempt much more difficult problems. But they're still really…You can still have a single problem that might take hours or days or weeks just to get an answer. And still that's going to be a little bit approximate. So the ability to do those sorts of analysis…there are lots of analysis that people could think of 10…20 years ago but not even attempt to do because it would take years or something with the best computers[at the time]. But now those things from years have gone down to weeks or days or hours. So that has been a big thing.

The other big technology change has been with genetic methodology. So when I was starting most analysis were done with what we call allozymes, which are enzymes. You take tissue samples and then you run analyses that actually require these enzymes to express themselves. The enzymes are proteins and they have different strings of amino acids[that] make up the proteins. And you could look for slight differences in amino acid structure with various techniques and that's why it was done among populations. But there were limited number of those[enzymes], so they managed to perfect [only]a few dozen. Or quite a few dozen for salmon, for example. Then they moved on to DNA methods and that opened up a much larger array of possibilities. Also, you could do non-lethal sampling. For the allozymes,to get all of the different markers you typically[get] for a fish you would sample muscle, liver, heart and eye. That's kind of hard to do that non-lethally. So mostly you are talking about sacrificing individuals. So either get adults after they are dying or dead or juveniles.

But now with DNA, you can just take a little fin clip and let a juvenile fish go. So that's a huge[advantage], particularly for conservation applications. And now in the last five or ten years, the results of spinoff from the human genome project have just had quantitative shifts in the amount of information you can get genetically. The amount of DNA sequences you can get with the same time and money has increased by orders of magnitude. Now, even ten [or]fifteen years ago we used to be restricted to 20, 30, 40 genetic markers. Now it's easy to take say a fin clip, or you go out and get an insect in the woods nobody ever studied before, take a sample from that, send it away to some lab and for not very much money at all, you could get back DNA results for 10,000 genetic markers…maybe 100,000. So that vast amount of genomics information has created a situation where we can now generate information much faster than we can make sense of it. So people are still in the phase of trying to make sense of all of this[DNA data]. So we have had several orders of magnitude increase in the volume of information you can get from the same individuals. And that's occurred over the space of the last decade. So we're still trying to sort through how do you maximize that information? Make best use of it? So that's a huge change that is still working out.

I mean other people [are]involved in fish biology here at the Center. I'm sure if you asked other people the question, they would have things like new tagging methods or, you know, there are lots of things like that that have helped. And I'm sure they have helped to some extent with salmon. But those are the two things that I think probably had the biggest direct effect on genetic methods and stuff I do.

MA: Yeah, I have hear EDNA come up a lot.

RW: Yeah EDNA's it's even…Well I'm not sure it's totally newer than all of this genomic stuff. It has been around for a while. But it's really picking up steam. And it's caught the interest of managers and so on. All of who are pressed for time and money. And if you can just go out and get a water sample…So there is no question you can get some really interesting information. But it's much easier to see how you get qualitative information rather than quantitative. Like, it doesn't tell you how many individuals are there. And there are all sorts of problems of contamination and so on. But it's not something that I personally have worked with.

MA: Yeah. And then, just to wrap it up, I guess, where do you see yourself in the next few years I guess with your position? Like do you have plans to retire or to keep working?

RW: Well, maybe ask me again after the first week of November. But I could easily retire now. I have enough time and age and everything. But I'm still enjoying [it]at the moment. I'm still finding out new things, still collaborating with a lot of people here and around the world on problems that are interesting and directly relevant. So, I don't have any specific plans to retire. But realistically, something probably will happen in the next 5 or 10 years. I might try to find ways to do some sort of partial retirement or periodically take some time off or…so it's a bit open ended but I don't have specific plans.

MA: Yeah, I've heard some people say they just keep doing research, kind of retire but keep doing their own research.

RW: Yeah

MA: Yeah. And what's your- what would be your advice for anyone who is an aspiring scientist/ marine biologist coming into the field now?

RW: Yeah,that's a good question. I guess I would say…well a couple things. One is, I wouldn't recommend necessarily jumping on the latest bandwagon which people tend to…like you say, EDNA. Certainly that's a big thing. There are…But they tend to be...they often can be flashy. You know? They will be what people throw time and money and everything on for a while and then there is a newer one that comes along and that gets all the attention. So I would suggest looking for questions that are important but most people haven't picked up on them yet. I mean, it's hard to pick the ones that are…that other people are going to think are important in the future. But anyway, at least keep a lookout for those. Because they may turn out to be really important in the future.

Just in terms of practicalities, I think keeping an open mind about various employment opportunities is pretty important. For a long time it was pretty much people going through academia or pretty much oriented to…well I'm going to have an academic job. But that's you know, if each professor trains lots of graduate students during their tenure, and they all get jobs in academia, then that whole system will only keep going like that if the number of universities expands exponentially, you know? So it's sort of a Malthusian problem. It's impossible for that system to keep up. I know lots of people who are professors who are concerned about that. Why are we training so many Ph.D.s when there are so few jobs? So be realistic about that to start with. But also consider alternative scenarios. There are quite a few jobs in the public sector, in both federal and…There arequite a few federal sort of things like Forest Service, USGS [United States Geological Survey], EPA [Environmental Protection Agency]. Lots of things have federal science and many of them are quite good. But it can depend a lot on not only which service you are in, but exactly which center and maybe even who your supervisor is, so…do some research and pay attention to that. Local governments, state governments particularly…certainly even at the Ph.D. level but certainly at the Master's level, there is lots of need for them. NGOs [non-governmental organizations], consulting firms…So, I guess it's pretty important for people to be realistic about what they are interested in and what they think their career opportunities would be. So there is no single and best answer, that's really going to depend on the person a lot too.

MA: Yeah well do you have anything else to add that you would like to talk about? Any more of you projects or awards you have won, or presentations, things like that?

RW: No, it's just that basically I work on things that interest me. But there are always practical problems. Some problem comes up and you say, "Okay" it's often…Stuff that interests me is looking at, say standard population genetics theory or standard ecological theory. You can go to textbook and find simple formulas that are developed from simple models. A simple model for population genetics that's pretty universally used, involves discrete generations,which means that in that model, an organism produces offspring. Offspring are all the same age. They all mature and at the same time, they reproduce, and then they die. And the next generation takes over. So that's very nice and tidy to model. But it's not very realistic. So most species like salmon– salmon have some features like that. They all die after spawning, Pacific salmon[do], which follows the discrete generation model. But they don't all mature at the same age. Like Chinook salmon mature at age two or three or four or five or six. You get sort of an overlapping generation's age structure. And then there[are]iteroparousspecies. That means species that reproduce more than one year. So they don't die…like humans or actually most species on earth are like that– most birds for example. So, they have truly overlapping generations.

So taking standard models for discrete generations and applying them to salmon life history, that's one of the first things I worked on when I came here. One of the things that interests me in recent years is these [iteroparous]species with true overlapping generations, cause that's marine mammals or most marine fish like rockfish or cod or halibutor anything like that. They will reproduce in many different years, and then there's a whole series of things you have to think about that are quite interesting. So I have been focusing a lot on those sorts of[problems],applying…taking simple models and[asking],"What does it mean when you have to apply them to real world data? So that's...can't remember what the question was that generated this.

MA: Just generally anything else that you wanted to talk about, so.

RW: Yeah, I'm just trying to explain what the sorts of problems that interest me, I guess. So in general it's...it's trying to apply basic evolutionary and ecological principals to complicated problems in the real world.

MA: Right

RW: And the simple models don't really apply, so what does it mean when you try to use those. Or can you modify them? Do an adjustment to account for the life history of the species? So those are the sorts of things that still-mostly interested me in particularly in the last five or ten years.

MA: And do you think that's what kind of originally got you into it, besides just liking being around the ocean.? Do you think those, solving kind of complicated problems?

RW: Yeah.

MA: That's what originally sparked your interest.

RW: Right, so some of them are more analytical. For endangered species, it was a problem where: "Okay here is this language in the Endangered Species Act about distinct population segments. Here is this really complicated life history and ecology of salmon. What does that mean when you try to apply this to salmon?" That was a gigantic problem nobody had really tackled before. But it was slightly different. It wasn't the[kind of problem from which] you might hope to get some neat analytical answer if you played around with stuff enough and made some adjustments. It required a different sort of approach- and you had it integrate information from lots of different things. And we resisted trying to come up with some simple formula because we didn't think that would be a reasonable approach. It ended up mostly being sort of- trying to...integrate best professional judgment. In a variety of ways to come at something and try and make that whole process a little more consistent.

MA: Well, that's pretty much all I have. If you are...if you are content with that.

RW: Sure.