6-3-2016

Shepherd, Gary ~ Oral History Interview

Joshua K. Wrigley

Recommended Citation

Shepherd, Gary. Interview by Joshua K. Wrigley. *Voices from the Science Centers*. Voices from the Fisheries, NMFS, NOAA. 3 June 2016.

This oral history was produced in 2016 as part of the *Voices from the Science Centers Oral History Initiative* conducted by *Voices from the Fisheries* with funding by the NMFS Office of Science and Technology.

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

Interview with Gary Shepherd by Josh Wrigley

Interviewee
Shepherd, Gary

Interviewer
Wrigley, Joshua

Date
June 3, 2016

Place
NOAA Northeast Fisheries Science Center, Falmouth, MA

ID Number
VFF_WH_GS_001

Use Restrictions

Biographical Note
Gary Shepherdis a research fishery biologistwith theCoastal Pelagic Resources Task in the Population Dynamics Branch of the Northeast Fisheries Science Center. He started working for NMFS as a summer student aide in 1975as a college freshman atUMass Dartmouth and did work-study in the Age and Growth Unit during his senior year. He went to Rutgers for graduate school where he conducted research on weakfish and striped bass populations. After a co-op at Rutgers' Sandy Hook Lab,Shepherdreturned to the Population Dynamics branch, where he serves as task leader for the Coastal/Pelagic group.

Scope and Content Note
Interview contains discussions of: weakfish, striped bass, black sea bass, fish populations, overfishing, fisheries, fishery science, fish reproduction, water pollution, striped bass migration, ICNAF, Hague Line, Georges Bank, NAFO, technology, early computers, early fishery science, modeling, data analysis, Beverton-Holt model, Ricker model and fishery management.

In this interview, Gary Shepherd discusseshis decades-long career trajectory within the Northeast Fisheries Science Center—from a student aide to a supervisor in the Population Dynamics branch. He discusses his graduate work on the effects of overfishing onweakfish and striped bass populations along the mid-Atlantic coast, his early days working at theNEFSC, and how the NEFSC has changed over time. He describes the process of completing papers and how he used early computers with punch cards for calculations. Shepherd also touches on the contributions of Graham, Beverton, and Holt to early fishery science in the first half of the 20th century. He discusses the relevance of computer modeling and ecosystem-based analysis to the future of fishery science and the importance of a conservation approach to preserve fisheries for the

future.

Indexed Names
Anderson, Emory
Anthony, Vaughn
Baird, Spencer
Beverton, Ray
Blaylock, Jessica
Boreman, John
Brown, Brad
Clark, Steve
Diodati, Paul
Goodyear, Phil
Graham, Michael
Grimes, Churchill
Holt, Sidney
Hughes, Pat
Jearld, Ambrose
Kelly, Gwen
Lamont, John
Lang, Ann
Legault, Chris
Mayo, Ralph
Miller, Alicia
Murawski, Steve
Nichy, Fred
Pope, John
Rago, Paul
Richards, Anne
Serchuk, Fred
Sissenwine, Mike
Sosebee, Katherine
Wilk, Stewart
Wigley, Susan
Wigley, Roland
Wood, William

Transcript

JoshWrigley: So, the machine is recording, I can see that the levels are pretty good, the sound levels there. They have to come up to a certain point in the audio bracket to let you know that you're recording at a proper level. So, I'll start off just by saying that this is an interview for the Voices from the Fisheries as part of the Voices from the Science Centers project funded by NOAA's Office of Science and Technology. I am Josh Wrigley, the Project Manager of Voices from the Fisheries, and I'm speaking today with Gary Shepherd, who is—let me get your full title here—Supervisory Research Fishery Biologist with the Coastal Pelagic Resources Task in

the Population Dynamics Branch of the Northeast Fisheries Science Center right here in Woods Hole. We're doing the interview at the Carlson Lane office, which is where the Social Sciences Branch is based here in Falmouth. The time right now is about 9:30, so I guess we can kick things off here. I'll just begin with the first question that we have as the universal question here: When did you begin working for the National Marine Fisheries Service?

Gary Shepherd: Well, I started on July 5th, 1975. Actually, it was pretty much all a mistake that I started working. What had happened is, I was a—finished my freshman year in college as a biology major at SMU, which is now UMass Dartmouth. I applied for a job with the Steamship Authority and we had a family friend who worked with the state and asked him to check to see how my application was proceeding, and he called back and he had got it all wrong. He had known I was a biology major and he says, I got you an interview with the aquarium. Well, I didn't even think about any of that, so I ended up getting an interview at the lab with Dr. Brad Brownwho was a—he ran essentially the population equivalent of what Population Dynamics, or division I think at the time. I was hired through a town youth, kind of a youth corps programfor young students as a student aide, and I was assigned to work in the Age and Growth unit. I had also—Fred Nichy, who at the time was the Director of that, the Age and Growth unit, I knew him from my family. So, I started working there for the summer, then it progressed. Must have done well enough…I was…I came back the following summer and then progressed though programs where I was able to, they call it a stay in school program, it allowed me to work during vacation times, et cetera.

JW: Was this still with Age and Growth?

GS: It was all within the Age and Growth unit. So, I was able to do that work-study arrangement when I was—my senior year, I think. When I graduated from UMass Dartmouth, I worked there also in the Age and Growth Unit as a half-year term appointment. After that expired, most labs had a summer appointment. And then I applied to grad school and went off to Rutgers University, and I was fortunate enough that Ambrose Jearld, who is only recently working there also, in conjunction with Brad Brown's good graces provided some grant money to work on weakfish biology while I was at Rutgers. So, during the course of my graduate Master's program I was kind of tangentially funded through the fisheries, they provided a grant to the university for working on weakfish. Then I was able to get into a co-op program where I actually worked at Rutgers[and the] Sandy Hook lab with Stu Wilk at Sandy Hook. So, the way that the co-op programs worked is that you essentially competed to become a co-op student, so you were eligible—you were expected to be hired as a permanent employee once you finished your co-op stint. So..

JW: So this is a way of transitioning people in?

GS: Transitioning, right. Rather than having to go through the regular hiring process where you had to compete for a job, in essence you had already competed for it. So, actually the day I defended my thesis, they began to pay for it and transition me to a part-time permanent position, again back at theAge and Growth unit. So, I worked there briefly and then there was a one-year term appointment position that opened up in the Population Dynamics Branch. In essence, I quit the job in the cottage, moved to the term appointment for the year and worked for John Boreman.

I was working on primarily river herringwork. So, that ended and I was able to go back to the cottage, to Age and Growth unit.

JW: Down in Sandy Hook?

GS: No, also in Woods Hole. I was up here at the time. Moved back to the Age and Growth for six months or a year or something, maybe less than a year, and John was able to convert that position to a permanent position, actually able to get two permanent positions out of it so myself and Anne Richards were both hired at the same time. I was able to go back to the Population Dynamics Branch—that was around 1983—and I've been there ever since. So I started off the whole process here as a student aide, I think making $2.10 an hour.

JW: That's quite a trajectory.

GS: I've gone up the food chain here to working on supervising other staff members in the Population Dynamics Group.

JKW: So, when you were doing your grad work on weakfish, what do those studies entail?

GS: I was doing work on age and growth and reproductive biology because there really hadn't been much done and that was a species that was increasingly of interest to the Center. So they felt that they needed some information to use, so I was able to work on developing age and growth information and reproductive studies, primarilyalong the New Jersey coast. When I first started, Churchill Grimes was my major professor at Rutgers, and actually he left Rutgers and later took a job with the Fishery Service in Panama City and became the Lab Director at Santa Cruz. But I mentioned how I needed to get fish and he said, Fine. The truck's outside, go find them. [Laughter] So I spent a week driving up and down the Jersey coast looking for people I could collect fish from—

JW: Just with recreational anglers?

GS: Recreational anglers, I went to fish houses…I started off at Sandy Hook and drove the coast down to Cape May. Lund's Fisheries down in Cape May were very helpful, and I was able to actually go to the fishery's office port agent down in Cape May and Pat Hughes, recently retired from here, was the port agent at the time, so she directed me to some resources and also fishery agents in Long Island. I was able to get samples out on eastern Long Island. So, some of those contacts—

JW: That's a lot of driving.

GS: Lot of driving. I was a grad student so it was good to do, so…

JW: What was the state of the weakfish population at the time?

GS: Well, as with my career,it was basically good fortune the whole time because they had been relatively low in the late '80s, late '70s period. There was this resurgence of weakfish such

thatthere was weakfish all over. There was an abundance of ten, twelve, fourteen pound weakfish that were coming into Delaware Bay to spawn. I was able to get a range of fish, all sizes. Few years after I—

JW: Were you purposely looking for different ages of fish to sample?

GS: Right, trying to get a whole size range to get different ages and et cetera, and reproductive biology…different states of maturity. Soon after I finished, the population declined drastically. It was probably another fifteen years before they saw big fish again. So, it just happened to be—timing was everything.

JW: What do people sort of attribute the resurgence of the weakfish to? Environmentally?

GS: Still don't know. It's one of those species where there's a lot of conjecture in terms of what drives the population. At the time there was a large—it's called Fly Net Shrimp Fishery in North Carolina—that was being pointed to saying, well, that was basically causing excessive mortality on the younger year fish and basically wiping out recruitment—

JW: Through by-catch?

GS: Through by-catch. They shut the fishery down and nothing really great happened. So then they started pointing to the striped bass, oh, it must be striped bass eating them all. But that's a pretty sketchy overlap between the two, so it's primarily, I think, a lot of it is environmentally driven. Good recruitment and low enough mortality to allow those big fish to rebound. So, there's currently… it seems to be some larger fish around. You can almost use the local catch as a barometer because when there's fish caught in Rhode Island, Massachusetts it's usually an indication that there's enough abundance that they spread out into the northern realm.

JW: So, this is sort of the northern extent of the weakfish population?

GS: Right. Pretty much Cape Cod is about it, and that's only occasionally you get a pulse of fish coming up. Although, at the time in eastern Long Island, Greenport area there was a regular fishery—

JW: Up on the North Fork?

GS: Exactly. So I was able to go out, it was a pound net fisherman that would take me out and allow me to collect samples with him. He was a fascinating character, he was—he had been doing it all his life.

JW: What was his name?

GS: …He was a Polish guy and I don't remember what his name was offhand. But he was a part-time farmer and a pound net fisherman and I'd meet him at the dock. I'd drive there, sleep in the truck until he pounded on my glass at 4:30 a.m. We'd go out in the boat, collect everything in the pound net and come back by noon, and he'd sell his fish and go do something else. What I was

fascinated by, the way they would operate is they would come up to the poundnet in their small boat and there'd be like a peg on the side of the gunwale. So he'd reach down with his left hand and pull the net up, hook it on the gunwale, and then whatever… So when you'd look at him, he looked like a fiddler crab because his left arm was the size of a log, his forearm.

JW: All that reaching.

GS: From doing that for like forty years with that one arm, pulling that net in—

JW: That's incredible.

GS: His right arm was, you know, relatively normal. He was a real nice guy, but he didn't care for the government agencies at all. I was a student, so I had some credentials that way [laughter].

JW: You weren't the enemy.

GS: I wasn't the enemy.

JW: So, did he have his pound net on Gardiners Bay?

GS: Right. It was on—towards Gardiners Bay. So they'd set it out in the spring. They'd pull it back up around late[spring]—early summer because it would get fouled with weeds so much. The fish… they were primarily targeting striped bass and weakfish at the time, so once those runs went by, they would pull them up until the fall. It was a nice fishery, they'd land a fish at the dock pretty much still kicking, put him on ice and have him at Fulton's the same day, you know, within an hour and probably get, you know,25%, 10, 20% more per pound for their catch because it was so fresh and it was frozen immediately and handled well. So, it was a pretty good deal for them but then restrictions started really, particularly on striped bass, it really started to cut into their ability to—

JW: So, that must have been at the beginning of the decline in the striped bass population, right?

GS: Right. That was probably around 1980 that it was happening, so the restrictions were really starting to crank down at the time. There really wasn't a good, reasonable striped bass until…it was a '82 year class that was okay, which was really the genesis of the whole resurgence of striped bass, kind of fostering that '82 year class through.

JW: And there were measures put into place to try to protect the 1982 year class?

GS: Right. They tried to stay ahead of that as it matured, so whatever the range of that size fish was the minimum size moved up to an inch or two above that and kept moving up until it got…I think it started around sixteen inches minimum size and made its' way up to like thirty-six inches. So, really, it worked [Laughter].

JW: So was that to allow them a greater chance to spawn before being harvested?

GS: Right. The idea was to allow 95—increase the probability that 95% of them would have an opportunity to spawn at least once. Then in 1989, there was also a reasonable, above-average year class that ended up partially re-opening the fishery.

JW: So when the striped bass population was declining in the early 1980s, what was the scientific thinking about that?

GS: Well, there was—it actually started to decline in the '70s. ’72 was the last big year class—I think it was ’72 or ‘70—came through and they would get hammered pretty heavily. Prior to that there would be, in Chesapeake Bay there was the dominant source of striped bass that you would see recruitment pulses every three to five years—you would see good year classes. Then through the '70s, that kind of stopped. We didn’t see—you’d have poor or below-poor year classes. So, that was really the focus of most of the science, was why was that happening. So there was a lot of money put in—

JW: That disruption in the pulse.

GS: Right, the poor recruitment. They were really looking for environmental signals to try to pinpoint—acid rain was a big issue, you know. Was the acidity of the water causing high mortality due to chemical contaminants, et cetera. Some of the modeling that was done. John Boreman was actually instrumental in doing some of that work with Phil Goodyear from Fish and Wildlife Service. Later, Paul Rago, who just retired as Branch Chief of Pop. Dy. group, he worked for Fish and Wildlife Service at the time. You know, it’s really fishing mortality that’s driving the whole thing, you’re just catching more than can reproduce at a time. So, that kind of turned out to be a combination of things where the conditions were quite variable for recruitment success, but you had so few fish that were in the spawning population producing egg. So, what would happen is it would be sort of a one-shot deal, the females come in and spawn, and if conditions were not good that week, that was it. You couldn’t get good recruitment. As opposed to—really the way their system evolved was to spread out their reproduction over the course of a month or so when you had a good abundance of adults. So, you’d really buffer any environmental changes. But it kind of narrowed kind of down to the point where it was kind of a hit or miss. So ’82 was reasonable conditions and you had reasonable recruitment.

JW: What were the ideal conditions, environmentally, for a good recruitment?

GS: Well, you needed—in order for striped bass to succeed, you really needed to have reasonable water flow, fresh water flow, to go up into the rivers, into the fresh water—

JW: Tributaries.

GS: Tributaries…Up into the freshwater part of the river where the brackish freshwater line is. So some of the research at University of Maryland, Hood and Rutherford had shown that you really need to have that water, that freshwater lens broad enough so you had a large enough habitat for eggs and larvae to succeed. If you have low rainfall years, that whole freshwater period would be really narrow, and if you have too much rain, it would just wash everything out. So it had to be something in between. And then you also have enough eggs in that system to

utilize the capacity of the habitat. So ’82 seemed to be, as far as waterflow, et cetera, to be quite reasonable. There was some work that had also been done a little bit later down in the Roanoke River. The waterflow in that river was controlled by the power authority in a dammed pond upstream. Abundance of striped bass was pretty low because they would shut the water down because of waterflow needs, energy needs, and so forth. So, there was a compromise worked out with the power authority and the Fish and Wildlife and NOAA to maintain some waterflow, adequate water flow, during that spawning period. And if you look now, I mean the abundance of striped bass just took off because, again, you had the right conditions, and those that survive go back and reproduce and it just builds on itself.

JW: Is the powerplant still in operation today, or has it been shut down by now?

GS: No, it’s still operating. I think it’s in Weldon, North Carolina, I think. So yeah, they just have to make sure that they maintain the water flow so that it’s constant, and not shut it down or open the floodgates unless it’s an emergency.

JW: Right. I’ve read that the striper population in Albemarle Sound and Roanoke is distinct. Does that mean that there is a lack of interbreeding then between those fish that are native to that area, fish from the Chesapeake, and then fish from the Hudson as well?

GS: Most of—there’s not a whole lot of crossing over. There’s the primary stock—it’s the Hudson River. The Hudson River never really declined like the Chesapeake in the '70s. Part of it was, it was so contaminated with PCBs that you couldn’t catch them and eat them, so people kind of left them alone. The Delaware River stock was decimated, that was gone. Part of that was attributed to pollution, as basically a pollution block around Trenton. So, stripers going upstream couldn’t really get past it because the dissolved oxygen was so low they wouldn’t survive. So as a result, the numbers crashed. Chesapeake was its' own story, and then the Albemarle/Roanoke system—they were, as were most of the striped bass, they were exploited pretty heavily. One of the thoughts was that the reason that you didn’t get too many found on the coast was that basically they didn’t get out alive. You know, they didn’t get big enough—survive long enough—to be migratory size. But with increased regulations and so forth, now you see more and more of them going out to the coast, mixing with more of the southern coastal areas.

JW: Was that due more to predation, or just their mortality due to environmental conditions…the toxicity of the water?

GS: No, it was mostly that the abundance was declining because of the river flow and fisheries exploiting them. Keep an eye on the minimum size back around then and it was twelve, sixteen inches, which were immature fish. It was no quotas so it was basically market-driven. So there was enough surviving to maintain the population, but it wasn’t at an optimum level. You wouldn’t find very big fish in the AlbemarleSound, yet there’s records of fish—125 pound striped bass being taken in there back in the late 1800s. Also, the geography of the area’s changed dramatically. Oregon Inlet was about fifteen miles north of where it is now or something. It was a whole different system back then so you had, fish had more direct access to coming and going into the ocean. The idea is that now that the AlbemarleSound is again unique—similar to the other systems—so there was an agreement that it would be managed

separate from the combined coastal migratory stock still under the auspices of the Atlantic States Marine Fisheries Commission. I think there's some thought now that maybe that needs to be rethought a little bit, as far as how much mixing is actually going on. There was a story at the time—there was a white paper that the striped bass working group had done, it was a biologist in North Carolina. In the conclusion, it was exactly that the idea that it may not be a characteristic of the stock that it's insular within the system, but it's just a matter that the size hasn't expanded to where it should be, and that it will probably become more migratory. This biologist was part of it— he was told, that's a touchy subject politically in North Carolina, you may not want to be on it—oh no, that's no problem, and so he signs as a co-author on this working paper and that was the last meeting we saw of him, he was out collecting blue gills in the hills in North Carolina somewhere after that. It's a hot topic, you know—striped bass in general creates a lot of emotional response from people [Laughter].

JW: So is the state of North Carolina more concerned, I guess, about the migration patterns of those fish in terms of being local, or are they…when it comes to what they're looking for in terms of the science?

GS: What right now—I mean the fish basically hang out in Albemarle/Roanoke Sound, go up the Roanoke River, spawn, and come back. The idea was, when they come back, do they go out to the ocean or not? The tricky part is if they become part of the ocean migratory stock, then they're under the same regulations as all the states from Maine to North Carolina like we manage the Chesapeake stock. Part of the quota goes to the overall coastal community. That's where it becomes politically, you know, not as…

JKW: More sensitive [laughter].

GS: Yeah, they don't like that [laughter]. Which, the whole point of the development of the ASMFCwas to get states to cooperate because, basically up until the striped bass in 1984—the Striped Bass Act was passed—states weren't required to follow the regulations of the ASNOC, it was more of a suggestion. There was no authority—

JW: More of an advisory body.

GS: Exactly. Then because of the demise of the striped bass, they instituted basically a federal hammer that said basically if you don't play by the rules and cooperate with it, that the federal will shut down your fishery. Since then, everybody is signed on for the coastal agreement. All the regulations are done in agreement so you don't have fish crossing the state line and suddenly they'd catch whatever you want, which had become a real issue. So that took a lot of political maneuvering to get the states to agree, and also to impose the regulations on striped bass after that. I mean, the state of Maryland shut the fishery down in '85, put a moratorium on it. Whereas Massachusetts, for instance, didn't. Like most fisheries, it's the local perception that drives the opinion, and you get different perceptions in Massachusetts of the size and abundance than you do in Maryland.

JW: Do you think that all states at that time recognized, in their own way, the dire nature of what was happening?

GS: I think they did. The recreational community was really on the forefront of pushing the agenda to make sure—they could see things were declining, so they put a lot of political pressure on making some changes. It seemed like in the commercial community they realized it, but because it was their business, they weren't going to really push to shut anything down. In fact, Massachusetts never put a moratorium on their fishery. They clamped down on sizes and everything else, but most every other state shut the fishery down by '89…pretty much it was closed commercially except for Massachusetts. But it was enough to improve the survival of them, so it worked [laughter].

JW: Was the haul setting industry in New York State still inactive at that point?

GS: Yep, it was still a viable system then…pretty much petered out after that. Actually the state was using that technology for an index for abundance. Hiring haul seiners to do an annual survey up until, you know, probably the late '90s, or even later than that. It got to the point where there wasn't the equipment and people didn't know how to do it anymore, [laughter] by the time they finally gave up.

JW: I guess it's a pretty antiquated technique.

GS: Pretty effective, but yeah, there's probably better ways now. But it was pretty cool [laughter].

JW: How much did the Delaware River population of striped bass contribute to the coast-wide population, do you think?

GS: At the time, when all the regulations were underway, it was probably zero. There really wasn't any viable recruitment coming out of the Delaware—they'd do juvenile indices and come up with zero. And then you slowly start to find a few as they started cleaning up the water—I mean, the Clean Water Act and pollution control in the Delaware River so they weren't just dumping stuff right into the Delaware—opened up the river enough and by the late '90s, it was declared restored. Abundance rose fast enough that there's a viable commercial fishery and a strong recreational fishery.

JW: Are there any guesses about how productive it had been prior to the heavy industrial pollution in Trenton?

GS: It was probably about ten or fifteen percent of the total, overall. It's kind of thought that the Hudson River's about ten to fifteen percent. Delaware a little bit less, maybe closer to ten percent. The Chesapeake is probably closer to 75, 80 percent…whatever the numbers add up to equal. But most of it is, the production, is coming from the Chesapeake. You have to keep in mind, we talk about the Chesapeake stock but really it's a whole series of tributaries in the Chesapeake—the Potomac, the Choptank, the Rappahannock, and so forth…the upper bay and Susquehannaarea. So there's actually differences among those tributaries in terms of productivity and annual productivity.

JKW: So there's an element of natal fidelity to each individual tributary?

GS: Exactly. They get lost, so it's hard—it's difficult to identify genetically something that's say, from a certain tributary, but you can characterize it as from the Chesapeake. But with tagging, and which there's been a tremendous amount of tagging, you can identify—those fish go back to where they were. Amazingly, even in their coastal migration they'll leave the Chesapeake, and after spawning around this time of year—May, June—they'll move north all the way up into the Bay of Fundy, particularly the Chesapeake fish. The state of Massachusetts has done some tagging for a number of years and there's been a couple of cases—there's one where Paul Diodati was running the program and said there was a guy on a charter they were using that tagged a fish at a rock off of the Vineyard one summer. The next year, that same guy on the charter caught the same fish at the same rock [laughter].

JW: That's incredible.

GS: And it hadn't over wintered there, it moved further south to spawn and back. So they tend to be very—

JW: Exhibit some site-specific behavior.

GS: Yeah, you expect to see that in the spawning behavior, but it's kind of cool that they follow the same migratory path and endpoint generally. As they get bigger, they move on for different foods and resources, but they're a lot like puppy dogs, you know [laughter]…going home.

JW: Cute and cuddly.

GS: Yeah.

JW: And I've heard now that there are populations in Gaspe as well, that have begun to increase in recent years.

GS: Yeah there's been a population in Saint Lawrence for a number of years…Actually, their abundance is declining I think, currently. There's always been up around Annapolis River and the Bay of Fundy and up around the provinces of Canada there's been resident populations of striped bass that aren't migratory. In fact, back in the—the striped bass on the West Coast, as well, they were captured on Navesink River in New Jersey in the late 1800s, transported on trains—

JW: Brought out of milk cartons [laughter].

GS: Yeah, milk trains and dumped in the bays in the Northwest and took off. There's striped bass in freshwater ponds, lakes, and so forth. They're pretty tolerant of cold and salinity, and eat pretty much anything…as you can tell if you go to the local Clam Shack down in Hyannis and throw french fries off the dock, you'll see the huge stripers come out from under the dock and snarf them up [laughter]. So, they're not particular.

JW: Well, it would be good to return to striped bass, definitely, but I guess we can move on to some of the other—sort of go back in time now as we had started out. So we were talking before about your research when you joined Age and Growth in the early '80s. Who were some of your coworkers when you joined the branch?

GS: Well, in the Age and Growth unit Fred Nichy was really the director there. When I moved into the Pop. Dy. Group, there was a lot of veteran scientists there—it was a group of relatively younger people at the time that had been brought in. They were older than me, but you know, Steve Murawski was a biologist there…Fred Serchuk, Ralph Mayo… Emory Andersonwas a little bit more senior biologist, he went on to a lot of work in ICES. Mike Sissenwine was there, Vaughn Anthony…So there was quite a core group of—

JW: And you were all part of the same cohort?

GS: For the most part. I mean, Vaugh and Mike and Emery were a little bit older, but Fred and Ralph, Steve Murawski and few others that were around that same—Steve Clark was another biologist that worked in Pop. Dy. So it was quite a talented group…It still is, but it was a lot of some, really neat work that was done. At the time there was a lot of associations with the ICES, it was ICNAF at the time, because—

JW: What does that stand for?

GS: ICNAF was International Commission for North Atlantic Fisheries, and then it became—ICES kind of usurped the whole thing... At the time, it was still foreign fisheries. When I started, the 200 mile limit wasn't in place yet, and so when I first got to one of your questions about one of the main research interests at the time—when I first started working, it was basically the development institution of the Hague Line was all hands on deck because it was still at the World Court. So, they were developing all of the evidence to support the U.S.'s case. What had happened is that the U.S. had declared the 200 mile limit in 1976, which basically encompassed Georges Bank for the most part—pretty much all of it, I think. At the same time, Canada declared a 200 mile limit, which also covered most of Georges Bank, you know the southwest corner of Nova Scotia. So that's where the contest began. Story was that after they worked out an agreement, like a treaty, to fish in each other's waters, but some of the fishermen in New Bedford objected to that, to giving up anything. So, they used someof their political clout and the whole thing got nixed. They decided to let the World Court and the Hague decide on the split. Now, Canada's argument was that Cape Cod wasn't a viable land entity, so therefore you should draw the line from basically the canal east [laughter], and therefore you'd only get a small part of eastern—western Georges Bank, rather, and they would get all of Georges Bank. I think the US.'s argument was similar, basically we got there first and it should be ours. So the World Court said, nope, we're just going to draw a line basically down the middle of it. Canada gets their side and we get our side, and don't cross that line. So, that was like 1984 that it was developed, so when I first started in Pop. Dy. that case was before the World Court. Most of the attention of the branch and the agency in general was to develop the evidence for their argument that there was a viable reason, a reason why it should be in the U.S. 200 mile limit area. So, once the World Court decided and all of management and everything else had to adjust accordingly. There were still foreign fisheries in U.S. waters, even though there was the 200 mile limit. There

was still joint venture operations with foreign vessels with mackerel and herring and so forth. The foreign vessels would come in and the U.S. vessels would catch a share of whatever the quota was. Some of the quota was given to the foreign vessels and the U.S. vessels would offload, sell their catch directly to the foreign vessel as a way to provide a market. So that went on into the early '90s…kind of petered out after that. So there was a lot of work done in the branch to try and examine some of those—the effects of that. There really wasn't much of a scallop fishery, at the time.

JW: Interesting.

GA: There was a couple of years where it was a bit of a boom, a good set and they caught most of them pretty quick. There was not too much—

JW: So it was mostly ground fishing before?

GS: It was mostly ground fish…cod and yellowtail was really the staple of the fishery, you know. There wasn't much of a herring fishery because most of the herring fishery was along the coast of Maine, for sardines. In the early years, there was probably a hundred canneries in coastal Maine for sardines—there aren't any now.

JW: Was that mostly Atlantic herring, or river herring?

GS: No, it was all Atlantic herring. The lobster fishery was going strong but there wasn't really an offshore lobster fishery. Things, justin my career, have changed, how the fisheries are dramatically. I'm sad to say that when I first would go to sea, you know, we'd get tows of cod where you'd run out of baskets to put them in, on the deck. Big, twenty, thirty pound cod…not, you know, little two-year-olds like they catch now. So yeah, there was cod around, and yellowtail and so forth. Saw it all go away [laughter]…

JW: Was there any cooperation between U.S. scientists and Canadian scientists during the HagueLine negotiations?

GS: I don't know during the Hague Line negotiations—I mean, the DFO and the U.S. scientists have always been on good terms, but I think, at that point, they weren't trading information that would bolster each other's case. But there was still research—other foreign vessel researchers would be in the U.S. I got to go on a German research cruise, the Anton Dohrn for two weeks looking for haddock on eastern Georges Bank, so that was pretty cool…quite a different operation than the U.S. research vessels at the time.

JW: Different sampling methods?

GS: Different style. It was a huge ship—it had to go into the WHOI dock, it was like 250 foot. We'd sample during—it was the middle, of early February, so it was really nasty. There was a small scientific staff, we'd never had to go on deck—the fishermen would drop the catch down below under a conveyor belt. We'd work from like seven in the morning to seven at night, and then have dinner and relax. We'd have wine at dinner, and they had a whole stock hold of beer—

JW: Not too bad.

GS: —and everything, so you could have a cold beer when you were done [laughter]. They had stewards who'd come in and make your bed in the morning for you.

JW: Really?

GS:[Laughter] Oh yeah. Do your laundry… It was, whoa [laughter]. So, it was a fun cruise. So that was unusual, it was a lot of Polish research vessels, some Russian researchers in the early years—apparently horrible to be on. Everyone who went on a Russian boat—

JW: Bad conditions?

GS: Oh God, it was like the food is rancid, rats and everything else on the ship. It was just pretty nasty.

JW: Not the ideal vessels to be on?

GS: No, that wasn't the one everybody wanted to go on [laughter].

JW: So what was the office environment like when you were first working in Pop. Dy.?

GS: It wasn't a whole lot different. It was very cordial, very intense in terms of doing the work. It was less structure in terms of how the science was completed. At the time, people would do an assessment and it'd be reviewed by your colleagues on the staff and that was it. That could be brutal in itself, because everybody knew where all the bodies were buried in the data. There wasn't any outside peer review at the time, so everything had to go through there. It was a lot more—it was a lot involved with the ICES, working groups, in the European—more of the senior scientists at the time. But it was a fairly laid-back environment, it was similar to what it is now.

JW: What types of involvement with the ICES groups?

GS: Basically assessment work, but because there was some of these areas at the time—basically before '84 it was jointly managed by, you know it was controlled by ICNAF as far as setting the quotas. So it was making sure that the U.S. was part of that whole process. After that, NAFO, which is the Northwest Atlantic Fisheries Organization, which we still have—in fact, one of the people on my task, Kathy Sosebee, is chairing the scientific committee this week in Halifax. Basically to work on assessments of any internationally fish stocks and so forth. At the time, when I first started, Pop. Dy. was very male-oriented—there was only a couple of women that were working there, and Anne Lang was a scientist there…Anne Richards came on with me. But there really wasn't that many…I'm trying to think if there's even any other women that were working there. Whereas now—

JW: The gender diversity has increased.

GS: Yeah, the gender diversity, now it's about fifty-fifty. So that's nice to see. You know, one of the questions you've brought up is about the changes that have occurred. Definitely the technology changes have occurred over the course of my career…It's just—amazement. I was talking to somebody the other day about one of the things that really changes just in writing a paper. Back in the day, we didn't have word processing, it was a typewriter. So you'd write your paper and give it to—Gwen Kelly was the typist of the Branch, and she'd type up your manuscript. And then if you found, well, page twelve here was a—I had to add a paragraph, well she'd have to start on page twelve and retype the whole remaining document.

JW: That's quite the undertaking.

GS: Oh yeah. Illustrations that you have—ok, you could either do them by yourself if you had any skills, or like maps and stuff you'd kind of sketch out what you wanted, you'd go in the main building…John Lamont was our staff illustrator, he had an art studio on the third floor. You'd take it over there and ask John if he'd do the maps, and he'd draw it, put all the stippling in and everything like that…

JW: So that was all done by hand?

GS: It was all done by hand, all the graphs and figures were all drawn by hand. Even my graduate work—I had a little set of pens, different size pens, so you'd have to draw your graph and all the dots. You'd actually stick on tape for doing the axis and so forth, and put little numbers on the axis…So it wasn't a trivial undertaking to write a paper. You had to make sure what you were doing was worthwhile, first of all. Because you're going to spend some time, just physically doing it. Whereas today, if somebody has a half-developed idea, they'll whip out a paper and sometimes get it published. Sometimes they crank out three, four, five a year.

JW: The ease of word processing.

GS: Yeah. It'd take you six months and then you'd get your review back and you'd have to have it all retyped because you'd have to address the comments and do it over—

JW: How many revisions did you normally go through?

GS: Oh, it might be one or two depending on the nature—how good it was. But it took a lot more to do something like that. There are pros and cons…I mean, there's a lot more information flow now because of that, but on the same hand not allof it is quality. In the same way, just doing analyses back then—my colleague now, Susan Wigley, was saying the other day when she worked for Fred as a student and they'd basically do all of the calculations on pad and paper with a handheld calculator. So, you know, when you're trying to calculate catch models—in fact, there was some of the modeling, mathematics was derived so that you could actually do it with pad and—easier than having to integrate equations and everything like that, there were shortcuts that—

JW: How long did it normally take?

GS: Oh, it could take several, quite a few months to do some of the analysis that we can do in a morning now [laughter]. Just pulling all of the data together and so forth. But you'd have—when computers came on the scene and were actually used here, as well as even at grad school—you'd have a series of punch cards. It'd be 80 columns, it'd be limited how much information you can get on one. You'd put a stack in the key punch machine of blank cards, and you'd type in your code—for computer code—one line at a time. Each line of code was a card, and so it'd be numbered and you'd have a whole stack in a box. Then once you'd finished writing your code, you'd take it to another location where the computer was, and they'd run the cards through the machine and spit out a printout of your results. There was always an error…If the code didn't work right the first time, you'd identify what line it was, find the card, remove that card, type out a new one with correction, put it in, take it back, and run it again—or wait in line, because there's other people there and they can only have one—and see if it worked. And then when it worked, you'd get a print out with the results and you'd have to transpose those into a pad of paper or something depending on how you were doing it. So it was—it took a long time to do things.

JW: It's a big process.

GS: Yeah. And here—by the time I got to the Pop. Dy. Group, we actually had computers where you could actually type in at the computer, but you know, a couple years before that you'd have a box of cards, and you'd have to walk up to School Street, where WHOI had their card reader. You'd run it, and you'd have to wait and get the printout—maybe a half an hour or something like that—look at it, and walk back to the lab, make the change, walk back up to School Street, have them read it again [laughter].

JW: So you got your exercise.

GS: Yeah, and God forbid if you ever dropped the box with the cards in it—you're done. In grad school, you'd see people crying because they dropped it. You know, like two years of their work and they couldn't get it all back together [laughter].

JW: Must have been horrible.

GS: So, it was a different environment. Whereas now my cell phone has more computing power than we had at the time by an[order]of magnitude…So eventually we got, in the Pop. Dy. group, portable computers, and they looked like giant sewing machines—they were made by Compaq. You'd set this thing and tilt it on its' side like a sewing machine—tilt it on its side and the bottom would come off and that would be the keyboard. It would be a little 6x6 or 8x8 inch square screen, a green background with orange letters, and you'd type and see your images—words and stuff, whatever you were typing came up there.

JW: And that was the early personal computer?

GS: Yeah, floppy disks—you know, the five and a half inch floppy disk—

JW: The big ones.

GS: Yeah, not even the big, big ones—there was another system that…Honeywell, I think it was, that the secretaries had at the time. And they had disks that looked like the size of LPs, they were like 12x12. You'd stick these things in there and they're really useless but that didn't last very long.

JW: So that was very quickly phased out?

GS: That was very quickly phased out and the five and a half inch ones became the standard. So you'd have stacks of those things because it only held like a hundred—I think the whole computer was a hundred megabytes, you know storage—

JW: Wow.

GS: Yeah, it might have been one.

JW: That's just a drop in the bucket now.

GS: It was—you really couldn't store much on it. It might have been even less than that…

JW: How large was the computer on School Street that accepted the punch cards?

GS: Well, I think they transmitted it up to Quissett Campus, which was like an entire room, like a bottom floor that had computers in it. I mean, they were large, large computers—

JW: A big operation.

GS: Yeah. And you'd have like nine track storage tapes, a big reel of storage information which—recently I got a tape that had information on it that we needed. You can't even find anybody that can read those anymore. You've got to pay some private company like a thousand dollars to try and extract data from those nine track tapes.

JW: Transfer it from analog to digital.

GS: Yeah, so that's kind of useless—I think it was the VAX computer it was called at the time, and then they went to Sigma, and now it's like Oracle servers which are way more powerful than any of that was at the time. If you go into the computer area up at WHOI, they're rolling all these—lights flashing, tapes spinning around, collecting information and so forth. It was a real "mad scientist" kind of style [laughter]…In fact at Rutgers, we never—our professor in quantitative ecology was—we were going to do it, we never did, but there was a computing system where you would actually code your program by connecting wires with alligator clips, and it would be like an analog computer. You'd actually clip all these together in order to create a system that would do the computing for you. It was a giant room and that was the computer, and you could analyze stuff that way.

JW: I'm trying to envision in my head how that would have looked.

GS: Yeah, it was very much like—

JKW: It's a little abstract.

GS: Yeah, like a cartoon type of thing. So yeah, the technology has changed so much now that it's impressive.

JKW: Was Pop. Dy. still over the aquarium at that time, or has it moved?

GS: When I started, it was over the aquarium, and it had been—when I first started working at the lab, it was in MBL, which is the stone building that's across the street from the cottages apartments now. They had rented rooms in there. There was some staff in the main building on the third floor. When that lease expired, they moved everybody up to Homeport in town, so there was a van you'd have to take to drive you back and forth.

JW: Where was that in town?

GS: It's on the corner by Gifford Street and Jones Road—it's across the street from Coonamessett Inn.

JW: Ok.

GS: There were people in like the basement offices in the back…It was moldy and damp. It was a horrible—it was like three buildings, people spread out in the different places. And that was a temporary thing while they built the second story on the aquarium, and then Pop. Dy. moved into where we still are now, which was a big advance. But pretty much stayed the same. We've had changes in the cubicles, but that's about it.

JW: What branches were in the main building, next door?

GS: It was a lot of administrators, more administrators on site at the time. There was Dr. Wigley…Roland Wigley, his lab was in there. There was—on the first floor where now the port office is there was a tank room where there were fish tanks set up for experimental studies…That whole bottom floor was laboratory space, the second floor was more office administrators, and then the third floor was John Lamont, illustrator, we had a photographer on staff…some of the data management folks were there. So it was a little bit more diverse staff at the time than there is now with all the stuff we did then is now at either headquarters or Norfolk or someplace else. It was—I was thinking about it the other day because in fishery science, a lot of the work—a lot of the basis for it was developed in the late '40s, early '50s, the mathematics of it. Michael Graham—

JW: You mentioned the Baranov Catch Equation before when we were talking.

GS: Right. I mean, that was the late '30s and a lot of the stuff—Michael Graham, who was a

Director of the Lowestoft Lab in the UK really developed a lot of the theory of fishing that we do now—it was around World War II. And then post-war, he hired these two young guys Ray Beverton and Sidney Holt, and they set them in an office for two years to write all the mathematics and theory and equations and stuff…They sat there and cranked this amazing volume of information out. Sidney Holt—I actually had the pleasure of meeting both of them, Ray Beverton and Sidney Holt. Ray Beverton was a real consummate gentleman, a real classy English gentleman, really nice. And Sydney Holt—I believe he's still alive—he's more of a character type, you know. Smart guy, but…As compared to Sidney Holt talking with Michael Graham, he had been working on this stuff and they went off to war. And he was—I don't know if it was in Normandy around that period—he had some down time and was sitting on a tank trying to figure out, integrate differential equations that he was trying to solve that related to the work he was doing at home with fishing, and he was having trouble with it. It turns out one of the other guys that was sitting on the tank waiting with him was a mathematician [laughter]. So, apparently on the back of an envelope, together they worked out a lot of the mathematics that we still use today.

JW: That was somewhere on the continent during the war?

GS: Yeah, it was during the war, during a couple hour down time, you know, figured the theory of fishing. That was only a few generations ago. Basically, people who were my father's age developing a lot of the math that we still base fishery science on. Compared to some of the other sciences, it's relatively new. A lot of theory, ideas were developed in the early 1900s, but it was really around that '50s and '60s that it really started to take off a little bit more—actually management, they're actually using it to manage fisheries. Before that it was like, catch them until they run out.

JW: When Beverton and Holt were working on their equations then, were they doing that in reaction to prior theories about fish population dynamics, or was this something that was completely new?

GS: I think it was a continuation of the work that Michael Graham and others had done. A lot within the ICESs, ICNAF arena… They actually worked at a lab—Michael Graham was their boss, so he basically was—post-graduate looking for a job type of young guys…I think it was a staff of guys, but they did most of the work apparently. They basically sat in a little room at the back of a building with a little coal stove and cranked out these amazing—a lot of the stuff, people haven't even…You go back and look, oh yeah, Bevertonand Holt did that already, sorry [laughter]. So, it was an amazing body of work they produced. But there was others in the U.S. and Canada that were similarly doing—starting to pick up the mantle and coming up with the quantitative basis for management that really hadn't been started.

JW: What data were they using?

GS: There was a lot of catch data. They would record—have information on catches and so forth. Back in the early 1900s, there was really the idea of fisheries recruitment. The Norwegians really were at the forefront of doing that. So, they basically really pulled a lot of that information into a quantitative network to be able to understand it better. But the catch data, landings

information, was collected back into the 1800s, you know, so there was a long time series for some of these. It was interesting because the war really obviously put a damper on fishing. It's hard to fish when you have U-boats chasing you in the U.S. and Europe and so forth. So, it was interesting because they had an opportunity to see what happened when you stop fishing. You'd look at the number of fish available and all of a sudden, it takes off—it's like, hmm, there's something to this perhaps. Also, a lot of the early stuff was developed for marine mammals, for whaling, and tunas and so forth. There's still argument whether it pertains to fishes in any cases, but that's the whole new direction science is going here.

JW: And so these equations are still in use today?

GS: Pretty much, yeah.

JW: As the basis for quantitative analyses?

GS: Yeah, I mean clearly they've been elaborated on. In some cases, we've refined—there were errors in the book that they've corrected. There's another volume that a group of scientists redid the Beverton-Holt original and there were some corrections that were made and so forth. Still pretty much, a lot of it's the same, the basic theory on what happens when you're fishing and environmental effects.

JW: What are some of the developments that have taken place since then, as they've built off of those original theories and reactions to them?

GS: I think the nature of some of the mathematical models—with the advent of computing, you can explore it a lot further in terms of diagnostics, the capacity of how broad you can make it. For instance, there was one of the British scientists, John Pope—back in the '70s I guess it was—modified the catch equation so that you could do the calculations easy in the whole thing, the Pope equation. So, instead of having—you just basically split things into two time periods, so you have discreet time blocks instead of a continuous functions because you can do the calculations that way. Well, now with the computing that we have, you don't need to do that. You can get more refined estimates, and so forth—just the volume of…Also as the time series expands, now you get into, the data sets get bigger and bigger and bigger, and you really need the computing power to do it. Also, some of the statistical framework, like the likelihood methods and so forth that really weren't developed well back then, if at all…Basically, the sophistication of how those types of analyses are done. Also, I think in more recent times, you think about ecology—there really wasn't such a thing, ecology really wasn't a thing until like the '70s when it really became at term that anyone thought of in terms of science as opposed to hippies or something. As a result, in fisheries—there were a lot of theories that were developed in fisheries that ultimately were developed in wildlife—

JW: Wildlife management strategies?

GS: Wildlife management, forestry management. When ecologists started to come on the scene, you were like,wow, the same equations, the same processes—and started thinking of them more

from the ecological perspective of other things that control fisheries, and the effect of the environment and species interactions, habitat restrictions, and so forth. Some of these things were touched on by Beverton-Holt and so forth, but it was never fully developed just because, again, it's hard to do some of these things with adding machines and a piece of paper.

JW: To consider the full range of dynamic interactions between various environmental factors.

GS: Exactly. So, it's become a lot more sophisticated and I think cross-cutting other fields of science, which is pretty exciting.

JW: So where do you see the scientific process going from here, as computer modeling continues to develop?

GS: It's a good question**.** I mean, clearly the direction we seem to be going in, in fisheries, is more towards ecosystem-based or—there's a whole series of terms—ecosystem-based modeling, or multi-species based modeling approaches and so forth. I think it's been slowly developing. My personal opinion is that it's sort of a long ways to go, I think, before we get to the point where the data that we have, the resolution of the data we have is enough that you can do that. I think the—you think about it, the data collection approaches that we use, trawl survey and so forth, it's a fundamentally basic approach and it works. It's proven to work regardless of—despite what the industry says, it does work. But it's really an archaic approach, and I can see in the future we'll have a much more sophisticated use of technology to do similar things. We're seeing that with scallops with the HabCam, where it's taking on a different approach just because it collects so much information that you need to have strong computing power and database skills to handle that. I think we're just beginning to delve into that.

JW: Just the amount of information.

GS: Yeah, and so I think once we can get to that point, I can foresee where a lot of the modeling approaches that we use will be more to verify and compare with abundance estimates that we get from other techniques. I think there's going to be a—you'll see a suite of approaches in the future where you have multi-species or ecosystem-based system models, you have individual species models, you have other estimates, acoustics and visual estimates…

JW: So information outputs that could be used for a variety of different purposes?

GS: Right. And you're going to need it because you see more and more conflicts in fisheries use and being able to—just ocean use, clearly, ocean policies that are being developed. Realizing okay, there's different demands for the same spaces and the policies that are developing, you're going to need information to support that. So, I think there's going to be a whole—there's going to be user groups and interests that are going to be developing data collection approaches that maybe just in fisheries we haven't had access to or thought of or what have you, that for other purposes—for example, in the mid-Atlantic Bureau of OceanManagement's been looking at doing HabCam surveys for habitat. I was like, well—also looking at fish habitat while you're doing that for trying to site wind turbines and so forth. When it really gets down to it, I think the Navy has probably been collecting all kinds of sonar information, oceanographic information

that relates to also marine mammal behaviors and so forth…there's probably a wealth of information in other agencies that we're—satellite data we're finding from satellite systems that relate to plankton in temperatures and so forth. So, I think it's pretty exciting to see a lot of this stuff coming together, but I think we do have to be careful that we don't get so excited that—ah, this is the answer—and it's like, that was the answer…some of these things thirty years ago were the answer, and it still isn't answering anything [laughter]. Like hydro-acoustics, you know, that was the big thing. We still don't really use that effectively for assessment or management purposes for fish. So, there's some pretty neat things coming down the line.

JW: Just to go back for a second to Beverton and Holt's equations, was their method of analysis primarily looking at how stock recruitment takes place, or how a fishery can be prosecuted, or what?

GS: All of the above. I mean, they covered the whole range of looking at growth models and looking at—analyzing catch per effort information from the fishery and looking at recruitment processes and looking at dispersal models…The book that came out of it, it's a horrible book to have to read through because it's like equations and so forth, but then you read some sections and it's like wow, they had it nailed already back in 1950. So they really covered a lot of it. One of the common stock recruitment models that we use is called the Beverton-Holt model. And then there's Ricker, up from Canadian—in the British Columbia area—he was working on similar things, too, actually wrote a similar book, different slant—more of a freshwater slant to it. There's also the Ricker model for recruitment. Those have been standards for sixty years, and they both have their pros and cons, people argue about which one is appropriate.

JW: What are the arguments surrounding them?

GS: Well, the basis for Beverton-Holt stock recruitment model is that there's basically a carrying capacity, and the relationship is asymptotic. No matter how much—you get to a certain point of spawning stock biomass egg production and it's just basically wasted.

JW: A point of saturation?

GS: Point of saturation. A habitat can only support so much, and it flat tops no matter how much SSB you add, you're going to get the maximum recruitment and that's it. The Ricker model was really based on salmon biology. His model says you reach a point of saturation, and as your SSB increases, your recruitment decreases—increased density overcompensation. And the reason for that is he was looking at salmon spawning, and salmon spawn and reds, they go in and—

JW: Sockeye salmon?

GS: Yeah, and they fan out and nest on the bottom gravel, deposit their eggs and then leave. Well, when you get huge numbers of salmon, the next wave come in and they fan out their nest and cover up the previous one. So, the more spawners you have, the less success there are because they're disrupting each other's spawning area. The other thing is cannibalism, too—if you get a lot of adults that are eating young, then the more adults you have, your recruitment actually declines instead of just being stable. So, there are two different perceptions of it. The

trouble is that recruitment data is really noisy, there's a lot of variability in it, and so sometimes you can fit both curves, and they both don't fit equally well. But the implication is very different from an assessment point of view because what it says with the Ricker model is that you can get too many fish that if you want to optimize your recruitment, you might have to fish harder to reduce the number of adults in the population to get it to that optimal level, whereas the Beverton-Holt says that you don't want to do that. Once you get past the point of—once you reach the asymptotic level of recruitment, you're looking to maximize and optimize your yield, not—it's not going to have any effect on your recruitment. The more just gives you more, it's not harmful. The implication is very different as far as what the optimal point of fishing is between the—depending on which approach you take. The tendency is to take the Beverton-Holt one unless you can prove it otherwise and it's difficult to prove.

JW: Yeah, I was going to ask—when establishing biological reference points, how you decide then which model to go with?

GS: What we do now routinely is we don't use either one of them. The whole stock recruitment models are used for calculating what the optimum level of spawning stock biomass is, whereas the fishing mortality optimal level is a lot easier to calculate. So, what we do is we run the projection out and say okay, if you're fishing at this optimal level and you fish at equilibrium, how much spawning stock biomass should you have? And that gives you the optimal level. So you don't have to be—what Chris Legault's group and some others have seen, if you take the optimal level from SSB and FMSY using the stock recruitment, if you were to fish at the optimal level to get out to there, it doesn't match sometimes. You can't get there from here. And so—

JW: It's not going to bring you to that point.

GS: Right. If you're trying to reach the SSB MSY while fishing at FMSY, you may never meet. So you've got to do one or the other. Given the uncertainty in the stock recruitment, it's usually much more justifiable to estimate it out empirically. But still, it drives a lot of conversations [laughter].

JW: I think we covered most of the—we were just talking about trends in your field, ways that the data has changed over time, the advent of computer modeling…So, I think that's pretty much it for the questions here. Was there anything else that you were particularly interested in adding in, or any other topics that you think we gave short rift to when we were talking before—about striped bass, or…you were working on bluefish, too, right?

GS: No, I mean, I think it's—working on bluefish, mostly black sea bass—

JW: And black sea bass, yeah. I saw your paper here, with Jess Blaylock.

GS: Yeah, hopefully that will come out pretty soon and Alicia Miller and Paul, a friend in town, he had done recently about the survival of the young of the year…There's a—it's kind of interesting because when you look at the state of fisheries in some of these things and you look back in the history, like way back, there was a—it's actually on our webpage in the classic publications. It was a series of public hearings that Spencer Baird had done back in 1869.

JW: Oh, with the [U.S.] Fish Commission.

GS: Yeah, the fish commissioner. He kind of went up the coast of New York to Boston, I think, talking—it was the first public hearing [laughter]—talking to fishermen about the state of scup. And when you read the comments, it's interesting because there were a lot of the same issues back then that we have now. The difference was, one of the fishermen I recall from the Vineyard had noted that the government should step in and do something about this—

JW: [Laughter] A vastly different perspective.

GS: Yeah, you don't usually get that now. But, just as now, all the fisherman—each one of them—had theories on why numbers had declined, pointing to the others, you know, the pound net guys are taking too many, we've got to stop them, pointing to the environment—

JW: Factional tensions.

GS: Yeah—there was one theory for bluefish decline, I thought was cool, was they had noted that on Nantucket, their tribe of Native Americans had been decimated by some sort of disease the winter before, and the bluefish didn't come back that summer. So, there's a link right there.

JW: Interesting.

GS: Whatever caused that demise of the Indian tribe kept the bluefish away, so that's the real problem. They all have theories about why it was, and to this day it's still the same way. We're dealing with that with striped bass and—not as much, but black sea bass, particularly if either the numbers are high or low.

JW: Black sea bass hit a low in the late '90s, right?

GS: Well, not really. They were always relatively stable but they did go down…But now they've resurged to the point where there are tremendous numbers of black sea bass, and the way it's manages, a lot of the fishermen in the Northeast don't have access to them. That's caused a tremendous amount of—any time a fisherman has to throw a good size fish back that is intended for the dinner plate otherwise, it's a bad thing. But one thing that you'll notice is that in—it's fun to be able to have done striped bass versus like sea bass or bluefish. Striped bass has a different following. It's much more of a—from a recreational perspective, it's much more of a trophy fishery. You know, fishermen would like to keep a few to go home—

JW: It has a cultural significance to it?

GS: Right, but catching a big striped bass, the catch and release ethic is much stronger. You catch a sixty pound bass, a lot of guys might want to take a picture with it, but there's a lot of guys that would just take a photo in the water and release it. Generally, they're content with one or two fish bag limit, where as you get the fluke fishery or sea bass and so forth…those guys are fishing to put as many fish in the cooler as they can. When you cut the bag limit back or increase

the size limit, it's like, oh my God, you're killing us here. Because they're fishing for meat as opposed to the fishing for the experience. Whereas in striped bass it's really the experience of catching them, more like a marlin or large trophy fish. But there's also a commercial entity which is also doing it for money, so it's a different ethic.

JW: Do you think that the conservation-oriented ethic within the recreational striped bass fishery is in part due to the memory of their decline in the 1980s?

GS: Oh, definitely. You hear that recently the spawning stock biomass declined because there was a dearth of recruitment between 2001 and 2011. It was average, below average. So SSB was starting to decline again, and you know, fishermen were calling up and saying, you guys have got to do something, you got to shut things down, before the managers took any action. They were hot on the fact that there wasn't action being done—a lot of them recalled a period when there was no fish, and so forth. On the other hand, they also have the memory of 2004 where the abundance reached a peak that was way above MSY. You could go out and pretty much catch a striped bass just going fishing. That's what they wanted to return to. They wanted to be able to catch one just by taking the family out and going fishing.

JW: Which is an unrealistic expectation.

GS: Right. We've declined from that—probably closer to MSY, where we should be. That wasn't what the expectation was, so that's a hard concept to get across. But things are improving, if you go out fishing on Buzzards Bay right now, you'll find a lot of striped bass out there in different—nice sizes.

JW: [Laughter] Barnstable Harbor too, right?

GS: Barnstable Harbor, anywhere around here. Lot of sea bass, lot of striped bass and so forth. So it's a—you know, the perception really changes depending on expectations. In the striped bass case, it's much more of a conservation ethic to do something, whereas in some of these other fisheries, it's more of a food-oriented—they want something to happen but to be able to catch more because they're wasting fish. Which, I can understand—sea bass are delicious [laughter]. You can also see that in the fact—recently, in cases in Buzzards Bay there have been like two notable poaching cases.

JW: I read about that in the paper…219 undersize black sea bass in Wareham.

GS: Yeah, there was a previous one the week before—it was 156 or something. There's a market for them, the commercial fishery's closed at the moment, so there's a lot of incentive—

JW: So they're selling them on the black market.

GS: Yeah…And that makes it hard for managers to manage—I would think—fisheries in a broad, multi-species sense because the intent is very different among all these. I mean, if you add bluefish into the mix—a lot of people are like, oh they're fun to catch, but I don't want to eat them. There's no minimum size—there's a ten fish bag limit, but generally people don't keep ten

fish, they keep a couple to eat and so forth. But they're really fun to catch, unless you're a tuna fisherman, then they are a real nuisance because they chew up your bait and they cost you a lot. So, it really varies across species by—between the rec and the commercial guys, even within the rec and among species. It's going to be a challenge to try and put all that into one management strategy and make it work.

JW: Right. So with striped bass, do you foresee any—as fisheries management sort of moves in this ecosystem-based direction—do you foresee any sort of inclusion of other environmental factors ranging from forage availability to the state of spawning tributaries and mycobacteriosis and other things?

GS: I think the environmental conditions, particularly in Chesapeake Bay—hopefully, it's been a bit of an impetus to help clean up the Bay because you can point to the conditions of the Bay, as it was back in the '70s. Aquatic vegetation was gone, there was a lot of pollution, and you could point to it and say, you know, the striped bass declined and everybody loves striped bass, clean up the Bay. I think it's helped move us and make a real tangible product as a result of having cleaner water. So, hopefully that continues. From an assessment point of view, the conditions are—it's always important to have. I've had this discussion about information we could use and I had a colleague—he proposed with me to do some analysis on the relationship between river flow and striped bass larval and juvenile survival so you could predict, based on river flow, what you would see. I said, that's great—there's a relationship there, it's worth capturing—but why do you need to? Because Maryland and a lot of the states do a juvenile abundance index survey in late summer, which links directly to how many two-year-olds you usually have. So why do you need to predict how much based on river flow you're going to have, when you can go out in July and measure it—how much do you have? Ok, well yeah, that's a good point. So a lot of these predictive abilities with the environmental information is interesting science, good to have…or you could just wait two years and see how many you actually have before they enter the fishery, rather than trying to predict it based on environmental conditions. But I think there's a lot of that going to start to be, like in striped bass, there's a push to use more of an ecosystem, at least an approach as far as how much forage fish is necessary. It becomes difficult with something like striped bass because they'll eat pretty much anything. They'll eat french fries.

JW: Opportunistic feeders?

GS: Exactly. There's probably preferences—if there's been menhaden around, sure, they'll feed on them, but they'll also feed on crabs and so forth. So as long as there's a variety—diversity of food items. A lot of the multi-species models that have been developed—to my limited knowledge—a lot of them come from the European, the Baltic and Norwegian coast where there's a very simple system. Norwegian coastal cod is in capelin, you can predict success of cod, how much quota, based on how much capelin is going to be—

JW: That one direct correlation.

GS: Right. Or in the Baltic where you have sprat herring and cod. You've got three, maybe four species. If one goes down, you look at salinity—blah, blah, blah…you know how much is going to be there. That's all they eat.

JW: Can that be seen as a comment on the biodiversity of those regions?

GS: Oh yeah, it's very limited. But you look at mid-Atlantic—you look at our survey, any particular survey you might catch 120 species. Most species are going to eat what's in their path. If they don't like it, they just don't eat much of it. So, like with striped bass, they'll say it's tightly linked to menhaden—it's like, no, not really. It's linked to menhaden, but it's also linked to bay anchovies, and linked to—

JW: Sand lance.

GS: Sand lance. Linked to—when they come up here, Atlantic herring and river herring and crabs and lobsters and blah blah blah…I mean, one of the best baits you can use for striped bass fishing is American eels, you know, yellow eels. How often does a striped bass encounter eels in the wild? Probably zero. Maybe in the estuary, they might come across them, but it's not—you look at the food habits data for striped bass and you don't hardly ever see eels, yet you throw it in front of them and they'll snarf it up, hook and all. I've often told people they're like Labrador Retrievers. The theory of a Lab is that it hits the floor, eat it. If it's not food, you can always throw it up later [laughter]. Bluefish, striped bass…they're similar things. You'll find rocks in their stomach, you know, they just go along and eat stuff. To put that into a model…It's hard, hard to collect the data necessary to do it, to make it generic enough. You can collect food data and say ah, this is what they're eating. That's just for that little point in time—you wait another six weeks and it won't be eating that any more. So, it's a challenge to look at it in detail, but in a broader sense it's clearly—they need prey, they need quality prey and so forth.

JW: I've got one more question for you that—it's a little bit of a historical question, but I just wanted to get your thoughts on it. When the striped bass fishing clubs in the Elizabeth Islands, on Cuttyhunk and elsewhere—I think there was a club on Squibnocket in Martha's Vineyard, and a few other places—started up in the immediate aftermath of the Civil War, they—from what I've read—experienced an abundance of striped bass which sort of helped to attract members to the clubs. But then, they closed down in maybe the early 1920s when the fish began to decrease. I was just wondering if there's any—what's the opinion of the scientific community on why that may have happened, or if it was a localized depletion, or any…what are your thoughts there?

GS: It's an interesting history because clearly from anecdotal evidence back inthe late 1800s, there was big fish around, there was records of seine hauls where there were a whole bunch of sixty pound fish came in…hundred pound stripers caught on hook and so forth. So like the Cuttyhunk club really took off—a lot of rich New Yorkers, bankers and so forth. They'd record the largest fish caught each year and you could see it decline so that by the late '20s or so, the early '30s, you are looking at a 25 pound fish would be the biggest for the season, and not too many of them. So there was clear evidence that abundance declined quite a lot, and it's probably overfishing combined with environmental—poor recruitment for whatever, probably in that case related more to river flow and so forth. Environmental conditions in some of the tributaries and rivers was horrible back then. I mean, you read accounts in the Hudson where all of the sewage and everything else was dumped right into the harbor—you'd see dead horses floating down

Hudson River, a horse would die, just throw it off the dock into the river. So, it was pretty organic, shall we say. Not necessarily --

JW: So it wasn't just the striped bass at the time?

GS: It wasn't just, yeah. Striped bass are hardy, I mean, some cases they can do alright so long as the dissolved oxygen hasn't gotten to the point where they can't get up the river. But the environmental conditions in these tributaries is probably pretty skanky. So, you likely have recruitment issues…could have been rainfall. I haven't looked to see if there are records of rainfall at the time, but clearly abundance declined—and we know that mortality was high. There was a—in the early '40s—there was a big recruitment event, like '41. By '43 there were like—nailed them. There was hardly any…no minimum size or basically whatever marketable size it was, twelve inches. A twelve inch female is two years old, and they don't start maturing until about six. They were getting them all before they hit maturity. The few survivors would keep it going. There was an interesting account—the Atlantic States Marine Fisheries Commission was really developed to protect striped bass. It was like 1941 was their first meeting in the Roosevelt Hotel in New York City. The guy that gave one of the opening talks was a well-known state biologist, state waters, and he describes the striped bass problem. At that time, they wanted to implement a twelve inch minimum size—I think it might have been twelve—and they wanted to go to sixteen inches. Oh my God, you'd think they were, you know…The commercial guys were saying you're going to put us out of business, a four inch addition so you can't get that in the frying pan, and nobody is going to buy a sixteen inch striped bass. The recreational guys are saying, you've got to stop the commercial guys because they're destroying our fishery. You fast-forward to 1994, the striped bass fishery from that '89 year class, it got to the requirement that they could reopen it. Restricted, but it was back to an open fishery. And you hear the same arguments—the commercial guys, the minimum of twenty-eight inches is going to put us out of business, the recreational guys, oh jeez, you've got to stop the commercial guys. The guys in the Chesapeake versus the guys on the coast…It's the same discussion, only different parameters around the discussion, but the same thing. So, it really became evident that—

JW: Some arguments never die.

GS: They don't. It's the same user groups and the same arguments. So, striped bass—I think the management that was imposed made it pretty evident that if you control the fishery to the point where you allow fish to spawn, make sure if their environmental condition is such that they're not spawning, that you keep on top of it and don't let it decline—but the whole resurgence of striped bass in modern times is really as much a stroke of luck as anything. You happen to have a period where there's reasonable recruitment at the same time that the management came into effect, and so the management success that they point to is successful--

JW: Helped along by other things.

GS: --yeah, but if the conditions weren't there, you wouldn't be talking about it. It's a good case study to use for good management with good luck [laughter]. You go back in history of striped bass, and they talked about it in the Pilgrim times of catching fish on a hook and blasting them in the head with a cudgel in order to subdue them and so forth.

JW: William Wood and *New England's Prospect*.

GS: The first tax in Massachusetts was on striped bass catches, basically funded the first public school.

JW: So really, we should have a golden striper hanging in the Statehouse, not the cod [laughter].

GS: Exactly, should bethatand you could still have them too [laughter].

JW: So, I guess we'll wrap things up there, and thank you very much for sharing your memories, your recollections, and your thoughts here.

GS: Yeah, it's been a fascinating time to work, a lot of changes just in my career, so I'm looking forward to seeing what happens next.

JW: Great, thank you Gary.

GS: You're welcome, thanks.