ORAL HISTORY INTERVIEW

Larry Stevens

Tempe, AZ

6 February 2017

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Interview conducted by:

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Glen Canyon Dam Adaptive Management Program Administrative History Project

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Notes	Lawrence E. "Larry" Stevens has been researching the Colorado River in Grand Canyon as a biologist and ecologist since 1974. He has been professionally involved with the National Park Service (NPS), the U.S. Department of the Interior (DOI), and the Grand Canyon Monitoring and Research Center (GCMRC). He is Senior Ecologist for the Grand Canyon Wildlands Council, through which he is actively involved in the Glen Canyon Dam Adaptive Management Program (GCDAMP). A "commercial river runner and a Grand Canyon devotee," Stevens also directs the Springs Stewardship Institute at the Museum of Northern Arizona.

Minutes	Summaries of interview content during each minute of the interview
0	**Q**: History of involvement with Glen Canyon Adaptive Management Program (GCDAMP). **A:** Stevens began doing research on Glen Canyon dam's effects on riparian vegetation in 1980 when he was a graduate student. Predecessor to GCDAMP, the Glen Canyon Environmental Studies (GCES) program, began in 1982.
1	More work and volunteer history: National Park Service (NPS), Department of the Interior (DOI), GCDAMP.
2	**Q:** What research did you work on? What are the insights or results? **A:** 20 years' research on dam effects on riparian vegetation and river shoreline habitat.
3	Studied the effects of river flow regulation (water releases from the dam) on shoreline habitats and riparian species. Became interested in endangered species while working as an ecologist for NPS.
4	Had $3 million/year budget and nine research teams at one point, researching everything from river morphology to the tiny Kanab ambersnail. Worked with both academics and policymakers to determine effects of dam on the river.
5	Came to understand that river systems are "small patches of the environment" that "support a lot of species at various times of their lives." E.g., tributary mouths are important to fish spawning, springs are "hotspots of biological activity." Stevens now runs Springs Stewardship Institute at Museum of Northern Arizona. **Q:** What were the larger purposes of some of those studies; what was the reason for doing research on impacts of the dam?

6 **A:** Stevens says, "Behind this, I'm also a commercial river runner and a Grand Canyon devotee." He is inspired by landscape, love of the land. Stevens says, "The impact of the dam on this largely wilderness landscape is just really very intriguing because it's such a social circus. So many voices, so many perspectives . . . it's become the most intensively studied river on Earth." All of these differing worldviews result in a "marvelous social environment" that Stevens is honored to be involved with.

7 **Q:** Did any of your research lead to management decisions that made a difference in ecological conditions? **A:** Absolutely. Points out that the GCDAMP scientists are advocates for one thing only: good science. The topics scientists choose to pursue, though, have an impact.

8 Points out that his published research has affected policy. **Q:** Much of program funding goes to research. How well has GCDAMP integrated scientific research with adaptive management?

9 **A:** Interesting evolution: "shotgun approach" to understanding of system at first. Length of the Environmental Impact Study (EIS) process effectively moved the program from the Reagan to the Clinton administration. Stevens states that very little was known about the Grand Canyon river environment before the EIS.

10 Explains some issues of applying existing research to understanding of the entire river: the mathematics, modeling of flow and sediment transport. "All of that had to be discovered in this system in a very physical way . . . how do you measure that?"

11 Had to develop new measurement technologies. Stevens says the seminal role he played in this process was exciting. Gives an example--how sediment transport is affected by variations in flows--of how discoveries create a starting point for adaptive management decision making.

12 The Colorado River is the best-managed in the world in terms of understanding sediment/flow relationship. **Q:** Can you step back and give us an idea of the larger goal of the GCDAMP, why it was created?

13 **A:** "Do you want the politically appropriate soundbite, or the real reason?" The real reason: to prevent river management from falling into litigation. Bring stakeholders together, facilitate communication, prevent lawsuits. Facilitates delivery of power and "maybe to some extent helps with the continuity of the environmental management issues." **Q:** In what way does the existence of the AMP eliminate the likelihood of litigation? **A:** In the early 1980s decisions were made in a "closed door process." Decisions were made, revealed to the public, and the public had two options: accept decisions or sue.

14 U.S. Bureau of Reclamation (USBR) decided to "rewind" the dam generators in 1981 or 1982 [to improve hydropower generation capacity and efficiency]. Wide daily fluctuations in the flow of water from the dam created an unnatural river environment and problems for river runners. River runners contacted wealthy past clients, many of whom expressed their concerns. Secretary of Interior (SOI) James Watt responded to this pressure by authorizing an EIS process (as detailed in Minute 9).

15 "Created a context for public involvement" in dam operations and river management. Hard to sue the government in these circumstances because public is part of the rulemaking/advisement process. "The purpose of the GCDAMP is to advise the Secretary of the Interior on how best to manage the dam." **Q:** So in a sense you're saying the project is as much about generating knowledge to inform decision making as it is about democracy, public engagement and conflict resolution?

16 **A:** Yes. However, the public policy aspect has two sides. Stakeholders have agendas that they do not fully reveal; so does the federal government: "more politics than water in the Colorado River." GCDAMP helps to limit that conflict. In early days "we actually had one of the stakeholders banging his shoe on the table;" now stakeholders have gotten to know one another and all can air their concerns.

17 **Q:** Do you feel GCDAMP has successfully engaged stakeholders and generated scientific research information to improve river system management? **A:** The science is "stellar," although neither complete nor as farsighted as it needs to be. Only beginning to understand the complex Colorado River system. On the "social side," getting to know stakeholders--tribes, federal agency staffers--has been great.

18 Major decisions on "whole suites of policies" are the real test of the program. The second EIS, assessing 20 years of the GCDAMP, was just completed. Maintains the status quo, not pleasing to some stakeholders.

19 Federal bureaucracy resistant to changes in operations. **Q:** You said the science has been "stellar." In your mind, has there been any science that should have been done, that you or others wanted to do, that has not been accomplished? **A:** Much. What has been done is world class and has been applied to river management. Still do not understand how the river ecosystem works. "These are questions that will take decades, if not centuries, to really answer."

20 Need to research topics like nutrient dynamics, especially pertaining to how Lake Powell affects the river. No predictive model for understanding how the dam affects development of riparian vegetation.

21 Need to assess recreation needs alongside ecological ones, especially regarding beach erosion. Hydropower stakeholders resist releasing flows for experimental purposes. Stevens details this reluctance and its effects.

22 Hydropower interests agree to only small experimental floods--not exceeding 45,000 cfs [cubic feet per second]--but "there are big questions that lie just beyond that envelope of flow that we can't address."

23 Important to understand the species in the river system, and not only the endangered ones. Information on the river's biodiversity must be compiled--a huge task with little funding.

24 Recent discovery of new species in the river corridor. GCDAMP does not pay attention to this avenue of research/understanding. **Q:** If you were to periodize the GCDAMP effort since 1980, what would be the key periods and moments of transition? **A:** Stevens makes clear that he started studying the Colorado River in 1974. 1974-1976 was first ecological inventory of the river.

25 Beginning to see the effects of the dam in the 1970s. Impact of non-native species first described in 1970s. This research led by Steven Carothers. One step before that, in 1969-1971, there was a dramatic increase in people visiting the river. Went from a few hundred people visiting the river corridor in mid-'60s to 20,000 in 1970.

26 Identified fish species. Took photos that could be compared to historic counterparts. In the early '80s, Lake Powell became full for the first time: marked "the future of water management in the Southwest." Around 1982, USBR proposed adding turbines to the spillways and rewinding generators (to increase hydropower generation). It captured public notice and protest.

27 Public concerned about degradation of the canyon. 1982-83 snowpack largest in 100 years, overfilling Lake Powell and nearly taking out the dam.

28 Large snowpack result of El Niño year and volcanic eruption. GCES Phase 1, 1983-87. Phase 2, 1988-91 (maybe 1995). Stevens describes the research in each phase.

29 1992 Grand Canyon Protection Act (GCPA) required that dam operations not degrade the Grand Canyon river corridor. 1995, EIS finalized; 1996, ROD (Record of Decision) was signed. Set stage for AMP to begin.

30 GCDAMP established in 1997 and ran for 20 years, amassing a high-quality body of research, especially on applied issues like managing river for sediment, managing endangered humpback chub. Second EIS, setting the stage for the next 20 years of management, was just signed two months ago [Long-Term Experimental and Management Plan (LTEMP) EIS; ROD signed December 15, 2016]. Those are the main stages in the adaptive management program.

31 Every year there was a new ecological surprise. Arrivals of new species, such as bald eagles in 1983--feeding on fish and occupying the river corridor. Because they were endangered at the time, inspired a wave of studies.

32 Just before this, peregrine falcon population in canyon increased. In 1976 only 4-6 nests in the canyon, by 1985 there were more than 100 pairs. Ducks another surprise--no mallard duck breeding in the river before 1982. Now common.

33 More recently, non-native species have arrived, especially mollusks. Such surprises mean "the ecosystem tracks off in some other direction" not previously anticipated.

34 The dam's effects on river temperature are a topic of management debate: what is the right balance between maintaining native and endangered species and discouraging invasive species? **Q:** Has there been a change in how GCDAMP participants have thought about the effort to reshape the Colorado River ecosystem?

35 **A:** Each stakeholder group has a bias. Current LTEMP focuses on sand and humpback chub, only two out of the many resources that could be monitored in the river.

36 Because of this focus, the GCDAMP does not pay attention to the many other "important drivers" of the river system situation. [At this point the recording is stopped for a break. When it resumes, interviewer gives Stevens a preview of the remaining questions.]

37 (Preview of remaining questions for interview)

38 **Q:** You mentioned changes in science and changes in management. How about changes in the social environment of the program over time? **A:** At its beginning the program was internally directed, closed, and information about dam management was not available to the public. Only when public comment was sought on the generator rewind did the public find out about changes in flow and have a basis for expressing concern--the incident that "led to the entire [adaptive management] program."

39 "Engagement of the tribes was also quite challenging for the managing agencies." They are sovereign states/nations; they were not apt to negotiate with each other. Determining which tribes held the Grand Canyon "as a key feature of their culture" was important.

40 "Several of the tribes have Grand Canyon as the place of their emergence into this dimension." Before GCDAMP, there was no way to engage tribes on management issues. **Q:** When were tribes brought into the stakeholder process**? A:** GCES Phase 1, led by David Wegner; "he pretty much single-handedly turned the battleship of the Bureau of Reclamation 90 degrees to bring it into an open social process, active science, tribal engagement, and a dialogue about how to manage, rather than a monolithic, in-house kind of effort."

41 Wegner managed the GCES program from 1982-1997. As a result of engagement, public is learning about tribal values, which are "quite different from the management values that are held by any other stakeholder group." Other shifts: transition from GCES to GCDAMP was "quite challenging."

42 David Garrett became Grand Canyon Monitoring and Research Center (GCMRC) chief. GCMRC shifted from DOI to U.S. Geological Survey (USGS) office around 2000. People and agencies dispersed through the Southwest began talking to each other about determining and mitigating dam impacts.

43 **Q:** Why was the transition in 1997 disillusioning to some people? **A:** "Because it was a pretty open, free-wheeling program up to that point."

44 It became "constrained after 1997" first by DOI, then by USGS. Now GCMRC is a "highly bureaucratized information management system." **Q:** What did you learn over the many decades you've been involved in the program: the science, the management/decision making, and the social aspect?

45 **A:** "The three legs of the adaptive management stool are policy, science and social process." Policy: Stevens had just finished his Master's degree when he started researching Grand Canyon and did not know how government agencies work. DOI houses the NPS, which "defends the integrity of natural landscapes," and also the USBR, which managed the dam and "the marketing and making money off of the process." DOI also houses the Bureau of Indian Affairs (BIA) and U.S. Fish and Wildlife Service (USFWS). These agencies have diverse and conflicting mandates.

46 This management system is hard to learn, communication up the "food chain" is difficult. Informative to see "how conflicts get either resolved or swept under the carpet." Science: Stevens is much more comfortable with the science leg. The ways ideas are formulated and shared, and sometimes "stolen" by other agencies. "Intellectual property is not really respected much in these kinds of discussions."

47 The way ideas are discussed and become areas of study makes good sense within the program. Some scientific surprises: one example is wood debris behavior during river floods.

48 Currents in a flooding river circulate from the center of the river, along its bottom, to its shores, perpendicular to the river's flow. This countercurrent circulation pattern develops at a certain threshold and is why debris accumulates in the center of a flooding river. [Stevens demonstrates this in the interview with hand motions.] This trait was quantified and measured for the first time in Grand Canyon. **Q:** Can you think of any others that you want to note? **A:** "Science is really this debate about the nature of reality, but the other side of it is it's a personal exploration of our biases and our beliefs."

49 "When something goes against your beliefs and yet the data conclusively show you that you're wrong, or just misguided, then it's the role of the scientist to actually accept that information and see what that means, and explore it." Humpback chub an example of a major management dilemma. In Grand Canyon, they spawn in tributaries and springs; in other locations, they spawn in the mainstem.

50 A bias of the GCDAMP is trying to manage the river to support humpback chub, even though they actually breed in the tributaries, which aren't managed under the program. Rainbow trout a related issue. Usually prey on insects and shrimp but sometimes eat humpback chub larvae.

51 A main scientific dialogue of the GCDAMP is movement of rainbow trout from upper to lower river areas and whether they pose a threat to humpback chub. Discussion has continued for 30 years without resolution. One of the few lawsuits concerning the GCDAMP ended with a judgment that there was no relationship between presence of rainbow trout and the endangerment of humpback chub.

52 The rainbow trout are non-native, but highly valued by sportfishers on upper portion of river and critical to some livelihoods. **Q:** Would it be accurate to say that the discussion about trout predation went on for so long due to conflicting stakeholder interests and their separate scientific study concerns?

53 **A:** Biases on the part of both groups influenced the way research was conducted. Many agencies conducting separate research on species. Each has ingrained biases that inform actions and that are hard to change, even when research erodes the suppositions on which they stand. Stevens points out that while rainbow trout have no demonstrable negative effect on humpback chub, brown trout do.

54 One of Stevens' professional disappointments is that an in-field lab has never been set up at Lees Ferry to conduct flow experiments. Social Process: Realization that every person involved in the program is trying to do their best.

55 Everyone involved serves a constituency and wants their interests well-represented. There is no good or bad, no enemies, no irreconcilable differences. Everyone is working hard to ensure that the GCDAMP works.

56 **Q:** Which documents and works are particularly important, set a historical precedent, remain relevant? **A:**

- In the pre-GCDAMP literature, Woodbury 1959, an important first look at the ecology of the river system [Angus Woodbury et al., "Ecological Studies of the Flora and Fauna in Glen Canyon," University of Utah Anthropological Papers, no. 40 (1959): 1-229].
- Stanton 1890, photographs of 100 years before the current era of flow management [The New York Public Library Digital Collections, "Robert Brewster Stanton Papers, 1851-1960, Series VI. Photographs," accessed August 14, 2017, https://digitalcollections.nypl.org/collections/robert-brewster-stanton-papers-1851-1960-bulk-1890-1950#/?tab=navigation&roots=2:7c8a2990-c5bf-012f-1467-58d385a7bc34].

57 Key documents continued:

- Carothers et al. 1976, ecology of the Grand Canyon river corridor [S.W. Carothers and S.W. Aitchison, ed., "An Ecological Survey of the Riparian Zone of the Colorado River Between Lees Ferry and the Grand Wash Cliffs, Arizona," Grand Canyon National Park Colorado River Research Series Technical Report No. 10 (Grand Canyon, Arizona: Colorado River Research Program, U.S. Department of the Interior, 1976), accessed August 14, 2017, http://www.riversimulator.org/Resources/NPS/GCresearch/1976no10riparian.pdf].
- Turner and Karpiscak 1980, pre- vs. post-dam ecology [Raymond M. Turner and Martin M. Karpiscak, "Recent Vegetation Changes Along the Colorado River

Between Glen Canyon Dam and Lake Mead, Arizona," Geological Survey Professional Paper 1132 (Washington, D.C.: U.S. Government Printing Office, 1980), accessed August 14, 2017, https://pubs.usgs.gov/pp/1132/report.pdf.].

- Dolan 1981, effects of the dam on river geomorphology [Alan Howard and Robert Dolan, "Geomorphology of the Colorado River in the Grand Canyon," *The Journal of Geology* 89, no. 3 (May 1981): 269-298, accessed August 17, 2017, https://erode.evsc.virginia.edu/papers/howard_dolan_grnd_cyn_81.pdf.].
- Final reports for GCES Phase 1 and 2, which are "loaded with insights from the shotgun science approach . . . how these many different topics are beginning to play out." [Links to the reports written during GCES, accessed August 14, 2017, http://www.riversimulator.org/Resources/GCMRC/GCEShyperlinkedByAuthorYear.pdf.]

58 Key documents continued:

- Grand Canyon Protection Act of 1992, requiring that dam operations not negatively influence the river.
- EIS 1996, compendium of information in one document for setting up GCDAMP.

59 Key documents continued:

- State of Knowledge of Grand Canyon 2005 [exact title does not match but this report matches Stevens' description: Steven P. Gloss, Jeffrey E. Lovich, and Theodore S. Melis, ed., "The State of the Colorado River Ecosystem in Grand Canyon, A Report of the Grand Canyon Monitoring and Research Center," USGS Circular 1282 (Reston, Virginia: U.S. Geological Survey, 1995), accessed August 14, 2017, https://pubs.usgs.gov/circ/1282/c1282.pdf]
- USGS PEP reviews [USGS/GCDAMP Protocol Evaluation Panel (PEP) reviews, http://gcdamp.com/index.php?title=PEP_reviews]
- Melis and Lovich 2005, overview of adaptive management outcomes [Jeff Lovich and Theodore S. Melis, "The State of the Colorado River Ecosystem in Grand Canyon: Lessons from 10 Years of Adaptive Ecosystems Management," International Journal River Basin Management 5, No. 3 (2007): 207-221, accessed Aug 14, 2017, https://www.gcmrc.gov/library/reports/Adaptive_management/Lovich2007.pdf]

60 LTEMP EIS 2016, summary of adaptive management outcomes. There are tens of thousands of reports on this most-studied river in the world; hard to go through all of the material, which has an impact on management.

61 **Q:** What do you think the value of the program has been, and is today? **A:** Understanding of adaptive management in the 1970s: ecosystems are too complex for humans to be able to manage them. Do experiments and either proceed or reverse course based on outcomes.

62 But this is not really how GCDAMP manages. Its strategy is based on how to balance stakeholder concerns rather than on how the ecosystem is functioning. Stevens would prefer, as an ecologist, to see extraction of services based on the abilities of the ecosystem to provide them, but the current model does not provide for that. He hopes that good stakeholder management will result in care for the ecosystem.

63 "This is probably the most successful adaptive management program in the world." Stevens emphasizes as a success the fact that tribes have a voice in the process and steer it in the direction of regard for the ecosystem.

64 Indigenous information has especially influenced fisheries management.

65 For the GCDAMP to be successful one has to "sit in the chair" [at AMWG and TWG meetings]: for two days every two or three months, stakeholders must listen to each other and try to convince others of the relevance of their own agendas. Requires diligence. The program has also generated a great deal of information about the management of a "geologically constrained river."

66 Provides insight into the characteristics and management of other deep river canyons around the world, most of which are endangered. Success also depends on the SOI being active in the program.

67 The program suffers when the SOI is "weak or uninterested." **Q:** Can you think of examples in the past when that process has broken down because of such a situation? **A:** Yes, many. Interest from the SOI is a direct reflection of the U.S. President's interest in these complicated programs.

68 Results in stakeholders not being effectively guided; this was the case in the first 8-10 years of GCDAMP. Stakeholders fixated on their pet interests without regard for other aspects of management. Like "starting to build a house not from the foundation, but from the third floor, and trying to understand what the house is going to look like by the time we get to the ground."

69 **Q:** A personal question about all of this. Why have you remained involved in the program for so long? **A:** "The deep appreciation and attachment to Grand Canyon is what drives my interest in the program." Learns from GCDAMP participants and river raft passengers; "even with the simplest questions I learn more about my relationship to Grand Canyon".

70 "It's a continually enlightening exercise to pursue this." Stevens does much of his work pro bono. **Q:** What are the program's failings or limitations? How would you like to see those resolved or addressed?

71 **A:** It is not necessary to subject the river to experiments, but some stakeholders are averse to relying on modeling for answers. Equalization flows from Lake Powell to Lake Mead are an example.

72 Models can tell operators the optimal flow conditions for minimization of sediment transport, but hydropower interests are resistant: they feel their ability to deliver product could be limited by more accurate information.

73 **Q:** Can you think of pathways for resolving that shortcoming in the program? **A:** It would take strong DOI leadership--they are resistant to changes in their management priorities. They are still wary due to major changes in their control over flows resulting from the 1996 EIS.

74 Stevens wanted to use models to test different flow regimes--such as running hydropower production on alternate days to disrupt wave patterns and preserve sediment--but this idea was strongly rejected by DOI.

75 Disappointing because modeling is a non-invasive tool for figuring out the balance between extracting resources and maintaining the ecosystem. **Q:** Can you reflect on which administrations have been most effective at advancing the GCDAMP which have been not as effective?

76 **A:** Bruce Babbitt and Ken Salazar provided strong support and effective Secretary-designees [the liaison between the SOI and the GCDAMP]. [Stevens recommended that one past designee, Anne Castle, be interviewed.]

77 **Q:** Lakes Powell and Mead are at historically low levels and some advocate emptying Lake Powell and/or dismantling the dam. What do you think of that, and how would such action reflect the legacy of adaptive management in Grand Canyon? **A:** "I deal with this question every day. Every day." Glen Canyon Dam was built intentionally near the boundary of the Upper and Lower Colorado River basins.

78 The boundary is just downstream of Lees Ferry. "It is probably the most politically important point in the Southwest." The 1922 Colorado River Compact requires that a certain amount of water flow past Lees Ferry each year, from the Upper Basin into the Lower Basin.

79 Stevens explains reservoir capacities and sedimentation timelines for Lakes Powell and Mead.

80 Many proposals to allow Lake Powell to dry in favor of keeping Lake Mead filled have been floated, but this would cause an ecological problem: Glen Canyon Dam is a barrier keeping upper river non-native fish and accompanying diseases out of the lower reaches of the river that would almost certainly wipe out native fish in Grand Canyon.

81 Native species in the Upper Basin are already greatly threatened by catfish and other non-native fish. Cataract Canyon is upstream of Lake Powell and functions like a wild river. Emulates conditions that used to exist in Grand Canyon: fluctuating and unpredictable flows, lots of sediment, warming water in summer and ice cover in winter.

82 Cataract Canyon is a cautionary story: few native fish, little shoreline viability. "If we were to restore those conditions in Grand Canyon it would be a disaster." The bias "if we are good environmentalists" is to restore natural conditions, but this counterintuitively would result in the loss of much biological diversity along the river in Grand Canyon.

83 It is a challenge to get these points across: what seems good and right compared to what is actually best for the system as it currently exists.

84 **Q:** There is a conservation dilemma: adaptive management seeks to restore some natural function and lost characteristics of the river, but in some instances it can't go back; there are serious challenges to letting nature take its course. Can you reflect on how we should understand these twin goals of preservation and restoration in a real river, not just as a set of ideals?

85 **A:** A 1998 paper by Stevens and Jack Schmidt lays out the achievable goals of adaptive management. [Schmidt jC, Webb RH, Valdez RA, Marzolf GR, Stevens LE. 1998. Science and values in river restoration in the Grand Canyon. BioScience 48: 735-747.] These questions require careful valuation of resources.

86 "If we want to keep humpback chub as a species on Earth," the canyon needs to be managed to that end. After 30 years of research, scientists still don't know all the answers. "There's been about half a billion dollars spent on ten thousand fish. So far. A huge amount of money has been spent trying to keep humpback chub in the picture." In the meantime, species are being lost: the southwestern willow flycatcher, and "quite a few that aren't listed--85 taxa by my count." These endangerments and losses are mostly due to "dam presence and operations."

87 What are our values for species, for resources, for outdoor experiences for the public, for hydropower and water delivery? "Balancing those out in a coherent framework is the challenge of the program." Native American concerns combine resource concerns with spiritual concerns. Fast change is what humans are really good at. Make a quick policy decision: "We'll take out a dam! Or build a dam!" These decisions have enormous impact on nature and on social context. Humans are not good at stepping back and saying, "Let's study this for a couple of decades" so that we can understand consequences.

88 A case in point is the temperature control device [TCD]. "OK, let's build it," and they came close to doing that. The thing is, "you can't necessarily go back. That's the issue. Just as we can't recover our own youth, we can't go back to where we were when we were teenagers or whatever, you can't simply take away something that's been constructed in an ecosystem and have the ecosystem return to...its natural condition. There are always consequences." Warming the water to benefit one species can take the ecosystem in a whole different direction—e.g., crayfish invasion.

89 Decisions need to be based on the current situation, not a preferred or imagined alternative. "The hard work of accepting that we've got an altered ecosystem." **Q:** If we can't always preserve or restore species or conditions, what is it that the GCDAMP is, or should be, preserving or restoring?

90 **A:** There is little guidance on what should be achieved. Right now it's driven by policies of different agencies. The NPS especially is supposed to focus on preserving natural states; "it has no capacity to manage an altered condition." Problem is that sometimes NPS equates doing nothing with fulfilling its mandate.

91 Explanation of why this can backfire re: riparian vegetation.

92 Are we willing to accept our role in this human-dominated ecosystem as managers? Many existing policies conflict with this reality. **Q:** Instead of managing for restoration, are there other concepts that can guide the GCDAMP in this situation?

93 **A:** Refers again to Stevens, Schmidt et al 1988. Working with valuation process described in Minute 87.

94 "We're getting there whether we want to or not, and we don't understand where we're getting to. But at least we've got some framework for understanding, as changes are happening, what those changes are." **Q:** Are you hopeful? **A: "**Always. Always. Because I get to study natural history and evolution, that gives me long-term hope." Things will be different in the future. Stevens tries to work against losses of species: "to me, any human-caused extinction is a crime . . . That's one way I proceed in life, is to try to make sure that nothing goes extinct that I have some kind of power to prevent."

95 **Q:** Could you give us some key words that are significant to the program?

96 (Response to the above.)

97 **Q:** Is there anything else that you would like us to ask you? **A: "**I think you've hit on most of the topics. Hope is important in this program. It would be interesting to know [soft laughter] how hopeful some of the next interviewees are on this."

98 **Q:** Who else do you recommend we interview? **A:** Dave Wegner--critical to understanding pre-AMP management. The tribal representatives, none of whom, Stevens notes, are themselves Native American: Mike Yeatts--Hopi representative. Kurt Dongoske--Zuni representative. Kerry Christensen--Hualapai representative.

End of interview.

Glen Canyon Dam Adaptive Management Program Administrative History Project

Oral History of Larry Stevens [LS]
In Phoenix, Arizona

Interviewers: Paul Hirt [PH] and Jennifer Sweeney

February 6, 2017

[00:00:00]

PH: We are interviewing Larry Stevens, one of the members of the Glen Canyon Dam Adaptive Management Program and there will be a series of questions starting with: during what years, Larry, were you involved in the Glen Canyon Dam Adaptive Management Program and in what capacity?

LS: As graduate student in 1980 I began researching riparian vegetation in Grand Canyon and in 1982 the predecessor of the Glen Canyon Dam Adaptive Management Program began. It was called the Glen Canyon Environmental Studies Program; in two phases, one phase started in 1982 that ran until the end of 1987, and then 1987 until 1990 was GCES 2 [Glen Canyon Environmental Studies phase 2]. As a grad student I was studying the effects of Glen Canyon Dam on riparian vegetation in Grand Canyon. And that put me in a kind of interesting place because as this large environmental program was initiated by the Department of Interior, I was a student of riparian ecology and shoreline ecology and the river. And I was able to run quite a few projects and get quite a bit of support for my graduate studies through the program. I worked then for the National Park Service after my Ph.D. I became a volunteer and then an employee of the Department of Interior. In the later phases of the GCES Program, [I] took a hiatus of about 3 years or 4 years and then began as a representative for environmental purposes, environmental voices on the present-day Glen Canyon Dam Adaptive Management Program. We call it the AMP. So, since 2004 to the present, I have been on the AMP as both a technical representative and as a full representative of the program.

[00:02:06]

PH: While you have been involved in the program all of these decades, what research or projects did you work on and what do you think you were able to come to understand [as far as] insights or results from your research?

LS: It's a long list of projects. I started out working on riparian vegetation and pursued that for almost 20 years, in terms of the research, looking at the effects of the dam on vegetation. Riparian vegetation is valuable to wildlife and recreationists and many other interests so there is a lot of interest on how the river effects the shoreline habitat. Those projects and papers range from the natural history of individual species, some native, some non-native species of vegetation along the

river, to river ecology as a kind of grand scheme, understanding how flow regulation affects the distribution of shoreline habitats and what that means in terms of germination [and] propagation of vegetation. In the middle of that, I became a Park Service employee and became interested in the endangered species on the river and what impacts of the dam were on those endangered species. And that precipitated a whole series of studies on endangered bald eagles, peregrine falcons, humpback chub, Southwestern Willow flycatcher, a funny little snail we call the Kanab Ambersnail, and those studies also each of those were multi-year efforts with many individuals. As a Park Service ecologist for Grand Canyon, what I did was coordinate teams of researchers. At one point, I had a $3 million a year budget with nine different teams doing research on everything from geomorphology of the river and the effects of the dam on those topics through very detailed studies on a life history of a snail and pretty much everything in between. So very coarse scale to fine scale analyses and played a role then in how the decisions about those resources in relation to dam operations got made. With a whole team of really wonderful researchers to work with there, both academics and policy people.

[00:04:39]

Let's see, those studies gave way to larger-scale studies about how rivers function so that precipitated more interdisciplinary research and I have been pursuing that for the last twenty years. But [I] also began to understand that these rivers systems are really fed by small patches of the environment and those small patches of the environment are quite interesting because they might do a lot of the uh… might support a lot of the species in various times of their lives. For example, tributary mouths are very important for fish movement in and out, fish spawning and what not. Springs along the river is also very important as hot spots of biological activity. And that precipitated a whole wave of studies and now I run an organization called the Springs Stewardship Institute of the Museum of Northern Arizona in Flagstaff. That has blossomed into a global inquiry into the ecology and improving stewardship of springs. I bring some of that expertise to the table as a representative of the Adaptive Management Work Group.

[00:05:54]

PH: Can you tell me a little bit about what you think the larger purpose of some of those studies was? What was reason for doing all of that research on the impacts of the dam on, say, riparian vegetation, or springs, or beaches?

LS: Yeah. So, behind all this I am also a commercial river runner and a long time Grand Canyon devotee. So it is the landscape that inspires me most. So it's the love of the land that really captures that attention. And from that larger perceptive on landscape the impact on the dam on this largely wilderness landscape is just really very intriguing because it's just such a social circus, so many voices, so many perspectives, and over the decades has become the most heavily studied, most intensively studied river on earth. Getting to interact with all those people, each with their own very particular worldview about how things work, it's a marvelous social

environment to be able to engage in, try to improve understand of, and work for the protection of it.

[00:07:10]

PH: Did any of the research that you do lead to any management decision making that made a difference in those ecological conditions that you care about?

LS: Absolutely. As scientists, we are not advocates. We are, we are… except for advocates for good science. However, the topics that we choose to pursue do eventually have an impact in some cases. So, emphasis on the riparian zone, emphasis on the role of many, many different meetings where I have participate in where some theme would be taken up and so I would have the opportunity as scientist to say, ok what do we really know about that, how can we get… how can we improve enough of what we want know about it to be able to able to model it and predict what, say, dam impacts are on that given resource, whether it's sand distribution or the shape of sand bars over time or the arrival of unexpected species in the landscape and how the dam will affect their populations over time. So, it's weaving all those things together. Many of the things that I have studied have been published and are cited so the decisions that get made about those topics often are falling back on the research I did then.

[00:08:34]

PH: So, much of the funding of the program goes to funding research so that we can have a more solid knowledge foundation for making adaptive management decisions about dam operations. How well do you think the program, over time, has integrated that scientific research with adaptive management? They're two different things and could be integrated well or not-so-well. What's your opinion on that relationship over time?

LS: So, an interesting story there, an interesting evolution there, is that when we began it was a shotgun approach to understanding the system. The Secretary of the Interior said, "I don't want this issue on my table. Here's some money, get it out of my administration." Of course, that worked out quite well. It took eight years for that to become an environmental impact statement, the second largest in the nation's history. It took it completely out of context of the Reagan administration and put it into the Clinton administration. So that Secretary solved his problem by throwing money at it. But initially there had been literally no inventory of most of the Canyon environment. It is a huge environment. So we really knew almost uh…very little about it. We had some very good early studies on some of the flow [of the river] and how flooding happened. In 1945, Eddie McKee did a really wonderful paper on how a flood works. Well, so if you are trying to measure flow, the floor of the river drops as you are measuring, as the flood comes through, because the materials are being scoured out and therefore your flow measurements have to keep in contact with a changing river as they are going through. Great information. OK, how do you implement that in an almost 300-mile-long river to understand how flows are moving through? What can you and can't you actually get to understand given the standing of the mathematics and the modeling capacity for understanding flow and sediment transport?

[00:10:46]

All that had to be discovered in the system in a very physical way: how beaches are changing through time. Well, what do you use for…how do you measure that? Some of the earliest measurements were simple survey transects from a point on a beach, OK maybe you had three transects from one point on a beach. That is not really that much information in terms of how the whole system is changing. And so, expanding that network of places that are being monitored, developing technologies that can actually allow you to map the entire surface of the beach and the floor of the river because everything is changing after a flood moves sediment moving through, all that had to be discovered here. And I got to play a pretty seminal role in figuring some of that stuff out so that was exciting. In terms of the management decision making associated with that, various analyses exist but one of the most popular one is to log transform the flow and the sediment transport relationship which is a power function. When you do that, of course, you get these beautiful straight lines but if you kind of break that data apart, de-transform those data you get this incredible scatter of points. But in doing that, what we discovered is there's a point at about 20,000-25,000 cfs, which is the upper level of dam operations, that really starts to bump sediment out. Ah, okay, there's a starting point for making decisions about flow regulation and how fast the flow fluctuates also plays a role in how much sentiment is brought into the water column and shunted out.

So, discovering those elements and working with people that had the mathematic skills to be able to put those stories together gave us a way to begin to manage the dam. Literally, this is the best managed river now in the world in terms of understand how flow and sediment interact.

[00:12:45]

PH: Can I ask you step back and give us concisely a broader perspective on what the larger goal of the Adaptive Management Program is? What's the whole point of having created this AMP?

LS: You want the —?

PH: A soundbite.

LS: —the politically appropriate soundbite or the real reason?

PH: Let's have both.

LS: The real reason is to prevent river management from falling into a lot of litigation. The real purpose of the program is to bring stakeholders together and have them communicate with each other to prevent lawsuits from happening. That helps facilitate the delivery of power and maybe, to some extent, helps with the continuity of the environmental management issues.

[00:13:41]

PH: In what ways does the existence of the Adaptive Management Program eliminate the likelihood of litigation?

LS: When we began in the early '80s this was a closed door process. Decisions would get made, they would get thrown out to the public, the public could sue the government about some of those decisions. The big brouhaha happened when the Bureau of Reclamation in 1982, 1980/1982, decided to rewind the generators and up the flow fluctuation going through the river. This is a system that had daily tides of more than fifteen feet moving through the river. So it was an incredibly unnatural, bizarre environmental transition to subject this river in the middle of a wilderness to. By that time, let's see, by the early eighties, probably 200,000 pretty wealthy Americans had gone through the river on river trips and when their guides wrote them and said we need to slow down this flow fluctuation story and limit that to protect the beaches of Grand Canyon a lot of people responded. And that's the original decision that the Secretary of the Interior, James Watt, was responding to in 1982. [Suggesting Watt's intentions] "well let's throw some money at this and get it out of our hair."

[00:15:02]

So, by having… that culminated in an Environment Impact Statement in 1990, 1995, and created a context for public involvement. And now, any member of the public can go to the meetings. Any of the stakeholders can sit in on the meetings. They are fully apprised of all the information available. They play a role in terms of voting on different issues that may come up in terms of dam management, and if you are involved in that process it's pretty hard to sue it, to sue the process, to sue the government for it, because you've been a part of the rule making, part of the advisement to the Secretary. The purpose of that Adaptive Management Program is to advise the Secretary of the Interior how best to manage the dam.

[00:15:51]

PH: So, in a sense, you're saying the project is as much about generating knowledge to inform decision making as it is about democracy, public engagement, and conflict resolution.

LS: Yes. The public policy part of it has two sides though. Because every one of the stakeholders has an agenda that they don't fully share and the federal government of course has an agenda that it doesn't fully share, but because this is such a controversial river—there's more politics than water in the Colorado River—as you know. On all sides, there are agendas that are being pushed, many of which conflict directly with each other. There is lots and lots of conflict here. So, to limit that conflict, it has become an open process with many stakeholders that no longer have to bang their shoe—we actually had one of the stake holder bang his shoe on the table. These folks don't have to do that anymore. They actually have gotten to know each other, communicate with each other, to some extent, and they have a context for being able to air their concerns.

[00:17:12]

PH: So it's your feeling that it has been overall a successful effort at engaging stakeholders and generating information from scientific research to help improve the management of the river system?

LS: Yes. I would say that the science is stellar. Not complete by any means and not fully far-sighted enough yet, but quite extraordinary scientific achievements in beginning to understand this incredibly complex, big river system. That part of it has been quite successful. The social side of it has been fabulous to get to know all the different stakeholders, the tribes, the federal agency folks, different departments—the Department of Energy plays a role here—so it has been quite great to be able to engage socially with those folks and really just better understand their points of view. The real test of the program, however, comes when major decisions are made on, uh, on whole suites of policies. So, we just completed the second EIS. After the twenty years of the Adaptive Management program we just completed the second EIS. Was that a smooth process? I don't think any of the stakeholders were completely pleased with the outcome. It maintains the status quo—which is not too surprising—but the ability for any the scientists or the policy folks to actually really push a shift in policy was pretty limited. So that was informative. The resistance that the federal bureaucracy has to changing the way operations are done was informative. That hasn't changed all that much I don't think.

[00:19:13]

PH: So you said that the science has been stellar so that leads to my next question. Has there, in your mind, been any important science that should have been done that you wanted to do or you wanted other people to do that has not been accomplished yet?

LS: Much. Much. The quality of the science that has been done has been quite applied, a lot of it quite applied, how do we manage the dam for flow and sediment. That information is world class. There is no other river with this level of understanding and of monitoring to support that. Does that mean we understand how this ecosystem works? No, not even…not there yet. These are questions that will take decades if not centuries to really answer. Things like the nutrient dynamics. They created Lake Powell, the nation's second largest reservoir, in the 48 states anyway, second largest reservoir, a huge body of water, 180 miles long, and the nutrient dynamics that are going on in the reservoir affect the downstream river. And we are just beginning to piece some of that story together. It is a big question. We have monitoring data, [but] the scientists that are hired thorough the U.S. Geological Survey have not been ecosystem scientists for the most part. Therefore, we don't get these big issue questions like: OK, we have got an ecosystem that's responding over long periods of time to modified nutrient inputs and we don't know about that yet, so there is a big arena there still to be opened up. To my disappointment, because I left the riparian world, riparian vegetation world, after working on it for twenty years, we don't have a model of how the dam affects, a predictive model where we can understand how the dam affects the development of riparian vegetation. That is too bad. That is something that's been quite important because as vegetation grows up in a very profuse way on the beaches, it begins to crowd campers; the vegetation takes over the camping areas.

And so, what's the right way to manage that vegetation with flows of the dam. It's also been a situation in which the um… (pause) …there's a lot of resistance on the part of the water and power components to releasing flows for experimental purposes. Through brute force, over the last twenty-five years or so, managed to institute planned flooding in the river. But these are small floods they only run up to 45,000 cfs which is the total output of the dam, not the spillways, and there are big questions that lie just beyond that envelope of flow that we can't address, haven't been able to address experimentally yet.

[00:22:28]

PH: Ok I think we need to break here since it is two o'clock. And the next interview is coming in the next two minutes.

LS: Ok.

Staff: (They are coming in at 2:15. So if you want to continue or if you want to go have lunch—so you decide.)

[00:22:45]

PH: Let's continue for ten more minutes.

LS: Let's see I have more to go with [more to say about] "what hasn't been done yet." I represent an environmental voice on the Adaptive Management Work Group and a scientific environmental voice. For me it is important to see what species we have in that river landscape. Not just the fish, some of which are endangered that attracts all the policy attention, not just a couple of bird species that are again "endangered" and therefore used for management policy purposes. But what's the total picture of life in that river? We don't know what that is. There are on the order some 10,000 insect species, some of which are rare, some of which have probably gone extinct in the last 25 years, 30 years. So, one of the emphases I place on the system outside of the program is to try to compile information on the biodiversity of the river because it is simply not known yet. That is a big task and there is no funding for it so it's a slow go, but group by group we are beginning to pull together what actually exists in the river corridor. There are many new species that we have described in just the last few years, half a dozen new species of insects and mollusks in the river corridor. So lots still to learn there and that's another big arena of knowledge to be improved upon, which the program does not pay much attention to.

[00:24:31]

PH: You've mentioned that you have been involved since 1980s, so you have seen a lot changes come to the program. How would you sort of… if you were going to periodize the Adaptive Management Program, what would be the key periods and moments of transition.

LS: So I actually started in 1974, but [inaudible] done studies before that. 1974-1976 period was the first ecological inventory of the river. The dam was having effects, we were beginning to see

them, non-native species like burros, tamarisks, other things were having an impact on the river corridor and this was the first opportunity to describe those impacts. So that early study, I think was a first step in this whole process. It was done by the Museum of Northern Arizona with Steven Carothers was the lead on that. One step before that was, of course, in the early '60s, no (pause) —get the right dates here, '69, '70, '71— the really dramatic increase in the number of people coming to visit Grand Canyon through the river. So, we went from just a few hundred people coming through the river corridor in the mid-sixties to 20,000 thousand in 1970, by 1970-71. That was probably the first big step in this process because suddenly there was public interest in the river. So, an ecological inventory was done, highly informative, set the stage for a lot of future studies and identified fish species that were rare; historic photos that could be re-matched and looked at the change through time, really dramatic stuff that way, and a lot of basic information about what living in the river corridor. In the early '80s, the filling of Glen Canyon, uh, of Lake Powell, was a kind of a big deal because for the first time we had a full lake. Okay, so this is the future of water management in the Southwest, our second largest reservoir is now full. Early-'80s, not too much going on; a test of the spillway in '82 but the political element was rewinding the generators and inflaming the now large public that was exposed to the canyon, knew it, and didn't want it degraded.

[00:27:12]

PH: When was that?

LS: The rewind decision was 1980-82. In 1983 then, I'm sorry, late 1982, the Secretary of the Interior threw some money at this program called the Glen Canyon Environmental Studies. That coincided with that winter, the winter of '82-'83, was the largest snow pack that we've had in a hundred years. That filled…the reservoir was full, they didn't have a way to manage more than full, they didn't know what to do with all the water that came through. The biggest flood in post-dam time came through and nearly took out the dam. $25 million worth of damage to the dam at Glen Canyon, the potential for the loss of all the dams downstream if Glen Canyon Dam had failed. Really big deal.

[00:28:10]

PH: That was an El Niño year right?

LS: It was an El Niño [year] but coupled with a big volcanic eruption. So that combination gave us our greatest snow packs. That was probably the biggest snow pack since 1884, the Krakatoa eruption time. So, that kicked off this GCES phase one from '83 through '87, and lots of documentation and reports on that. Not so much peer-reviewed publication, but some, but mostly these were government publications. From '88 through 1991—really through 1995 maybe—[was] the Glen Canyon Environmental Studies phase two.

[00:28:59]

Glen Canyon Environmental Studies phase one pointed to the dam as having a large impact on the system. The Department of Interior came back and said, "Ok, so if it's having an effect what are the effects and can we modify them by modifying dam operations?" So phase two was about pursuing those questions. That EIS culminated…also the Grand Canyon Protection Act of 1992 set the stage for having this be a requirement that operations of the dam not degrade the Grand Canyon river corridor. That was kind of a big step there. 1995, the EIS was finalized. 1996, the decision was signed. That set the stage for the Adaptive Management Program to begin. Much learning, much policy process going on during all of those phases of course.

[00:30:00]

Then the Adaptive Management Program gets established in 1997 and runs for twenty years accumulating lots and lots of really high quality scientific information especially on applied issues such as how to manage the river for sediment and how to manage endangered humpback chub. Those two questions have been the dominant questions. And so, this recent EIS…revisiting all that information and trying to set a new stage for management for the next twenty years was just signed a couple months ago. Two months ago, yeah. [Long-Term Experimental and Management Plan (LTEMP) EIS; Record of Decision signed December 15, 2016.] Those are kind of the big steps in the political process I would say.

[00:30:57]

PH: December of 2016 is when it [was signed]?

LS: December or January, it might have been January. I can't quite remember when the announcement was. It was signed in Las Vegas. It might have been December.

[00:31:09]

PH: That was the LTEMP?

LS: Yeah, the LTEMP. (Pause) Now interestingly, going on with all that—oh is there time? Another minute? Sorry. Interestingly, going along with that whole process were the ecological surprises. Every year, a new surprise. I mean just right from the…every year that we've had this program going, some new surprise happened. Oftentimes at the arrival of some new species. Initially, we had bald eagles move into the system. In 1983, the first bald eagle is seen in Grand Canyon. It was actually living in the river… occupying the river corridor, feeding on fish, and being there. Bald eagles were endangered at that point and therefore having a new endangered species move into the system was a big idea or big issue. That precipitated a whole wave of studies about bald eagles. Just before that, peregrine falcon populations in Grand Canyon irrupted. They were also endangered at the time, therefore a whole suite of studies on peregrine falcons came about.

[00:32:20]

PH: When was that?

LS: When was that? Well, that was recognized in 1976. I did a trip and we found only four peregrine falcon nests in the whole canyon, four to six. By 1985 or so, we had more than a hundred pairs. That was in part related to our recovery program in the Rockies. The peregrines all came into the Grand Canyon to feed. It has been one species after another. Now these initial surprises were endangered species or important things like ducks. We have no duck breeding along the river until 1982. Mallard ducks began to breed in the river and now every eddy. There's got thousands of eddies in the river system. Pretty much ever eddy in the upper canyon has a pair of mallard ducks breeding in it. So that change happened. More recently, it's been non-native species that have begun to arrive. New Zealand mud snail was a big deal, initially, and it was quite dominant in the upper sections [of the river]. About 2009, the first quagga mussel was detected. Quagga mussels stand to change the entire structure of the ecosystem. So, these are surprises that are…they could have been anticipated I suppose but we didn't really, don't have that kind of far vision, future vision.

[00:33:56]

So, these things happen and then ecosystem tracks off in some other direction. Early on the policy was because we understand the river is colder now because of the dam than it was pre-dam time, the emphasis was on warming the river with a temperature control device put on the dam that would draw surface water off and warm up the downstream river. Great. $200 million, now $500 million, a very expensive undertaking. That whole discussion though recently shifted to keeping the river colder. To keep things like quagga mussel and some of the non-native fish at bay. So the whole mind set about temperature control, oh we have to change…warm up … a huge amount of effort going into warming up the river. Now it's: well, we need to keep the river colder. So, as these different surprises have happened there've been different impacts on basic thoughts about policy.

[00:34:56]

PH: Has there been a change in how participants in the Adaptive Management Program have thought about the effort to reshape the Colorado River ecosystems?

LS: I would say behind the program are a whole suite of biases. Individual stakeholders or stakeholder groups have a particular focus on their resource of interest, and those have really not changed very much. It has been more how to manipulate the other side to get them to … to focus on the topics that keep those individual biases viable. As an example, largely the present program, the LTEMP, is focused on sand and humpback chub, two resources. Those are two of ten thousand, twenty thousand different possible resources we could look at in the river, but the program has migrated to those two points and tried to solve those problems and actually pretty much has now at least understands how to manage those two resources. But it doesn't pay attention to the many, many, many other issues that are in that system and that are important drivers.

[Lunch Break before resuming the interview]

[00:36:41]

PH: At an administrative level, what was learned and accomplished during the time that you were involved?

LS: At an administrative level? Okay.

PH: Not a good question. How would we rephrase that? Just what was learned and accomplished? Because I didn't want them to focus on one study that you did.

LS: Yeah. Yeah. Right. Right. I think the question might be more; what did you learn about the three legs of the stool? That might be more of a way to get folks to open up.

PH: Great.

LS: Everybody learns all the time about innuendoes of policy and the science is erupting all the time. (Pause)

[00:37:33]

PH: Ok let me rephrase that question. What do you think has been the value of the program? Now we are getting big. What do you think has been the value of the program? And the next one; in your opinion what have been the program's failings or limitations and how might they be addressed in the future? Give us ten to fifteen significant key words on the program's evolution.

LS: Ok.

PH: And lastly, who do you think we should interview for their perspective? So, we will try to get through those.

LS: Good.

[00:38:10]

PH: Are you ready? (recording staff: "yeah." Sound of a hand clap. Formal interview resumes.) So we were talking about significant changes that occurred in the program over the time you've been involved and you mentioned that there were changes in science and changes in management, how about changes in the social environment of the program over time?

LS: Yeah. The program began as an internally directed, closed program. If there was advice going to the Secretary of the Interior about how to manage the dam that was not available to the public. Only by requesting comments on the rewind [of the dam's generators] did the public even find out that the dam managers were going to increase the amount of flow fluctuation. But they did find that out and that precipitated the initial wave of public concern that then led to the entire program.

[00:39:13]

So engagement of the public is one element that was new to this whole process. Engagement of the tribes was also quite challenging for the managing agencies. The tribes are regarded as sovereign states, sovereign nations and they don't talk to each other, and so it was only by the invitation by the Department of the Interior, which over sees the Bureau of Indian Affairs, that you actually begin to initiate conversations with the tribes. Finding out what tribes regarded Grand Canyon as a part of their homeland was an important step and there are about seven or eight tribes that do, that have it as a key feature of their culture. Several of the tribes have the Grand Canyon as their place of emergence into this dimension and that whole understanding gives them a great focus on Grand Canyon therefore they have been engaged as stakeholders. There are half a dozen tribes now engaged in the program. But initially, there was no way, no mechanism to engage the tribes or to have discussions about what the tribal values were that should be paid attention to in a management program.

[00:40:35]

PH: When were they brought into the stakeholder process?

LS: GCES phase one. Which was led by David Wegner. He pretty much single handedly turned the battleship of the Bureau of Reclamation 90 degrees to bring it into an open social process [with] active science, tribal engagement and a dialogue about how to manage rather than a monolithic in-house kind of effort by the federal government.

[00:41:16]

PH: What years was that?

LS: He was the GCES program manager from late 1982 until 1997. I would say engagement of the tribes has been one of the biggest steps for this program, and for the first time not only the program but the public is actually beginning to learn about what tribal values are. They are quite different than the management values that are held any other stakeholder group of the twenty-seven stakeholders that are on the Adaptive Management Program. Other major shifts there, on the social side of it, the transition from the GCES program to the AMP [Adaptive Management Program] was quite challenging. David Garrett became the Grand Canyon Monitoring and Research Center chief, it became a USGS office by 2000 or so. But for a while that was a Department of the Interior office that took over the GCES program. Once you start one of these programs, this GCES program, engaged many, many people across the Southwest, all of whom began talking to each other for the first time; began asking questions, some of them doing research, some agencies following their interests in the program, meeting together, trying to figure how to better understand what dam impacts were, and then how if possible to mitigate those on the Grand Canyon. That transition was quite difficult then because it was an established program [that] had been running from 1983-1997, fourteen fifteen years, and then was taken over by a much more formal, much higher up federal process.

Many people became disillusioned with that transition. Quite a bit of discomfort with transitioning this information system, this information gathering structure that had been developed into the U.S. Geological Survey. Nonetheless, that's the way that program went and the USGS as a bureaucracy took it over and rules the roost now.

[00:43:47]

PH: Why was the transition on 1997 disillusioning to some people?

LS: Because it was a pretty open, freewheeling program up to that point. If somebody had a question, finding the expertise to answer that question was there. It became constrained after '97 by the bureaucracies that were involved, first the Department of the Interior then by the U.S. Geological Survey. So now it's returned to a highly bureaucratized information management system.

[00:44:31]

PH: What did you learn over the many decades you've been involved? What did you learn about the program and what I will call its three stools: its science aspect of the program, the management decision making aspect of the program, and the social aspect that you've also been talking about? What have you learned about the relationship between the three, their evolution, which ones have been more influential at what times, and change over time?

LS: Alright. If the three legs of this adaptive management stool are policy, science, and social process, when I started, of course, I was wrapping up my master's degree. I had no more idea of how the government worked than any other American does. The Department of the Interior houses together the National Park Service which defends the integrity of natural landscapes, with the Bureau of Reclamation which was at the time not only managing the dam but also managing marketing and making money off of the process, as well as the Bureau of Indian Affairs, the Fish and Wildlife Service, and other agencies within the department. These agencies have directly conflicting mandates and yet they are all being managed as one. And so understanding what those conflicts were, how the Department of the Interior has to resolve them. So that was quite a learning process there. Having policy discussions all the way up the food chain from our local Grand Canyon effort all the way to the Secretary of the Interior's office has been quite informative. Seeing how decisions actually get made and conflicts get either resolved or swept under the carpet.

[00:46:35]

The science side of it I am much more comfortable with. It has been a pretty continuous process of putting out ideas, having those kicked around by various people, stolen by some agencies that's kind of the way some of this intellectual freedom or intellectual property is not really respected much in these kind of discussions. So an idea that seems like a really great, kind of cool thing to study often gets taken up by some agency who wants to pursue that and

has the power to be able to take over the question. That's the way that works. But at least it's this proposition [propagation] of ideas and thinking about things and asking questions, having those kicked around a bit and seeing the way that those become programs of study. That makes pretty good sense in terms of the flow of science.

[00:47:36]

There have been surprises in the science world that haven't been perused enough necessarily and some that we don't have the experimental capacity right now to achieve. For example, anybody who has ever seen a flooding river sees all the driftwood out in the middle of the river. It wasn't until we actually ran our first experimental flood in 1996 that we understood that the way that happens is that currents are being directed up against the shore that either bring sediment or tear sediment away from the shore and then current recirculates back out to the middle. So when we are looking at a flooding river and seeing a line of driftwood running down the middle of the river, it's because there is a counter current circulation pattern that develops at a certain threshold, and it's river specific certainly. So that was quantified and actually measured in Grand Canyon for the first time. It hasn't been looked at really very much since. Many of those kind of surprises, scientific "ah-ha" moments have come out of the program.

[00:48:44]

PH: Can you think of any others that we want to, like, mark for posterity, or ask other members of the program about? Scientific surprises?

LS: Yes. Well, let me give you a couple examples. Some scientific surprises are—science is really, you know, it's this debate about the nature of reality, but the other side of it is it's a personal exploration of biases and our beliefs. And when something goes against your belief and yet the data conclusively shows you that you are wrong, or just misguided, then it's the role of the scientist to actually accept that information and see what that means and explore it. One of the huge dilemmas in this system has been how the river should be managed for humpback chub. And, based on information about the fish in the upper Colorado River Basin, chub appear to be a mainstream spawning fish up in the upper Colorado River Basin, where there are five populations that are of interest, all declining. In Grand Canyon, it is not a mainstream spawning fish. It spawns in the tributaries and every place we find spawning going on is typically associated with some kind of tributary, or either a tributary coming in like the Little Colorado River or a spring coming up, and the fish congregate at these water sources.

[00:50:13]

So, one of the persistent biases is how can we manage the river to best support the humpback chub. Well, if there breeding is really going on in the tributaries, that's not as important a question as how can we make sure that they are breeding successfully in the tributaries. Gradually, that has been more clearly recognized in Grand Canyon, still not in the upper basin yet. We really don't know how they are breeding in the upper basin. Its hard to believe it's the

same fish. But, coupled with that is the role of rainbow trout. Rainbow trout are in the clear water reach in the upper portion of the river. Rainbow trout are usually insectivores or shrimp salad feeders but they can occasionally feed on humpback chub and other larval fish. One of the big dialogues that has gone on scientifically has been if the trout are in the upper river and they are moving down to the lower river, are they posing a threat to humpback chub by eating their larvae? The discussion on that has gone back and forth and back and forth for thirty years. It wasn't until the resolution of one of the few lawsuits that was ever kind of launched in this program where the judge actually—his brief on the trial said there's no relation between humpback chub and rainbow trout because the populations are not changing in any kind of consistent way. The chub population was rising as the trout population was rising so therefore it is not predation of trout on chub that is affecting it, the endangered fish. The trout are also nonnative so that throws that element in. The trout are also highly valued by the anglers up in the upper portion of the river above Lees Ferry where [it's a] big industry and the failure of that industry affects a lot of people. The changing trout conditions up there are important to them.

[00:52:30]

PH: Would it be accurate to say that one of the reasons that that question, that scientific question about the potential impact of rainbow trout on humpback chub, that the reason that that went on for so long, so controversial was that you had one set of stakeholders interested in the chub and another set of stakeholders interested in the trout and they weren't integrating their studies? They were seeking research that would validate their interests?

LS: Yeah. Certainly biases on the part of both groups are what dominated the way the research was conducted. In fact, with the chub four different agencies were researching the chub, doing very different things with the chub and only through this process in the later stages of GCES was that information beginning to be brought together. Now it is pretty well integrated. But still the biases, the embedded biases of the program, are everywhere apparent there. Because the trout are nonnative and because they are quite abundant they must be bad and must have an impact on the chub and all the data actually pointed in the opposite direction. The chub don't really…they are not much influenced by rainbow trout. Brown trout is another nonnative fish in the system. They do have a negative impact on chub and nobody disagrees about that. But the role of rainbow trout has been much subject to agency bias and that really shapes the way the research takes place, which further embeds the condition rather than resolving it.

[00:54:14]

So much of this work could be done experimentally and one of my disappointments with the program is that we have never gotten an in-field experimental laboratory set up at Lees Ferry where we can actually test some of these very basic ideas without having to subject the entire river to a flow regime to see whether or not the issue is something that can be managed with flows.

[00:54:45]

PH: OK. Let me move to the next question. What key—

LS: Woops. Can I add one more thing here.

PH: Please.

LS: We talked about science we talked about policy, but we didn't talk about the social leg of this. The insight that I have had about that was that every person involved in the program is trying to do their best. Every person there is working hard to support the themes and the constituents that they serve and trying to do their best to have their interests well represented, strongly represented. And so that's been an insight. As a naïve outsider you might think good/bad, good/evil, whatever the interests might be. Environmental interests against economic interests. There must be enemies here that are irreconcilable differences going on. That's not the case. Almost everybody that's involved in the program that I have met is really working hard to ensure that the program works. That their interests are well represented. And that by doing so, in an adaptive management context those interests do get vetted fairly.

[00:56:09]

PH: Which documents and reports are you aware of that haven been produced over the years that you think are particularly important to keep on the forefront of our memory, that remain relevant, that provide some historical precedent that was important?

LS: OK, so in the pre-Glen Canyon Dam Adaptive Management Program literature, Woodbury 1959, is an ecological survey of Glen Canyon before it was dammed. Really important first look at the ecology of that river system. Stanton's book in 1890 also was important in that he presented photographs of what the river looked like a hundred years before this era of flow management took place. So, in 1976 the Carothers et al. report on the ecology of Grand Canyon, of the river corridor of Grand Canyon. Many papers came out of that including Turner and Karpiscak's [1980] photo re-matching and looking at the riparian vegetation changes pre versus post dam. In that era, papers beginning to identify—papers by Bob Dolan [1981] for example—began to identify the effects of the dam on the geomorphology of the river. Then I would say the final reports for the Glen Canyon Environmental Studies phase one and phase two both loaded with really great insights from the shotgun science approach that was taken up; how these many, many different topics are beginning to play out. By reading through those one can begin to see patterns that actually set the stage for pretty much all the science we are looking at now.

[00:58:19]

That brings up through 1990. Grand Canyon Protection Act [was] very important, influential policy document that came out in 1992 requiring that dam operations not negatively influence the Grand Canyon. The EIS document in 1996 [was a] great compendium of all of that information into one document for the purposes of setting up the Adaptive Management

Program. Stepping forward from then, there's been many, many different research topics. There is a state of knowledge of Grand Canyon document produced in 2005 that was a pretty good summary of the more recent research up to that point. Each of the science topics studied by the US Geological Survey undergoes a protocol evaluation panel review. So those are important documents for each of the themes of science being taken up. Those are done about every five years or so. A paper by Melis and Lovich [2005] on the results of adaptive management, the effects of adaptive management of Grand Canyon, the success of the program. It was a ten-year analysis of how successful the Adaptive Management Program was in terms of the key resources that are being monitored, that's an important one. And then the LTEMP Document [2016] tries to summarize that information as well.

This again is the best studied river in the world so it has got literally thousands of peer reviewed documents, tens of thousands of agency policy reports and white papers. Vast. So that makes it really difficult for anybody to, really—it would take several years actually to go through all of that literature, I think, and really be able to use it in decision making.

[01:01:02]

PH: Well perhaps you can cut through all the static of all of those hundreds and thousands of research reports and tell us, big picture, what you think the value of the program has been and is today. Should we continue the program and why?

LS: Good question. This whole theme of adaptive management is something Carl Walters and others began to put forth in the seventies. Their conceptualization of adaptive management was based on the understanding that ecosystems are too complicated for humans to be able to manage them. And that, really, we should use science in an experimental context to be able improve our decision making. If experiments didn't work, then reverse our policy, our management strategy, and follow the lead that makes more sense in terms of what the science tells us. So that form of adaptive management is not what we have. We have an adaptive management strategy that is based on stakeholder concerns and how to balance stakeholder concerns rather than how the ecosystem itself is functioning.

[01:02:17]

As an ecosystem ecologist I always go back to the original kind of hope that we will be managing the ecosystem for its natural functioning and trying to understand how much, how many of the goods and services we can extract from it without harming it, and the timing of that kind of extraction. But that's not the way the program is structured. It is about social engagement of many stakeholders, all of whom have some vested interest in some portion of the resources and hoping that all of that dialogue combined will somehow work towards an effective management system that supports the ecosystem but also the supports the subsidies that are being extracted from it. This is probably the most successful adaptive management program in the world. So therefore that alone is relevant.

The social program gets us some way down the road towards effective ecosystem management, leaves many things off to the side, but we have been able to engage members of the population and cultures that have not previously had a voice. So, the half a dozen tribes that are involved in this program have a voice and have had great influence on the way the program has developed. For example, the Uto-Aztecan tribes in the process feel it's wrong for there to be a lot of loss of life in the system. Fish, especially aquatic life, which is really important to Zuni and Hopi tribes, and that therefore programs that seek to control, say, rainbow trout in the portion of the canyon where they're not commercially fished, should simply not kill a trout. The trout should be… if they are being managed, then they shouldn't be killed because death there is not appropriate. These are the birthplaces of their culture so they don't want to see fish massacres going on in their homeland, at the very heart of their homelands. So that's actually had a huge impact on the way the fisheries program has been structured, so having that indigenous information coming into the program has been important, and something that we have respected very deeply.

[01:05:00]

From the standpoint of the program working, its works—it stumbles along pretty well. This is such a process of sitting in the chair. The only way it works is you have to sit in the chair for two days every two or three months and listen carefully to what's being said and try to pose questions that are going to actually change the way the rest of the group sees the process going. And it takes a lot of diligence to do that. My hat's off to everybody who's been with the program and then actually going through that process because it just takes a lot of patience and attention to the quality of the program. The success of the program relies on that. I think the other advantages of the program are certainly that it's brought to light so much information about the management of a constrained river, a geologically constrained river. These are the places that dams are usually placed, so we've actually lost enormous volumes of the earth to impoundment without ever understanding how they work ecologically. So it has been a great advantage to scientific understanding of these kind of habitats. Large, deep canyons are at risk everywhere in the world because of dams. Those are scientifically, policy-wise, and socially I think there are strong advantages to having the program go on. With the LTEMP decision, that puts in place this structure for the next twenty years anyway.

[01:06:50]

I was going to say one more thing, though. The success of the program relies on the Secretary of the Interior being an active part of the program. The Secretary of the Interior usually designates someone from his office to come in, one of his undersecretaries, to come in and oversee, to be the recipient of the advice from the program. When the Secretary is weak or uninterested that breaks down and the program suffers. Because this a federal advisory committee, it requires a strong active engagement with the Department of the Interior.

[01:07:26]

PH: Can you think of examples in the past when that process has broken down because of less effective participation from the Department of the Interior?

LS: Many examples, yeah. As the administrations come and go, the interests of the Secretary of the Interior reflects the interests of the President in these complicated environmental and economic interactions. And so, when that designee or the Secretary of the Interior themselves are disinterested we end up with a…well, we just let the stakeholders choose what they want to look at. That situation prevailed for the first eight years of the program, eight or ten years of the program in which stakeholders said well I want to study chub because I am a Fish and Wildlife Service representative and chub are an endangered species. Or I want to study trout because I am an angler, I represent the anglers and I want trout to be there. If there weren't strong voices for a resource, then they simply didn't get on the Christmas tree. These are research ornaments on a tree but we never get to understand what the tree looks like, so we're putting these pieces together or maybe we are building a house, but not from the foundation up, we're starting on the third floor and trying to understand what the house is gonna look like by the time we get to the ground. So, with weak oversight, we end up with a complicated stakeholder-led selection of research topics.

[01:09:20]

PH: So, a personal question about all of this. You have articulated reasons why the program is valuable and its accomplishments, why have you remained involved in the program for so long? What have you gotten out of it?

LS: Alright. Again, my deep appreciation and attachment to Grand Canyon drives my interest in the program. I learn with every person I talk to in this program and every passenger I take down the river and even from the simplest questions I learn more about my relationship to Grand Canyon. So that's just a continually enlightening exercise to pursue this. Our organization is pretty small. We often don't have funding, so I do a lot of my work pro bono. But the effort at trying do our best to manage Grand Canyon is what drives me. So, whatever it takes to do that, I'll be in the chair.

PH: Looking back –

LS: Maybe except, unless there's a river trip that might conflict with the time that I should be in the chair.

PH: River trip takes priority.

LS: Not necessarily but I try to keep them…I try to manage my time carefully.

[01:10:51]

PH: What do you think has been the program's failings or limitations? How would you like to see those resolved or addressed?

LS: Alright. (Pause) We have the tools to be able to answer questions without having to subject the river to treatments. And one of the failures of the program has to do with the unwillingness of some stakeholders to use the models we have to answer questions, at least conceptually, answer those questions before we encounter those situations. One example is that Lake Powell is used to—sometimes, under good flow years—used to equalize the level of Lake Mead. And under those years a lot of water is released out of Lake Powell and sent downstream to Lake Mead. A very straightforward question is—and we have very good models of how flow and sediment interact given different starting conditions for sediment in the river—sediment is derived from tributaries. If it builds up, then we have the ability to manage it. We can use these models to answer the question: how can we best manage the equalization flows for these two reservoirs to minimize sediment export? So we preserve the sediment supplies we have in the system using these models. What is the right way to do it?

[01:12:29]

We don't threaten anybody's water allocation or any issue with hydropower production necessarily. We are just running a model to see what the right way to do it is. The system is resistant to that. The water and power interests don't want to go there because that might shift their ability to market hydropower for some reason. So that to me is a limitation. We've made some pretty good headway with understanding, *really* great headway with the modeling, and these are questions that we could answer with the tools we've got, but because it threatens the, whatever, behaviors of these different organizations that market power, they don't want to test those models in that fashion.

[01:13:14]

PH: Can you think of possible pathways for resolving that shortcoming in the program?

LS: Again, it would take strong leadership by the Department of the Interior to help with that. Because water and power, they are pretty resistant to any kind of potential threat to the way they manage their organizations, and they've taken quite a hit with the modification of the dam over time, modification to the flow regime from the dam over time. Dampened flow fluctuations were the result of 1996 EIS and those have been perpetuated now into the present so that they can longer run these huge daily tides through the system. More conversation with them continued to push on it, but it would take strong Secretarial support to use the models that we have to test some of those notions. One thing I've been particularly…One idea that I've had that's been particularly strongly rejected was using the models to look at flow fluctuation on every on other day. Again, higher flows produce more hydroelectric power, run one day with high…running alternate days of hydropower production, or a different…maybe multi days.

[01:14:50]

There's many issues there because if you run daily flow fluctuations from the dam, those translate into a wave form that is a very fast uprising wave that scours up a lot of sediment and

if you could slow down that cycle then you could probably slow down a lot of the erosion rates. Again, this is not having to subject the system to this kind of analysis. Use the models we have, which are perfectly capable of doing this to test out these alternative flow regimes that might be much more conservative of sediment. The models are also set up to look at the economic cost of those. Those are great tools to be able to have and if we can ask those kind of questions we might be able to get at what the flow rate regime is to best support both the economics and the ecosystem.

[01:15:42]

PH: You've talked about different phases that the program has evolved through over time and you've talked about the importance of a strongly committed Secretary of the Interior to the effective functioning of the Adaptive Management Program, can you reflect back on which administrations in your experience have been most effective in advancing the Adaptive Management Program and which administrations have been not as effective in advancing the goals and accomplishments of the program?

LS: Yes. Quite easily. I don't understand, really, the relationships between the Secretary of the Interior and the President in any of these situations, but to say that under Bruce Babbitt's time as Secretary of the Interior and under Ken Salazar's time as Secretary of the Interior those are the big advances in terms of strong secretarial support, really great Secretary designees–Anne Castle I hope is somebody you will be able to interview—fabulous at the high level policy implications and keeping a bunch of renegade stakeholders on track and helping move the program forward.

[01:17:04]

PH: I just thought of a rather controversial, speculative question. There is a lot of talk these days about what to do with the reservoirs behind Lake Mead and Lake Powell because both are half empty or more than half empty. Climate change is not giving us much confidence that those reservoirs will be full again in our lifetimes. A former Commissioner of the Bureau of Reclamation has actually advocated for the dismantling, or at least if not the dismantling of Glen Canyon Dam, the emptying of the reservoir. What do you think of that possibility, and how would that affect river flow regimes in the Grand Canyon and the whole legacy of the program?

LS: I deal with this question every day, every day. Glen Canyon Dam was built where it was built because it lies just upstream of the boundary between the upper Colorado River Basin and the lower Colorado River Basin. That boundary is at a place called Lee Ferry, just downstream from Lees Ferry, and it is probably the most politically important point in the Southwest because the river has been divided into these two basins. The 1922 Colorado River Compact requires that on average 8.23 million acres feet of water pass past Lee Ferry each year from the upper basin into the lower basin. That's on average, on a ten-year average. And it's over allocated. Only about 7.5 million acre feet can be delivered reliably [annually] in a ten-year period.

[01:18:52]

That's the political context of where the dam is. Lake Powell, 186 miles long, will take 640 years to completely fill with sediment. We are 54 years into the story right now, so we've got a long time before that actually becomes compromised by sedimentation. Lake Mead, because of the Glen Canyon Dam, is protected from…it's got a life span of a thousand years or more. Yes, the reservoirs are low now, climate change is not looking very promising in terms of being able to fill Lake Mead but the upper basin is actually not anywhere as near as bad shape in terms of the climate change predictions as the lower basin is. Therefore, filling of Lake Powell is not, certainly not impossible. It will probably happen again.

[01:19:46

We are probably at the end of concluding a long-term drought here, so in the next five to ten years we may see a change in the snow pack and melt off and how the lake fills, reservoir fills. So, draining Lake Powell to support Lake Mead is something that has been proposed by some people, is entertained in the EIS actually. Fill Mead first means let Lake Powell just simply go dry. There is an ecological problem here. Glen Canyon Dam is blocking the inflow of non-native fish and non-native fish diseases that would almost certainly wipe out the remaining native fish in Grand Canyon. [There are] many non-native fish in the upper basin. A host of fish diseases that are being now blocked by the dam. So, simply letting the river flow through Glen Canyon and into Grand Canyon, while that sounds like a great thing to do as a conservationist—you know, oh good, bring back the river, that's fabulous, good thought there—except for we would probably lose the resources we were trying so hard to preserve in Grand Canyon because of that process, the biological resources.

The upper basin, the river is paved in catfish as far as I can tell. You can't throw a line out anywhere there and not catch a catfish within one minute, and the native fish in the upper basin are dreadfully threatened.

[01:21:23]

PH: Catfish is a non-native—

LS: Catfish is non-native, carp are non-native, twenty other non-native species in that system. Many of them are predators, warm water predators. Much better approach from my standpoint, even though I am supposed to be a conservation advocate, is to really study carefully the ecology of Cataract Canyon, because Cataract Canyon—this is upstream from Lake Powell—is a place where we get all the normal functioning of a wild river; huge variation in flow over the course of the year, lots and lots of sediment, the temperatures warm up very warm in the summer and ice covered in the winter. All the conditions that took place in Grand Canyon, and if those are the conditions that we want to recover in Grand Canyon, restore in Grand Canyon, what are the consequences of those conditions on the native fauna and fish, uh, fish and terrestrial fauna. The story is not actually very good. The natural river up there has very few native fish, very little

shoreline…kind of…viability, and lots of challenges up there that if we were to restore those conditions in Grand Canyon it would be a disaster for our natural resources and especially the biota in Grand Canyon.

[01:22:49]

These are big challenges because, again, the bias is well we should restore Grand Canyon, if we are good environmentalists, we should restore the natural, physical conditions and therefore everything will be in good shape, but that's not the case. So, therefore, we are stuck with this situation of keeping the dam as an important barrier to non–native species influx, learning enough about the Grand Canyon portion of the river to be able to preserve those features that we want to have there, the species that we want to have there, prevent non-natives from taking over and decimating the river ecosystem, and having that be still something socially acceptable in terms of hydropower production and the subsidy delivery that we expect from Glen Canyon Dam. It's a huge challenge and without going through that whole discussion with people, eliminating the dam sounds like a great idea to the public. But there are many issues that have to be considered before that takes place—and we have the time. So, in terms of environmental policy, this is…it's a bit of a challenge to get these points across.

[01:24:13]

PH: Some of what you've been saying highlights a couple of concepts that are critical to conservation and conservation history: preservation and restoration. And it sounds like part of the goal of the Adaptive Management Program is to preserve some of the natural functioning of the river which is challenged, perhaps inhibited, to a certain extent by operations of the dam and to restore some of the lost characteristics, ecological characteristics, of the river. But in your discussion with us, you're suggesting that in some instances we can't go back. And in some instances, in order to preserve some of the things that we want, we can't let nature take its course because there are serious challenges to it; we've got to invest time and money and labor to preserve certain ecosystems. Can you reflect a little bit about how we should understand these twin goals of preservation and restoration, understand those in a way that makes sense in a real river rather than just being ideals that are applied at a real place?

LS: Yeah, so a paper that Jack Schmidt and I and several other co-authors wrote in *Bioscience* in 1998 lays out the terrain of what might be achievable in terms of management and the role of science in that. These are complicated questions. They require a very clear valuation of resources. So, if we want to keep humpback chub, as a species on earth, we need to manage the Grand Canyon in a way that supports it. What's the right way to do that? That's been thirty years of research and we're still learning. There's been half a billion dollars spent on about 10,000 fish so far. A huge amount of money has been spend trying to understand how to keep humpback chub in the picture. Because we have enough humpback chub to work with, that money certainly went somewhere. For other species we've lost, in that system, lost southwestern willow flycatcher, lost quite a few species that aren't listed [as endangered].

Eighty-five taxa by my count, with one of the committees I serve on, groups of species that have been lost because of the dam presence and operations. [We are] trying to understand what our values are for species, for resources, for experiences for the public, as well as the value of hydropower production and water delivery downstream. Balancing those out into a coherent framework has been the…is the challenge of the program. And that, I think now, with respect to Native American concerns about the landscape as well because theirs are spiritual concerns as well as resource concerns.

[01:27:34]

Putting that all together and sorting that all out, fast change is what humans are really good at. Make a policy decision and we'll take out the dam, OK, or build a dam. And those have enormous impacts on the fabric of nature as well as the social context of these changes. Humans are good at changing things too quickly, not good at stepping back and saying well let's study this for a couple decades, actually, to really get at the answers, so we know what the consequences of our decisions are. One example within this context was the discussion about the temperature control device, TCD. Okay we are going to build it, and we actually came pretty close to building it. You can't necessarily go back. That's the issue. Just as we can't recover our own youth, we can't go back to how we were when we were teenagers or whatever. You can't simply take away something that's been constructed in an ecosystem and have the ecosystem return to its natural condition. There are always consequences. You warm up the water for a few years and crayfish may colonize. You can't get rid of crayfish, there is just no way to eliminate them. They eat everything and you can't control them. So therefore, if you warmed up the water with a temperature control device, and allowed crayfish to get started you'd have an irreparable change to the system that would completely take the trajectory of development of the ecosystem in a different direction.

[01:29:17]

So that's an important thing to understand; we can't go back. We have to make decisions based on what we have, what we know, what we can learn about, what we can model is particularly useful then we don't have to manipulate the system to move further. But, you know, it's just the hard work of accepting that we've got an altered ecosystem and that fast changes, quick policy decisions, are probably not going to solve our problems.

[01:29:51]

PH: So, if we can't always preserve or restore a particular species, an endangered species, and we can't always preserve or restore a particular assemblage of plants along the river, say, on a beach, what is it that the Adaptive Management Program is restoring and preserving? Or what should it be?

LS: Yes, uh-huh. Yeah, so there is very little guidance in this…as to what we can achieve or what we should achieve. Right now, it's driven by policies of different agencies, [like the] Park Service. It's

purpose is to preserve the natural condition. [It] has no capacity to really manage for an altered condition, because it's altered. The Park Service should always be driving itself toward the natural condition. They use that, sometimes as an excuse, for not acting because letting nature take its course is the way the Park Service thinks it's getting its job done. One example there is, the riparian vegetation has grown up dramatically, as a surprise in the system, a profuse development of riparian vegetation along the river. Three hundred miles of riparian vegetation, the biggest stand of riparian vegetation left in the Southwest where 90% of this habitat has been eliminated. Incredibly productive for birds, for wildlife, for insect life. It's not natural. Therefore, there's always been a reluctance on the part of the National Park Service to want to manage that system; it would be better to have that not be there. But, the park is now an island of habitat for birds and wildlife that require that kind of habitat and have lost it elsewhere. So, the Park Service if they lost that habitat would actually be doing grave and perhaps irreparable harm to the wildlife and bird species of the Southwest. Are we willing to actually accept our role in this human dominated ecosystem as managers? Many of the existing policies are kind of in conflict with us being able to step up to the plate on that.

[01:32:25]

PH: What do you think should be the goal for the Adaptive Management Program? For example, should we, instead of trying to recover or preserve specific ecosystems or species, should we try to recover or preserve resiliency or biological productivity? Is there other kinds of concepts like that that could guide us in this difficult situation where we don't know what is natural and whether we can go back or not to a previous time?

LS: Yeah, in this paper by Jack Schmitt et al. in 1998, we lay out the terrain. The altered river system is…it's not natural, it's got components that are desired and it's got artifacts of the past that are still valued, and the balance of managing those together, along with the goods and services being produced by hydropower production and water delivery, that is the balance that we're working with. It's a social process to value those, to decide which we want to maintain. Somehow in this adaptive management process that's proceeding, although the valuation process for things other than humpback chub and sediment resources is not very clear, but the process is going in that direction without a lot of large, coarse-scale kind of overview of what those directions are. We are getting there whether we want to or not, and we don't really understand where we are getting to. But at least we've got some framework there to able to understand, as changes are happening, what some of those changes are.

[01:34:16]

PH: Okay, are you hopeful?

LS: Always, always. Because I get to study natural history and evolution, that gives me long term hope. And, yes, things will be quite different in the future. Loss of some of these species is something I try to work against. So, for me, any human caused extinction is a crime. And

therefore that's one way I proceed in life is try to make sure that nothing goes extinct that I have some kind of power to prevent.

[01:35:04]

PH: That was a nice place to end. I am going to ask you a couple practical nuts and bolts kind of questions to finish this up.

LS: Good.

PH: One is, um, if you could give us some key words that you think are significant to the program and its evolution. We are going to make a key word list and make sure that everything in the archive is tagged with these important key words.

LS: Okay. Well certainly it's going to be the humpback chub, sandbars, flow, traditional ecological knowledge TEK, adaptive management, flow regulation…(pause)…the way we have described the ecosystem as Colorado River Ecosystem CRE—that is a common acronym for that, but that captures the concept, imperfectly, captures the concept that a river is more than water, it's also where the water has been: the terraces, the landforms, as well as the species that make up the river. I guess the various policies that are in play that matter: the Organic Act, the National Park Service, the Endangered Species Act, the Grand Canyon Protection Act, the LTEMP, the LTEMP ROD [Record of Decision]—how many is that? That's a dozen?

PH: That is about fifteen.

LS: Good, that's a starting point but you will have many more.

[01:37:01]

PH: Yeah, I've made some notes to tag acronyms, as you mentioned, and to tag the documents and reports but also to tag tribes and stakeholders and federal agencies. So I will have Jennifer start a document in the Dropbox folder for tagging, and [speaking to Jennifer Sweeney] here's my notes, actually, from the interview. And then you can go back and listen to that last section of the interview and [inaudible] if you have any questions about what they are you can write to me as well as to Larry. He's in the field a lot so if you don't hear back from him that means he is out there.

LS: Well I am electronically available until April 3rd, April 2nd.

[01:37:44]

PH: Is there anything else you would like us to ask you while we've got you on tape today?

LS: You've I think hit on most of the topics. Hope is important in this program, I think. And it would be very interesting to know (laughs) how hopeful some of your next interviewees are on this.

[01:38:06]

PH: Yeah, that was a spontaneous question that came up from the conversation and I thought I like that and I think I should ask everybody that. [Inaudible] There is another question: who else would you recommend we interview?

LS: Oh right, we've talked about that. Dave Wegner for the pre-AMP part of the program. Dave Wegner is critical. I think he lives in Tucson. Did I send you his information?

PH: I don't know if I have his contact information yet, but you did say that he lives in Tucson so I will have to double check, I have some notes.

LS: For the tribal representation in this program it is usually by white guys who represent the tribe—

PH: —because the tribe hired consultants.

LS: Yes, uh-huh. But very long-term people. So, they also maybe not be, maybe haven't been on a list, but Mike Yeatts, he is with the Hopi. Kurt Dongoske with the Zuni Tribe.

PH: How do you spell his last name?

LS: D-O-N-G-O-W-S-K-I [Dongoske].

PH: You said Kirk?

LS: No, sorry, Kurt. And then Kerry Christensen with the Hualapai Tribe, K-E-R-R-Y. Christensen with an E.

PH: Dongoske is with the Zuni?

LS: Yeah. So their perspectives would be I think quite interesting to hear as well.

PH: You said Kerry is Hualapai?

LS: Hualapai. Yep.

PH: Yeah, I'll add them to the list and start looking for contact information.

LS: The other tribes have people that show up occasionally, are not quite as well-informed long-term as these three guys are.

[01:40:13] End