ORAL HISTORY INTERVIEW

Rich Valdez

Salt Lake City, UT

4 March 2020

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Interview conducted by:

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and

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Glen Canyon Dam Adaptive Management Program Administrative History Project

Administered by Arizona State University

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Date	3/4/20
Location	Salt Lake City, Utah
Interviewers	Paul Hirt and Jennifer Sweeney
Annotator	Jennifer Sweeney
Project	Glen Canyon Dam Adaptive Management Program Administrative History
Notes/Bio	Aquatic ecologist Richard "Rich" Valdez has been associated with GCDAMP (Glen Canyon Adaptive Management Program) since 1989, when he led a study on endangered humpback chub for GCES, the program's predecessor. Valdez began studying Colorado River fish in 1968, and is an expert on humpback chub and other native species. He has been associated with the environmental consulting companies BIO-WEST and SWCA for much of his career. In addition to GCDAMP, Valdez has contributed his expertise to the Upper Colorado River Endangered Fish Recovery Program and other river basin recovery efforts.

Minutes	Summaries of interview content during each minute of the interview
0	Introductions. **Q:** What positions have you held in GCDAMP (Glen Canyon Adaptive Management Program) during the years you participated? **A:** In 1989, Valdez worked under contract with USBR (U.S. Bureau of Reclamation), studying humpback chub in Grand Canyon for GCES (Glen Canyon Environmental Studies). The study surveyed fish populations along 280 miles of river.
1	In 1999 Valdez convened a scientific panel on strategies to increase humpback chub populations, and in 2000 he participated in the LSSF (Low Steady Summer Flow) experiment. In 2003 he worked on a team assessing the need for a TCD (Temperature Control Device) for Glen Canyon Dam.
2	In 2004 Valdez worked with Steve Carothers on a fisheries survey of the Colorado River and its tributaries in Grand Canyon. He worked in 2010 on a razorback sucker reintroduction team. The Colorado River Basin states asked Valdez to convene a panel in 2012 to evaluate alternatives for the 2016 LTEMP (Long-Term Experimental and Management Plan) EIS (Environmental Impact Statement).
3	Valdez recently joined the brown trout management team with Mike Runge and Charles Yackulic. **Q:** How much of your work was contract research work with SWCA [SWCA Environmental Consultants] versus work directly as a participant with AMWG (Adaptive Management Work Group) or TWG (Technical Work Group)?
4	**A:** It was mostly contract work through BIO-WEST or SWCA. Valdez attended numerous AMWG and TWG meetings while working with those companies. **Q:** Let's drill down on the role of humpback chub in GCDAMP. You're probably going to be the most knowledgeable expert we interview on life history and recovery efforts for humpback chub. How did that get started and develop over time?

5 **A:** The humpback chub is probably the keystone species in GCDAMP. He has served as recovery team leader since 2015. Valdez is very familiar with humpback chub populations in Grand Canyon. He started studying fish populations in the Upper Colorado River Basin in 1968.

6 Before the Endangered Species Act (ESA) was passed in 1973, humpback chub were included in the Endangered Species Preservation Act (1966) and the Endangered Species Conservation Act (1969). The ESA mandated better protections, but nobody knew exactly how to protect endangered fish in Grand Canyon.

7 Valdez was involved in early Environmental Assessment (EA) and EIS processes concerning endangered native fish, especially in the Upper Colorado River Basin. He started with U.S. Fish and Wildlife Service (USFWS) in 1979 to evaluate native fish populations above Lake Powell, which were declared to be in jeopardy on passage of the ESA.

8 Amendments to the ESA in 1980 introduced the concept of reasonable and prudent alternatives, "which really opened the door and allowed agencies, now, to start doing good things for the species to offset or mitigate those potential bad things." The alternatives developed for native fish affected by Glen Canyon Dam operations became the heart of the 1995 EIS.

9 In 2008, USFWS changed to a non-jeopardy determination for humpback chub. New conservation measures were finalized in 2010. Now USBR and NPS are working "not just to mitigate the potential jeopardy effects, but also to benefit the species." Because Grand Canyon has the largest population of humpback chub in the Basin, it was the stage for determining how the ESA would apply to the species.

10 The humpback chub was the main driver of management actions in the area. **Q:** In terms of modifying dam operations, improving habitat, or reducing predation? **A:** All of those things. Glen Canyon Dam put about 200 miles of what used to be native fish habitat under a lake. Razorback suckers can survive in a reservoir, but pikeminnow and humpback chub do not. The dam also changed downstream habitat by releasing cold water drawn from the depths of the reservoir.

11 Because native fish in Grand Canyon are adapted to warm water, biologists speculated that cold-water releases through the turbine penstocks may need to be offset with a Temperature Control Device (TCD). Proposed around 2002, the controversial TCD would have modified the dam to mix warmer surface water with the deeper cold water going into the penstocks.

12 In retrospect, biologists may not have adequately understood the situation. Cold-water releases may benefit native species by inhibiting the incursion of non-native warm-water fish into the system. Humpback chub still have access to the Little Colorado River (LCR), where the seasonally warm water is good for spawning.

13 Managers could target a water temperature using a selective withdrawal TCD, which would employ elevators to withdraw water from any level of the reservoir and release it through the penstocks.

14 The cost to install a selective withdrawal TCD would have been about $100 million. While making careful evaluations in the face of concerns about the cost, scientists were reminded that despite our efforts at control, nature usually drives the system.

15 Elevations in Lake Powell and Lake Mead were dropping due to long-term drought since 2000. Water releases from Glen Canyon Dam that had been 8-10 degrees centigrade increased to up to 16 degrees centigrade. The warmest water came through in the fall due to "reservoir overturn."

16 The warmer water in the fall was of little benefit to humpback chub, which are spring spawners. Ironically, it could now be argued that a TCD may be needed cool the releases. **Q:** Have humpback chub always spawned in the LCR, or did that develop after the dam was built?

17 **A:** It has always occurred, at least in recent history. The Kolb brothers [historic Grand Canyon photographers] observed numerous fish in the LCR at spawning time early in the 20th century, and 1970s studies documented spawning in the system. Scientists suspect humpback chub also spawned in the mainstem before the closure of Glen Canyon Dam.

18 Post-dam spawning in just the LCR provides enough young to sustain the population. The other surprise from nature was the lowering elevation of Lake Mead, similar to that occurring at Lake Powell. This increased the length of the Colorado River into the Lake Mead basin.

19 The area that was once underwater in the upper reaches of Lake Mead has a layer of thick accumulated sediment brought down by the Colorado River that is now exposed. The river is re-carving out its original channel through those sediment layers and riparian habitat is regenerating. Humpback chub in that area have become the most productive of the monitored populations.

20 Native fish are thriving in the area between Diamond Creek and Pearce Ferry. Sometimes nature provides a twist that defies plans and expectations. **Q:** Science is a practice of developing a hypothesis, doing research, and developing a limited knowledge base of understanding. In adaptive management, we do a management action, try to monitor the effects, and find out if the response is what we expected. So it's constant learning.

21 **A:** Adaptive management also provides an opportunity to assess past hypotheses, analyses, and management actions from the vantage of many years later, "to see how right or wrong we were."

22 Carl Walters emphasized that adaptive management is a learning process. "If one were to believe that you could structure something in a way that's definitive, with predictable results and responses, that of course is not true at all. You learn as you do. You learn as you go." Nature always throws in unanticipated variables.

23 The benefit of being involved with GCDAMP over a long time period is realizing how much its participants have learned, whether or not they got things right. **Q:** Some of our other interviewees talked about how early hypotheses about predation evolved over time as we learned more. Can you talk a little bit about that?

24 **A:** The Colorado River has been isolated from nearby river basins for at least 3 to 4 million years. The river in the Upper Basin has not changed much through that time. In Grand Canyon, the river captured streams as the plateau rose.

25 Fish diversity is low in the river due to its historical isolation. Not counting marine fish in the estuary, only about 14 species are native to the entire Colorado River Basin, compared to other rivers with hundreds of species. The Colorado River has historically supported a "unique evolutionary scheme." Native species evolved with limited native predators and have few adaptive traits to cope with predators introduced into the system.

26 Valdez says of native species in the Colorado River, "all you have to do is look at them and you can tell, these are special. Very, very special fish. They're very uniquely adapted." The humpback chub's torpedo-shaped body and large falcate fins help it "soar," rather than swim, in high-velocity currents. A poor swimmer in laboratory experiments, it knows how to find eddies or pockets of low water velocity.

27 Valdez has worked with humpback chub throughout the Colorado River Basin. He enjoys watching the fish maneuver in the clear water of Grand Canyon. He equates them with raptors that ride thermals, making minor adjustments to maintain position with little energy expenditure. "Well, humpback chub do the same thing, except that they're in a water environment." The river delivers food to them as they stay in one place.

28 They have deeply embedded scales and thick skins to withstand the scouring of sand-laden water. The top of the humpback chub's head is flattened to allow water to pass by, and it has its namesake hump. **Q:** What is the purpose of that hump? **A:** Robert Rush Miller, who provided the fish's first taxonomic description in 1946, thought the fleshy structure of the hump was a hydrodynamic feature.

29 The razorback sucker also has a hump, formed around a bony structure, along with thick skin and large fins. It and the humpback chub are highly adapted to the Colorado River environment.

30 Starting in the 1930s with Lake Mead, the Colorado River Basin states looked at dams and reservoirs as opportunities to develop recreational fisheries. Up to now, more than 35 non-native fish have been introduced to the system. Humpback chub are ill-adapted to cope with alien species who prey on or compete with them.

31 Non-native fish are vectors for diseases and parasites. Now scientists understand that cold-water releases from the dam may be discouraging movement of warm-water adapted predatory fish into Grand Canyon. The fish currently preying on humpback chub in Grand Canyon are cold-water brown and rainbow trout.

32 **Q:** And they were introduced for fisheries recreation, right? **A:** Yes. NPS introduced them in the 1920s, starting in Bright Angel Creek. Grand Canyon National Park had just been established, and while the muddy, turbid Colorado River mainstem was not appealing for sport fishing, the side streams were.

33 Trout did well, and a hatchery was set up on Bright Angel Creek. **Q:** We have native trout in Arizona, like the Apache trout. Were there any native trout in the side streams, or were they all imported? **A:** The Apache and Gila trout are more closely related to salmon species than to mountain cutthroat trout.

34 They are native to Gila River tributaries, upstream of where it meets the Colorado River. Arizona native trout do not occur in waterways that flow into Grand Canyon.

35 The introduced rainbow trout came from California hatcheries, and the brown trout, a European species, from hatcheries in Michigan. **Q:** You were talking about their role in predation on the humpback chub. Where does that come in? **A:** Rainbow trout are concentrated between Glen Canyon Dam and Lees Ferry, forming a blue-ribbon sport fishery.

36 That area is usually too cold for brown trout, which were concentrated in the area of Bright Angel Creek and sometimes in the mainstem near the LCR. Warmer releases from Glen Canyon Dam seem to have enabled brown trout to spend more time in the mainstem.

37 Now, a sizeable number of brown trout are found at Lees Ferry, where it is feared they will compete with rainbow trout. In 2017, GCDAMP formed a science panel to explore alternatives for managing brown trout impacts on rainbow trout and humpback chub.

38 **Q:** A previous interviewee mentioned that early on, the thinking was that both species of trout were probably eating humpback chub and depressing the population. After further research, it was determined that the rainbow weren't, and the brown trout were. Is that correct in your mind? **A:** Yes.

39 Mike Yard found that both trout species prey on humpback chub, but brown trout eat 3 to 4 times the number of fish that rainbow trout eat. The smallmouth bass, which can tolerate cool water, is another potential predator.

40 Smallmouth bass have recently migrated into Grand Canyon, but there is no evidence that they have reproduced there. **Q:** And you expect them to be predators on humpback chub? **A:** They are intensive predators. The Upper Colorado River Endangered Fish Recovery Program spends about 40% of its budget removing smallmouth bass and northern pike. **Q:** There are northern pike in the Colorado River? **A:** Yes. The state of Colorado introduced them into Elkhead Reservoir some years back, and they escaped, along with smallmouth bass.

41 There are guided fishing tours in the Yampa River for northern pike, which prefer cold water and seldom leave the area. Smallmouth bass can tolerate a range of temperatures and may prove problematic in Grand Canyon. "It fills that intermediate niche between the cold-water species and the warm-water species, and could probably do quite well." **Q:** Where are we at today with the recovery of the humpback chub? I heard recently that there was talk about downlisting it from "endangered" to "threatened." What's the status now and where do you think we're going in the near future?

42 A: The humpback chub is currently listed as endangered. It was included in the original list of endangered species in 1966 and grandfathered into the Endangered Species Act in 1973. Today, the species is doing well in all parts of Grand Canyon.

43 There are six or seven aggregations, or small groups of humpback chub populations, outside the LCR area in warm-water areas. Humpback chub readily interact with boaters and are one of the fish most commonly sighted on river trips.

44 Humpback chub are very social and travel in groups. There are five populations outside Grand Canyon, in the Upper Colorado River Basin. A population in Yampa Canyon was recently declared functionally extirpated. The humpback chub recovery team is exploring the prospect of translocating humpback chub back into the Yampa River.

45 The Upper Basin populations are not doing quite as well as those in Grand Canyon, but they are currently self-sustaining. USFWS initiated a downlist proposal in February 2020.

46 If the proposal is deemed appropriate, it could be implemented within the next year. Valdez thinks it will be, as the Grand Canyon populations are doing well and the Upper Basin groups are mostly stable.

47 The endangered Colorado pikeminnow is being evaluated for reintroduction into Grand Canyon. It had been extirpated there since 1975. **Q:** As a result of the changes in the river due to the construction of Glen Canyon Dam, or something else? **A:** Probably several factors.

48 The Colorado pikeminnow is highly migratory within a given river system. In the pre-dam Colorado River it probably migrated from as far as Yuma, perhaps even feeding in the estuary. Evidence shows this fish could reach 6 feet long and 100 pounds. Now restricted to the Upper Basin by Glen Canyon Dam, Colorado pikeminnow weigh no more than 30 pounds.

49 Some Colorado pikeminnow were introduced into the Salt and Verde rivers but are not part of a recovery program. USFWS, NPS and Arizona Game and Fish Department (AZGFD) are looking at reintroducing the species in Grand Canyon. Such a population would likely not be self-sustaining.

50 The life history requirements for Colorado pikeminnow are not present in Grand Canyon due to the current state of the dammed river.

51 A downlisting for humpback chub would not significantly change Glen Canyon Dam operations. The difference between an endangered species and a threatened species is small relative to Section 7 of the ESA. The states would have a more active part in conservation measures, providing some flexibility in management.

52 **Q:** To what extent is the improved health of the humpback chub population in Grand Canyon traceable to GCDAMP and changes in dam operations? How much of it is just serendipity, and how much of it is the results of our efforts to recover the species? **A:** It is a "scientist's nightmare" to look back on the management decisions made in a program and realize that many of them did not make much of a difference.

53 The humpback chub's recovery is partly attributable to GCDAMP management decisions, but part of it is serendipitous, stemming from the results of lowering elevations in Lake Powell and Lake Mead [due to the long-term drought].

54 One helpful management action, implemented in 1995, was reducing the large flow fluctuations created when maximizing hydropower generation. The daily 20-foot river elevation increase at the foot of Glen Canyon Dam generated a wave "that was almost a daily flushing of the Grand Canyon."

55 The daily fluctuations not only disrupted boat trips, they were detrimental to young humpback chub that used the shoreline for nursery areas.

56 The fluctuating flows displaced young fish from protected areas and exposed them to predation. The Modified Low Fluctuating Flow (MLFF) alternative resulted from studies conducted prior to 1995. Valdez argued at the time that flows needed to be even more stable, since the historic river was low and fluctuated very little in the summer.

57 The Low Steady Summer Flow (LSSF) concept was implemented in 2000 to test the low flow hypothesis. Scientists discovered that humpback chub adapt to modified fluctuating flows quite well by staying near talus slopes.

58 While high flow fluctuations were not good for humpback chub, moderate fluctuations may actually benefit them. Another highly beneficial management tactic was mechanical removal of trout, carp and channel catfish.

59 **Q:** Are catfish also predators on humpback chub? **A:** Absolutely. **Q:** But not carp? **A:** Carp are voracious predators of fish eggs. Valdez remembers watching red shiners spawn in Spencer Creek, and a few minutes later an "entire herd" of carp "vacuumed" the area of eggs. The effect of predation on native fish eggs and larvae may not get the attention it deserves.

60 High Flow Experiments (HFEs) also benefit native fish.

61 HFEs build beaches and deposit sediment into large recirculating eddy complexes, creating backwater habitat for fish. Native flannelmouth and bluehead suckers and speckled dace use the backwaters more than humpback chub do.

62 **Q:** How has the science of HFEs and our understanding of their impacts evolved over time? **A:** The first HFE was in 1996. "We called it the controlled flood through Grand Canyon."

63 Valdez and others edited a book on the flood, archiving many of the studies done on the first HFE. [Webb, Robert H., John C. Schmidt, G. Richard Marzolf, and Richard A. Valdez, eds. *The Controlled Flood in Grand Canyon*. Vol. 110, *Geophysical Monograph Series*. Washington, DC: American Geophysical Union, January 1, 1999. https://agupubs.onlinelibrary.wiley.com/doi/book/10.1029/GM110.] HFEs were formerly called Beach Habitat Building Flows (BHBFs). Dave Wegner asked the National Academy of Sciences to do a review of GCES in the mid-1980s, soon after the emergency dam releases during the flood years of 1983-1984.

64 The National Academy of Sciences concluded high flows were bad for the river ecosystem through Grand Canyon because they transport large amounts of sediment out of the system.

65 A subsequent review a few years later was more nuanced, proposing high flows could be used to build beaches by suspending sediment and entraining it in recirculating eddies.

66 The Secretary of the Interior approved the first HFE. It was notable because the 30,000 cfs (cubic feet per second) release involved the bypass tubes, which did not generate electricity. The 1996 HFE lasted for almost 2 weeks.

67 Most of the sediment influenced by the HFE moved in the first 2 or 3 days, so 48-96 hours is enough time to get the desired effect. Managers later developed a protocol for doing HFEs when sediment was available in spring or fall. Because sediment from the Upper Basin is trapped in Lake Powell, the LCR and the Paria River provide most of the sediment downstream of the dam.

68 The Paria contributes sediment in late summer, and the LCR contributes in spring. HFEs were initially done in spring because that better simulated the natural hydrograph.

69 Because the Paria contributes the majority of sediment and is closer to the dam, and many of the large recirculating complexes are upstream of the LCR, the HFE protocol changed to fall releases.

70 A recent decline in production of insects and algae--the Grand Canyon food base--may be tied to fall HFEs. Production is inhibited by the scouring effect of 40,000 cfs releases in the Lees Ferry reach and a low sun angle in fall that limits photosynthesis, followed by winter weather that does not allow for recovery.

71 Fall HFEs may be a net negative for the system. **Q:** We've been hearing about low Bug Flows lately. Can you explain that? **A:** Releases from Glen Canyon Dam are a uniform temperature rather than fluctuating with the seasons, and although recent releases are warmer, the river still does not reach pre-dam temperatures.

72 Cold and unvarying water temperatures, along with fluctuating flows, have a negative effect on certain invertebrate species that fish rely on as food. Species that require both a warm and a cold period to complete their life cycles cannot currently exist in Grand Canyon.

73 Ted Kennedy of Grand Canyon Monitoring and Research Center (GCMRC) proposed the Bug Flow concept. Bugs crawl onto rocks to lay their eggs, and a steady release can keep the rocks wet long enough for the eggs to hatch before drying out. **Q:** Is that working? **A:** It appears to be, in that certain insects that fish feed on are doing better. The scouring effects of HFEs are still an issue under consideration.

74 **Q:** As I understand it, they won't even do an HFE if they haven't determined that a certain amount of sediment has come down one of those two tributaries and is available to push down the Colorado. **A:** Yes. Two factors determine if an HFE will take place: availability of a volume of water aside from that needed for normal dam operations, and availability of sediment.

75 There are years when an HFE is not authorized. **Q:** How about if we take a short break now, and then come back in about five minutes? (Recording paused.) **Q:** One of the topics we touched on earlier was mechanical removal of predatory fish that impact the chub population. What role has mechanical removal of brown and rainbow trout played in fish management, and what happened when it was adopted for GCDAMP?

76 **A:** Predation on humpback chub, especially the young, was a concern across the Colorado River Basin. The most direct management solution was mechanical removal of as many non-native predatory fish as possible.

77 Going back to the 1996 Record of Decision (ROD), predation was identified as a major threat to native fish in Grand Canyon.

78 Although brown trout had been identified as the biggest threat to humpback chub, they were outnumbered by rainbow trout.

79 Water in the Colorado River mainstem was too cold for rainbow trout to self-sustain, so AZGFD introduced them annually to sustain the fishery. They were able to reproduce after implementation of the MLLF alternative. Younger trout began to move downstream, closer to prime humpback chub territory near the LCR.

80 Managers proposed intensive removal between Lees Ferry and Badger Creek at key times of the year, when they suspected rainbow trout would be moving downstream. They did removal experiments and coordinated an Environmental Assessment.

81 **Q:** Was the research on that before the 1995 EIS, or at the time it was being developed? **A:** Immediately after. In the early 2000s, the idea of removing trout when they got to the LCR area, rather than trying to intercept them on their way, was proposed. The multi-year experiment involved several removal trips.

82 Mass trout removal led to some complicating issues. The first was what to do with the dead fish. NPS would not allow them to be ground up and returned to the water or buried alongside the river. Instead, the ground fish remains were put in barrels and used as fertilizer.

83 The second issue was that Native American tribes had concerns about the taking of life in Grand Canyon. Removal was effective in reducing trout numbers as long as it was ongoing.

84 It only took a year or two for rainbow trout to repopulate a designated area, leading to doubts about mechanical removal as a sustainable management action. Managers considered how many adult humpback chub there needed to be for a population to sustain a certain amount of predation by rainbow trout, and developed triggers for mechanical removal based on numbers of both species.

85 The research was incorporated into the 2016 LTEMP EIS. Predation by brown trout, which primarily spawn in Bright Angel Creek, continued to be a problem.

86 In about 2012, NPS put a fish weir at the mouth of Bright Angel Creek to remove brown and rainbow trout.

87 **Q:** So rainbow trout were spawning also in Bright Angel Creek. **A:** Yes. In the last 5 years, NPS has removed trout directly from Bright Angel Creek. Valdez cites a paper reporting a decline in these non-native trout of 75%-80% following removal actions. [Healy, Brian D., Robert C. Schelly, Charles B. Yackulic, Emily C. Omana Smith, and Phaedra Budy. "Remarkable Response of Native Fishes to Invasive Trout Suppression Varies with Trout Density, Temperature, and Annual Hydrology." *Canadian Journal of Fisheries and Aquatic Sciences.* Ottawa: NRC Research Press e-First Article, June 3, 2020. https://www.nrcresearchpress.com/doi/10.1139/cjfas-2020-0028#.Xz8YHDV7mUn.] **Q:** Let's pause. (Recording paused.)

88 The NPS interception of large, spawning adult trout was also controversial. People made annual hikes down Bright Angel trail to catch the big fish in the fall.

89 The paper reporting the sharp decline in trout after removal efforts in Bright Angel Creek (see Minute 87) also cited a 400% increase in that area of native flannelmouth and bluehead suckers.

90 The costs of maintaining management actions for as long as needed has to be considered at the outset. Another option is to do them periodically.

91 GCMRC and AZGFD monitor the river through Grand Canyon, so any sudden increase of a given species should be detectable before it becomes a big problem. Smallmouth bass may be the next problematic species. **Q:** So as far as you know, there isn't an active mechanical removal program today, but it's still a possibility and may become necessary in the future?

92 **A:** The mechanical removal program in Bright Angel Creek is ongoing. There is also some removal in Havasu Creek. Humpback chub were translocated there, as well as to Shinumo Creek. In light of Native American concerns, the approach is to improve humpback chub population so that it can sustain a certain level of predation.

93 The brown trout management team has developed an incentivized removal program at Lees Ferry that pays "bounties" on brown trout brought in by anglers.

94 The incentivized removal program has the potential to be cheaper overall than mechanical removal.

95 **Q:** Are you aware of any objections by the Havasupai Tribe of mechanical removal of trout in Havasu Creek? **A:** Valdez is aware of concerns, but has no recent involvement in the issue. **Q:** Who do you think have been the most important researchers and participants in GCDAMP over time? **A:** Valdez says he knows more scientists than administrators or managers.

96 Dave Wegner was instrumental in bringing together scientists under GCES. The GCMRC facilitated Carl Walters' participation in GCDAMP. Walters "shook up the scientific community in Grand Canyon. Because we thought we were pretty darn good at what we were doing. Carl made us realize that we could do more, much more."

97 Walters urged GCDAMP participants to understand how adaptive management really works, and to be alert to "natural experiments that were taking place right in front of our eyes."

98 Scientists and managers must remember that conditions in Grand Canyon varied from year to year. "It was basically conducting a huge outdoor experiment over which you have little control over environmental variables." Condition dependency allowed for conducting experiments only in years when the conditions were suitable.

99 Bill Pine initiated the Near Shore Ecology Studies that broadened understanding of young humpback chub survival.

100 Pine also introduced the use of laser ablation sampling of fish inner ear bones, which can reveal in detail the life events of individual fish.

101 Lew Coggins also introduced new analytical techniques. Coggins earned his PhD under Pine and Walters, who both have strong marine fish backgrounds.

102 The study of marine fisheries involves large scales and much uncertainty, so its analytical techniques are more advanced than those used in freshwater fisheries. Coggins developed a mark-recapture model to better estimate the numbers of humpback chub in Grand Canyon.

103 Josh Korman applied his research experience with trout in Canada and Alaska to better determine how brown and rainbow trout behave in Grand Canyon.

104 Korman and Mike Yard found out that rainbow trout in Grand Canyon are late winter spawners. After hatching in spring, the fry stay in shallow, sheltered areas around Lees Ferry. A fluctuating flow dam operations scenario strands the young because they are in shallow water.

105 Young trout seek out rocky, steeper shorelines as they get older. This knowledge inspired the concept of trout management flows for regulating their population.

106 Intentionally stranding fry before they have a chance to grow and migrate downstream is an alternative to mechanical removal. **Q:** Has anyone tried that option yet? **A:** Experimental trout management flows have worked to a certain degree.

107 Part of the trout population in the Lees Ferry reach was spawning not in shallow areas, but more toward the middle of the channel. Warmer releases from the dam expanded the spawning window, so there are young of different ages in the area over a longer time.

108 There may be competition for spawning areas between rainbow and brown trout. Browns spawn from October into January, and rainbows from late December to February. "I think the important message here is that, if you understand the life history of the species, it may not be a direct sledgehammer that's the solution."

109 That understanding illustrates the value of Walters' and Pine's influence. Jack Schmidt pioneered understanding of sediment distribution and the HFE concept. Schmidt has mentored many graduate students in studying Grand Canyon, including Paul Grams of GCMRC.

110 Most recently, Charles Yackulic joined GCMRC around 2010. He has an extensive ecosystem modeling background.

111 Yackulic has especially advanced understanding of the relationship between the Colorado River mainstem and the LCR for humpback chub. He coordinated work across the different Grand Canyon science disciplines for evaluating the 2016 EIS alternatives. Larry Stevens is knowledgeable in almost every aspect of Grand Canyon science.

112 Stevens has an "almost insurmountable" understanding of Grand Canyon. Steve Carothers conducted one of the first fish surveys through Grand Canyon.

113 Carothers started environmental consulting company SWCA in the 1970s. Valdez joined SWCA in the late 1980s, when Carothers got tired of competing against him for research contracts. **Q:** What key reports or studies would you highlight as particularly important, that have retained their value over time?

114 **A:** The 1996 EIS is pivotal. Glen Canyon Dam was built before NEPA (National Environmental Policy Act) compliance was a factor. The 2016 LTEMP EIS is a good archival document for GCDAMP research and management. The four reviews from the National Academy of Sciences show "evolution of thinking by scientists in the Grand Canyon."

115 The first review was done right after the natural high flows of 1983-1984. Flows through Grand Canyon peaked at almost 90,000 cfs. The National Academy of Sciences cautioned that an HFE would flush all the sediment into Lake Mead, a contention subsequent NAS reviews revised.

116 Jack Schmidt was a proponent of common-sense management policy. There are many reports and manuscripts detailing Grand Canyon Science. In his own work, Valdez is most proud of an article he co-authored in *BioScience*. [Schmidt, John C., Robert H. Webb, Richard A. Valdez, G. Richard Marzolf, and Lawrence E. Stevens. "Science and Values in River Restoration in the Grand Canyon: There is No Restoration or Rehabilitation Strategy That Will Improve the Status of Every Riverine Resource." *BioScience* 48, no. 9 (1998): 735–747. https://doi.org/10.2307/1313336.]

117 In a "wonderful conversation" that happened before the time of GCDAMP, Schmidt encouraged Valdez and his other co-authors to document what they had learned in studying Grand Canyon.

118 The paper introduced the "intractable dilemma" concept, the recognition that no single management action in Grand Canyon could simultaneously benefit all resources.

119 The idea that different conditions are available at different times of the year and management should be conducted accordingly "opened the door, beautifully, for adaptive management." Experiments are designed and continuously evaluated and adjusted over time.

120-21 Yackulic and others recently published a paper that nicely visualizes how humpback chub spend their lives in the Grand Canyon system. [Yackulic, Charles B., Michael D. Yard, Josh Korman, and David R. Haverbeke. "A Quantitative Life History of Endangered Humpback Chub That Spawn in the Little Colorado River: Variation in Movement, Growth, and Survival." *Ecology and Evolution* 4, no. 7 (2014): 1006-1018. doi:10.1002/ece3.990.]

122 **Q:** What do you think is the value of adaptive management in trying to manage complex resources in a environment that we can't predict or control? **A:** That is the most pressing question for many systems.

123 The system in Grand Canyon is similar to others in the western U.S. in that dams and diversions have fundamentally altered the ecosystem. The Colorado River ecosystem, while dynamic, had persisted over 3 to 4 million years. Evidence shows lava flows dammed the river in parts of Grand Canyon before slowly eroding.

124 It was a dynamic system long before it was subject to large-scale human influences.

125 It is unlikely that the system could be restored to its pre-human state. The components of the historical river cannot be replicated, and managers have to work with the system in its current form.

126 Ideas about how the current components might work can be expressed as hypotheses, making the system a good setting for adaptive management.

127 Surprises from nature and condition-dependent frameworks complicate experiments. "You're basically doing experimentation in a large open laboratory, with no control whatsoever, except for perhaps a large spigot called Glen Canyon Dam."

128 Now that Valdez is not as involved in GCDAMP, he finds value in the ability to look at it objectively. Mechanical removal of non-native fish was more complicated than first hypothesized. HFEs had unanticipated effects that had to be incorporated into subsequent experiments.

129 Carl Walters cautioned that experiments need to be conducted and evaluated before policy is implemented. Many GCDAMP participants have trouble understanding how long that experimentation and evaluation actually takes.

130 There are few definite answers for managers, even after over 30 years of experimentation. Ongoing involvement, and ongoing understanding of the system's dynamics, are critical. **Q:** Will there be some point in the future when we've learned enough that we don't really need GCDAMP anymore? Or is the constant evolution and accretion of knowledge so valuable that it should be continued, at least for the foreseeable future?

131 **A:** Yes, it should be continued, but not simply for the sake of science. Society has decided that Grand Canyon is one of North America's most valuable resources. "It's important to maintain the Grand Canyon as well as we can, and maintain all the resources within the Grand Canyon. When it is a societal decision, and it is a societal value, I think it does rise to the level of justifying an ongoing funding of the program."

132 AMWG is a federal advisory committee under the authority of the Secretary of the Interior. This reduces complexity, especially in funding. Only the program managers can decide if paring down the budget is necessary.

133 The role of scientists in Grand Canyon is to gather information objectively, and the role of GCDAMP administrators is to facilitate science-based decision-making. Those roles are necessary to protect resources in Grand Canyon and downstream.

134 If GCDAMP were to go away, the situation might be similar to the "water wars" that happened before the Upper Colorado River Endangered Fish Recovery Program was implemented.

135 **Q:** What advice would you have for people coming newly into GCDAMP about how to be successful in advancing the program?

136 **A:** Patience and humility. New members have to realize that many people before them have been working toward the best balance of water management and protection of resources. Understanding of roles. Scientists, especially, need to understand their function in GCDAMP.

137 Humility is essential. No one person is going to be able to solve every problem.

138 Have patience with fellow stakeholders. Understand that the intent of adaptive management is to figure out how to do things better.

139 GCDAMP does well at coordinating the science. Having GCMRC under USGS means reports are easily accessible and kept current, which is not the case with all river basin programs.

140 Thanks and goodbyes.

Jennifer Sweeney:	00:00:00	Recording.
Paul Hirt:	00:00:02	This is Paul Hirt and Jennifer Sweeney, of Arizona State University, interviewing Richard Valdez at the SWCA [SWCA Environmental Consultants] offices in Salt Lake City on March 4, 2020. Rich, thanks for interviewing with us today.
Rich Valdez:	00:00:16	Thank you for asking me.
Paul Hirt:	00:00:18	Would you just start out by telling us, um, the positions that you've held in the Adaptive Management Program over the years and the years that you were participating?
Rich Valdez:	00:00:27	Yeah. Thank you. I, um, I started working, um, in the Grand Canyon with Glen Canyon Dam operations in (pause) in 1989. That was when it was the Glen Canyon Environmental Studies, GCES, under Dave Wegner, and the [U.S.] Bureau of Reclamation. And, uh, at that time I was contracted to do a life history and ecology of the humpback chub through the Grand Canyon. So that was my first time there. And as a result of that involvement, I, uh, I also did some other things. I worked some with the Hualapai Tribe. So we extended a lot of our investigations below Diamond Creek, all the way to Pearce Ferry. So we were doing about two hundred and seventy-five, two hundred eighty miles of river that we were surveying for fish populations. And with that, uh, I then was asked to convene several, uh, panels of scientists. One in 1999 to look at the possibility of a second population of humpback chub in the Grand Canyon. And I met with the geneticists and biologists to look at ideas of how to start humpback chub in the Grand Canyon. That was about 1999. In, uh, in 2000 I was involved in the Low Steady Summer Flow experiment. I did the fisheries evaluation of that experiment. And then in, um (pause) in 2003, I was part of a team of scientists that were looking at the possibility of a Temperature Control Device [TCD] for Glen Canyon Dam, and that was being coordinated by the Bureau of Reclamation. And in, uh, in 2004, I coordinated a survey of some of the tributaries in the Grand Canyon with Steve Carothers. So we looked not only at the mainstem, but also fisheries populations in places like Shinumo or Bright Angel Creek or Havasu Creek and some of the others, uh, in the system. And then in 2010, I was asked by the, um, the Bureau of Reclamation to convene a science panel on reintroducing razorback sucker into the Grand Canyon. And, uh, and then in, uh, in 2012, I was asked to convene another science panel by the, uh, seven Colorado River Basin states, to evaluate possible alternatives that would become part of the 2016 LTEMP [Long-Term Experimental and Management Plan] EIS [Environmental Impact Statement]. LTEMP was of course the Long-Term Experimental Management program for the Grand--Glen Canyon Dam. And then, and then most recently, uh, I

		was, uh, asked to be a member of the brown trout management team, looking at options of how to manage brown trout. Worked with, uh, Mike Runge and Charles Yackulic to look at the options of how to manage brown trout and reduce predation by brown trout on, uh, on humpback chub and on other trout species in the system, especially in the tailwater. So, it's pretty much spanned from about 1989 to, here most recently, 2019.
Paul Hirt:	00:03:43	That's a nice long tenure.
Rich Valdez:	00:03:45	Yeah.
Paul Hirt:	00:03:46	Um, how much of the work that you did was, uh, say contract research work with SWCA versus work, um, directly as a participant in the Glen Canyon Dam Adaptive Management Program, like with AMWG [Adaptive Management Work Group] or TWG [Technical Work Group]? Can you--?
Rich Valdez:	00:04:05	Yeah, most of it was contract work. Most of it was contract work either through BIO-WEST or through SWCA. And the BIO-WEST work was that initial, uh, study of fisheries, the life history ecology of humpback chub through the Granya--through the Canyon. And then the, uh, subsequent to that, uh, it's been through BIO-WEST. And I was involved in a number of AMWG and TWG meetings, but pretty much always as a, uh, as a linkage to one of these two companies.
Paul Hirt:	00:04:38	Mm-hmm, great. So let's, um, drill down a bit on, um, the role of the humpback chub in the Adaptive Management Program. You're probably going to be the most knowledgeable expert we interview on the life history and the status and the recovery efforts of the humpback chub so, talk a little bit about how that all got started and developed over time.
Rich Valdez:	00:05:06	Yeah, it's an important part of, uh, of the Glen Canyon Dam operations, because the humpback chub is perhaps one of the keystone species, if not the keystone species, for, for that particular project and that operation. Um, I've been, uh, the, the recovery team leader for the humpback chub recovery team since 2015, so it's put me close to some of the populations, not only in the Grand Canyon but in the Upper [Colorado River] Basin as well. But the interesting part about it is the, the genesis of how the humpback chub came into the importance and significance that it holds in the Grand Canyon. I started working in the Upper Colorado River Basin in 1968, uh, with a fellow graduate student. He was doing work on the Colorado and Green rivers and I was doing work in Alaska, so we would trade ea--trade off helping each other. And, uh, after that, then I was, um, uh, I got involved in some of the work, earlier research--now, this is before the Endangered Species Act [ESA] was passed in 1973. And at that

time, um, the humpback chub and the, what was at that time known as the Colorado squawfish, and is now called the Colorado pikeminnow. At that time, those species were, were included under the Endangered Species Conservation Act, uh, the Preservation Act of '66, and then the Conservation Act of '69, prior to the passage of ESA. So, uh, in 1973, when, uh, the Endangered Species Act was enacted and signed by President Nixon, those species then became part of this suite of species in this country that people had to protect somehow, but no one ex--knew--no one knew exactly how to do it. And so I was in on some of the original, uh, Environmental Impact Statements, the EAs [Environmental Assessments] that affected some of these species. Uh, the, that took place in the, uh, especially in the Upper Colorado River Basin. But it's interesting to note that in, um, and I was with [U.S.] Fish and Wildlife Service starting in 1979. I was hired by the Service to start a field station in Grand Junction, Colorado. To do that, specifically to evaluate the distribution and abundance of these fish in the Upper Colorado River Basin, so, above Lake Powell, basically. And in (pause) and in, and until 1980, from the time that the [Endangered Species] Act was passed in '73, we had these Biological Opinions that all declared jeopardy. In other words, that the action would, would likely continue to jeopar--or, continue to jeopardize the existence of the species. Um, in 1980, with the a--with the amendments to the Endangered Species Act, that concept of reasonable and prudent alternatives was then put into the Act, which really opened the door and allowed agencies, now, to start doing good things for the species to offset or mitigate those potential bad things. And that, that became the heart of what became, then, the Glen Canyon Dam EIS, is basically those reasonable and prudent alternatives that were put forward.

Rich Valdez: 00:08:32 Now, the first EIS was done, of course, in 1995, when the, uh, humpback chub was, um, was listed, and the Biological Opinion was under a jeopardy determination. In other words, it was declared that the operation of Glen Canyon Dam was likely to jeopardize the continued existence of the species. That changed in 2008, when the [U.S. Fish and Wildlife] Service came up with a non-jeopardy determination, and decided that, instead, they would go with conservation measures, which was, which were finalized in 2010. So now we have an agency, or agencies, the Bureau of Reclamation and the [National] Park Service, in that case, that were looking at ways to do things better as a way to benefit, not just to mitigate the potential jeopardy effects, but also to benefit the species. So (pause) so the humpback chub underwent a whole, I think evolution of understanding of how that species worked out with the Endangered Species Act, how the Act was going to apply to that species specifically. And the Grand Canyon became kind of the (pause) the stage for that to all take place. Where the Grand Canyon supported the largest population of humpback chub known in the Basin. Uh, there were six other populations in the Upper Basin, but they were all smaller. Uh, but the humpback chub was the main driver, I think, of a lot of the actions that took place in that system.

Paul Hirt: 00:10:11 And actions in terms of modifying dam operations? Or, um, actions in terms of, uh, improving habitat or reducing predation, all of those things?

Rich Valdez: 00:10:22 It was all of those things, and initially, as a fish biologist, my first reaction to seeing, uh, a large dam put in the middle of a river that used to be occupied by these fish, was that of course--that dam, first of all, backed up Lake Powell for about two hundred miles, and that meant there was two hundred miles of river that were under a lake. So it eliminated that habitat to the species. And these are not lake dwellers, except for the razorback sucker. Uh, the humpback chub and the pikeminnow don't do well in lakes, or reservoirs. So that eliminated that habitat. But also what the dam did is it was now drawing water from dee--from the depths of the reservoir, what is known as the hypolimnion, and that's the cold region, so you had cold releases going downstream, that we all knew was not good for the warm-water native fish like humpback chub. So our first reaction was to, and then I--I talk, I say that collectively for most fish biologists, was to say, we're going to somehow need to offset that cold water coming out of the dam by some kind of temperature control devices. So the TCD became a pretty important and controversial, I might say, uh, proposal, starting in about 2002 or 2003. Where some of us were advocating to have the dam modified to allow warmer water, warmer, more surface water to, to be released, and warm the water downstream for the humpback chub. In retrospect, as it turns out, that probably was (pause) uh, a lack or a, uh, not a good enough understanding by the biologists to really know what was going on. As it turns out, it could be (pause) it could very well be that the cold releases have been part of the savings grace for the humpback chub in Grand Canyon.

Paul Hirt: 00:12:29 How so?

Rich Valdez: 00:12:30 In that those cold releases now prevent, or at least inhibit, other non-native warm-water fish that are predators or competitors to the humpback chub, from entering and coming into the system. And, in addition to that, the humpback chub in the Grand Canyon has been using the Little Colorado River, which is a seasonally warm system, for spawning, so it made, and still does, it makes for an ideal situation for that fish to be able to live as adults in the mainstem, and then migrate annually into the Little Colorado River and spawn in, in warmer water, and then their young then descend down into the mainstem. So that's the way that, that's the way the situation is today. And, and we didn't know that, of course, at that time. Many of us were advocating to have a Temperature Control Device, and in fact, uh, we had a series of meetings, uh, with the Bureau of Reclamation and many scientists. And in fact, Reclamation even did a, a rough estimate of what it would cost to put in a (pause) a selec--what's known as a selective withdrawal Temperature Control Device, which would mean that, that the, uh, the gates at the penstocks, where the water leaves the reservoir and it goes through the dam, the gates would be modified with elevators, so that they would, you'd have the option of basically withdrawing water from any level that you wanted within a given range. So you could mix it, warm with cold, and get target temperatures. The only problem was that (pause) the estimated price tag was about a hundred million dollars. And, um, that, um, of course raised many eyebrows, and caused much concern as to how serious we really wanted to get, uh, about that proposal.

Rich Valdez: 00:14:34 So, um (clears throat), so one of the lessons we learned, I think, as scientists in going through Glen Canyon Dam and evaluating the effects and sitting d--sitting down together and coming up with different alternatives was that, in the end, uh, it's Mother Nature that really drives everything. And, as we were considering a Temperature Control Device, of course, the elevations of both Lake Powell and Lake Mead were dropping. And with the decline in elevation of, uh, of Lake Powell, we now started to see warm water being released from the reservoir. By warm, I mean what had been ten degrees centigrade, eight to ten degrees centigrade releases were now twelve, thirteen, fourteen, maybe even up to fifteen or sixteen degrees centigrade. But that water was, that warm water was coming out in October and November. In the fall. And the reason for that is that, um, in the fall, the reservoir overturns, there is what is known as a fall overturn. And as that warmer surface water is mixing with the lower water, it comes in contact with the, those penstocks, where water is being withdrawn through the dam. And so that's why we see that warmer water at that time. Well, it just so happens, though, that that was not what the humpback chub necessarily needed, because the humpback chub is a spring spawner. So we were not seeing warmer water in the spring, we were seeing warmer water in the fall. But we were seeing warmer water nevertheless. (Pause.) So, that was one thing that we didn't fully understand and expect or appreciate when we started talking about a Temperature Control Device. Now, ironically, if you look at the system in the Grand Canyon, uh, if you, if one were to consider the continued trend or pattern of lowering reservoir elevations and more warm releases, one might even go as far as to say that maybe we *do* need a Temperature Control Device, but in fact to cool it.

Paul Hirt: 00:16:50 Wow.

Jennifer Sweeney: 00:16:53 Um, can I ask you a question, Rich, about the, um, humpback chub spawning in the, uh, LCR [Little Colorado River]? Is that something

		that's always occurred or is that, uh, something that developed after the, after the dam was built?
Rich Valdez:	00:17:08	As far as we know it's always occurred, or at least, uh, in recent history. The, there were two brothers, the Kolb brothers, who are famous for their explorations in the Grand Canyon and their photography in the Grand Canyon. And we have historic photographs of the Kolb brothers going down to the Little Colorado River at about the time that the fish would be spawning and talking about that there were a lot of fish in that system and they took their rod, their fishing poles and caught all they wanted for, to eat. The earlier studies that were done in about the 1970s also show that the fish were using that system that way, so it's probably part of the historic, uh, use of the species, that is, the Little Colorado River. But we also suspect there was (pause) there was spawning also occurring in the mainstem of the Colorado as well. That is, prior to closure of Glen Canyon Dam in, and in the 60s. And then, uh, the releases of cold water. So, if anything did change, it was probably humpback chub could no longer spawn in the mainstem, but they were still using the Little Colorado, and that was providing the young to sustain the population. So, the changes in the elevation of Lake Powell was one little bit of a surprise from Mother Nature. The other, which is somewhat related to that, was also declining reservoir elevation in Lake Mead, which now increased the length of the Colorado River into the Lake Mead Basin between about Separation Rapid, it was Separation Rapid, which is where the, uh--
Paul Hirt:	00:18:54	Powell.
Rich Valdez:	00:18:54	Powell, historically, and the Howland brothers, historically, left or abandoned the Powell Expedition. Uh, between there, for about, uh, some sixty-five or so, seventy miles, all the way down to Pearce Ferry. (Pause.) And so now, uh, what *was* under, uh, Lake Powell [Lake Mead]--and I surveyed that area and then I, in the 90s, when it was in fact under Lake Powell at the time and there was a very--
Paul Hirt:	00:19:21	Do you mean Lake Mead?
Rich Valdez:	00:19:22	I'm sorry, Lake Mead, excuse me. Thank you. And there was a thick layer of sediment in there. There was the deposits of, uh, of Lake Mead. Now, uh, with the receding levels of Lake Mead, the Colorado River has carved out its original channel. And much of that historical habitat has been restored. And in fact, the most, um (pause) productive population that we have of humpback, of humpback chub is probably in that, what we've referred to as the western Grand Canyon. Which is downstream of Diamond Creek, and all the way down to about Pearce Ferry. So, that area is, uh, if you go down to that area now, and sample some of the backwaters in that area, you'll catch primarily native fish. Not just humpback chub, but flannelmouth

suckers and bluehead suckers and speckled dace, the other species that are also there. And so, that has been another unexpected, uh, twist from Mother Nature, like I said. Uh, where one can sit and plan all the things that you anticipate are going to happen, but there's some things you just don't expect that, that will occur, and take place.

Paul Hirt: 00:20:38 Um, the other thing that you brought up that I found fascinating is, not only does nature surprise us, but, um, when we make (pause) science is a practice of developing a hypothesis, doing some research, developing a kind of a limited knowledge base. And then in adaptive management, we go do a management action, try to monitor it and find out if the response is what we expected, so it's constant learning. And what you--the, the stories that you were telling us, is about how fisheries biologists come up with a hypothesis, and then do some experiments and then learned that that's part of the story, but it's more complicated. And we're constantly developing a knowledge base over time. That's--

Rich Valdez: 00:21:31 And, and it takes that opportunity to be able to get involved at the, at the beginning of planning something like, uh, Glen Canyon Dam EIS, and trying to structure those alternatives, and doing intense analyses of all the available data, and testing of hypotheses, to try to anticipate or predict the response by resources to different management actions or scenarios. But it takes that opportunity, and then, to go back years later, and, and looking to see how right or wrong we were [P.H.: Mm-hmm]. And, and it emphasizes that concept of Carl Walters' adaptive management, whereby it's all a learning process. If one were to believe that you could structure something in a way that's definitive, with predictable results and responses, that of course is not true at all. You learn as you do. You learn as you go. And so that was, that to me that was the biggest lesson from this. Not only the way that resources responded to the things that we predicted were going to happen, but also this, this, these tricks from Mother Nature. Also Mother Nature throwing little things at us like climate change and lowering reservoir elevations or different volumes of water coming down at different years. Or perhaps, uh, bigger floods or smaller floods out of the Paria River or the Little Colorado River, that deliver different amounts of sediment into the system. There was always something going on that one, somehow, cannot always anticipate or, or make sure you cover as you're working on this and so, it really does, especially as you get involved in a--as one gets involved in a project from the beginning, and you think you've really got this right, and then you start looking at the responses down along the road a few years later and then look back at it twenty or thirty years later and you realize, wow, we learned a lot. We got some things right. We got some things not so right. And there were some *absolute* surprises.

Paul Hirt: 00:23:49 So, in addition to the surprises related to the role of temperature, river temperature, on the viability and health of the chub, uh, population, there's also been some interesting surprises in the role of predation. Some of our other interviewees talked about how early hypotheses about predation, um, evolved over time as we learned more. Can you talk a little bit about that?

Rich Valdez: 00:24:18 Yeah. Um, the, the Colorado River, um, is an historic (pause) an historical river. In that it was, it has been isolated from other river--other surrounding or nearby river basins for probably the last, uh, three to four million years or more. The historical river in the Upper Basin is very much like it has been for about that period of time. Through the Grand--through the Grand Canyon, of course, we know that more recently, as the plateau rose and the river carved its way through the canyon and captured some of the streams in the Lower Basin, we know that's a, a little bit younger, uh, geologically. But because the Colorado River has been isolated for so many years, the diversity of fish species in the system has always remained quite low. And in fact, if you look at the main Colorado River, not in--not including the species that would be marine species or that would use the estuary, not including those, there's only about fourteen species that are native to the entire Colorado River Basin. And if you compare that to, for example, the Mississippi or the Missouri, where you have hundreds of species, you can now begin to understand that you have a very, very different, very unique evolutionary scheme that has taken place in these systems. A, uh, a situation where you have few predators, and therefore have few adaptive traits to be able to cope with predators if they get introduced into the system, alien predators from other, other systems.

Rich Valdez: 00:26:07 The species in the Colorado River are, and all you have to do is look at them and you can tell, these are special. Very, very special fish. They're very uniquely adapted. You look at something like the humpback chub. It is a species that is very torpedo-shaped to deal with high-velocity current. It is a species that has large falcate fins, to be able to soar in that current. Not to necessarily swim into it at high velocity--in fact, the humpback chub is a very poor swimmer in laboratory experiments. They're not even as good a swimmer as any salmon species, or striped bass, or any riverine species. But they're smart. They know how to deal with these high currents by finding small eddies or small pockets of low velocity. And, and I, I am fortunate enough to have been in the--have worked with the species in the Upper Basin, and to have worked with the species in the Lower Basin and Grand Canyon, where the water was clear and I could now see the fish. And it's fascinating to watch humpback chub, uh, and how that fish is able to maneuver through currents in the Grand Canyon. And I--and I like to equate that somewhat to a raptor that is soaring on the edge of a cliff or a rim, and is using those thermals to maintain its position. And all you see is it tweaks one wing a little bit, or a feather, and it's able to stay there with relatively little energy expenditure. Well, humpback chub do the same thing, except that they're in a water environment. *And*, in addition, the river also delivers food to them as they're sitting there, with little energy expenditure. So it's a fascinating species, they have very, uh, they have deeply embedded scales. They have thick leathery skins, to resist the, the um, the scouring of a sand-laden system. They have a flattened, uh, rostrum or, the top of their head is flattened, so that it allows water to pass by. And, also, they have that hump, which is, which is the origin of their name, of course.

Paul Hirt: 00:28:28 What is the purpose of that hump? Does anybody know?

Rich Valdez: 00:28:30 Well, Robert Rush Miller, that, who identified the fish, or described the fish initially, taxonomically, in 1946, thought--and I, and I think there's a lot to it, that they're, it's part of uh, a hydrodynamic, uh, feature, that enables or allows the fish to maintain that position in the--in a river current. It--there is no bony structure in it at all, it's simply a fleshy structure, unlike the razorback sucker. The razorback sucker has a--in fact, it was also called the humpback sucker for many years. The razorback. Now it's called the razorback sucker. The razorback sucker does, in fact, have a modified bony structure that forms the razor, or the hump. Not so with humpback chub, the humpback chub has a fleshy protrusion behind the head that takes place, so it helps to stabilize. So, if you look again at the different species, you can see these adaptations. You see razorback sucker with a, a (pause) a hump on their back, that if you look at it from the front, appears to be this very nicely designed, hydrodynamic, uh, feature, that would allow that fish to stabilize itself and to maneuver around. It also has a very thick skin, and also has fairly large fins. And so, these fish were very, very specifically and very highly adapted to the environment that is the Colorado River. Now, along comes (pause) uh, well, in the, um (long pause) in the nineteen, uh, starting in the 1930s, of course, with Lake Mead, and then through the Colorado River Storage Projects, uh, with Glen Canyon Dam in '63 and then, uh, Flaming Gorge, '62, '63, and then Navajo also. The states looked at the formation of these reservoirs as a great opportunity for recreational fisheries.

Rich Valdez: 00:30:31 And so, with that, they started introducing things like largemouth bass and crappie and bluegill and green sunfish and bullheads and fathead minnows and red shiners, all kinds of fish. And in fact all together today, you've got fourteen fish that are native to the system and you've got upwards of about thirty to thirty-five that are alien or from other river basins. And, you have fish that are not--are ill-adapted, that is, the humpback chub, ill-adapted to coping with those, with those alien predators or competitors. And they're also vectors for diseases and parasites as well. So (pause) so now we go back to this idea of a Temperature Control Device, and what protections the, uh, cold water releases out of Glen Canyon Dam have provided to the humpback chub. Now we began to better understand how that cold water has in fact, been a barrier or at least, uh (pause) discouraged the invasion of many of these alien fish, that could have come up from Lake Mead or could have come down from Lake Powell. Yes, they are in the system, but they are not thriving as you might otherwise expect if it was a warm-water system. So predation is a, is a key issue. And it is in the Grand Canyon. Interestingly enough though, in the Grand Canyon, predation is not necessarily from (pause) warm-water fish. Predation is principally from the cold-water fish, that is rainbow trout and brown trout.

Paul Hirt: 00:32:12 And they were introduced for a fisheries-based or recreation--fisheries recreation, right?

Rich Valdez: 00:32:19 Yeah. The, the, uh--

Paul Hirt: 00:32:20 Those are not native to--

Rich Valdez: 00:32:21 Both the rainbow trout (pause, clears throat) both the rainbow trout and the brown trout were introduced by the National Park Service in the 1920s. Into, initially into Bright Angel Creek. And of course at that time (pause, clears throat) excuse me, the Colorado River was a warm, muddy, turbid river. And yet there was Grand Canyon National Park that had just been established. And, so there was a need to have--people have some kind of recreational opportunity, you wouldn't imagine fishing this dirty, warm mainstem Colorado River, but you *would* gain enjoyment, and in fact a unique opportunity to fish for trout, literally in the middle of the desert. And so--

Paul Hirt: 00:33:12 In these side streams.

Rich Valdez: 00:33:13 In these side streams. Exactly, in places like Bright Angel Creek. And Bright Angel Creek was one of the places, in fact, it was *the* main place, where trout were brought in by the Park Service, in the ni--

Paul Hirt: 00:33:24 I heard they brought them in in Clear Creek too, a little ways upstream from Bright Angel.

Rich Valdez: 00:33:30 They did, they did. And in fact--

Paul Hirt: 00:33:31 And they did well there.

Rich Valdez: 00:33:33 They did *quite* well. And in fact, there was a hatchery facility that was set up at Bright Angel Creek.

Paul Hirt:	00:33:38	Wow.
Rich Valdez:	00:33:39	To culture rainbow trout and brown trout. And--
Paul Hirt:	00:33:43	Now I'm curious, we have native trout in Arizona, like the Apache trout. Um, I wonder, I've never heard anybody say that, um, there were any Apache trout native in these side streams. Were there any trout in the side streams, or were they all imported?
Rich Valdez:	00:33:58	The, um, the Apache trout and the Gila trout are, um (pause) were derived from a, uh (pause) a fish that was more closely akin to the salmon species, as opposed to the mountain cutthroat trout. The Apache trout and the Gila trout, uh, are not in tributaries of the Grand Canyon. They are, they're native of the tributaries of the Gila River. That eventually does go into the Colorado River, but further downstream. And so, uh, historically and even today, we don't have Apache trout or Gila trout in either headwaters of the Little Colorado River, or in Havasu Creek or any of the other, uh, tributaries that come in on that side or, for that matter, on the other, on the North Rim, either out of Bright Angel or Shinumo or any of the other tributaries there as well. So those were outside of the system so, the fish that were introduced were in fact, uh, rainbow trout from, uh, from hatcheries in California, and then brown trout from hatcheries in Michigan, that eventually came from Europe. Because the brown trout is a European species.
Paul Hirt:	00:35:24	And, um, you were talking about, um, their role in, in predation on the humpback chub. Where does that come in?
Rich Valdez:	00:35:32	Yeah. And so, um (pause) the rainbow trout, of course, has been concentrated principally in the tailwater, uh, of, of Gle--of Glen Canyon Dam. The fifteen miles from the dam down to, uh, down to Lees Ferry. And that of course has become a world-renowned blue-ribbon trout fishery. People come from all over the world to fish there. Uh, there have not been many brown trout in that system, perhaps because the water was *too* cold. Brown trout, historically, or that--that is, after the dam was completed in, uh, 1963, brown trout were, were principally concentrated around Bright Angel Creek. And that's of course where they were introduced originally. And there were some in the mainstem as well. We would catch brown trout at the mouth of the Little Colorado River, which is upstream of Bright Angel Creek. And, they were moving up there and then evidently moving back, and then spawning in Bright Angel Creek. With the increasing temperature, as a result of lowered elevations in Lake Powell, and warmer water coming out of the dam, it has apparently enabled or allowed brown trout to move around more in the mainstem. So they perhaps are not as closely tied to Bright Angel Creek, for example, as they were historically. They can now start using

the mainstem more because they're a warmer-water fish species than, say, rainbow trout. Recently, we have found brown trout up in Lees Ferry. And in fact in, in sizeable numbers. And a concern is that brown trout may in fact be competitors and predators for the rainbow trout at Lees Ferry.

Paul Hirt: 00:37:25 Really?

Rich Valdez: 00:37:26 And then--in 2017, uh, the GCDAMP [Glen Canyon Dam Adaptive Management Program] asked to convene a science panel that was headed up by Mike Runge of the USGS [U.S. Geological Survey] and Charles Yackulic from GCMRC [Grand Canyon Monitoring and Research Center], myself, and other biologists in that program, to look at what alternatives might be available for controlling brown trout, removing them, and reducing that predation and competition threat, not just for rainbow trout in the tailwater, but the potential is that if brown trout were to expand, then they could end up in prime humpback chub habitat. Which is, uh, which is at the LCR, River Mile 61, so about seventy-five miles or seventy-six miles downstream from the dam. So that's a concern that we have now, is the potential for brown trout being a major predator in that system.

Paul Hirt: 00:38:23 I can remember, um, one of our interviews, uh, somebody mentioned that, uh, early on, the thinking was that both species of trout were probably eating humpback chub and depressing the population. And after further research, it was determined that the rainbow, basically, weren't, and the brown trout were. Is that correct in your mind?

Rich Valdez: 00:38:47 Yeah, there was--

Paul Hirt: 00:38:48 How did we learn that?

Rich Valdez: 00:38:49 Yeah, there was, there was some excellent work that was done by, uh, Mike Yard, uh, on looking at the effects of predation by both species. And, it followed up on some of the work that we had done there earlier, when we were doing the life history and ecology studies on the humpback chub, and what Mike found is that, uh, brown trout--both species eat humpback chub. They both will prey on them. But brown trout eat them, as I recall, something like three to four times more (pause) they'll eat three to four times *more* humpback chub than rainbow trout do. So the pr--so for one brown trout, you're going to have a fish that would equal maybe three or four rainbow trout in terms of the numbers of humpback chub that that fish might eat. So predation was a, is a real problem, especially with brown trout. Um, the other species that we're seeing in the system is, is the smallmouth bass. And we're especially concerned about smallmouth bass, because they in fact are a cool-water species. They do tolerate cooler water than, say, largemouth bass or crappy or bluegills or some of the warm-water fish. That fish has now recently gotten into the Grand Canyon. To my knowledge, there is--there's no evidence of reproduction in that system yet, but it's certainly a, a river that would be suitable for reproduction by the, by that species. So that's another one we're kind of keep an eye--our eye on.

Paul Hirt:	00:40:16	And you expect them to be predators on humpback chub?
Rich Valdez:	00:40:20	They are--they are *intensive* predators. In fact, um, the Upper Colorado River [Endangered Fish] Recovery Program that manages these, these endangered fish in the Upper Basin above Lake Powell, currently spends about forty percent of its budget controlling, mechanically removing, smallmouth bass and northern pike in the Upper Colorado River, specifically in the Yampa--
Paul Hirt:	00:40:45	There's northern pike in the Colorado River (laughs)?
Rich Valdez:	00:40:50	Yes, there are. They were introduced by the state of Colorado into Elkhead Reservoir some years back, and they escaped--both northern pike and smallmouth bass. And in fact, today, there are guided tours for fishing for northern pike in the Yampa River [P.H.: Wow]. You can hire a guide out of Colorado to take you down the Yampa River and catch these twenty-pound northern pike out of the Yampa River [P.H.: Wow]. Now those fish are more, uh, aligned with cold conditions, cold-water conditions, you don't see them leaving the Yampa much, although we catch them in the Green River as well, but not as much. But the, the, the smallmouth bass is a much more, uh, plastic species in terms of temperature, it can tolerate a big range of temperatures. And that's one that I, that I believe could be a real problem in the Grand Canyon in the years to come, because it fills that intermediate niche between the cold-water species and the warm-water species, and could probably do quite well in a place like the Grand Canyon.
Paul Hirt:	00:41:53	So, um, where are we at today with the recovery of the humpback chub? I heard recently that there was talk about downlisting it from "endangered" to "threatened." Um, what's the status now and where do you think we're going in the near future?
Rich Valdez:	00:42:12	Yeah, the humpback chub is currently listed, of course, as endangered. Um (pause) it was brought into--it was grandfathered into the Endangered Species Act in 1973. It was included in the original list of endangered species in 1966. Um, and so, it has been listed as endangered for, you know, since (pause) fundamentally--
Paul Hirt:	00:42:41	Half a century?

Rich Valdez: 00:42:42 Yeah, yeah. Since, yeah, right. Half a century. Um (pause) because of the, uh, expanding numbers of humpback chub that we see especially in the Grand Canyon (pause) the, the increased abundance of humpback chub in the western Grand Canyon, and how well the species is doing in the main g--in the main Grand Canyon. In addition to the fish that are in the Little Colorado River, there are about, oh, about six or seven other, what we refer to as aggregations. They're small groups of fish that are located usually in, in springs, warm-water spring areas like Fence Fault, at 30 Mile, near Vasey's Paradise. Or around the Little Colorado River, which is a seasonally warm system. Or around, uh, perhaps, um, uh, Havasu Creek.

Paul Hirt: 00:43:33 I saw a bunch at Havasu Creek, mouth of Havasu Creek [R.V: Yup, yup]. And it was clear water, so I got to take pictures of them while I'm standing kind of over them, and they're swimming around in that sandy bottom. It was cool.

Rich Valdez: 00:43:43 And in fact, yeah, in fact, many people who travel down the Grand Canyon now, raft down the Grand Canyon, uh, observe that one of the most common fish they see is in fact the humpback chub. [P.H.: Wow.] If there's scraps of food or whatever fall in the river, they're the first ones there, and they often almost are begging like a bunch of little puppy dogs (laughter), waiting to be fed. Uh, they're a very social species. They usually, uh, move around in schools as groups of individuals. And so, um, that population of humpback chub is doing quite well. In addition to that, there are also, uh, five other populations in the Upper Colorado River Basin, in Black Rocks, Westwater [Canyon], Cataract Canyon, Desolation [Canyon], Gray Canyon and Yampa Canyon. The Yampa Canyon population has recently been declared as functionally extirpated. [P.H.: Oh.] Uh, we did a species status assessment for the humpback chub about two years ago, and determined that the numbers of fish in that population were pretty much gone. We recently convened a, uh, part of the humpback chub recovery team to look at the prospect of translocating humpback chub back into the Yampa River, and establishing a population there connected with Echo Park and Whirlpool [Canyon] in the Green River, which is below Flaming Gorge, to try to reestablish that population. The other populations are either stable or perhaps in slight decline, so they're not doing quite as well, perhaps, as the Grand Canyon population, but they're, they're self-sustained, they produce young every year. Uh, we see, you know, good numbers of them in these populations. And so, the [U.S. Fish and Wildlife] Service has decided that, uh, if we examine the, the terms of the Endangered Species Act and what's defined as an endangered species, one likely to go extinct within the foreseeable future, that the humpback chub is in fact probably not that. It is an, a, a species that faces threats. And so, uh, perhaps the classification of threatened is more appropriate. So the, uh, U.S. Fish and Wildlife

Service here, uh, about a month ago, which would be back in about February sometime--

Paul Hirt:	00:46:00	2020?
Rich Valdez:	00:46:01	2020, yeah. Of this year, correct. Uh (pause) initiated the process of a downlist proposal for the species. The proposal was published in the Federal Register about a, about a month ago, which would be about February 2020. And, is open to comment, I think, 'til the end of March, 2020. If it is determined that uh, that it's appropriate to downlist the species, the humpback chub could be downlisted within (pause) within the next year. (Pause.) Uh, that would be determined, of course, as part of the, uh, ruling in the Federal Register. So that, that's one, that's one prospect. The likelihood, I think, of that is pretty good. Um, given that the population is doing so well in the Grand Canyon, and given that the population in the Upper Basin are holding their own, perhaps in a little decline, perhaps, in some years, they go back up, and if we can get fish into the Yampa River, I think we'll be in pretty good shape. But it certainly does not meet the definition of endangered, if you look at it that way. Um, there is, there is another species that's also being considered, now, in the Grand Canyon, and that's the Colorado pikeminnow. Colorado pikeminnow is also an endangered species. And there is, uh, there is currently, um (pause) an evaluation of possibly reintroducing the Colorado pikeminnow into the Grand Canyon.
Paul Hirt:	00:47:40	It's extirpated from the Grand Canyon right now?
Rich Valdez:	00:47:42	It has been extirpated from the Grand Canyon since about 1975.
Paul Hirt:	00:47:47	As a result of the changes in the river due to the construction of Glen Canyon Dam, or something else?
Rich Valdez:	00:47:53	Probably, um, all of the above, where, uh, it was a highly it's p--it's what's known as a potadromous [or potamodromous] species. In other words, it's highly migratory within a given river system so, we believe that Colorado pikeminnow, at one time, probably migrated all the way from, say, Yuma, Arizona, which is where it was warmer, and perhaps even went into the [Colorado River] estuary to feed. And, uh, the evidence is strong that the fish got to about six feet or so in length and weighed a hundred pounds. Uh, North America's largest minnow. And we've got bone fragments and remains that support that contention. Now, the biggest fish we see are about twenty-five, maybe thirty pounds. Uh, so, we're not quite seeing the large fish now. Perhaps, because they're restricted to the Upper Basin, and perhaps because they don't have the full, uh, regime of temperature year-round to, to allow that growth.

Paul Hirt:	00:48:47	So we don't have any below Lake, uh, Hoover Dam and Lake Mead.
Rich Valdez:	00:48:52	No, there are none below, um, there are none below Glen Canyon Dam.
Paul Hirt:	00:48:58	Okay.
Rich Valdez:	00:48:59	At this time. Everything is above Glen Canyon Dam. Except for small numbers that were introduced. They're not natural, but they were introduced into the Salt and Verde rivers, tributaries of the Gila [River]. And those are known, those are now currently called 10(j) populations, or experimental nonessential populations. In other words, they are there just to have them there to maintain, but they're not part of recovery targets at this time. So, the idea is being entertained right now, by U.S. Fish and Wildlife and Arizona Game and Fish Department and the National Park Service, to perhaps look at the possibility of bringing Colorado pikeminnow into the Grand Canyon. At least to have them there. The, I think it's questionable whether all the life history requirements are there for the species to be self-sustained, I don't think so at this time. Uh, that fish needs, uh, long rivers to migrate, to spawn in clean headwater areas, warm temperatures. The young drift, uh, perhaps, many miles, up to fifty, sixty miles or more, into, uh, small sand backwaters, where they can feed and live for most of the, most of the rest of the year. It's a summertime spawner, they spawn in, usually, about late June, July sometime. Those, those key life history elements are probably not present in the Grand Canyon, but I think that that's still being looked at, at least to have the species there. To say that they are someplace in the Lower Basin. Um (long pause) so, so at this point in time, the, um (pause) again, the humpback chub is being proposed for downlisting. I think there's information that would warrant that at this time. We'll see what the public decides and what others decide as well. If that li--if that downlisting takes place, it really would not change much in terms of how Glen Canyon Dam is operated. The difference between an endangered species and a threatened species is (pause) is small relative to Section 7 of the envir--of the Endangered Species Act. Um, it can open some opportunities for additional conservation measures. For example, there is a section of, in the Endangered Species Act called the 4(d) rule, that is a provision that allows the states, now, to become more active and more participant in part of the conservation measures. It gives, for example, the states the opportunity to define take. What is known as take. In other words, how you can take or kill or capture or maintain these, these individual, individual fish. So it might give some flexibility to, to management, which I think would be good.
Paul Hirt:	00:52:07	Um, can, can you say to what extent the um, improved health of the humpback chub population in the Grand Canyon is traceable to the

Adaptive Management Program (soft laughter) and, you know, changes in dam operations? I mean, how much of it is just serendipity, and how much of it is the results of our efforts to recover the species?

Rich Valdez: 00:52:34 That, that is--that is a thing of, uh, scientists' nightmare (laughter) uh, where one spends a lifetime trying to be smart enough to come up with a right management actions and then implements a program like Glen Canyon Dam LTEMP EIS, and then looks back upon it twenty years later or whatever (pause) and again, we're not that far away from it yet, but we're going to be. Uh, and you realize that many of the things that you did either made a difference or didn't make a difference, most of them, perhaps, didn't make much of a difference. And then, the word serendipity is perhaps the most, uh, the best word for that. How many things took place naturally or normally? Part of the, of the, um, the expanded, uh, distribution and abundance of the humpback chub is, in fact, due to reoperation of Glen Canyon Dam, and the actions that were put in place by the federal agencies in cooperation with the states and other stakeholders. Part of that recovery is directly attributed. Part of it, however, is, in fact, serendipitous relative to the changing elevations of Lake Powell and Lake Mead. Warmer releases from the dam and also, uh, re-excavation of the historic river channel downstream of Diamond Creek and all the way down to Pearce Ferry. Now specifically, the things that were put in place that have really helped, I think the humpback chub is that, um, prior to 1995, the, uh, Glen Canyon Dam operation was, um (pause) was a, uh (pause) a hydropower generation type facility, where hydropower is maximized by having flows as low as three [thousand] or 5,000 cubic feet per second [cfs] and uh, in, in the middle of the night, and then at about four o'clock in the morning, uh, start ramping those releases up to, say, 30,000 cubic feet per second, which is the capacity of the power plant. And, you would see then, about a twenty-foot increase in the elevation of the river right there below the dam. And this of course would generate this, uh, kinematic wave all the way downstream, and fundamentally that was, uh, almost a daily flushing of the Grand Canyon, if you may, I mean, to be a little extreme perhaps, but that, that was kind of the effect. And so when I first got involved, that was what was happening is we had these very, very high fluctuations, and of course, people will tell stories about when you were down there with the big rafts, that you had to make sure you parked those boats in such a place that you wouldn't be stranded on the beach for the next day, until those flows, you know, came back up.

Rich Valdez: 00:55:34 Um, that operation of these very, very large changes in flow, and river elevation, were probably, um (pause) were not beneficial to young humpback chub that used the shoreline for nursery areas. The fish would come out of the Little Colorado River as four- or five-month-old fish, and then they would hang out along the shoreline, which was the

		better place for them to escape predators and to find food. With flows going up and down, even as far down as the LCR, maybe as much as four, five, six feet or more, then you would have displacement of these fish, and they would either be displaced downstream or de--be displaced away from that cover, and be exposed to predation by, by another fish. So that was good. That, the idea of what was known as the Modified Low Fluctuating Flow, MLFF, that came about in (pause) in 1995, basically, as a result of those, those studies that were done prior to that. Um, that was good. Tha-- and so that, that made the, the habitat for the humpback chub a little bit more stable. Now, admittedly, I was one of the biologists that were saying--that was saying at the time, in fact, you have to try to get those flows even more stable, because if you look at summertime in the Colorado River, except for places where there's monsoonal storms that would be large enough to increase flow, by and large, the flow of the Colorado River during the summertime was relatively stable. It didn't fluctuate.
Paul Hirt:	00:57:13	And low.
Rich Valdez:	00:57:14	And low, correct. Low. And that's what brought about the Low Steady Summer Flow concept, the flow that we had in 2000, to test that hypothesis. But what we found out, and thanks to some of the work done by Bill Pine and, and others, is that in fact the humpback chub was quite plastic in terms of its ability to be able to move with those flows, and use those talus slopes. If you look at the, at the slopes in Grand Canyon, for example, downstream of the Little Colorado River, where you have young humpback chub, they are in fact slopes of talus that are continuous rock and boulder mixture all the way up the slope. So, all humpback chub has to do is just move with the water and it's at a new interface that is still that boulder-talus habitat, where it can still use those areas for, for cover.
Paul Hirt:	00:58:06	(Speaking simultaneously) Get behind in the backwater, you mean.
Rich Valdez:	00:58:08	Get behind in the little, little eddies and backwaters and little cubbyholes, in and between these boulders [P.H.: Uh-huh]. So, the large fluctuations that we saw, prior to MLFF, were probably not good for the humpback chub. The more modified fluctuations have probably helped to benefit the species, and in fact probably do help, even stimulates, maybe, some production along those shorelines when you have that water moving around the way it does. So that, that, that did help out. The other thing where we think there was quite a bit of benefit is, is there was in fact mechanical predation, mechanical predator removal in the Grand Canyon, um (pause) even before the LTEMP EIS. Where we were removing, uh, brown trout and rainbow trout from the system as well as others, other species,

removing ca--channel catfish or carp from the Little Colorado River as well.

Paul Hirt: 00:59:07 Are catfish also predators on humpback chub?

Rich Valdez: 00:59:10 Absolutely. Very much so that--

Paul Hirt: 00:59:12 But not carp, because--

Rich Valdez: 00:59:13 Well, carp, we know, are, are voracious predators of fish eggs.

Paul Hirt: 00:59:20 Oh, okay.

Rich Valdez: 00:59:21 And I've watched uh, red shiners spawning in Spencer Creek, which is the lower end of Grand Canyon. And then as the red shiners were spawning early one morning, it wasn't but five minutes, and here comes a, an entire herd of humpback (laughter)--of, excuse me, of carp, common carp that came up and just vacuumed that entire area for eggs. So they're very--

Paul Hirt: 00:59:45 And they're not native, either. That's a European fish, correct? (Speaking simultaneously)

Rich Valdez: 00:59:46 They're not native either. That's correct. Yeah. And that, that's another species that we may underestimate in terms of their effect to, to these native fish is how, how much effect they may have on eggs and on larvae, and, and their predation there as well. So, um (pause) so that, so that was another thing is, is modifying those uh, fluctuating flows. Doing some predator control to reduce the, the predation on those fish. The other, the other thing that probably did help humpback chub was, um (pause) was these High Flow Experiments [HFEs] that provided, uh, large sandy beaches and deposits in the large recirculating eddy complexes of the Grand Canyon. And as part of that recirculating complex, of course, what happens is that the water is laden with sediment because it, it is a higher volume, higher velocity. Uh, the base flows may be at uh, fifteen, twelve, fifteen, ten, fifteen, 12,000 cubic feet per second. With a High Flow Experiment, you're going up to 45,000, which is the, for--the 30,000 out of the power plant and then the 15,000 out of the bypass valves. So, when you've got 45,000 cfs going down the system, you are lifting, activating, energizing the sediment in the system, suspending it, and then when it gets to these large recirculating eddies, it slows down and drops out in the eddy. Well, as part of that large sandy beach, there is the recurrent channel, which is that little stream of high-velocity water that goes right against the bank and behind that sandbar. That recurrent channel forms a backwater. Which is very nice habitat for fish. And, hu--while humpback chub don't necessarily use those that often, they are there nevertheless, and the High Flow Experiments do help to provide that environment for the fish, but also other native species like flannelmouth suckers and bluehead suckers and speckled dace *do* use those habitats. So it has helped. So those are some of the things that the reoperation has done to benefit the fish, but like I said, many of the others are, like you said, serendipitous, because they are tied to Mother Nature and climate change and availability of water in different years.

Paul Hirt: 01:02:14 That's great explanation. Thank you. Um, you did some studies of the early High Flow Experiments, to determine whether they were being effective or not. Can you talk about how the science, and our understanding of the impacts of those High Flow Experiments, has evolved from the ver--the first one was sometime in the 1990s, right? And that's when you were looking at that, and you have a couple of publications from 1999 and 2001 on that.

Rich Valdez: 01:02:45 Yes.

Paul Hirt: 01:02:46 So how did our understanding of those High Flow Experiments evolve over time?

Rich Valdez: 01:02:51 Well, the first experiment of course was the 1996 controlled flood. We called it the controlled flood through Grand Canyon. [P.H.: Mmm.] And of course, uh, I was fortunate enough to, uh, edit a book with, uh, Bob Webb, Jack Schmidt and Dick Marzolf called *The 1996 Controlled Flood in the Grand Canyon* [*The Controlled Flood in Grand Canyon*]. And it's available through the [American] Geophysical Union, it's available on the internet. And that archived many of the studies that were done at that time and what we found out about a High Flow Experiment. Now prior to that, it was, it was called the, uh, Beach Habitat Building Flow. BHBF. That was a terminology that was supposed to be descriptive of what it was supposed to do and that was to beach--to build habitat, to build beaches. Beach Habitat Building Flow. But the history of that is, is, I think, even more interesting. The Natio--when, when Dave Wegner was, uh, head of the Glen Canyon Environmental Studies, GCES, this is all the way back into the, um, the mid-80s, he asked the National Academy of Sciences to do a review of studies and, and the program GCES in the Grand Canyon. And of course that was just after the high flow of 1983 and '84, where the capacity of Lake Powell was practically exceeded. And there were these emergency releases, you, you can read about it in, uh, the book by Kevin Fedarko--

Paul Hirt: 01:04:33 *The Emerald Mile*.

Rich Valdez: 01:04:34 *The Emerald Mile*, correct. Did an excellent job of documenting what was happening at that time. But, um, what the National Academy of

		Sciences concluded after that, uh, after those, that experience with those high flows, was that, in fact, high flows are bad for the Grand Canyon, because in fact they transport large amounts of sediment.
Paul Hirt:	01:04:57	Out.
Rich Valdez:	01:04:58	Out of the system. Correct. And so the initial thought was, "Oh my goodness, we can't allow these high flows to take place in the Grand Canyon." A second review by the National Academy of Sciences a few years later said, "No, there's perhaps more to it than that." Perhaps we can use certain releases from Glen Canyon Dam to in fact suspend that sediment and not transport *all* of it out of the system, but, but in fact entrain some of it in these large recirculating eddies, and it was people like Jack Schmidt, then other scientists, that said this, this is a way perhaps to preserve sediment, sand in the Grand Canyon, as beaches for river runners, for camping and as substrate for riparian habitat for, all the way from Southwest Willow flycatchers to, uh, reptiles and lizards and all kinds of animals that rely on those riparian areas. And so, in the, um, leading up to the 1995 EIS, the concept was, was developed, uh, of Beach Habitat Building Flows, BHBFs. And as a result of that, uh, the Secretary of Interior approved a high flow release, which was, which was really significant because it in fact, um, was a release that not only involved the full power plant capacity of 30,000 cubic feet per second, but also involved the bypass valves. Now the bypass valves, or are what are known as the jet tubes, do not have hydropower generating facilities. And so, there was in fact the costs associated with them and then--
Paul Hirt:	01:06:46	Lost hydropower revenue cost, you mean?
Rich Valdez:	01:06:48	Exactly. And so, the first, uh, ni--the 1996 experiment went for, uh, gosh, almost, almost two weeks, as I recall. It went for a long period of time. But again, we learned a lot from it, because what we learned is in fact the majority of that sediment was moved in about the first two or three days. So we learned that you don't need to have these for a very long period of time, you can only ha--you can have them for just fort-eight to, say, ninety-six hours, something like that. And that's more than enough to move that sediment. Um (pause) so, so the uh, so what happened is that, um, as that understanding was becoming better known, then, uh, there was eventually a protocol developed for releasing water from Glen Canyon Dam. That was both a fall HFE and a spring HFE. For the possibility of releasing water depending on when sediment was available. Now, it just so happens that the major sources of sediment to Grand Canyon now, because all of the sediment from the Upper Basin is trapped in Lake Powell, the major sources of sediment are of course (sound of a passing truck), the Paria River, which is fifteen miles downstream from the dam, and the Little Colorado River, which is about seventy-six miles downstream from the

dam. The Paria River is principally a fall monsoonal storm-driven system. So that that sediment is usually driven in the late, uh, is usually transported in the late summertime. In about July, August, during the monsoonal storms. The LCR, the Little Colorado River, further downstream, is a spring flood system. So that sediment is available at a different time of year. Initially, uh, the High Flow Experiments were being done in the springtime, with the idea that it was more simulating the natural hydrograph. That, you know, those were spring floods. Um, eventually, it became better understood that the majority of sediment in fact would be available from the Paria, because it was right there just downstream from the dam, and you could release it in a timely way, that you could take advantage of that large amount of sediment. Besides, the majority--many of those large recirculating complexes that entrain that sediment are located upstream of the Little Colorado River. So it's that area around, uh, from Vasey's Paradise on down, all the way down, pretty much, to the LCR. That's, that’s where a lot of the benefit would come, although there are other areas downstream as well.

Rich Valdez: 01:09:37 Now, um (pause) so HFEs, then, High Flow Experiments, became, initially were spring High Flow Experiments, and then became fall High Flow Experiments. Now, most recently, and here's, here's adaptive management coming into play, right? Where, most recently, the people that are looking at, uh, production of insects in the Grand Canyon and production of algae and everything else, are saying, "We're seeing a real decline in our food base in the Grand Canyon, and we think part of the reason is it's tied to these fall High Flow Experiments." Whereas--where in the fall, when you have a High Flow Experiment, you have got 40,000 or so cubic feet per second coming out of the dam. You've got a real scouring effect, especially on that, uh, where most of that primary production takes place, and that's in that fifteen-mile reach of Lees Ferry. So if you scour that production at that time of year, you are now at the point in this--in the year, to where you've got a low sun angle. And you don't have as much potential photosynthetic production taking place as you might otherwise. And then you've got the entire winter period, where that community does not have a chance to recover, and have, you know, and be back and productive again as you might otherwise think. So that's one of the things we're learning, the fall HFEs may be beneficial for storage of sediment because it maximizes that sediment availability, but it also might be net negative or detrimental to, to production in the system, which drives the whole, the whole food base in the system.

Paul Hirt: 01:11:22 We've been hearing about low Bug Flows lately. Can you explain that?

Rich Valdez: 01:11:26 Yeah. Um (long pause) the combination of cold water releases through the Grand Canyon, in a uniform manner without seasonal warming, because the water is always coming out or, you know, at one, at about one temperature. Before, before Lake Powell went down, it was always at about eight to ten degrees centigrade. Now it's between ten, twelve, maybe thirteen. But it's not warming up to, say, hist--what the river used to be historically, which was twenty-five degrees centigrade. So you don't see that seasonal warming. [P.H.: Mm-hmm.] That, combined with the fluctuating flows that we see, has precluded, uh (pause) the establishment of certain, uh, species of invertebrates, especially mayflies, stoneflies, caddisflies. Species that--

Paul Hirt: 01:12:26 Fish food.

Rich Valdez: 01:12:27 Fish food. Exactly. Fish food. The basis [of] production in the system. Um (pause) species of insects that are what we refer to as multivoltine species, or species that require both a warm period and a very cold period, to complete their life cycle. So those species are not in the system, there are univoltine species which can, which can, uh, survive and exist in places like we have in the Grand Canyon now. And so, the idea came up, a gentleman named Ted Kennedy who's with GCMRC, came up with the idea of what are known as the Bug Flows. So that, on weekends, especially, when there's not that much power demand and we have more flexibility in dam operations, then, then perhaps instead of fluctuating, then you run the flow at a certain level, and then you allow these bugs to crawl up on the rocks and deposit their eggs and keep the eggs wet, so they don't dry out and die. And then you have hatching of those, and you've got at least some reinstatement of some of that historical bug community, so to speak.

Paul Hirt: 01:13:37 Is that working?

Rich Valdez: 01:13:38 It, it appears to be working. The experiments are limited, of course, at this time, because they're being done on a limited time basis. But they do appear to be working. There--they do appear to be, uh, there are more, uh, of certain species of insects in the system, that are potentially food for the fish. And so that in and of itself is working, however the issue of fall HFEs and their scouring effect on production is still one that's being--

Paul Hirt: 01:14:07 A problem--

Rich Valdez: 01:14:07 Considered. Uh, and, and talked about. And in fact, there is, uh, consideration of, of now switching perhaps back to spring HFEs or switching back and forth perhaps, and not having these continuously during the fall. So, um--

Paul Hirt:	01:14:23	As I understand it, they won't even do an HFE if they haven't determined that a certain amount of sediment has come down one of those two tributaries and is available to push down the Colorado. So some years they won't (pause) do they do one every fall, or do th-- some falls they don't do an HFE at all if there isn't enough sediment?
Rich Valdez:	01:14:42	Yeah. There, there's two factors that determine the, the um, uh, an HFE taking place. One of course is the availability of water. Availability of enough volume to be able to release that volume that may not otherwise be part of normal operations. And then the second is the availability of the sediment, the amount of sediment in the system. And of course that's monitored on an, on an ongoing basis to make sure that there's enough sediment there that if you do an HFE, you're going to have some benefit from it. So yes, there are some times when an HFE is not (pause)--
Paul Hirt:	01:15:17	Authorized.
Rich Valdez:	01:15:18	Authorized, or suitable, because of the lack of sediment.
Paul Hirt:	01:15:23	How about if we take a short break now, and then come back in about five minutes?
Jennifer Sweeney:	01:15:27	Okay, pausing recording.
		Recording paused
Jennifer Sweeney:	01:15:32	Resuming recording.
Paul Hirt:	01:15:36	Um, one of the topics we touched on in the first half of the interview was the, um, topic of mechanical removal of predatory fish that, uh, impact the chub population, brown trout in particular, but also rainbow. Um, can you talk a little bit about how mechanical removal--what role mechanical removal has played in fish management, and what happened when it was adopted for the Glen Canyon [Dam] Adaptive Management Program?
Rich Valdez:	01:16:06	Yeah. Uh, the threat of predation especially, and to a certain degree competition, on especially the humpback chub, was a common theme across the Colorado River Basin. In all populations, one of the biggest concerns was the numbers of young fish, especially, that would be lost to, uh, things like smallmouth bass or largemouth bass or channel catfish or other species, literally *eating* those young, removing them from the population. So, um, the idea--there were, there were many ideas that were, that were discussed in terms of how to manage these non-native species. Uh, and one of the, of course, most outstanding and most direct was the concept of mechanical removal. That is, you

simply just put people out there in electrofishing boats or nets or whatever gears you can use, and catch as many of those non-native fish as you can and remove them from the system. With presumably the desired outcome that you would have fewer of them, and therefore you would have less predation and fewer of the native fish--more of the, more of the native fish surviving, and helping to sustain the population. So, um, in the Grand Canyon (pause) going back to pretty much--pretty much after the 1995, uh, Biological Opinion and the 1996, uh, Record of Decision on the final Environmental Impact Statement, at that time one of the biggest threats to the humpback chub was seen as, uh, as predation. And, because we recognized it was a cold-water system, we acknowledged the possibility of, of, uh, competition and predation from warm-water fish. Um, but we, we knew that there weren't that many, we knew that the cold water was pretty much limiting the populations in the Grand Canyon, but we began to recognize that, uh, perhaps the biggest threat was predation and competition, especially predation from rainbow trout and brown trout. And like I mentioned earlier, uh, Mike Yard did a, I think, a very good, uh, piece of work there when he looked at those proportions of fish that were being taken by the two species and found out that the big predator was, was brown trout. However, um, rainbow trout were still far, far more abundant than brown trout in the Grand Canyon. Carl Walters brought up the idea that, if you look genetically and historically at the rainbow trout, it really is the, uh, progeny of an anadromous species, right? A species that moves or migrates. So we should not discount the possibility that fish--and at that time, the rainbow trout were in fact being actively introduced every year by Arizona Game and Fish Department to sustain the fishery. Because the water was literally too cold for rainbow trout to reproduce in the Grand Canyon, and the fluctuations were so great that it stranded and isolated their eggs, so self-su--the population of trout in the Grand Canyon was not self-sustainable until we went to Modified Low Fluctuating Flows.

Rich Valdez: 01:19:29 Those high fluctuating flows were simply not allowing trout to sustain themselves in the Grand Canyon. So once, once that population became more self-sustainable in the Lees Ferry reach, then we started to see some of those younger trout moving downstream. And, we were concerned that that movement downstream, all they have to do is go from the, from Lees Ferry down to the LCR, is sixty-one miles. So they don't have to go very far to be in humpback chub (pause) heaven, let's say. Humpback chub territory. Um, and so, we, uh, came up with the idea that one of the things we could do was set up a, uh, Lees Ferry to Badger, to Badger Creek, removal, as, as being intensive removal in that area, at key times of the year when we thought that those rainbow trout would be moving downstream. To, so to speak, to intercept them, before they would reach the Little Colorado River. So it actually was, it was called the Paria-to-Badger, uh, proposal. Paria-to-Badger mechanical removal proposal. And there were some experiments that were done, there was some removal, there was a, a complete, uh--in fact, there was a high, uh, an EA, an Environmental Assessment, done on that, coordinated by Mike Runge, to look at that prospect of doing that and then linking that to the 1995 EIS. As a way to, um, authorize that removal. Now, while--

Paul Hirt:	01:21:11	So the research on that and the proposal for that was before the 1995 EIS was being developed. Or at the time it was being developed.
Rich Valdez:	01:21:17	It was after. And, immediately after.
Paul Hirt:	01:21:20	And immediately after.
Rich Valdez:	01:21:20	And it was after, correct. Right. And then, uh, starting in the early 2000s, then, uh, the idea was floated that, um, we could also be just targeting and removing fish, trout that is, from around the Little Colorado River. Because the--trying to intercept them in that Paria-to-Badger reach was, perhaps, more (pause) chance, than something more certain, and instead go to the source itself, go to the end point and remove them there. So that became, uh, a program that was designed as a multi-year experiment, to where there were, there were multiple trips, I think there was something like six or eight removal trips, through that area, uh, of the Little Colorado River, both upstream and below, uh, the Little Colorado River, where electrofishing boats were removing trout in mass, and just taking them from the system. (Pause.) Now, that became complicated to a certain degree, because you had two issues, one is what do you do with them once you pull them from the system, you have a mass of, uh--
Paul Hirt:	01:22:29	Protein (laughs).
Rich Valdez:	01:22:30	You know, of several hundred, yeah, several hundred pounds of fish protein, what do you do with it? The [National] Park Service would not let us grind them up and put them back into the system. We thought of burying them in some riverside pits or something, but that didn't go over very well either. So, someone came up with the idea of something called the “bass-o-matic,” which was a, basically a huge grinder, and you would just put them through a grinder and then put all that, pour all that soup into, um, I think they were, like, thirty-gallon barrels, that were put on boats and then floated out all the way to Diamond Creek, and then taken out and made available for fertilizer. And they were used by, uh, the Hualapais, and I think others too, as fertilizer. Eventually, it became, we had a, we eventually had a surplus of fish soup, that, no one had any further use for those, so we didn't quite know what it, what to do. Meantime, the Native American tribes, and, and rightfully so, um, had concerns about taking life in the

Grand Canyon, what was referred to, the sanctity of life, which we of course wanted to make sure was respected. So, um, so those removal, that--those removal experiments went on for, I think, about three years, and the information was written up, and what we found is that they were effective as long as that removal was ongoing. But as soon as it was relieved for about a year or so, you started to see the influx, then, of additional fish to, to repopulate that area, and I'm talking specifically rainbow trout. And so, it became questionable whether that was, in fact, a sustainable management action. Whether you could keep doing that or whether, you know, maybe something else would be better, maybe.

Rich Valdez: 01:24:24 So then we started thinking, okay, so what would the humpback chub population need to reach? How many, how many adults? Five thousand? Ten thousand? Fifteen thousand or more? In order to be able to sustain a certain amount of predation by rainbow trout. And so that became, then, we developed triggers around that. We said, okay, we won't implement non-native fish removal until it's necessary to do so. And the trigger will be, not just the abundance of rainbow trout in that area, not how many fish are there, but also how low that humpback chub population is, and how much, how susceptible it might be to effect[s] of predation. So those two factors came into effect and that was all, eventually that was all part of the consideration of the, uh, of the 2016 LTEMP EIS. But by the time we got there, people like Mike Yard had done these studies on the relative, uh, effect of predation by brown trout versus, versus rainbow trout. And it was determined that in fact, probably brown trout were, perhaps, a bigger threat than rainbow trout. So, instead of implementing the Paria-to-Badger, uh, strategy, or removal around the LCR, um, it was decided instead to go to Bright Angel Creek, and try to go to the source of brown trout that were primarily spawning, uh, in Bright Angel Creek. And you see these ten-pound brown trout, and we've caught them off the mouth of Bright Angel Creek, that go into Bright Angel Creek to spawn. So they're using the, the main river a lot like humpback chub. They are living and being sustained in the main Colorado River. And, and every year in the fall, they're fall spawners, they migrate and go into Bright Angel Creek to spawn. And then that's where they're young are hatched and that's where they come out.

Paul Hirt: 01:26:21 And that's where you intercept them?

Rich Valdez: 01:26:23 And so in a about 2000, and um, and I probably have the year wrong here, but about 2012 or so, uh, there was a, the Park Service together with, uh, other biologists put a, um, uh, a fish weir, at the mouth of Bright Angel Creek, that was literally catching all of the--all the fish going into Bright Angel Creek, and they removed, uh (coughs) excuse me, large numbers of rainbow trout and brown trout at that weir.

Paul Hirt:	01:27:00	So rainbow trout, were spawning also in Bright Angel Creek.
Rich Valdez:	01:27:02	Rainbow trout. We're also using that, and going into it. And then most recently, in about the last, now, five years, the Park Service has implemented a program to where they go into Bright Angel Creek and literally just remove the trout fr--directly from Bright Angel Creek. Both brown trout and rainbow trout. I just reviewed a manuscript submitted to one of the Canadian journals, that reports that the effect of that or result of that, and the non--the non-native fish have declined, uh, by like 75 or 80%. I mean, it's, it's really had an effect. (Coughs.) Excuse me. Maybe--
Paul Hirt:	01:27:48	Let's pause. (Coughing.)
		Recording paused
Jennifer Sweeney:	01:27:53	Recording resumes.
Rich Valdez:	01:27:56	So the, um, the decision was made, then, to, uh, move the mechanical removal to Bright Angel Creek. And the Park Service, uh, was the lead in this, in this effort. Um, there was a, uh, a fish weir that was set up in about 2010, 2012, that was intercepting these large spawning adults that were coming in from the mainstem--both rainbow trout and, uh, brown trout. I remember we were handling ten-pound brown trout in the main channel, just off of Bright Angel Creek. So, these fish were coming into Bright Angel Creek and spawning there. Um, that was not without controversy either, because there were fishermen, a select group of fishermen, that had recognized this for some years, and would make annual, annual treks to, hiking down the trail to Phantom Ranch, to fish those big rainbow, those big brown trout, especially, in the fall. The weather was nice, it was cool, it wasn't so hot hiking up and down that trail. And so--the BA [Bright Angel] trail. And so, uh, that became a bit of a controversy that those fish were being removed from that system. I recently received a manuscript, uh, from one of the Canadian, uh, journals, uh, where, uh, Brian Healy from the National Park Service and Charles Yackulic from GCMRC have put together a paper evaluating the results of those, those removals in there. And it, and it was, it's absolutely amazing how well that has worked. Um, they removed something about 75 to 80% of the (pause) of the trout in that system, mostly rainbow trout, but browns as well. And the, the native fish population, the flannelmouth sucker--flannelmouth suckers, bluehead suckers. There are no humpback chub in Bright Angel, but those other native species have just increased something like 400% of their former abundance.
Rich Valdez:	01:30:03	So, so it has worked pretty well. But once again, once you remove that effort, the question becomes, "How long will it be before that system becomes re-invaded?" So again, there are costs associated with

management actions that have to be considered whenever one implements those actions, and looks at the prospect of having to do that, you know, for whatever long it takes. Or, perhaps to do them periodically, to just maintain some balance of what's going on. So, so the issue of non-native fish and especially mechanical removal has been a major issue in the Grand Canyon, and it has been at the center of, uh, of some of the proposed management policies, but also it, it has been controversial, um, in a number of different areas. Where that's going to go now, um, I think there are some different prospects or possibilities of what may happen next. The system, because of the way that GCMRC and the Arizona Game and Fish Department are currently sampling through the Grand Canyon, the system is currently, essentially, being monitored. So that any, um, sudden explosion, you might say, or expansion of a given species, whether it's smallmouth bass or something else, should be detectable before, perhaps, it gets, it gets too far. And, and I think the strategy now is to try to get at something like that if it were to happen, to try to get into those areas and mechanically remove before that expansion takes place. So, I think that that system is being monitored right now, but I would suspect smallmouth bass may be the next problematic species in the Grand Canyon.

Paul Hirt: 01:31:54 So as far as you know, right now, 2019, 2020, there isn't an active mechanical removal program, but it's still a possibility and may become necessary for smallmouth bass in the future?

Rich Valdez: 01:32:10 The mechanical removal program in Bright Angel Creek is ongoing.

Paul Hirt: 01:32:14 It *is* ongoing.

Rich Valdez: 01:32:15 So that's still going on. There's also some removal, uh, in Havasu Creek, which is one of the places that humpback chub have been translocated to. Humpback chub were translocated into, uh, Shinumo Creek and then Havasu Creek, to try to establish additional populations. But as far as I know at this point in time, those are the only two places where there is mechanical removal. And I think the approach is, you know, given the Native American concerns, the approach is to try to improve that humpback chub population sufficiently so that it is able to sustain a certain level of predation [P.H.: Right]. And you don't have to go in and mechanically remove. But, so now what's going on in the Grand Canyon as a result of this, uh, brown trout management team that we convened in 2000 and, uh, 2017 (pause) there are just being put in place, uh, incentivized removal programs at Lees Ferry. So, for example, the, um, the program will pay, uh, essentially a bounty on brown trout that are brought in by fishermen, by anglers. So that if you bring in "x" number of brown trout, you can make some money fishing, basically. If you're good at it, and can catch those fish.

Paul Hirt:	01:33:45	And have fresh fish for dinner (laughter).
Rich Valdez:	01:33:47	And have fresh fish for dinner. Exactly. You, you basically just take them to a person who is, uh, examining those fish and verifies that that's what they are, and you, yeah. You keep them and take them home. Now that's just being implemented right now. The interesting thing about it, is that you can actually, and this is part of what the brown trout management team did, is from an economic perspective, you can actually look at the cost of mechanical removal, that is, putting crews out there with electrofishing boats repeatedly removing these fish from the system, and compare that to the cost of an incentivized program. And it's actually, potentially cheaper to implement an incentivized program, even though you may be paying people, you may pay them, uh, you know, five, ten dollars a fish, whatever it might be. And then periodically you might offer, uh, for a tagged fish, let's say, that that's a hundred-dollar fish or maybe even a thousand-dollar fish. So you incentivize people to continue to try to remove those fish, to try to catch them. So, those are some, you know, new ideas that we're coming up with as a way to deal with this mechanical removal, or this non-native fish issue.
Paul Hirt:	01:35:00	Are you aware of any objections by the Havasupai Tribe of mechanical removal of trout in Havasu Creek?
Rich Valdez:	01:35:06	That is a, uh, a sensitive issue at this time. I haven't been directly involved with that program. I know that there are some concerns about that. I really couldn't answer that at this time. I haven't had recent involvement with that.
Paul Hirt:	01:35:23	All right. Well, thank you for going back over that topic with us again. Um, can you, uh, tell us who you think the most important researchers and the most important participants in the Adaptive Management Program have been over time? Should be called out for their long-term high-quality work?
Rich Valdez:	01:35:48	Well, from my perspective, of course, I look more at the scientists in the program, perhaps more so than the managers or administrators. Not that they, not that there aren't people there that have done excellent work in terms of facilitating the science and some of the research that has been taking place, but, I think that, um, certainly when I first got involved in the program in 1989, Dave Wegner was a, an instrumental person in terms of being able to bring together scientists under the Glen Canyon Environmental Studies, the GCES, at that time. Um (pause) after that, uh, the program transitioned as a result of the, um, of the Grand Canyon, uh--
Paul Hirt:	01:36:35	Protection Act?

Rich Valdez:	01:36:37	Protection Act, thank you. Uh, transitioned into the GCMRC, the, uh, Grand Canyon Monitoring and Research Center. Um (long pause) that program, then, was what facili--facilitated people like Carl Walters to come into the program. And Carl (pause) Carl really, I think, shook up the scientific community in Grand Canyon. Because *we* thought we were pretty darn good at what we were doing. Carl made us realize that we could do more, much more. Especially introducing this concept of adaptive management and how that really works into, uh, being able to work in the system. So, so Carl fundamentally came in and said, "Okay, what are your hypotheses about how you think the system works? You think it's temperature that affects humpback chub? All right, then look at it, investigate it, look at different options, look at opportunistic, uh, warming periods." We had 2005, for example, that, uh, where the re—where the release of the dam in 2005 was very similar to a two unit TCD [temperature control device]. So we had, in some ways, natural experiments that were taking place right in front of our eyes, but we weren't seeing it that way. So, he made us better understand the opportunities that were available in the system at the time. And, and how to implement those experiments and then how to evaluate them over time, under the concept of condition dependency. So that, if we wanted to implement an experiment, we had to realize that the condition in the Grand Canyon, whether it's water availability or temperature or whatever else, climate change, was not going to be the same every year. So, because--so it was basically conducting a *huge* outdoor experiment, over which you have little control over environmental variables.
Rich Valdez:	01:38:37	And so in order to deal with that, he, you know, proffered the idea of condition-dependent experiments, whereby you conduct experiments when the conditions are suitable for doing that, and in years when you can't do that, you don't. So, your condition, your sampling design may be a rather expanded matrix, that has probability of occurrence associated with a certain volume of water or a certain temperature, that you may be trying to test. But you're not going to be able to do it every year. So, Carl was significant in terms of introducing some very novel, very, very, I think very good ideas in terms of understanding the science better. Carl also, uh, brought with him, and enabled us to also have access to people like Bill Pine. Uh, Carl, of course with--was with the University of British Columbia in Vancouver. Bill Pine was with the University of Florida at Gainesville. So Bill brought forward concepts that we--of how we better understand young humpback chub survival. He initiated some, what are known as the Near Shore Ecology Studies in the Grand Canyon, that were looking at the humpback chub coming out of the Little Colorado River, and what they were doing to survive in the mainstem. How they were using those talus slopes for protection, for food availability and so on, and so Bill was instrumental in that, as well as other things. He, he introduced technology like, uh, like laser ablation technology that is

taking a, uh, an otolith, the inner ear bone of a fish, of a humpback chub. And the inner ear of course is one of the first calcified parts of a fish. When they're born, they have inner ears, they have otoliths when they're born. So it's a complete record of the, uh, of the life of the fish. And those otoliths establish, um, daily growth rings that you can track, and you could look at, like the growth rings on a tree. And they also have broader, wider annual growth rings. And so, you have a record that you can go back and look at. Now if you take a laser and take, uh, samples of the different parts in the life of that ring, where you know how old the fish is when it experienced certain things, you can then trace back what, um, what environments it occupied, by looking at isotope ratios, for example. So you can tell when the fish left the Little Colorado River. You can tell what habitats they were using in the mainstem, whether they were using warm, nearshore habitats, backwaters, or the main channel, or other experiences; *or* whether they were going into the mainstem, turning around and going back up into the Little Colorado River as part of a, uh, an archive of the life history of the species in the system. So it was, it was these things that we had not thought of before, and that you need external scientists like this to--to introduce these ideas and these concepts.

Rich Valdez: 01:41:48 Um, one of Carl Walters', uh, and Bill Pine's students was a, was a man named Lew [Lewis] Coggins, who got his PhD under Bill Pine and Carl. And Lew, now, introduced new analytical techniques for us. Now you had two fundamentally (pause) two scientists, Carl Walters and Bill Pine, with very strong, uh, marine fish backgrounds. And marine fisheries is so much further ahead in terms of analytical techniques than freshwater fisheries, because they deal with large fish populations, they deal with unknowns, they deal with uncertainties, they deal with fish that are being reported from, uh, large fishing boats, not with a lot of mark-recapture opportunities, they're not dealing with small streams and lakes, they're dealing with something the size of the Pacific Ocean. So they have to have much better developed, uh, analytical skills. And so, with their help, we had Lew Coggins come in and redo our mark-recapture program, of how we were estimating the numbers of humpback chub that were in the Grand Canyon. And he developed a wonderful mark-recapture model with the help of both, you know, especially Carl Walters, but Bill Pine as well.

Rich Valdez: 01:43:09 Um, another student of, uh, of Carl's was, um (pause) was um, in addition to Lew Coggins was (pause) I'll have to think of his name here in a little bit, but he also brought in, um, uh, a wealth of knowledge with respect to understanding, uh, the trout population. His experience was mostly up in Canada and Alaska with rainbow trout and other species of trout. So, uh, and his name was Josh Korman. I apologize for not remembering it earlier. Josh Korman was also instrumental in--and Josh is still working in the canyon now. He works a lot with Mike Yard, and they've done an absolutely marvelous job of better understanding the population of rainbow trout, especially rainbow trout, but brown trout as well, in the Grand Canyon. How those populations function, how they spawn, the survival of the young, what habitats they use, how they are affected by operation of Glen Canyon Dam. One of the things that they found out is that, for example, uh, when, uh, the, the rainbow trout in the Grand Canyon is a, is actually a late winter spawner. They spawn in about January, February. And when their--and their eggs will incubate for sixty to maybe, maybe as much--well, for forty, maybe sixty days, something like that. When they hatch, when they emerge, they will go to the near shoreline areas (pause) as fry. So when they're very, very young, they're looking for shallow, sheltered areas. So they will go into the shorelines in that Lees Ferry area, and go to about the shallowest area. If you are running a fluctuating flow scenario, you're going to [P.H. murmurs something unintelligible] strand those individuals, right? Because they're in very, very low--very shallow water.

Rich Valdez: 01:45:06 Now, as they get older, they go from these low-angle shorelines to the more high-angle shorelines, to more rocky, steeper shorelines. So, understanding that, of course, enables you to better understand not just how the populations survive, but perhaps, potential, um, management flows for regulating those populations. So as a result of that, the concept of trout management flows came about. That you can regulate the population to a certain degree if you want to, by basically raising flows to a certain level, say, fifteen thousand cubic feet per second, in that Januar--well, in about, uh, in about that March, April period. And have those young fish go up on those shallow areas in Lees Ferry, then drop the water on them quite suddenly, and you strand them. You regulate the population that way by not having to do any mechanical removal, by not having to intercept the fish in the Paria-to-Badger reach, by maybe not having to worry about the fish moving downstream to the LCR. Because there, there is a certain degree of density dependence that takes place with these populations, whereas, if you have too many trout in the Lees Ferry reach (pause) just by common sense, the surplus of those fish are going to want to leave that area and would move downstream. So, that's been another option as an alternative to mechanical removal, is better understanding the populations, and managing those populations to where they don't exceed their carrying capacity for the system.

Paul Hirt: 01:46:49 Has anyone tried that option yet?

Rich Valdez: 01:46:52 Uh (pause) yes. Um, trout management flows have been implemented on an experimental basis. They have worked to a certain degree. (Pause.) But again, there are these little twists of fate, so to speak, where, um (pause) the-- a big part of the trout population in Grand

Canyon, the Lees Ferry reach, was in fact, not necessarily spawning in those shallow areas, they're spawning more toward the middle of the channel. You still have some of those young fish coming up. That, combined with a, with warmer releases of, out of the dam, have also expanded the window of spawning. So we have those young of different ages, now, being more, occurring more over longer periods of time. So those have been effective at some times, and perhaps not so much at others. Because of these nuances having to do with spawning. What we think is happening now, that brown trout management team, what we concluded from that, is that one of the possibilities is that, um (pause) that, that there's competition for, uh, spawning areas between rainbow trout and brown trout. To where you could have one species spawning on top of the other. Because brown trout are fall spawners, and so there's almost an overlap in the spawning, now, between brown trout that spawn in October, November, December, even in January, and rainbow trout that are spawning in maybe even late December, January, February. So you have a little bit of that competition maybe taking place as well. So, these are again, the things that are still being looked at to better know how to manage that system. But, I think the important message here is that, um, if you understand the life history of the species, it may not be a direct sledgehammer that's the solution. You may be able to find out nuances about the life history. And that's what people like Carl Walters and Bill Pine enabled us to understand.

Rich Valdez: 01:49:09 Now, um, there's been, of course other scientists that have been, uh, very instrumental. Jack Schmidt, I think, is one whose name is associated, in fact, almost with the Grand Canyon. Jack was at the front of better understanding this concept of sediment distribution through the system, the concept of Beach Habitat Building Flows and High Flow Experiments. He was right in the middle-- I remember I was down there in 1996 during the, that controlled flood. And I was, uh, doing fisheries work down, uh, just downstream of the Little Colorado River. He came by, and he was doing some of the research he was doing, of course, on sediment. They were tracing the dye as it was-- they had introduced dye into the water and they wanted to understand the kinematic waves through the system. So Jack, of course, has been instrumental, and he's many--had many graduate students down there. Paul Grams is one of those. Paul is now a member of the staff of the Grand Canyon Monitoring [and] Research Center, so he carries forth that so-called flag [P.H.: uh-huh] of sediment, you know, geomorphologists that are in the Grand Canyon.

Rich Valdez: 01:50:18 Um (long pause) and most recently, and probably most significantly, uh, a gentleman named Charles Yackulic, who is a graduate of Columbia University and Oxford. Charles joined the Grand Canyon Monitoring [and] Research center in two thousand--about 2010, 2011. Hadn't been there very long. But he, his backgr--he has a very, very strong background in quantitative ecology. And he has, uh, an incredible background in, uh, ecosystem, uh, models. And ecosystem design. And has the ability to be able to bring together complex interactions among different species of organisms. And has focused--some of his focus has been on humpback chub, where he has helped us to really understand that relationship between the mainstem Colorado River and the Little Colorado River, and how humpback chub are using that system. Charles was, uh, instrumental in doing the evaluation of the alternatives of the 2016, uh, EIS. He coordinated, uh, across the different disciplines, all the data that was available from hydrology to sediment to humpback chub to trout to riparian habitat to recreation. Everything. He's the one that coordinated all that work. He has been a significant, uh, I think, scientist in the Grand Canyon, especially most recently.

Rich Valdez: 01:51:53 Um (pause) Larry Stevens, of course. What can you say about Larry Stevens? Larry Stevens is just the person who has just been there all the time. His, his, uh, knowledge, his areas of expertise, in fact, uh, go across virtually every discipline you can think of in the Grand Canyon. Larry is always out there. Larry doesn't do trips down the river to study one thing. Larry, when he's down there, is looking at fish, he's looking at lizards, he's looking at insects, he's looking at virtually everything around him. One of the most incredible ecologists, I think, that, that I can think of, anyway. His knowledge is almost insurmountable in terms of understanding the Grand--the Grand Canyon.

Rich Valdez: 01:52:40 I think another one who goes back, in fact predates me, certainly, and predates many, many biologists in the Grand Canyon. He was one of the first to conduct fish surveys through the Grand Canyon, and that's Steve Carothers. Steve Carothers, um, uh, was the manager of the Museum of Northern Arizona, which is right there in Flagstaff. And he, uh, started the company SWCA back in the, in the 70s. And I, I happened to run, well, I, my relationship with Steve was that we were both bidding on that humpback chub life history ecology work that Reclamation issued back in the, in the late 1980s. And, and I won the contract and he did not. And so he finally came up to me one day and he said, "You know, I'm tired of you and I competing against each other. We should join forces." And that's been a wonderful relationship that I've had with Steve since. He's, uh, if you want to know about birds in the Grand Canyon or reptiles in the Grand Canyon, Steve Carothers is one of the more knowledgeable, certainly. I'm sure I'm, I'm leaving certain scientists out, but those are the ones that come to me at this time.

Paul Hirt: 01:53:57 How about key reports or studies that you want to highlight as particularly important, that have retained their value over time?

Rich Valdez: 01:54:06 Yeah. Um (pause) well certainly, um (pause) the, uh, the final Environmental Impact Statement of 1996 is pivotal. Um, because of, that was the first--there was never NEPA [National Environmental Policy Act] compliance done on Glen Canyon Dam. Because it was built way before NEPA. And, so that was the first efforts to try to consolidate all that information. Um, the 2016, the most recent LTEMP EIS, I think, is also a good archival document for many of the things that have taken place. There are four, uh, reviews from the National Academy of Sciences that I think people--people sometimes overlook, in terms of going back and looking at the history of the Grand Canyon. And I think those are significant, because it *really shows* this, this transition, uh, and evolution of thinking by scientists in the Grand Canyon. As I mentioned earlier, uh, the first review, because it was right after the '83, '84 high flows, the natural high flows through--there was, of course, historic snowfall in the Upper Colorado River Basin. Uh, I remember doing Cataract at about seventy-five, 80,000 cfs, and it was a, it was a nightmare. And of course, flows through the Grand Canyon reached a peak of almost 90,000 cfs, when everything was being allowed to go downstream of the dam. And, as a result of that, when the National Academy of Sciences met, they said, "Don't do any kind of high flows in the Grand Canyon," right? Because that'll flush all the sediment downstream into Lake Mead. Well, of course, subsequent reviews from the National Academy of Science have said, no, that's not really true. And again, Jack Schmidt, I think, was instrumental in bringing that back to some common-sense management policy that could be put in place. And so now we have, it's not policy, it's experiments. Now we have the High Flow Experiments that are, in fact, showing that that is one way to conserve sediment in the Grand Canyon.

Rich Valdez: 01:56:23 Um, there are of course, a collection of reports and published manuscripts having to do with the Grand Canyon. Wonderful pieces of work by many, many scientists. Um, the one that, the one that I, that I was associated with, that I am most proud of, is a 1999, uh, publication in *BioScience*, uh, that I did with, uh, Jack Schmidt was the lead author. Uh, Bob Webb was involved in it, Dick Marzolf, Larry Stevens and myself. It was the result of a brainchild that took place in San Francisco (laughs). We were, we were at the, uh, Geophysical Union meeting in San Francisco, sitting, uh, in the lounge, in between sessions. And, Jack had asked the five of us to get together, and he said, uh, "Gentlemen, we should document what we're learning in the Grand Canyon." This is before the concept of adaptive management, this is before any of that had ever come together, this was before Carl Walters or anybody. And he said, "What do we know and what have we learned?" And we went through, uh, I wish I had recorded it, because it was a wonderful conversation with, um, who I considered the top scientists, probably, that were involved. You know, Dick Marzolf was, at that time, with the, uh, U.S. Geological Survey out of

Reston, Virginia. He was one of the main science coordinators for USGS. Bob Webb was out of USGS out of Tucson, one of the noted authorities on whitewater rapids, and had done a lot of work in the Grand Canyon on Lava Falls--on Lava Rapid and so on. And of course, Larry Stevens was involved in that as well, and we sat around and talked about what it is that was happening in the Grand Canyon, and what was possible in terms of science, and so it was called "Science and Values [in River Restoration] in the Grand Canyon." That was the title we came up with.

Rich Valdez: 01:58:31 The conclusions, I thought, were remarkable for that time, given our fundamentally feeble understanding of the way the system worked. But we made observations over what we saw. And one of the things that we concluded was this concept of, what we referred to as "the intractable dilemma." Where, um, we realized and recognized that there was no single management action that could (long pause) that could simultaneously benefit all resources. You couldn't have one Glen Canyon Dam operations that would be best for sand and best for humpback chub and best for riparian habitat and recreation and everything else. It didn't work that way. You of course had different conditions that were available at different times of the year. And so you basically, you managed according to that. And, and so what that did is it fundamentally opened the door, beautifully, for adaptive management. Whereby you recognize that, you realize that, and you say, okay, well, we have to do then is implement a series of experiments over hypotheses, and then you evaluate those over time. They work sometimes, they don't work other times. You benefit some resources, sometimes, not other times. So that, that uh, val--"Science and Values [in River Restoration] in the Grand Canyon" in *BioScience* 1999 was, I think, a landmark paper. Um, thanks again to Jack, I think, largely to Jack Schmidt on that one.

Rich Valdez: 02:00:09 Um, there were a number of other papers, of course, that were published by Lew Coggins, Carl Walters on humpback chub populations. It was the first opportunity we had to really bring together the life history and ecology, the work that I had done was mostly in a large report. They, I think, uh, you know, very well brought that information together and published it. Um, did uh, an excellent job of that. Um, then, and there--and those papers are in various journals, uh, that you can find. And then most recently, Charles Yackulic published a paper about now, uh, about six or seven years ago. And it is, uh, it's entitled something like "Growth and Survival of Humpback Chub in the Grand Canyon." ["A Quantitative Life History of Endangered Humpback Chub That Spawn in the Little Colorado River: Variation in Movement, Growth, and Survival."] And he, and he has a (pause) this is how scientists think wonderfully. He has a lot of little, uh, icons of fish, as part of his models in that manuscript. Showing how humpback chub come from the mainstem into the LCR, spawn, and then their little babies come drifting out, or move into the mainstem, and then grow up, and then turn around and some of them come back and some of them don't. And then there's the concept of skipped spawning, where they don't spawn every year. They may skip a year. And so, he very nicely characterized that in the paper. And it's by Charles Yackulic, I think it's a wonderful piece of work.

Paul Hirt: 02:01:42 How do you spell Yackulic?

Rich Valdez: 02:01:43 Um, Y-a-c-k-u-l-i-c. Charles Yackulic. And that was coauthored by, uh, Mike Yard, Randy Van Haverbeke, and, um, oh my goodness, I can't remember who the other author is [Josh Korman].

Paul Hirt: 02:02:00 We'll look it up.

Rich Valdez: 02:02:00 Yeah. But that was, that's a *very* good paper. More recent type of paper. Um, Jack, of course, Schmidt did some (pause) uh, landmark pieces of work, that I think can be found under his name, relative to Grand Canyon. Um (pause) those are the ones that come, I think, to mind at, at this time. Yeah.

Paul Hirt: 02:02:27 Great. Thanks. Well, how about a couple of big picture questions? (Valdez laughs.) What do you think is the value of adaptive management in trying to manage complex resources in a environment that we can't predict or control?

Rich Valdez: 02:02:49 Yeah. And, and that's, uh, that's probably the, the, you know, fifty million-dollar question, I think, for many systems. Um, the Grand Canyon system is somewhat similar to other river basin programs across the western United States in that there are, uh, most river basin programs have dams, or water diversions, or whatever that have fundamentally altered the basic structure and function of the ecosystem. Ecosystems that, in the case of the Colorado River, were probably in place, although dynamic, maybe over a period of three to four million years. And yes, in the Grand Canyon, probably about a million years ago or so, there were, uh, it was a very seismically active area at the time that the plateau was rising. There is very strong evidence that there were lava flows that dammed the Colorado River in the Grand Canyon. And those dams probably lasted quite some time. Although the releases were not hypolimnetic cold releases like we see today, they probably were overflow or topping over the top of those lava dams until they eventually eroded over a period of time. Some of those presumably could have lasted about a thousand years, perhaps, perhaps a little less. Um, so, but, but fundamentally, you can, despite the dynamics that you see over, say, a million years or a three to four million-year period, you still recognize that there was a dynamic system that was there before there were any, uh (pause) any of man's influences, such as dams, such as water diversions, such as depletion of sediment and so on.

Rich Valdez: 02:04:53 When one considers those kinds of effects (pause) the first, the first thing to understand is that it is unlikely that that so-called historical system, whatever that used to look like, pre, pre-man, say, it's unlikely that that would ever be restored to what it was. And so, you have to, you have to work with an altered system. It is also unlikely that one can restore the function, the structure and function of the components of that system. The way the river used to work, the big floods in the springtime, the high temperatures, et cetera. The absence of alien fish. And so, um, so the problems are--so the problem becomes first understanding the way the system works in its current state, the dynamics of that contemporary river system. And part of that, of course, is trying to better explain how some components of that system might work, that are, in scientific terms, expressed as hypotheses. And so, it is (pause) it is, in fact, the--almost the ideal setting for adaptive management. Whereby you try to explain a particular problem or particular issue having to do with the Grand Canyon or operation of Glen Canyon Dam, you establish a hypothesis, and then you test the hypotheses in different ways. You realize that when you do test it, like High Flow Experiments, for example, you don't quite get it right the first time. The first High Flow Experiment was 1996, we went for ten or twelve days, I can't remember how long it was, and most of the sediment moved in about the first two or three days. So we learned from that. We learned that those don't need to be as long, so that was part of the cycle of adaptive management. Uh, it's true of virtually every resource in the Grand Canyon, that, you have to understand that. So adaptive management, in and, in and of itself as a concept, is probably well-suited to something like, like Grand Canyon. To be implemented in that system.

Rich Valdez: 02:07:07 Now, what Carl Walters also taught us, though, was what we talked about earlier, those unexpected surprises that nature may throw on you. The condition dependency, where you have times when you cannot implement an experiment because there's not enough water available to do it. Or the experiment goes awry because the temperatures weren't what you expected from the river. Again, you're basically doing experimentation in a large open laboratory, with no control whatsoever, except for perhaps a large spigot called Glen Canyon Dam. And so, um (pause) the, to me, the most informative part of it, though, is to be able to implement adaptive management and then perhaps even remove yourself from the program as I have. And not that I've removed myself, but I--I'm not as involved as I was. And then look at it from the outside in a really objective way. And look at what has worked and what hasn't worked. And I think by and large, um, aspects of what has--have been put in place have worked, and aspects of it have not worked. In some cases--

Paul Hirt: 02:08:26 For example--?

Rich Valdez: 02:08:27 Um, well, for example, the concept of, um (pause) when we first started looking at mechanical non-native fish control, we thought, okay, we can, we can go in there and put electrofishing boats in the river and take out a lot of trout, and that'll solve the problem. Well, not quite, because you had this invasion, this re-invasion of those areas. Uh, another example is perhaps, uh, high flow experiments, where you're trying to preserve sand and sediment, you take advantage of when that sediment is most available in the fall, but now perhaps you're scouring the food base. And so, you have to understand that every one of those actions that you're implementing as an experiment, has some kind of reaction, perhaps, to other resources. So, again, that's something that Carl Walters cautioned us about, that management--that experimentation, you have to go through experimentation first before you implement policy. Before you put that as part of your normal operation, you have to evaluate it first. What ad--many of us did not understand, and certainly many managers and administrators and even today, don't understand, is how *long* that takes to do that. (Pause.) I mean, we've had a science program in the Grand Canyon since about 1985. With GCES, with Dave Wegner. That's a long time. That, you know, that's thirty some-odd years of experimentation in the Grand Canyon, and of course managers always say, "How long is this going to take you? When are you going to give us the answer?" Well, there is no particular answer. It really, it really speaks to the need for ongoing involvement. And ongoing understanding of what's happening in the system and the ongoing dynamics. So that, to me, is the most valuable part, is this retrospective opportunity to look back on it. And see what worked, what didn't work and what surprises we had. And it's that last one that's often the largest effect of any of those.

Paul Hirt: 02:10:38 Well, that's a (pause) an articulate defense of the value of the program over time. Um, yeah, it's been thirty, I think thirty-eight years since the launching of GCES I, that came out--started in 1982. Almost four decades. And twenty-five years since, um, the launching of the Glen Canyon Dam Adaptive Management Program proper. (Pause.) It's a pretty expensive program. We have learned a lot. Do you anticipate that there will be some point in the future in which the program is, we've learned enough that we don't really need the program anymore? Or is the constant evolution and accretion of knowledge so valuable that it should be continued at least for the foreseeable future? In your opinion?

Rich Valdez: 02:11:31 Well, unfortunately, the continuance of that program is not under our control of course, but I would certainly hope that that program continue. And the reason is because, um, it's not for science, it's not for the sake of science alone. It is for the sake of better understanding how to manage one of the most valuable resources that we have in North America. And society has made that decision. That it's important to maintain the Grand Canyon as well as we can and maintain all the resources within the Grand Canyon. When it is a societal decision, and it is a societal value, I think it does rise to the level of justifying an ongoing funding of the program. In its current state, it is a, um (pause) it is a federal advisory committee. So it's under the direct authority of the Secretary of the Interior. I hope it stays that way. Because it certainly, I think, has, um, eliminated a lot of the complexity, especially for funding the program. Now, whether that can be pared back some, I think only managers can make that decision. Uh, again, the, the role of science in the process is, gathering information in an objective manner, in order to give that information for managers to make informed decisions. And for administrators to facilitate those decisions and provide the logistics for those being done. I think that's important. I think those roles are necessary in a system like the Grand Canyon. And again, not for the sake of science, but really for the sake of the resources in the Grand Canyon, not just in the Grand Canyon but downstream as well. Because that water that's delivered through the system is also important to the downstream states, Nevada, California and Arizona, as well, as it, as it goes downstream. So I see, and I'm hoping that the program continues in some form. Because I think it's necessary, um, to do so.

Rich Valdez: 02:13:49 If one were to, um, speculate a little bit on what might happen if the program would go away. For one thing, we've learned from programs like the Grand Canyon program, like the Upper Colorado River [Endangered Fish] Recovery Program, like the San Juan River [Basin] Recovery Implementation Program, uh, like the Lower Colorado River MSCP [Multi-Species Conservation Program], we've learned that those programs have certainly brought together all of the interests in the system. Peop--many millions of people rely on these rivers. For delivery of water, for recreation, for many other values. Those are, those programs are important to maintain, because, I do remember before, for example, the Upper Colorado River Basin program. I do remember, uh, what were then almost termed "water wars," where there was some uncertainty about how to best manage the water, who owned the water, how it was to be transferred and passed through the system. Um, people like Tom Pitts, who was a water coordinator in the Upper Colorado River Basin, came up with many concepts as to how to do this, and one of the ideas he came up with was to establish a recovery implementation program. Which was to enable water users to get together and talk about how to best manage (pause) water resources in concert with natural resources. And so I'm, I am hoping that this program does continue.

Paul Hirt: 02:15:29 Last question. What advice would you have for people coming newly into the program? Some young postdoc who gets his, his or her first research grant, or somebody, a stakeholder that gets placed on the Adaptive Management Work Group or Technical Work Group. What advice would you have for them about how to be, uh, successful in advancing the program?

Rich Valdez: 02:16:00 Patience and humility. Not necessarily in that order (laughter). Um (pause) the, uh, there are, the recognition that there have been many people before them, working to the best of their ability to try to put a program in place, the best mana--the best balances, water management and protection of resources. That's important. Um, the understanding of roles. Especially those with scientific backgrounds. To understand that, that the role of a scientist is in fact to provide information by which others can make informed decisions. And that was one of the big things that we talked about in that *BioScience* paper I mentioned earlier, the role of science. That, that's an important concept, I think. Because, we make decisions on the basis of societal needs and societal demands, not on the basis of what scientists think. However, the better informed those decisions are, the better off we're going to be. So I think that that's important. The other part of it is humility. And I certainly learned that one the hard way (laughs) because all of us, uh, as young PhDs think we pretty much know about all there is to know and just turn us loose on the planet and we'll solve all the problems. Um, you know, that, that is where people like Carl Walters and Bill Pine were so, um, so enigmatic about being able to tell us how to better manage a system while being patient with us and while being, you know, tutorial, more or less, helping us understand better how to, how to see things, how to view things. So, I think patience and humility are probably the best guidance I could give to someone coming into the system. Uh, be patient with other stakeholders, especially those that have been in the program for some time. They may be knowing things that may be a surprise. And yet, at the same time, as a scientist, one may observe, a new scientist may observe that, "Gosh, you guys recommended such and such back when and it didn't work, did it?" Well, again, that's part of patience, that's part of adaptive management. No, it may have not worked, but let's look at it further. That's, let's do it better. Let's figure out a way to do it better. Um, and I see a lot of new scientists coming into the program that I think are aware of some of those fundamentals. I certainly see people like Charles Yackulic, who has been very, very helpful. And understands that, having worked around the world, I think he's encountered these situations before. But, um, the, uh, the GCDAMP does a wonderful job of coordinating the science. The TWG, Technical Work Group of the GCDAMP, has done a wonderful science of--a wonderful job of helping to coordinate and assimilate that information in a meaningful way. And they've been very good, I think, at issuing reports and reporting, and giving scientists the opportunity. A good thing was to bring the U.S.--or, the GCMRC under the U.S. Geological Survey. Because now if you go to the website, you will find all of the reports, they're up to date, everything is being archived in a very good fashion. You don't have any trouble finding what people are doing, you can see it right there. That's not true of all river basin programs. This one is a wonderful example. Is everything perfect? Of course not. No. There are many things that need improvement within the GCDAMP, but those are the kinds of things that you learn as you go and you try to improve as best as possible. So, um, yeah, like I said. Patience and humility.

Paul Hirt:	02:20:06	Well thanks, Rich, for, um, your meeting with us today, for your wisdom and your openness and, and your lifetime of research trying to advance these really important goals of balancing, as you said, balancing societal needs with, um, with the health and resilience of the ecosystems we depend on.
Rich Valdez:	02:20:28	Well, thank you. I appreciated, uh, you asking me to do this interview and thoroughly enjoyed it. Thank you.
Paul Hirt:	02:20:34	Okay.

End of recording