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Jeffrey Kline: All right. Thanks, Joel, and, um, good morning. So, I'd like to start off by, well, just introducing my co-authors: uh, Everglades National Park and the people here from the South Florida Natural Resources Center that we worked with, uh, both with the monitoring and some of the hydrology work; uh, Bill Loftus with the USGS has quite a bit of time down there in the Everglades and is really good with the history of the non-native species and tracking some of the new introductions; uh, Michelle Robinson with the National Audubon Society, they've got some pretty key, uh, sampling sites in the park; and Joel Trexler also has a real big monitoring program.

So before I start talking about the non-native species, I want to discuss quickly the, uh, the mandates of Everglades National Park. And Everglades National Park was preserved; well, it was established to preserve flora and fauna in the natural state. And, uh, with the Expansion Act it was directed to maintain, uh, natural abundance, uh, diversity, ecological integrity of native plants and animals. So I think these are real key words into how we need to look at Everglades National Park and manage, uh, its, its wetlands.

Unfortunately, uh, we've had nine non-native species in Everglades National Park noted prior to 2000. Uh, we know that canals harbor, uh, and facilitate the distribution of non-native species; canals and deep water habitats, uh, refuges from cold winter temperatures; and, uh, they border Everglades National Park in, in several areas, and I'll discuss that a little more. Uh, and Bill noted that there were several species in the border canals, uh, that, that weren't yet found in Everglades National Park, and these non-native species violate the mandates of our park. So the objectives of the talk were to document some of the recent water management changes, uh, document the history of fish introductions in Everglades National Park, relate that to water management and, and look to identify some of the sources of colonization.

So, water management in Everglades National Park, and the period I'm gonna be looking at is before 1999 and after 1999. So before 1999 we had a system of water management, and I'm gonna concentrate on this eastern area of Everglades National Park of where we had the L31W canal, uh, which flows to the south and, uh, is fed on by the urban canal system. And we had a system here where, uh, water would passively flow into the L31W canal and then be pumped out at the headwater of Taylor Slough. Now this was a pretty, pretty unnatural way to, to introduce water into the wetland because we know that Everglades wetlands were shallow and had a large area of sheet flow. Well, under this situation we had, we, we functionally had a bubble of water associated with this, with this pump

station. So that was a pretty unnatural way to manage, uh, the Taylor Slough.

Well, starting in about 2000, uh, with the ISOP Plan and it continued into the Interim Operational Plan, uh, there was a redistribution of water, uh, on how it got into Everglades National Park, and there was construction of retention areas where it, pump stations and retention areas where water was pumped in from the L31 north into these two retention areas. But one of the main changes were, was how they operated, uh, around the L31W canal. Uh, they stopped operating this S332 structure. Uh, they closed off this S175 structure and what they did instead was start operating the S332D structure. Uh, first they initially pumped directly into the canal and then they, then they constructed, uh, a retention area. The end result of this was raising the canal water levels to an extent that they either overflowed into Everglades National Park or there was at minimum, uh, direct connectivity between the canal water and, and these marsh water, marsh habitats right here. And this can be best, uh, best noted by looking at this stage in the L31W canal. And if we, uh, if we look from 1979 to the present, uh, first I want to concentrate on the period 1979 to 1999. What we see when; during the operation of the S332 structure, that during that 20 year period we only had one point where the L31W canal overflowed the, overflowed the bank into Everglades National Park. And this was associated with a, a really large, uh, tropical storm rain event and it was, it was not just in the L31W area. It was, it was pretty large in scale south Florida wide.

So we have this period where the L31W canal doesn't overflow the canal bank elevation, but then starting with a test at the end of 1999 and regular operations since, the L31W canal consistently now overflows, uh, the canal bank into Everglades National Park marsh. If we keep the canal stage, and up on the top graph here, and then we add the timeline of introduced species that have been entering Everglades National Park, uh, we can kind of see a couple patterns here. First, if we; well, I'll break this up into three steps. Uh, 1960 to 1980 there were three non-native species of fish known in Everglades National Park. Beginning in about 1982, uh, there was an increase in the number of species that were noted in the park. And then we see again starting in 2000, and this actually started in the summer of 2000, uh, we started to see a second increase in the numbers of non-native species that we see in Everglades National Park.

Now I don't want to just only focus on the L31W canal, uh, because down here just a little south of the L31W and also part of, functionally part of the same, the same canal system, because up at this point here the L31 north turns into the C111 canal. And it, uh, there was a little bit of a change in, in some of the structure down here. There was a series of spoil mounds associated with the construction, uh, and in 1996 through 1997 they

removed those spoil mounds. These spoil mounds, there were gaps in between, so there was some direct connection between the canal and the marsh. But the spoil mounds were removed to help facilitate some of the flow into the park.

So, uh, just to summarize a little bit and, and to explain a little bit of what species we're seeing, uh, seven new non-native species in Everglades National Park since 1999. We started seeing 'em in 2000. Some of the most prevalent ones are the African jewelfish, which is, uh, becoming really abundant in the Everglades marshes; Jaguar guapote; and the Brown hoplo catfish. And then I'll discuss a couple of these others here in a little bit. But we have 16 non-native species of fish observed in the Everglades National Park at this point. Not all are established. Uh, one thing of importance to note is that 15 of these 16 fish were established outside of Everglades National Park in the urban canal system prior to being collected in Everglades National Park.

What I, what I wanted to do is just, uh, summarize a couple, a couple of our, our sampling programs. And with our co-authors we have a, a big combination of sampling programs that, that have multiple techniques. Uh, we sample in, in multiple habitats and seasons and, and years. Uh, some of these samples, like the throw trapping, go back to the late 1970's. We also have minnow trapping, some electrofishing, uh, some drift fence works, drop traps in the mangrove zones, and visual estimates can be pretty important to track, or to, to find new non-native species.

One of these sampling programs in, uh, was to look at the distribution of fish across, basically across the Shark River Slough and the, uh, associated habitats on the side. And so in, in 2003, I, I, we established a set of transects that ran from the eastern boundary two miles west, uh, through the center of the rocky glades, kind of along the eastern transition of Shark River Slough, straight down the center of the slough, western transition and across the western Marl Prairie. And each of these had three sites per transect and, uh, we used six minnow traps each and we, they're sampled overnight and, uh, we sampled them in June, August and October. What we saw from this sample was that the catch, the catch per unit effort of non-native species was highest along this eastern boundary and it tended to decrease as we, we moved along the transects to the west. So we had a suggestion here that, that, that non-native species are, are somehow being pumped up on, on this side and they're not, they're not as prevalent over here on the western side.

We wanted to look at this pattern a little more, uh, so we expanded, uh, how we sampled. So we established a, a; well, we, we had a grid of points and we placed this grid randomly on Everglades National Park, uh, primarily in the fresh water area. And, uh, this was just to look at the

spatial distribution of non-native species in the park. Uh, this also used, uh, six minnow traps at each point. Uh, one other thing to note is that we, we looked at areas of concern as well, uh, areas near the boundary canals such as the L31W here, uh, and along the C111. And those were a non, non-randomly placed sites.

And I'll just show, uh, an example distribution here of the number of exotic species that was collected in 2005. Uh, if we look at the, at the figure here, we go from zero non-native species collected, which is the small black dot, to four non-native species, which is the largest red dot. And we kind of see a general pattern where along this eastern boundary there's, there's pretty good numbers of non-native species that are being collected along the L31W canal. C111 has a little bit of a, uh, quite a few species there, especially when compared to some of the marshes a little lower. Uh, and along the S12 structures there's a little bit of a bow here. We do have a few, a few spots within Everglades National Park within some, uh, willow holes up in this area; this is within the pine lands, so this is kind of in a large area that drive down to one spot, and we know that non-native species like, are able to persist in willow holes and solution holes, those types of things; but also down here, uh, near Old Ingram Highway where there is some, some Madeira ditches some artificial habitats. But 2005 was an interesting year because it, it was really wet and we had lots of inflows coming in; uh, well through all areas really.

So we see, we see a general trend here where the non-native species are, uh, are highest near these, these canals. If we look specifically at the C111 canal, uh, we do have a little bit of a history on, on some of the non-native species and when they were first observed within these canals, this canal. Uh, in 1999 the Asian swamp eel was first collected within the C111 canal and in 2002 the Spottfined spinyeel was collected within the C111 canal.

Well, it only took a little bit of time and then, uh, they started to collect down here in these, the Highway Creek and the, uh, Joe Bay sampling area, part of Michelle's sampling down here in these mangrove zone that, uh, the first collection in 2004 was the Spottfined spinyeel. This fish has subsequently, uh, been collected in other areas, at Taylor Slough and up in the L31W canal and, and other areas of the park. Uh, and sometimes it's, it's more easily seen than collected. The most recent introduction into Everglades National Park that we know of is the Asian swamp eel. And, uh, they collected this down in this area in December, this past December, uh, and they've collected a few individuals at this point. So we don't have much more information on, on where this species is at this point, so.

The unfortunate thing is that, that Everglades National Park is surrounded by canals and these canals are connected to the urban canal system in

some way or another, and we know that there is additional species in this urban canal system, so eventually; so our concern is that eventually these things like the other species could make their way into Everglades National Park

So in, in summary, uh, we note that, uh, there's an increased connection with the L31W and the C111 canals with, with Everglades National Park. Since 2000 we've seen seven new non-native species, uh, in Everglades National Park, and it seems to correspond with some of the water management changes. Uh, it corresponds to some of the areas of canal inflows. And this is really a violation of Everglades National Park and, and the restoration objectives, the goals that we have set for how we manage Everglades National Park. So basically in summary, border canals appear to be boosting the non-native species in, in Everglades. So we the set of restoration considerations, and I think, uh, I think we have to take a step forward here and, and, and consider non-native species when we, we design water management changes. Uh, non-native species should be considered as a form of bio-pollution, or we can consider them as a form of bio-pollution. They come in with the water it seems. And so, you know, this, this brings a fear or a concern about well, you need the water so let's, let's give it to you. Well, uh, I don't think there's necessarily a tradeoff between the water and, and non-native species.

I think, I think we need to study alternative ways of delivering water without delivering the non-native species. And in some ways I think this is a mandate of Federal agencies, because we have Executive Order 13112 which, which guides us to say that, that Federal agencies need to consider non-native species, uh, and try to prevent the spread of non-native species so we have some, some guiding mandates for us. Uh, so we need to study the alternative ways; and I think, I think we need to look at the CERP and all the restoration projects and take a step back and look at how, look at what we can do to, uh, try to prevent the inflow of non-native species or the movement of non-native species into natural areas. And we definitely need to restore unnatural habitats such as canals. Uh, whenever possible I think we need to remove, uh, canals and borrow pits, these unnatural habitats where non-native species can, can be transported, but they can also persist in these artificial deep water habitats.

A second step we need is to develop rapid response protocols. We need to look; uh, we need early detection monitoring. This is something that has been lacking in the border canal areas and in south Florida in general within the canals, so we're gonna be fortunate to be working with, uh, the, uh, the South Florida and Caribbean Network of National Park Service Inventory and Monitoring Group to, to do a little bit of monitoring in some of our border canals. And I think we need to take the next step and look for opportunities to control and, uh, look for options to control non-native

species. And early detection provides you an opportunity to do this. If you detect a species early on, you might have the opportunity to knock their population back to a level that they might not be sustainable.

And I think primarily we need to control outside of natural areas. Uh, canals are, are relatively restricted in space, especially when they run through the urban areas. You just have a channel of water. That's a much easier place to collect and control fish than in a wide open marsh habitat. So with that I'd like to acknowledge our volunteers and co-workers and, uh, some of our projects were funded by the Critical Ecosystem Science Initiative. Thanks.