

Dwarf Dolly Varden featuring Randy Brown and Alex Huryn

Hey to all you fish enthusiasts out there. Whether you're an avid angler or just curious about fish, we'd like to welcome you to Fish of the Week!, your audio almanac of all the fish. It's Monday, March 13 2023, and one our week by week tour of fish across the country with guests from all walks of life. I'm Katrina Liebich with the US Fish and Wildlife Service in Alaska,

and I'm Guy Eroh and this week we're heading back to Alaska to talk about our, well at least my favorite species named after Charles Dickens character. We're talking about the Dolly Varden specifically some dwarf populations found in North Arctic springs.

I'm very pleased to introduce our guests, Randy Brown, my favorite northern Alaska fish biologist is back and we talked with Randy about Bering Cisco in season one. We're very pleased to also welcome Alex Huryn, who's a freshwater ecologist and professor at the University of Alabama. So happy you two are here.

Good to be here.

Yeah, great to be here.

Okay, so we've got a little bit of context setting to do before we jump into the specifics of these isolated dwarf char, because part of their intrigue is where they're found and how they're different from the sea-run forms and the other char are found across the landscape. Most people probably aren't going to be making it up to the Arctic Refuge in their lifetime, but it's absolutely stunning. So I was hoping maybe one or both of you could help us set the stage in terms of where exactly we're going on the map. And how do you get there?

Well, I'll take a shot at this. This is northeast Alaska north of the Brooks Range, and there is kind of a narrow coastal plain that tapers down to the Beaufort Sea. And there's a number of different rivers that flow from the Brooks Range to the Beaufort Sea in that area. And they don't really have groundwater for the winter. So none of them flow in the winter. But there are these perennial springs and it's ancient water. So it comes from rain and snow from hundreds or 1000s of years ago that goes under the ground and they emerge in the foothills of the Brooks Range and the coastal plain. And they create this aquatic habitat that all of the freshwater fish in the area gravitate to.

Yeah, I know it's closer for you, Randy being based in Fairbanks. So how do you actually get to these spots?

It's a challenge. It's really remote. And you can either drive the Haul Road up towards Prudhoe Bay and take off from Galbreath Lake or Happy Valley or some of these other locations there. In other words, have an airplane come and meet you and take it out. There are some really adventurous people that go and walk across the some of this area, go up to Kaktovik or take off from the Haul Road and walk in the mountains and go places that way. Some winter travelers go through that area. And then of course, there's the residents from Kaktovik that make headway back in and mostly in the winter, back to various different places to fish or hunt. You can also go by airplane, but there are fuel issues and everything because it's a long ways from Fairbanks. But that's the way to get there. It's a challenge.

Awesome.

Yeah, with our work, we use helicopters. And so we stage out of the Toolik Field Station, which is about 120, 130 miles south of Deadhorse at Prudhoe Bay. And we get to the springs using helicopters year round.

Awesome. You sent me a really neat picture Alex of one of these fish. So I was hoping maybe you could help the listeners just kind of visualize what they look like if you had one in your hands.

To somebody who really doesn't have any experience with Dolly Vardens at all there's chances are they'll be familiar with brook trout. And so brook trout are really widespread common species that occurs within the same genus. And the brook trout will have these sort of wavy little vermiculation along the dorsal part of the fish that are very distinctive, and those aren't present in the dollies. The dollies have a continuous sort of olive color. And then they have these beautiful sort of vermilion, little light yellowish speckles and their fins can be really colored up. And they had these really nice leading edges on their pectoral and pelvic fins and are just absolutely, you know, just beautiful. A lot of them are duller in color, especially the young ones, but when the little dwarfs are in their breeding coloration. They're really pretty fabulous, but they look a little bit like brook trout.

And Randy size wise. So if you were to compare one of these dwarfs, if you could kind of give us an indication the size of one of them, and then one of the larger fish that you've worked on with the anadromous form that go to sea and get really big. What did they look like?

Yeah, well, so the dwarfs are quite a bit smaller. Mature size ones are anywhere from about 10 centimeters to 20 centimeters, that's about four to eight inches and some of the large ones get to be by 10 inches long, whereas the big anadromous ones typically might be 50 centimeters, which is just a little less than two feet long and some of them are out towards 70 centimeters, which is towards 30 inches long.

So like, like a good sized salmon almost the size wise.

They're as big as a big chum salmon. Yeah, so the big anadromous Dolly Varden can have several 1000 eggs in a mature female, and the little dwarf ones kind of max out right around 200 eggs for the very biggest of them. And some of them are less than 100 eggs in a mature female. So they're quite a bit smaller, and they retain their parr marks. So even as adults, some people call them "black fish" or "old man fish" because they're pretty dark compared to the big anadromous ones that lose their parr marks.

So they these dwarf populations, is it just the habitat that's restricting your size? Because I know you go down to you mentioned brook trout like Alex just did. You go down to like North Carolina and Appalachians, you get these high mountain streams and the fish mature at much smaller sizes. But if you take one of the dwarf dollies and say put it down in the river to mature, would it get bigger or genetically is it growth inhibited?

Well, so they are genetically different. They've evolved in these little perennial spring habitats. These dwarf ones actually occur in a number of different places. You know, they're in the central Brooks Range. They're in some of the headwater streams in the north side of the Kobuk River in western Alaska. And then there's a number of populations over in the McKenzie system and Babbage River has a population and they're isolated in these little springs. And it's not that they couldn't get out. They might be able to in some of them, but they're pretty abundant in that system. And they've evolved and how they got there I don't know. But one of the theories is that, you know, they're kind of a glacial relic similar to lake trout or pygmy whitefish in some lake systems.

So we're talking about Arctic Refuge, the North Slope of Alaska, is water kind of evenly distributed across this geographical area or are there certain pockets where it's like more lakes?

Okay, so I've been doing a bit of study up there, and certainly the Western Arctic, you know, Prudhoe Bay, and west is a big flatland area with lots of lakes. They don't have perennial springs down in that area. And so they don't really have populations of Dolly Varden, other than in the Anaktuvuk River, one of the tributaries of the Colville. The Dolly Varden, really like these fast run rivers, and there's very little water on the landscape over in the eastern Arctic, where these fish are occurring.

And those springs are a pretty kind of scarce commodity, really important it sounds like, because it is like flowing water that's happening all year round for these fish.

Not all of them, but a lot of them are primarily associated with this large geological feature called the Lisburne Limestone. And it's overcapped by some different types of rock layers that don't allow the penetration of water. They're called aquacludes. But the limestone itself, fractures in these big blocks, and there's also a faulting systems that affects it. So all these structures channeled the groundwater in such a way that they emerge as the springs.

I always have trouble distinguishing Arctic Char from Dolly Varden. I'm curious if you two might be able to elucidate that a little bit how I might be able to tell the difference?

Well, there's a habitat difference, that sort of a rule of thumb, you know, with the Arctic Char, reproducing in lakes and the Dolly Varden being dependent on flowing water.

That habitat difference, is that exclusive to like Alaska and North America?

Yeah, so the habitat differences that Alex was talking about, they're really profound. You know, the Arctic Char are found in the western and eastern Arctic, but they're bound in Lake systems. And they live a life similar to a lake trout in that realm to the west of the Mackenzie River. And when you get to the east of the Mackenzie River, you have a completely different geology, you've got these lakes systems, with relatively short run rivers out to the sea, and the Arctic Char there, migrate up these rivers into the lakes to spend the winter, and to spawn and rear, and then we'll make short forays out to sea but run right back up into the lakes. The Dolly Varden are in these fast run rivers, they roar to the sea, and they like it. They go right up them and live in them and occupy them for the winters and during

rearing, and they spawn in the perennial spring habitats within those rivers. They're truly way different habitats that they occupy.

Whenever I send Randy an email, I always get a response back with articles attached and Randy you had sent me some from the set '70s And I was starting to get confused because it was calling these Arctic char. I guess what was the process whereby people found out that these were indeed Dolly Varden versus Arctic Chars. Is there any kind of like brief synopsis of the history of how they figured this out?

Well, they knew that there were differences, and it is biologically profound, but subtle morphologically. So they were making headway, though. And they knew that the fish to the west of the Mackenzie were different than those to the east. And they identified it, but they called them all Arctic Char, *Salvelinus alpinus*. So that's why the distinction in the literature is not very clear to somebody who doesn't read it closely. But they knew.

Okay, yeah, you could correct me on this. But I think, you know, there's really subtle differences. It's like differences in the number of gill rakers or something like that is morphologically what's used to separate these. And so if you hold on one in your hand, you don't know where they came from, the characters that you might use morphologically to separate them are pretty subtle.

People that study both where they both occur, like down in some of the Bristol Bay drainages. They say they can tell them apart very easily. But they deal with them all the time, and I don't. So I don't have a real good handle on whether I would be able to identify an Arctic Char is separate from Dolly Varden.

If you didn't have that habitat context...

Right.

Or if you didn't cut them open and count the pyloric caeca or something?

Yeah, literally.

Can you talk a little bit more about what the springs are like, because I've never been up there and I'm having a little bit of trouble visualizing them. Because I know like down in Florida, you get these big clearwater springs, then, you know, out in Utah, you get these tiny trickles that have hardly any water. And so I'm just trying to imagine what this actually looks like where these fish are growing up.

Um, there's two large springs on the North Slope, there's Sadlerochit spring and Shublik spring. And Sadlerochit...it's about 1000 liters per second. And so the water just bursts out of this orifice. And then it forms a fairly complex channel, you know, as it makes its way down slope. And then a lot of the other springs that I'm familiar with are quite a bit smaller, a lot of them seem to have discharges that are sort of average, around 100 liters per second. And they're really obvious features on the landscape, when you're flying around. For one thing in the winter, it's the only, you know, headwater streams that are flowing. So they're pretty obvious there. And one of the features that they often have are they have

these poplar groves around them. So these trees will get to be, you know, 30 feet high or more. And so you're out on the Arctic tundra. And there's no vegetation higher than like maybe your knee unless you're in some of these willow thickets or something like that. And then lo and behold, you'll have these little forests of maybe, you know, 100, to 1000 trees, that are just forming the riparian zone in the springs. And there are also very green, you know, the warmer ones. And so it's just pretty spectacular, these little sites, and they're often a little hotspots for plant diversity, where you have, you know, wild roses and things like that you normally wouldn't see in other areas of the tundra. And it's because because this warm flow, it produces what we call a large thought bulb where the permafrost is fairly deep year round, and you have this active layer that's thought year round. And so these plants can sort of make a toehold there. That's cool. And yeah, they're amazing.

Is there any pool habitat? Or is it basically like a torrent all the way down?

Most of them are a torrent. Some of them just burst out of mountain slopes and just shoot straight down and then form channels at the foot of the little slopes familiar with probably like about a dozen that I've worked in, and they're pretty consistent, pretty much constant temperature, pretty much constant flow.

Very consistent habitat for the fish it sounds like.

Yeah, and because of that morphology, the channels just tend to be really consistent. These long runs. But the temperature, like some of the streams are flowing at around two degrees year-round. Ivishak Spring that I've worked in for a long time bursts out of this mountain slope at about 7.4 degrees and at some point four degrees in January or July doesn't matter. And then the temperature changes as it goes down the channel but like in January, at Ivishak Spring, you're 100 meters downstream of the source of water will be like five degrees.

What's this in Fahrenheit?

I'd say probably about 48-50 degrees.

I wouldn't go in there!

Yeah, maybe a little colder than it.

Chilly.

I might put waders on for that one...

In January, they're warm, you know?

Yeah. Jump in on your helicopter, dip your toes in the 50 degree water. It'd be nice. How long are these? Like how much habitat is available to these fish? And is there any kind of understanding of like numbers of fish in these springs?

You know, we started working in a number of other springs, but you know, we just started. And so we don't know. But Ivishak Spring, you'd have about 250 meters of stream channel, you know, before it starts entering other tributaries with different water sources. And we might have like 700 fish, but these are not dwarfs, these are immature dollies that would, after hatching, like in late spring, they make their way upstream into the springs. And then they remain in the springs anywhere from three to eight years or so, maybe a little longer. And then they'll transform, they'll smoltify and head down to go downstream to the ocean and then repeat that cycle.

How can you tell the difference between just a juvenile anadromous form that has been living in the springs versus a resident dwarf that's been living in the springs?

That's a little complicated. Randy's the expert on this. But in Ivishak Spring, you'd have individuals that look like dwarfs, and they're almost always males, and they have very well-developed testes. And apparently, these are what we call "sneaker" males. So they're reproductive fish are males. And so during the breeding season, when the sea-runs come up, and start producing redds in the larger rivers, like in the Ivishak River itself, these guys supposedly will go downstream and hang around the redds. And then when the large sea-run, males are trying to fertilize the eggs of the female, they'll just run in amongst them in spill milt. And then once that's over, they head back into the spring. So in theory, we have some resident sneaker males, but the rest of them, you know, are pretty obvious. Juveniles, you know, they have the parr marks that are not very colored up. And then, you know, they disappear when they smoltify. And the marked individuals just vanish. I guess they head downstream. Randy, could you give a more comprehensive story?

Sure. So the dwarfs that we're talking about that are in these isolated springs are not going to be out in the river and fraternizing with the anadromous population. There is a small number of the anonymous population that don't go to sea and those are the resident males that will become fertile, as Alex was talking about, and they do spawn. They're the same genetic qualities of the anadromous population. They're definitely an anomaly to that group.

They just have a different strategy there right, they don't want to go to sea and risk getting eaten out there.

That's right.

That's kind of like rainbows versus steelheads a little bit.

It's exactly like that, actually. But it's almost all males that choose not to go to sea and yet become fertile. And they still retain their parr marks similar to the dwarf populations. So they're distinct from the, you know, immature, anadromous population that will become anadromous at some point. The dwarf ones, though, are really in kind of isolated places. And it's not available habitat for the anadromous populations. For example, the Shublik Spring, which is a wonderful spring. It's two major ports. And Like Alex said, it just pours out of the side of a mountain. And these two ports come roaring down through this steep gradient. It comes out at about 5.5 degrees out of one port and maybe five degrees out of the other. And, and that's Celsius. And then works its way across a little more than a kilometer

before it falls off about a 30 foot tall waterfall into the Canning River. And this population of dwarf Dolly Varden live entirely their whole lives, there's no real erosion in it. It doesn't freeze at all, no matter what time of year it is. It's always just open water flowing there. I think it's been measured at about one cubic meter per second, which is a little less than the Sadlerochit Spring that comes out of the ground at several ports, but kind of in a confined area at about 13 degrees Celsius, and it flows for about six kilometers before it gets to a really braided shallow region of the stream. In the winter it turns into a big aufeis field for I don't know, 20 miles or so. Virtually all of the water that comes out of these perennial springs gets bound up in aufeis downstream over the course of the winter.

The site that we really worked in intensively. This is in the Kuparuk. By the end of the winter, you could have over 15 meters of ice.

Oh my goodness.

Yeah. And then below that aufeis, it forms this thick insulating layer over the groundwater that's forming the ice sheet. So the groundwater still flowing beneath the ice sheet. And you could have a 30 meter depth of thawed groundwater. It's moving beneath the aufeis year round with a very distinctive groundwater fauna. I call it the yin and the yang because you have these perennial springs that flow year round, that produce this ice feature that then allows this groundwater habitat to exist.

Did you say 15 meters of ice meters? That's like a five story building? That's like 50 feet, right?

It's close to 50 feet. This is the deepest place that we could measure. It's incredible. It is amazing.

You could fly over Arctic Refuge in the winter. And Randy, I've seen your photographs and your video and stuff. But I mean, it looks just like frozen and to have these really neat little pockets. And Alex, you mentioned like the wild roses and the larger trees. Are there any other things in these springs?

Otters.

Otters?

Oh, tell us more about kind of the biodiversity in the springs beyond the fish. Are there any other fish? You mentioned otters, what are the bugs?

There are otters, which is kind of weird. I mean, we knew that there are otters up there, they're not common. You know, we were working Ivishak one day and I found some otter scat. At that time, were marking little dollies with these little alphanumeric elastomer little rubber tags, you know eye tags, and the tags are in the auto scat. So the otter is in these springs are feeding on the dollies. And I don't know if that's sustainable, but the otters are still there. So they've been active at this single site for at least 15 years. Now, they're eating a lot of dollies because I would take the scat and then break it apart and sieve it and then take specific bones so I could estimate the number of fish represented by the scats and the size distribution and that sort of thing. And so the otters are living in the area of that spring, but they can't be feeding only in the spring. I would think they'd have to have a pretty long range.

They're not feeding on these juveniles or dwarf populations. They're in the big springs that hold the mature fish in the winter. And it's like a captive hatchery population. Usually there's an open lead somewhere or a crack in the ice where they can get under. I think they sit there and they eat these big sea run Dolly Varden all winter.

That totally makes sense. One thing I just want to mention really quick is another thing, do you know what dippers are?

Those little birds?

Typically there is a pair of dippers at each one of these springs.

All of them.

Yeah, pretty, pretty phenomenal. And they only occur at the springs, you go to a spring and then there's a pair of dippers there.

All winter long.

Yeah, all winter long. You'll be there January they'll be calling and doing their thing. And you know, they don't occur anywhere else on the north slope. They're at these springs. Resident dippers and otters. And one thing we have noticed is that the size distribution of fish in the Ivishak has really shifted to much smaller fish. So that might be a predation effect, we really don't know,

Do you have any like research questions about these dwarf dollies that haven't been answered yet? It seems like there's just many opportunities in the Arctic still out there.

One of the things that I've been really interested in is the productivity of these systems. And the whole sort of thrust of our study has been geared towards the weird environmental context of the springs. Because they have a relatively constant temperature, the light regime changes drastically. So in the winter, you have a period where the sun doesn't rise for quite a while. And then you have another period during the summer where you have light for 24 hours. So it provides this sort of interesting context for energetic research, where you can actually decouple the effects of temperature and the effects of light. And what we found just sort of in a nutshell, is the springs are really nasty, nasty places to live, and we call the project "freeze or famine" because Dolly Vardens for example, have to live in these springs during the winter to persist because they're the only habitats with flowing water year round. But during the winter, energetically, it gets very nasty because the light turns off, the photosynthesis just screeches to a halt, and everything starves. It's like turning the light switch off, you know? The invertebrates stop eating productivity goes down to almost nothing. The juvenile dollies lose about a quarter to a third of their mass during the winter. And so the juvenile dollies in the springs, it takes some eight years or more to get large enough to be able to smoltify and head to sea because they lose so much mass every winter, at least in Ivishak Spring. So now we're looking at a whole range of springs that are arranged along this thermal gradient. And we're interested in answering questions



about how the thermal environment will affect the suitability of the springs for overwintering for these different taxa.

I'm going to kick it to Randy quick. Seems like there's so many neat questions that are still kind of out there and answers to find.

It's these little isolated populations that are genetically different than the bigger anadromous populations. They're also different from each other. I mean, they're all Dolly Varden but they are unique and they've had 1000s of years of being isolated in these habitats that are small by comparison to you know, a bigger rivers or big lakes, and they are relatively rare cross the North. Five that we know of from Prudhoe Bay to the Mackenzie River, and I sort of see them similar to desert pup fish populations out in the springs in the southwest. They don't interbreed. They don't share genes with anybody else. And they have this very limited habitat.

That's a good comparison. And so it's only five? Are there you think there's any more out there that you don't know about? or is that like, the census has been done on these springs, and that's what it is?

They're similar ones in the central Brooks Range, although they're not necessarily in perennial springs. They're in the river systems, the headwaters of the Brooks Range, both South flowing in North flowing and also out in northwest, you know, some of the headwaters to the Kobuk and so they occur out there, but they're a little bit different in terms of the habitats that they occupy. These ones in the north are...they're confined to these isolated springs where you don't get the other species coming in, and other forms of Dolly Varden coming in, it's them, and it's only them.

Is that all within the Refuge?

No, there's two of them within the refuge. There's the Sadlerochit and the Shublik. And then there's another one on the west side of the Canning, just a little upstream from Shublik Spring. And it doesn't have a name, but it's a little spring that comes out of the side of a hill and moves for about seven kilometers or so down to where it flows into the Canning.

We're wrapping up here, but maybe give me like a 10 second take home, that you really want folks to know about this place or these fish.

Alex you go first.

There's just nothing like them in the world.

There's nothing like in the world. I think that's great. How about you Randy? Real quick one.

Here you are in this giant treeless landscape, and you come across this perennial spring, and it's water that is coming out of the side of a mountain. Has cottonwoods around it. And these little fish living in it. It's an oasis. It's absolutely an oasis.

Dwarf Dolly Varden featuring Randy Brown and Alex Huryn

Awesome. Thank you guys so much. I think we could probably talk for another hour, but super, super cool. And thanks again. Sounds great.

Yep. Well, thank you for having us.

Yeah, thank you very much. I like talking to Randy, I learned a lot from you, man.

Randy's good to talk to. Alright, so get out there and enjoy all the fish and be amazed at where they can live thanks to these ancient perennial springs.

Thanks for listening to Fish of the Week! My name is Katrina Liebich. And my co host is Guy Eroh. Our production partner for this series is Citizen Racecar. Produced and story edited by Tasha AF Limley. Production management by Gabriela Montequin. Post production by Alex Brower. Fish of the week is a production of the US Fish and Wildlife Service, Alaska Regional Office of External Affairs. We honor thank and celebrate the whole community, individual tribes, states, our sister agencies, fish enthusiasts, scientists and others who have elevated our understanding and love as people and professionals of all the fish.