

Finding Fish with eDNA

By Kate Feiffer



Squibnocket Pond, Photo: Stephen Chapman

The last day of August felt like an unremarkable end to a most unusual summer. It was a calm day with temperatures reaching the mid-seventies. Cormorants stretched their wings on Lily Pond and striped bass swam off the shore of Squibnocket, as did bluefish, Atlantic menhaden, cunner, sand lance, northern kingfish, snake eel, striped cusk eel, black sea bass, American butterfish, and clearnose skate.

Thanks to innovations in the world of marine environmental DNA (eDNA), the above list of fish is factual, and not the imaginings of a writer staring out over the ocean. With only a liter of water (collected from the ocean, or a pond, brook, or river) there is now a relatively easy and inexpensive technique available which can decipher DNA and detect which vertebrates have been in that water during the previous 48-hours.



Sample Water Bottles, Photo: Jesse Ausubel

Rockefeller University biologist and part-time Vineyard resident Jesse Ausubel has been working with his colleague Mark Stoeckle since 2014 on developing the process of aquatic eDNA analysis. Ausubel has explained that what you can now ascertain from just a liter of water is “comparable

to what you get from sieving with a giant net (trawling) 66 million liters. That’s a football stadium up to the top of the goal posts.” In a recent article by Stoeckle and Ausubel in *Sea Technology*, they call it “The eDNA Revolution,” writing, “It revolutionizes the ability for people to know, affordably, what lives in the waters near them.”

According to the U.S. Geological Survey, “Environmental DNA originates from cellular material shed by organisms (via skin, excrement, etc.) into aquatic or terrestrial environments that can be sampled and monitored using new molecular methods.” Ausubel has likened the DNA shed to dandruff.

On August 31st, Ausubel, SMF board member Lisa Foster, and executive director Adam Moore spent the afternoon collecting water samples from seven water sources at Red Gate Farm (now called Squibnocket Pond Reservation). Ausubel took the water back to New York and had it analyzed at the labs at Rockefeller University.

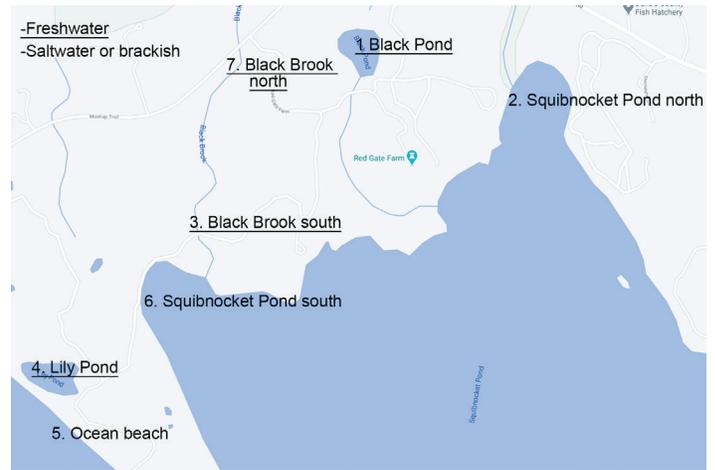
“I was wearing my rubber galoshes, and it took me 20 seconds to collect a liter of water,” Ausubel explained during a recent phone conversation. “We filter the water. We extract the DNA, then we have a kind of magic chemical called a primer, which grabs all the DNA that comes only from vertebrates.”

The DNA results obtained in the lab at Rockefeller University are then compared to sequences in a database called GenBank, which is maintained by the US Government. The numbers on the graph (see chart and map) refer to what can be thought of as pieces of



2020 Red Gate Farm Chart of Fish

	FRESH 1	SALT 2	FRESH 3	FRESH 4	SALT 5	SALT 6	FRESH 7
	Black Pond	Squibnoctet north	Black Brook south	Lily Pond	Ocean	Squibnoctet south	Black Brook north
American eel	0	40,988	77,992	0	0	0	377,003
White perch	0	113,902	0	0	0	194,444	0
Banded killifish	0	0	0	210,639	0	0	0
Atlantic silverside	0	144,370	0	0	0	30,926	0
Nine-spined stickleback	0	0	97,166	0	0	0	0
Mummichog	0	28,708	0	0	0	29,107	0
Inland silverside	0	17,465	0	0	0	21,395	0
Striped bass	0	0	0	0	20,419	0	0
Atlantic menhaden, river herrings	0	9,098	0	0	4,742	135	0
Golden shiner	13,032	0	0	0	0	0	0
Striped killifish	0	0	0	0	0	10,228	0
Bluefish	0	0	0	0	9,283	0	0
Cunner	0	0	0	0	8,324	0	0
Sand lance	0	0	0	0	9,990	0	0
Northern kingfish	0	0	0	0	3,393	0	0
Sheepshead minnow	0	0	0	0	0	2,987	0
Snake eel species	0	0	0	0	2,006	0	0
Black sea bass	0	0	0	0	1,585	0	0
Striped cusk eel	0	0	0	0	749	0	0
Flagfin mojarra	0	0	0	0	0	98	0
American butterfish	0	0	0	0	15	0	0
Clearnose skate	0	0	0	0	3,826	0	0
Thrasher family	0	0	233,696	0	0	0	2,125
Muskrat	0	0	128,654	0	0	0	0
Cormorant	0	4,414	0	9,699	0	0	0
Meadow vole	0	0	0	0	0	0	11,334
American bullfrog or green frog	0	0	3,517	3,018	0	0	3,024
Red-eyed vireo	0	0	0	0	0	0	7,132
American robin	0	0	0	0	0	0	10,193
Herring or great black-backed gull	0	0	0	0	5,179	0	0
Raccoon	0	0	0	0	0	0	5,118
Finch species	0	0	0	0	0	0	4,613
Gray squirrel	0	0	0	0	0	0	3,030
Deer mouse	0	0	2,284	0	0	0	0
Norway rat	0	0	0	0	0	0	2,039
Flicker	0	0	991	0	0	0	0
Catbird	0	0	1,607	0	0	0	0
Wood duck	713	0	0	0	0	0	0
Towhee	0	0	670	0	0	0	0
Catbird	0	0	0	0	0	0	0
Black-crowned night heron	429	0	0	0	0	0	0
Laughing gull	0	12	0	0	0	0	0



Pond, only banded killifish. The pond was placid on August 31st, so whatever DNA traces were in the water remained stagnant.

Golden shiners were found in Black Pond and American eel (the count here was an impressive 77,992) and mummichog were detected in Black Brook south. (If you visit our online newsletter, we will link you to information about all the fish found.)

“You can detect eleven species of fish from the foamy surf coming up on the beach at Squibnoctet. That seems like magic,” marveled Ausubel. Findings on August 31st off of Squibnoctet beach included plentiful striped bass, but fewer bluefish, although there were large numbers of the smaller fish that bluefish tend to eat.

It’s important to reiterate that all this information can be gathered from just one liter of water from each water source. During our conversation Ausubel asked rhetorically, “What would we do if we wanted to get this information some other way? Would we hire a couple of fishing boats from Menemsha with long mesh nets and have them spend several hours out there pulling up all the nets and then sorting all the fish?”

But why is this necessary? Why should we care? One reason is that our water sources are being impacted by continued development on the Island and climate change. This past summer, for the second summer in a row, toxic blue-green algae blooms were found in Chilmark Pond and through monitoring aquatic life one could further analyze the effects of the algae on the presence and abundance of other forms of life, ranging from fish to birds. For people tracking climate change, it is a useful tool to detect if southern species are showing up further north, whether invasive species have been introduced, and how storms impact the fish population around the Island. Swimmers could be alerted if great white shark DNA is found and flycasters could have a bit of a heads up on what might be biting.

And it’s not just fish being found. Birds from the thrasher family, muskrats, cormorants, voles, frogs, racoons, seagulls and ducks were a few of the more visible vertebrates detected.

Ausubel noted that the results from this sample provide information from one day during one summer, but with additional testing throughout the year, which he hopes can happen in the near future, a more comprehensive understanding of aquatic life on Sheriff’s Meadow properties and elsewhere of the Vineyard can be achieved.

Chart and map courtesy of Jesse Ausubel and Mark Stoeckle

DNA that correspond to specific species, not the number of actual fish found, which means the 40,988 American eel at Squibnoctet North doesn’t mean there could be over 40,000 eels slithering around your ankles. Ausubel explained, “We match these long strings of letters, which we know are vertebrate DNA, and we’ll get 40,988 reads of 110 letter sequences that are American eel.”

Ausubel pointed out that DNA from six species of fish, including white perch and nine-spined stickleback, were found in water taken from the north side of Squibnoctet Pond, while water from the south side detected seven species—there weren’t any traces of striped killifish or sheepshead minnow on the north side. There was not much by way of fish in the water collected from Lily



Jesse Ausubel and Lisa Foster, Photo: Jesse Ausubel