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June 5, 2024

Meagan Sims
Maine Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017

Dear Ms. Sims:

We (the Board of Supervisors of Hancock County Soil & Water Conservation District) and our partner organizations (filing separately) request that the Board of Environmental Protection and DEP adopt pH criteria for Maine waters. As a pollution control organization, **DEP needs to control all pollutants**, especially three of the most common and important ones, namely: pH, turbidity, and nutrients. This letter will focus on pH while, turbidity and nutrients will be considered in separate proposals.

Citation of Standard: 38 MRS Article 4A §464 and §465 provides the classification standards for Maine waters. There are currently no water quality criteria for pH.

Details of proposed change: The standard for Maine must protect sensitive life stages of Atlantic salmon, protect aquatic life, and protect treaty fishing rights, and must be pH 6.5 – 9.0.

We propose that 38 MRS Article 4-A §465, 1B be amended as follows:

From: B. The aquatic life, dissolved oxygen and bacteria content of Class AA waters must be as naturally occurs, except...

To: B. The aquatic life, dissolved oxygen, pH, and bacteria content of Class AA waters must be as naturally occurs, except...

And that §465, 2B be amended as follows

From B. The dissolved oxygen content of Class A waters may not be less than 7 parts per million or 75% of saturation, whichever is higher, except ...in identified fish spawning areas.

To: B. The dissolved oxygen content of Class A waters may not be less than 7 parts per million or 75% of saturation, whichever is higher, except ...in identified fish spawning areas. And that pH falls between 6.5-9.0.

And that §465, 3B be amended as follows

From: B. The dissolved oxygen content of Class B waters may not be less than 7 parts per million or 75% of saturation, whichever is higher, ...April 15th and October 31st,

To: B. The dissolved oxygen content of Class B waters may not be less than 7 parts per million or 75% of saturation, whichever is higher, ...April 15th and October 31st, and that pH falls between 6.5-9.0,

Reasons for Change:
Maine law (38 MRS Article 4A §464, 4(F)) states that outstanding national resource waters (like Maine salmon rivers) must be protected.

2) Where high quality waters of the State constitute an outstanding national resource, that water quality must be maintained and protected. For purposes of this paragraph, the following waters are considered outstanding national resources: those water bodies in national and state parks and wildlife refuges; public reserved lands; and those water bodies classified as Class AA

Water quality criteria for pH are extremely important for protecting sensitive life stages of Atlantic salmon, other aquatic life, and treaty fishing rights. Water pH can mean the difference between having fish and not having fish. For instance, in a study of Maryland streams, a pH 6 was found to be a threshold above which there were 9000 fish per river mile. Below that there were only a few fish per river mile. And below pH 5 there were no fish at all.

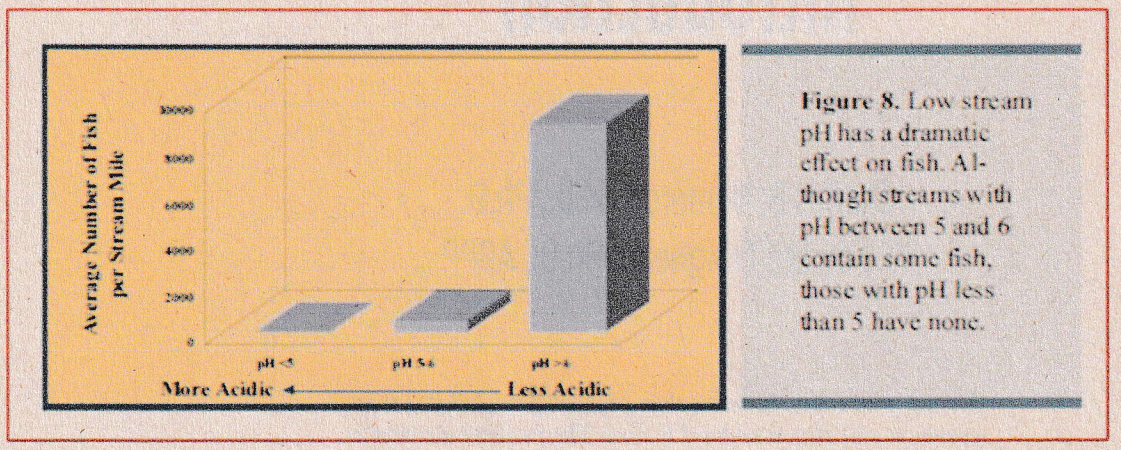

Figure 8. Low stream pH has a dramatic effect on fish. Although streams with pH between 5 and 6 contain some fish, those with pH less than 5 have none.

Figure 1. From Boward, D, P Kazyak, S Stranko, M Hurd, & A Prochaska. 1999. ***From the Mountains to the Sea: The State of Maryland's Freshwater Streams.*** *Maryland Department of Natural Resources, Annapolis, MD.*

The reason is that pH extremes are toxic. A pH of 7 is neutral and a pH below 6.5 or above pH 9 are problematic for many species. If conditions exceed critical survival thresholds, fish are eliminated. Looking at the distribution of salmonids and other coldwater species that are associated with the unpolluted "reference condition" (Figure 2), except for brook trout and rainbow trout, these species are **not found below pH 6.5**. Even brook trout and rainbow trout are not abundant below pH 6 (and some of these are stocked).

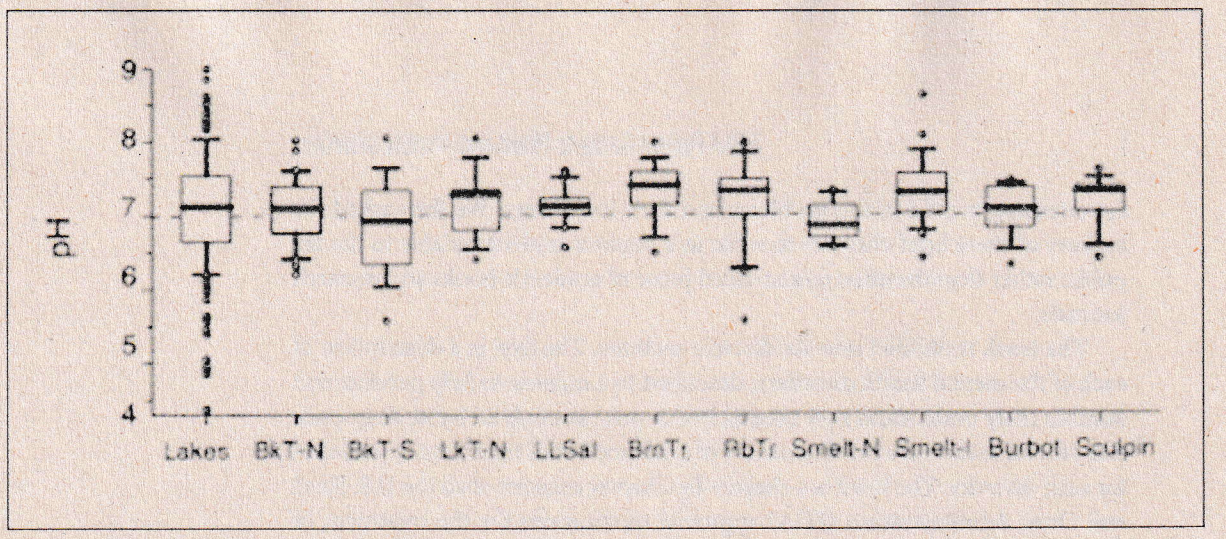

Figure 2. From: Halliwell, DB, TR Whittier & NH Ringler. 2001. ***Distributions of lake fishes of the Northeastern United States - III. Salmonidae and associated coldwater species****. Northeast Naturalist 2: 189-206. Species are from left to right, brook trout (natural), brook trout (stocked), lake trout, landlocked salmon, brown trout, rainbow trout, rainbow smelt (natural), rainbow smelt (introduced), burbot and sculpin.*

Much the same pattern exists for minnows. Minnows overall are found at higher pH than salmonids but have the same response to pH below 6.5. Only golden shiner and carp are found below pH 6.5.

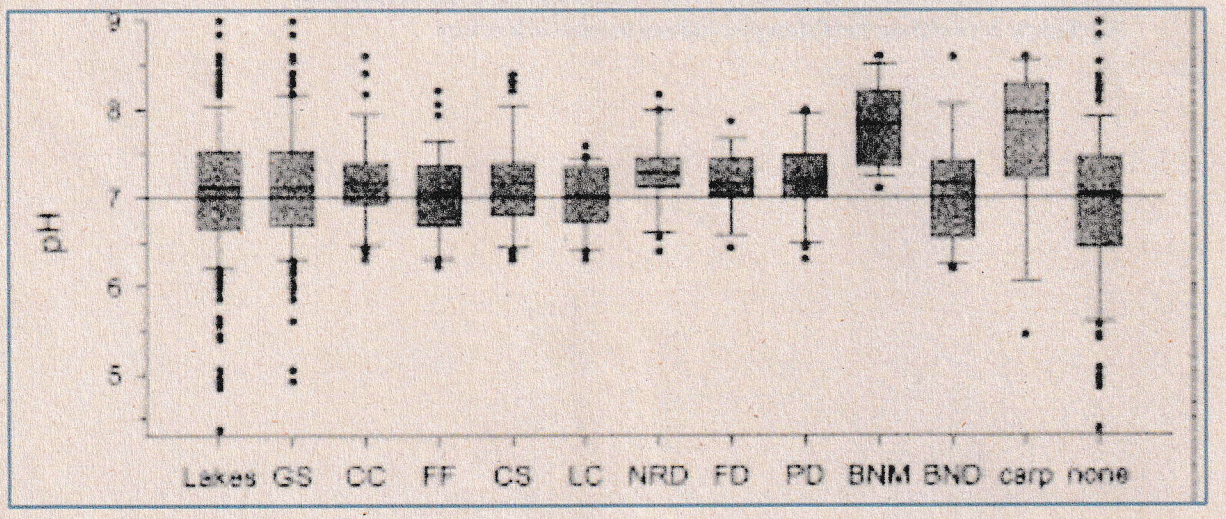

Figure 3. From Whittier, TR, DB Halliwell & RA Daniels. 2000. ***Distributions of Lake Fishes in the Northeast - II: the Minnows (Cyprinidae).*** *Northeast Naturalist 7 (2): 131-156. The species are golden shiner, creek chub, fallfish, common shiner, lake chub,*

northern redbelly dace, finescale dace, pearl dace, blacknose dace, bluntnose dace, and carp.

Water Quality Data: In DEP's 2006 305(b) report, the authors note that of the high elevation lakes that were assessed for acidity, approximately 1% were acidic (defined by the authors as Alkalinity < 0). This has been taken by some to infer that acid rain is not a problem in Maine. This is not true. First, rivers and streams were not investigated, and flowing water is more sensitive to pH impacts than lakes. Secondly, a negative or zero alkalinity would support a pH that is well below 5.0 - which would result in the total loss of fish species. The Maine standard for water quality in Great Ponds is "natural." So, lakes should be able to support fish, and should support all wildlife species that are natural to that lake. It is important to have criteria, but it is also important to have the correct criteria.

I worked for DEP in the Salmon Rivers Program before I retired in 2016. It was my job to determine if there were water quality issues that were inhibiting salmon restoration in Maine. I did a survey of the water quality of some of the major river systems in Maine (Whiting 2015) and found that water quality was indeed a problem in large parts of the state and particularly in the Downeast salmon rivers.

Table 1. From: Whiting 2015, ***Water Quality Survey of Maine Salmon Rivers: the 2015 Field Season, Downeast, the Union & the Aroostook Rivers****, a progress report for the DEP Salmon Rivers Program. A calcium threshold of 2.5 mg Ca/L is needed to support minimal reproduction of brook trout, a threshold of 4 mg/L is needed for most species of fish to thrive. Salmon are a species that need the higher calcium levels. I used calcium criteria, since it was more limiting than pH or alkalinity.*

Table 4. A summary of all samples from a given watershed, including 2015 and historical data, compared to proposed calcium concentration thresholds. Most values are from baseflow conditions, and so represent the most favorable end of the seasonal range. Warm water fish can tolerate the lower threshold, while adult salmonids and fry need the higher concentrations. The values in the table are the percentage of sample sites meeting the thresholds.

Watershed	Calcium Concentration		
	% sites > 1.0 mg/L	% sites ≥ 2.5 mg/L	% sites ≥ 4mg/L
Dennys	100.00	40.00	0.00
E Machias	100.00	61.54	0.08
Machias	100.00	24.13	0.03
Pleasant	100.00	0.09	0.00
Narraguagus	100.00	43.48	13.04
Tunk	80.00	0.00	0.00
Coastal streams	100.00	25.00	25.00
Aroostook	100.00	100.00	100.00
Penobscot	100.00	66.67	54.16
Saco	100.00	100.00	63.64
Union	100.00	60.00	20.00

Table 2. This is a copy of my current water quality criteria for fishery restoration work in Maine. Low calcium tends to be more limiting in Maine than pH. A threshold of 1 mg Ca/L is needed to have any fish at all, and even stocked fish struggle to survive. A threshold of 2.5 mg Ca/L is a threshold where even brook trout struggle to reproduce, and egg and sperm survival is low. A threshold of 4 mg Ca/L is needed for most fish species and life stages to thrive. The alkalinities are those that appear to be needed to support a pH of 5.8 for brook trout and pH 6.5 for salmon and other sensitive species.

Analysis	Threshold	Species	Life Stage	Source
pH	≥ 6.5	Atlantic salmon	all	EPA 1976
pH	> 6.5	Aquatic life	all	EPA 1976
pH	> 5.8	Brook trout	all	Thome 2024
Calcium	> 1.0 mg/L	All fish species		Howells et al 1983
Calcium	> 2.5 mg/L	Brook trout	adults	Danner 2004
Calcium	≥ 4 mg/L	Brook trout	all	Danner 2004
Alx	< 27 ug/L	All fish species		Driscoll et al 2003
Alkalinity	≥ 10 mg/L	Brook Trout	juveniles, adults	Petty et al 2005
Alkalinity	≥ 15 mg/L	All fish species	all	Whiting 2024

In 2023, with the Friends of Taunton Bay, I did a water quality study of 4 tributaries to Taunton Bay (see attachments). These brook trout streams appeared to have poor biological outcomes due to low pH, low alkalinity, and especially low calcium.

So, this is what we mean when we say that pH criteria are critical to fisheries restoration work. We have ample empirical evidence here in Maine that shows that EPA's criteria of pH 6.5-9 is correct. Where do we find pH problems in Maine? Notice where we find Zone 1 alkalinities (less than 100 ueq/L) in the Northeastern USA. The Catskills, Poconos, and Adirondacks are all places where acid rain problems have been well documented. Also notice the Zone 1 part of northern New Hampshire. This is where Hubbard Brook and the White Mountains are located, another region of well documented acid rain issues. Notice that Zone 1 extends into western Maine (this is also the White Mtns and Northern Appalachians) and has the same issues documented at Hubbard Brook. Notice that Zone 1 also extends into eastern Maine, especially in Hancock and Washington Counties and upper Penobscot County. These are not mountain tops like the other sites. However, they have the same vulnerability characteristics (thin acidic and nutrient-poor soils with underlying low calcium bedrock) and the same documented acid rain problems (this also holds for coastal plains in Rhode Island and Cape Cod). Rhode Island and New Hampshire have the largest acid rain impacts in the Northeastern US (about one-half of the state), and Maine has the third largest impact (about one-third of the state). But Maine has the worst impact in terms of square miles affected. Both terrestrial and aquatic resources are impaired.

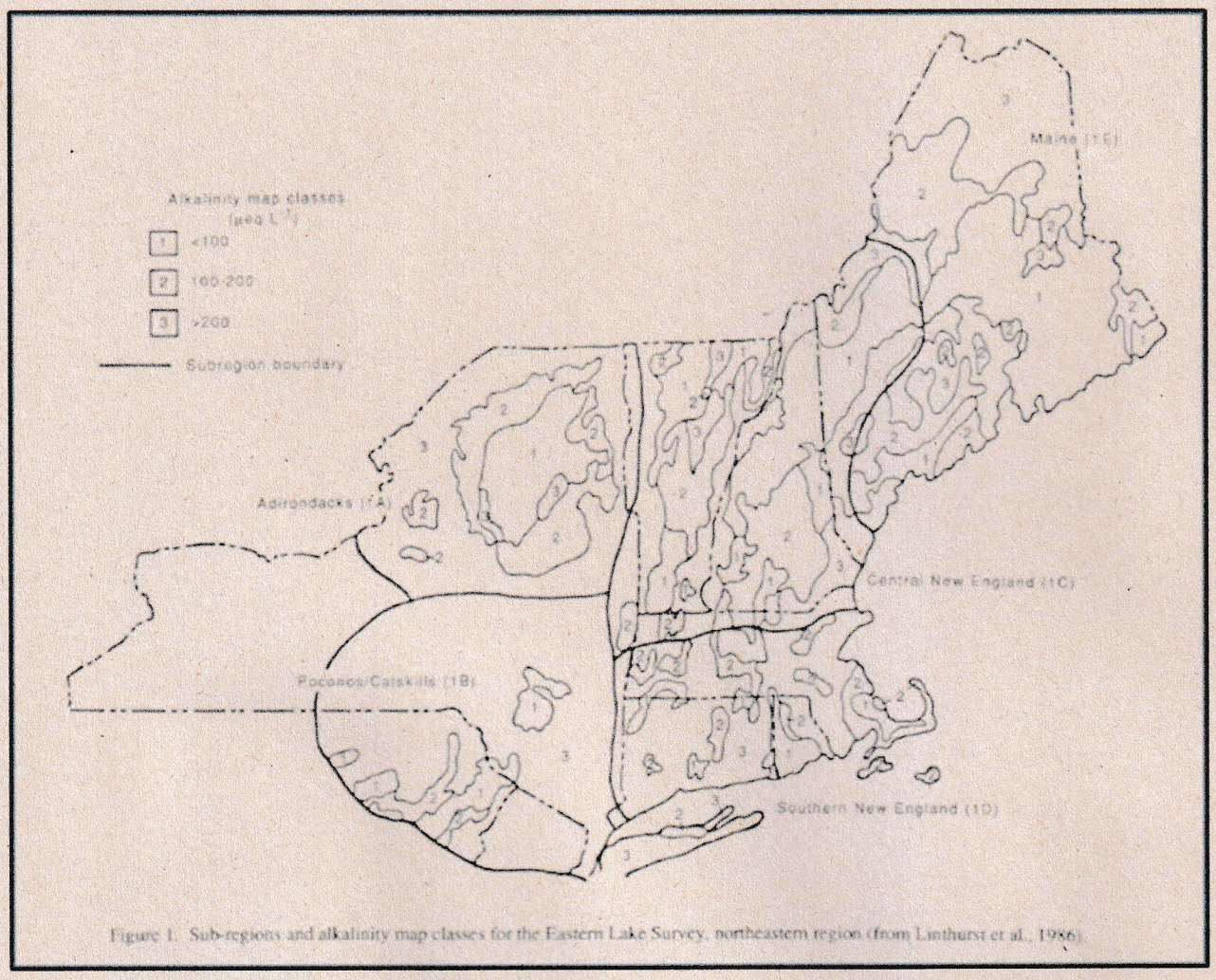

Figure 4. From Lakehurst et al 1986, an EPA study of the water quality of lakes in the Eastern US.

So, is Zone 2 safe? We know that some parts of Zone 2 also have documented acid rain problems, such as elimination of species and streams that only support brook trout, as documented in the Berkshires (Halliwell 1989, ***A Classification of Streams in Massachusetts***, Thesis, U Mass). So, somewhere between one-third and two-thirds of the state of Maine probably have acid rain impacts, pH, and calcium issues that are impacting freshwater biodiversity. This is why we need water quality criteria. It is easy to measure pH, but it is important to be able to determine if a particular water quality outcome is protecting fish and wildlife. The EPA standard for aquatic life is pH 6.5 or better. My proposal for an alkalinity value that is needed to support a pH of 6.5 is about 300 ueq/L on the map (maybe even parts of Zone 3 are inadequate). It is DEP's job to figure this out.

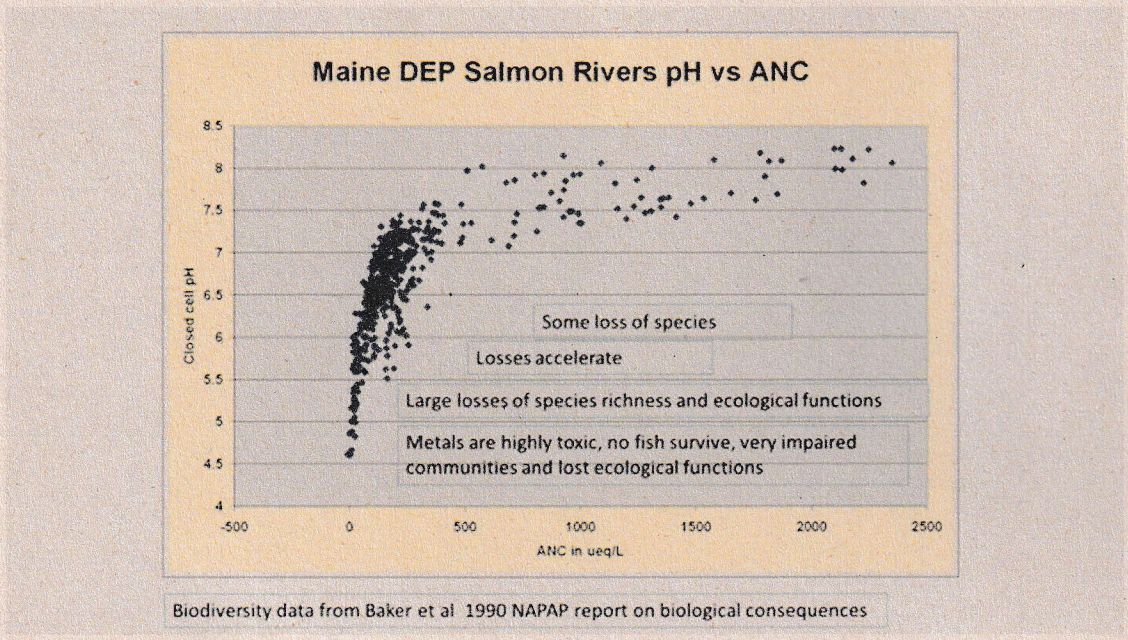

Figure 5. This is my graphic from the DEP Maine Salmon Rivers water quality data. An alkalinity of about 200 ueq/L (10 mg/L) is needed to support a pH of 6.0 for brook trout restoration. A pH of 6.5 needs a little more, maybe 300 ueq/L. However, pH is variable, highest during summer low flow and lowest in the spring and fall (and sometimes in the winter) during high flows. If the lowest pH has to be 6.5 then the summer baseflow (most of these data points are summer baseflow) must be about 7.5 (300-400 ueq/L) to allow for a one pH unit depression during high flows. Going back to our map of the Northeastern USA, only about one-third of Maine has good alkalinity values to protect salmon, other fisheries, aquatic life, and treaty fishing rights.

Another way of looking at pH and alkalinity is to look directly at biological outcomes and work backward to see what pH and alkalinity are needed to get the results we want ("as naturally occurs" in Class AA waters, and even Class C waters must support all indigenous fish species). The following is water quality and fish data from Shenandoah National Park. An alkalinity of 100 ueq/L is enough to support some brook trout and some other species. However, there are 40 species of fish that occur in the park. What is the alkalinity needed to support all indigenous species of fish? We cannot tell because even 200 ueq/L is not nearly enough. Another paper by the same authors with water quality data extending to 300 ueq/L, found that the linear relationship was sustained, additional species were supported, but not all species occurred.

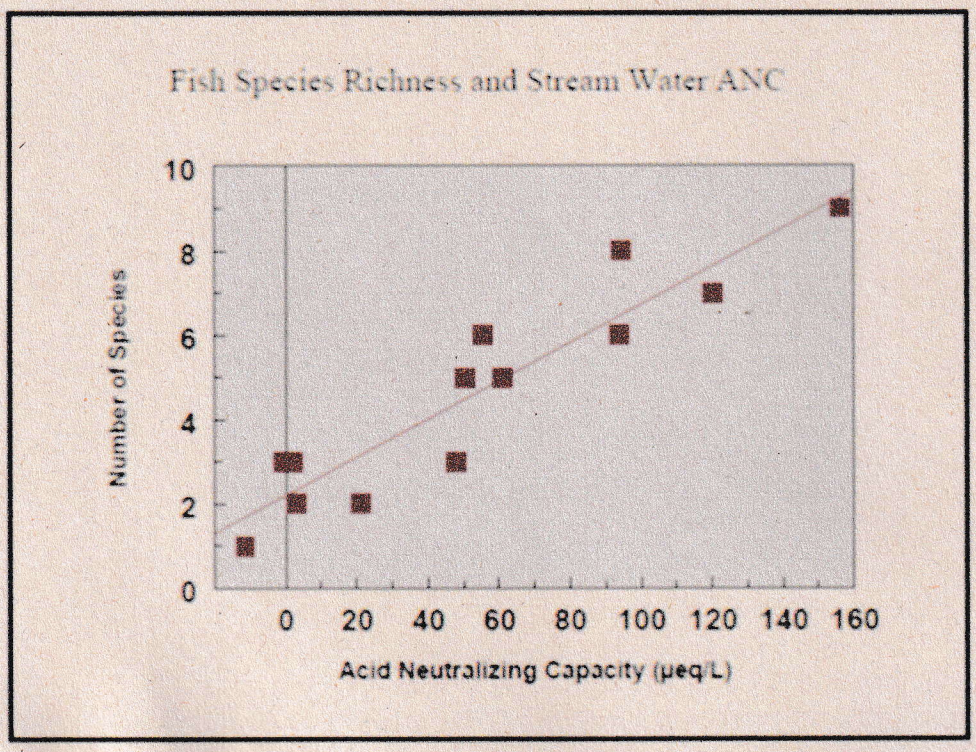

Figure 6. From Crosby, BJ, JR Webb, JN Galloway, and FA Deviney. 2006. ***Acidic Deposition Impacts on Natural Resources in Shenandoah National Park.*** *US Dept of Interior, National Park Service, Technical Report NPS/NER/NRTR—2006/066. There are 40 species of fish found in Shenandoah National Park. The alkalinity (here expressed as Acid Neutralizing Capacity) needed to support all species is well over 160 ueq/L (13 species are shown). Take another look at Figure 4, note that Zone 2 has alkalinities that are 100-200 ueq/L. This is not enough to support stream life "as naturally occurs" in the Shenandoah Watershed - and probably not in Maine either.*

In 1976 (**48 years ago!**), EPA first asked Maine DEP to develop pH criteria. EPA and others have asked several times since then. We asked during the last triennial review. We are trying to restore fisheries resources in Maine and need DEP's help to do so. One of the impediments is a lack of consensus of what is needed to recover salmon. DEP has a funded position to look at water quality issues related to salmon recovery and communicate those findings to the fishery agencies. When I served in that capacity from 2000-2016, extensive water quality data was found to support the EPA's recommended standard of pH of 6.5 - or better - to support aquatic life. We strongly feel that the background information and evidence provided necessitates swift action by the DEP and we look forward to engaging with the Department on this urgent, rectifiable, matter

before more waterways become untenable for their natural species. **EPA has told us what the answer is (pH 6.5-9). I have provided the background information needed to support such a decision. It is time to act!**

Financial Impact: Unknown. The primary polluters responsible for acid rain in the Eastern United States are coal fired power plants in the Ohio River Valley. These are being closed for financial reasons. The Clean Air Act has greatly reduced acid rain, and there has been some recovery of Eastern USA rivers, streams, and lakes. However, recovery is slow. The regeneration of base cations in soils is by weathering of soils and bedrock. This is a geological process that proceeds on a geological time scale. We need to recover endangered species, fisheries, and protect ecological systems right now.

Sincerely,

Mark Whiting, Chair
Board of Supervisors, HCSWCD

Attachments: Whiting 2015 water quality study, Whiting 2023 water quality study of tributaries to Taunton Bay, Whiting Literature review on acid rain in Maine, Whiting literature review on water quality criteria for fishery restoration work in Maine, and Whiting ***Proposed Water Quality Criteria for Atlantic Salmon Restoration 2023***.