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To the
United States House of Representatives
Committee on Transportation and Infrastructure

Hearing on
"Status of the Nation's Waters, including Wetlands, Under the Jurisdiction of the Federal Water Pollution Control Act"

Mr. Chairman and Members of the Committee:

Good afternoon. My name is Judy Meyer, and I have been a professor at the University of Georgia and conducted research on headwater streams for three decades. I have received awards from scientific societies for this research and have served on local, state, and national scientific advisory bodies addressing water resources around the country. I appreciate having the opportunity today to provide this Committee with the scientific evidence for the importance of headwater streams in maintaining the physical, chemical and biological integrity of our Nation's waters.

The scientific evidence is clear that small streams and wetlands must be protected if we are to reach the goals of the Clean Water Act. Decades of scientific research have shown that the mighty river cannot be protected without also protecting the small stream. Rivers are networks whose navigable portions are inextricably linked to small headwaters just as our own circulatory system is dependent on the function of healthy capillaries. Reaffirming the broad definition of waters in the text of the Clean Water Act is critical to maintaining the physical, chemical and biological integrity of our Nation's waters.

Long-standing and robust scientific evidence demonstrates the interdependence of small streams and navigable rivers. Today I will summarize four key points that demonstrate these connections. These points are supported by hundreds of peer-reviewed scientific publications. References to some of this extensive scientific literature are being submitted for the record and have been more completely summarized in the document, *Where Rivers Are Born, The Scientific Imperative for Defending Small Streams and Wetlands* (http://www.americanrivers.org/WhereRiversAreBorn or http://www.sierraclub.org/WhereRiversAreBorn), which is also being submitted for the record. The importance of headwater streams in supporting biodiversity and ecosystem services was recently described in detail in series of technical papers in volume 43(1) of the *Journal of the American Water Resources Association* (http://www.blackwell-synergy.com/toc/jawr/43/1). These points have also been made in a letter to Chairman Oberstar and Ranking Member Mica from the North American Benthological Society, a

scientific society whose members study rivers and streams. This letter has also been submitted for the record.

1. Small streams are ubiquitous. The smallest streams comprise the greatest number and length of channels in a river network. This is illustrated in Figure 1, which shows the percentage of stream miles in the smallest streams. In many parts of the U.S. well over half of stream miles are in these smallest streams.

Yet even this is probably an underestimate of the total length of small streams because of the scale of the maps used in the analysis. For example, standard topographic maps identify only 21% of the stream channel length in the watershed of the Chattooga River, North Carolina. And standard topographic maps are at a more detailed scale (1:24,000) than the data currently available on the National Hydrography Database (1:100,000), which is what was used to derive the information shown in Figures 1 and 2. Hence the information shown in those figures are an underestimate of the extent of headwater streams.

In addition, a sizable fraction of channel length in a river network is in headwater streams that do not flow permanently. This is shown in Figure 2. In arid states such as Arizona, 96% of stream miles do not flow continuously. Intermittent streams are also significant in states that receive more rainfall; for example, in Michigan intermittent streams comprise 48% of the length of stream channels in the state.

2. Permanent and intermittent headwater streams contribute to the physical integrity of the river network. Small streams are an important source of water for large rivers. Recent research has shown that over half of the water in large rivers in the northeastern U.S. is delivered by headwater streams.

Small streams and their associated wetlands hold and store water during storms making them critical for mitigating downstream flooding. When human activity eliminates or degrades small streams, both frequency and intensity of flooding increases downstream, and base flows are lower. In the face of global warming and increased threats of flooding in parts of the country, small streams will thus play an even more critical role in reducing flood damage.

Small streams are also important for retaining sediments. Soils eroded during storms are stored in small channels and released gradually downstream. If this storage is reduced, more sediments are transported downstream during storms; this reduces water quality and negatively impacts fish feeding, spawning, and overall stream productivity and health.

3. Intermittent and permanent tributaries are essential to the maintenance of the chemical integrity of navigable rivers. The basic chemical composition of unpolluted streams is largely established in headwater streams because these are the channels in closest contact with the soil, and they are the sites of extensive chemical and biological activity that influences water quality. For example, recent research has shown that over 40% of the nitrogen found in navigable rivers in the northeastern U.S. originates in

headwater streams. Pollutants and contaminants introduced into headwaters will make their way down to navigable waters.

Recent research has also demonstrated that small streams in the network are the sites of the most active uptake, transformation, and retention of nutrients. For example, recent studies have shown that 64% of the inorganic nitrogen entering a stream is retained or transformed in the headwaters. When headwater streams are eliminated or degraded by excess inputs of pollutants, more of the nutrients being applied to farm fields and lawns are delivered to downstream lakes and estuaries. Nuisance algal blooms, low oxygen concentrations, and fish kills are potential consequences of these excess nutrients.

Small streams serve a vital role as buffers for larger rivers. Nutrients and contaminants enter streams from non-point sources primarily during storms, and it is during storms when ephemeral and intermittent streams are most likely to contain water. Hence the pollutant removal capacity of small streams is most significant when pollutant inputs from non-point sources are the greatest.

4. Intermittent and headwater tributaries contribute to the biotic integrity of river networks in many ways, diagrammatically illustrated in Figure 3. Here I highlight three types of contributions:

- Headwaters are the primary habitats of many aquatic and terrestrial species. For example, my colleagues and I have found over 290 taxa in tiny streams in North Carolina (Table 1). Many headwater species are either imperiled or yet undiscovered. A typical headwater stream probably contains hundreds of species of fishes, amphibians, insects, crustaceans, mollusks, worms and other invertebrates, vascular plants, and algae, as well as untold numbers of microbial species. Many of these species occur only in headwater streams, either because of the unique physicochemical conditions present in headwaters, or because headwaters provide refuges from predators, competitors, or alien species (Figure 3). Even intermittent streams have a rich fauna and flora; for example, summer-dry streams in Oregon have a higher species diversity than permanently flowing streams in the same river basin. Dozens to hundreds of headwater species are either listed as threatened or endangered by USFWS or are considered by NatureServe to be imperiled (G1 or G2). Even in relatively well-studied parts of the United States, biological surveys of headwater streams routinely turn up new species, genera, and even families of animals.

- Headwaters provide spawning habitat, serve as nursery areas, and offer a refuge from predators, competitors, invasive species, and stressful temperatures (Figure 3). Species may use small streams only part of the year, but it is essential that the streams are present and accessible when needed. For example, scientists have shown that brook trout in the Ford River, Michigan retreat to cooler headwaters in summer. Recent research in West Virginia showed that over 80% of brook trout reproduction occurred in headwater streams and intermittent seeps. In coastal streams in Oregon, scientists found that 11 – 21% of coho salmon spawned in

intermittent streams, and the young salmon from intermittent tributaries were larger and therefore more likely to survive than those using permanent tributaries. Over 40% of adult rainbow trout in Sagehen Creek, California, spawned in an intermittent tributary while less than 15% spawned in the perennial main channel. In addition, terrestrial and riparian animals (e.g., birds, bats, other small mammals) find shelter and dispersal corridors along headwater streams.

- Headwaters supply food resources to downstream and riparian ecosystems (Figure 3). For example, fishless headwater streams in Alaska export enough food to support hundreds to thousands of young-of-the-year salmon in each mile of larger salmon-bearing stream. Bird and mammal species in wetlands and riparian zones adjacent to small streams feed on aquatic insects that emerge from the streams.

Conclusion

Extensive scientific research has shown that permanent and intermittent headwater streams are an integral part of a river network; they are not isolated from the larger navigable channels. They provide ecological goods and services of value to society. Whether or not they have a direct hydrologic connection to a navigable river during all months of the year, these headwater streams have a direct impact on the physical, chemical, and biotic integrity of navigable waters as I have illustrated in this testimony.

These small streams have traditionally been protected by the Clean Water Act. Recent Court decisions and agency guidance have not adequately incorporated scientific understanding that the entire river network requires protection. I believe that legislation to reaffirm the original intent of the Clean Water Act is needed to reunite the law with the science. It is critical that headwater streams, which are an extensive and valuable part of our nation's water resources, are clearly under the protection of the Clean Water Act.

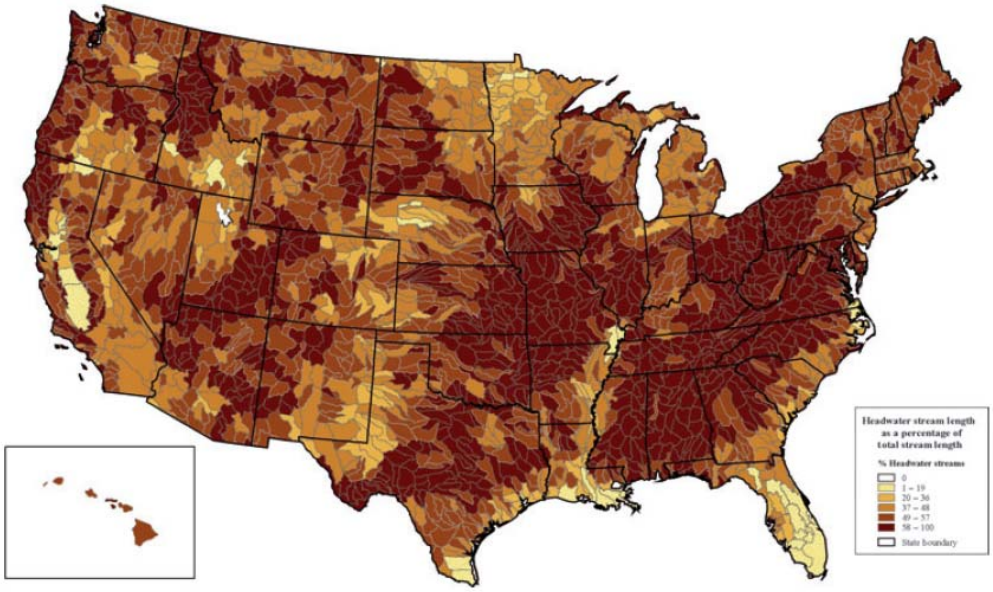

FIGURE 1. Headwater Stream Length, as a Proportion of Total Stream Length Within Each 8 Digit HUC Watershed, in the U.S., Excluding Alaska, as Computed Querying the NHD RAD v2.0 for Reaches That Have No Other Inflowing Streams at the 1:100,000 Scale. The NHD RAD v2.0 Does not Capture Streams Under 1 mile (i.e., 1.61 km) in Length.

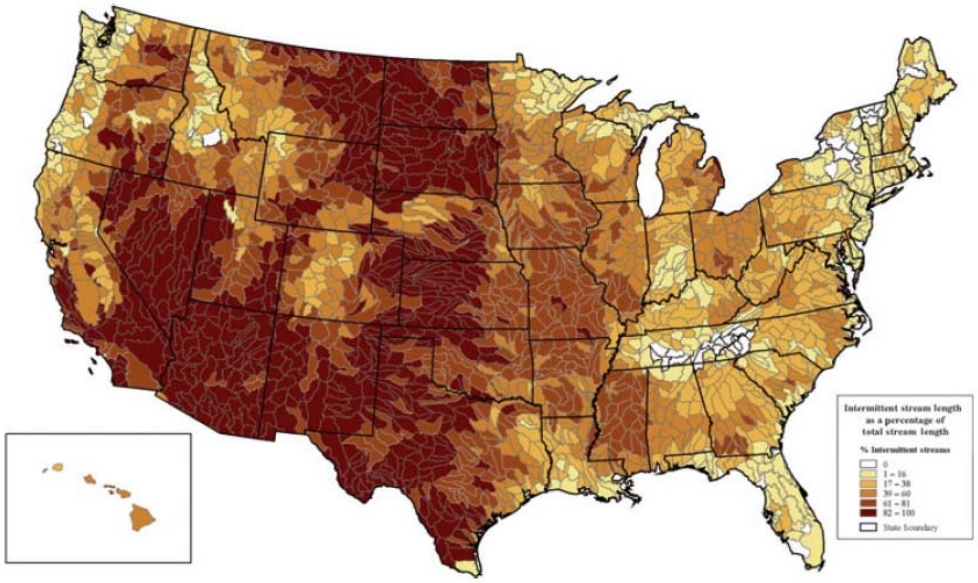

FIGURE 2. Combined Intermittent and Ephemeral Stream Length in the U.S., Excluding Alaska, as a Proportion of Total Stream Length Within Each 8 Digit HUC Watershed, as Computed by Querying the NHD RAD v2.0 for Reaches That Contain Water Only Part of the Year at the 1:100,000 Scale. The NHD RAD v2.0 does not capture streams under 1 mile (i.e., 1.61 km) in length.

Figures 1 and 2 are from T. Nadeau and M. Rains. 2007. Hydrological connectivity between headwater streams and downstream waters: how science can inform policy. Journal of the American Water Resources Association 43(1): 118-133.

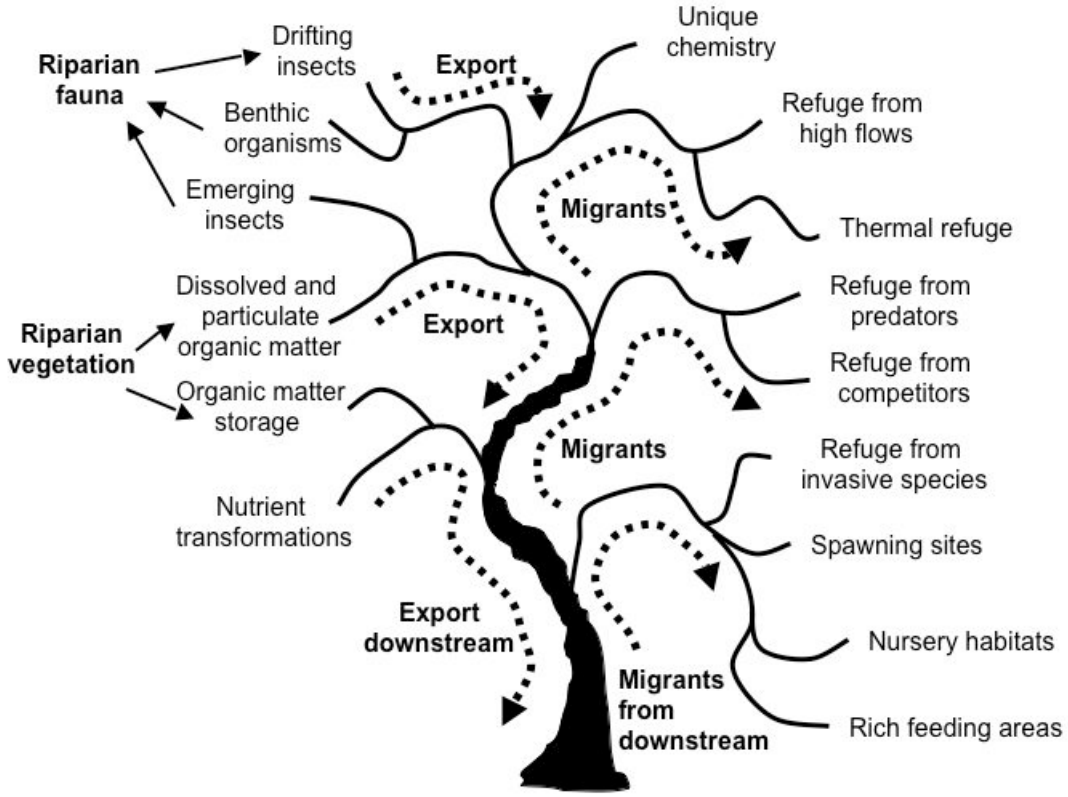

Figure 3: Factors that contribute to the biological importance of headwater streams in river networks. Attributes on the right benefit species unique to headwaters and also make headwaters essential seasonal habitats for migrants from downstream. On the left are biological contributions of headwater ecosystems to riparian and downstream ecosystems. From J.L. Meyer, D.L. Strayer, J.B. Wallace, S.L. Eggert, G.S. Helfman, and N.E. Leonard. 2007. The contribution of headwater streams to biodiversity in river networks. Journal of the American Water Resources Association 43(1): 86-103.

Table 1. A minimum estimate of taxa associated with three small, fishless, headwater streams in North Carolina (average discharge < 0.09 cfs draining watersheds only 12 -18 acres in size (from J.L. Meyer, D.L. Strayer, J.B. Wallace, S.L. Eggert, G.S. Helfman, and N.E. Leonard. 2007. The contribution of headwater streams to biodiversity in river networks. Journal of the American Water Resources Association 43(1): 86-103).

Taxon	**Estimated number of taxa**
Algae	30 diatom species
	10 other algal taxa
Bryophyta	7 moss and 4 liverwort taxa
Fungi	51 taxa
Protista	> 7 taxa
Nematoda	> 10 taxa
Copepoda	5 species
Cladocera	1 species
Decapoda	1 species
Ostracoda	1 species
Gastrotrichia	> 5 taxa
Oligochaeta	> 4 taxa
Branchiobdellida	1 species
Rotifera	> 10 taxa
Turbellaria	> 4 taxa
Tardigrada	2 taxa
Acarina	> 3 taxa
Bivalvia	1 species
Ephemeroptera	4 families; 7 genera; > 7 spp.
Odonata	2 families; 2 genera; > 2 spp.
Plecoptera	6 families; 8 genera; > 8 spp.
Coleoptera	3 families; 4 genera; > 4 spp.
Trichoptera	14 families; 19 genera; > 20 spp.
Diptera	15 families; 55 genera; > 59 spp.
Hemiptera	2 genera; 2 spp.
Collembola	1 family; 1 genus; > 1 spp.
Arachnida	19 genera[a]
Amphibia	2 genera; 5 spp.
Reptilia	> 3 spp.
Aves	2 spp.
Mammals	4 spp.
TOTAL	**> 293 taxa**