

Warming Waters Send Warnings

by Glenda C. Booth

American writer Washington Irving nailed it when he wrote, “There is certainly something in angling that tends to produce a serenity of the mind.” That serenity may be at risk as more signs portend trouble for Virginia’s freshwater fish in a warming world.

Fish are especially sensitive to temperature and grouped generally as coldwater species, like trout, and warmwater species, like striped bass. Forty percent of all fish are freshwater species. “Climate change has become the single-greatest threat to fish and wildlife and our sporting traditions,” William Geer, director of the Theodore Roosevelt Conservation Partnership, has opined

found, “By the end of the century, habitat that meets the climate requirements of coldwater species is projected to decline by 50 percent across the United States.”

This means that coldwater fishing could decline by one million days by 2030, the authors predict. For the Appalachian region, warmer water temperatures could bring a 61 percent decline in trout, warns NWF. Trout Unlimited (TU) cites U.S. Forest Service scientists who predict that “over half of the wild trout populations will likely disappear from the southern Appalachian Mountains because of the effects of warming stream temperatures.”

And from the U.S. Fish and Wildlife Service website: “In the aquatic environment, evidence is growing that higher water temperatures resulting from climate change

(North Branch), Chickahominy, Nottoway, Blackwater, Roanoke, Smith, and Holston rivers.

What do warmer waters mean for fish? Because fish are very temperature sensitive, slight changes can have significant impacts. The warming of coldwater habitats can negatively affect eggs and other life stages. “As water temperatures move away from a species’ optimal temperature range, growth and survival rates decline, reproductive success declines, and the fish become more susceptible to pollution, parasites, and disease,” reports NWF.

Coldwater fish depend upon cold, clear water throughout all stages of their life histories. As water temperatures rise, their habitat will diminish and shift to higher elevations. As quality habitat disappears, coldwater fish will concentrate in small, fragmented headwater streams. Coldwater and warmwater species will compete for habitat as warmwater fish expand their ranges.



More frequent storm events bring increased, heavy precipitation with potential to cause runoff into area waterways, degrading habitat for fish and other aquatic life.

Ten of the warmest years on record have occurred since 2000.

Virginia's Changing Climate

The year 2014 was the warmest since 1880, announced the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) in January. Ten of the warmest years on record have occurred since 2000.

In Virginia, the average warming could be 5.6°F and precipitation could climb by 11 percent between 2000 and 2099, reported the 2008 Governor’s Commission on Climate Change, citing the Intergovernmental Panel on Climate Change. Researchers with the Virginia Institute of Marine Science predict sea level will rise between 1 and 3.5 feet by 2060.

For the future of fish, scientists and others present some troubling scenarios. A 2013 analysis by the National Wildlife Federation (NWF), *Swimming Upstream*,

are negatively impacting cold and cool water fish populations across the country. Climate change has the potential to cause abrupt ecosystem changes and increased species extinctions.”

Warming Waters

Warmer air temperatures increase water temperatures. A 2010 study of 40 U.S. rivers and streams, including the Potomac, found that 20 had experienced significant, long-term warming (ranging from 0.2° to 1.4°F per decade) over the past 50 to 100 years because of higher air temperatures. A 2014 U.S. Geological Survey study concluded that 27 Chesapeake Bay streams in Virginia are warming largely due to this reason. In the waterways surveyed between 1960 and 2010, temperatures rose 2.52°F; this included the Shenandoah, Rappahannock, Mattaponi, Appomattox, James, Roanoke, Potomac

Ecosystem Changes

“Climate change will have a significant impact on Virginia’s ecosystems,” offered the state’s climate commission, threatening to disrupt both their structure and functioning. For example, as the ocean rises, more salt water will move into freshwater tributaries, contracting habitat available for freshwater fish. In rivers that are dammed, fish cannot move upstream to escape saline conditions. During droughts and reduced freshwater flows, saltier water moves farther inland. If a rising sea floods a coastal wetland and the wetland’s landward migration is blocked by a hardened structure, the wetland will become open water; a fish nursery could vanish.

The USGS study of Chesapeake Bay streams elaborates: “Continued warming of contributing streams to the Chesapeake Bay will result in shifts in distributions of aquatic biota and contribute to worsened eutrophic conditions in the bay and its estuaries.” For

eutrophic waters—those with high concentrations of nutrients—warmer temperatures are an added stressor.

Behavior

Many fish time certain behaviors and survival patterns, such as spawning and migration, to changes in temperature and length of daylight. For spring spawning species, rising temperatures cue reproduction; for fall spawners, declining temperatures stimulate reproduction. Largemouth bass spawn when water warms to 62° to 78°F. Walleye spawn as early as late February, when water temperatures reach the upper 40s and lower 50s. Brook trout usually spawn in late October and early November when temperatures drop. Temperatures falling later in the year than fish are accustomed to could affect these cycles, says Trout Unlimited’s Seth Coffman. A TU study found that some Eastern brook trout are delaying the timing of their fall spawn and constructing fewer nests.

On fish migration, TU’s *Healing Troubled Waters* study reports, “Fish in rivers

are extending their ranges northward and migrating earlier, to waters that were previously colder than the fish could tolerate.”

Mayflies and other aquatic insects that some fish feed on could emerge earlier in the spring. “If the timing of aquatic insect availability changes, there could be negative consequences,” comments Steve Reeser, a fisheries biologist with the Department. Temperature can also influence size at hatching, developmental rate, and survival, found Ned W. Pankhurst and Philip L. Munday in a 2010 study.

In short, global warming can confuse the signals.

More Precipitation & Drought

Climate scientists predict a future of more frequent, more severe storms. Precipitation and runoff will increase in Virginia, according to Virginia’s Climate Modeling and Species Vulnerability Assessment.

Stormwater runoff degrades fish habitat when it sends pulses of sediment, phosphorus, and nitrogen into streams and lakes. More

Smallmouth bass. ©Engbreton Underwater Photo

©Dwight Dyke



©Eric Engbretson

A Case Study: Virginia Brook Trout

The brook trout, Virginia's state fish, has been many anglers' favorite for over 250 years. Its name, *Salvelinus fontinalis*, means "little salmon of the springs" because this fish depends upon clean, cold water seeping through the stream bottom.

Virginia has some of the most robust brook trout populations on the East Coast and over 600 streams or portions of streams that are home to brook trout—where clean, cold water is present at temperatures below 70°F. For extended periods. Stream temperatures are affected by air temperature, ground water, and streamside shading. These streams are at risk as air temperatures rise.

"... Virginia could become climatically unsuitable for brook trout by mid-century," reports Virginia's Climate Modeling and Species Vulnerability Assessment. "This could result in the possible extirpation of this fish and other coldwater species."

A project sponsored by the DGIF and the Eastern Brook Trout Joint Venture assessed the susceptibility of Virginia's trout streams to adverse impacts from climate change. Researchers Brad Trumbo and Mark

Hudy identified 272 brook trout watersheds that could be damaged, reduced, or eliminated by climate change. "As air temperatures increase, it is likely that water temperatures will also increase to levels that are lethal to brook trout," Hudy predicts.

Seth Coffman, project manager of the Shenandoah Headwaters Home Rivers Initiative for Trout Unlimited, has summarized: "The full impact of climate change on native brook trout in Virginia is yet to be seen, but we know brook trout need clean, cold water to survive and thrive. As that changes and the amount of available habitat dwindles and shifts, so will the angling opportunities."



Brook trout fingerling

©Ralph Hensley

phosphorus and nitrogen flowing into waterways can lead to algal blooms and oxygen-depleted, hypoxic zones. Also, heavy rainfall erodes unprotected riverbanks and sends sediment downstream, burying spawning habitat and invertebrates. Severe flooding and erosion scour incubating eggs from nests and affect the hatch rate, experts say.

Climate scientists also anticipate more severe, prolonged droughts in some areas, which could make shallower water vulnerable to even more warming and leave fewer coldwater refuges for fish. Receding water can shrink and fragment habitat, leaving fish stranded.

Droughts can reduce both stream flow and the streamside vegetation that helps keep water cool. Extended droughts also mean drier, more fire-prone forests. Fire can destroy riparian habitat and cause quick, even lethal, spikes in water temperature.

"Global warming is bringing more frequent and severe heat waves ...," says NWF's Dr. Amanda Staudt, projecting more extremely hot summer days for every part of the country. Water temperatures can become so warm that they cause massive fish kills and direct thermal stress.

As water temperatures rise above a fish's optimal temperature, stressed fish become more susceptible to toxins, parasites, and pathogens. Reeser explains, "Some pathogens (viruses and bacteria) prefer warmer temperatures and could become more prevalent and more virulent." Fish growth and survival rates can decline.

Adaptation

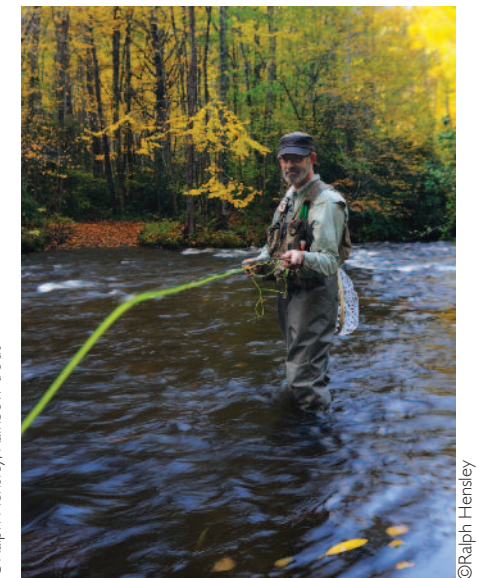
Can Virginia's freshwater fish adapt? Some will adapt and some will not, fisheries scientists say. Fish cannot always move to more hospitable locations. For example, during droughts, fish stranded in isolated pools could die. Many species can move upstream, but upstream represents a smaller area and dams can block fish passage.

"... today's rate of change could outpace many species' ability to adapt," conclude the authors of *Beyond Season's End*.

"... the outlook for most species that depend on coldwater systems is grim," maintains the authors of Trout Unlimited's study.



©Ralph Hensley, Rainbow trout



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In short, global warming can confuse the signals.

"Species will likely survive the averages on temperature changes just fine," says Chris Burkett, Wildlife Action Plan coordinator for the Department, adding, "What we have to worry about are the extreme events that will drive changes in these averages."

Many questions loom. A suite of factors and their interactions affect how fish will adapt. Fish with a wider tolerance of temperatures will adapt, predicts Reeser. Non-natives like brown trout and rainbow trout that can withstand warmer waters may have an advantage over Virginia's native brook trout. Largemouth bass prefer warmer waters than smallmouth, so species composition could shift in warmwater streams.

Helping Fish Survive

Here are some ways landowners can support healthy aquatic systems:

- Reduce impervious surfaces and create habitats to allow water to infiltrate naturally;

- Increase tree canopy and vegetation along streams;
- Reconnect fragmented streams and high quality habitats;
- Direct development away from sensitive aquatic habitats and climate-vulnerable areas;
- Maintain and restore wetlands; and,
- Work to reduce the greenhouse gas emissions that fuel climate change.

The Department is incorporating climate change impacts into the revised *Wildlife Action Plan*, to be completed in

October. Burkett has outlined the goal: "The question is how to help species persist, how to provide healthy habitats to give fish the best chance to adapt. The revised plan will put us on a road to help those species do so."

The waters of Virginia are screamingly important in Virginia to people and to fish. Working to maintain the quality and quantity of our rivers is not just an esoteric exercise," he adds. ☛

Glenda C. Booth, a freelance writer, grew up in Southwest Virginia and has lived in Northern Virginia over 30 years, where she is active in conservation efforts.

RESOURCES

Swimming Upstream – Freshwater Fish in a Warming World

www.nwf.org/News-and-Magazines/Media-Center/Reports/Archive/2013/09-04-13-Freshwater-Fish-Climate-Change-Report.aspx

Beyond Season's End: <http://old.tu.org/beyond-seasons-end>

Virginia Wildlife Action Plan: www.bewildvirginia.org/wildlifeplan/

Climate Change: www.tu.org/sites/default/files/Climate_Change_CurrentImpacts.pdf

Wildlife in a Warming World, ways to combat the climate crisis:

www.nwf.org/pdf/Reports/NWF_Wildlife-Warming-World_Report_web.pdf

National Fish Habitat Partnership: www.fishhabitat.org/about

The Eastern Brook Trout Joint Venture: <http://easternbrooktrout.org/>

Virginia Fishes: www.dgif.virginia.gov/wildlife/fish/

Fish Guide: www.fws.gov/fisheries/fishguide/fishguide.html

Chesapeake Bay Program, Field Guide and Video: www.chesapeakebay.net/fieldguide/critter/brook_trout