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# Wildfire Impacts on Surface Waters

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Every year from 1993 to 2012, an average of 77,780 wildfires were reported in the United States, burning about 5.7 million acres annually.

The incidence of wildfires in the southwestern United States is often linked to the El Niño Southern Oscillation (ENSO). The desert southwest typically receives above average precipitation during the El Niño episode of ENSO and then experiences drought conditions during the following La Niña episode. Plants flourish during the El Niño periods. Grasses and forbs may accumulate during this time and later dry out, setting up conditions for increased wildfire risk during the La Niña episode.

Although wildfire is a natural process associated with native rangeland ecosystems, the immediate aftermath can be startling. One of the most obvious landscape changes is reduced plant cover. This reduced vegetation can have indirect impacts on surface water bodies such as streams and stock ponds or tanks, affecting water quality, fish populations, livestock, and wildlife (Fig. 1).

Wildfire effects on water quality can be physical, chemical, biological, or some combination of these. However, all are relatively short-term, lasting from weeks to a few years.

Reduced plant cover leaves the soil vulnerable to increased rainfall runoff and soil erosion. If not prevented, the increased erosion can continue to deteriorate the pond or surface water quality.

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**Figure 1. Livestock in a stock tank in Pecos County, Texas.** *Photo credit: Sarah McKenzie, McKenzie Land and Livestock.*

## Physical Effects

Soil moisture, weather conditions, and the fuel type and quantity influence fire behavior. Plants and litter (organic matter) on the soil surface make up the fuel for a fire. Grasses, trees, and fallen logs all burn differently, destroying some or all of the standing vegetation and the layer of plant litter (Fig. 2).

The first rainfall events after the fire produce the most sediment. Over time, sediment loss can lead to reduced rangeland productivity and turbid or murky water in streams and stock ponds. After the first rainfall, a crust develops on

**Figure 2. Litter layer composed of dead leaves, twigs, and dung.** *Photo credit: Alyson McDonald, Ecosystem Science and Management, Texas A&M AgriLife Extension Service.*

fine-textured soils that have little or no vegetation. While soil crusting reduces rainfall infiltration, it also reduces erosion. This is also true of rain falling on bare soil after a prolonged dry period, even in unburned pastures.

In addition to sediment, ash washes into surface waters with rainfall runoff or settles from the air as dry fallout. A heavy influx of ash and sediment is detrimental to fish and amphibians and can harm terrestrial wildlife and domestic animals that drink the contaminated water.

## Chemical Effects

Ash often contains elevated amounts of ammonium, nitrate, phosphate, and potassium. It may also contain trace levels of antimony, arsenic, copper, lead, mercury, or zinc. (See *Water Quality: Its Relationship to Livestock* for recommended limits of the concentrations of these chemicals in livestock drinking water.)

Smoke is another source of ammonium and nitrate (Fig. 3), and asphyxiation from smoke inhalation causes many fire-related livestock deaths.

The influx of soil and associated organic nutrients into a pond can cause bacteria to flourish and lower the dissolved oxygen (DO) content of

**Figure 3. Rockhouse Fire in Jeff Davis County, Texas, 2011.** *Photo credit: Carolyn Miller, Fort Davis, Texas.*

the pond water. Low DO causes fish die-offs as well as odor and foul taste so that livestock may avoid the affected water source.

Wildfire may result in elevated levels of cyanide in the air and water. Various sources can produce cyanide. Burning plant biomass releases cyanide into the atmosphere in the form of hydrocyanic acid. Studies have detected cyanide in ash leachate at levels that are lethal to fish. Some fire retardants contain sodium ferrocyanide, or yellow prussiate of soda.

Sunlight increases the toxicity of cyanide. Lethal concentrations interfere with the ability of red blood cells to absorb oxygen; sublethal doses can impact fish fertility. Depending on the pH of the water, cyanide in streams becomes diluted, biodegraded by bacteria and protozoa, and oxidized or passed off as vapor.

**Figure 4. Bright green cyanobacteria floating on a pond surface.** *Photo credit: Michael Masser, Wildlife and Fisheries Sciences, Texas A&M AgriLife Extension Service.*

## Biological Effects

The input of sediment, ash, and nutrients, especially nitrogen, encourages microbial growth. Cyanobacteria, or blue-green algae (BGA), are microorganisms that can produce toxins that cause liver disease or death, which can occur almost immediately or up to several hours after drinking affected water. BGA thrive in warm, still, nutrient-rich waters, especially water with elevated nitrogen. They float on the water surface (Fig. 4) and wind typically causes them to accumulate along the shore.

Because these organisms do not continually produce cyanotoxins, the presence of BGA does not necessarily indicate a danger. About 50 species of cyanobacteria produce toxins; what triggers BGA to produce these toxins is unknown. Fatalities and severe illness of birds, fish, livestock, pets, and wildlife from cyanobacteria blooms occur worldwide, and cases of cyanotoxin poisoning are reported every year in Texas. The Texas Veterinary Medical Diagnostic Laboratory at Texas A&M University can test for some of the more problematic cyanotoxins.

## Remediation Strategies

Burn severity maps can be useful to quickly identify critical or severely burned areas where remediation may be necessary. These maps were developed in the western United States to rapidly assess and categorize the impacts of fire on soils and vegetation over expansive and rugged landscapes.

Burn severity is the level of visible impact a fire causes to the soil surface and herbaceous and woody plants. The severity level, measured using remote-sensing techniques developed by the United States Geological Survey and the United States Forest Service, is classified as 1) severe, 2) moderate, 3) low, and 4) none.

Seeding is a common way to establish new plants that filter overland water flow and reduce rainfall runoff. However, seeding efforts may fail if soils are not allowed to recover sufficiently. Because bare soil can be a prime environment for invasive species, seek sound advice and closely monitor affected areas before reseeding.

Small-scale remediation can protect critical areas. Place straw wattles (See Resources on page 4) or other barriers upslope from stock tanks to minimize the impact of runoff and sediment. You can also excavate debris basins upslope from streams or stock tanks to intercept sediment.

Channel treatment involves installing temporary, in-stream stabilizers and check dams to reduce water velocity and minimize channel cutting and erosion of downstream riparian areas.

Adding alum (hydrated potassium aluminum sulfate), Epsom salt (magnesium sulfate), or gypsum (calcium sulfate) can reduce turbidity caused by suspended clay particles in runoff. These products cause clay-sized particles to clump together and settle out to help clarify the water.

The pH of the pond water indicates which amendment is appropriate. Using a do-it-yourself kit, collect a water sample and test the pH level. Adding alum to acidic (low pH) pond water can make the water toxic to fish. Neither gypsum nor Epsom salt will cause an appreciable change in the pH.

A recommended method is to collect four 1-gallon water samples from the pond or tank and add your amendment of choice (alum, gypsum, or Epsom salt) to each gallon at a rate of 1 to 4 tablespoons, respectively, to determine which dose results in acceptable settling and clearing

## How to Calculate Pond Size and Volume

The volume of water in ponds is often expressed in units called "acre-feet." An acre-foot represents one surface acre that is one foot deep (325,851 gallons). To calculate the acre-feet of water in a pond, you'll need the surface area (acres) and an average depth (feet) of water in the pond.

### *Area*

Estimate the surface area of a circular-shaped pond by measuring the distance around the pond shoreline in feet. Square the shoreline distance and divide by 547,390 to get the pond area in acres. For example, a pond that is 520 feet along the shoreline would have an area = $520^2$/547,390 or 0.49 acres.

Estimate the surface area of a rectangular or square-shaped pond by measuring the length and width of the pond sides in feet. Multiply the length by the width to calculate the surface area ($ft^2$). Convert this value to acres by dividing by 43,560 $ft^2$/acre. A pond that measures 300 feet long and 200 feet wide would have an area = 300 feet × 200 feet = 60,000 $ft^2$ or 1.37 acres.

### *Depth*

The second step in determining the number of acre-feet in a pond is to measure the water depth at several locations in the pond and calculate an average. For a typical bowl-shaped pond, estimate the average depth as 0.4 times the maximum depth. So, a pond with a maximum depth of 12 feet would have an average depth of about 4.8 feet.

### *Volume*

The volume of water in the pond (ac-ft.) = Area (acres) × Average depth (feet)

1.37 acres × 4.8 feet = 6.6 acre feet

of the sample after 12 hours. Either by wading or from a boat, apply a slurry of the calculated rate of alum mixed with pond water to the surface water across the pond. For each tablespoon of alum required to clear the water sample within 12 hours, apply 30 pounds of alum per acre-foot of water to the pond (See calculation tips above). Each tablespoon of either gypsum or Epsom salt is equivalent to a rate of 80 pounds per acre-foot of water. Use a seed or fertilizer spreader to apply gypsum and Epsom salt directly to the surface water. (See *Water Management: Clearing Cloudy and Muddy Water in Ponds and Lakes* for more information.)

Many impacts of wildfire on surface water quality are short-term and can be managed by reducing soil erosion, using an alternate water source, or treating with chemicals to remove sediment from the water column (from the surface to the bottom of the body of water).

## Resources

### Testing Services

**Texas Veterinary Medical Diagnostic Laboratory**
Texas A&M University
tvmdl.tamu.edu

### Erosion Management Products

**L and M Supply Company Texas**
126 Texas Ave., Building #2
San Marcos, TX 78666
Phone: (512) 667-6635
www.landmsupplytx.com

**Texas Erosion Supply**
1327 Century Way
Wylie, TX 75098
Phone: (972) 575-8800
info@texaserosionsupply.com

**Arizona Bag Company, LLC**
2530 West Buckeye Road
Phoenix, AZ 85009-5746
Phone: (602) 272-1333
Toll Free: 1-800-270-2247
Fax: (602) 278-7871
info@arizonabag.com

### U.S. Fire Statistics

http://www.usfa.fema.gov/data/statistics/
http://wildland-fires.findthedata.com/

### Related Publications

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Sink, T. and M. House. *Understanding Water Quality Reports for Your Pond*. Texas A&M AgriLife Extension Service, EWF-017, http://fisheries.tamu.edu/files/2014/12/Understanding-Water-Quality-Reports-for-Your-Pond.pdf. Also available at http://www.agrilifebookstore.org/Understanding-Water-Quality-Reports-for-Your-Pond-p/ewf-017.htm.

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