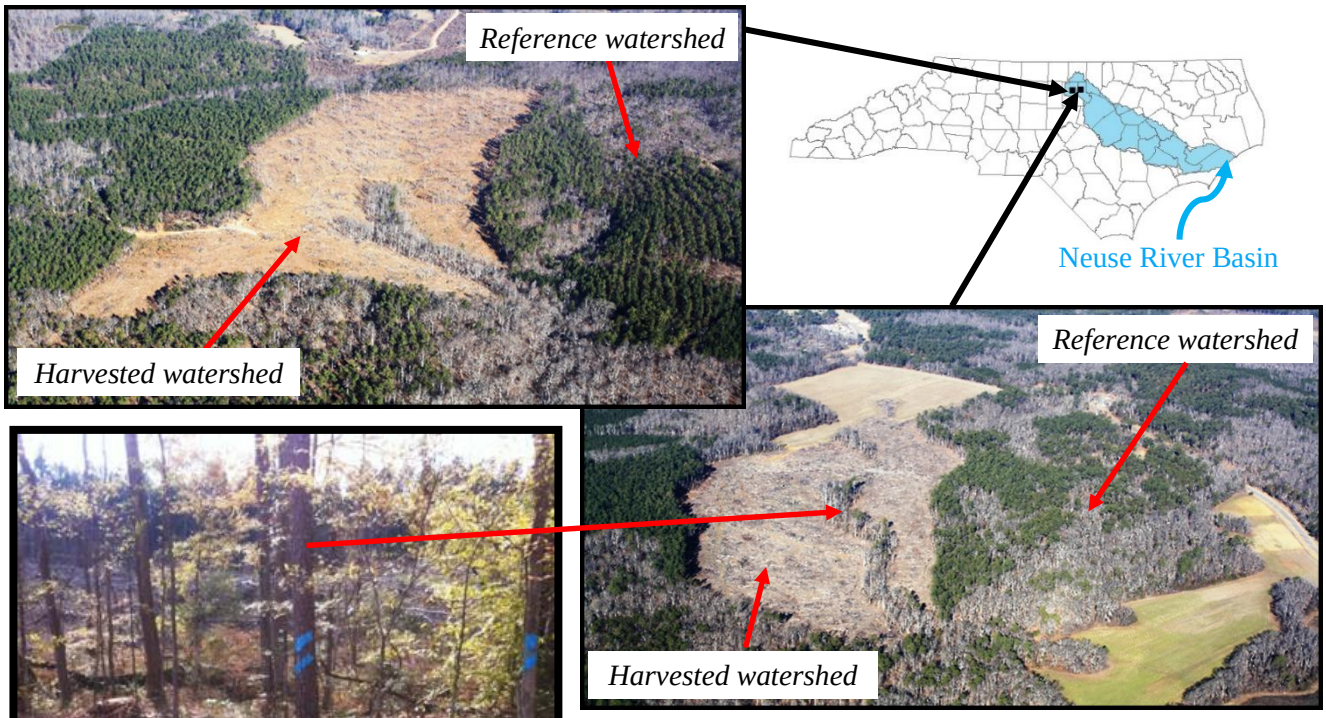
Timber Harvesting Effects on Water Quality and Quantity in the Headwaters of the Neuse River Basin

A snapshot of a long-term paired watershed study results

What We Did

- The North Carolina Forest Service completed and published a non-technical summary of a 6-year (2007-2012) paired watershed research project that evaluated the effects of timber harvesting on water quality and quantity in two headwater stream systems of the Neuse River Basin in North Carolina.
- Timber harvesting complied with the Forest Practice Guidelines Related to Water Quality (FPG's) and Neuse Buffer Rule. Additionally, the timber harvest followed appropriate voluntary forestry best management practices (BMPs) to help protect water quality.
- The non-technical summary distilled technical results into "take-home points" for forest management.



Locations: North Carolina State University's Hill Demonstration Forest (Durham Co.) and North Carolina Department of Agriculture and Consumer Service's Umstead Research Farm (Granville Co.)

- *A **watershed** is an area of land where all of the water that drains off of it or is under it collects into the same place (a stream).*
- *The bottom left photo is an onsite example of a section of the Neuse Riparian Buffer Rule Zone, which functioned as a streamside management zone (SMZ). A SMZ is an area along both sides of a stream or other water body where extra precaution is used in carrying out forest practices in order to protect water quality. A SMZ is required by the N.C. FPG's.*

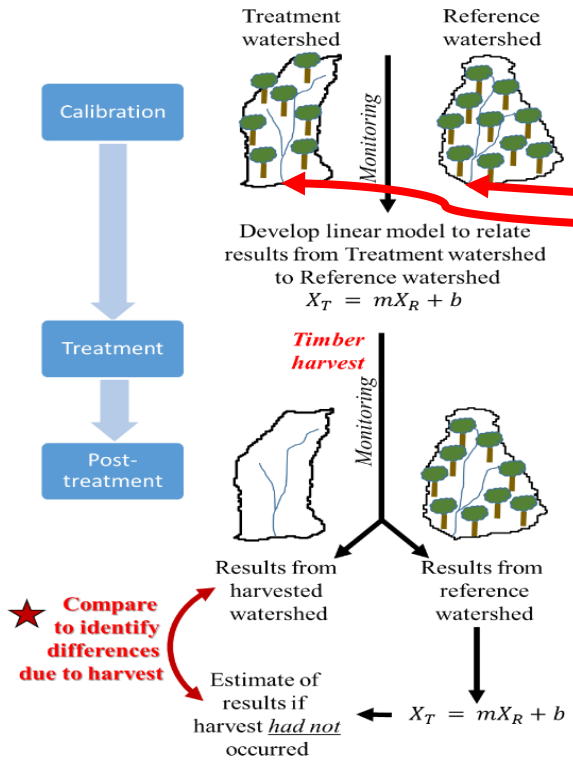
What Questions Did Researchers Ask?

1. Does implementation of the Neuse Buffer Rule and voluntary forestry BMPs maintain water quality levels on harvested watersheds compared to non-harvested watersheds?
2. Are there stream flow effects, and if so, how long will the streamflow effects be observed?
3. Are there negative effects on aquatic wildlife in the streams of the clearcut watersheds?
4. How are riparian vegetation and groundcover affected by a clearcut timber harvest?

How Did the Researchers Do It?

- Researchers monitored stream flow and water quality before and after timber harvesting using the paired watershed method.
- Automated water samplers, flow control structures, and other hydrological measuring equipment were utilized to collect high quality data.

Paired Watershed Method



Above is a flume (picture center) and an automated water sampler (picture background on the right). ***Flumes*** *are devices used to control the flow of water for various purposes, one being to measure water discharge.* ***Automated water samplers*** *are powered with a large battery and collect water samples at programmed times using suction.*

What Were Researchers Measuring?

Data Category	Parameters
Meteorology	Precipitation, air temperature, relative humidity, total solar radiation, wind speed, soil moisture
Stream discharge (flow)	Calculated from stage and flume/weir dimensions
Stream channel shape	Cross sections of the stream
Evapotranspiration (tree water-use)	Residual trees in the streamside management zone
Riparian vegetation structure	Timber overstory and midstory; groundcover survey
Water chemistry	Total Suspended Solids, nitrate nitrogen, ammonium nitrogen, total phosphorus, Total Kjeldahl nitrogen, and total organic carbon
Water temperature	Temperature (°C)
Aquatic-based insects	Diversity, tolerance to pollution, feeding needs

What Did Researchers Find?

Hydrology and Stream Discharge

- Within harvested watersheds, actual streamflow discharges were greater than modeled estimates (estimates of the discharge had the timber not been harvested). Increases were especially notable in watersheds that had clay soils, which naturally limit downward water infiltration and readily generate runoff.
- After three years of new vegetative growth following harvests, stream flow began to return to preharvest levels. However, the trees retained in the buffer zone increased their collective water use after harvest, and at least partially offset the hydrologic effects of the timber harvest.
- Ultimately, underlying geology and soil type had a stronger influence on stream discharge than tree water-use, regardless of whether timber was harvested in these watersheds.

Photo of streamflow postharvest in one of the study watersheds.

Photo of a researcher taking a grab sample (above) and researchers sampling aquatic insects (below).

Water Quality

- Increased levels of sediment and nutrients following timber harvests did not exceed North Carolina's water quality standards.
- Throughout the study, all watersheds exhibited sediment and nutrient loads similar to natural background levels from forests in other research studies, and much less than other land uses.
- No consistent increases in sediment and nutrients were observed from all monitored watersheds *except* nitrate nitrogen, which peaked 1.5 years postharvest and returned to preharvest levels after 2 years.
- Stream temperature did not exceed 84.2°F, which is the maximum allowable temperature for maintaining healthy stream habitat for aquatic life.
- Aquatic insects were classified as Good/Fair to Excellent in the harvested watersheds, postharvest. No functional degradation was observed in the sampled aquatic life after the timber harvests in harvested watersheds.

Riparian Buffer Characteristics

- After timber was selectively removed from alongside the stream, ground-cover vegetation diversity increased. Increased sunlight reaching the forest floor promoted growth of herbaceous and bush vegetation.
- Even after selective harvest and removal within the SMZ, tree canopy cover met forestry BMP recommendations and was sufficient to shade the stream on all watersheds.
- The total number of stems in the riparian buffer zone did not significantly change after harvest. However, significant damage including broken tree tops and windthrown trees occurred to the residual timber in the riparian buffer zones as a result of windstorms in 2012 and 2013.

Photo taken from the stream looking through a Neuse Buffer Zone into the harvested area.

Forest Management Take-home Points

- **Harvesting timber will increase water yield in both absolute volume and duration of time for a short-term period. However, the underlying geology in this study played a more significant role in the system than vegetation.**
- **Timber harvesting can be compatible with sustaining and/or protecting water quality conditions in streams when harvest operations include effective and adequate methods to protect the riparian environment and reduce soil erosion.**
- **Even though stream discharge increased notably after clearcutting, the residual trees in the riparian buffer zone increased their usage of water, and the relative increases of stream discharge began to diminish as the harvested area regrew. Prompt reforestation after a harvest will sustain timber availability and contribute towards balancing the watershed cycle back to preharvest conditions.**
- **If the forest manager has an objective of water supply management, then increased water use by residual riparian trees may drive some of the decisions regarding whether or not to selectively harvest trees from stream buffer zones, and if so, what species of trees to retain or harvest, given that different tree species cycle water differently.**
- **Harvesting of overstory trees can provide more sunlight to reach the ground and foster the growth of more diverse groundcover and shrub vegetation. Foresters and resource managers may be able to promote changes in low-growing vegetation type and structure, depending upon if and how overstory trees are removed from a riparian area.**
- **When selecting trees to retain within a riparian area, careful consideration should be taken to retain trees that provide long-term vegetation structure, soil stability, and stream shade.**

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