

## Chapter 8: Human Caused Instruments of Watershed Change (pg. 98)

- Major agents of change:
  - 1) Modification of river flow
  - 2) Agriculture
  - 3) Timber Harvest
  - 4) Urbanization
  - 5) Fire suppression
  - 6) Mining
  - 7) Harvesting of fish and wildlife
  - 8) Introduction of exotic species
  - 9) Accelerated climate change
  - 10) Human population and development
  - 11) Point and nonpoint source pollution
- If intensified change exceeds certain thresholds, recovery of natural resources is no longer certain

### (1) Modification of River Flow

- Natural flow regimes vary in magnitude, frequency, duration, and timing, and provide these services:
  - Move sediment and debris downstream
  - Provide breeding habitat for aquatic organisms
  - Shape physical structure of river ecosystem
  - Scour vegetation
  - Transport seeds and plants
- Impoundment and water withdrawal reduce flow amplitude, increase baseflow variation, alter temperature regime, and reduce mass transport of materials
  - Dams act as sediment traps and alter temperature regime
  - Dams that stabilize base flows and ensure sediment exchange mimic natural flow regime
- Example: Modification of river flow can prevent Alligator Gar from reaching spawning grounds on floodplains

### (2) Agriculture

- Agriculture affects watersheds in the following ways:
  - Removes streamside vegetation
  - Grazing practices shift grassland vegetation
  - Soil tillage increases erosion
  - Irrigation practices dewater streams
  - Fertilizers and pesticides increase nutrient content
- Clearing of forested watersheds for crop and pasture land degrades water quality and modifies flow regimes
  - Increased erosion, turbidity, fluctuations in discharge and temperature
  - Increase in dissolved nutrients  $\text{NO}_3$  (nitrate) and  $\text{PO}_4$  (phosphate) increases primary production
- Unlimited livestock grazing increases sediment and debris input, encourages invasive plant growth, and directly deposits waste into waterways
- BMP (best management practice) examples:
  - Limit livestock access to waterways to reduce vegetation trampling, overgrazing, and waste deposition

-Retain vegetation buffer strips along streams to filter nutrients, stabilize banks, reduce soil loss, moderate water temperature, and create habitat corridors (minimum 30 feet wide on each bank)

### **(3) Timber Harvest**

- Loss of mature vegetative cover due to timber harvesting has the following effects:
  - Decreases interception of rainfall by vegetation
  - Reduces evapotranspiration
  - Increases surface runoff and therefore augments peak flows
  - Fragments and degrades terrestrial habitat
- Road construction on steep slopes can increase sediment delivery, elevate water temperature, increase turbidity, and increase substrate uniformity, impairing habitat for many invertebrate species
- Streamside Management Zones are forested buffers maintain soil stability, intercept precipitation, shade streams (keeps water cool, maintaining dissolved O<sub>2</sub> in water), and provide habitat

### **(4) Urbanization**

- Increases surface runoff, peak flows, and flood frequency
  - Channelization of streams and storm sewers compound these effects, increasing flow velocities
- Point source pollutants (sewage, industrial effluents) and nonpoint source pollutants (atmospheric deposition, street litter) are loaded directly into streams and lakes from impervious surfaces
- Watersheds with 25% imperviousness experience peak flow volume of a 100-year storm every 5 years

### **(5) Fire Suppression**

- Fire suppression causes vegetation overcrowding and increases potential for high-intensity crown fires
  - Provides pathways for flames to reach canopy
  - Crown fires usually kill species resistant to moderate and low-intensity fires
- In Texas, native grasslands, savannahs, and open woodlands are overgrown with woody species
- Periodic fire disturbance increases soil nutrients and a mixture of successional stages increases biodiversity

### **(6) Mining**

- Waste rock containing sulfide is stored aboveground and reacts with water to form sulfuric acid
  - Resulting leachate known as acid mine drainage (AMD) that pollutes water through surface drainage
- Over 90% of ore ends up as tailings (residue) stored in ponds and piles near mine, contains toxic chemicals e.g., toluene, a solvent damaging to human respiratory, circulatory, and nervous systems

-Tailings expose arsenic, cadmium, copper, lead, and zinc to water causing heavy metal contamination

-Effects exacerbated by AMD, which creates low pH and mobilizes heavy metals

- Mining and smelting release pollutants such as cadmium and air pollutants such as sulfur dioxide

### **(7) Harvesting of Fish and Wildlife**

- Commercial fishing results in a gradual shift from large, long-lived, high-trophic species to smaller, shorter-lived, lower trophic level species
- Changes in abundance at one trophic level can cascade to lower trophic levels
- Harvest regulations such as size, daily bag limits, and possession regulations maintain populations

### **(8) Introduction of Exotic Species**

- Invasive species spread via waterways and often outcompete native species
- Some invasives are introduced intentionally such as ornamental plants, popular game, and aquarium or bait fish species, while others are introduced unintentionally e.g., Zebra Mussels, which arrived from Europe in ballast water of large ships
- Examples of invasive species: salt cedar (tamarisk), giant reed, Chinese tallow, Chinaberry, Privet, K-R bluestem, Japanese honeysuckle, Bighead Carp, Blue Tilapia, giant salvinia, water hyacinth, water lettuce, hydrilla
  - Riparian areas dominated by invasive species have lower plant diversity and lower habitat quality

### **(9) Accelerated Climate Change**

- Human-caused climate change differs from natural climate change in the rate at which it occurs
  - Global annual average temperature has increased 0.8°C (1.5°F) since 1880 (through 2012)
  - Atmospheric CO<sub>2</sub> concentration has increased from 280 ppm to 360 ppm over the same period
  - CO<sub>2</sub> concentration and global temperature are strongly correlated
- When air temperature increases by 1°F, air can hold 6% more water, increasing water exchange between ocean, land, and atmosphere
  - Longer droughts punctuated by heavy rains increase frequency of flash flooding
- Projections suggest more frequent and more intense drought, severe rainfall events, and heat waves
- Woody shrubs and invading prairie grasses are favored by increases in CO<sub>2</sub>, changes in moisture cycles, fire suppression, and soil disturbances

### **(10) Human Population and Development**

- Land use categories include agriculture, industry, recreation, residential, and urban
- Decrease in water infiltration caused by impervious surfaces reduces groundwater recharge
  - 60% of Texans rely on groundwater aquifers for their water supply

- Construction increases erosion and habitat fragmentation

## **(11) Point and Nonpoint Source Pollution**

- Point source pollution is discharged from a clearly defined, fixed point such as a pipe, ditch, channel, sewer, or tunnel e.g., wastewater discharged by industrial facilities and municipal sewage plants
  - Untreated or partially treated wastewater can lower dissolved O<sub>2</sub> concentration in water
- Nonpoint source (NPS) pollution does not originate from a clearly defined, fixed location
  - Monitoring is especially difficult—storm water and excess irrigation carries pollutants into surface and underground waters
  - NPS pollution is the leading cause of the nation's water quality problems
  - In Texas, NPS pollution affects 92% of water bodies
  - Four categories: bacteria, nutrients, sediment, and toxic/hazardous substances
- Bacteria:
  - Most are harmless to people, but some can be pathogenic and cause disease
  - Bacteria enter water bodies from failed septic systems, boat discharges, livestock, waterfowl, and pets
  - In Texas, more than half of water bodies are impaired by bacteria
  - As bacteria decompose organic matter, they deplete dissolved oxygen
  - Can result in hepatitis, cholera, salmonella
- Nutrient pollution:
  - Main concerns are nitrogen and phosphorus—components of manure and other animal waste and fertilizer
  - Stimulated plant growth can lead to eutrophication
- Sediments:
  - Loose particles of clay, silt, and sand from erosion
  - Most sediment comes from agricultural fields, mines, and construction sites
  - Can cloud water reducing light penetration, smother benthic macroinvertebrates, clog waterways
- Hazardous substances:
  - Includes insecticides, fungicides, herbicides, toxic chemicals
  - Enter waterways through erosion, leaching, and spray drift
  - Often decompose into compounds that are more toxic
  - Many pesticides decompose slowly and build up in food chain
  - Fuel combustion releases hydrocarbons and metals into the atmosphere that end up in water through atmospheric deposition or runoff