

AFS Policy Statement #13:  
Effects of Surface Mining on Aquatic Resources in North America (Revised)  
(Full Text)

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### **A. Issue Definition**

In North America, mining-like agriculture, silviculture, transportation, and urbanization is ultimately a transitory use of the land that provides fuels and minerals used in a country's growth and development. The total land area in the United States disturbed by mining is small (0.12%) (National Academy of Sciences 1979). However, the nature of land change caused by mining has resulted in long-term disruption of terrestrial and aquatic habitats, and hydrologic systems often with extensive "off-site" impacts, e.g., stream pollution. Mineral extraction, including dredging, placer, area, mountain-top removal, and contour operations, is only one aspect of mining. Secondary mining impacts range from urban development to support mining to the creation of road networks for exploration activities. For example, dredging is occurring in the Beaufort Sea, Canada, in support of hydrocarbon development. Surface mining can entail exploration, site preparation, mining, milling, waste management, decommissioning or reclamation, and even abandonment.

### **History**

Surface mining for coal began in 1866, when the first mine in the United States opened near Danville, Illinois (Lewis 1972). However, it was not until the 1940s that large-scale surface mining became commonplace. The first law in the United States requiring reclamation of land surface-mined for coal was enacted in West Virginia in 1939. As society changed its concept of an acceptable level of impact and increased its awareness of the potential effects, laws regulating surface mining operations have become more stringent. In 1977, the U.S. Congress passed the Surface Mining Control and Reclamation Act (SMCRA), Public Law 95-87, which imposed national standards regulating surface coal mining and exploration activities as well as regulating surface impacts of underground mining and required land reclamation. The goals of this act are to ensure prompt and adequate reclamation of coal-mined lands and to provide a means of prohibiting surface mining where it would, "in the opinion of experts," cause irreparable damage to the environment. The act also instituted the Office of Surface Mining (OSM) to administer and enforce provisions of the act; however, the OSM, contrary to the law, continued to allow mining in acid-potent coal seams, where residual acid seepage is surely "predicted by experts." Mining is allowed in this situation if the coal company agrees to treat the acid to meet water quality standards for as long as necessary. This has resulted in a growing liability, with large river systems now depending on "uninterrupted perpetual treatment."

Because of topographical, climatic, and other regional differences among major coal deposits, each state may acquire primacy and administer its own program, which must be

no less stringent in environmental protection than the federal program. States with reclamation plans approved by the OSM may also elect to administer their own "Abandoned Mine Land Reclamation Fund" to ameliorate the health, safety, and environmental impacts from coal mines unreclaimed or inadequately reclaimed prior to 1977. These funds are accrued on a tonnage basis as part of the proceeds from mining operations at a rate of 35 cents per ton for surface-mined coal, 15 cents per ton for underground coal, and 10 cents per ton for lignite.

In Canada, each province has jurisdiction over resource development except where federal lands such as Indian reservations and federal parks are involved. Therefore, primary responsibility for regulating surface mining development and associated impacts lies with the provinces, rather than the federal government, where the tendency has been toward flexible approaches that consider site-specific characteristics. The federal government is, however, responsible for control of surface mining operations in the Yukon and Northwest Territories (approximately 50% of Canada's total area) and offshore activities.

Most mining in the eastern United States occurs on private lands and is regulated by state and local laws. In the western United States, most of the land under mineral development is administered by federal agencies. Federal, state, and sometimes local regulations are imposed on surface mining of these mineralized lands, and stringency varies with location, mineral, historical perspective, and controversy generated by proposed or existing projects.

### Mining Operations

Surface mining, as considered herein, usually consists of exploration to delineate the coal or mineral reserve, the actual mining phase, and then reclamation.

Topography; depth; size and grade; geological and hydrological characteristics; the shape and slope of the ore; the presence, nature, amount, and location of acid-potent materials; and the resulting economic projects all influence the exploration and mining phases.

Generally, exploration techniques consist of drilling boreholes, excavating shallow trenches or pits, sinking shafts or adits, or combinations of all three techniques.

Exploration activities vary in size and impact, with construction of support roads and camps possibly constituting a major surface disturbance, particularly in some arid western states and provinces. Surface mining methods employed to recover minerals and fuels are generally classified as open pit (quarry, open cast), surface (area, contour, mountain-top removal), auger, dredging, or hydraulic. In western regions, heap leaching with acids and cyanide is used to remove the desired mineral(s). Special impacts are associated with each mineral recovery technology. For example, in the heap leach technology just referred to, serious groundwater and surface water pollution has been documented. In the United States and Canada, wastes produced during coal mining are typically buried to isolate material with toxic acid potential away from surface or groundwater flows. However, during mining for other minerals, the waste materials may be handled differently, including ocean disposal for molybdenum in Alaska.

## **B. Impacts on Aquatic Environments**

Surface mining is highly visible land use because it temporarily eliminates surface vegetation and can permanently change topography as with mountain-top removal and valley fill operations. It also permanently and drastically alters soil and subsurface geologic structure and disrupts surface and subsurface hydrologic regimes. The surface subsidence following long-wall deep mining can dewater stream reaches and divert flows into different surface stream channels that are not adjusted to such increased flows. Altered patterns and rhythms of delivery can be expected as well as changes in water quality. The backfilled, reclaimed surface mine site constitutes a manmade, porous "geological recharge area," where infiltrating water percolates through the fill to emerge as a seep or a spring. Often, these are very acid and will flow even when drought conditions dry up natural waters. Additionally, many receiving streams have naturally little alkalinity (<10mg/l), and great volumes or distances are required to neutralize even small mine flow that may carry 1,000 mg/l or 2,000 mg/l of acid. Many small streams—even though they are low in alkalinity are valuable trout streams. This is particularly true in Appalachia, which is rich in coal resources. Off-site impacts of mining can generally be controlled while the site is being mined, but many now-well-known, acid-potent coal reserves cannot be mined with current technology without "residual acid seepage." The magnitude of surface mining impacts on aquatic life depends on the mining technology employed, extent of the disturbance, chemical and physical composition of the mineral and its overburden, surface and subsurface hydrologic patterns, and method of reclamation.

Since promulgation of SMCRA, planning, reclamation, monitoring, and regulation for coal mining is consistent throughout the United States. There is considerable state-to-state variation in type and extent of reclamation required for other minerals. Although there is province-to-province variation, Canadian regulations generally require mined lands to be returned to a productive state. In British Columbia, a reclamation program must be left "in a condition satisfactory to the minister," but regulations are not specific. The 1973 Alberta Land Surface Conservation and Reclamation Act is more comprehensive and states that mined lands should be returned to a higher level of productivity.

In most areas, reclamation after coal mining reduces off-site impacts, mitigates aesthetic damage to disturbed land, and reconstructs topography, soil profiles, and hydrologic patterns to permit a wide range of options for future land use that will protect valuable aquatic resources. There is even an opportunity to enrich, cool, and stabilize stream flows. However, even with current regulations, surface mining can affect fish and aquatic resources through erosion and sedimentation, dewatering of wetlands, diverting and channelizing streams, and contaminating surface water and aquifers with toxic chemicals. These negative effects can occur with unregulated mining or when a company does not follow its mining plan. The result is a loss of sensitive species, biodiversity, and ecosystem integrity. Changes occur in the productivity of aquatic ecosystems through effects on reproduction, growth, behavior, and migration. The accumulation of contaminants in fish may render them unsuitable for human consumption. Chemical

pollution can result in a complete and "permanent" loss extending far downstream. Although some impacts, such as increased erosion, are generally associated with mining, others are directly related to specific mining industries and geographic region. A brief review of some types of mining follows:

Sand and gravel resources are ubiquitous and are probably the most commonly mined resource. The sand and gravel industry is perhaps also the least regulated of any form of mining. In the United States, 80% of this resource is extracted under jurisdiction of state and local laws only (Swanson 1982). The most important sources of sand and gravel are river channels, floodplains, and previously glaciated terrain. Although not allowed in Saskatchewan or most of Canada, dredging is widely used in large U.S. rivers and can increase sediment bed load through resuspension, physically eliminate benthic organisms, and destroy fish spawning and nursery areas, all of which ultimately change aquatic community composition. It may also alter river channel hydrology function and hydrologic function and stability.

Phosphate-rock deposits in Florida and North Carolina typically lie below the water table, which must be dewatered before mining. This can result in loss of wetlands and their associated biota as well as lead to water quality degradation, disruption of groundwater systems, and nutrient enrichment of adjacent rivers, streams, and estuarine systems. Disposal of wastes also is a problem associated with phosphate mining, as is potential radioactive contamination by elements associated with phosphate deposits. Conversely, Florida's phosphate operations create productive lakes in areas that previously had no open water habitat.

Peat is typically mined after a wetland has been drained, but some operations use dredging. In the United States, peatlands are classified as wetlands by the U.S. Fish and Wildlife Service (Cowarden et al. 1979). Currently, few peat deposits are being mined, but peat mining is developing rapidly and could disrupt important fish and wildlife habitats in Canada and the United States in the future.

Copper, silver, gold, lead, zinc, and other heavy metals are frequently mined and milled during the same mining operation. Open pit or underground mining accounts for most of their production. The ratio of these metals to associated materials is relatively low, resulting in large quantities of finely powdered mill wastes. Land restoration is difficult because milled wastes (tailings) cannot be returned to the mine and ultimately contributes to erosion problems at the site. Trace metals in the tailings create a water pollution problem through metal contamination.

### **C. Needed Actions**

The American Fisheries Society endorses the conservation of energy by greater efficiency and where it appropriates the use of renewable resources. Use of solar energy, water, and recycling can minimize the need for minerals and fuels that require mining. Our goal should be globally sustainable growth.

Proper selection, operation, and reclamation of mine sites are opportunities for humanity to effectively manage natural resources. Specifically, surface-mined areas, quarry sites, gravel pits, re-created wetlands, and reclaimed surface mine ponds and lakes present an opportunity for resource managers. Resource managers not only have an interest in seeing that suitable fisheries habitat is created but that enhancement techniques are employed to optimize production and use of aquatic resources. Water quality can be improved by working with geologists and mining engineers. Turbidity can be reduced, and an enriched, cool, steady flow of usable water can sometimes be produced. Where mined land is privately owned, fisheries biologists should work with property owners and administrators of the Soil Conservation Service and State Abandoned Mine Land Reclamation Fund to see that fisheries benefits are part of both short- and long-range reclamation plans. Since 1977, the SMCRA has mandated that the state agency administering the mining program under OSM supervision receive from the state natural resource agency a formal comment on each mining permit application. Expert fish biologist input is required; this should be timely, useful, and effective input. The "Order Respecting the Removal or Displacement of Gravel in or about Certain Waters of the Province of British Columbia" was designed with direct input from fisheries managers to protect spawning grounds of Pacific salmon and other fish species. Fisheries biologists should have a valuable role in providing information leading to state or provincial and local laws regulating the mining industry. Labor must be available to respond properly to the mandated review of cumulative hydrological impacts.

At the federal level, U.S. fisheries biologists should seek OSM overhaul of its mining regulations to better protect water quality and aquatic habitats. The Clean Water Act needs to overlap with the SMCRA so water quality is not degraded from mining. That is, one act or the other would cover all potential discharges from a mining operation.

Research and information needs are significant and must be addressed in the context of changing industry needs as well as changing regulations and public opinions. Fishery biologists are best qualified to identify, define, and investigate deficiencies regarding aquatic habitat and biota. Some research needs are identified below:

(1) Methodologies to predict potential biological impacts due to multiple mines in a watershed must be improved. This encompasses a need for collaborative databases and regionalized computer models (interfacing water quality, hydrology, and biology) to provide alternate strategies and a priori answers concerning when multiple mines will create unacceptable impacts.

(2) Methods of predicting eventual toxicity as it relates to the quality of post-mining surface water and groundwater must be determined. Adequate pre-mining sampling of the reserve, the overburden, and the strata under it are essential. The predictive technology of acid-base accounting; leach quality and rate; and the quality, size, and amount of each type of material involved needs to be improved as does their interpretation by mining engineers. Water quality (volume and buffering capacity) of the receiving stream(s) and the aquatic potential all need to be part of the mine application. The hydrology present and inferred post-mining need to be submitted with the fishery biologists' predictions of

impact from any "residual acid seepage." A further goal will be to identify "areas unsuitable for mining."

(3) Wetland reclamation strategies must be developed further. Are wetlands the cure for acid mine drainage, or are they merely temporary "fixes" that ultimately become sinks for many toxic materials?

(4) Investigations of stream reclamation should be accelerated and include channel design, erosion control, bank stabilization, and riparian revegetation. Restoration efforts should concentrate on techniques that will optimize fish production and promote aquatic diversity. Where possible, public access and use should be promoted.

(5) Studies need to be performed that determine whether current water quality standards that allow discharges from mines protect or harm aquatic biota.

## Policy

It is the policy of the American Fisheries Society (AFS) to encourage energy conservation, use of renewable resources, and recycling to minimize the need for nonrenewable minerals and fuels that are obtained through mining processes. When mining occurs, it is AFS policy to encourage legislation and diligent regulation of all surface mining by local, state, provincial, and federal government to provide adequate protection or aquatic resources. Federal legislation provides uniformity of standards nationwide. While the Surface Mining Control and Reclamation Act has attempted to minimize environmental impacts from coal mining, similar legislation and enforcement should be encouraged for other minerals. The Society encourages its members to become involved in this process by providing technical information essential for protection and continued propagation of fishery resources to policy makers so decisions are made on a scientific, rather than emotional or political, basis.

## References

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