



U.S. Geological Survey Fact Sheet

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Monitoring environmental effects of irrigation projects in the West

In the early 1900's, the U.S. Bureau of Reclamation (USBR) began constructing dams and canals in the western United States for water supplies to arid regions, thereby encouraging settlement and development in regions that would otherwise be unsuited for agriculture. In California, on the western edge of the San Joaquin Valley, part of one project—a drainage canal—was not completed. Drainage, therefore, collected in evaporation ponds, concentrating mineral salts washed out of the surrounding area. Birds began using the ponds as nesting sites and in 1970, the U.S. Department of the Interior (DOI) set the area aside as Kesterson National Wildlife Refuge.

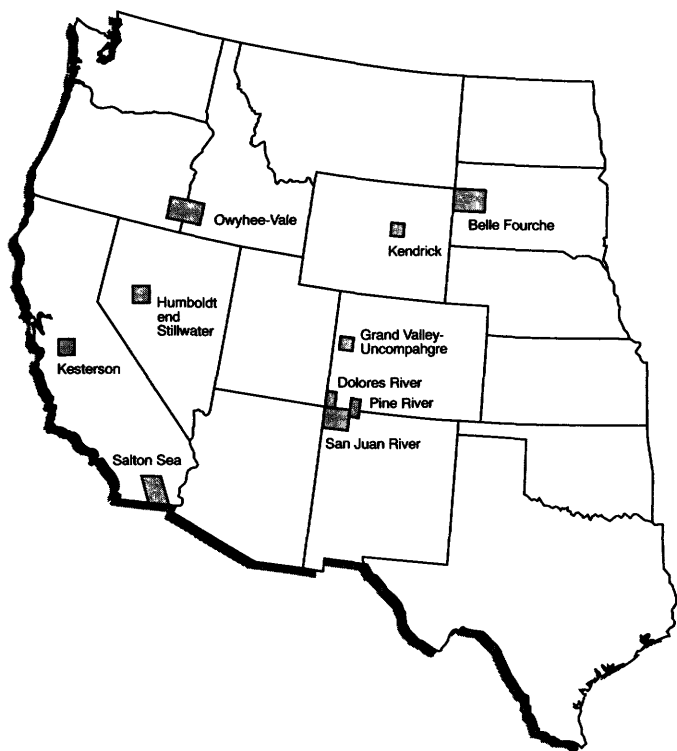
In 1983, U.S. Fish and Wildlife Service (USFWS) personnel discovered many unhatched

eggs and many deformed young birds in the nesting areas. The deaths and deformities were found to be caused by high selenium concentrations in the water. The selenium had been leached by irrigation water from selenium-bearing shales on the west side of the project, carried to the ponds, and concentrated by evaporation. Because of the problems that were encountered at this irrigation project, the DOI formed a task force consisting of participants from several Federal agencies including the U.S. Geological Survey (USGS), to investigate potential problems at other USBR irrigation projects.

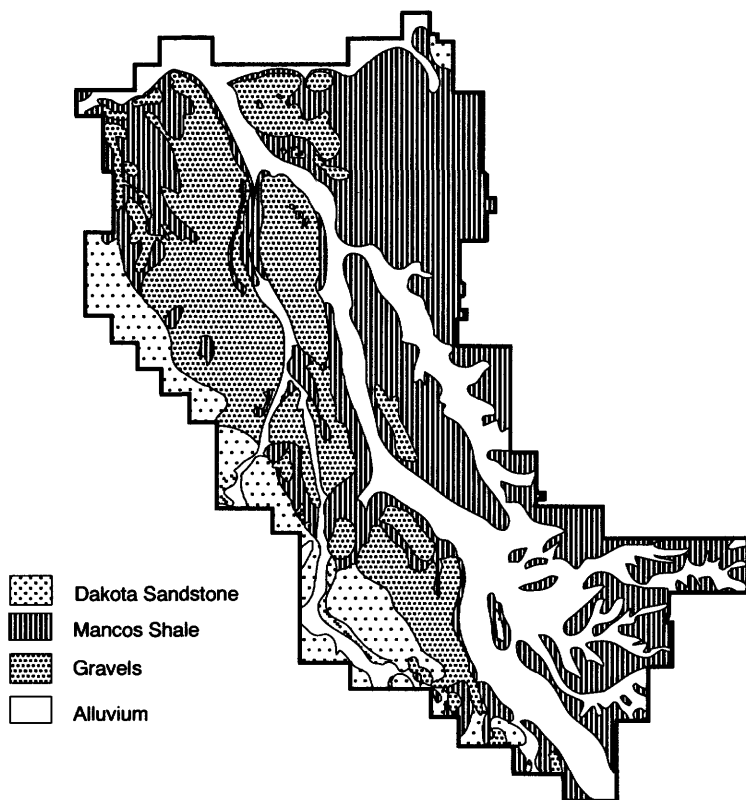
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Farmers in the Uncompahgre Valley in western Colorado are supplied with water from a USBR irrigation project that was completed in 1912. A selenium-bearing shale underlies some of the irrigated land. Water samples from the Uncompahgre River, which drains the irrigated area, and samples from a private lake (Sweitzer Lake) constructed on shale were found to have selenium concentrations higher than the standard set by the Environmental Protection Agency (EPA) to protect aquatic life. As part of the cooperative investigations, the USGS was asked to examine the distribution of selenium in soils and in alfalfa from the irrigated area and to determine if the selenium distribution is affected by irrigation.

The USGS compiled a map of the project area from existing geologic and soil maps. From this combined map it was determined that soils in the area had developed on five geologic units: (1) selenium-rich Mancos shale; (2) alluvium derived from the shale; (3) alluvium derived from flood plain deposits of the Uncompahgre and Gunnison Rivers; (4) gravels deposited by erosion of ancient mountains; and (5) Dakota sandstone. On each geologic unit, soil and alfalfa were sampled and analyzed for total selenium content. Soil samples were also leached with water. By comparing the amount of water-soluble selenium in the



Examples of federally-funded irrigation projects in the western United States



Outline of Uncompahgre Project Area showing distribution of soils developed on different geologic units. Alluvial units are not differentiated.

soil to the selenium in alfalfa, the USGS determined the proportion of total selenium in the soil that can dissolve in ground water or surface water and that might enter animal food chains.

Results of the study showed that all soils of the project area contain more selenium than most soils in the western United States. Soils developed on the Mancos Shale also have higher concentrations of selenium than soils west of Kesterson Wildlife Refuge. Surprisingly, alluvial soils derived from the Mancos Shale—not soils developed directly on the shale—are the most enriched in total and water-soluble selenium. Selenium in alfalfa was also the highest in samples from the alluvium.

Federal agencies concluded that irrigation water moves selenium downhill from the high-selenium shale, and that the selenium becomes more available to alfalfa in places where the soils are not well drained, such as river bottoms. A similar mechanism caused selenium to accumulate in ponds such as Kesterson or Sweitzer Lake. In closed basins where the water evaporates, selenium may also accumulate in vegetation. Such accumulation in food sources causes the problems that waterfowl experienced at Kesterson.

In the Uncompahgre Project area, most irrigation drainage flows directly into the Uncompahgre River and does not collect in areas of standing water. Therefore, even though the soils in this irrigation project contain higher levels of selenium than other parts of the West, 96 percent of the alfalfa grown here contains selenium at levels that are not considered to be toxic to livestock. The study suggests that problems with high selenium in alfalfa or other plants used for animal food could be remediated by improving drainage.

The results of this cooperative study are helpful to farmers, private industry, and wildlife enthusiasts who may benefit from water supplied by federally-constructed dams and canals. The same agencies involved in the preliminary studies at Kesterson are now helping groups at local levels to assure that problems with selenium or other elements in soils affected by irrigation are corrected or prevented.

Selected References

- Butler, D.L., Kreuger, R.P., Osmundson, B.C., Thompson, A.L., and McCall, S.K., 1991, Reconnaissance investigation of water quality, bottom sediment and biota associated with irrigation drainage in the Gunnison and Uncompahgre River Basins and at Sweitzer Lake, West-Central Colorado, 1988–89: U.S. Geological Survey Water-Resources Investigations Report 91–4103, 99 p.
- Crock, J.G., Stewart, K.C., and Severson, R.C., 1994, Listing of geochemical data and assessment of variability for soils and alfalfa of the Uncompahgre Project Area, Colorado: U.S. Geological Survey Open-File Report 94–580, 83 p.
- Stewart, K.C., Crock, J.G., and Severson, R.C., 1993, Chemical results and variability assessment of selected water-extractable constituents from soils of the Uncompahgre Project Area, West-Central Colorado: U.S. Geological Survey Open-File Report 93–505, 27 p. □

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