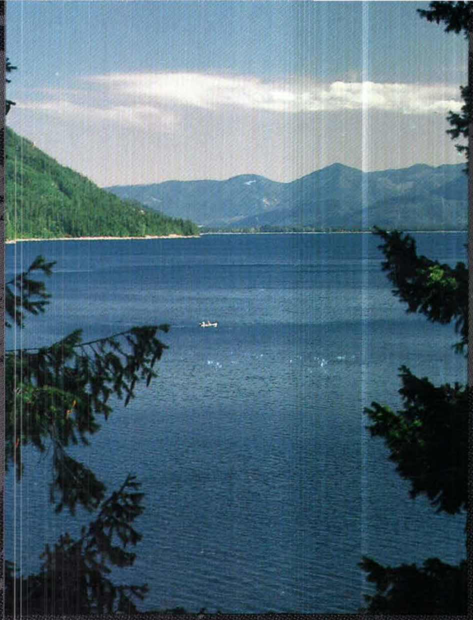
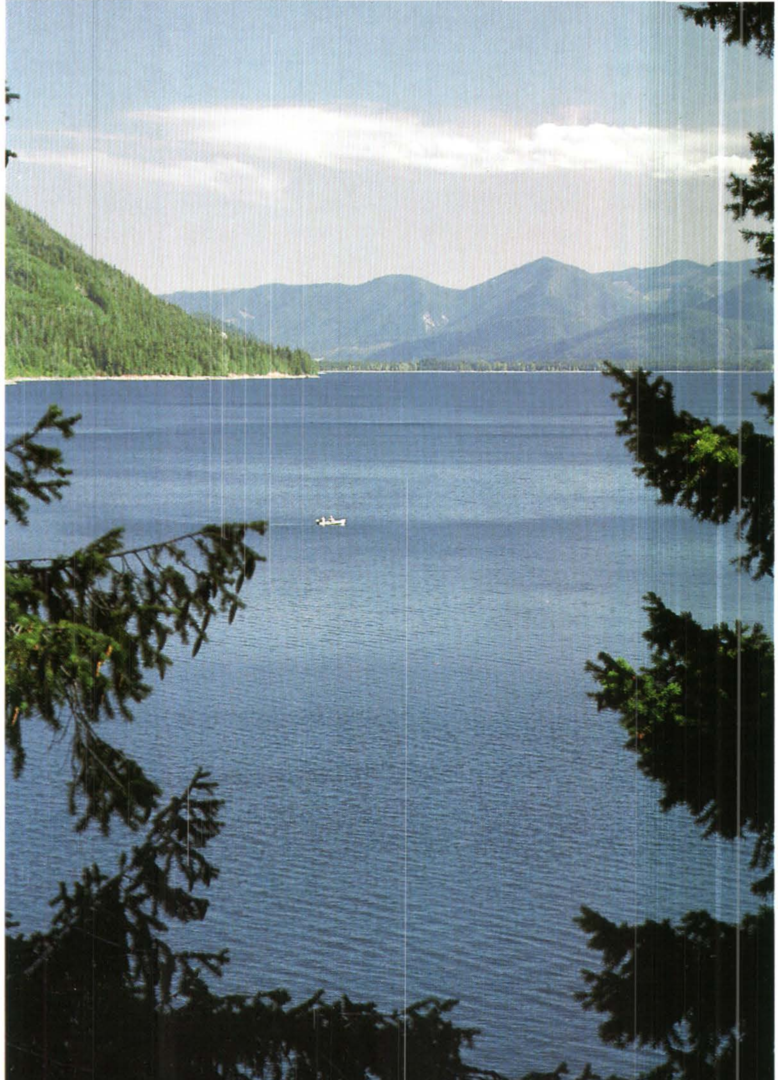


Persistence of the DDT Pesticide in the Yakima River Basin Washington

U.S. GEOLOGICAL SURVEY CIRCULAR 1090



PERSISTENCE OF THE DDT PESTICIDE IN THE YAKIMA RIVER BASIN WASHINGTON

By

Joseph F. Rinella, Pixie A. Hamilton, and Stuart W. McKenzie
Graphic design and layout by Joan M. Rubin

U.S. GEOLOGICAL SURVEY CIRCULAR 1090

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

UNITED STATES GOVERNMENT PRINTING OFFICE: 1993

Free on application to the
Books and Open-File Reports Section
U.S. Geological Survey
Federal Center, Box 25425
Denver, CO 80225

FOREWORD

Established in 1879, the U.S. Geological Survey (USGS) has provided scientific information on the Nation's water, energy, and mineral resources for the benefit of Americans. A major part of the mission of the U.S. Geological Survey is to assess the quantity and quality of the Nation's water resources and to provide information to assist resource managers and policymakers at Federal, State, Tribal, and local levels in making sound management decisions. To a significant extent, these responsibilities are being carried out in the National Water-Quality Assessment (NAWQA) Program, whose goals include providing a sound understanding of the natural and human factors that affect water quality.

The NAWQA Program will include investigations in 60 study areas throughout the Nation that represent a variety of geologic, hydrologic, climatic, and cultural conditions. These studies are building blocks for understanding regional differences in physical, chemical, and biological characteristics of the Nation's ground water and surface water. An important goal of the program is to ensure that key findings are available to the public so that they can be aware of the quality of the Nation's water resources.

This report is part of a series of nontechnical publications based on results from the NAWQA Program. The purpose of these publications is to describe key findings from the individual investigations and to relate those findings to water-quality issues of regional and national concern. By disseminating this information, the U.S. Geological Survey seeks to increase awareness of water-quality concerns when considering the Nation's environmental issues.

Director

DDT IN OUR ENVIRONMENT... A NATIONAL AND LOCAL CONCERN

To improve the quality of our water, we need to turn greater attention to the polluting effect of water running off our agricultural fields, city streets, and suburban developments. We need a strong Clean Water Act with standards for non-point-source pollution and incentives that will unleash the creative and technological potential of our firms, farmers, and families to reduce and prevent polluted run-off at the source.

President Bill Clinton

As a former governor of an arid state, I have a special appreciation for the value of water resources. Unless we have sufficient supplies of good quality water when and where we need it—and understand how natural and human conditions affect water quality—we cannot wisely manage this vital resource. As part of the National Water-Quality Assessment, the U.S. Geological Survey will continue to work with state and local agencies to assess and protect our Nation's water resources.

Bruce Babbitt, Secretary
U.S. Department of the Interior

The Nation's water resources are an aggregation of many surface- and ground-water systems, each of which has its own hydrologic and chemical characteristics and responds to natural and human-induced stress in its own way. In recognition of this diversity, the design of the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS) includes studies of 60 surface- and ground-water systems across the Nation. These studies will provide the foundation for understanding local and regional differences in the quality of our Nation's waters, as well as for addressing issues of national concern.

KEY CONCERNS

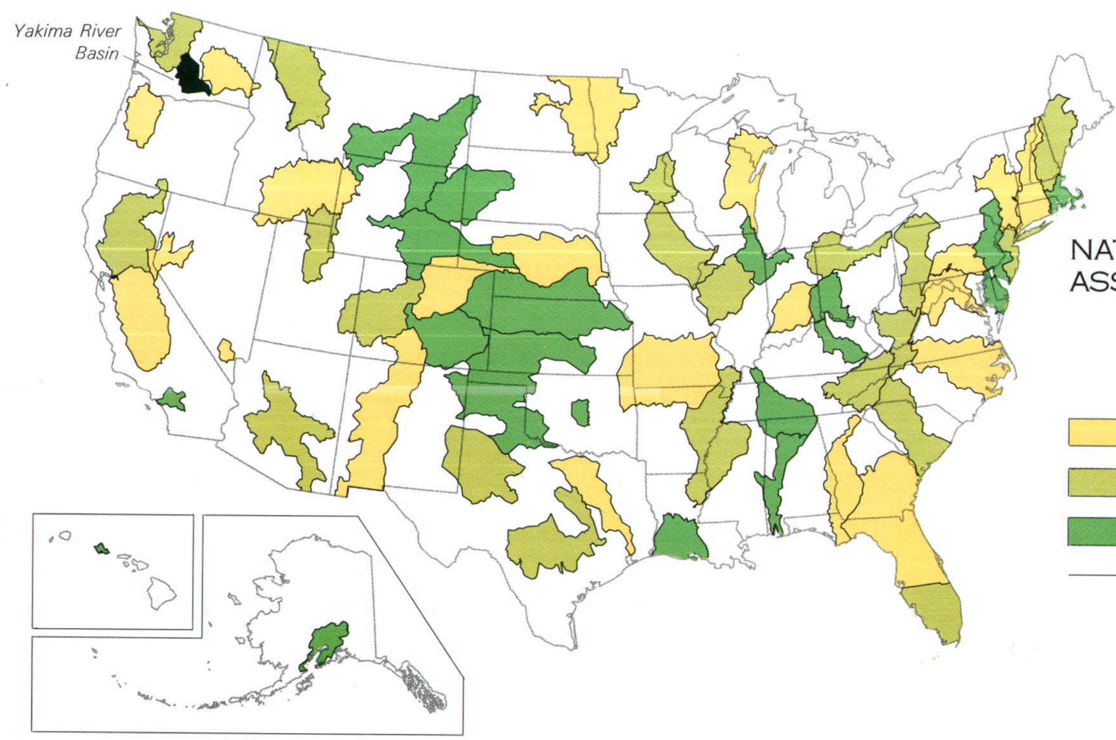
Where do DDT and its breakdown products DDE and DDD [Total DDT (T-DDT) = DDT + DDE + DDD] occur? In agricultural soils? In stream water? In stream sediment? In fish? In birds and mammals?

What are the sources of T-DDT in the basin? How does T-DDT enter streams?

Have concentrations of T-DDT decreased in stream water and fish since the ban on the production and distribution of DDT in 1972?

How do concentrations of T-DDT in fish in the Yakima River Basin compare with concentrations elsewhere in the Nation?

Are T-DDT concentrations of concern relative to human health and fish predators in the Yakima River Basin?



NATIONAL WATER-QUALITY ASSESSMENT STUDY AREAS

EXPLANATION

- STUDIES STARTED IN FISCAL YEAR 1991
- STUDIES PROPOSED FOR FISCAL YEAR 1994
- STUDIES PROPOSED FOR FISCAL YEAR 1997
- BOUNDARY OF STUDY AREA

A major national concern is the degradation of water quality that results from non-point sources of pollution, such as agricultural runoff that contains fertilizers and pesticides. Although crop yields are improved greatly by applications of fertilizers and pesticides, the increased production often comes with a price that is measured in terms of effects on human health, streams, fish, and other wildlife. One of the first studies in the National Water-Quality Assessment Program was done to characterize these effects on streams and fish in the Yakima River Basin.[1] Soil, water, sediment, and fish were sampled for a variety of chemicals that have been and (or) continue to be used in the basin.

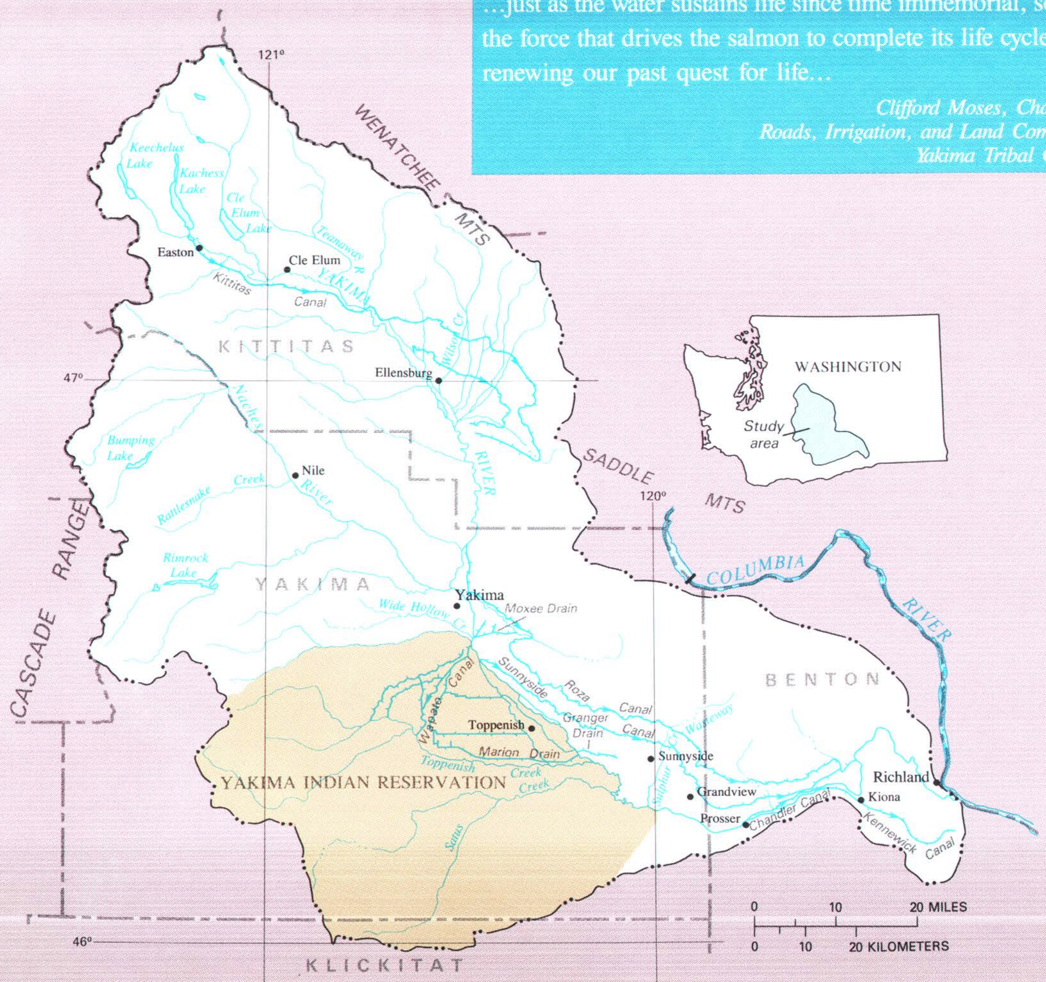
This report focuses on the occurrence of one of these chemicals in the Yakima River Basin—the insecticide DDT. Even though two decades have passed since its production and distribution was banned (1972), DDT and its breakdown products DDE and DDD are still widely dispersed in the environment. Concentrations of DDT, DDE, and DDD remain elevated in agricultural soils, stream water, suspended and streambed sediment, and fish in the Yakima River Basin. Elevated concentrations of these compounds are a continued concern of residents, resource managers, and policymakers in the basin. Why? Because its broad toxicity can affect many organisms other than insects for which it was designed, such as fish and birds. Its persistence in the environment can lead to dangerous accumulations and adversely affect the reproductive capabilities of birds and other wildlife. And, its cancer-causing potential can possibly affect human health.

[1]The U.S. Geological Survey is preparing a detailed interpretive report on the occurrence of DDT and 90 other pesticides in the Yakima River Basin.

THE YAKIMA RIVER BASIN

...just as the water sustains life since time immemorial, so does the force that drives the salmon to complete its life cycle; thus renewing our past quest for life...

Clifford Moses, Chairman,
Roads, Irrigation, and Land Committee,
Yakima Tribal Council



YAKIMA RIVER BASIN

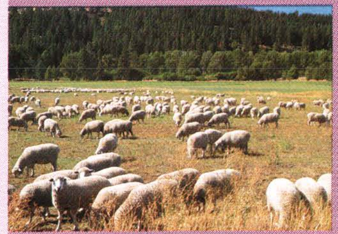
Drainage area: 6,155 square miles
Population: 250,000 (1990)

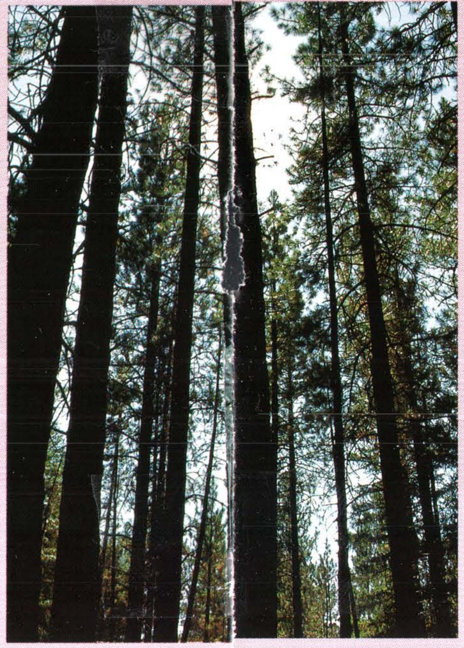
EXPLANATION

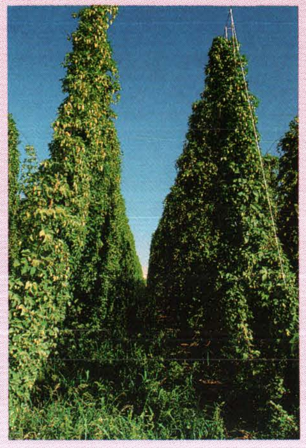
YAKIMA INDIAN RESERVATION

BOUNDARY OF DRAINAGE BASIN

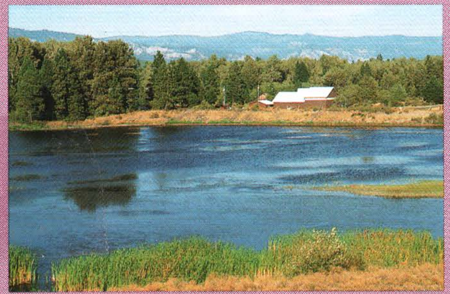
CANAL—Arrow indicates direction of flow







TALL PINE TREES NEAR THE TEANAWAY RIVER IN THE FORESTED HEADWATERS OF THE BASIN. YAKIMA COUNTY RANKS FIRST IN THE NATION IN THE PRODUCTION OF APPLES, MINT, AND HOPS.



THE YAKIMA RIVER NEAR EASTON, WASHINGTON.

The Yakima River Basin, which is part of the larger Columbia River Basin, is located on the eastern slope of the Cascade Range in south-central Washington. The terrain in the upper basin is rugged, and altitudes range up to 8,200 feet in the Cascade Range. The lower valley, located downstream from the city of Yakima, is much flatter, and altitudes reach only a few hundred feet. The Cascade Range receives an average annual precipitation, mostly snowfall, of about 100 inches. The climate of the lower valley is more arid; average annual precipitation is less than 10 inches.

Most of the residents in the Yakima River Basin live in the lower valley and depend in one way or another on farming. Approximately 60 kinds of crops, including fruit, vegetables, seed, grain, and forage, are grown. Yakima County, the largest of the three counties in the basin, ranks first in the Nation in the production of apples, mint, and hops and fifth in total agricultural production. Cattle and sheep ranching and dairy farming also are important agricultural activities. Total market value of all agricultural products exceeds $500 million per year. The small cities and towns (the largest is the city of Yakima, population 54,800 in 1990) primarily support processing of agricultural products (canning, fruit-packing, freezing, and meat-packing) and timber harvesting.

Fishing also is an important activity in the Yakima River Basin. Before major agricultural and irrigation development in the early 1900's, the Yakima River was one of the most important salmon habitats in the Columbia River Basin. The river provided the Yakima Indians with a way of life that centered on the bountiful harvests of migrating salmon each spring. These fish continue to be a vital part of the tradition of the Yakima Indians. The economic importance of fishing has diminished, however, because of declining fish populations caused by increased irrigation development and other human activities.

STREAMFLOW MANAGEMENT IN THE YAKIMA RIVER BASIN

HISTORY OF IRRIGATION IN THE YAKIMA RIVER BASIN

At the time of the Lewis and Clark Expedition, the Yakima River Basin was inhabited by Indians. Many of the names used for streams and lakes in the basin were derived from the early Indian culture, such as Naches, which means ''plenty of water,'' and Cle Elum, which means ''swift water.''

White settlement began in the 1850's when Ben Snipes selected the area for cattle raising because he ''found grass tall enough to reach the belly of his horse.'' The Yakima Indian Reservation, which was established in 1855, spans about 1 million acres of land in the southwestern part of the basin.

Organized development, management, and regulation of water resources began in the basin after the passage of the Reclamation Act in 1902. The Reclamation Service (now known as the Bureau of Reclamation) of the Department of the Interior initiated a study of water storage in the basin and the development of irrigation projects. More than 121,000 acres were irrigated, which is about 25 percent of the present (1993) irrigation. The irrigated water came from natural flows in the Yakima River and its tributaries. Irrigated water was later released from five major storage reservoirs that were built in the next 30 years; the last and largest, Cle Elum Lake, was completed in 1933.

In addition to the Reclamation irrigation projects, the Wapato Irrigation Project was developed and constructed by the Bureau of Indian Affairs between 1896 and 1930. This irrigation district is the largest in the basin, and in the valley accounts for about one-third of the irrigated land and one-third of the water use.

Today (1993), the Yakima River Basin is one of the most intensively irrigated areas in the Nation, and involves irrigation of about 500,000 acres. The basin has 6 government-constructed irrigation districts and more than 50 small irrigation systems.

Onni Perala, U.S. Bureau of Reclamation

The Yakima River and its tributaries provide a critical link to society's livelihood and prosperity in the basin. This precious resource is the necessity of life, providing water for intense agricultural activities, municipal water supplies, and hydroelectric power; supporting fish and wildlife; and furnishing many recreational pursuits. The resource is limited, however, so competing water demands are held in a delicate balance.

Harvey R. Nelson Jr., U.S. Bureau of Reclamation

THE YAKIMA RIVER NEAR ELLENSBURG, WASHINGTON.

THE YAKIMA RIVER BASIN IS ONE OF THE MOST INTENSIVELY IRRIGATED AREAS IN THE NATION AND INVOLVES IRRIGATION OF ABOUT 500,000 ACRES.

THE YAKIMA RIVER NEAR GRANDVIEW, WASHINGTON.

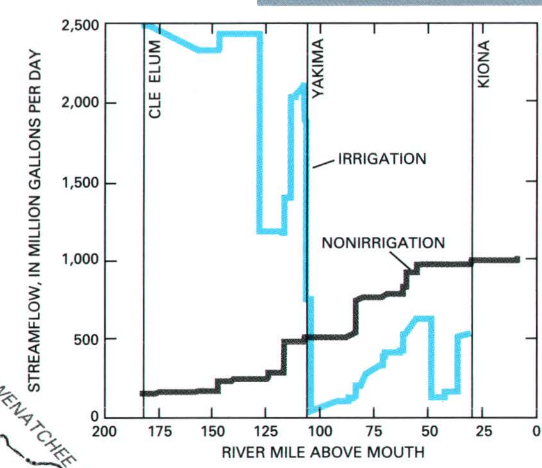
The Yakima River, which is one of the largest rivers in Washington, flows southeastward for about 215 miles from the eastern slopes of the forested Cascade Range to the Columbia River. The Yakima River and its tributaries supply drinking water to the cities of Yakima and Cle Elum. About 60 percent of the total water use in the basin is associated with agriculture, which involves irrigating about 500,000 acres. Agricultural water use is greatest during the April-to-October growing season when rainfall in the basin valley typically is at its lowest.

To meet irrigation needs, significant changes have been made to the river's natural flow. To regulate, divert, and distribute streamflow, 5 major storage reservoirs, 14 major diversion dams, and about 2,000 miles of irrigation canals have been constructed. The reservoirs are located in upstream mountainous areas, where annual precipitation is greatest. During irrigation season, most of the river water downstream from the city of Yakima is diverted into canals. Return flows from agricultural land (Wilson Creek, Moxee Drain, Granger Drain, and Sulphur Creek Wasteway are among the largest) account for as much as 80 percent of the main-stem flow in the lower valley during the irrigation season.

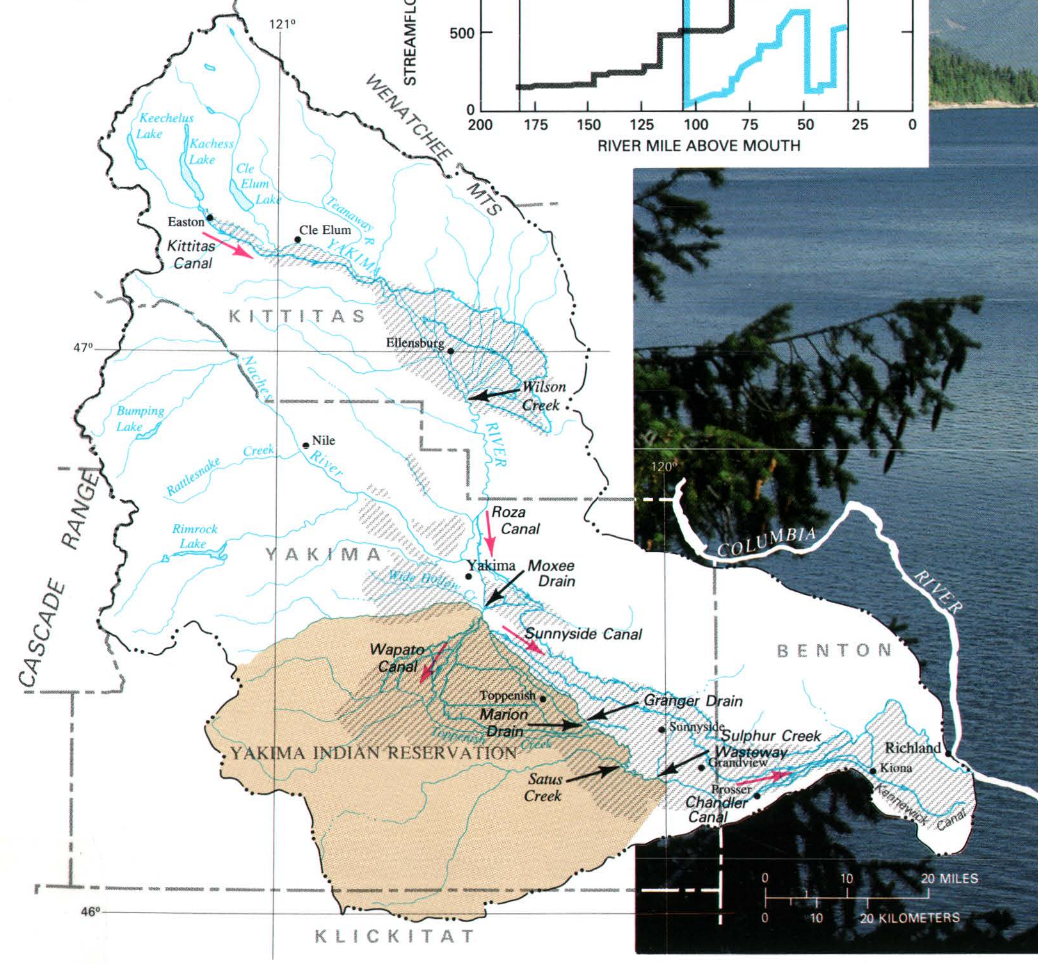
In addition to meeting irrigation needs, the Yakima River is regulated to maintain required flows for migration and spawning of salmon and steelhead trout. Fish ladders have been constructed on diversion dams to allow adult salmon to safely head upstream to their spawning grounds. Fish screens have been placed on entrances to canals to prevent juvenile fish from becoming trapped in irrigation distribution systems.

STREAMFLOW IN THE YAKIMA RIVER DURING NONIRRIGATION AND IRRIGATION SEASONS, 1988

During the nonirrigation season, streamflow is typical of unregulated streams with flow that increases downstream. The irrigation season reflects a managed stream with large fluctuations in flow because of diversions for irrigation. Return flows from agricultural land account for as much as 80 percent of the main-stem flow in the lower valley downstream from the city of Yakima during the irrigation season.



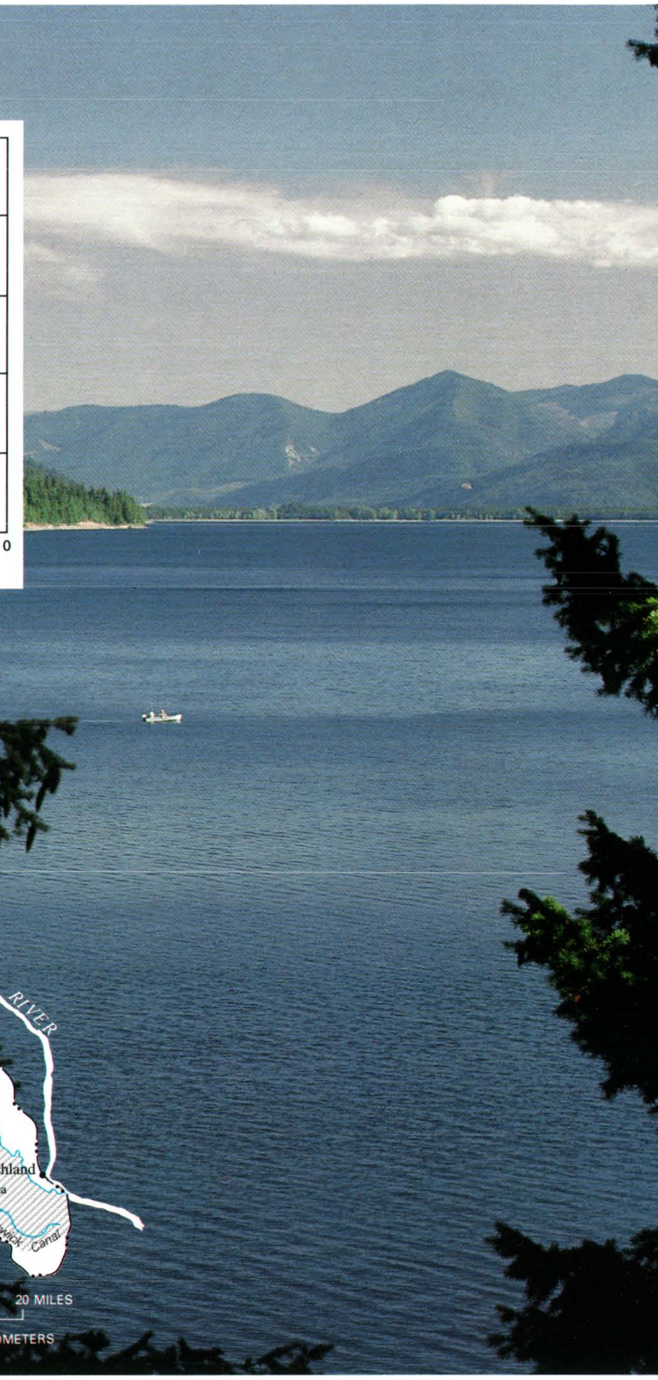
For comparison purposes, 200 million gallons per day is about 310 cubic feet per second, or 224,000 acre-feet per year. The city of Yakima, with a population of about 50,000, uses more than 10 million gallons per day.



YAKIMA RIVER BASIN

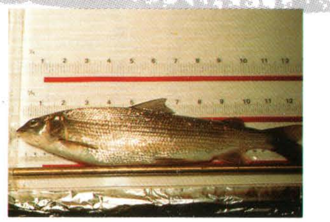
EXPLANATION

- IRRIGATED AREA
- YAKIMA INDIAN RESERVATION
- BOUNDARY OF DRAINAGE BASIN
- CANAL—Arrow indicates direction of flow
- MAJOR RETURN-FLOW DRAIN
- MAJOR DIVERSION



KACHESS LAKE, ONE OF THE FIVE MAJOR RESERVOIRS USED TO REGULATE STREAMFLOW TO MEET WATER NEEDS IN THE YAKIMA RIVER BASIN.

SAMPLING STRATEGY IN THE YAKIMA RIVER BASIN



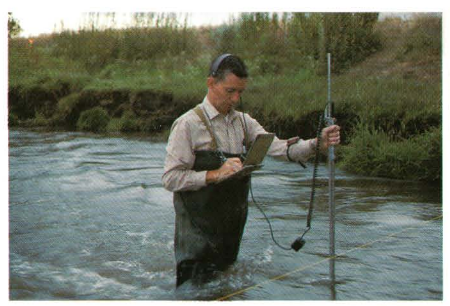
The U.S. Geological Survey began the National Water-Quality Assessment (NAWQA) study of the Yakima River Basin in 1986. From 1986 to 1991, hydrologists collected samples of soil, water, sediment, and fish for analyses of pesticides and other water-quality constituents at about 400 sites. Analyses were done for more than 90 different pesticides in water and sediment samples, and about 65 pesticides were detected. Many of these pesticides were detected in the lower Yakima River, which is downstream from intense agricultural activities. This report focuses on the occurrence of one of these pesticides—the insecticide known as DDT.[2]

Samples were collected from the headwaters to near the mouth of the river at Kiona and along the major tributaries and agricultural-return flows. The sampling strategy was designed to reflect different soils, seasonal variations associated with weather (snowmelt and rainfall runoff), variations in agricultural activities and irrigation practices, and locations of municipal and industrial discharges. The diversity of samples permits an analysis of the areal distribution of DDT and its breakdown products [Total DDT (T-DDT) = DDT + DDE + DDD] in soil, water, sediment, and fish; seasonal and longer term changes in T-DDT concentrations; and relations between T-DDT concentrations and land- and water-use patterns. The sampling design provides the foundation for understanding where T-DDT occurs, what the sources of T-DDT are in the basin, and whether concentrations of T-DDT have decreased since the ban on the production and distribution of DDT in 1972.

[2]Analytical data for DDT and other pesticides detected in samples collected 1987-91 can be obtained from the U.S. Geological Survey, 1201 Pacific Ave., Suite 600, Tacoma, Washington 98402.

HYDROLOGIST COLLECTING WATER SAMPLES FOR ANALYSES OF PESTICIDES AND OTHER WATER-QUALITY CONSTITUENTS.

A BUREAU OF RECLAMATION GAGING STATION AT THE SUNNYSIDE CANAL DIVERSION USED TO MONITOR STREAMFLOW IN THE YAKIMA RIVER.



HYDROLOGIST MEASURING STREAMFLOW IN A TRIBUTARY TO THE YAKIMA RIVER.

DDT: BANNED BUT NOT FORGOTTEN

Use of DDT was prevalent for about three decades after its introduction in the early 1940's. As in most agricultural areas of the world, crop yields in the Yakima River Basin were improved by widespread applications. However, after its adverse effects on birds and other wildlife and its cancer-causing potential became well known, the production and distribution of DDT was banned nationwide by the U.S. Environmental Protection Agency in 1972.

Only days after DDT was banned, another chemical, known as dicofol (trade names such as Kelthane, Acarin, Hilfol, Mitigan, and Cekudifol), was registered with the U.S. Environmental Protection Agency as an agent that would kill mites, particularly on citrus and cotton crops. Dicofol originally contained as much as 15 percent DDT. Since about the mid-1980's, U.S. manufacturers of dicofol have pledged to reduce DDT concentrations to 0.1 percent. Although application of dicofol was approved for hops (new plantings only), mint, and apples in the basin, little of the compound has been used because target pests have become resistant.

Does the banning of DDT 20 years ago and the minimal use of dicofol mean that DDT is no longer a threat in the Yakima River Basin? Probably not because some of the characteristics that made DDT desirable as an insecticide make it a potential hazard in the environment for many decades. The persistence of DDT and its breakdown products assure a long-lasting presence in soil, streams, fish, birds, and other animals.

HAZARDOUS TRAITS OF DDT

Broad toxicity. DDT and its breakdown products, DDE and DDD [Total DDT (T-DDT) = DDT + DDE + DDD], affect many organisms other than insects for which it was designed, such as clams, fish, and birds.

Persistent. T-DDT is chemically stable and is not readily broken down by microorganisms, heat, or ultraviolet light. T-DDT can, therefore, persist in soil, water, sediment, and animal tissue for years.

Low solubility in water and high accumulation in fat. T-DDT is relatively insoluble in water. However, T-DDT is stored readily in the fatty tissue in animals, where it is resistant to metabolic breakdown.

Food-chain effect. Once in streams, T-DDT makes its way into streambed sediment and into plants and animals at the base of the food chain. Fish acquire T-DDT through uptake in food, by feeding on, for example, smaller fish or stream invertebrates (aquatic insects, snails, and clams). Fish also accumulate T-DDT directly from water passing over their gills. Terrestrial animals and birds eat the contaminated fish and invertebrates, and so on up the food chain.

CROP YIELDS IN THE YAKIMA RIVER BASIN HAVE BEEN, AND CONTINUE TO BE, IMPROVED BY THE WIDESPREAD APPLICATIONS OF PESTICIDES.

SOME DDT FACTS:

What is DDT?

DDT is a general-purpose insecticide.

What are DDE and DDD?

DDT breaks down to other compounds DDE (in the presence of oxygen) and DDD (in the absence of oxygen).

What is the chemical composition of the DDT compounds?

DDT compounds are chlorinated hydrocarbons (also known as organochlorines) that consist of carbon, chlorine, and hydrogen.

D D T— **D**ichloro**D**iphenyl**T**richloroethane
D D E—**D**ichloro**D**iphenyldichloro**E**thylene
D D D—**D**ichloro**D**iphenyl**D**ichloroethane

What are the possible effects on human health?

DDT and its breakdown products [Total DDT (T-DDT = DDT + DDE + DDD] can affect the human nervous system, liver, kidneys, and skin. The compounds have been classified as probable human carcinogens (compounds that cause cancer) by the U.S. Environmental Protection Agency.

How much is too much for human consumption?

The U.S. Environmental Protection Agency has not set a standard for the protection of human health against which T-DDT concentrations in water or fish can be compared. This report presents preliminary and theoretical degrees of risk that reflect the lifetime (considered to be 70 years) chance of contracting cancer from consumption of T-DDT in water or fish. Risk calculations are based on the current (1993) understanding of the cancer-causing potency of T-DDT (extrapolated from studies by the U.S. Environmental Protection Agency of the effects on laboratory animals). The calculations include some uncertainty because of limited information on human fish-consumption rates and the toxicity of T-DDT (see p. 17 through 20 for further explanation of human risk).

Consumption of water—Daily consumption of 2 quarts of drinking water with a T-DDT concentration of 0.1 microgram per liter[3] by a 150-pound person over a 70-year lifetime corresponds to an incremental increase in cancer risk of 1 per 1 million people.

Consumption of fish—Weekly consumption of one 5-ounce serving of fish filets with a T-DDT concentration of 0.01 microgram per gram[4] of fish by a 150-pound person over a 70-year lifetime corresponds to an incremental increase in cancer risk of 1 per 1 million people.

The Food and Drug Administration established an action level of 5 micrograms of T-DDT per gram of whole fish (wet weight). Action levels are established to regulate levels of contaminants in human food and animal feed sold to the public. Action levels do not apply to consumers of noncommercial, locally caught fish, such as sport fishermen and their families.

What are the possible environmental effects?

The most conspicuous effect of T-DDT has been on the reproductive capabilities of fish-eating birds, such as the great blue heron and the bald eagle. Studies have shown that elevated concentrations result in thin egg shells that break easily in the nest.

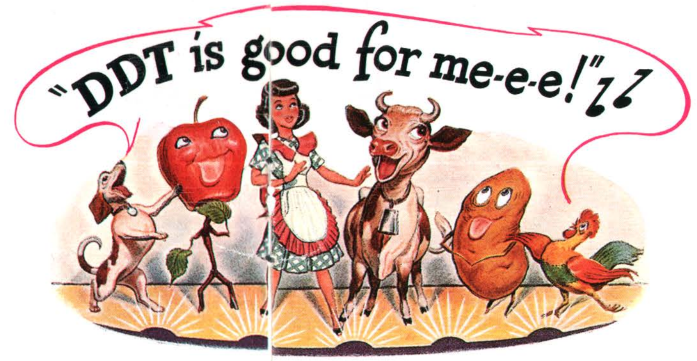
How much is too much for aquatic life and fish predators?

The chronic-toxicity criterion for T-DDT in water for the protection of freshwater aquatic life, established by the U.S. Environmental Protection Agency and adopted by the Washington State Department of Ecology, is 0.001 microgram per liter.

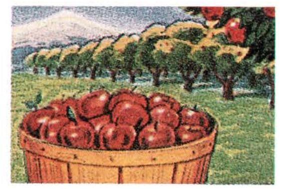
The guideline for the protection of fish predators, established by the National Academy of Sciences, is 1 microgram of T-DDT per gram of a whole fish (wet weight).

[3]One microgram is equal to one-millionth of a gram or one-thousandth of a milligram, and a milligram is equal to the weight of about six crystals of salt. One microgram per liter also is expressed as one part per billion (analogous to about one person in China).

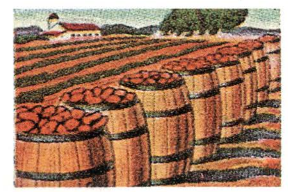
[4]One microgram per gram is equal to one part per million (analogous to about one person in the State of Idaho).



The great expectations held for DDT have been realized. During 1946, exhaustive scientific tests have shown that, when properly used, DDT kills a host of destructive insect pests, and is a benefactor of all humanity.

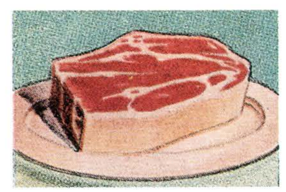


GOOD FOR FRUITS—Bigger apples, juicier fruits that are free of unsightly worms . . . all benefits resulting from DDT dusts and sprays.



GOOD FOR ROW CROPS—*25 more barrels of potatoes per acre* . . . actual DDT tests have shown crop increases like this! DDT dusts and sprays help truck farmers pass these gains along to you.

FOR THE HOME—Helps to make healthier, more comfortable homes . . . protects your family from dangerous insect pests. Use DDT powders and sprays as directed . . . then watch the bugs "bite the dust"!



GOOD FOR STEERS—Beef grows meatier nowadays . . . for it's a scientific fact that—compared to untreated cattle—beef-steers gain up to 50 pounds extra when protected from horn flies and many other pests with DDT insecticides.

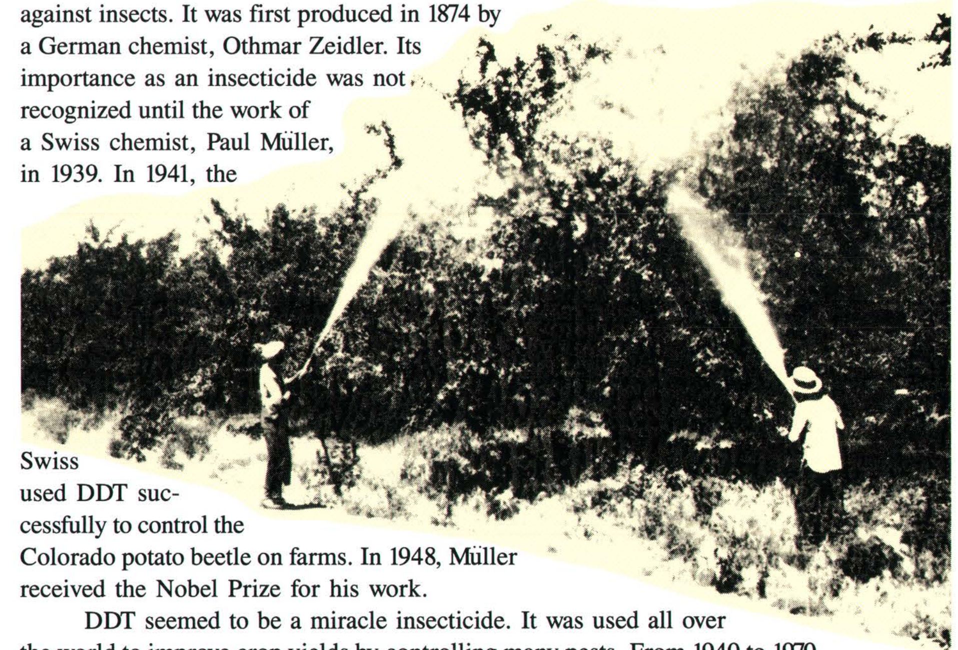
EXCERPTS FROM A FULL-PAGE COLOR ADVERTISEMENT FOR DDT IN THE JUNE 30, 1947 TIME MAGAZINE.

THE HISTORY OF DDT

FROM MIRACLE TO MENACE

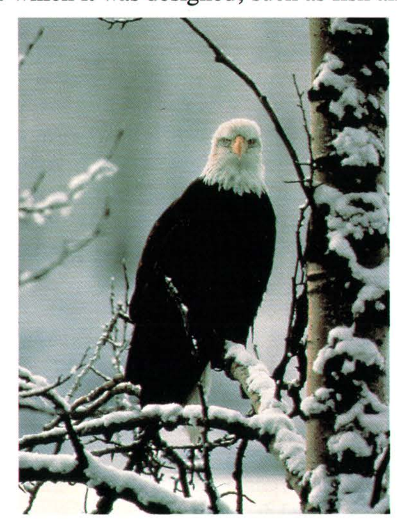
"DDT was a miracle: Highly toxic to insects, virtually insoluble in water . . . it seemed to be the universal solution to insect problems."

DDT was the first of a family of synthetic chemicals that revolutionized man's war against insects. It was first produced in 1874 by a German chemist, Othmar Zeidler. Its importance as an insecticide was not recognized until the work of a Swiss chemist, Paul Müller, in 1939. In 1941, the Swiss used DDT successfully to control the Colorado potato beetle on farms. In 1948, Müller received the Nobel Prize for his work.



DDT seemed to be a miracle insecticide. It was used all over the world to improve crop yields by controlling many pests. From 1940 to 1970, more than 4 billion pounds were used, with 80 percent used in agriculture. Production reached its maximum in the United States in 1961 when 160 million pounds were manufactured; this accounted for nearly one-fourth of the Nation's insecticide use. DDT also was an effective control for insects that carried diseases, such as malaria and yellow fever. It was used during World War II by Allied Forces to control mosquitoes and as a personal insecticide in clothes to control lice. In the 1950's and 1960's, municipal foggers traveled the roads and sprayed DDT into the air to eliminate mosquitoes; gasoline-powered lawn mowers were adapted to drip DDT into the hot exhaust system to assure temporary relief from mosquitoes in the homeowner's yard.

The DDT miracle, however, was short lived. Its broad toxicity affected many organisms other than insects for which it was designed, such as fish and birds. Its persistence led to dangerous accumulations in animals. By the 1960's, the "food-chain effect" (accumulation of DDT and its breakdown products in organisms from low to high in the food chain) began to attract public attention. The most conspicuous effects were on the reproductive capabilities of birds. The peregrine falcon, for instance, disappeared from extensive parts of its North American range. These environmental problems and potential health risks associated with DDT were described in *Silent Spring* by the distinguished biologist Rachel Carson. The book sparked interest among citizens all over the country and laid the groundwork for the decision by the U.S. Environmental Protection Agency to ban the production and distribution of DDT a decade later (1972).



George Woodwell, Science, November 1984

IS DDT CONTAMINATING STREAMS IN THE YAKIMA RIVER BASIN

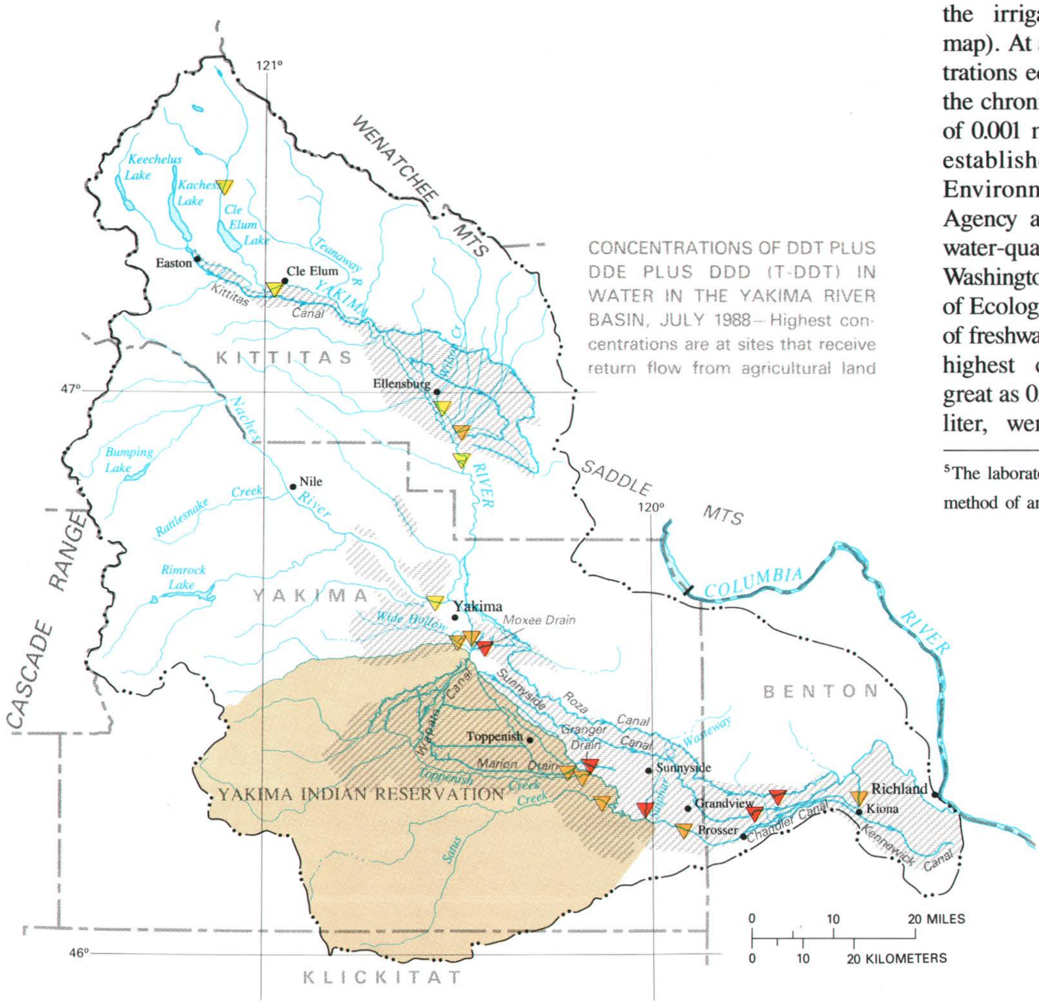
IS DDT IN THE STREAMS? HOW WIDESPREAD IS IT?

In July 1988, DDT and its breakdown products [Total DDT (T-DDT) = DDT + DDE + DDD] were detected in water at 13 of the 18 sites (about 72 percent) sampled in the main stem and tributaries of the Yakima River during the irrigation season (see map). At all 13 sites, concentrations equaled or exceeded the chronic-toxicity criterion of 0.001 microgram per liter established by the U.S. Environmental Protection Agency and adopted as the water-quality standard by the Washington State Department of Ecology for the protection of freshwater aquatic life. The highest concentrations, as great as 0.120 microgram per liter, were in agricultural-return flows. The lowest concentrations of T-DDT in stream water in July 1988 were in the forested headwaters of the basin. These concentrations were below the chronic-toxicity criterion and the laboratory-reporting level.[5]

In July 1988, T-DDT concentrations in water in the main stem of the Yakima River varied from place to place. The highest concentrations were in the lower 110 miles of the river where the basin is farmed intensively and where main-stem flow is dominated by return flow from agricultural land. Because of diversions for irrigation, main-stem flow provides minimal dilution of contaminants from the relatively large return flows from agricultural land. Concentrations near the mouth of the river at Kiona were not as high as those sampled in the river where tributaries that carry agricultural-return flow enter the main stem, probably because of dilution and the settling out of T-DDT associated with the sediment.

Concentrations of T-DDT were high in streambed sediment at sites that received return flows from agricultural land. Samples collected in Wide Hollow Creek during 1987–90 showed a maximum concentration of 2.1 micrograms of T-DDT per gram of streambed sediment.

[5]The laboratory reporting level is the lowest reliable concentration for a particular method of analysis that is reported by the laboratory.



CONCENTRATIONS OF DDT PLUS DDE PLUS DDD (T-DDT) IN WATER IN THE YAKIMA RIVER BASIN, JULY 1988—Highest concentrations are at sites that receive return flow from agricultural land

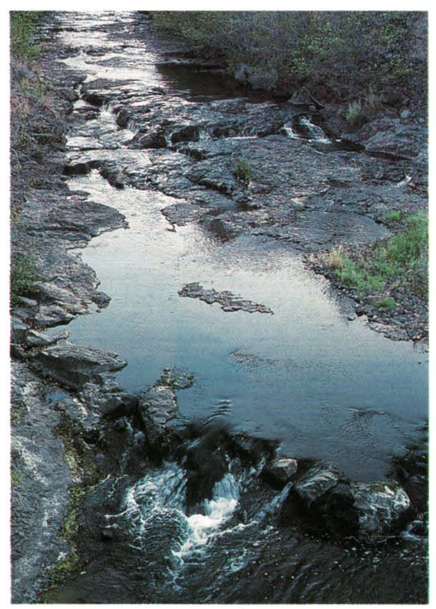
YAKIMA RIVER BASIN

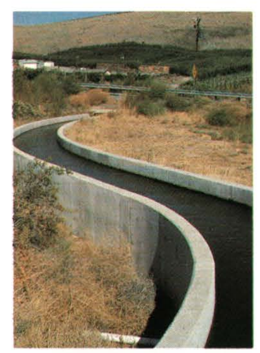
EXPLANATION

- IRRIGATED AREA
- YAKIMA INDIAN RESERVATION
- BOUNDARY OF DRAINAGE BASIN
- CANAL—Arrow indicates direction of flow

CONCENTRATIONS OF DDT PLUS DDE PLUS DDD (T-DDT), IN MICROGRAMS PER LITER—The chronic-toxicity criterion for T-DDT established by the U.S. Environmental Protection Agency for the protection of freshwater aquatic life is 0.001 microgram per liter

- None detected
- 0.001 to 0.01
- Greater than 0.01





DO CONCENTRATIONS OF T-DDT VARY DURING THE YEAR?

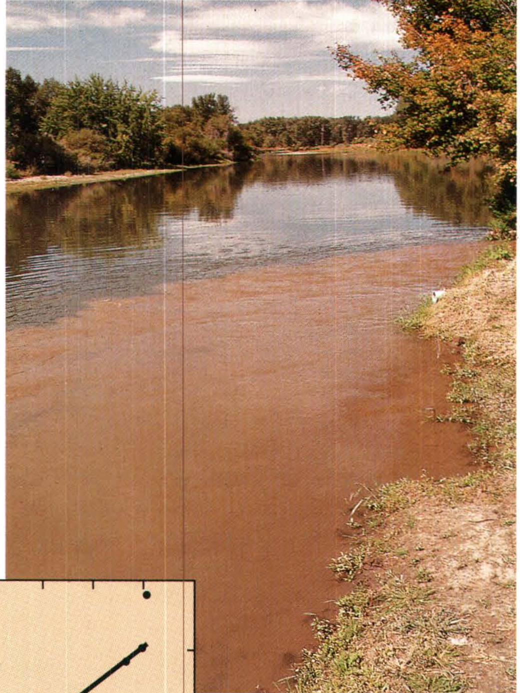
Throughout 1988–89, T-DDT concentrations exceeded the chronic-toxicity criterion for the protection of freshwater aquatic life in several agricultural-return flows (Moxee Drain, Wide Hollow Creek, Granger Drain, and Sulphur Creek Wasteway). The concentrations ranged from 0.003 to 0.120 microgram per liter. Concentrations were highest during peak irrigation and heavy rainfall in the agricultural areas. Although lower than those of the agricultural-return flows, concentrations in the Yakima River at Kiona equaled or exceeded the chronic-toxicity criterion in 9 of 10 samples that were collected year-round in 1988–89.

RIDGE AND FURROW IRRIGATION PROMOTES SURFACE RUNOFF OF AGRICULTURAL SOILS TO THE STREAMS.

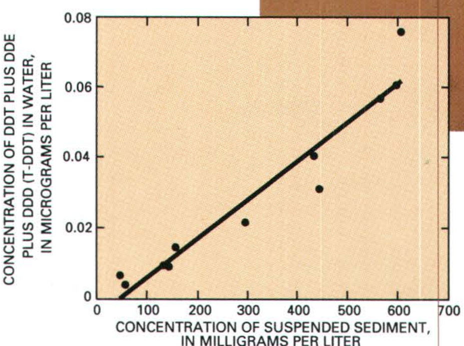
WHAT IS THE SOURCE OF T-DDT IN STREAMS?

Are elevated concentrations of T-DDT in streams a vestige from the past or is T-DDT presently entering streams? Analyses of water samples collected from May 1988 through December 1989 indicate that runoff of agricultural soils is a near-continuous source of T-DDT to the Yakima River. During peak irrigation and periods of heavy rainfall, contaminated agricultural soils erode from fields into the streams. Some of this soil remains suspended in the water. The amount of T-DDT in the water is directly related to the amount of suspended sediment (see graph). A portion of the suspended particles settles out and carries some T-DDT to the stream bottom. Some T-DDT dissolves in the water. Dissolved T-DDT is released directly from suspended and streambed sediment. Some T-DDT also dissolves in runoff that enters streams from agricultural land.

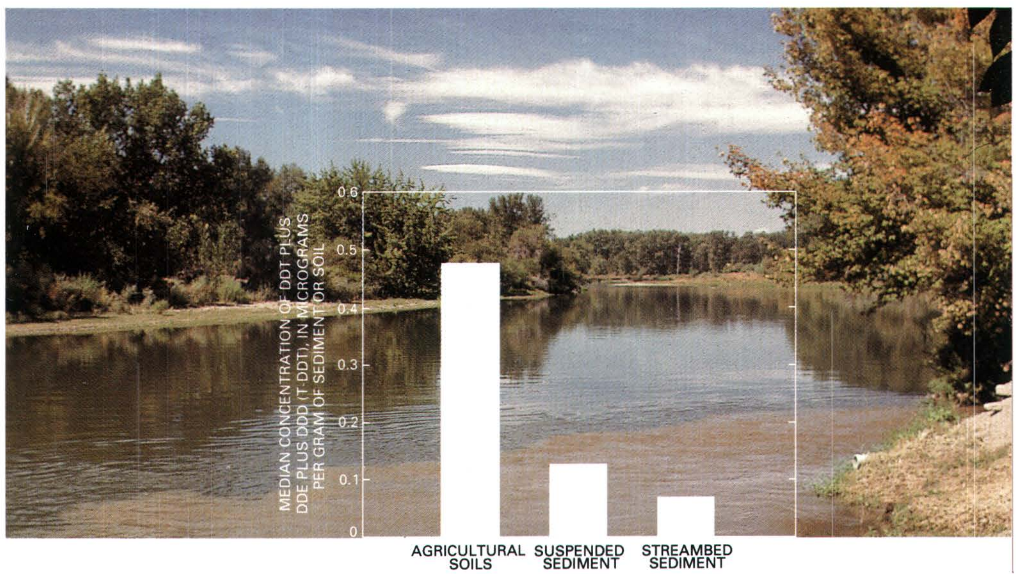
Analyses of a few samples of agricultural soils show that concentrations of T-DDT are about four times higher than concentrations of T-DDT in the suspended sediment in the water and streambed sediment (see bar chart). Apparently, soil eroded from agricultural land is the major source of T-DDT in streams. Because of the large reservoir of T-DDT in agricultural soils, the compounds are likely to be present in stream water and stream sediment for many decades.



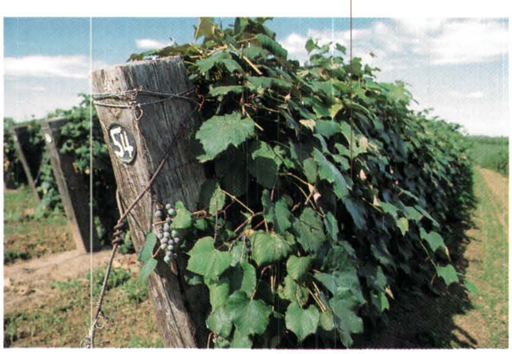
TURBID STREAM WATER AT THE JUNCTION OF GRANGER DRAIN AND THE YAKIMA RIVER, WHICH RESULTS FROM SURFACE RUNOFF OF AGRICULTURAL SOILS DURING PEAK IRRIGATION AND PERIODS OF HEAVY RAINFALL.



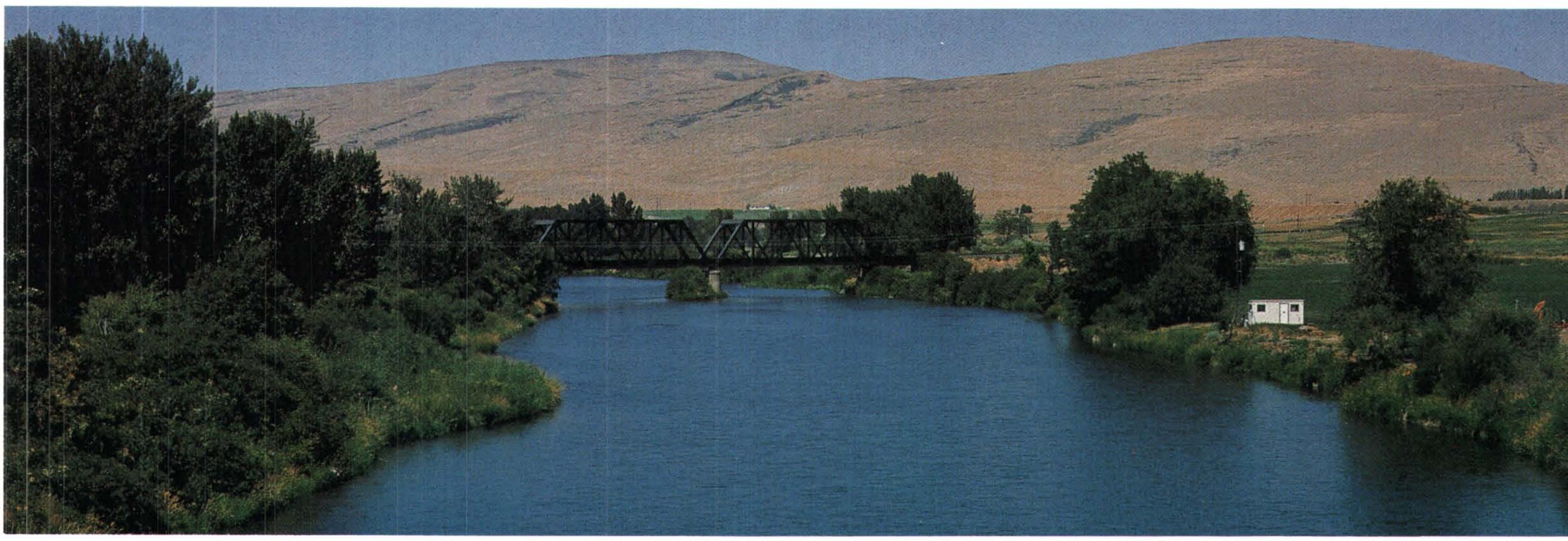
CONCENTRATIONS OF SUSPENDED SEDIMENT AND DDT PLUS DDE PLUS DDD (T-DDT) IN WATER IN MOXEE DRAIN, 1988-89–The amount of T-DDT in the water is directly related to the amount of suspended sediment in the water



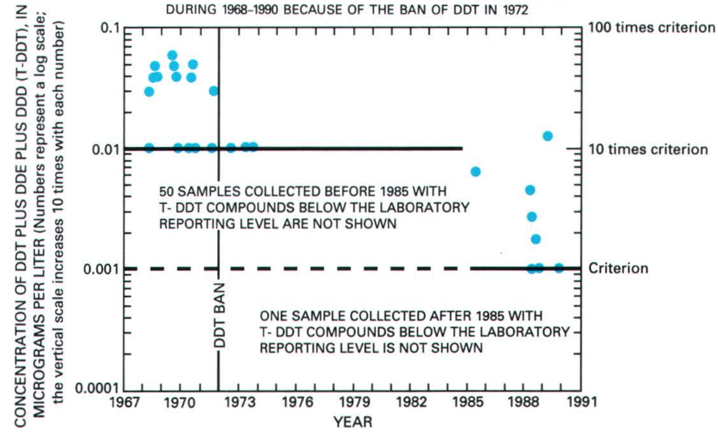
CONCENTRATIONS OF DDT PLUS DDE PLUS DDD (T-DDT) IN AGRICULTURAL SOILS ARE AT LEAST FOUR TIMES HIGHER THAN THOSE IN SUSPENDED AND STREAMBED SEDIMENT–Each bar represents a median; the number of samples with concentrations above the "median concentration" equals the number of samples with concentrations below it



Concentrations of T-DDT in the Yakima River have decreased since the ban on DDT in 1972. Concentrations in the main stem at Kiona decreased from about 0.06 microgram per liter in 1969 to generally less than 0.01 microgram per liter in 1990 (see graph). However, the 1990 level is still as much as 10 times higher than the chronic-toxicity criterion for the protection of freshwater aquatic life established by the U.S. Environmental Protection Agency. The long-term decrease in concentrations of T-DDT in stream water results, in part, from decreased concentrations of T-DDT in agricultural soils. In addition, the decrease in concentrations of T-DDT in stream water probably is a consequence of reduced soil erosion from agricultural fields and less suspended sediment. Over the past 20–30 years, erosion of soils in the Yakima River Basin has been reduced because (1) irrigation practices have changed (from less use of ridge and furrow irrigation to more use of sprinkler and drip irrigation), (2) cropping patterns have changed (fewer acres are used to grow row crops, such as sugar beets, potatoes, corn, and beans, and more acres are used to grow permanent crops, such as apples, pears, and grapes), and (3) cover crops of grasses and grains have been planted in orchards and vineyards. Data for T-DDT in soils or suspended sediment in the early 1970's are not available to confirm the relations. Long-term trends in T-DDT concentrations at other sites in the Yakima River and in agricultural-return flows are unknown because historical data are lacking.



CONCENTRATIONS OF DDT PLUS DDE PLUS DDD (T-DDT) IN THE YAKIMA RIVER NEAR KIONA, WASHINGTON HAVE DECREASED DRAMATICALLY DURING 1968–1990 BECAUSE OF THE BAN OF DDT IN 1972

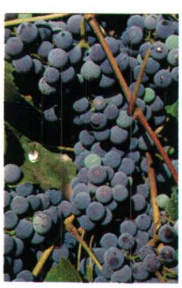


EXPLANATION

— LABORATORY REPORTING LEVEL–The laboratory reporting level is the lowest reliable concentration for a particular method of analysis. As methods improve, the reporting level is lowered, such as in 1985

– – CHRONIC-TOXICITY CRITERION FOR T-DDT–Established by the U.S. Environmental Protection Agency for protection of freshwater aquatic life

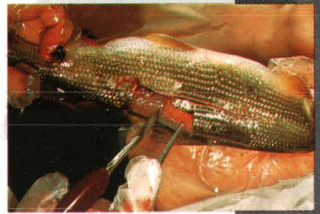
● CONCENTRATIONS OF T-DDT AT OR ABOVE THE LABORATORY REPORTING LEVEL



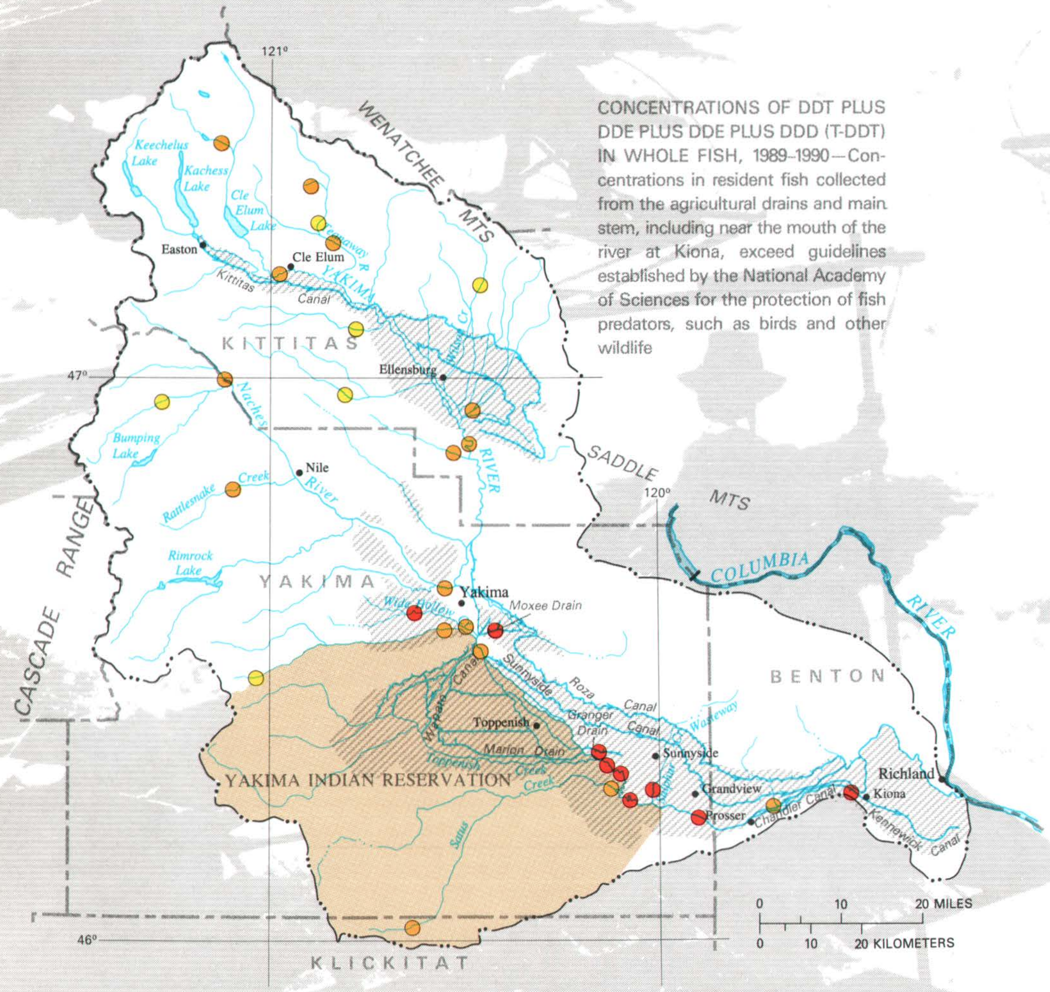
IS DDT CONTAMINATING FISH IN THE YAKIMA RIVER BASIN?

WHAT IS THE SOURCE OF DDT IN FISH?

Fish acquire some DDT and its breakdown products [Total DDT (T-DDT) = DDT + DDE + DDD] through uptake in food, by feeding on, for example, stream invertebrates or smaller fish that have fed on contaminated plants. Fish also accumulate T-DDT directly from water passing over their gills. T-DDT is stored in the fatty tissue of the fish and is not readily metabolized (broken down). The accumulation of T-DDT depends, in part, on fat content—fish with a low fat content do not accumulate as much T-DDT as fish with a high fat content—and, in part, on age, sex, species, and availability of food.



PREPARATION OF MOUNTAIN WHITEFISH FOR TISSUE ANALYSIS.



CONCENTRATIONS OF DDT PLUS DDE PLUS DDE PLUS DDD (T-DDT) IN WHOLE FISH, 1989–1990—Concentrations in resident fish collected from the agricultural drains and main stem, including near the mouth of the river at Kiona, exceed guidelines established by the National Academy of Sciences for the protection of fish predators, such as birds and other wildlife

YAKIMA RIVER BASIN

EXPLANATION

- IRRIGATED AREA
- YAKIMA INDIAN RESERVATION
- BOUNDARY OF DRAINAGE BASIN
- CANAL—Arrow indicates direction of flow

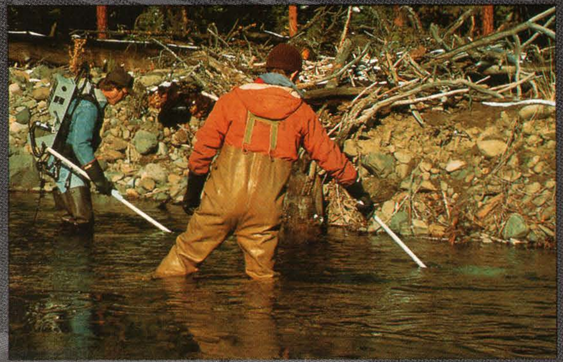
CONCENTRATIONS OF DDT PLUS DDE PLUS DDD (T-DDT) IN MICROGRAMS PER GRAM, WET WEIGHT—The National Academy of Sciences guideline to protect fish predators equals 1 microgram of T-DDT per gram of whole fish, wet weight

- Less than 0.01
- 0.01 to 1
- Greater than 1

YAKIMA INDIANS COLLECTING FISH NEAR UMTANUM, WASHINGTON, FOR MEASUREMENT AND ANALYSIS OF RESIDENT FISH POPULATIONS IN THE YAKIMA RIVER.

The Yakima River supports a complex web of human activities and fishery and wildlife needs that depend on a healthy river system. Man requires high-quality water for drinking and recreation, and ample quantities for irrigation and industry. The river also provides habitat for (1) wildlife that live and feed along the banks, (2) fish that reside in or migrate to and from the basin, and (3) millions of microscopic aquatic organisms at the bottom of the food chain. Water is the link to life, and we need to continue daily efforts to sustain a healthy river system, while we efficiently meet our water needs.

Mike Llewelyn, Olympia, Washington
Washington State Department of Ecology



U.S. GEOLOGICAL SURVEY HYDROLOGISTS COLLECTING FISH SAMPLES FOR TISSUE ANALYSIS FROM RATTLESNAKE CREEK NEAR NILE, WASHINGTON.

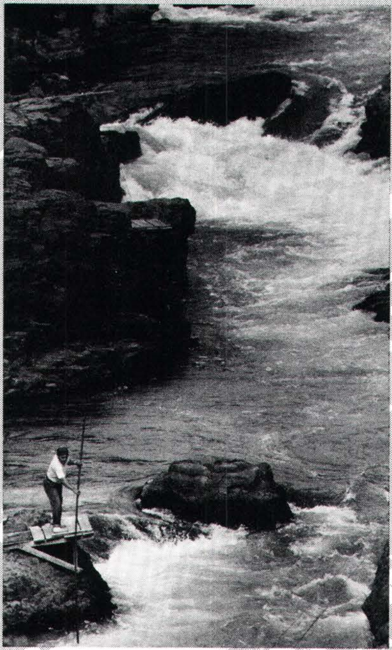
ARE CONCENTRATIONS OF T-DDT DETECTABLE IN FISH THROUGHOUT THE BASIN?

Samples of resident fish collected in 1989–90 at 31 sites in the basin, including pristine headwater sites, show that T-DDT is detectable in fish throughout most of the basin.[6] Concentrations of T-DDT are lowest (less than or equal to 0.01 microgram of T-DDT per gram of whole fish, wet weight) in species that reside in the headwaters, such as rainbow trout. Concentrations are highest (a maximum of 4.8 micrograms of T-DDT per gram of whole fish, wet weight) in species that reside in agricultural-return flows and in the lower 110 miles of the Yakima River where main-stem flow is dominated by agricultural-return flow, such as largescale suckers, mountain whitefish, bridgelip suckers, and chiselmouth. Concentrations in fish collected from agricultural-return flows and the main stem in the lower valley, including near the mouth of the river at Kiona, exceeded guidelines established by the National Academy of Sciences for the protection of fish predators (1 microgram of T-DDT per gram of whole fish, wet weight).

Data collected by the U.S. Geological Survey in 1989-90 do not include fish samples for T-DDT in migrating salmon and steelhead trout in the Yakima River Basin. Previous studies (1985) by the Washington State Department of Ecology indicate that concentrations of T-DDT were substantially lower in young, ocean-bound salmon and steelhead trout than in the adults of resident species, such as largescale suckers. Downstream migrating spring salmon and steelhead smolts (young fish) intercepted at Prosser had concentrations of 0.57 and 0.10 microgram of T-DDT per gram of whole fish, respectively. These concentrations fall in the middle to lower range of those observed in resident fish in the basin and below the recommended maximum guideline for the protection of fish predators.

[6] All analyses of fish collected by the U.S. Geological Survey during 1989–90 were performed by a U.S. Fish and Wildlife Service contract laboratory.

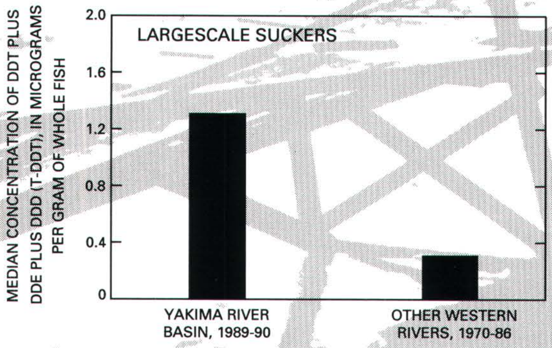
HOW DO CONCENTRATIONS OF T-DDT IN FISH IN THE YAKIMA RIVER BASIN COMPARE WITH CONCENTRATIONS IN FISH IN OTHER STREAMS THROUGHOUT THE NATION?



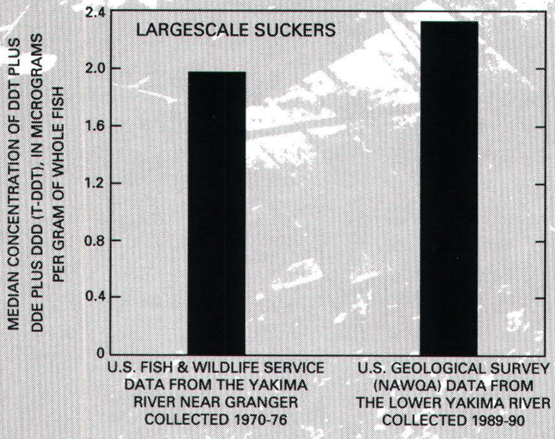
Fish in the Yakima River Basin have among the highest concentrations of T-DDT in the Nation, as suggested by a comparison of this study with a national study of fish collected by the U.S. Fish and Wildlife Service at 112 stations in major rivers in 1984–85. The median concentration of T-DDT in largescale suckers collected in 1989-90 in the main stem and agricultural return-flows of the Yakima River Basin (about 1.3 micrograms of T-DDT per gram of whole fish) is greater than concentrations of T-DDT in fish collected by the U.S. Fish and Wildlife Service at 103 of the stations (more than 90 percent). Concentrations of T-DDT in largescale suckers in the main stem and agricultural return-flows in the basin are about four times higher than concentrations of T-DDT in largescale suckers in 13 other western streams sampled from 1970 to 1986 by the U.S. Fish and Wildlife Service (see bar chart). The highest average concentrations of T-DDT in the Nation were in fish collected in 1984-85 by the U.S. Fish and Wildlife Service from the Yazoo River in Mississippi (greater than 5 micrograms of T-DDT per gram of whole fish). Other concentrations of greater than 1 microgram of T-DDT per gram of whole fish (guideline for the protection of fish predators) were in fish from intensively farmed areas of the Arkansas and lower Colorado Rivers, the Rio Grande, and Lakes Michigan and Ontario.

Nationwide, concentrations of DDT in freshwater fish are lower now than at any time since monitoring of organochlorine pesticides was initiated in the 1960's, in keeping with the removal of DDT from the marketplace. U. S. Geological Survey findings for the National Water-Quality Assessment of the Yakima River, which suggest relatively stable, high concentrations over the past decade, imply that the soils and sediments of the Yakima watershed harbor a sizeable mass of residual DDT.

Christopher J. Schmitt
U.S. Fish and Wildlife Service Contaminant Biomonitoring Program



CONCENTRATIONS OF DDT PLUS DDE PLUS DDD (T-DDT) IN LARGESCALE SUCKERS IN THE YAKIMA RIVER BASIN (NAWQA DATA) ARE ABOUT FOUR TIMES HIGHER THAN IN LARGESCALE SUCKERS IN THIRTEEN OTHER WESTERN STREAMS (U.S. FISH AND WILDLIFE SERVICE DATA)



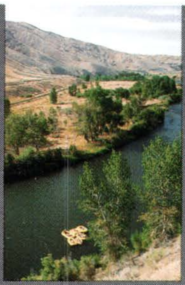
CONCENTRATIONS OF DDT PLUS DDE PLUS DDD (T-DDT) IN LARGESCALE SUCKERS FROM 1970 THROUGH 1976 ARE SIMILAR TO THOSE OBSERVED IN 1989-90

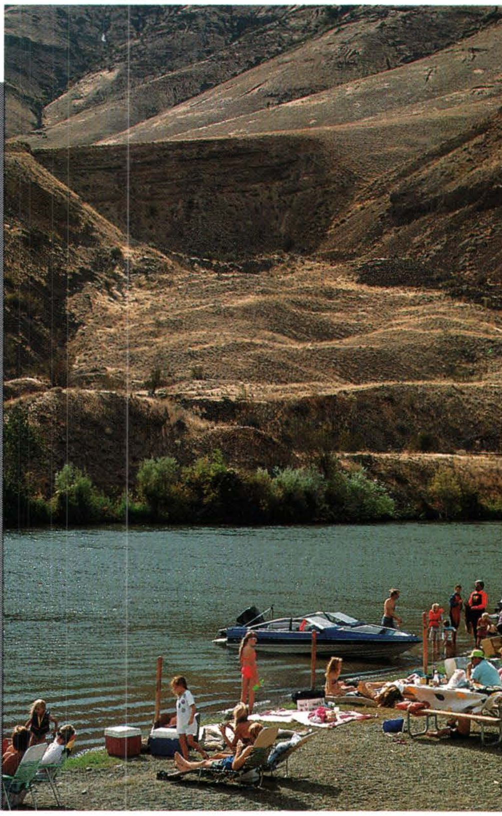
Each bar of the graphs represents a median; the number of samples with concentrations above the "median concentration" equals the number of samples with concentrations below it. The National Academy of Sciences guideline to protect fish predators equals 1 microgram of T-DDT per gram of whole fish, wet weight

ARE CONCENTRATIONS OF T-DDT CHANGING IN FISH?

Data collected at 112 stations in major rivers across the nation by the U.S. Fish and Wildlife Service in 1976 and 1984–85 indicate that concentrations of T-DDT in fish showed no significant changes at 91 stations, decreased at 20, and increased at 1. The concentrations in largescale suckers collected in the lower Yakima River by the U.S. Geological Survey in 1989–90 were similar to those collected near Granger in the lower Yakima River by the U.S. Fish and Wildlife Service from 1970 through 1976 (see bar chart). This similarity suggests that even though total concentrations of T-DDT in stream water have declined, the amount of T-DDT in the basin (including in the water, sediment, and invertebrates) remains high enough to maintain elevated concentrations in fish.

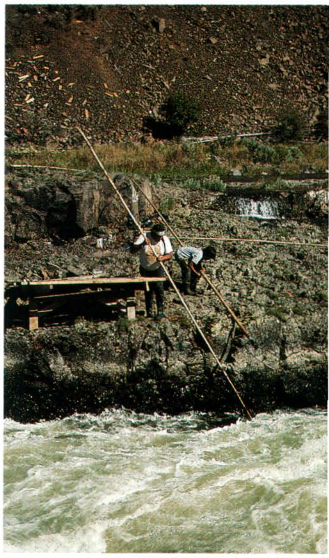
IMPLICATIONS OF FINDINGS ON MANAGEMENT OF DDT IN THE YAKIMA RIVER BASIN





It is important to understand that estimating risks from exposures to pollutants involves many uncertainties and assumptions. These uncertainties and assumptions span the entire development of risk predictions, ranging from determining the concentrations of pollutants in water and fish to estimating the levels of human exposure. The U.S. Environmental Protection Agency is encouraged by the apparent reduction in T-DDT concentrations in streams during the last 20 years. However, we are concerned that T-DDT residues are still present in fish. This concern stems from the knowledge that people are eating locally caught fish in the Yakima River Basin, sometimes in substantial amounts. Therefore, we feel it is important to further control the inputs of T-DDT to streams in the basin through the efforts of farmers, soil conservation districts, and others to minimize soil erosion and irrigation water runoff.

Charles E. Findley
U.S. Environmental Protection Agency, Region 10, Director, Water Division



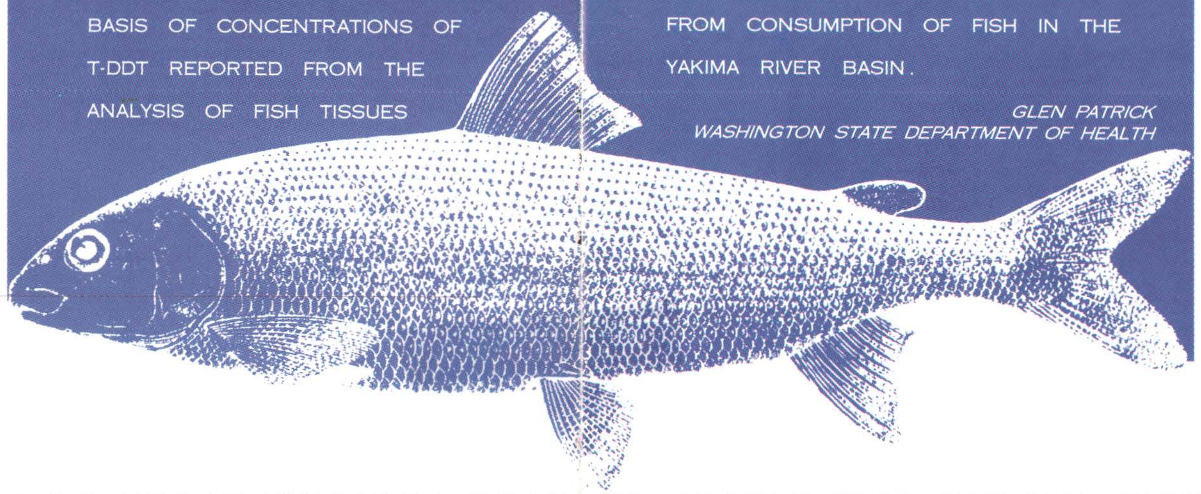
Even though two decades have passed since its production and distribution was banned, DDT and its breakdown products [Total DDT (T-DDT) = DDT + DDE + DDD] are still widely dispersed in the environment. Concentrations of T-DDT remain elevated in agricultural soil, stream water, suspended and streambed sediment, and fish in the Yakima River Basin. Concentrations in water commonly exceed the chronic-toxicity criterion for the protection of freshwater aquatic life, which was established by the U.S. Environmental Protection Agency and adopted as the water-quality standard by the Washington State Department of Ecology. Concentrations of T-DDT in fish in the basin are among the highest in the Nation and commonly exceed the guideline for the protection of fish predators established by the National Academy of Sciences. Highest concentrations in water and fish occur in agricultural-return flows in the lower 110 river miles in the basin.

Are concentrations of T-DDT of concern relative to human health in the Yakima River Basin? Currently (1993), no standards for the protection of human health exist against which T-DDT concentrations in water or fish tissue can be compared. Preliminary and theoretical degrees of risk reflect the lifetime chance of contracting cancer from consumption of T-DDT in water or fish tissue. A "lifetime" generally is considered to be 70 years. Calculated risks are only theoretical estimates that provide guidance to agencies that regulate water quality or protect human health and information for identifying potential health concerns to researchers and the public. The risks are calculated on the basis of current understanding of the cancer-causing potency of T-DDT (extrapolated from U.S. Environmental Protection Agency studies of laboratory animals, primarily rats and mice). These calculations include some uncertainty and assumptions, including possible differences in toxicological response of humans and laboratory animals to T-DDT and are based on limited information on relevant factors, such as fish-consumption rates. A human-health impact analysis is being conducted by the Washington State Department of Health to assess if T-DDT concentrations reported in this study pose a health threat to people who consume fish from the Yakima River Basin.

IMPLICATIONS

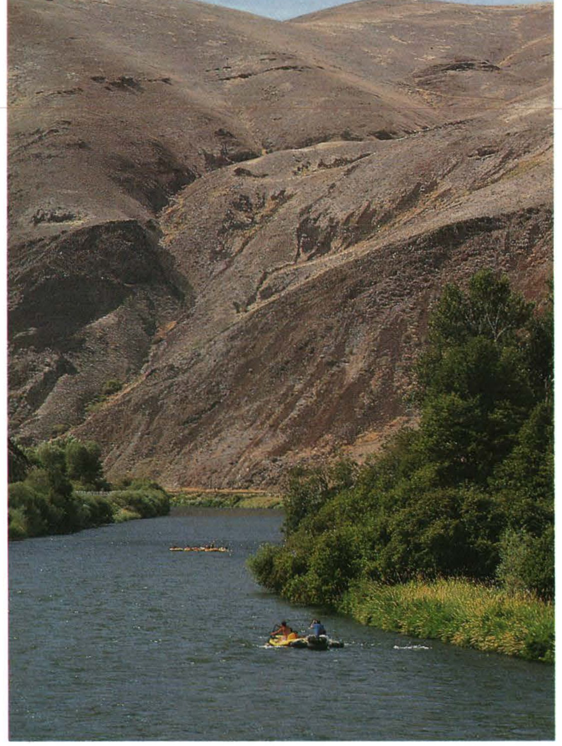
THE WASHINGTON STATE DEPARTMENT OF HEALTH HAS DETERMINED THAT A HUMAN-HEALTH IMPACT ANALYSIS SHOULD BE CONDUCTED TO DETERMINE IF CONCENTRATIONS OF T-DDT IN FISH IN THE YAKIMA RIVER BASIN POSE A THREAT TO HUMAN HEALTH. THIS DETERMINATION WAS MADE ON THE BASIS OF CONCENTRATIONS OF T-DDT REPORTED FROM THE ANALYSIS OF FISH TISSUES IN THE NATIONAL WATER-QUALITY ASSESSMENT STUDY AND RESULTS OF PRELIMINARY RISK-ASSESSMENT CALCULATIONS. THE WASHINGTON STATE DEPARTMENT OF HEALTH CURRENTLY (1993) IS WORKING ON THIS PROJECT AND WILL BE ISSUING A SEPARATE PUBLIC-HEALTH STATEMENT ON THE HEALTH EFFECTS THAT MAY RESULT FROM CONSUMPTION OF FISH IN THE YAKIMA RIVER BASIN.

GLEN PATRICK
WASHINGTON STATE DEPARTMENT OF HEALTH



WHAT DO THESE FINDINGS MEAN TO PEOPLE WHO DRINK THE WATER?

In June 1989, treated Naches River water from the city of Yakima Treatment Plant was sampled; no data were available for treated river water at Cle Elum. The concentration of T-DDT in the drinking-water supply was 0.00036 microgram of T-DDT per liter. Daily consumption of 2 quarts of city of Yakima drinking water by a 150-pound person over a 70-year lifetime corresponds to an incremental increase in cancer risk of about 4 per 1 billion people (see inset on human risks). T-DDT concentrations are low in the drinking-water supply because the intake is located upstream from intense agriculture and because the treatment process used by the facility removes most of the sediment and, thus, most of the T-DDT associated with the sediment.



RESIDENTS ENJOYING THE BEAUTY AND EXCITEMENT OF THE YAKIMA RIVER.

WHAT DO THESE FINDINGS MEAN TO PEOPLE WHO EAT THE FISH?

Samples of resident fish collected in 1989–90 in the Yakima River Basin show that T-DDT is detectable in fish throughout most of the basin. Concentrations of T-DDT in all fish collected in 1989–90 are below an action level of 5 micrograms of T-DDT per gram of food that has been established by the Food and Drug Administration to regulate concentrations in human food and animal feed sold to the public. The action level represents the limit at which the Food and Drug Administration can remove products from the market. Action levels do not apply to consumers of noncommercial, locally caught fish, such as sport fishermen and their families.

Concentrations of T-DDT are lowest (about 0.01 microgram of T-DDT per gram of whole fish, or an estimated concentration of about 0.008 microgram of T-DDT per gram of fish filet[7]) in species that reside in the near-pristine forested headwaters, such as rainbow trout from the Teanaway River. Consumption of one 5-ounce serving of rainbow trout per week over a 70-year lifetime corresponds to an incremental increase in cancer risk of about 1 per 1 million people (see inset, on human risks).

Concentrations of T-DDT are highest in species that reside in agricultural-return flows and in the lower 110 miles of the Yakima River, such as largescale suckers and mountain whitefish. Human-health risks associated with ingestion of T-DDT in fish in the lower 110 miles of the Yakima River are, therefore, higher than those associated with ingestion of T-DDT in fish from the headwaters of the basin. The highest concentration of T-DDT in Yakima fish occurred in Sulphur Creek Wasteway (4.8 micrograms of T-DDT per gram of whole fish or an estimated 2.6 micrograms of T-DDT per gram of filet). The incremental increase in cancer risk associated with this concentration is 250 per 1 million people. Concentrations of T-DDT in mountain whitefish and large-scale suckers near the mouth of the Yakima River at Kiona ranged from 1.7 to 2.8 micrograms of T-DDT per gram of whole fish, or an estimated average concentration of 1.4 micrograms of T-DDT per gram of fish filet. Consumption of one 5-ounce serving of mountain whitefish or largescale sucker from the lower Yakima River per week over a 70-year lifetime corresponds to an incremental increase in cancer risk of about 130 per 1 million people.

Human-health risks associated with ingestion of T-DDT in fish in the Naches River are higher than those associated with ingestion of treated Naches River water from the city of Yakima Treatment Plant. The concentration of T-DDT in mountain whitefish from the mouth of the Naches River was 0.75 microgram of T-DDT per gram of whole fish, or an estimated concentration of about 0.60 microgram of T-DDT per gram of fish filet. Consumption of one 5-ounce serving of mountain whitefish from the Naches River per week over a 70-year lifetime corresponds to an incremental increase in cancer risk of about 60 per 1 million people (see inset on human risks).

[7]Concentrations in fish filets are less than concentrations in whole fish because fat is less in filets than in whole fish and T-DDT is stored mostly in the fat. Relative concentrations in fish filets are estimated from data collected by the Washington State Department of Ecology in 1983. Analyses for fish filets collected in October 1991 by the U.S. Geological Survey are not expected to be complete until 1993.

ESTIMATED RISKS ASSOCIATED WITH SELECTED HUMAN ACTIVITIES

Lifetime Chance of Death (50 years)[8]

Motor vehicle accident	17,000 in 1 million
Drowning	2,500 in 1 million
Fire	2,000 in 1 million
Electrocution	370 in 1 million
Lightning	35 in 1 million

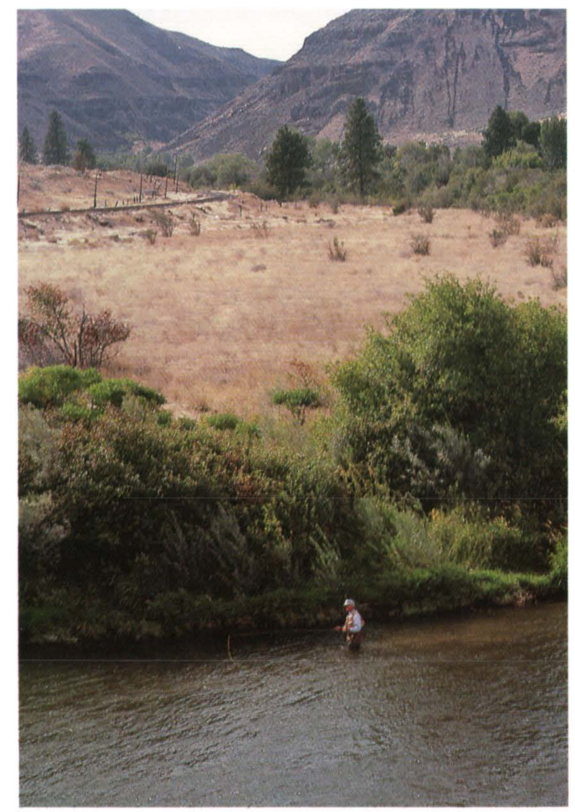
Lifetime Chance of Contracting Cancer (70 years)

Cigarette smoking[8]	80,000 in 1 million
Air pollution[8]	1,000 in 1 million
Five ounces of largescale sucker from Sulphur Creek Wasteway per week	250 in 1 million[9]
Five ounces of mountain whitefish from the Yakima River at Kiona per week	130 in 1 million[9]
One-half gallon whole milk per week[8]	100 in 1 million
Two ounces of peanut butter per week[8]	80 in 1 million
Five ounces of mountain whitefish from the mouth of the Naches River per week	60 in 1 million[9]
Five ounces of rainbow trout from the Teanaway River per week	1 in 1 million[9]
Two quarts of city of Yakima drinking water per day	0.004 in 1 million[10]

[8]Crouch, E. A., and Wilson, R., 1984, [in] Rodricks, J., and Tardiff, R., eds., Assessment and Management of Chemical Risks: American Chemical Society, Washington D.C.

[9]Number represents risk associated with T-DDT only. Additional contaminants (such as other organic compounds or trace elements) might be associated with fish in the Yakima River Basin that increase human-health risks.

[10]Equal to 4 in 1 billion.



TROUT FISHERMAN IN THE YAKIMA RIVER.

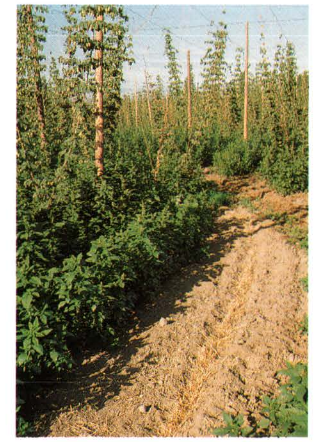
IMPLICATIONS

During a study in 1986 and 1987, the U.S. Fish and Wildlife Service, in cooperation with the Army Corps of Engineers, found high concentrations of DDE and PCBs in bald eagle eggs from nests along the Columbia River. The high concentrations of DDE were found to be associated with significant eggshell thinning and poor reproductive success of bald eagles nesting along the river. Productivity levels of eagles from the Columbia River during 1987–91 were 30 to more than 50 percent lower than levels found in statewide surveys of eagles nesting in Oregon and Washington. While productivity levels of eagles along the Columbia River are very low, levels of nesting populations in the two states are nearing some of the recovery guidelines required to remove the species from the Endangered Species List.

Marvin L. Plenert, Regional Director, Region 1, U.S. Fish and Wildlife Service

Water-quality improvement is a high priority goal of the USDA Soil Conservation Service. With the technical potential to achieve ''zero'' return flows from irrigated agriculture, we can significantly reduce both sediment-borne and in-solution contamination of surface water. This is especially true of DDT and its breakdown products, DDE and DDD.

Lynn A. Brown, State Conservationist, Soil Conservation Service



EROSION CONTROL PROGRAMS, INCLUDING MULCHING FURROWS WITH STRAW, USING SPRINKLER AND DRIP IRRIGATION, AND PLANTING COVER CROPS OF GRASSES IN ORCHARDS, HAVE BEEN IMPLEMENTED BY FARMERS IN THE YAKIMA RIVER BASIN.

DOES T-DDT AFFECT FISH PREDATORS?

Concentrations of T-DDT in fish collected from agricultural-return flows and the main stem of the Yakima River, including near the mouth at Kiona, exceed guidelines (1 microgram of T-DDT per gram of whole fish) established by the National Academy of Sciences for the protection of fish predators, such as the bald eagle. Information is not available on concentrations of T-DDT in fish predators that reside in the Yakima River Basin. Recent studies by the U.S. Fish and Wildlife Service, however, show elevated concentrations of DDE in bald eagle eggs from birds that nest near the mouth of the Columbia River. The Yakima River, which is located about 300 miles above the mouth of the Columbia River, is one of several sources in Washington and Oregon that are contributors of T-DDT to the Columbia River.

WILL T-DDT CONTAMINATION IN STREAMS AND FISH IN THE YAKIMA RIVER BASIN CONTINUE?

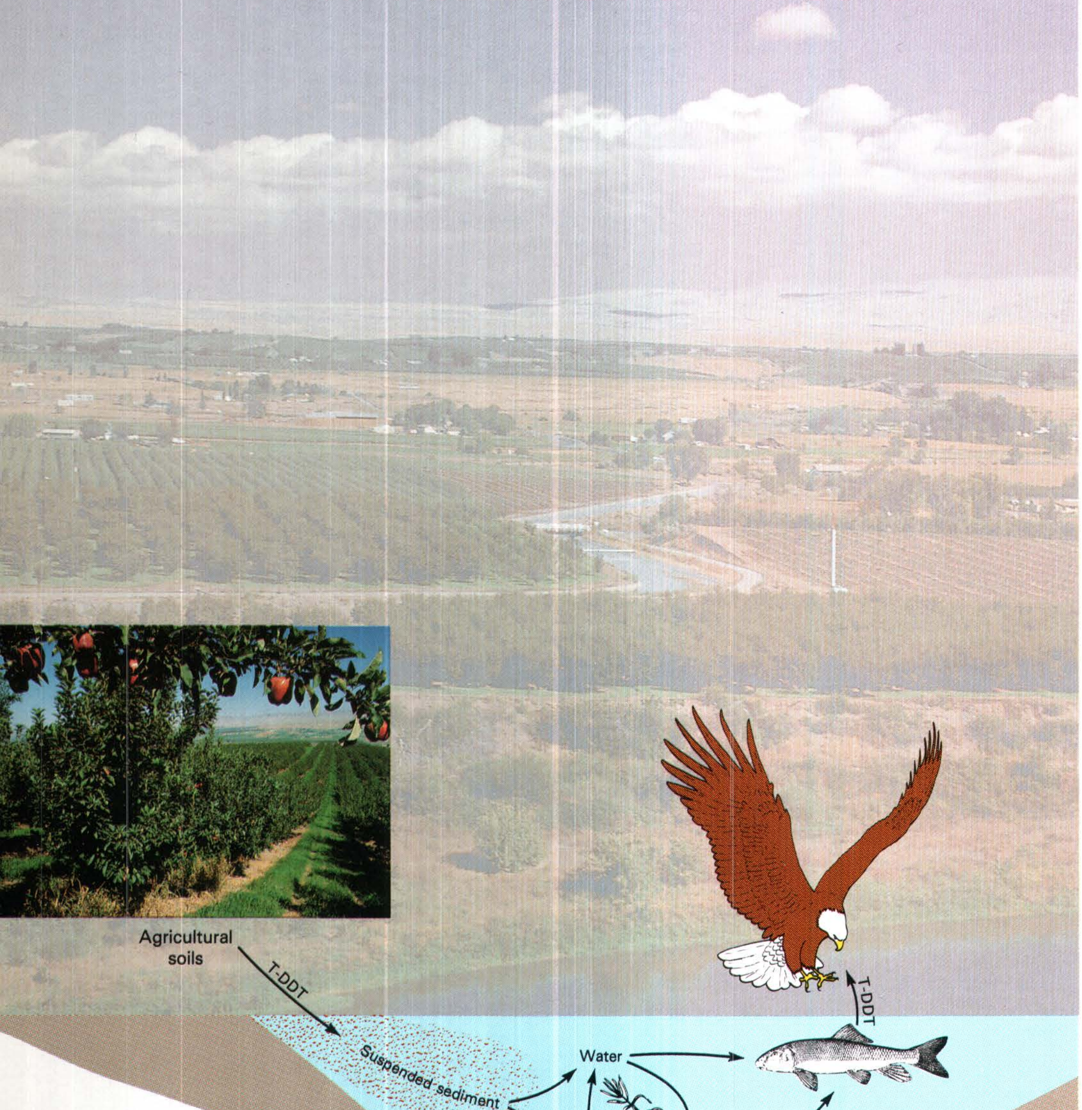
T-DDT contamination of streams and fish is an ongoing process, in part, because contaminated soils are eroded during the irrigation season and periods of heavy rainfall in agricultural areas. The presence of T-DDT in agricultural soils is attributed to historic applications and to the persistent chemical makeup of the compounds. Information to assess the environmental persistence and fate of DDT and its breakdown products in the agricultural soils in the Yakima River Basin is insufficient; the amount of time it takes for DDT compounds to break down in the soils depends on environmental conditions, soil type, and many complex chemical processes.[11] It is, therefore, difficult to quantify when T-DDT contamination in the streams and fish in the Yakima River Basin will subside or end. Results of this study indicate, however, that chemical breakdown of T-DDT is slow because, despite the ban on the production and distribution of DDT in 1972, concentrations of T-DDT in the Yakima River near Kiona commonly exceeded the chronic-toxicity criterion for the protection of freshwater aquatic life between 1972 and 1990. The contaminated agricultural soils could, therefore, provide a large and long-term reservoir of T-DDT to streams and fish in the Yakima River Basin for decades to come.

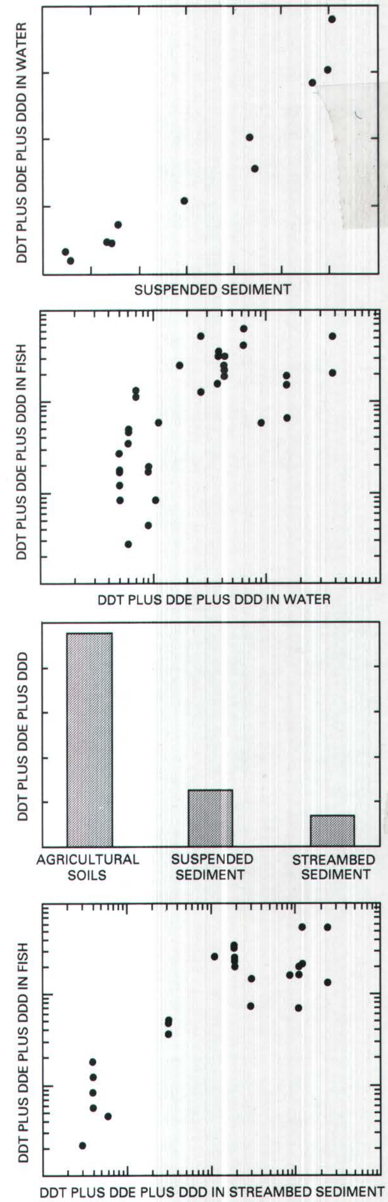
Federal, State, Tribal, and local programs have been implemented in the basin to reduce erosion of contaminated soils, thereby reducing the amount of T-DDT that enters streams. Over the past 20–30 years, erosion has been reduced because irrigation practices and cropping patterns have changed and cover crops of grasses and grains have been planted in orchards and vineyards. Erosion-control programs implemented in the basin within the last 10 years include mulching furrows with straw and irrigating with underground drip units. These newest methods help maintain adequate soil moisture and help promote less tillage and surface runoff. The erosion-control programs, which have been provided with technical and cost assistance from local Conservation Districts, the Agricultural Stabilization and Conservation Service, and the Soil Conservation Service, have been implemented by farmers. Such programs will help reduce the amounts of suspended sediment and T-DDT that enter streams.

[11]Callahan, M. and others, Water-related environmental fate of 129 priority pollutants: U.S. Environmental Protection Agency Report 440/4-79-029a, v. 1.

IMPLICATIONS

IMPLICATIONS OF FINDINGS ON SAMPLING AND RESEARCH STRATEGIES





Direct relations exist among concentrations of T-DDT in agricultural soils, stream water, suspended and streambed sediment, and fish. For example, concentrations of T-DDT in stream water are directly related to concentrations of suspended sediment in the water, and those in fish are correlated with concentrations in stream water and sediment. These relations imply that knowledge of concentrations of T-DDT in one medium provides an estimate of concentrations in other media. For example, analyses of streambed sediment might be used to estimate relative accumulation in fish. Such relations can be useful for optimizing resources required for monitoring T-DDT in the Yakima and other river basins.

The continuous replenishment and widespread dispersal of T-DDT among different media in the Yakima River Basin has raised concern by researchers of many disciplines (fish biologists, health scientists, soil scientists, water-resource managers, and hydrologists). Coordination and cooperation among agencies and organizations at all levels are essential to implement and maintain an effective program to assess where T-DDT occurs and to determine the sources in the Yakima River Basin.

COMMUNICATION AND COORDINATION AMONG THE U.S. GEOLOGICAL SURVEY AND OTHER INTERESTED SCIENTISTS AND WATER-MANAGEMENT PERSONNEL ARE IMPORTANT COMPONENTS OF THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM. TO MAKE BEST USE OF THE RESOURCES AVAILABLE, WE ARE COMMITTED TO FOSTER INFORMATION EXCHANGE AND COOPERATION AMONG ALL RELEVANT AGENCIES THROUGH THE DURATION OF THIS LONG-TERM PROGRAM. EVERY LEVEL OF GOVERNMENT AND THE PRIVATE SECTOR HAS A ROLE TO PLAY.

PHILIP COHEN, CHIEF HYDROLOGIST, WATER RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY

A COORDINATED EFFORT

Coordination among agencies and organizations at all levels is essential to understanding the distribution and variability of T-DDT in the Yakima River Basin. This publication was coordinated with the following Federal, State, Tribal, and local agencies and non-profit organizations. These organizations also provide reports on many aspects of the Yakima River Basin, including the distribution of surface water, chemical quality of the water, biological studies, and general water resources. General information on water resources can be obtained by writing to:

FEDERAL ORGANIZATIONS		
U.S. Army Corps of Engineers		
North Pacific Division	P.O. Box 2870 Portland, OR 97208-2870	503-326-3736
U.S. Department of Agriculture		
Forest Service	301 Yakima St., P.O. Box 811 Wenatchee, WA 98807-0811	509-662-4335
Soil Conservation Service	1606 Perry St., Suite F Yakima, WA 98902	509-454-5736
U.S. Department of Energy		
Bonneville Power Administration Public Information Center	P.O. Box 12999 Portland, OR 97212	800-622-4519
U.S. Department of the Interior		
Bureau of Indian Affairs	P.O. Box 632, Fort R Toppenish, WA 98948	509-865-2255
Bureau of Reclamation	1150 N. Curtis Rd., Mail Code 140 Boise, ID 83706-1234	208-378-5020
Fish and Wildlife Service	3704 Griffin Lane, SE. Suite 102 Olympia, WA 98501	206-753-9440
Geological Survey	1201 Pacific Avenue Suite 600 Tacoma, WA 98402	206-593-6510
U.S. Environmental Protection Agency, Region 10		
Water Division	1200 Sixth Avenue Seattle, WA 98101	206-553-8514
YAKIMA INDIAN NATION		
Environmental Protection Program	P.O. Box 151 Toppenish, WA 98948	509-865-5121
WASHINGTON STATE AGENCIES		
Department of Agriculture Pesticide Management	P.O. Box 42560 Olympia, WA 98504-2589	206-753-5064
Department of Ecology Public Disclosure	106 S. 6th Ave. Yakima, WA 98902-3387	509-454-7658
Department of Fisheries Habitat Management Div.	P.O. Box 43155 Olympia, WA 98504	206-753-6650
Department of Health Office of Toxic Substances	Airdustrial Center, Bldg. 4 P.O. Box 47825 Olympia, WA 98504	206-753-1930
Department of Natural Resources Photo and Map Sales	P.O. Box 47031 Olympia, WA 98504-7031	206-753-5338
Department of Wildlife	2802 Fruitvale Blvd. Yakima, WA 98902	509-575-2740

Much appreciation is extended to U.S. Geological Survey employees for their expertise in the production of illustrations by Leslie J. Robinson and James O. Whitmer; type composition by Shirlie A. McManus; and photography by David F. Usher.

Appreciation is also extended to those individuals and agencies that contributed photographs:

Charlie Collins, U.S. Geological Survey
Lynn Hatcher, Yakima Indian Nation, Fisheries Program
Gregory K. Scott, Nature Photos, Gilman, Wisconsin
Bureau of Reclamation
Central Washington Agricultural Museum
Columbia River Inter-Tribal Fish Commission
U.S. Fish and Wildlife Service
Yakima Valley Museum and Historical Society

Local and Interstate Agencies, Universities, and Nonprofit Organizations

Benton Conservation District	618 8th St. Prosser, WA 99350	509-786-1923
Benton-Franklin Health District	800 W. Canal Dr. Kennewick, WA 99336	509-582-7761
Central Washington University	Chemistry Dept., Dean Hall Ellensburg, WA 98926	509-963-2811
Columbia River Intertribal Fish Commission	729 NE. Oregon, Suite 200 Portland, OR 97232	503-238-0667
Kittitas County Conservation District	P.O. Box 679 Ellensburg, WA 98926	509-925-5375
Kittitas County Health Department	507 N. Naneum Ellensburg, WA 98926	509-962-7515
Northwest Power Planning Council	851 6th Ave. SW., Suite 1100 Portland, OR 97204	503-222-5161
North Yakima Conservation District	1606 Perry St., Suite F Yakima, WA 98902	509-454-5736
South Yakima Conservation District	P.O. Box 230 Toppenish, WA 98948	509-865-4012
Washington State University at Prosser		
Irrigated Agricultural Research and Extension Center	Box 2953A Prosser, WA 99350	509-786-2226
Washington State University Cooperative Extension		
Benton County	1121 Dudley Ave. Prosser, WA 99350-1399	509-786-5609
Kittitas County	5th and Main, Room 217 Ellensburg, WA 98926-2887	509-962-7507
Yakima County	233 Courthouse Yakima, WA 98901	509-575-4242
Washington Water Research Center		
Washington State University	Pullman, WA 99164	509-335-5531
Yakima Health District	104 N. 1st St. Yakima, WA 98901	509-575-4265
Yakima River Basin Association of Irrigation Districts	P.O. Box 810 Sunnyside, WA 98944	509-837-5141
Yakima Valley Conference of Governments	6 S. 2nd St., Suite 605 Yakima, WA 98901	509-575-4372

Additional information on the National Water-Quality Assessment Program can be obtained by writing to:

Deputy Assistant Chief Hydrologist, NAWQA Program
U.S. Geological Survey
National Center, 12201 Sunrise Valley Drive, MS 413
Reston, Virginia 22092

Suggested Readings:

Hopkins, B.S., Clark, D.K., Schlender, M., and Stinson, M., 1985, Basic water monitoring program, fish tissue and sediment sampling for 1984: Washington State Department of Ecology, Water Quality Investigations Section, Report 85-7, 43 p.

Johnson, Arthur, Norton, Dale, and Yake, William, 1986, Occurrence and significance of DDT compounds and other contaminants in fish, water, and sediment from the Yakima River Basin: Washington State Department of Ecology, Water Quality Investigations Section, Report 86-5, 89 p.

Richards, R.P. and Baker, D.B., 1990, Estimates of human exposure to pesticides through drinking water—A preliminary risk assessment *in* Kurtz, D.A., ed., Long range transport of pesticides: Lewis Publishers, p. 387–403.

Rinella, J.F., McKenzie, S.W., Crawford, J.K., Foreman, W.T., Gates, P.M., Fuhrer, G.J., and Janet, M.L., 1992, Surface-water-quality assessment of the Yakima River Basin, Washington: Pesticide and other trace-organic-compound data for water, sediment, soil, and aquatic biota, 1987–91: U.S. Geological Survey Open-File Report 92-644, 154 p.

Rinella, J.F., McKenzie, S.W., and Fuhrer, G.J., 1991, Surface-water-quality assessment of the Yakima River Basin, Washington—Analysis of available water-quality data through 1985 water year: U.S. Geological Survey Open-File Report 91-453, 270 p.

Schmitt, C.J., Zajicek, J.L., and Peterman, P.H., 1990, National contaminant biomonitoring program—Residues of organochlorine chemicals in U.S. freshwater fish, 1976–84: Archives of Environmental Contamination and Toxicology, v. 19, p. 748–781.

Smith, J.A., Witkowski, P.J., and Fusillo, T.V., 1988, Manmade organic compounds in the surface waters of the United States—A review of current understanding: U.S. Geological Survey Circular 1007, 92 p.

Woodwell, G. M., 1984, Broken eggshells: Science, v. 5, p. 115–117.

Rinella, Hamilton, and McKenzie—PERSISTENCE OF THE DDT PESTICIDE IN THE YAKIMA RIVER BASIN, WASHINGTON—U.S. Geological Survey Circular 1090