United States
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Soil Conservation Service
Forest Service
Economic Research Service

Southeast Washington

Cooperative River Basin Study

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Preface

The State of Washington, through the Washington State Department of Ecology, Washington State Conservation Commission, and Conservation Districts in Washington State, requested that the Southeast Washington River Basin Study be performed. Major study objectives included:

- Basin-wide evaluation of erosion and sediment problems, present land management and stream habitat condition.
- Intensive study of the Tucannon River, to determine instream effects of erosion and sediment on water quality and stream habitat conditions.
- Evaluation of impacts of conservation practices and land use change as applicable to cropland and forested areas and production practices on rangeland areas in the basin.
- Obtain local guidance and input to the study and provide the user groups meaningful data resulting from the study findings.

The results of this study are presented in four types of reports: this summary document, ten individual watershed reports, an appendix, and two separate reports relating directly to the special Tucannon River instream investigation.

Readers of the several reports will have various general and specific areas of interest. The summary report evaluates the entire basin and compares the various watersheds. It evaluates the causes and effects over the large area and a variety of conditions and contains a glossary of terms.

The individual watershed reports are site specific and in much more detail. They are more useful to local groups dealing with community concerns.

The appendix is a technical dissertation on the methodology and techniques used in the study.

The Tucannon instream investigation reports are highly technical discussion of results from an exhaustive special emphasis part of the basin investigation. They will have special value to those concerned with fish and wildlife interests and stream corridor management.

Data for the study was collected during 1980-1981. Evaluation of this data has been performed using 1981 as the base year for costs, prices, land use conditions and soil erosion rate computations. A 7 5/8 percent discount rate was used for interest calculations.

This study was performed by the U.S. Department of Agriculture (U.S.D.A.). U.S.D.A. agencies cooperating in the study were the Soil Conservation Service, Forest Service and Economic Research Service. Washington State Department of Ecology has assisted U.S.D.A. in study administration, coordination and direction. It is authorized by Section 6 of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress, 68 Stat. 666 as amended).

Summary

The Southeast Washington Cooperative River Basin Study found that soil erosion is a continuous and serious problem on cropland areas. Average erosion rates are less on forest areas and rangeland than cropland. Sediment has been found to be a more serious problem on forest areas and rangeland than erosion. The study confirms that the problems can be solved. It shows what kinds of conservation practices can be most effective in solving these problems and what economic and other impacts will result from their application.

Study results show:

Total erosion and sediment by source:

Source	Erosion 1000 tons/yr.	% of Total	Sediment 1000 tons/yr.	% of Total
Cropland	9,648	93	1,543	92
Rangeland	419	4	60	3
Forest Areas	177	2	14	1
Other Areas	113	1	68	4
Total	10,357	100	1,685	100

- Ninety three percent of the basin's erosion results from sheet and rill erosion on cropland.
- 10.3 million tons of soil erosion occurs in the study area each year.
- The average erosion rate on cropland is 8 tons per acre per year.
- Over 50 percent of the erosion occurs on class IV and VI land which comprises 31 percent of the cropland area.
- Average erosion rates are highest in the areas of the basin where mean annual precipitation is 15-18 inches per year.
- Soil erosion rates on cropland are highest in the Touchet, Walla Walla, Alpowa, Dry Creek and Tucannon Watersheds. In these watersheds they average 7 to 13 tons per acre per year.
- Soil productivity will continue to decline if erosion continues at present levels. Over the next 20 years the value of lost production will amount to nearly $40 million.
- 1.7 million tons of sediment move from upland areas to streams each year, severely damaging water quality and fish habitat. This sediment would cover an acre of land to a depth of over 900 feet.
- Summerfallow is a major cause of soil erosion.

- Changes to more intensive cropping systems with a reduction of summerfallow acreage can significantly reduce erosion.
- Reduced tillage, crop residues use and conservation cropping systems can provide a major reduction in soil erosion at a minimum cost.
- No-till farming can reduce erosion by as much as 95 percent.
- Terraces can reduce erosion by 37 to 49 percent.
- Stripcropping can reduce erosion by 52 to 64 percent.
- Erosion rates can be reduced to less than 5 tons/acre on all cropland acres even when present cropping systems are used.
- Range has deteriorated to a point where 73 percent is in poor and fair ecological condition and is producing at only 43 percent of its potential.
- Forage production can be increased 60 percent in 20 years with proper management but will require 90 years to reach full potential.
- Range production could increase from 180,000 to 333,000 animal unit months and produce 14,560,000 more pounds of beef.
- Range reseeding provides the quickest improvement in range production but the benefits from other practices may not materialize within the planning horizon of present operators.
- The average erosion rate on the forested area is .37 tons per acre per year.
- Roads and streams are the major source of erosion and sediment that can be treated in the forested area.
- Only roads and streams have mean annual erosion or sediment rates over 1 ton per acre in the forested area.
- The average cost of reducing sediment by ten percent on forested areas is $11.04 per ton.
- There is a very close correlation between road density and sediment yield by watershed in the forested area.
- The sediment rate in tons per square mile per year is nine times the road density.
- The largest yield of erosion in the forested area is from undisturbed areas.

- Pataha and Dry Creeks have the highest erosion and sediment rates of the nine forested watersheds evaluated.

- Existing sediment levels were found to be detrimental to fish reproduction and rearing habitat.

- The lower two-thirds of nearly all basin streams have only poor or fair fish habitat condition.

- High stream temperature is the key limiting factor for fish production. It is estimated that fish production could be nearly doubled if temperatures were reduced to suitable levels for salmonoids.

- Reduction of stream temperatures coupled with a sixty percent reduction of intra-gravel sediment will result in more than a three-fold increase in salmon and steelhead numbers.

Since the basin was first farmed in the mid 1800's soil erosion resulting from runoff has been a continuous and increasing problem. Most of the precipitation, both rain and snow, occurs during winter months. Most erosion occurs during the winter and spring. Amounts of erosion are influenced by the steep topography, highly erodible silt loam soils, kinds of farming systems, temperature and rainfall intensity.

High soil erosion rates for cropland are expected to continue. Erosion rates were determined using the universal soil loss equation (USLE). Average annual erosion of 8 tons per acre is expected unless farming systems change.

Gully erosion, though serious when it occurs, accounts for only a minor part of soil eroded from the basin annually.

Erosion rates on portions of fields are much higher than overall averages. Rates of 20 to 30 tons are common and 100 to 200 tons per acre losses occur occasionally on some steep slopes. Erosion rates on cropland are usually less in the lower precipitation zones of the western portion of the basin. Highest rates have consistently been measured in the intermediate 15 to 18 inch precipitation zone. They are highest in that zone because of extremely steep topography, complexity of slopes, farming systems used, and climatic conditions.

High erosion rates cause severe losses. Soil productivity on cropland is declining as soils erode. The estimated value of this production loss over the next 20 years is nearly $40 million. This loss has left the land permanently less productive. Eroded soil causes other problems as runoff water carries sediment from the land. Sediment smothers crops in bottom land areas. Extensive costs are incurred each year in cleaning sediment from highway ditches. Stream channels, waterways, and drainage ditches fill with sediment and increase flood problems. As runoff water flows from upland areas, the sediment it carries fills downstream hydroelectric reservoirs, destroys fish habitat, ruins recreation areas and pollutes the waters, making them unfit for other uses.

An important part of the study was an attempt to relate sediment to fish spawning and stream habitat. Special analyses were made on the Tucannon River to assess its limitations and potentials. High temperatures are the major limiting factor. Sediment deposition significantly reduces fish spawning success, rearing habitat and fish food production.

The study shows that problems of erosion and sediment can be solved. A farmer can do little to change the weather, kind of soil, or steepness of the land he farms, but he can change the way he farms the land. If farmers are going to reduce erosion they need to do such things as reduce acreages of summerfallow, till the soil less, retire the steepest most erosive areas from cultivation, change cropping systems, divide long slopes with two or more crops and install terraces on long gentle slopes.

The use of summerfallow, especially in the higher rainfall portions of the central and eastern basin, is a major contributor to soil erosion. When fields are summerfallowed, the uncropped land is tilled during the summer to control weeds and store moisture for growth of the next year's crop. Erosion rates from summerfallow fields average 25 to 30 percent higher than non-fallow fields. Excessively cultivated fields also erode more. Use of minimum tillage methods for seedbed preparation on annually cropped land or stubble mulch on summerfallow fields can reduce erosion rates by 30 to 75 percent. Use of no-till can be even more effective, reducing erosion rates by as much as 95 percent.

More than 50 percent of the erosion comes from 31 percent of the steeper cropland. Retirement from cultivation of part, or all, of this land would reduce erosion and sediment significantly.

Six alternatives were developed for reducing erosion on cropland and compared to the present situation. Combinations of land treatment practices and cropping systems were formulated to:

1. Present situation
2. Maximize net income.
3. Maximize net income with limited cropping system shifts.
4. Reduce erosion to soil loss tolerance level (T objective on every acre).
5. T level-limited cropping system shifts as in alternative 2.
6. T level-present cropping system.
7. Minimum erosion.

Alternative	Net returns $1,000	Sheet & rill Erosion 1,000 tons	Sediment 1,000 tons
1	67,007	9,537	1,543
2	112,549	6,043	1,000
3	99,348	8,064	1,278
4	109,715	3,151	496
5	97,075	3,498	551
6	67,322	3,341	552
7	-4,934	353	55

- Farmers can maximize their incomes and still reduce erosion by 3.5 million tons annually. (Alternative 2)

- Farmers can nearly maximize incomes and reduce erosion by 6.5 million tons and be at soil loss tolerance levels on all cropland acres. (Alternative 4)

- When acreage shifts are constrained both income and soil erosion reductions decrease. (Alternative 3, 5 and 6)

- Net returns with each alternative except Number 7 equaled or exceeded the present situation with significant erosion and sediment reduction.

- Minimizing soil erosion rates on cropland can reduce delivered sediment to 55 thousand tons per year, if the land is retired from cultivation and planted to hay and/or pasture. However, net returns would decline from 67 million to a loss of $4.9 million. (Alternative 7)

- Major shifts in cropping systems are needed to achieve maximum net income levels. This increase is approximately $45.5 million or 41 percent over present conditions. These shifts would result in a reduction of summerfallow and increased acres of wheat and barley planted. Cuts in operating costs through use of reduced tillage systems will result if these increases in net returns are realized. Shifts to more intensive cropping systems and application of new conservation practices increases the risk of maintaining farm income.

- Soil erosion rates of less than 5 tons per acre on all cropland acres can be achieved if changes to less erosive cropping systems are used in combination with increased acreages protected with conservation practices. Net returns will rise above present levels. However, if present crop acreages are retained and the 5 ton per acre objective is achieved solely through use of more conservation practices, net returns will remain at near present levels.

- Eight alternatives were developed for reducing erosion and sediment on forested areas by 10 percent increments from 0 to maximum reductions for each of the six watersheds with significant amounts of forested area.

- Acres treated, total annual costs, and cost per ton of erosion and sediment reduced varied by watershed but they all increased considerably for each successively larger alternative on forested areas.

Sediment reduction alternatives	Area treated 1,000 acres	Annual cost $1,000	Annual cost per ton Dollars
10	.4	10	11.04
20	1.5	44	22.36
30	5.3	113	39.55
40	9.4	305	85.40
50	84.9	832	209.05
60	206.0	2,384	497.49
70	262.0	5,332	873.21
Maximum	297.0	11,504	1,440.28

- Priorities for reducing sediment on forested areas, based on the lowest cost per ton of sediment reduced are the 10 percent sediment reduction alternatives for Tucannon, Touchet, and Asotin watersheds. The annual cost per ton for achieving these alternatives are $5.58 for the Tucannon, $7.46 for the Touchet and $12.80 for Asotin.

Implementation:

- An implementation program should be initiated to accelerate application of conservation practices under ongoing USDA programs and the cooperative effort of federal, state and local agencies and private organizations.

Action items needed:

- Financial assistance to provide incentives for participation of farm operators in programs to solve erosion and sediment problems.

- Establish local coordinating committees to redirect conservation activities to those areas with the highest potential for implementation.

- Provide increased technical assistance to plan and carry out conservation systems.

- Emphasize long term commitments and contracts with farm operators.

- Continue research programs directed at better ways of solving problems related to soil erosion and sediment. Further develop methods for determining the impact of upland management activities on water oriented resources.

- Gather data to be used to monitor and evaluate effectiveness of the program and verify that objectives are being met.

- Review and adjust, if needed, commodity and cost-sharing programs and forest management practices as they effect conservation practice application.

- Improve cooperation among agencies to improve ways in which they work together to achieve program objectives.

- Acceleration of education-information programs to increase awareness of farmers and the community to the areas problems and their solutions.

Watershed	Cropland	Rangeland	Forested area	Streams	Weighted potential
	Implementation potential				
Pataha	M	M	H	M	H
Tucannon	M	M	L	H	M
Grande Ronde	--	L	M	L	L
Snake	M	L	L	--	L
Asotin	L	M	M	H	M
Alpowa	H	L	L	H	M
Deadman	M	L	--	L	L
Alkali	M	H	--	--	L
Touchet	H	H	H	H	H
Dry	H	M	H	--	M
Walla Walla	M	M	M	M	M

H = high potential
M = medium potential
L = low potential

Study results indicate that implementation program priorities should be directed at:

- Class IV and VI cropland in portions of the Dry, Touchet, Alpowa, Walla Walla, and Tucannon-Pataha Watersheds where average annual precipitation exceeds 15 inches per year.

- Reduction of forest road and stream sediment. Emphasis should be placed on these problems in the Dry, Pataha, and Touchet watersheds.

- Improvement of range management systems to increase productive capacity. The Touchet and Alkali Flat watersheds have greatest potential for improvement.

- Improvement of stream corridors in the Tucannon-Pataha, Touchet, Asotin and Alpowa watersheds.

Programs that are presently available to accelerate implementation efforts include:

Ongoing U.S.D.A. Soil and Water Conservation Programs directed by the Soil Conservation Service, Agricultural Stabilization and Conservation Service and Forest Service can meet needs for implementation. Accelerated funding levels will be required to meet these needs.

Public Law 566 Small Watershed Land Treatment Programs have potential to meet needs over and above ongoing programs in high priority areas such as the Dry, Alpowa, Walla Walla, Touchet and Tucannon-Pataha Watersheds.

Washington State Referendum 39 funds are a possible source whereby conservation districts can obtain needed equipment for use by farmers in the area for application of needed conservation practices (conservation tillage equipment, no-till drills, etc.).

The Pacific Northwest Electric Power and Conservation Planning Council is presently initiating a program for fishery and wildlife enhancement. Funding for implementation of approved projects is being provided by Bonneville Power Administration. The Touchet, Tucannon, Asotin and Alpowa Watersheds have good potential for fish habitat enhancement under this program. Washington State Referendum 39 funds may also be a possible source of funds for fishery and water quality enhancement.

Setting

The Southeast Washington River Basin Study area, located in southeast Washington State, encompasses 2,785,081 acres (4,351 square miles). All of Asotin, Garfield, Columbia, and Walla Walla Counties and parts of Franklin and Whitman Counties are included in the study area. (Figure 1)

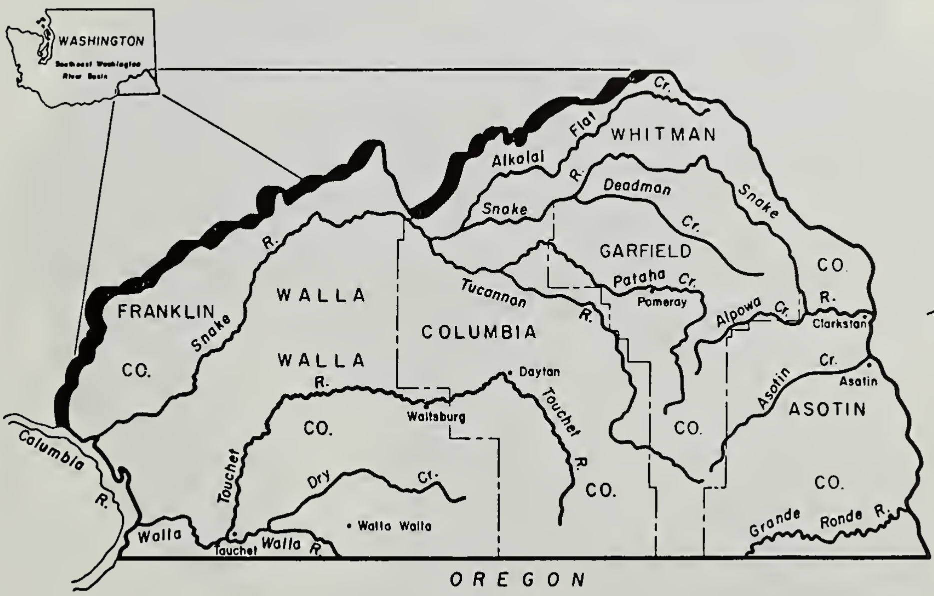


FIGURE 1. -- SOUTHEAST WASHINGTON RIVER BASIN STUDY AREA.

The area is bordered on the south by the State of Oregon and on the east by the State of Idaho and the Snake River. The study areas's northern and western boundary is formed by the northern drainage boundary of the Snake River from Whitman and Franklin Counties.

Most of the southeastern portion of the study area is mountainous forest -- the Blue Mountains. At their highest points the mountains exceed 6,400 feet. The forested area is transected with numerous steep canyons. A portion of the area has been designated as the Wenaha - Tucannon Wilderness Area. Intermixed with the forested area, are large areas of rangeland. Rangeland areas extend along canyon slopes throughout much of the basin.

From south to north the area presents itself as a giant open fan. Ridges which project from the fan axis are cultivated. Numerous streams flow to the fan's outer edges where they join the Snake River. Areas too steep to farm, along the canyon walls, produce native grasses and are used as rangeland. Most areas bordering the Snake River on both north and south banks are also rangeland.

The landscape is varied with mixtures of forest, cropland and rangeland.

Mean annual precipitation varies from less than 10 inches per year in the west to over 70 inches per year in high mountain areas (Figure 2). Ninety percent of the precipitation falls between September 1 and May 30 with twenty-five to thirty percent of the winter precipitation in the form of snow. However, much less snow falls in the dryer western region and a larger percentage accumulates at high elevations in the mountains. The growing season averages over 155 days in the west and less than 100 days at elevations of 4,500 feet in the mountain footslopes.

At lower elevations, maximum summer temperatures usually range from 80°F to 95°F. but exceed 100°F nearly every year. Temperatures will normally decrease about 4°F. with each 1,000 feet increase in elevation. In winter, maximum temperatures range from 30°F to 40°F. Winter low temperatures approaching -30°F. have been recorded in the area.

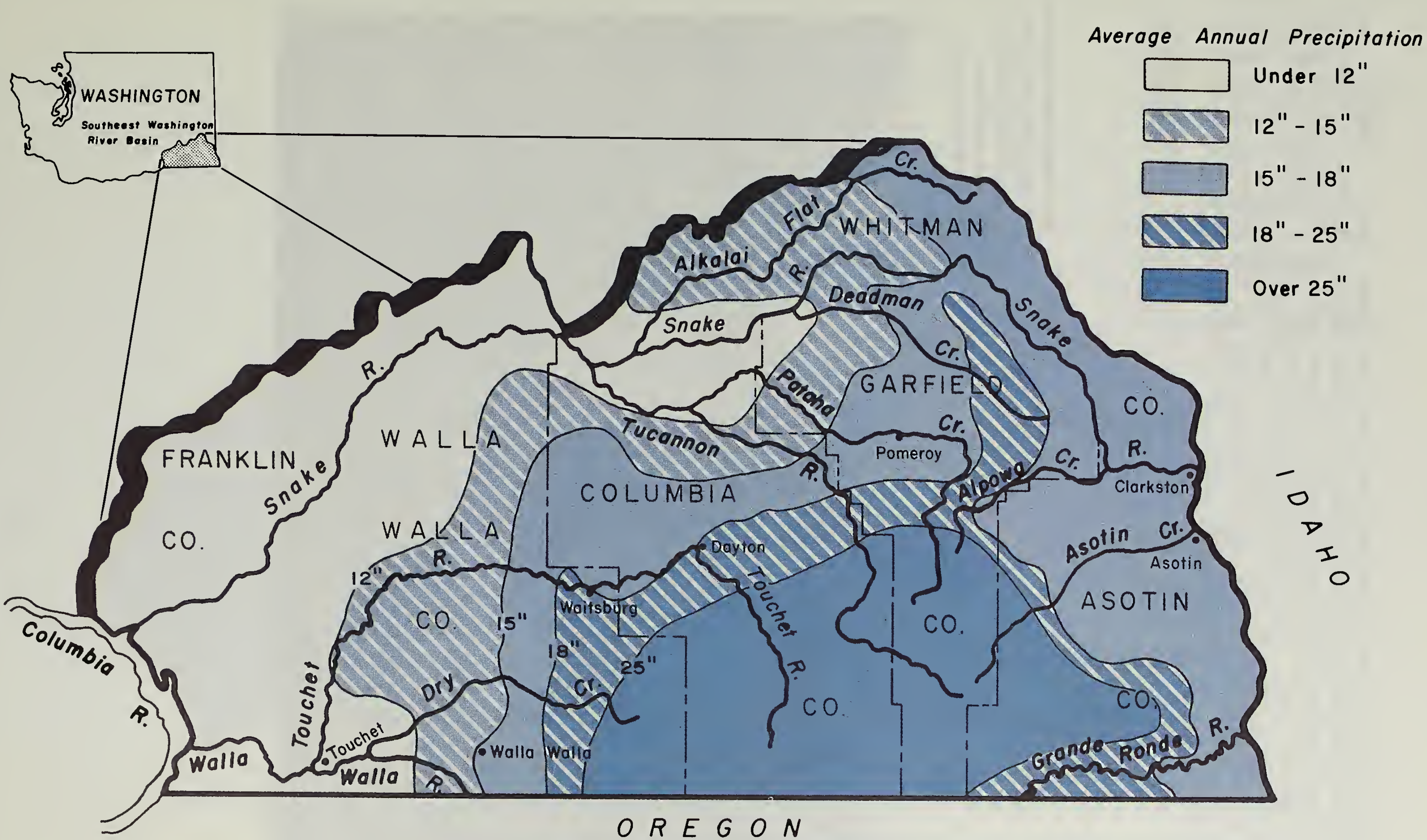


FIGURE 2. -- SOUTHEAST WASHINGTON RIVER BASIN AVERAGE ANNUAL PRECIPITATION.

Major streams include the Columbia River and the Snake River. Numerous small tributaries include Alkali Flat Creek in Whitman County; in Asotin County are the Grande Ronde River and Asotin Creek; Alpowa Creek in Garfield and Asotin Counties; Deadman Creek in Garfield County; Tucannon River and Pataha Creek in Columbia and Garfield Counties; the Touchet River in Columbia and Walla Walla Counties; and Dry Creek and the Walla Walla River in Walla Walla County. The watersheds of these stream systems constitute the ten major areas used as a basis for evaluation in this study (Figure 3).

The Snake River encircles the study area from the Oregon-Idaho borders in the southeast to the Columbia River in the southwest.

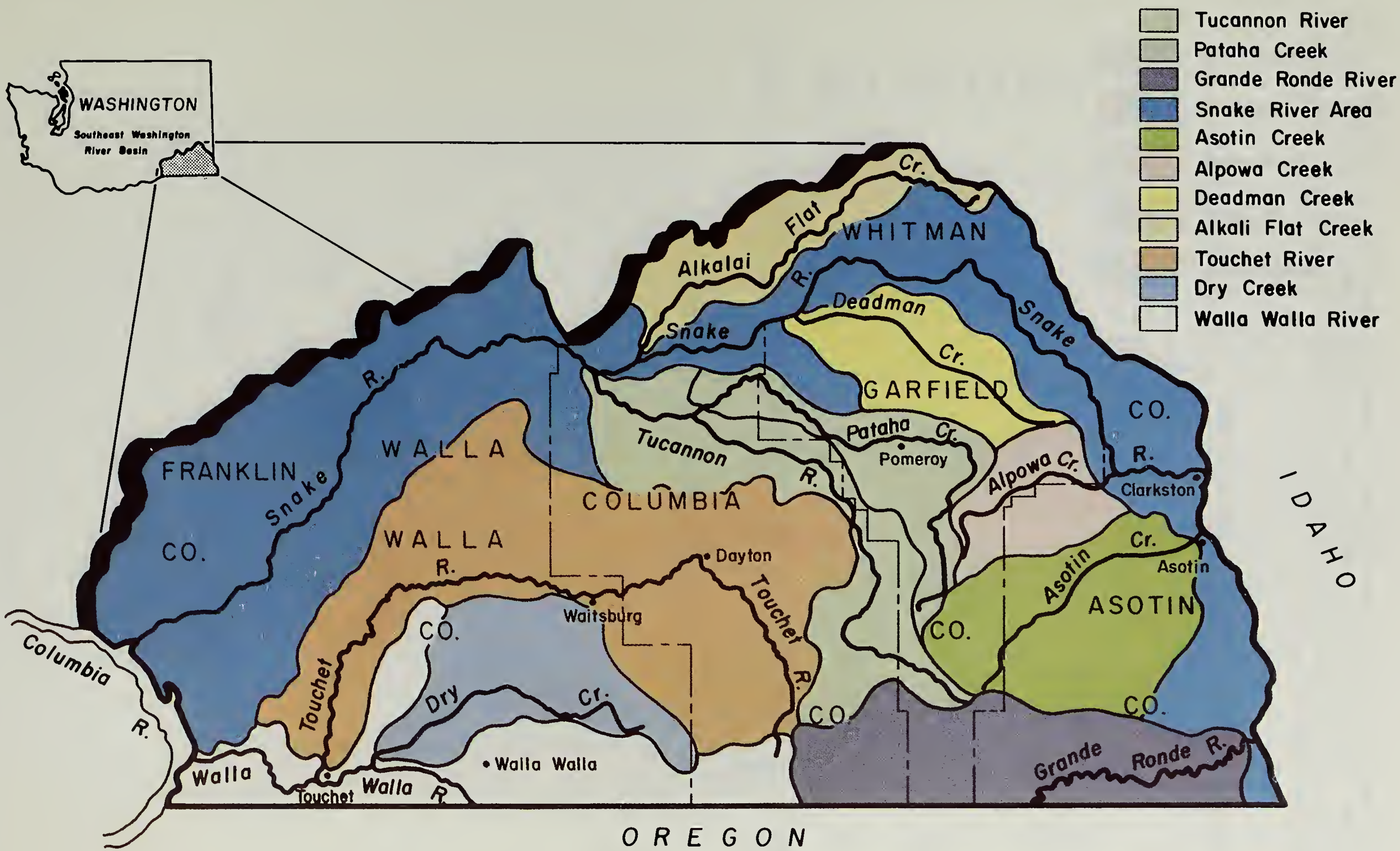


FIGURE 3. -- SOUTHEAST WASHINGTON RIVER BASIN WATERSHED AREA MAP.

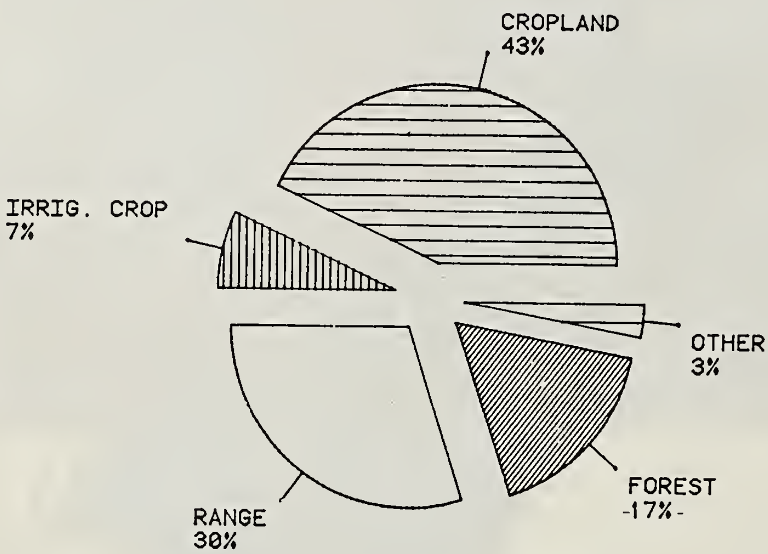
Forty-three percent of the study area is used for production of dry crops, seven percent irrigated crops, 30 percent is rangeland, 17 percent forested area, and the balance for other uses such as roads, streams, and urban areas (Table 1 and Figures 4 and 5).

Table 1.—Land use by watershed, Southeast Washington, 1981

Watershed	---Cropland--- Irrig.	Dry 1/	Rangeland	Forested area	Other	Total
	1,000 acres					
Tucannon-Pataha	3	116	113	87	3	322
Grande Ronde	1	1	44	156	16	218
Snake	82	310	422	3	74	891
Asotin	--	59	60	83	2	204
Alpowa	--	27	51	4	1	83
Deadman	--	86	43	--	1	130
Alkali Flat	1	95	12	--	1	109
Touchet	10	314	29	113	7	473
Dry	7	134	4	7	2	154
Walla Walla	88	55	21	27	10	201
Total	192	1,196	799	480	117	2,785

1/ Further references to cropland includes only dry cropland acreages.

Figure 4.—Land Use—Southeast Washington, 1981



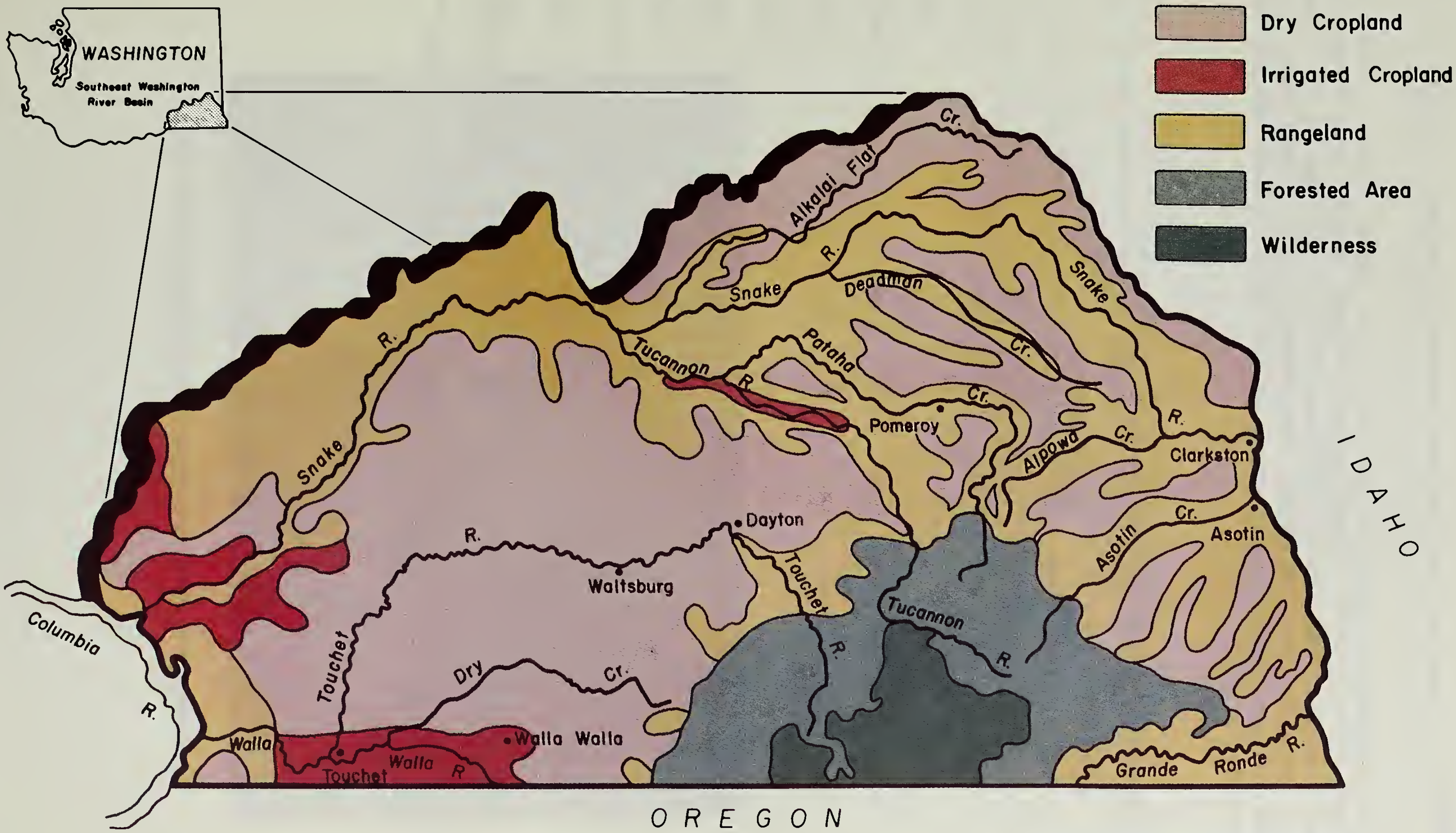


FIGURE 5. -- SOUTHEAST WASHINGTON RIVER BASIN LAND USE MAP.

CROPLAND

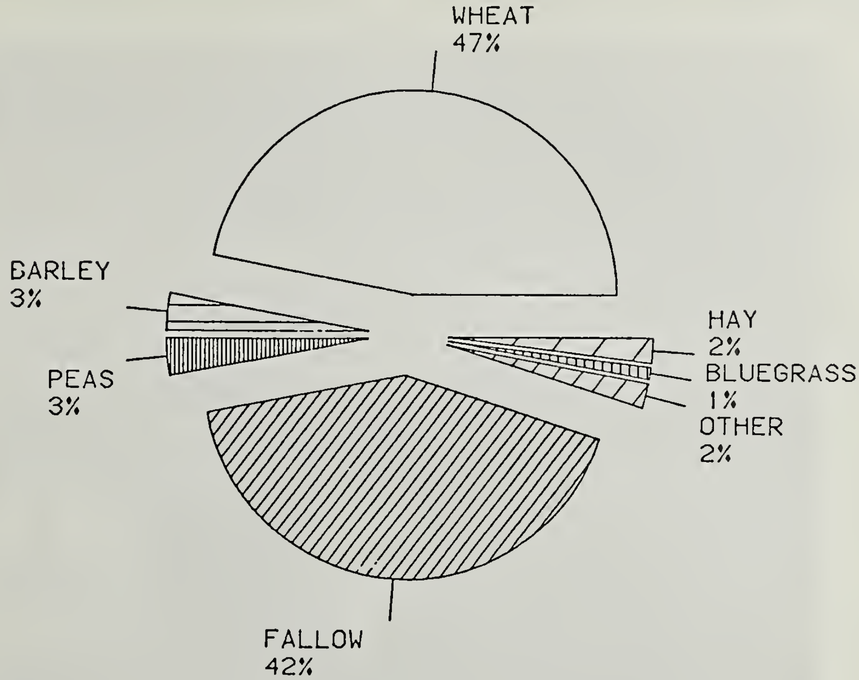
Most of the cropland is used for production of winter wheat. Other crops grown include spring wheat, spring barley, winter barley, dry edible peas, green peas, bluegrass seed, and alfalfa hay (Table 2 and Figure 6). Cropping systems most commonly used are winter wheat-summerfallow; winter wheat, spring grain, summerfallow; wheat, peas; annual winter wheat; annual spring barley, and/or winter barley.

Table 2.—Cropland acreage by watershed, Southeast Washington, 1981

Watershed	Winter wheat	Fallow	Peas	Spring barley	Winter barley	Hay	Blue-grass	Other 1/	Total
	Acres								
Tucannon-Pataha	54,053	52,072	1,981	1,132	1,698	2,264	2,830		116,030
Grande Ronde	602	602							1,204
Snake	149,082	140,807	3,956	3,237	8,272	2,158	2,158		309,673
Asotin	29,211	29,211				749			59,171
Alpowa	11,382	11,381		3,520	469				26,752
Deadman	37,990	37,700	290	4,640	1,740		3,480		85,840
Alkali Flat	39,524	39,523		8,993		7,100			95,140
Touchet	144,795	125,364	14,859		762	6,858		21,336	313,974
Dry	66,804	51,326	11,865	516		3,096			133,607
Walla Walla	24,123	15,996	7,353		516	3,870		3,096	54,954
Total	557,030	503,982	39,764	22,038	14,536	26,095	8,468	24,432	1,196,345

1/ Primarily includes permanent cover crop on cropland areas which were formerly under cultivation.

Figure 6.—Crop Acreage-Southeast Washington River Basin Study Area, 1981



Winter wheat, barley and peas are major crops grown in the watershed.

Most of the crops produced in the watershed are transported by barge on the Snake River from grain terminals such as this.

Productivity of soils and their ability to produce crops in the basin varies significantly. Soil productivity or crop production capacity is influenced by mean annual precipitation, length of growing season, farm management and soil depth.

Most upland soils in the non-forested area are silt loams formed from wind deposited loess and in bottom land areas of loess and water-deposited material (alluvium). Mountain soils are mixed and were formed from loess and weathered basalt bec-ock. In many mountain areas stones are often mixed with other soil materials and the topography is very steep.

The loess soils have formed the typical "Palouse Hills" of the study area (Figure 7). Most of these hills having up to a 45 percent slope are under cultivation. North and east facing slopes are generally very steep, while south and west slopes are generally flatter.

Figure 7.—Profile of a Typical Palouse Hill

		IIe	IIIe	IVe	VIe	IIIe	IIe
% SLOPE	RANGE	3 - 7	7 - 25	3 - 40	25-55	7-25	3 -7
	MEAN	5	16	12	36	21	5
TOPSOIL DEPTH (in)		24	15	4	20	20	21
ORGANIC MATTER IN Ap LAYER (%)		3.6	3.0	1.8	3.1	3.8	4.0

Profile of a typical Palouse hill showing differences in percent slope, depth of epipedon, and soil organic matter for the constituent land capability subclasses. (Revised after Pawson et al., 1961)

Soils in the cropland areas have been grouped by capability class - a general grouping which shows the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. Soils are grouped into the following land capability classes. Land capability subclasses were not evaluated separately since over 90 percent of the cropland is included in subclass e, where erosion is the predominent hazard. About 80 percent of the cropland is class IIIe and IVe. (Figure 8)

1. Class IIe soils have few limitations or hazards. Erosion rates are usually low, and only simple conservation practices are needed to control erosion. Slopes of most class IIe land in the basin are less than 7 percent.

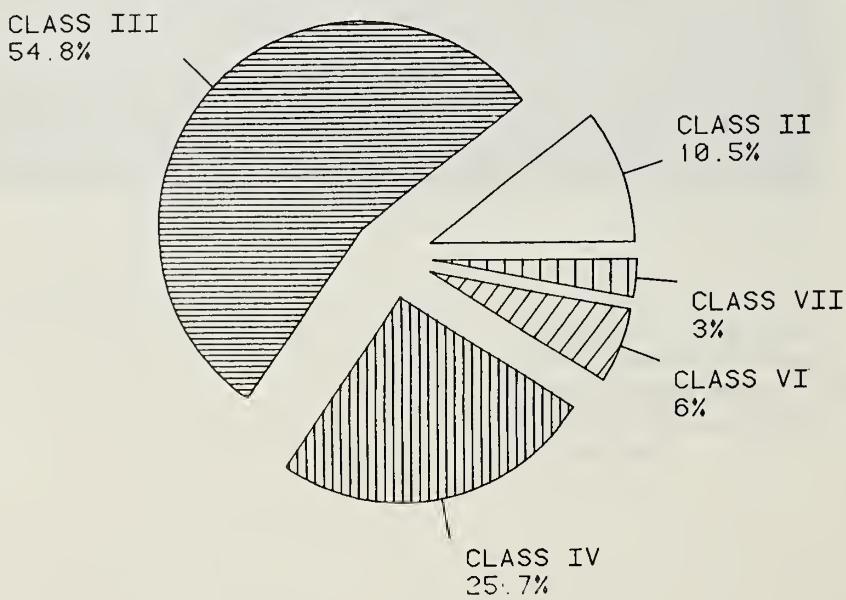
2. Class IIIe soils can have severe erosion problems. Slopes range from 7 to 25 percent. These soils need more complex conservation practices if erosion is to be controlled.

3. Class IVe soils have erosion problems which are very difficult to control and erosion rates usually are high. They need very complex conservation practices for erosion control. Slopes range from 25 percent to 40 percent (7-25 percent when eroded) on most soils.

4. Class VIe soils have severe limitations or hazards and are generally considered unsuited for cultivation because of shallowness, erosion problems, and/or steep slopes. Slopes exceed 40 percent (25 to 40 percent when eroded).

5. Class VIIe soils have very severe limitations that make them unsuitable for cultivation. Use of these soils is restricted to pasture, rangeland, woodland or wildlife habitat.

Figure 8.—Distribution of soils by land capability class, cropland, Southeast Washington Study Area.



RANGELAND

Thirty percent of the study area, 799,000 acres is rangeland. Over one-half is located along the mainstem of the Snake River, another 20 percent in the Tucannon River Watershed and the remainder in other watersheds. (Table 1 page 14)

Rangeland areas are generally unsuited to cultivation because of steepness of slope, frequent rock outcroppings, stoniness, shallow soils, wetness, salinity and or alkalinity. Rangeland provides important forage for livestock and often is vital to various wildlife species. It also influences water quality and quantity, enhances aesthetics, and provides open space for recreation.

Rangeland was classified into ecological sites and condition in accordance with Soil Conservation Service procedures for this study. An ecological site is a natural plant community which is the product of the environment that differs from other sites in plant species, proportion and amount. Range condition indicates the degree of departure from the climax plant community. The traditional range condition names and percentages of key climax species are as follows: Poor = 0-25%, Fair = 25-50%; Good = 50-75%; Excellent = 75 -100%.

Productivity of rangeland and its ability to produce forage may vary significantly. Forage production is directly related to the ecological site and the present ecological condition of the forage resource. Approximately 750 lbs. of dry forage represents one animal unit month. A comparison of rangeland of various conditions on loamy sites is shown in Table 3.

Table 3.—Comparison of rangeland productivity-by ecological condition for favorable growth years, loamy sites, Southeast Washington, 1981

Annual precipitation zone	Ecological condition			
	Excellent	Good	Fair	Poor
	Total plant production - lbs./acre			
6-9 inch	1,000	750	500	250
9-15 inch	1,400	1,050	700	350
15-18 inch	2,250	1,650	1,100	550
18+ inch	3,100	2,300	1,550	750

Historically overstocking and continuous grazing have been major contributors to the deterioration of 584,570 acres of rangeland. Twenty-seven percent (216,280 acres) are in good or excellent condition through proper management and in some cases non-use. Ironically, the least productive ; shallow, very shallow, and sandy sites, have the most rangeland in good or excellent condition. Much of the rangeland in good or excellent condition has not been over utilized because of: steep topography, rockiness, vegetation maturity, lack of water, and/or remoteness. Many range sites with deeper soils have tended to be over utilized. This has deteriorated their ecological condition and productive capacity.

Stream corridor access is important to livestock and wildlife since streams are often the only source of water for the animals. Proper livestock management is necessary to maintain riparian vegetation in these areas. Riparian vegetation shades the stream, provides food and cover for wildlife and helps maintain streambank stability. An assessment of riparian vegetation along stream corridors is included in the Stream Habitat section of this report.

Forage production on rangeland is directly related to ecological site and condition.

FORESTED AREA

Essentially all the land in the study area supporting timber and intermixed areas of brush, forbs and grass is defined as the "forested area".

The forested area, located in the south central portion of the study area, covers 480,484 acres or 17 percent of the total study area. All but two watersheds in the study area contain some forest.

The forested area is generally mountainous country dissected by very deep canyons or steep-sided valleys with narrow flood plains. Elevations of major ridge tops range from 5,000 to 6,000 feet with a maximum elevation of 6,400 feet at Oregon Butte. Lower limits of the forested area range from 2,000 feet in valley bottoms to 4,000 feet on ridge tops. The forest boundary usually begins between the 20 and 30 inch annual precipitation zone and rises to 70 inches along 6,000 foot elevation ridge tops.

South facing slopes and ridge tops with shallow soils produce open forest or grass cover. North facing slopes are typically heavily timbered with Douglas-fir and true fir or hemlock. Regardless of slope aspect, high elevation areas usually support Douglas-fir and mixed conifer types if there is adequate soil. Ponderosa pine is common on drier sites at lower elevations.

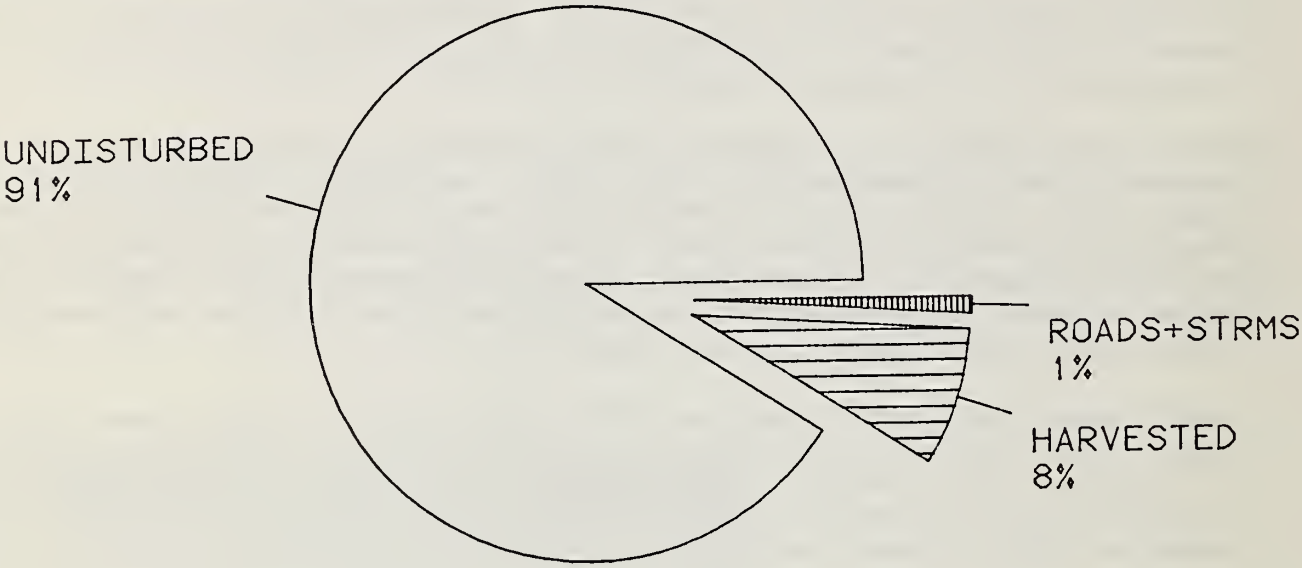
The Wenaha-Tucannon Wilderness Area is located in the south central portion of the forested area. The wilderness area covers approximately 110,000 acres or 23 percent of the forested area.

The Forest Service manages 311,740 acres or 65 percent of the forested area, the State of Washington manages approximately 2%. Thirty three percent is privately owned and managed.

Timber harvested from the area supports local mills in Walla Walla, Clarkston, and Dayton, Washington and Lewiston, Idaho. Approximately 30 million board feet of timber was harvested in 1981 from approximately 2,400 acres. The stumpage value received by landowners for this timber is estimated at over $300,000.00. Other major valuable resources from the forested area include: water, recreation, forage, fish and wildlife.

Much of the forested area, 438,650 acres (91 percent), has not been disturbed by timber harvesting or road construction during the past seven years. Only 38,000 acres (8 percent) have been recently harvested. There are 2,973 acres of roads and 813 acres of streams in the forested area (Figure 9 and Table 4).

Figure 9.—Land use, forested area, Southeast Washington, 1981



Of the total forested area, nearly 439,000 acres (91 percent) are located in the Tucannon, Pataha, Grande Ronde, Asotin, and Touchet Watersheds. The Snake, Alpowa, and Dry Creek Watersheds contain the remaining nine percent of the forested area. (Table 4).

Table 4.—Land use, forested area, Southeast Washington, 1981

Watershed	Undisturbed	Harvested	Roads	Streams	Total
	Acres				
Tucannon	69,645	2,745	410	203	73,003
Pataha	9,853	3,214	464	53	13,584
Grande Ronde	149,971	5,126	463	167	155,727
Snake	3,125	0	41	0	3,166
Asotin	67,635	15,048	626	101	83,410
Alpowa	3,822	504	44	0	4,370
Touchet	101,524	10,773	728	216	113,241
Dry	6,408	201	79	17	6,705
Walla Walla	26,667	401	118	56	27,242
Total 1/	438,650	38,012	2,973	813	480,448

1/ There are 36 acres of ponds within the forested area not included in the table. The total forested area is 480,484 acres.

Seventeen percent of the Southeast Washington Study area is forested.

In the undisturbed area nine different units were used for the evaluation of current conditions and problems. The evaluation units were derived from land types used in the Oregon Butte Planning Unit. Land types with similar erosion and sediment rates were combined to form evaluation units (Table 5). A more detailed description of evaluation units is included in the appendix.

Table 5.—Description of evaluation units, Southeast Washington, 1981

Evaluation unit	Erosion rate T/A/Y	Sediment rate T/A/Y	Landform description	Primary vegetation
1	.023	.001	Flood plains	Douglas-fir
2	.047	.002	Gently sloping table lands	Douglas-fir
3	.067	.003	Gently sloping table lands	White fir
4	.112	.004	Moderately dissected uplands	Open grassland
5	.127	.006	Gently sloping table lands	Subalpine fir, Lodgepole pine
6	.106	.008	Slightly dissected uplands	Mixed conifers
7	.232	.010	Ridgetops, uplands, side slopes	Alpine fir, White fir, Alder
8	.376	.014	Dissected side slopes	Bunchgrass
9	.658	.010	Extremely dissected side slopes	Bunchgrass, Mixed conifers

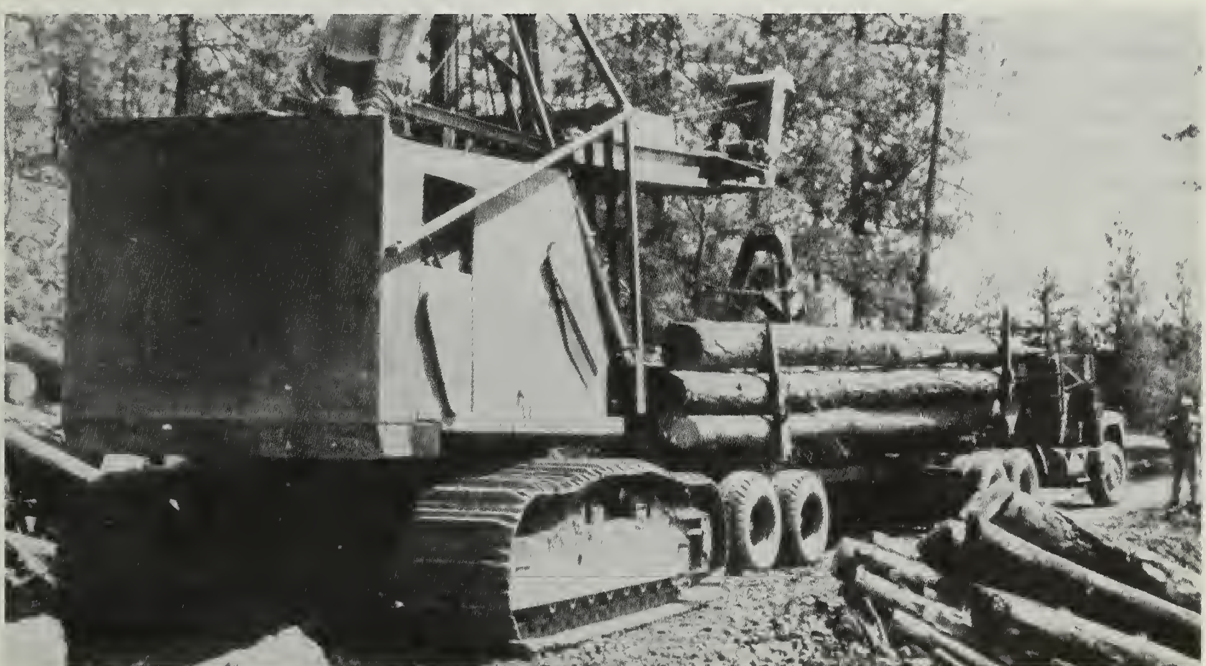
Each evaluation unit has a different productive capacity for total herbage and timber. Forest productivity of the area is shown in Table 6. Although this shows average annual production, much of the area is considered unharvestable, e.g. wilderness areas, inaccessible because of terrain, etc.

Table 6.—Estimated average annual production, undisturbed forested area, Southeast Washington, 1981

Evaluation unit		Estimated annual productivity			
		Herbage		Timber	
No.	Acres	Lb./ac	1,000 lb.	Cu ft./ac	M cu.ft
1	4,224	485	2,049	55	233
2	24,101	334	8,050	54	1,304
3	23,289	262	6,102	54	1,265
4	11,454	289	3,310	33	379
5	8,333	412	3,433	44	367
6	28,452	269-312	8,265	59	1,682
7	89,653	181-289	21,068	34	3,057
8	157,149	302-912	95,389	25	3,867
9	91,995	313	28,794	20	1,831
Total	438,650		176,460		13,985

Source : Oregon Butte Planning Unit Environmental Impact Statement USDA FS, Umatilla National Forest, 1977

M cu. ft.= 1,000 cubic feet.



Approximately 30 million board feet of timber was harvested from the forest in 1981.

STREAMS

Nearly all streams in the study area flow from their headwaters in the Blue Mountains. The lower reaches of these streams are bordered by non-irrigated cropland, rangeland, and in some cases irrigated cropland. Upper reaches are bordered by forest and rangeland. Streams evaluated in the study include Joseph Creek, a tributary to the Grande Ronde River in Asotin County; Asotin Creek and Alpowa Creek, also in Asotin County; Deadman Creek in Garfield County; Pataha Creek in Garfield County; the Touchet River in Walla Walla and Columbia County and the Walla Walla River in Walla Walla County. The Tucannon River was also studied but in much greater detail than other streams in the study area.

Most of the streams in Southeast Washington once supported large populations of anadromous fish. These populations have declined significantly for a variety of reasons including widespread habitat degradation. In some cases, such as Pataha and Deadman Creek, anadromous fish no longer use the streams. Most of the perennial streams in the area support populations of resident fish, at least in the upper reaches. Rainbow trout are stocked in many of the streams by Washington State Department of Game.

IRRIGATED CROPLAND

Irrigated cropland erosion and sediment problems were not studied. Problems of erosion and sediment on irrigated lands are being evaluated in the Yakima River Basin during 1984. Data provided by the Yakima Cooperative River Basin study report will be useful to those interested in planning and applying conservation practices on irrigated lands in this area.

OTHER LAND

These areas are primarily urban areas, railroads, roads and streams. Erosion and sediment problems on roads and streams were included in the study . They are included separately for the non-forested portion of the study area.

Problems

The primary thrust of this study has been evaluation of erosion and sediment problems of the area. Annually, over ten million tons of soil are eroded from the land and over one and one half million tons of sediment enters the stream system. Erosion causes a problem on site as it occurs. These problems can be dramatic and long lasting. When soil moves off site the effects may be even more far reaching.

Soil erosion by runoff is widespread from November through March. Localized high intensity rainstorms can cause heavy runoff and serious soil erosion and sediment problems any month of the year.

Several kinds of soil erosion occur. Sheet and rill erosion affects the largest area and removes the most soil. All slopes of more than 3 to 5 percent are susceptible to sheet and rill erosion under certain weather conditions and land treatments. Soil slips occur on many steeper slopes. Silty clay soils on ridgetops are especially subject to sheet erosion when rain strikes bare ground.

Other basin problems are related to erosion and sedimentation. Stream channel and gully erosion removes soil, deposits sediment on fields, and pollutes the streams. Productivity of cropland is being rapidly depleted as soils erode, increasing the need for fertilizer.

Sediment carries nutrients and pesticides that accumulate in deposition areas or pollute streams. Wildlife and fish populations are adversely affected, and environmental quality of the area is greatly reduced.

Precipitation, soil erodibility, length and steepness of slopes, cropping systems and erosion control practices are major factors that affect sheet and rill erosion.

Runoff, the major cause of soil erosion and sedimentation, results primarily from spring snowmelt. Amounts and intensities of precipitation vary during the growing season. Most runoff occurs when soil is frozen near the surface and water cannot penetrate the soil. The resulting flow of water literally scalps the soil down to the frozen layer and carries large volumes of sediment into the stream system. Considerable lowland flooding, and varying amounts of streambank erosion also are common in the 10 watersheds. The Basin discharges an average of 2 to 3 inches of runoff per acre per year.

The detrimental effects of soil erosion do not end with erosion of valuable topsoil. After soil has been washed from its place of origin, some is deposited after traveling only a short distance and some a considerable distance. Sediment can fill streambeds and lessen their capacity to carry high flood flows.

Only part of the eroded soil is delivered to the stream system. Delivery rates vary from 12 to 90 percent. Stream channel delivery rates are highest because the source originates at the stream. Areas further from the stream have lower delivery rates.

Once sediment is deposited on bottom lands, cropland is damaged. Hydroelectric storage reservoirs on the Snake and Columbia Rivers are filling with sediment deposits. This is depleting their storage capacity, increasing dredging costs and causing a loss of recreation facilities and fish habitat - all of which adds up to millions of dollars in damages. Sediment is significant, not only in terms of voluminous soil loss, but because plant nutrients and other kinds of pollutants are transported with the soil particles.

Sediment delivered to fish spawning areas is a major problem. A detailed study of stream habitat conditions to evaluate effects of sediment on the fishery resource was conducted on the Tucannon River. Less intense studies of stream habitat conditions of other streams in the area were also conducted.

Soil erosion rates on forested areas average only .37 tons per acre per year. However, erosion on forest roads and along streams in the forest are severe problems in some areas averaging over one ton per acre per year.

Problems of erosion and sediment on rangeland are much less severe than on cropland. The extent of these problems were evaluated. However, primary emphasis of the study on rangeland was directed at forage production and ways that the forage resource could be improved.

Table 7 summarizes the amount of erosion occurring by source for each of the watersheds. Sheet and rill erosion accounts for 96 percent of the erosion problem and 91 percent of it occurs on cropland. Table 8 shows the same information for sediment delivered to streams.

Table 7.—Total erosion, by source and watershed, Southeast Washington, 1981

Watershed	Cropland		Rangeland		Forested area				Other areas		Total
	Sheet & rill	Concentrated flow & gully	Sheet & rill	Concentrated flow & gully	Undisturbed	Harvested	Roads	Streams	Roads	Streams	
	1,000 tons/year										
Tucannon-Pataha	808	12	59	2	23	1	2	1	19	9	936
Grande Ronde	1/	1/	20	1/	55	1	3	<1	1/	1/	79 +
Snake	1,651	4	206	2	<1	—	<1	—	3	4	1,870 +
Asotin	152	<1	32	<1	19	3	5	<1	1	2	214 +
Alpowa	244	<1	27	<1	1	<1	<1	—	3	3	278 +
Deadman	415	3	19	<1	—	—	—	--	7	1	445 +
Alkali Flat	495	2	6	<1	--	--	—	—	1	1	505 +
Touchet	3,630	24	19	12	35	2	6	1	24	9	3,762
Dry	1,680	55	3	<1	3	<1	1	<1	3	10	1,755 +
Walla Walla	462	10	12	<1	12	<1	1	<1	6	5	508 +
Total	9,537	111	403	16	149	7	18	3	67	46	10,357
Percent	92	1	4	1	1	1	<1	<1	1	<1	

1/ Area not evaluated.
<1 Less than 0.5
+ Values shown slightly less than actual because of rounding

Table 8.—Total sediment delivered to streams by source and watershed, Southeast Washington, 1981

Watershed	Cropland		Rangeland		Forested area				Other areas		Total
	Sheet & rill	Concentrated flow & gully	Sheet & rill	Concentrated flow & gully	Undisturbed	Harvested	Roads	Streams	Roads	Streams	
	1,000 tons/year										
Tucannon-Pataha	129.3	6.8	11.2	1.1	1.4	0.2	1.0	1.0	9.1	8.5	169.6
Grande Ronde	1/	1/	1/	1/	1.3	0.1	1.2	0.4	1/	1/	3.0
Snake	264.2	1.8	24.7	0.9	1	0	0.1	0	1.3	3.0	296.0
Asotin	24.4	0.2	2.7	0.1	0.5	0.4	1.5	0.2	0.7	1.9	32.6
Alpowa	16.0	0.2	3.7	1	1	1	0.1	0	1.7	3.0	24.7
Deadman	66.4	1.7	2.3	0.3	—	—	—	—	3.7	0.5	74.9
Alkali Flat	79.3	1.0	0.8	0.2	—	—	—	—	0.3	0.8	82.4
Touchet	580.7	11.9	2.3	5.9	0.9	0.2	1.7	0.8	8.6	7.8	420.8
Dry	252.0	28.0	0.3	1	1	1	0.2	0.1	1.0	9.3	290.9
Walla Walla	73.8	5.2	3.2	0.1	0.2	1.0	0.2	0.2	3.2	3.7	89.8
Total	1,486.1	56.8	51.2	8.6	4.3	0.9	6.0	2.7	29.6	38.5	1,684.7
Percent	88	3	3	1	1	<1	1	<1	2	2	100

1/ Area not evaluated.

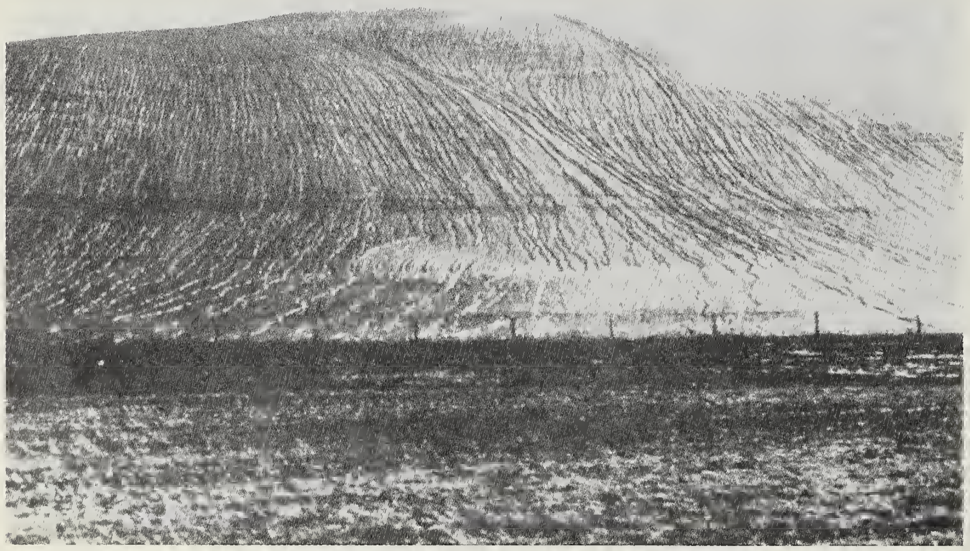
CROPLAND

Under present farming conditions over nine million tons of soil are eroded from fields each year by sheet and rill erosion; an average of 7.85 tons per acre. Over 1.5 million tons of sediment resulting from this erosion reaches streams. A comparison of sheet and rill erosion by watersheds is shown in Table 9.

Table 9.—Sheet and rill erosion from cropland by watershed, Southeast Washington, 1981

Watershed	Tons/year	Tons/ac/year 1/	Allowable soil loss (T)
Tucannon-Pataha	808,191	7	5
Grande Ronde 2/	3,203	3	5
Snake	1,651,075	5	5
Asotin	152,421	3	2
Alpowa	244,000	9	2
Deadman	415,280	5	5
Alkali Flat	495,481	5	5
Touchet	3,629,676	12	5
Dry	1,679,774	13	5
Walla Walla	461,645	8	5
Total	9,536,876	Ave. 8	

1/ Rounded to nearest ton.
2/ Estimation from nearby watersheds.



Fields that are excessively tilled and have few residues on the surface are extremely vulnerable to sheet and rill and concentrated flow erosion during winter months.

Allowable soil loss, (T) the maximum rate of annual soil loss that will permit crop productivity to be obtained economically and indefinitely, is 5 tons per acre on most cropland in the study area. Asotin and Alpowa Watersheds have shallow, fragile soils and the tolerance in these watersheds is only 2 tons per acre per year. Currently, average annual soil erosion rates on cropland in six of the 10 watersheds exceed T. Alpowa, Touchet and Dry Creek are now eroding at a rate of 2 T or more.

Excessive tillage, resulting in destruction of soil structure, compaction and loss of surface residues, especially on steep land, leaves the soil vulnerable to sheet and rill erosion. Erosion on class IVe and VIe land is most severe, averaging 18 to 20+ ton/ac/yr, and difficult to control. Current erosion rates average over 5 tons per acre on much of the non-irrigated cropland (Figure 10). With some cropping and tillage systems, average erosion rates of 25 tons per acre are common, especially in upland areas of watersheds where there is more precipitation and runoff. Fifty-one percent of the soil erosion occurs on class IVe and VIe land which is only thirty-one percent of the total cropland area (Table 10).

Table 10.—Comparison of land area with amount of sheet and rill erosion, class IV and VI land, by watershed, Southeast Washington, 1981

Watershed	Land area class IV and VI	Sheet and rill erosion class IV and VI
	Percent	
Tucannon-Pataha	20	34
Snake	38	53
Asotin	8	5
Alpowa	11	19
Deadman	20	35
Alkali Flat	7	21
Touchet	39	59
Dry	46	62
Walla Walla	32	64
Study area average	31	51

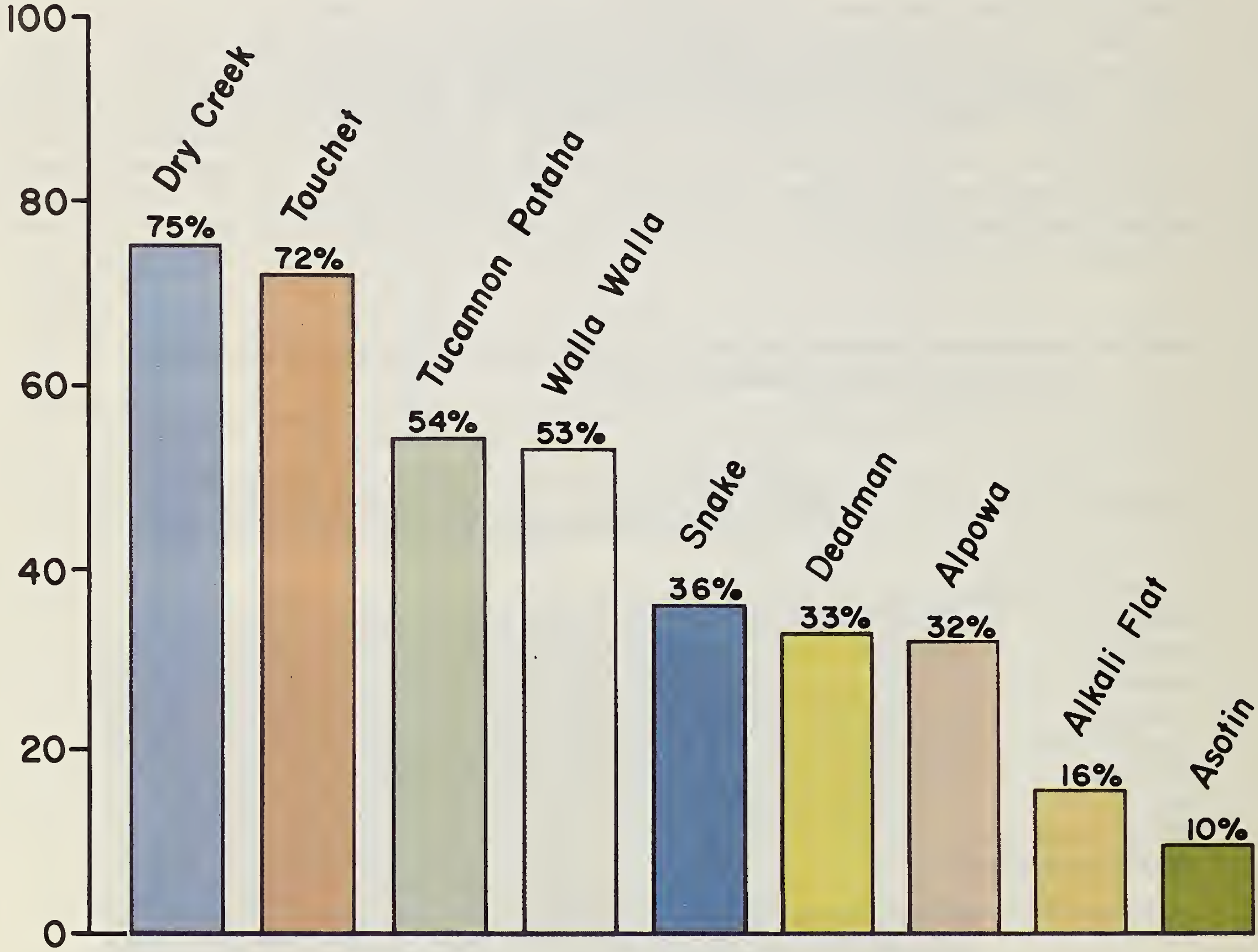


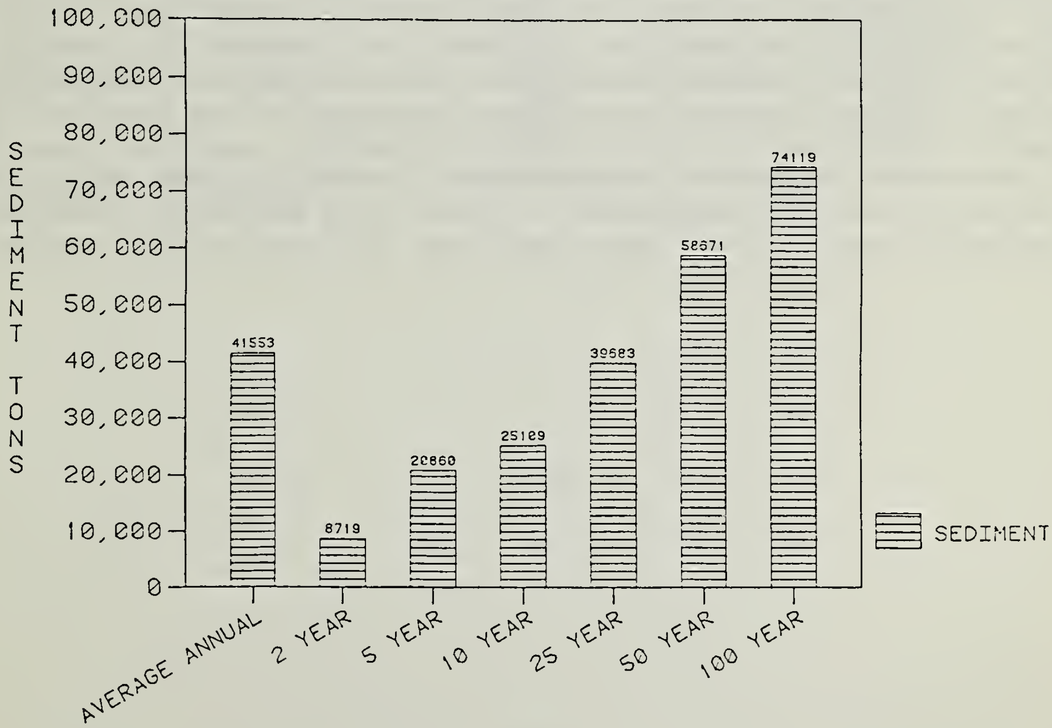
FIGURE 10. -- PERCENT OF NONIRRIGATED CROPLAND AREA WITH EROSION RATE OVER 5 TONS PER ACRE PER YEAR, SOUTHEAST WASHINGTON, 1981.

The extent of sheet and rill erosion problems are sometimes very difficult to visualize. A 5 ton soil loss can not be readily seen - nor can a 10 or 15 ton loss. An erosion loss of 15 tons per acre amounts to an average of only one tenth of an inch of soil. People can therefore be easily lulled into a false sense of security because easily visible erosion occurs only every few years.

As part of a separate watershed study comparisons were made for erosion and sediment for single storm events and average annual measurements. While this is compiled for a stream system it well illustrates how the average annual loss of soil per acre actually occurs.

Although the reduction in erosion and sediment in a watershed may be described on an average annual basis, erosion from occasional, high intensity storms continues. To determine the potential sediment delivery from various storm events, a separate analysis was conducted including 2, 5, 10, 25, 50 and 100 year occurrences. Sediment yield from the Willow Creek watershed of 18,000 acres averaged 41,550 tons per year under present management conditions. Eighty-eight percent of this sediment results from sheet and rill erosion on cropland. By comparison, a single two-year storm event (a storm that on the average occurs once every two years) will produce only 8,720 tons of sediment (20% of the yearly average). A 100 year storm event (see Figure 11) will produce 74,120 tons (178 percent of the yearly average annual sediment). Several storm events may occur during a single year. The average annual is the sum of 100 years accumulation divided by 100.

Figure 11.—Sediment delivery from Willow Creek Watershed resulting from 2, 5, 10, 25, 50 and 100 year storm events as compared to average annual sediment delivery



Concentrated flow and gully erosion accounts for an average annual loss of 110,120 tons of soil from cropland in the basin (Table 11). The amount of this kind of erosion varies significantly between watersheds. The Dry Creek Watershed has the highest rate with a loss of .41 tons per acre per year. Asotin Creek is lowest with only a trace. These broad differences are greatly influenced by topography differences of the watersheds. Farm management also has a significant effect on these erosion rate differences.

Table 11.—Amounts of concentrated flow and gully erosion on cropland areas, by watershed, Southeast Washington, 1981

Watershed	Cropland 1,000 ac	Tons/year	Tons/ acre/year
Tucannon-Pataha	116	11,748	.10
Grande Ronde	1	2/	2/
Snake	310	3,592	.01
Asotin	59	225	t 1/
Alpowa	27	312	.01
Deadman	86	2,814	.03
Alkali Flat	95	1,709	.02
Touchet	314	23,906	.08
Dry	134	55,407	.41
Walla Walla	54	10,407	.19
Total	1,196	110,120	.09

1/ t = Less than .01 tons/acre/year.
2/ Area not evaluated.

This type of erosion creates the same problems as sheet and rill but also has significant impacts of its own. Production is often lost through smothering and voiding but in addition problems are created in farming the land. Concentrated flow erosion and gullies are very hard on equipment--especially combines and grain trucks. Many times inconvenient and more expensive harvest methods or patterns need to be used. Certainly, wear and tear on equipment and operations increases dramatically. Another effect of a gully is the depletion of the soil base around it when it is filled in. The erosion effect on production may be many times wider than the area actually voided.

The long-term economic importance of soil erosion can be measured by adverse effects it has on yields and unrealized farm income. Loss of an inch of topsoil in the Southeast Washington area can reduce wheat yields by 2 bushels per acre. Average annual soil loss is 8 tons per acre (0.05 inches) with a range of from .03 tons to nearly 40 tons per acre. With an erosion rate of 40 tons per acre, the annual soil loss is approximately 0.26 inches.

Technology has masked the effect of severe past erosion. The combination of higher yielding grain varieties, higher commercial fertilizer application rates, improved tillage, and better chemical weed control sprays should have produced even higher yields than are now produced on the eroded areas.

Although productivity losses for a single year may seem small, they accumulate over time. These long-term losses, over a twenty-year period, total nearly $40 million (Table 12). A high percentage of this loss (approximately 40%) occurs on class IV and VI land (31% of the cropland area).

Table 12.—Present value of potential productivity loss over 20 years due to sheet and rill erosion by watershed, Southeast Washington, 1981

Watershed	Cropland	Productivity lost
	1,000 acres	1,000 dollars
Tucannon-Pataha	116	3,425
Grande Ronde	a/	a/
Snake	310	5,808
Asotin	59	564
Alpowa	27	470
Deadman	86	1,891
Alkali Flat	95	1,934
Touchet	314	16,073
Dry	134	7,834
Walla Walla	55	1,663
Total	1,196	39,662

a/ Area not evaluated

RANGELAND

Sheet and rill erosion currently occurs at a rate of 1/2 ton per acre per year for a total annual loss of about 403,000 tons of soil. This amounts to 24 percent more erosion than would occur if all rangeland was in excellent ecological condition. Concentrated flow and gully erosion totals over 16,000 tons per year. Higher erosion rates can be expected on poor range during winters that follow a year of below average precipitation since poor condition rangeland, dominated by annual plants, furnishes less cover. Erosion and sediment rates on rangeland are much lower than cropland. Since the rates are very low, study emphasis was placed on ways to improve conditions of forage resources and evaluation of the impact changes would have on the economy. Range is in a deteriorated condition and 73 percent of it is in only poor or fair ecological condition. It is producing at 43 percent of its potential.

Low producing range has depressed many ranch incomes and many ranches are marginal or losing money. If they can improve production while holding their fixed costs constant there is a dramatic opportunity to increase net income while paying for the increased variable costs.

Plants are the key to use and management of rangeland. Production for grazing land is based on the amount and quality of plants. Although plants are managed mainly through the manipulation of grazing and browsing animals, such management should also be based on plant needs. Prolonged heavy grazing use impairs plants and they become less vigorous, less competitive and more susceptible to damage by drought, heat, insects or disease. Plants with continued heavy grazing eventually die or are replaced by other less desirable plants including noxious weeds. As this kind of use continues annuals and non-preferred plants invade the areas formerly occupied by desirable plants. Overgrazing reduces plant cover causing increased runoff, erosion and sediment. The loss of soil moisture and soil reduces and changes the capability of rangeland to produce forage. Once rangeland has been locally depleted, it may take many years with proper management for it to return to its climax state. In some cases a climax state may be irretrievable.

FORESTED AREA

Forest land management, including conversion of timbered areas to dryland crops and rangeland, has changed erosion and sediment patterns in the forested area. Current average annual erosion from the forested area is 177,083 tons. The average annual sediment yield to streams is 13,981 tons. Average erosion rates for all sources in the forested area is .368 tons/acre/year (T/A/Y) and the average sediment rate is .029 T/A/Y. These rates are very low compared to cropland and rangeland.

Water quality in the forested area is higher than in rangeland and cropland areas. State water quality standards are also higher. Therefore, an amount of sediment from the forested area will have a much higher significance than a similar amount of sediment from cropland. For example, headwater streams in the basin must meet or exceed Washington State class AA (extraordinary) water quality standards while many streams outside the forested area are class B (good) waters.

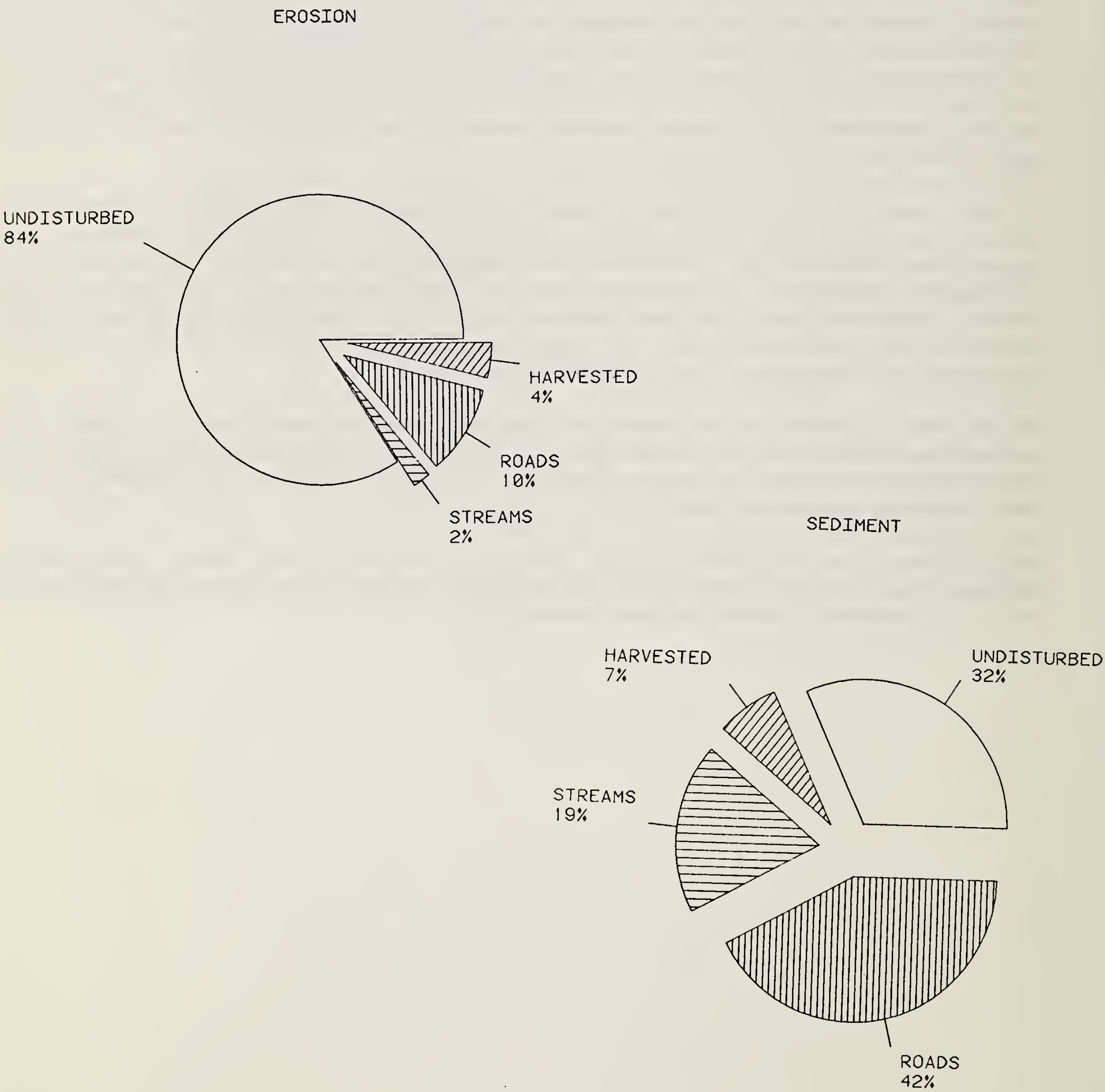
Although waters in the forested area are generally much cleaner than those in other areas, they may not meet class AA standards. To apply agriculture reach (class B) standards to forested area (class AA) waters is a violation of Washington State law. It is important to understand basic concepts of water quality standards by individual stream reach when developing watershed plans. Water quality standards can be found in Chapter 173-201 WAC Water Quality Standards for Waters of the State of Washington.

Within the forested area there are erosion and sediment sources that yield rates that exceed state water quality standards. These are generally sites that require treatment to accomplish reductions in erosion and sediment by the most cost efficient methods.

The highest erosion rates in the forested area are from roads and streams. Although roads occupy less than one percent of the area, over ten percent of the total erosion occurs in these areas.

Sediment rates are also highest from roads and streams. Forty two percent of the total sediment delivered to streams comes from roads. Eroding stream channels contribute 19 percent of the total sediment. Roads in the Pataha and Dry Creek watersheds are the highest contributors of sediment. Stream channels in the Tucannon, Pataha, and Touchet Watersheds are major contributors of sediment (Figure 12).

Figure 12.—Percent of erosion and sediment by source, forested area Southeast Washington, 1981



A summary of erosion and sediment data for the entire forested area is shown in Table 13. This table shows that roads have the highest erosion rates and produce more sediment than any other source. Streams have highest sediment rates and undisturbed areas produce the largest amount of erosion. Undisturbed areas have higher erosion rates than harvested areas since they are usually located on steep slopes and are protected from erosion only by grass, forbs, shrubs and a few trees. Detailed inventory information about erosion and sediment sources is included in the individual watershed reports.

Table 13.—Erosion and sediment by source, forested area, Southeast Washington, 1981

Source	Area	Erosion		Sediment	
	Acres	T/A/Y	T/Y	T/A/Y	T/Y
Undisturbed areas	438,650	0.3	148,560	0.010	4,416
Harvested areas	38,012	0.18	6,974	0.025	944
Roads	2,973	6.89	18,102	1.985	5,901
Streams	813	4.24	3,447	3.200	2,719
Total	480,448 1/	0.38	177,083	0.029	13,981

1/ 36 acres of lakes are not included in this area.

Additional understanding of problems concerning erosion and sediment can be obtained by comparing rates by sources by watershed. Nine watersheds in the area of study have a forested area. A summary of data by watershed is shown on Table 14 and Figures 13 and 14. Pataha Creek Watershed has the highest sediment rate and the second highest erosion rate. Figure 15 shows a close correlation between road density and sediment rate. Only a very weak correlation exists between area harvested and sediment rate. Road density appears to have the strongest effect on sediment of any of the sources inventoried.

Table 14.—Erosion and sediment by source, by watershed, forested area, Southeast Washington, 1981

Watershed	Area		Erosion			Sediment		
Source	Acres	Percent	T/A/Y 1/	T/Y 2/	Percent	T/A/Y	T/Y	Percent
Tucannon								
a. Undisturbed	69,645	95	0.28	19,323	88	.008	567	33
b. Harvested	2,745	4	0.21	568	3	.029	79	5
c. Roads 3/	410	4/	2.66	1,090	5	.907	372	22
d. Streams	203	4/	4.24	861	4	3.394	689	40
Total 5/	73,403	100	0.30	21,842	100	.023	1,707	100
Pataha								
a. Undisturbed	9,853	73	0.41	4,072	63	.085	835	47
b. Harvested	3,214	24	0.24	758	12	.033	107	6
c. Roads	464	3	2.81	1,304	20	1.248	579	32
d. Streams	53	4/	6.58	349	5	5.189	275	15
Total 6/	13,584	100	0.48	6,483	100	.132	1,796	100
Grande Ronde								
a. Undisturbed	149,971	96	0.37	55,154	92	.009	1,276	43
b. Harvested	5,126	3	0.16	823	1	.021	107	4
c. Roads	463	4/	7.51	3,475	6	2.549	1,180	40
d. Streams	167	4/	2.95	492	1	2.323	388	13
Total	155,727	100	0.38	59,944	100	.019	2,951	100
Snake								
a. Undisturbed	3,125	99	0.08	262	49	.005	17	17
b. Harvested	0	0	0	0	0	0	0	0
c. Roads	41	1	6.63	272	51	2.073	85	83
d. Streams	0	0	0	0	0	0	0	0
Total	3,166	100	0.17	534	100	.032	102	100
Asotin								
a. Undisturbed	67,635	81	0.28	19,174	70	.008	514	20
b. Harvested	15,048	18	0.19	2,862	10	.023	391	15
c. Roads	626	4/	7.80	4,881	18	2.326	1,456	56
d. Stream	101	4/	4.16	420	2	2.257	329	9
Total	83,410	100	0.33	27,337	100	.032	2,690	100
Alpowa								
a. Undisturbed	3,822	87	0.31	1,174	77	.008	31	24
b. Harvested	504	12	0.16	78	5	.020	10	8
c. Roads	44	1	6.39	281	18	2.000	88	68
d. Streams	0	0	0	0	0	0	0	0
Total	4,370	100	0.35	1,533	100	.029	129	100
Touchet								
a. Undisturbed	101,524	90	0.34	35,024	81	.009	873	24
b. Harvested	10,773	9	0.17	1,790	4	.022	237	6
c. Roads	728	4/	7.63	5,554	13	2.389	1,739	48
d. Streams	216	4/	4.65	1,005	2	3.657	790	22
Total	113,241	100	0.38	43,373	100	.032	3,639	100
Dry Creek								
a. Undisturbed	6,408	96	0.44	2,816	79	.009	58	16
b. Harvested	201	3	0.16	32	4/	.020	4	1
c. Roads	79	1	7.63	603	17	2.468	195	56
d. Streams	17	4/	7.47	127	4	5.706	97	27
Total	6,705	100	0.53	3,578	100	.053	354	100
Walla Walla								
a. Undisturbed	26,667	98	0.43	11,561	93	.009	246	40
b. Harvested	401	1	0.16	63	4/	.020	8	1
c. Roads	118	4/	5.44	642	5	1.763	208	34
d. Streams	56	4/	3.45	193	2	2.696	151	25
Total	27,242	100	0.46	12,459	100	.023	613	100
Total study area	480,484		0.37	177,083		.029	13,981	

1/ T/A/Y is Tons per acre per year.
2/ T/Y is Tons per year from the source area.
3/ Roads includes trails.
4/ Indicates less than 1 percent.
5/ There are 34 acres of lakes included in total acreage but not included in the individual sources.
6/ There are 2 acres of lakes included in total area but not included in the individual sources.

Figure 13.—Comparison of erosion rates by watershed, forested area, Southeast Washington, 1981

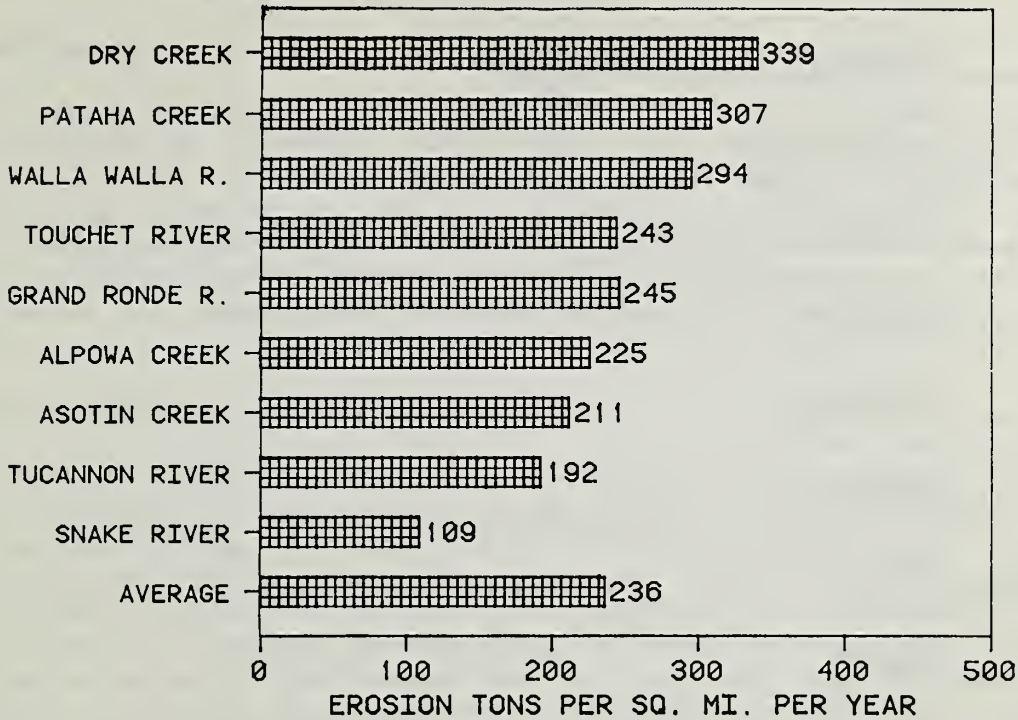


Figure 14.—Comparison of sediment rates by watershed, forested area, Southeast Washington, 1981

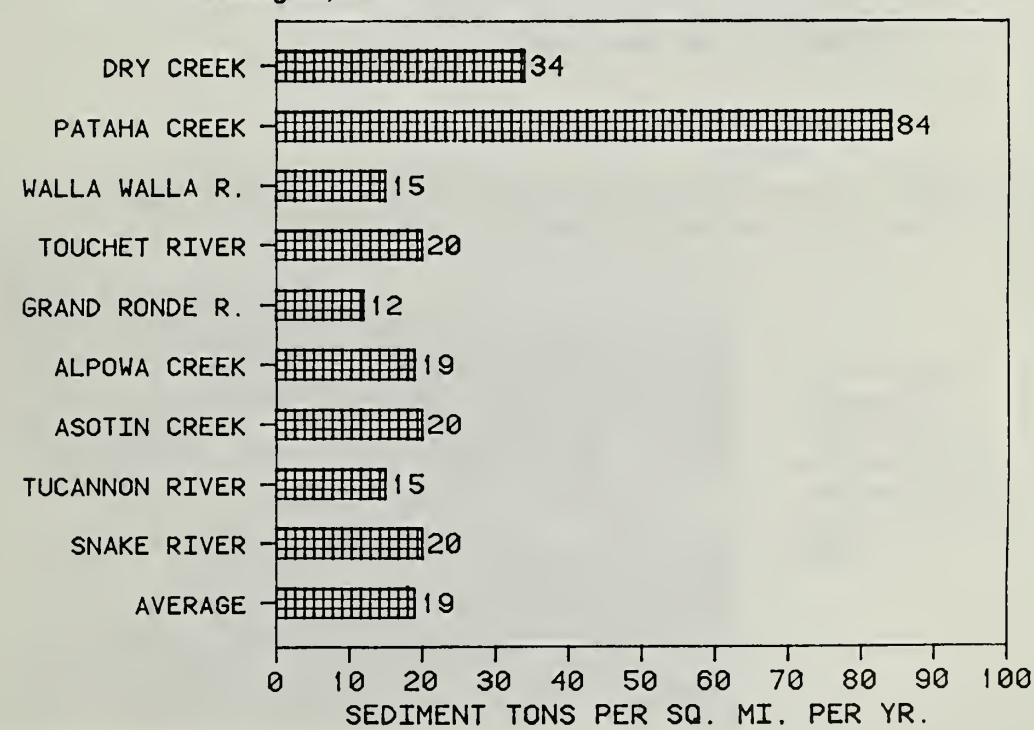
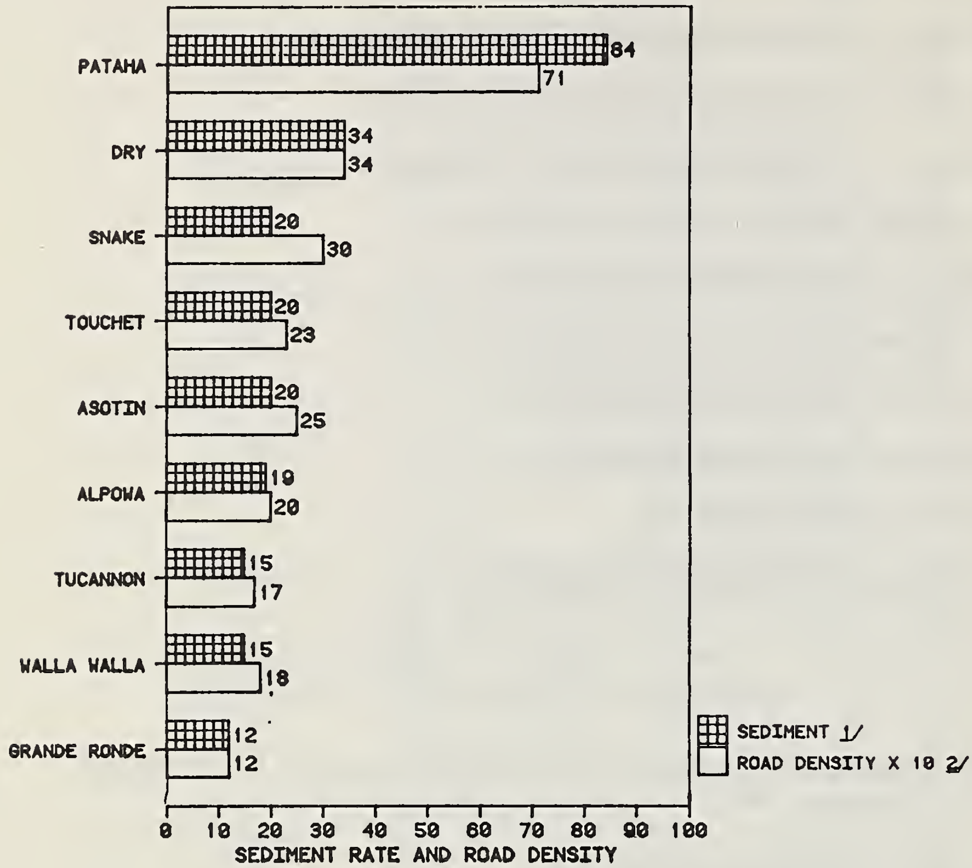


Figure 15.—Comparison of sediment rates and road density by watershed, forested area, Southeast Washington, 1981



1/ Sediment is expressed in tons per square mile per year.
2/ Road density is miles of road per square mile.

OTHER LAND

Roadbank Erosion

There are over 2,000 miles of roads in the non-forested portion of the study area. 800 miles of roadbanks along these roads have erosion problems. A total of 67,434 tons of soil is lost from these areas by erosion each year. Erosion problems along roads are most severe in areas where banks are very steep and lack vegetation. Erosion increases along roads following road ditch cleanout operations and in areas where farming operations are performed on or near the banks in a manner which disturbs existing vegetative cover.

Streambank Erosion

In the Southeast Washington River Basin there are 6,373 miles of streambanks in the non-forested portion of the study area. About 662 miles of these streambanks have erosion problems (11% of the total length). The 662 miles of eroded streambanks lose a total of 45,820 tons of soil each year. Streambank erosion is most severe in those areas where vegetative cover including grasses, trees and shrubs, are lacking. Erosion is most pronounced along streams where bends in the channel occur. Loss of channel vegetation is usually most pronounced in areas where livestock are allowed to graze the stream corridor or where natural vegetation has been removed mechanically or with herbicide sprays.

In some areas such as this along Dry Creek long time stream-bank erosion can have catastrophic effects.

Stream Habitat Condition

Through evaluation of streams the study team has found the lower reaches are in generally poor condition for supporting anadromous or resident fish populations. In general, habitat quality improves in the upper reaches. Poor habitat quality is generally the result of poor instream structure, the lack of adequate riparian vegetation, accelerated sediment deposition and elevated stream temperatures.

There have been profound changes in the channel and riparian zone of most streams during the past 40 to 50 years. Many streams have changed from a predominately meandering pattern to one that is primarily braided. These changes are largely the result of destruction of riparian vegetation, stream channelization, and increases in peak runoff caused by conversion of watershed cover to cropland. Often the channels are steeper and shorter depending on the amount of change that has occurred. Woodland areas on the valley floors have been sharply reduced, as much as 50 percent, by encroachment of other land uses. Wooded banks which shade the streams and stabilize the channel have been reduced significantly. These changes in channel configuration have caused the channels to be wider and shallower with swifter and warmer flows. The beds of the stream have become more mobile and snags, boulders, and fallen trees are much less abundant. Long pools and beaver ponds have disappeared or been reduced to a small fraction of their former value. These changes have adversely affected spawning and rearing habitat values.

The proportion of pools in relation to stream riffles and glides is generally very low. The lack of pools is a major constraint to the rearing of juvenile salmon and steelhead. Juvenile steelhead and salmon would benefit from an increase in the number or volume of pools. More pools would also help reduce maximum daily temperatures.

Sediment which accumulates in the streambed not only fills ponds and accelerates braiding but also lowers the quality of these streams for fish reproduction. Fine sediment deposition is abnormally high in the lower reaches of nearly all streams. The major source of this sediment is soil erosion on cropland adjoining the streams although in some areas erosion of streambanks and roadbanks is a major source of sediment in the stream. The deposition of fine sediment in the gravel substrate also significantly reduces the production of food upon which juvenile salmon and steelhead are dependent.

Considerable time was spent studying the effects of sediment on intra-gravel dissolved oxygen levels in the Tucannon River. Survival of salmon and steelhead eggs and sac-fry requires oxygen levels above 6 parts per million. The quantity of intra-gravel dissolved oxygen is dependent on water temperature, the amount of organic matter in the gravels, and to a large extent the amount of fine sediment. At higher temperatures water will hold fewer parts per million of oxygen. At higher water temperatures more decomposition of organic matter occurs which in turn removes more oxygen from the water. If the pores in the gravel are clogged with fine sediment the flow of oxygenated water through the gravel past the eggs is impeded.

Intra-gravel dissolved oxygen levels in the Tucannon River were found to be good in the upper reach, grading from fair to poor in a downstream direction in the mid-reach, and always poor in the lower reach. It is probable that similar conditions occur in other streams in southeast Washington.

A 60 percent reduction in sediment deposition in the intragravels in one mid and lower reach of the Tucannon will result in an increase of approximately two to six parts per million of oxygen. This increase will raise the mid-reach into a "good" egg incubation category. Approximately 2 to 3 times more fish eggs can be incubated successfully with this magnitude of improved spawning conditions. This could result in 2 to 3 times more juvenile fish and ultimately 2 to 3 times more adult fish - assuming that other stream habitat components are suitable to support all other stages of their life cycles and that sufficient numbers of adult fish return to spawn. These relationships will probably hold true in other streams such as Alpowa and Asotin Creek and the Touchet River.

Unfortunately, increased numbers of juvenile fish will not result in increased numbers of adult fish because of another major limiting factor. At present, approximately two-thirds of the Tucannon River below the forested area boundary is too warm in the summer to provide a rearing area for juvenile salmonoids. As a result, the Tucannon River is producing young fish at only about one-third of its potential below the forest boundary.

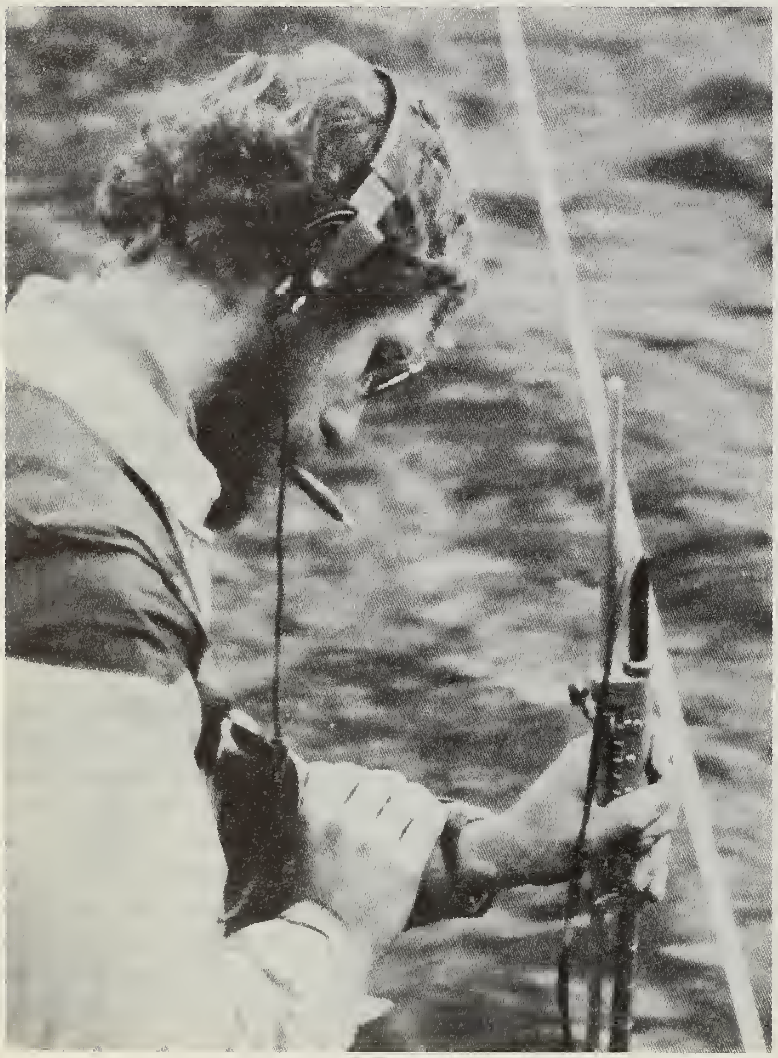
Elevated water temperatures in the Tucannon River and other southeastern Washington streams can be largely attributed to loss of riparian vegetation which shades the water. Much riparian vegetation has been lost to livestock grazing, cultivation, and stream channelization. For example, on the Tucannon River, wooded streambanks have been reduced in various segments from 88 to 52 percent between 1937 and 1978. Similar conditions were found in other area streams.

As shown in Table 15, high sediment levels and high water temperatures are major problems in all streams of the study area. General habitat conditions in most streams are only fair to poor.

Table 15.—Stream habitat conditions below the National Forest Boundary, Southeast Washington, 1981

Stream	Length Inventoried	Sediment			Water temperature			Habitat condition[1/]		
		Stream reach			Stream reach			Good	Fair	Poor
	Miles	Lower	Mid	Upper	Lower	Mid	Upper	-----	Percent	----
Tucannon	38	High	Med	Low	High	Med	Low	0	29	71
Pataha	45	High	High	Med	High	High	Med	0	29	71
Alpowa	18	Med	Med	Low	High	High	Med	0	18	82
Asotin	58	Med	Low	Med	High	High	High	0	48	52
Deadman	39	High	High	High	High	High	High	0	21	79
Touchet	90	High	High	Med	High	High	Med	19	39	42
Walla Walla	50	High	Med	Low	High	High	Med	0	19	81

1/ Good = stream habitat suitable for salmonoids to complete their life cycl
Fair = production potential for salmonoids is reduced over natural conditions, or habitat is available for only a portion of the life cycl - i.e. - suitable for spawning but unsuitable for rearing.
Poor = habitat unsuitable for all stages of salmonoid life cycles.

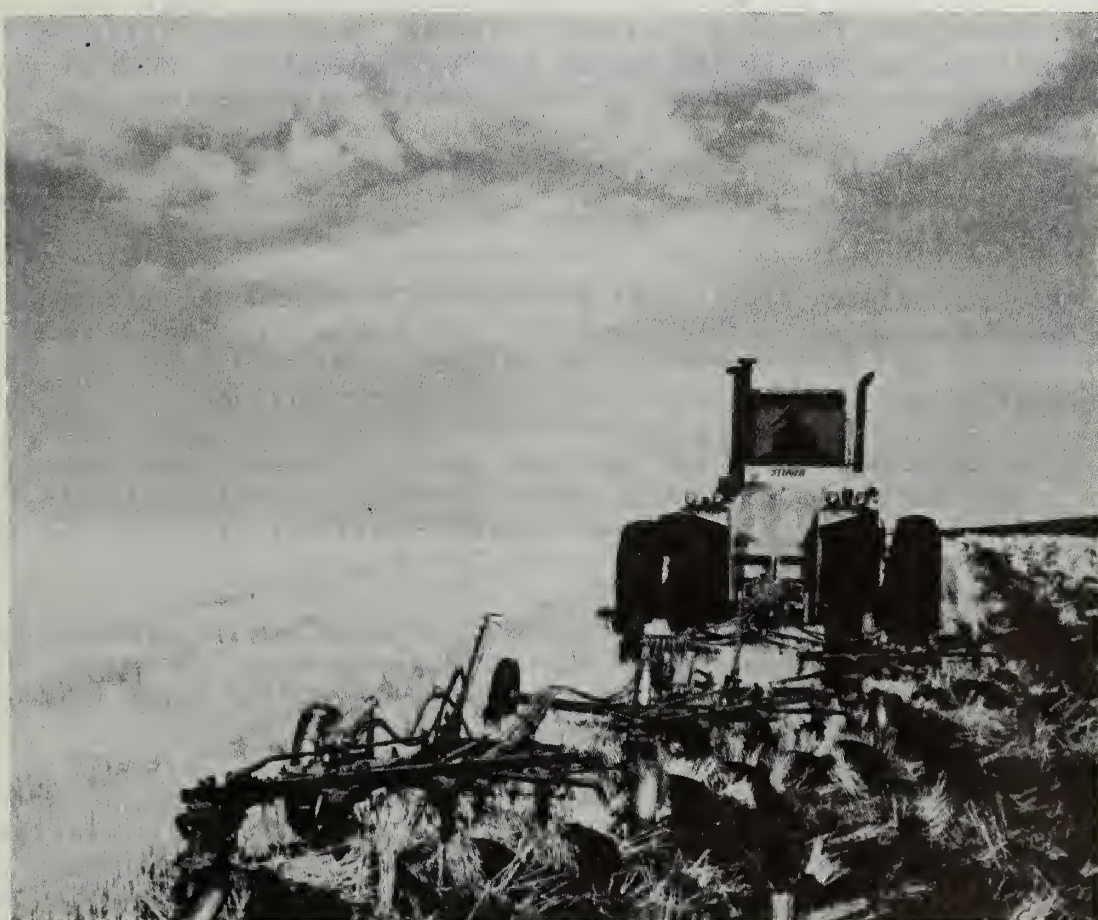


Stream habitat studies show that high sediment levels and high water temperatures are major problems for fish in streams of the area.

Alternatives

Alternative solutions to basin problems have been developed for the major land use areas. In this way those interested in cropland can find the alternative, and comparisons analysis in one place. This is also true for rangeland, forest areas, other areas and the stream corridor analysis.

Because of the nature of the resources and available data the alternatives studied varied for the several land use areas. This is explained in each section and further detail is available in the appendix.



Alternative solutions to basin problems have been developed for each of the major land use areas.

CROPLAND

So far the study has shown that erosion is predicted to average eight tons per acre in the basin if farming continues "as usual". Erosion is above tolerance levels in six of the ten watersheds and specific areas in the remaining four will exceed tolerance (5 or 2 ton T). What can be done? Are there solutions that will reduce erosion effectively? Can a farmer have flexibility in crops he grows and the conservation practices he uses? In this section are some of the answers to these questions.

Unless a farmer is willing to move to another area, he must farm the soil he has. North-south or east-west field exposures and length and steepness of slope have been formed by nature. Climate, more specifically precipitation, has patterns over which the farmer has little control. Each of these natural factors affects how, when and to what extent erosion occurs.

The farmer usually has control over how he uses and manages the land, kinds of crops, sequence for growing them, tillage practices, planting times, residue use and erosion control.

Management includes a series of interacting decisions to influence achievement of the farmer's goal. Each decision has a specific impact--good or bad--on erosion rates. Each decision also affects other decisions in a complementary or negative way that may even cancel out other decisions.

If soil conservation is an important goal, a farmer must make the kind of management decisions that will reduce erosion to desired levels. Management systems selected must be tailored to the individual farm; to the crops grown, soils, topography and climate.

This study has determined what rates of erosion can be expected from various crop rotations and conservation practices anywhere in the basin. Soil erosion rates differ for each of the four major precipitation zones and for the land capability classes within each precipitation zone.

Since some conservation practices, cropping systems and combinations thereof, are more effective than others in reducing soil erosion, those that are most effective have become the primary tools used in the analysis to achieve the desired objectives. Effectiveness of the practices and cropping systems was measured not only on their ability to reduce soil erosion but also on their costs in relation to other practices. Erosion rates shown in table 16 are not specific to sites. They are based on averages from field data collected in the study. Actual erosion rates will vary due to site, climate, management, cultural and similar influences.

In planning a conservation program a farmer must first decide what crops to grow and in what sequence. The annual precipitation of the area in which his farm is located has major significance on the practical choices available to him. A cropping system that is selected will have major impacts on potential erosion rates (Table 16). No conservation management (as used in this table) reflects a field condition with low surface residue, late fall germination, and farming without regard to the slope of the land.

Table 16.—Predicted average annual erosion rates by cropping system by precipitation zones with no conservation management, Southeast Washington, 1981

Precipitation zone	Cropping system	Erosion rate
		Tons/acre
Less than 12"	Wheat-fallow	7
	Seedout	0.1
12 - 15"	Wheat-fallow	13
	Wheat-barley-fallow	8
	Annual barley	4
	Seedout	0.1
	Hay and pasture	0.3
15 - 18"	Wheat-fallow	17
	Annual wheat	11
	Wheat-pea	19
	Wheat-barley-fallow	5
	Seedout	0.3
	Hay and pasture	0.3
18" +	Wheat-fallow	17
	Annual wheat	7
	Wheat-pea	20
	Wheat-barley-fallow	10
	Seedout	0.3
	Hay and pasture	0.3

As shown in Table 16, predicted soil erosion rates will vary significantly between different cropping systems within each precipitation zone and between the same cropping system in different precipitation zones. There are several reasons for these differences.

Management of crop residues is one of the most important factors in erosion control. Cropping systems such as annual grain, which produce crop residues each year, provide more protective cover than wheat-fallow systems. Increased amounts of protective cover help reduce erosion. Another factor is tillage. Annual grain crops usually receive much less tillage than systems with summer fallow. More tillage usually results in a finer soil surface and a greater possibility of erosion. Annual grain crops use most of the precipitation received and provide a soil profile that can hold winter moisture. A cropping system such as grain-fallow provides a soil profile that is partially filled with moisture that it receives during spring and summer. Fallow ground, which has not had a crop on it the previous year, is often unable to hold all of the precipitation it receives during winter. Consequently, runoff and erosion are more likely to occur. Fallow ground with little residue usually freezes harder and deeper.

Two major factors can be attributed to differences in erosion rates on similar cropping systems in different precipitation zones: amount of precipitation and topography.

Erosion rates are higher in the 15-18 inch precipitation zone than the 12-15 inch precipitation zone. Erosion rates for annual grain are lower in the over 18 inch precipitation zone because more crop residues can be produced than in the 15-18 inch precipitation zone. Less crop residue is produced in the 12-15 inch precipitation zone but erosion rates are lower because of more moderate topography and less annual precipitation. Extremely steep topography in much of the 15 to 18 inch precipitation zone also contributes to the high erosion rates in this area (Table 16).

These erosion rates are predicted for crop rotations with "no conservation management". Different conservation practices have different levels of effectiveness in reducing erosion. Conservation practices are used in the study area to control erosion, maintain soil productivity, conserve water, protect plants and generally improve soil, water, and plant resources. These practices are not equally effective in reducing soil erosion on varying land classes. Class IIe and IIIe land may not require those practices which are necessary on steeper class IVe and VIe lands.

Conservation practices evaluated in the study include: Minimum tillage (for annual grain rotations), stubble mulching (for summerfallow), stripcropping, divided slope farming, terraces and no-till farming, A description of each of these practices can be found in the glossary. The average rate of erosion reduction resulting from each of these practices is shown on Table 17.

Table 17.—Percent erosion reduction by conservation practice by precipitation zone, Southeast Washington, 1981

Conservation practice	Precipitation zone			
	Less than 12"	12-15"	15-18"	over 18"
	Percent reduction			
Minimum tillage or stubble mulch 1/	70	75	75	68
Cross slope farming	25	13	13	13
Stripcropping	64	52	52	50
Divided slopes	56	35	35	35
Terraces	37	41	44	49
No-till	87	95	94	94

1/ With residue level greater than 1,000 pounds per acre on the surface.

Different conservation practices have different levels of effectiveness in reducing erosion.

Minimum tillage and stubble mulch can be very effective when adequate crop residues are retained on the soil surface (over 1,000 lbs per acre for effects shown in Table 17). The study shows that cross slope farming, stripcropping and divided slope farming are more effective in the low precipitation zone. Minimum tillage, stubble mulch farming, terraces and no till farming are more effective in the higher precipitation zones. Terraces can be very effective in controlling erosion when they can be used. However, much of the land is not suitable for terracing because of steepness of the topography.

Although conservation practices are shown separately in Table 17 they are often used in combination one with another. The combined effect will provide even greater erosion control benefits which may be needed to protect the soil resource by meeting soil loss tolerance levels, maintaining acceptable water quality, and achieving desired ecological and management levels for selected resource uses.

We know we can reduce erosion on an individual acre! What happens though when we try it on a large area - a watershed or an entire basin? With change there are numerous causes and effects that may be positive or negative. In the study analysis of alternatives was designed to develop comparison data such as:

- Amounts of farm products produced
- Erosion amounts
- Sediment production
- Long term soil productivity
- Fuel use
- Fertilizer use
- Labor requirements
- Gross receipts
- Costs
- Net returns
- Level of risk

Alternatives for change are many and varied. Originally 12 alternatives were selected and studied in an effort to find those things that make significant impacts. Many of the 12 did not reflect major differences and were discarded. Seven alternatives were selected for comparison. These are:

1. Present situation
2. Maximum net income
3. Maximize net income with limited cropping system shifts as effected by factors such as the influence of weather risks and commodity programs.
4. Reduce erosion to soil loss tolerance level (T objective on every acre).
5. T level-limited cropping system shifts as in alternative 3.
6. T level-present cropping system.
7. Minimum erosion.

The present situation alternative is just that. It is an analysis of what is on the land now - the cropping pattern and amounts of various conservation practices now in place.

The maximum net income alternative meets the NED (National Economic Development) objective. The cropping patterns and conservation practices selected were geared to maximize the farmer's net income.

The soil loss tolerance rate alternative is based on the objective of treating each acre to achieve highest net returns while protecting the resource base. Eight of the watersheds were formulated to 5 ton T and two were formulated to 2 ton T.

The minimum erosion alternative is considered to meet environmental quality objectives. Its goal was to reduce erosion to the absolute minimum and had no cropping pattern, practice or economic constraint.

Alternatives 3, 5, and 6 are the same as listed above except acreages of crop shifts were constrained. It is important to understand the rational for these constraints in that they may reflect the reality of not being able to make large cropping pattern shifts in the future. Annual precipitation, available soil moisture, expected prices, market demand, preferences and personal habits, available machinery, labor, capital, lease arrangements, changing commodity programs, level of skills and management ability can all have a major effect on the amount of shifts in cropping systems that can be expected

Much of the basin receives limited rainfall and in these areas farmers use a typical two year cropping system of wheat-fallow. Farmers include summerfallow to reduce risk of crop failure or yield reduction, to control weeds and to meet acreage requirements of farm programs. The wheat-fallow system is generally considered essential in areas of the basin where annual precipitation averages less than 12 inches. Three year, wheat-barley-fallow cropping systems are common where annual precipitation exceeds 15 inches. Difference between watersheds in relation to precipitation received is shown in Table 18.

Cropping and tillage systems used in the area differ with different precipitation zones.

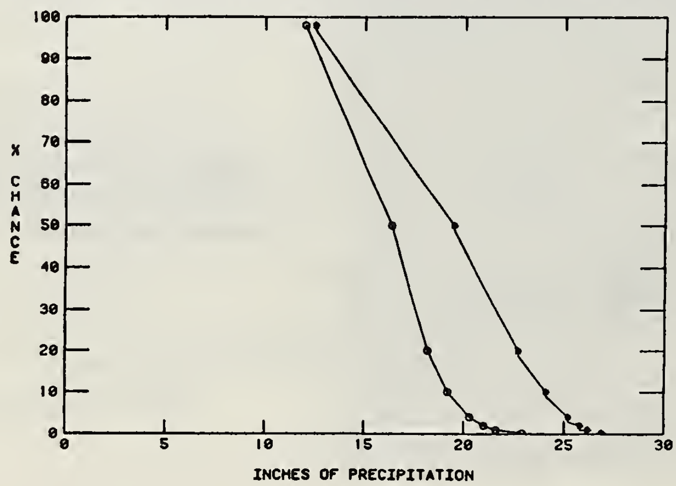
Table 18.—Percent of cropland by precipitation zone and watershed, Southeast Washington, 1981

Watershed	Precipitation zone			
	Under 12"	12-15"	15-18"	Over 18"
	Percent			
Tucannon-Pataha	9	29	47	15
Snake	44	25	25	6
Asotin	0	78	6	16
Alpowa	0	21	11	68
Deadman	1	18	43	38
Alkali Flat	0	78	22	0
Touchet	15	21	38	26
Dry	6	30	23	41
Walla Walla	34	23	14	29

Proper use of herbicides and proper timing of tillage operations will usually provide adequate weed control. Acreage control programs varied dramatically in past years and may continue to play a key role in decisions made by farmers regarding cropping systems. The risk of inadequate moisture in any one year, especially at lower elevations, is also very real.

To determine the extent of risk related to annual precipitation, rainfall records at Dayton and Pomeroy weather stations were evaluated. Average annual precipitation during the past 50 years at these stations is 16.5 inches at Pomeroy and 18.5 inches at Dayton (Figure 16). Analysis shows that during the period of record 16.5 inches were received 54 percent of the time at Pomeroy and nearly 80 percent of the time at Dayton. Data also shows that precipitation equal to or in excess of 12.5 inches can be expected 98 percent of the time at both locations.

Figure 16.—Precipitation for Dayton * and for Pomeroy o



To produce a wheat crop each year an adequate supply of available moisture is needed in the soil profile. Four inches of available soil moisture is needed to produce a wheat plant. An additional inch is needed to produce each seven bushels of wheat. Therefore, the total available moisture supply in the root zone (5-6 feet) is the key to a profitable crop.

Many factors influence the moisture available to crops once precipitation reaches a field. Moisture is lost through runoff, evaporation, transpiration and deep percolation. Tillage, rainfall intensity, soil condition, weeds temperature, and numerous other factors influence this dynamic relationship. In the Dayton-Pomeroy area tests conducted by soil testing laboratories indicate that an average loss of five to seven inches can be expected from most fields. Table 19 provides a general guide of potential crop production based on an average loss of six inches of moisture per year.

Table 19.—Relationships of average precipitation received, available moisture and potential winter wheat and spring barley yields (based on 6 inch total moisture unavailable for crop), Southeast Washington

Precipitation received	Moisture available	Potential winter wheat yield	Potential spring barley yield
Inches/yr	Inches	Bushels	Lbs.
12	6	14	700
14	8	28	1,400
16	10	42	2,100
18	12	56	2,800

The time of year when precipitation is received is also important. Spring rains are important to winter wheat and especially important to spring planted crops. Weather station data indicated that 40 percent of the total precipitation can be expected to fall during the months of February through June 74 percent of the time.

To assess the risk of annual cropping compare Figure 16 with Table 19. Assume that the farmer perceives that his farm must produce 42 bushel per acre to be profitable. In Pomeroy, he has a 55 percent chance of making his crop and to him this is too great of a risk. In Dayton, with a 75 percent chance for a profit, it may be well worth the risk to annually crop part or all of his land.

Moisture available in the fall is a key factor in addition to the expected annual rainfall. The greater the amount of available moisture in the soil profile going into the fall season the less the risk will become.

The second major influence on the constrained alternatives was the reality of some of the various farm programs. Some U.S. farm programs were instituted to help farmers stay economically sound. They have dealt with problems of erratic crop production, changes in labor requirements and scientific and technical improvements. The original Agricultural Adjustment Act reduced production and provided crop support payments as key elements. Farm surpluses had a major impact in the basin since 1954 by spawning programs to limit crop production through acreage controls. Price support payments were based on average individual farm yields. To meet acreage restrictions, farmers reduced wheat plantings. Since alternate crops generally could not be substituted because they were either under acreage controls or unsuited for climatic conditions, most farmers achieved acreage reduction by increasing acreage of summerfallow. This not only helped reduce the wheat acreage but also improved acreage yields through collection of additional moisture in the soil and thus releasing soil nitrogen. As yields increased in response to the summerfallow, support payments based on average yields also increased. With the present situation of continuing surpluses it is anticipated that these programs will continue to influence cropping systems.

The following discussion and Tables 20, 21 and 22 show alternatives evaluated, how the devised results of each alternative was achieved and the effects that can be expected if any one of them is implemented. A basin-wide summary and individual watershed analysis data is provided to show shifts in cropping systems, conservation practices and effects the various alternatives will have on erosion, net returns, fuel, labor, fertilizer, soil productivity loss, costs and gross receipts.

Seven alternatives were evaluated to show their potential effects on erosion, net returns, fuel use, labor, fertilizer needs, soil productivity loss, costs and gross receipts.

Cropping systems

- If crop acreages are allowed to shift without constraints (alternatives 2 and 4) most cropland would shift from summerfallow to wheat and barley in the medium and high precipitation zones.

- The maximum net income (alternative 2) and soil loss tolerance (alternative 4) alternatives can be achieved with very similar shifts in cropping systems. The major difference is that more land would be protected with hay and pasture for the soil loss tolerance alternative.

- The acreage of seedout is actually reduced in most alternatives. This reduction is accomplished through increased acreages of land planted to crops with no-till drills. Although no-till may not be as effective as grass in controlling erosion, erosion rates are very low. The use of no-till plantings are selected since income producing crops are of economic advantage.

- Additional acreages of bluegrass occur in all alternatives except the soil loss tolerance, present acreage alternative (alternative 6) and the minimum erosion alternative (alternative 7). Bluegrass is very effective in controlling erosion and has provided good economic returns. However, acreages of this crop were not allowed to increase significantly because of limited market conditions.

- Acreages of rotation hay and pasture declined in the analysis except in the soil loss tolerance, present crop acreage alternative and the minimum erosion alternative (alternative 6 and 7). This reduction occurred because of lower net returns from hay and pasture than from other crops. Acreages were increased in alternative 6 and 7 in order to meet the soil loss tolerance and minimum erosion objectives.

- In the minimum erosion alternative (alternative 7) crop acreages have shifted to rotation hay and pasture. Steeper, class IVe and VIe land, was retired from cultivation and seeded to permanent grass to achieve minimum erosion levels.

- In some watersheds, such as Snake River, there are differences in ability to shift out of wheat-summerfallow cropping systems to more intensive cropping systems. A high percentage of these watersheds receive less than 12 inches of annual precipitation (Table 18).

- Cropping systems selected under actual conditions will vary with changing conditions. Cropping systems in the higher precipitation zones which favor a wheat-barley rotation may favor a wheat-pea or wheat-barley-pea rotation if prices for peas would increase relative to those received for barley.

Table 20.—Comparison of crop acreage shifts for various alternatives, Southeast Washington, 1981

Watershed		Alternative	Wheat	Barley	Peas	Hay	Seed-out	Bluegrass	Fallow	Total
			1,000 acres							
Study area	1	P	559	36	40	26	24	8	503	1,196
	2	M I	789	152	0	0	0	20	235	1,196
	3	M I C	685	126	0	3	0	20	362	1,196
	4	T	800	126	0	4	0	20	246	1,196
	5	T C	684	120	0	17	1	20	354	1,196
	6	T P	557	35	35	36	24	8	501	1,196
	7	M E	0	0	0	324	872	0	0	1,196
Tucannon-Pataha	1	P	54	3	2	2	0	3	52	116
	2	M I	79	15	0	0	0	6	16	116
	3	M I C	63	13	0	0	0	6	34	116
	4	T	81	14	0	0	0	6	17	116
	5	T C	62	13	0	1	0	6	34	116
	6	T P	53	3	2	3	0	3	52	116
	7	M E	0	0	0	39	77	0	0	116
Snake	1	P	149	12	4	2	0	2	141	310
	2	M I	186	26	0	0	0	4	94	310
	3	M I C	162	22	0	0	0	4	122	310
	4	T	186	25	0	0	0	4	95	310
	5	T C	162	22	0	0	0	4	122	310
	6	T P	149	12	4	2	0	2	141	310
	7	M E	0	0	0	159	151	0	0	310
Asotin	1	P	29	0	0	1	0	0	29	59
	2	M I	28	15	0	0	0	1	15	59
	3	M I C	29	9	0	0	0	1	20	59
	4	T	28	15	0	0	0	1	14	59
	5	T C	29	9	0	0	0	1	20	59
	6	T P	28	0	0	3	0	0	28	59
	7	M E	0	0		2	57	0	0	59
Alpowa	1	P	12	4	0	0	0	0	11	27
	2	M I	23	0	0	0	0	1	3	27
	3	M I C	22	1	0	0	0	1	3	27
	4	T	22	2	0	0	0	1	2	27
	5	T C	22	1	0	0	0	1	3	27
	6	T P	12	4	0	0	0	0	11	27
	7	M E	0	0	0	0	27	0	0	27
Deadman	1	P	40	5	t	0	0	3	38	86
	2	M I	68	5	0	0	0	7	6	86
	3	M I C	54	8	0	0	0	7	17	86
	4	T	68	5	0	0	0	7	6	86
	5	T C	55	7	0	0	0	7	17	86
	6	T P	40	5	t	0	0	3	38	86
	7	M E	0	0	0	17	69	0	0	86
Alkali Flat	1	P	39	9	0	7	0	0	40	95
	2	M I	45	25	0	0	0	0	25	95
	3	M I C	43	15	0	0	0	0	37	95
	4	T	45	23	0	4	0	0	23	95
	5	T C	41	15	0	4	0	0	35	95
	6	T P	38	9	0	9	0	0	39	95
	7	M E	0	0	0	0	95	0	0	95
Touchet	1	P	145	1	15	7	21	0	125	314
	2	M I	225	42	0	0	0	1	46	314
	3	M I C	190	39	0	0	0	1	84	314
	4	T	231	29	0	0	0	1	53	314
	5	T C	193	36	0	3	0	1	81	314
	6	T P	144	0	13	11	21	0	125	314
	7	M E	0	0	0	38	276	0	0	314
Dry	1	P	67	1	12	3	0	0	51	134
	2	M I	99	18	0	0	0	t	17	134
	3	M I C	88	15	0	3	0	t	28	134
	4	T	103	10	0	0	0	t	21	134
	5	T C	87	13	0	7	1	t	26	134
	6	T P	67	1	11	4	0	0	51	134
	7	M E	0	0	0	48	86	0	0	134
Walla Walla	1	P	24	1	7	4	3	0	16	55
	2	M I	36	6	0	0	0	t	13	55
	3	M I C	34	4	0	0	0	t	17	55
	4	T	37	3	0	0	0	t	15	55
	5	T C	33	4	0	2	0	t	16	55
	6	T P	24	1	7	4	3	0	16	55
	7	M E	0	0	0	21	34	0	0	55

P = Present situation
MI = Maximum net income alternative
MIC = Maximum net income, constrained acreage alternative
T = Soil loss tolerance alternative
TC = Soil loss tolerance, constrained acreage alternative
TP = Soil loss tolerance, present crop acreage alternative
ME = Minimum erosion alternative

t = less than 500 acres

Conservation Practices

- Low residue tillage operations decline significantly with all alternatives. To achieve maximum net income (alternatives 2 and 3) it is most cost effective for farmers to go to medium instead of high residue tillage. High residue tillage systems are more costly because of added costs of chemicals for control of weeds.

- In the soil loss tolerance alternatives 4, 5 and 6 shifts from low and medium residues to high residue and no-till were necessary to achieve the soil loss tolerance objective. Changes in tillage systems are the most cost effective conservation practice evaluated. Conservation tillage systems, crop residue use and conservation cropping system are also considered necessary as part of resource management systems which include use of stripcropping and terrace systems.

- The analysis shows that no-till farming is not as cost-effective as other methods in the maximum net income alternatives. No-till is an essential practice in obtaining the soil loss tolerance objective on many steep, class VIe, slopes. (alternatives 4, 5, and 6)

- Stripcropping and terraces are costly to install and maintain. This cost is reflected in the analysis where these practices decrease from present conditions. Acreages of stripcropping and terraces increase to higher levels in alternative 5, and 6 where soil loss tolerance is the objective and crop acreages are held at near present levels.

- Seedout (establishment of permanent vegetative cover) and rotation hay and pasture declined in alternative 2 through 5. This decline occurred as more profitable crops were added in the maximum net income alternatives and acreages protected with no-till increased with the soil loss tolerance alternatives.

Table 21.—Comparison of conservation practices needed to meet various alternatives, Southeast Washington, 1981

Watershed	Alternative		Residue level Low	Med.	High	No till	Strips & terraces[y]	BG, hay, pasture seedout
			- - - - -	- - - - -	- - - -	1,000 acres	- - - -	- - - -
Study area	1	P	412	416	172	0	140	56
	2	M I	223	471	350	24	107	21
	3	M I C	382	476	167	25	123	23
	4	T	133	210	525	182	122	24
	5	T C	132	355	462	75	132	40
	6	T P	222	366	282	163	190	63
	7	M E	0	0	0	0	0	1196
Tucannon-Pataha	1	P	41	15	20	0	37	3
	2	M I	10	41	34	2	23	6
	3	M I C	27	41	17	2	23	6
	4	T	6	33	42	6	23	6
	5	T C	1	45	30	6	28	6
	6	T P	8	48	19	6	30	5
	7	M E	0	0	0	0	0	116
Snake	1	P	123	88	70	0	25	4
	2	M I	136	76	76	0	18	4
	3	M I C	175	78	39	0	14	4
	4	T	70	35	139	44	18	4
	5	T C	74	54	148	12	18	4
	6	T P	74	83	113	14	22	4
	7	M E	0	0	0	0	0	310
Asotin	1	P	4	23	5	0	26	1
	2	M I	2	6	31	0	19	1
	3	M I C	0	7	12	2	37	1
	4	T	0	6	31	2	19	1
	5	T C	0	7	12	2	37	1
	6	T P	0	3	28	0	25	3
	7	M E	0	0	0	0	0	59
Alpowa	1	P	9	6	6	0	6	0
	2	M I	0	16	5	0	5	1
	3	M I C	3	16	3	0	4	1
	4	T	0	14	5	3	4	1
	5	T C	0	16	3	3	4	1
	6	T P	0	16	3	5	3	0
	7	M E	0	0	0	0	0	27
Deadman	1	P	23	35	5	0	20	3
	2	M I	1	51	16	0	11	7
	3	M I C	7	56	9	0	7	7
	4	T	1	38	28	0	12	7
	5	T C	1	57	14	0	7	7
	6	T P	0	0	2	52	29	3
	7	M E	0	0	0	0	0	86
Alkali Flat	1	P	20	57	11	0	0	7
	2	M I	0	31	64	0	0	0
	3	M I C	37	31	27	0	0	0
	4	T	0	3	82	6	0	4
	5	T C	0	41	50	0	0	4
	6	T P	0	0	0	55	31	9
	7	M E	0	0	0	0	0	95
Touchet	1	P	126	107	27	0	26	28
	2	M I	47	158	72	15	21	1
	3	M I C	80	166	34	15	18	1
	4	T	41	45	118	88	21	1
	5	T C	41	89	117	38	18	11
	6	T P	126	107	27	0	26	28
	7	M E	0	0	0	0	0	314
Dry	1	P	44	68	19	0	0	3
	2	M I	8	79	40	5	1	1
	3	M I C	28	64	20	5	14	3
	4	T	3	27	60	28	16	t
	5	T C	3	35	67	11	14	4
	6	T P	5	15	69	24	17	4
	7	M E	0	0	0	0	0	134
Walla Walla	1	P	22	17	9	0	0	7
	2	M I	19	13	12	2	9	t
	3	M I C	25	17	6	1	6	t
	4	T	12	9	20	5	9	t
	5	T C	12	11	22	2	6	2
	6	T P	9	4	20	7	7	7
	7	M E	0	0	0	0	0	55

P = Present situation
MI = Maximum net income alternative
MIC = Maximum net income, constrained acreage alternative
T = Soil loss tolerance alternative
TC = Soil loss tolerance, constrained acreage alternative
TP = Soil loss tolerance, present crop acreage alternative
ME = Minimum erosion alternative

y = All residue levels
t = less than 500 acres

Effects of Alternatives

Erosion

- All alternatives evaluated will reduce erosion from the present situation.

- It is possible to reduce erosion by 96 percent if all cropland is protected with permanent vegetative cover.

- If maximum net income is selected as a major objective it is possible to reduce erosion by 37 percent.

- If the extent of shifts in cropping systems are limited (alternative 3) potential erosion reduction opportunities are much less than those possible associated with major cropping system changes (alternative 2).

- Differences in erosion rates achieved with the three soil loss tolerance alternatives (alternatives 4 through 6) are minor. The difference here is in how the objective is achieved. With either alternative total erosion is cut by approximately 65 percent.

Fuel

- With four alternatives (2, 3, 4 and 5) fuel use increases. Increased fuel requirements occur since larger acreages are planted to small grain crops.

- Tillage operations are reduced with all alternatives. This saves fuel. However, with increased acreages planted to small grain fuel use in seeding, fertilizing and harvesting operations increase. The effect of reduced fuel use with reduced tillage is reflected in alternative 6 where crop acreages are retained at present levels and acreages protected with reduced tillage and no-till are high.

- Fuel is required with the minimum erosion alternative (alternative 7) since over 320,000 acres would remain in hay and pasture. The remaining acreage in seedout will also require some fuel for maintenance activities.

Soil Productivity Loss

- Declining soil productivity and related dollar losses follow in direct proportion to reductions in soil erosion.

- Values of reducing soil productivity losses have not been added to net returns. Average annual savings in soil productivity represent an annual benefit of the various alternatives considered. Their value are of importance when implementation programs and potential benefits of the various alternatives are considered.

- Average annual productivity losses can be reduced from $3.28 per acre under present conditions to $1.12 per acre with alternative 6. This is equal to $2.16 per acre per year.

Net Returns

- Net returns shown reflect returns to land, management, capital, and risk. Net returns are based on current conditions and do not reflect the loss of future soil productivity due to erosion.

- Net returns can be expected to increase with all but two of the six alternatives (alternative 6 & 7).

- Net returns are highest with those alternatives where crop acreages are allowed to shift without constraints (alternatives 2 and 4). This results as summerfallow decreases and larger acreages are planted to wheat and barley.

- Net returns remains at near present levels with alternative 6 since crop acreages do not change, thus income does not increase. Costs for fuel, fertilizer and labor are less with this alternative.

- If erosion is reduced to minimum levels (alternative 7) net returns will drop by nearly $72 million below present conditions. This loss occurs since only 324,000 acres of hay and pasture are retained as income producing crops. Costs remain high with this alternative.

Costs

- Costs shown reflect all costs associated with the various alternatives including costs of production and costs of applying conservation practices.

- In all alternatives except alternative 6 (soil loss tolerance alternative - present acreage) a large proportion of increased costs is directed at increased production which in turn results in the increased net returns realized with each of these alternatives.

- Since differences in net returns reflect increased costs and income changes, differences between the present condition and alternative 5 provided a logical guide in determining real costs of obtaining the soil loss tolerance objective. At a total difference of $6,637,000 annual costs of applying conservation practices to meet the soil loss tolerance objective averages $5.55 per acre; a cost of approximately $0.72 per ton of soil erosion reduced.

- Costs of applying conservation practices have been established on an average annual basis. Initial investments of establishing practices will be much higher. Higher initial costs usually occur during the first year with practices such as terraces and stripcropping because of major costs of special equipment used in construction, changes in farming systems and needs for different kinds of farm implements. Initial costs of reduced and no-till farming practices are also higher because of needs for different kinds of tillage equipment. Some production losses often occur the first few years following adoption of conservation practices. These losses result during the period of time needed by farmers in learning new management techniques required with the practices. Maintenance costs will continue throughout the life of the various practices. Maintenance costs are especially high for terraces, divided slope farming and stripcropping.

Labor

- Labor requirements increase with all alternatives except the soil loss tolerance, present crop acreage (alternative 6) and minimum erosion (alternative 7) alternatives. The increase in needs for labor occur because of increased crop acreage and increases in labor required for management activities related to conservation practices applied.

Fertilizer

- Fertilizer requirements also increase from present conditions with all alternatives except alternatives 6 and 7. This increase is directly related to the increased acreages of crops (wheat, barley and blue-grass) that would be planted if these alternatives were applied.

Gross Receipts

- Gross receipts reflect total receipts received for the sale of farm products. Receipts are highest with those alternatives where the largest crop acreages are harvested each year (alternatives 2 and 4). Gross receipts are highest with alternative 2 (maximum net income) and lowest with alternative 7 (minimum erosion).

- Gross receipts for alternative 7 (minimum erosion) may be unrealistic since available markets for the large increase in hay and pasture, or products produced on these areas, may decline below present levels and thereby further reduce receipts for those products.

Table 22.—Comparison of effects of various alternatives on soil erosion, fuel consumption, lost soil productivity, net returns, costs, fertilizer, labor and gross receipts, Southeast Washington, 1981

Watershed	Alternative		Erosion (1,000 tons)	Fuel (1,000 gal)	Lost soil productivity ($1,000)	Net returns ($1,000)	Cost ($1,000)	Labor (1,000 hrs)	Fertilizer (1,000 lbs)	Gross receipts ($1,000)
Study area	.1	P	9,537	6,779	39,662	67,007	51,266	1,121	45,212	118,273
	2	MI	6,043	7,456	22,237	112,549	62,841	1,354	78,859	175,381
	3	MIC	8,064	7,293	27,989	99,348	65,892	1,243	64,373	155,241
	4	T	3,148	7,364	12,508	109,715	55,044	1,344	75,257	174,758
	5	TC	3,498	6,911	14,149	97,075	57,903	1,239	63,765	154,979
	6	TP	3,341	5,904	13,563	67,322	51,402	1,096	44,538	118,724
	7	ME	353	3,619	1,411	-4,934	39,522	1,206	39,641	34,588
Tucannon-Pataha	1	P	808	681	3,425	7,714	5,129	110	4,424	12,843
	2	MI	437	770	1,768	13,783	6,731	139	8,535	20,514
	3	MIC	584	726	1,883	11,303	5,679	121	6,376	16,982
	4	T	316	770	1,342	13,676	6,780	139	8,518	20,456
	5	TC	331	691	1,452	11,192	5,790	120	6,372	16,982
	6	TP	352	642	338	7,867	4,987	108	4,375	12,854
	7	ME	27	311	114	-136	4,451	128	3,871	4,315
Snake	1	P	1,651	1,576	5,808	15,101	11,758	263	10,497	26,859
	2	MI	1,827	1,705	5,921	22,206	13,505	306	15,953	35,711
	3	MIC	2,343	1,669	7,330	19,216	11,960	280	12,731	31,178
	4	T	813	1,630	3,341	21,416	14,260	302	15,022	35,676
	5	TC	867	1,542	2,953	18,641	12,521	272	12,781	31,162
	6	TP	944	1,509	573	15,095	11,794	258	10,470	26,889
	7	ME	81	1,906	282	1,292	16,165	505	10,876	17,457
Asotin	1	P	152	324	564	2,510	2,544	52	2,210	5,054
	2	MI	150	320	516	4,234	2,762	62	3,112	6,996
	3	MIC	244	349	811	3,821	2,641	60	2,864	6,462
	4	T	70	315	258	4,223	2,879	62	3,105	7,102
	5	TC	141	343	486	3,804	2,765	60	2,857	6,569
	6	TP	215	358	629	2,596	2,521	60	2,221	5,117
	7	ME	7	61	26	-700	700	6	1,775	0
Alpowa	1	P	244	172	470	1,847	1,195	26	1,257	3,042
	2	MI	112	194	220	3,615	1,717	35	2,309	5,333
	3	MIC	139	195	258	3,452	1,657	34	2,184	5,108
	4	T	40	193	190	3,583	1,750	34	2,225	5,332
	5	TC	41	188	222	3,414	1,694	33	2,100	5,109
	6	TP	33	146	188	1,882	1,181	24	1,219	3,063
	7	ME	8	28	15	-316	316	3	803	0
Deadman	1	P	415	525	1,891	6,659	3,716	80	3,689	10,357
	2	MI	228	620	853	12,644	5,508	110	7,418	18,152
	3	MIC	275	585	1,196	10,958	4,784	98	5,959	15,742
	4	T	188	628	756	12,625	5,528	110	7,418	18,153
	5	TC	206	586	924	10,936	4,803	98	5,959	15,739
	6	TP	23	146	734	6,767	3,656	76	3,689	10,423
	7	ME	15	174	67	-259	2,387	61	2,749	2,128
Alkali Flat	1	P	495	533	1,934	5,447	4,225	100	3,590	9,672
	2	MI	372	501	1,430	7,475	4,398	99	5,084	11,863
	3	MIC	764	535	2,809	6,507	3,897	91	4,061	10,404
	4	T	229	509	750	7,306	4,681	109	4,906	11,986
	5	TC	302	484	1,097	6,375	4,199	96	4,082	10,574
	6	TP	331	482	929	5,441	4,200	99	3,571	9,641
	7	ME	28	97	103	-1,126	1,126	9	2,854	0
Touchet	1	P	3,630	1,764	16,073	16,634	13,265	288	11,774	29,899
	2	MI	1,890	2,108	7,528	29,783	17,697	379	22,971	47,480
	3	MIC	2,358	2,007	8,675	26,591	15,443	341	18,417	42,034
	4	T	910	2,087	3,550	28,671	18,389	370	21,215	47,060
	5	TC	1,011	1,892	4,421	25,702	15,818	334	17,898	41,520
	6	TP	896	1,565	9,162	16,543	13,481	278	11,491	30,024
	7	ME	120	510	531	-3,195	6,718	269	10367	3,523
Dry	1	P	1,680	863	7,834	8,428	6,591	139	5,662	15,019
	2	MI	747	907	3,135	14,259	7,817	165	10,183	22,076
	3	MIC	994	897	3,850	13,203	7,303	161	8,822	20,506
	4	T	398	904	1,794	13,795	8,019	160	9,615	21,814
	5	TC	413	866	1,797	12,843	7,647	167	8,754	20,490
	6	TP	389	752	833	8,410	6,734	133	5,418	15,144
	7	ME	51	373	215	-795	5,362	157	4,488	4,567
Walla Walla	1	P	462	341	1,663	2,667	2,843	63	2,109	5,510
	2	MI	280	331	866	4,550	2,706	59	3,294	7,256
	3	MIC	363	330	1,177	4,297	2,528	57	2,959	6,825
	4	T	143	328	527	4,420	2,758	58	3,233	7,178
	5	TC	142	319	797	4,168	2,666	59	2,962	6,834
	6	TP	135	304	177	2,721	2,848	60	2,084	5,569
	7	ME	16	159	58	301	2,297	68	1,858	2,598

P = Present situation
MI = Maximum net income alternative
MIC = Maximum net income, constrained acreage alternative
T = Soil loss tolerance alternative
TC = Soil loss tolerance, constrained acreage alternative
TP = Soil loss tolerance, present crop acreage alternative
ME = Minimum erosion alternative

Concentrated Flow and Gully Erosion

Detailed analysis of alternatives available for solution of concentrated flow and gully erosion problems was not conducted. However, estimates of costs of solving these problems were made.

Concentrated flow and gully erosion problems will be reduced if sheet and rill erosion problems are solved. However, in some fields additional conservation practices will be needed to reduce these damages. In most cases installation of grassed waterways in areas where runoff water concentrates will solve the problems. Terraces can also be very effective, especially in control of concentrated flow erosion, when they can be used.

It is estimated that the cost of installing grassed waterways in those areas needing treatment will average $1,320.00 per acre. In addition, an annual loss of crop production will reduce net returns by $4.00 to $5.00 per acre for the area planted to grass. Cost of installing grassed waterways in the entire study area is estimated at slightly over $1 million; a cost of approximately $9.00 per ton of erosion and $15.00 per ton of sediment reduced.

Problems of concentrated flow and gully erosion can often be solved by installing grassed waterways.

RANGELAND

The following assumptions were established for the study:

1. Most rangeland can be managed to reach its climax by applying specific conservation practices over a period of years.
2 The time-lag for condition change is dependent on the ecological site and its current departure from climax conditions.
3. Management has the necessary time, organizational structure, facilities, and finance to apply the needed conservation treatment.
4. Rangeland valuation is based on the maximum potential use of the forage resource by livestock. The use of all available forage by livestock provides a proxy value for all rangeland uses.
5. Cost estimates assume all rangeland, grazed or ungrazed is operable for livestock production.

Conservation practices are used on rangeland in the study area to improve forage production, control erosion, and generally improve the environment. These practices are not equally effective in solution of conservation problems on all lands or suitable for all range sites. Combinations of more than one practice are often required to solve a conservation problem.

Practices commonly used and evaluated in the study are, planned grazing systems, proper grazing use, range seeding and brush control. A definition of these practices are included in the glossary of this report. Fencing, salting, stock trails and livestock water facilities are generally needed as rangeland conservation practices are implemented and are included as a part of the cost for implementing planned grazing systems.

In the study area rangeland forage will presently support the equivalent of 180,130 animal units. If all were consumed by livestock, 14,789,640 pounds of red meat would be produced (Table 23). This is 43 percent of the amount of meat that could be produced if all rangeland was in excellent condition. The net economic value of present red meat production is $162,120; only 4 percent of its maximum potential. This occurs because four watersheds (Snake River, Asotin Creek, Alkali Flat Creek, and the Walla Walla River) currently have deteriorated forage resources producing net economic losses. Production costs currently just equal returns.

Future Economic Potential

Change in range management is economically feasible but extensive time is needed to cause a shift in ecological condition and achieve the benefits desired. Alternative resource management systems that involve various conservation practice combinations were analyzed to determine how much range could feasibly be treated for increased forage production. Three resource management systems in addition to low intensity management were compared - (1) proper grazing use and planned grazing systems (PU and PGS), (2) PU and PGS with seeding, and (3) PU and PGS with brush control.

The objective was to optimize long term benefits from alternative resource management systems. The analysis shows those resource management systems that will maximize net income levels.

The maximum net income alternative, would produce net annual returns of $2,289,360, an improvement of $2,127,240 over current returns. This would return rangeland to 86 percent of its original productivity and would occur only if all rangeland was in excellent condition. The number of animal units that could be supported would increase from 180,130 to 332,810 and produce 14,559,710 more pounds of red meat. Average annual soil erosion would be decreased by seven percent from present conditions.

Conservation practices on rangeland can improve forage production, control erosion and improve the environment.

Table 23.—Comparison of present condition and maximum net income alternative impacts on rangeland watershed, Southeast Washington, 1981

Watershed	Alternative	Net returns	Animal units 1/	Present vs maximum potential	Beef production	Erosion
		$1,000	1,000#	Percent	1,000 lbs.	1,000 tons
Tucannon	Present	241,240	36,070	52	2,884,400	59,220
	Max net income 2/	698,130	68,510		5,864,420	56,060
	Max potential 3/	1,041,540	71,320		6,183,330	55,330
Grande Ronde	Present	121,480	16,370	57	1,322,470	20,100
	Max net income	301,040	27,540		2,372,680	19,560
	Max potential	328,350	29,420		2,536,630	19,110
Snake	Present	(257,270)	73,700	58	6,295,390	205,650
	Max net income	446,830	127,880		11,722,680	190,070
	Max potential	1,377,780	157,760		14,912,730	147,890
Asotin	Present	(36,550)	11,430	52	963,280	31,880
	Max net income	97,100	21,450		1,932,820	27,940
	Max potential	247,010	25,280		2,270,430	24,410
Alpowa	Present	75,050	14,740	60	1,186,470	27,410
	Max net income	198,980	24,770		2,125,170	24,880
	Max potential	307,830	27,280		2,356,110	22,840
Deadman	Present	73,850	12,570	48	1,009,710	19,340
	Max net income	298,400	27,410		2,412,380	18,400
	Max potential	492,420	28,440		2,570,750	18,730
Alkali Flat	Present	(82,620)	2,780	43	215,280	6,410
	Max net income	61,820	7,260		630,770	5,200
	Max potential	103,940	7,260		630,770	5,200
Touchet	Present	44,980	8,990	43	636,970	18,930
	Max net income	176,200	21,210		1,683,240	18,690
	Max potential	350,520	24,360		1,950,150	18,640
Dry	Present	10,730	1,340	48	91,650	2,740
	Max net income	26,780	2,680		205,120	2,740
	Max potential	47,910	3,340		258,070	2,740
Walla Walla	Present	(28,770)	2,140	51	184,020	11,550
	Max net income	(15,920)	4,100		400,070	11,390
	Max potential	33,580	5,510		605,870	11,070
Study area	Present	162,120	180,130	54	14,789,640	403,230
	Max net income	2,289,360	332,810		29,349,350	374,930
	Max potential	4,330,880	379,970		34,274,840	326,220

1/ Animal unit: A measurement of livestock numbers based on the equivalent of one mature cow (approximately 1,000 pounds).
2/ Maximum net income alternative, evaluated at 7 5/8 percent interest, 100 years.
3/ If all rangeland were currently in excellent ecological condition. Range may never return to this condition.

Currently 49 percent of the rangeland is poor, 24 percent is fair, 21 percent is good, and 6 percent is in excellent ecological condition (Table 24). Alpowa Creek Watershed is in the best ecological condition and Alkali Flat Creek Watershed was found to be in the poorest condition.

With the maximum net income alternative, rangeland in excellent condition can be increased to 554,900 acres; rangeland in poor condition is reduced to 245,930 acres (Table 24). Table 25 shows the resource management systems that would be applied with the maximum net income alternative. Low intensity management would be reduced from 584,570 acres under current conditions to 247,870 acres with the maximum net income alternative. Those acres left untreated are typically shallow and less productive range sites. These acres could not feasibly be treated because of their low productivity and the long time period needed to improve ecological condition. Proper use and planned grazing systems could be applied to 552,980 acres with reseeding on 83,970 acres and brush control on 2,510 acres. Average annual sheet and rill erosion would be reduced by 7 percent to 374,930 tons. During those winters that follow droughty summers the benefits of perennial grasses in reducing soil erosion would be most noticeable.

Application of proper use and planned grazing systems should provide additional benefits to stream corridors by improving riparian vegetation. The stream habitat section of this study provides a summary of potential effects of improved stream corridor management.

While the evaluation looks at long term (up to 100 years) effects of applying alternative resource management systems, a significant portion of the change (60 percent) occurs during the first 20 years (see Figure 17). This means that many ranchers whose cattle currently graze this rangeland will realize gains in productivity during their tenure on the land. The maximum net income alternative shows that it is economically feasible to implement resource management systems; however, significant gains can be made only if society is concerned about improving rangeland productivity. Improved rangeland, besides increasing forage for livestock, also provides more forage for wildlife, improves water quality, reduces erosion and sediment, and enhances aesthetics and recreation - all direct benefits to society.

Table 24.—Comparing rangeland ecological condition by watershed - present condition and maximum net income alternative, Southeast Washington, 1981

Watershed	Alternative	1,000 Acres	Ecological Condition			
			Poor	Fair	Good	Excellent
			Percent			
Tucannon-Pataha	Present[1/]	113	39	30	25	6
	Max net income[2/]	113	11	3	0	86
Grande Ronde	Present	44	44	21	20	15
	Max net income	44	13	0	1	86
Snake	Present	422	50	22	22	6
	Max net income	422	34	5	0	61
Asotin	Present	60	51	23	22	4
	Max net income	60	25	10	0	65
Alpowa	Present	51	38	28	26	8
	Max net income	51	15	9	0	76
Deadman	Present	43	54	37	9	0
	Max net income	43	18	0	0	82
Alkali Flat	Present	12	60	40	0	0
	Max net income	12	0	0	0	100
Touchet	Present	29	70	15	12	3
	Max net income	29	25	0	0	75
Dry	Present	4	57	14	29	0
	Max net income	4	29	0	0	71
Walla Walla	Present	21	47	31	19	3
	Max net income	21	13	0	1	86
Study area	Present	799	49	24	21	6
	Max net income	799	26	5	1	69

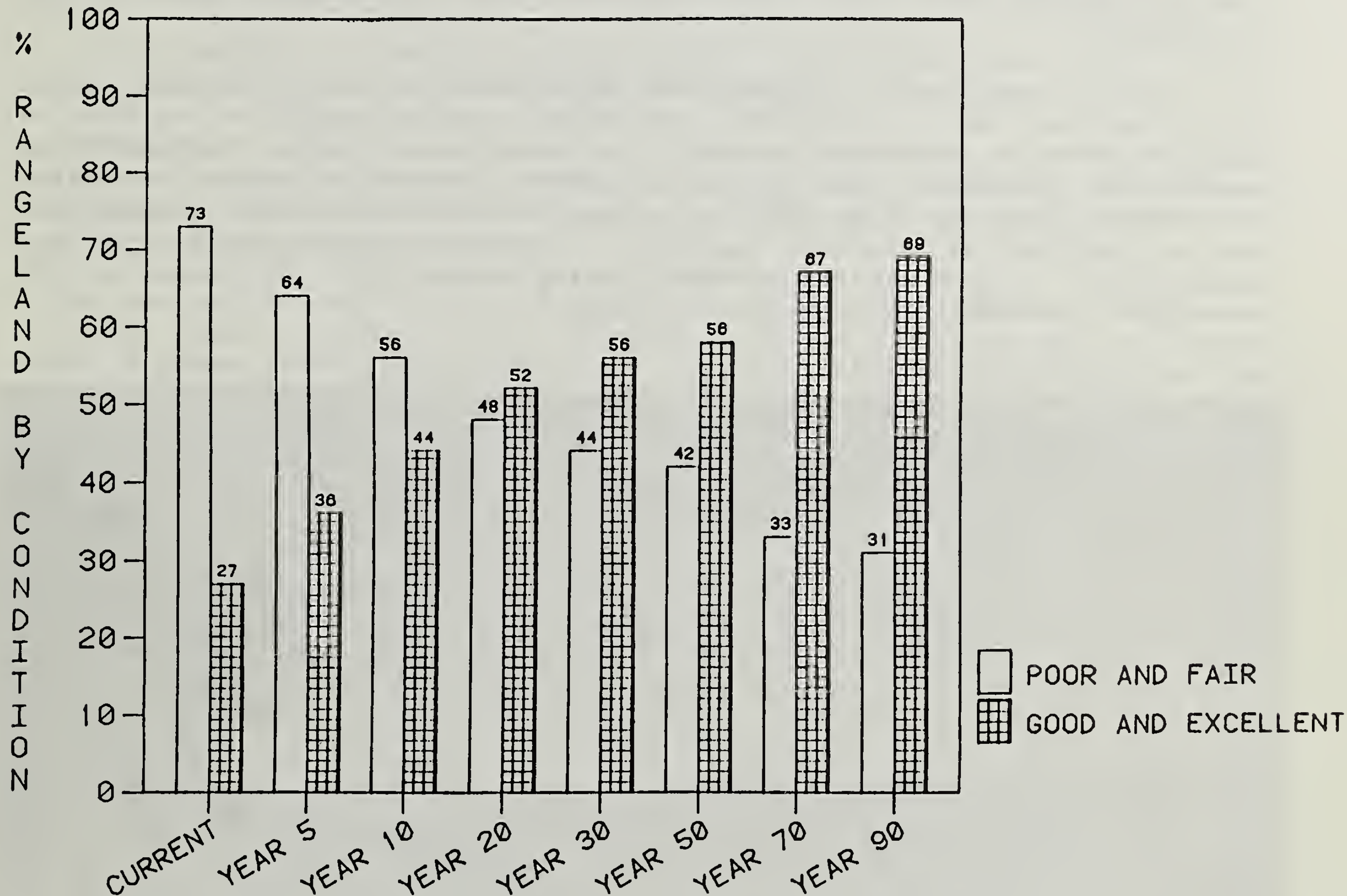
1/ Present condition.
2/ Maximum net income alternative.

Table 25.—Rangeland resource management system by watershed, Southeast Washington, 1981

Watershed	Alternative	Resource management systems: Low intensity	PU & PGS[1]	PU & PGS[1] & seeding	PU & PGS[1] & brush control
		Acres			
Tucannon	Present[2]	78,190	35,070	-	-
	Max net income	16,080	80,760	16,420	-
Grande Ronde	Present	28,910	15,280	-	-
	Max net income	5,780	33,490	4,510	410
Snake	Present	303,900	119,040	-	-
	Max net income	166,300	219,920	36,720	-
Asotin	Present	44,440	15,510	-	-
	Max net income	20,960	31,210	5,680	2,100
Alpowa	Present	33,790	17,390	-	-
	Max net income	12,420	33,190	5,570	-
Deadman	Present	38,890	3,950	-	-
	Max net income	7,910	27,560	7,370	-
Alkali Flat	Present	12,100	-	-	-
	Max net income	--	8,860	3,240	-
Touchet	Present	25,150	4,330	-	-
	Max net income	7,460	19,160	2,860	-
Dry	Present	2,800	1,120	-	-
	Max net income	1,120	2,330	470	-
Walla Walla	Present	16,400	4,590	-	-
	Max net income	9,840	10,020	1,130	-
Study area	Present	584,570	216,280	-	-
	Max net income	247,870	466,500	83,970	2,510

1/ Proper use and planned grazing system
2/ Present condition

Figure 17.—Change in range condition over time with maximium net income, Southeast Washington, 1981



Conclusions:

Rangeland is presently producing at only 43 percent of its productive capacity because of poor ecological condition. Dramatic improvements can be made in range condition and productivity. During the first 20 years, 60 percent of the benefits could occur. However, 90 years will be required to realize the full effect. Potential for improvement of the rangeland resource varies because of present conditions and past management practices. The Snake River, Asotin Creek and Alkali Flat Creek Watersheds offer the greatest potential for improvement.

If rangeland improvement programs are implemented, benefits to areas other than rangeland can be expected. Particular benefits would be realized as wildlife habitat conditions improve. In many areas, stream corridors are bordered by rangeland. Benefits to the fishery resource will occur as erosion and sediment rates on rangeland are reduced. Reduction in stream temperatures can be achieved if riparian vegetation along the stream corridor is re-established. Proper use and planned grazing systems will be needed and in some cases livestock exclusion may be required.

With improved management, rangeland production can be increased significantly.

FORESTED AREA

Once the levels of erosion and sediment are well defined the next step is to develop a set of alternatives to reduce the problems. Alternatives fall into two general categories:

1) Preventative - those plans and actions that modify how a disturbance activity, e.g. forest harvesting, will be done to minimize erosion and sedimentation.

2) Remedial - measures taken after a disturbed site has become a significant erosion and sediment source.

Preventative planning and actions are the best approach to reducing future erosion and sedimentation. However, because the effects or magnitude of sediment reduction for this approach are difficult to quantify, emphasis was focused on remedial-type measures.

For each erosion and sediment source there are several remedial measures that can be taken to reduce rates. Measures that are effective vary by source. For a given source there are usually several measures that have been used effectively in the study area. Installation cost, longevity, and effectiveness determine the practical value of a measure in reducing erosion or sediment. For this study 50 control measures were evaluated but only 29 measures were used to determine least cost alternatives. These measures' installation costs, life expectancy and annual costs are listed in Table 26.

Narrative descriptions of some of the basic measures are included in the appendix. They are ones that were selected for one or more alternatives shown in the individual watershed reports. Combinations of these measures are often used to form selected control alternatives.

Numerous alternatives are available for solution of erosion and sediment problems on forested areas.

Table 26.—Description of remedial control measures, Southeast Washington, 1981

Source and control measure	Installation cost[1]	Expected life[2]	Annual cost
	Dollars	Years	Dollars
Undisturbed and harvested areas			
Seed grass	86	50	5.00
Fertilize	53	50	3.00
Seed grass and fertilize	294	50	21.00
Plant trees 8'x8'	321	50	23.00
Fertilize, plant trees 8'x8'	374	50	27.00
Seed grass, fertilize, plant trees 8'x8'	428	50	34.00
Roads			
Seed grass, fertilize, drill	299	50	21.00
Seed grass, fertilize, hay mulch	476	50	34.00
Seed grass, fertilize, asphalt mulch	962	50	70.00
Seed grass, fertilize, water bar	983	50	71.00
Seed grass, fertilize, water bar, scarify	1,390	50	101.00
Temporary road closure	534	5	131.00
Gravel road surface	10,155	10	1,454.00
Gravel road surface, stabilize cut and fill	10,449	10	1,481.00
Seed grass, fertilize, water bar, close road	3,100	50	227.00
Seed grass, fertilize, hydromulch	695	50	50.00
Seed grass, fertilize, water bar, close road plant trees 8'x8'	3,260	50	238.00
Streams			
Plant trees 8'x8'	534	50	39.00
Plant trees and shrubs 3'x3'	732	50	54.00
Back slope, plant trees and shrubs 3'x3'	2,111	50	155.00
Construct check dams	11,224	10	1,607.00
Remove debris dams	14,110	50	1,039.00
Remove scattered debris	1,603	10	230.00
Fence exclosure	481	5	118.00
Terrace and seed grass	2,961	50	217.00
Seed grass and fertilize	299	50	21.00
Seed grass, fertilize, plant trees 8'x8'	1,069	50	78.00
Large rock riprap, more than 18"	62,086	50	4,570.00
Small rock riprap, less than 18"	26,724	50	1,967.00

1/ All costs are based on a dollar per acre basis.
2/ Measures that are expected to last for longer periods are amortized over 50 years at 7 5/8 percent interest to develop annual costs.

The six watersheds containing extensive forested area were evaluated to determine the least cost combination of treatments to achieve a variety of alternatives. Alternatives were developed for both sediment and erosion reductions for each watershed. The first alternatives developed determined the maximum level of reduction that could be achieved using the 29 practices selected. The maximum alternatives generally reduced from 70 to 90 percent of the current sediment or erosion. No attempt was made to obtain the least cost solution for the maximum alternatives. Alternatives that reduce sediment and erosion by 10, 20, 30, 40, 50, 60, and 70 percent of the current level were then developed. Tables 27 and 28 show the acres treated, annual cost, and annual cost per ton of sediment and erosion reduced from each of five watersheds by alternative. (The Grande Ronde is not displayed because the area in the Wenaha-Tucannon Wilderness Area distorted the output data).

Many roads of the forested area need additional erosion control practices.

Table 27.—Summary, area treated and costs by erosion reduction alternative, forested area, Southeast Washington

Watershed & area or cost	Units	Erosion reduction alternative 10	20	30	40	50	60	70	Maximum
Tucannon									
Area treated	1,000 ac	15	44	47	47	47	58	59	61
Annual costs (total)	$1,000	55	169	332	591	851	1,218	1,883	2,495
Annual costs per ton	Dollars	25	39	50	61	78	93	123	158
Pataha									
Area treated	1,000 ac	2	3	6	6	6	6	9	14
Annual costs (total)	$1,000	7	19	41	70	99	129	187	677
Annual cost per ton	Dollars	11	15	21	27	31	33	41	119
Asotin									
Area treated	1,000 ac	.5	18	53	53	53	55	76	83
Annual cost (total)	$1,000	34	92	236	407	580	838	1,196	3,084
Annual cost per ton	Dollars	12	17	29	37	42	51	62	130
Touchet									
Area treated	1,000 ac	8	47	94	74	94	95	95	113
Annual cost (total)	$1,000	58	182	428	701	973	1,450	1,956	4,324
Annual cost per ton	Dollars	13	21	33	40	45	56	65	115
Walla Walla									
Area treated	1,000 ac	7	21	26	26	26	26	26	27
Annual cost (total)	$1,000	23	67	144	222	300	417	565	985
Annual cost per ton	Dollars	18	27	38	45	48	56	65	90
Total 5 watersheds 1/									
Area treated	1,000 ac	32.5	133	226	226	226	240	265	298
Annual cost (total)	$1,000	177	529	1,181	1,991	2,803	4,052	5,787	11,565
Annual cost per ton	Dollars	16	24	34	43	49	58	71	122

1/ Grande Ronde Watershed is not included. Most of the Watershed is in a Wilderness Area.

Table 28.—Summary, area treated and costs by sediment reduction alternative, forested area, Southeast Washington

Watershed, area or cost	Units	Sediment reduction alternative 10	20	30	40	50	60	70	Maximum
Tucannon									
Area treated	1,000 ac	.05	.2	1	3	51	58	59	61
Annual costs (total)	$1,000	1	6	30	149	445	1,203	2,145	2,495
Annual costs per ton	Dollars	5.58	17.66	57.75	218.79	521.51	1,175.19	1,794.97	2,029.79
Pataha									
Area treated	1,000 ac	.08	.5	3	5	5	5	5	13
Annual costs (total)	$1,000	2	11	22	43	76	108	142	682
Annual cost per ton	Dollars	13.20	30.14	40.01	60.34	84.15	100.01	112.98	436.27
Asotin									
Area treated	1,000 ac	.09	.3	.6	.6	4	22	68	83
Annual cost (total)	$1,000	3	13	28	47	104	286	852	3,063
Annual cost per ton	Dollars	12.80	23.73	34.32	43.53	77.28	177.48	453.20	1,357.03
Touchet									
Area treated	1,000 ac	.11	.4	.6	.7	1.9	94	103	113
Annual cost (total)	$1,000	3	11	25	49	116	488	1,603	4,277
Annual cost per ton	Dollars	7.46	14.63	22.72	33.74	63.60	223.56	629.28	1,416.06
Walla Walla									
Area treated	1,000 ac	.05	.1	.1	.1	23	27	27	27
Annual cost (total)	$1,000	1	3	8	17	91	299	590	987
Annual cost per ton	Dollars	15.15	25.66	42.95	70.61	298.71	811.20	1,375.60	1,962.24
Total 5 Watersheds 1/									
Area treated	1,000 ac	.38	1.5	5.3	9.4	84.9	226	262	297
Annual cost (total)	$1,000	10	44	113	305	832	2,384	332	11,504
Annual cost per ton	Dollars	11.04	22.36	39.55	85.40	209.05	497.49	873.21	1,440.28

1/ Grande Ronde not included

Each alternative displays a program that shows what treatment to apply by source to achieve the least cost solution for the indicated reduction. Table 29 is a summary of area to be treated by source type by watershed for six sediment alternatives. Table 29 and figure 18 show that roads and trails and streams are primary sources to be treated for the 10, 20, and 30 percent alternatives. Higher level alternatives shift emphasis to undisturbed areas and harvest units. Details of each alternative are shown in the watershed reports.

Figure 18.—Comparison of sediment reduction alternatives, forested area, Southeast Washington, 1981

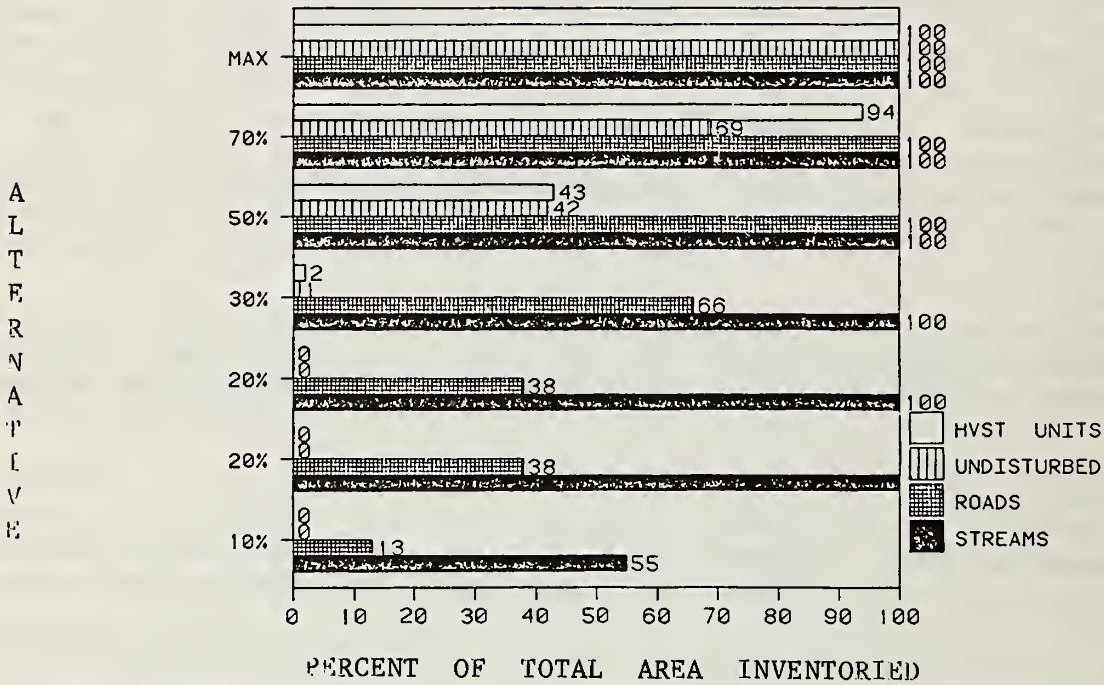


Table 29.—Area treated by sediment reduction alternatives by source and by watershed, forested area, Southeast Washington, 1981

Land treatment area	Percent sediment reduction alternative					
	10	20	30	50	70	MAX
Undisturbed areas	Acres					
Tucannon	0	0	0	47,658	55,947	57,279
Pataha	0	254	3,029	3,029	3,029	9,853
Grande Ronde	0	0	0	1/	1/	36,335
Asotin	0	0	0	0	6,010	67,635
Touchet	0	0	0	0	90,951	101,524
Walla Walla	0	0	0	22,253	26,507	26,667
Total	0	254	3,029	72,940	182,444	299,293
Harvest units						
Tucannon	0	0	710	2,745	2,745	2,745
Pataha	0	0	0	1,286	1,286	3,214
Grande Ronde	0	0	0			5,126
Asotin	0	0	0	3,177	15,048	15,048
Touchet	0	0	0	1,008	10,773	10,773
Walla Walla	0	0	0	401	401	401
Total	0	0	710	8,617	30,253	37,307
Roads and trails						
Tucannon	0	103	152	410	410	410
Pataha	154	154	203	203	462	464
Grande Ronde	67	295	295			463
Asotin	52	149	476	610	610	626
Touchet	27	134	366	721	721	721
Walla Walla	4	54	54	111	118	118
Total	304	889	1,546	2,055	2,321	2,784
Streams						
Tucannon	46	129	129	129	129	129
Pataha	51	51	51	51	51	51
Grande Ronde	85	85	85			85
Asotin	40	95	95	95	95	95
Touchet	83	215	215	215	215	215
Walla Walla	41	51	51	51	51	51
Total	346	626	626	541	541	626
Total all areas 2/	650	1,769	5,911	84,153	215,559	340,010

1/ The maximum attainable sediment reduction for the Grande Ronde watershed is 33 percent.

2/ Includes only the six watersheds evaluated with the linear program model.

STREAM HABITAT

Suitable habitat for salmonoids must include, among other things, suitable spawning and egg incubation areas and suitable rearing areas. In the Tucannon River and other streams of the study area approximately the lower two-thirds of the river is unsuitable for rearing because of elevated temperatures. The mid one third of the stream is fair for spawning and egg incubation and the lower one-third is poor for spawning and egg incubation because of excessive sediment deposition. At present an imbalance of these life requisites occurs in the Tucannon River and in other streams in the area. There is more spawning area than rearing area. Therefore, initial attempts at increasing fish numbers should be aimed at improving rearing habitat by lowering water temperatures. Thereafter, spawning and rearing habitat should be improved in compatible increments so that an imbalance of these life requisites does not occur. Riparian re-vegetation and sediment reduction should occur simultaneously.

If streambanks were re-vegetated so as to create suitable temperatures in the mid one-third of the Tucannon River (down to Pataha Creek), there would be more suitable rearing area than spawning area. Sediment should then also be reduced in order to realize the full spawning potential.

Table 30 displays the incremented increase in juvenile fish populations and Table 31 the increase adult fish return from lowering stream temperatures and improving spawning habitat in the Tucannon River.

Economic evaluations were made of the enhancement of salmon and steelhead resources in the Tucannon River following procedures recommended by Meyer (1982) and Meyer et al. (1983). Tables 32 and 33 summarize the results of this evaluation showing estimated average annual benefits from improving salmon and steelhead resources in the Tucannon River ranging from $325,000 to $844,000.

Table 30.—Estimated juvenile fish production in the Tucannon River, Washington

Treatment	Yearling steelhead	Young-of-the-year Chinook salmon
Presently (1980) 1/	111,000	170,000
Level 1 - Suitable stream temperatures to Pataha Creek	206,000	314,000
Level 2 - Level 1 plus 60 percent reduction of intra-gravel sediment to Pataha Creek	263,000	400,000
Level 3 - Level 2 plus suitable stream 1/ temperatures to mouth of Tucannon River	279,000	430,000
Level 4 - Level 3 plus 60 percent reduction of intra-gravel sediment to mouth of Tucannon River	363,000	528,000

1/ Kelly and Associates, 1982.

Table 31.—Estimated adult fish returns to Tucannon River, Washington 1/

Treatment level	Steelhead	Chinook salmon
Present (1980)	1,832	884
Level 1	3,399	1,633
Level 2	4,340	2,080
Level 3	4,604	2,236
Level 4	5,990	2,746

1/ Based on U.S. Fish and Wildlife (1982) est. of 1.65 and .52 percent survival from smolt to returning adult for steelhead and spring chinook.

Table 32.—Net monetary value per escaping spawner by treatment level, Tucannon River, Washington

Treatment level	Steelhead			Chinook salmon		
	Spawners	Enhance-ment	Annual benefit 1/	Spawners	Enhance-ment	Annual benefit 2/
Present (1980)	1,832	-	-	884	-	-
1	3,399	1,567	382,350	1,633	749	217,210
2	4,340	2,508	611,950	2,080	1,196	346,840
3	4,604	2,772	676,370	2,236	1,352	392,080
4	5,990	4,158	1,014,550	2,746	1,862	539,980

1/ $244/spawner, Meyer 1983.
2/ $290/spawner, Meyer 1983.

Table 33.—Present worth and average annual benefits 1/, Tucannon River, Washington

Treatment level	Steelhead		Chinook salmon		Total	
	Present worth	Ave. annual benefit	Present worth	Ave. annual benefit	Present worth	Ave. annual benefit
1	2,721,690	207,660	1,546,170	117,970	4,267,860	325,630
2	4,356,050	332,360	2,468,910	188,380	6,824,960	520,740
3	4,814,610	367,350	2,790,950	212,950	7,605,560	580,300
4	7,221,880	551,020	3,843,740	293,270	11,065,620	844,290

1/ Based on 7 5/8%, with a 20 year installation and re-vegetation period for riparian habitat.

OTHER LAND

Roadbank Erosion

Approximately 804 miles of roadsides in the non-forested portion of the study area have moderate to severe erosion problems. It is estimated that these areas can be stabilized and protected from erosion at an initial cost of $169,000.00. Annual costs of maintaining these areas and associated losses of crop production on land planted to grass are estimated at $117,000.00; an annual cost of approximately $3.00 per ton of erosion and $4.00 per ton of sediment reduced.

Streambank Erosion

Approximately 460 miles of streambanks in the non-forested area need treatment for erosion problems. Estimated cost of treating these areas is $275,000.00. with an annual cost of $193,000.00. Since an estimated 44,000 tons of soil erode from these areas each year the annual cost per ton of soil erosion reduced is $4.38 and $5.01 per ton of sediment reduction.

Approximately 460 miles of streambanks in the non-forested area need treatment of erosion problems.

Implementation

An implementation program needs to be developed which will significantly reduce erosion in the Southeast Washington River Basin Study Area. Such a program will require accelerated application of conservation practices under ongoing USDA programs and the cooperative effort of federal, state, and local agencies, and private organizations. To achieve full potential of erosion and sediment reduction two conditions must be satisfied. First, recommended management practices must be followed to a high degree of precision; and second, all of the recommended improvements in needed resource management systems must be installed.

Various action items have been identified which can be essential to a successful implementation program. These action items are:

1. Secure a level of funding that provides incentive for voluntary and continued participation of farm operators and forest and rangeland managers to achieve early completion of the recommended plan to reduce soil erosion and sediment problems and achieve desired improvements in rangeland production and fish habitat.

2. Establish a local erosion control coordinating committee and follow implementation priorities established by that committee to ensure that those areas with the highest rates of soil erosion and that contribute the most sediment to streams will be treated first.

3. Provide increased technical assistance by SCS through Conservation Districts in Southeast Washington and by ASCS county offices to service accelerated work loads.

4. Obtain a long-term commitment from land managers utilizing long-term agreements to begin an implementation program based on individual conservation plans and to accelerate that program consistent with established priorities for early completion of planned objectives.

5. Continue research programs to determine applicability, limitations and effects of various erosion control and sediment reduction methods that are applicable to local conditions of soil, climate, crops, and economics.

6. Initiate a program to gather data to monitor and evaluate the effectiveness of land management improvements and to verify that objectives of the erosion and sediment control programs have been achieved.

7. Review and adjust, if needed, commodity and cost sharing programs and forest management practices as they effect conservation practice application.

8. Improve cooperation among agencies to improve ways in which they work together to achieve program objectives.

Implementation can be accomplished with on-going USDA programs. However, an accelerated effort is needed. On-going programs can be accelerated with increased funding and additional personnel. PL-566 small watershed land treatment projects can be developed to meet needs over and above those that can be met with on-going programs. Washington State Referendum 39 funds are a possible resource whereby Conservation Districts can obtain equipment for use by farmers in the area for application of needed conservation practices (conservation tillage equipment, no-till drills, etc.). County and state programs for control of weeds (especially yellow star thistle) on rangeland need to be accelerated. Additional funds are needed to provide assistance to owners of forested areas in application of conservation practices and to insure that State Forest Management Practice Specifications are followed. The Pacific Northwest Electric Power and Conservation Planning Council is presently initiating a program for fish and wildlife enhancement. Funding for implementation of approved projects is being provided by the Bonneville Power Administration.

Studies in the area indicate that soil erosion is a significant source of sediment that is damaging potential fishery habitat in streams of the study area. Future research needs to be conducted to further evaluate relationships of erosion problems on upland areas and the impacts of sediments in streams on the fishery resource. New erosion control systems should be low in cost and have low requirements for labor and energy if they are to be widely adopted. Research should be directed to determine applicability and limitations of various conservation practices under local soil, climate, crop, and economic conditions. Design criteria should be developed and refined for local conditions. Finally, those systems or kinds of equipment that appear to be practical should be demonstrated to promote local acceptance.

Present assistance available to soil conservation districts in the study area include: three District Conservationists [1/]; four Soil Conservationist; and eight Engineers and Technicians. Additional expertise in conservation planning, range conservation, engineering, construction, forestry, and biology will be needed. Current personnel ceilings must be increased if additional expertise is to be made available without severely reducing or eliminating the limited level of technical assistance now available elsewhere. The estimated additional cost for technical assistance annually is shown in Table 35, 37, 38 and 39.

1/ For Whitman County approximately 1/4 District Conservationist and 1/2 Range Conservationist time also available for this area

The level of funding, both public and private is a critical element that will affect implementation of works of improvement. It is recommended that implementation be completed within 10 years. In order to achieve this goal, a long term level of federal funding must be authorized so that each landowner will have the incentive to meet the remaining level of funding needed throughout the implementation period. Also the USDA's annual ACP funding limit for farmers should be increased so that extensive work can be done in concentrated areas in the shortest possible time.

CROPLAND

Conservation Planning

Conservation planning will be done with a concentrated effort to minimize adverse environmental effects of on farm practices for erosion and sediment reduction programs. Planners using computer analysis techniques will develop recommendations for improved conservation practice application on each field of each farm. Recommendations for conservation practice installation will be evaluated with recommended physical improvements and potential environmental concerns during planning for implementation. Conservation planning will include reviewing recommendations and environmental concerns with the farm operator and recording his decisions regarding the type and extent of practices to be installed, the schedule for installation, and his agreement to follow recommendations for conservation practice installation.

Long Term Commitments

Long term contracting is recommended as a way to assure the farm operators continued commitment and to secure their cooperation for implementation. The Pleasant Valley Small Watershed Land Treatment Project and Long Term Agreements, LTA's, under ACP provide patterns for administering long term contracts. Initiation of Land Treatment Watershed Projects in this area is a potential that should be investigated to meet special needs of the area.

Demonstration and Monitoring

Typical farms in sample areas of the study area need to be selected for demonstration and monitoring in cooperation with the farm operator. Impacts on water quality of various erosion control practices need to be included in this evaluation. Technical assistance and appropriate equipment will be needed. The Resource Inventory Program of the Soil Conservation Service could be utilized and directed towards meeting the needs of this activity. The Utilization of Washington State Referendum 39 funds for procurement of special conservation tillage equipment by Conservation Districts would also be beneficial to accelerated demonstration.

Implementation Priorities

Study data shows extreme variability in the magnitude of soil erosion and sediment problems throughout the study area. The variability suggests priority rankings so that treatment will start in those areas where the greatest problems exist and the greatest benefits can be achieved. Priority ranking is based on two conditions. One condition considers the extent of erosion problems and those watersheds that have the highest soil erosion rate. The other condition considers potential benefits to downstream areas. A guide for this type of ranking is provided in Table 34.

Table 34.—Potential for implementation of resource conservation programs by watershed, Southeast Washington

Watershed	Erosion and sediment problem 1/	Downstream benefits 2/	Priority
Tucannon	M	H	M
Pataha	M	M	M
Snake	M	-	L
Asotin	L	H	M
Alpowa	H	H	H
Deadman	M	M	M
Alkali Flat	M	-	L
Touchet	H	H	H
Dry	H	-	M
Walla Walla	M	M	M
Grande Ronde	-	-	-

H = High potential
M = Medium potential
L = Low potential
1/ Based on predicted soil erosion and sediment rates in relation to soil loss tolerance levels.
2/ Based on stream habitat study and potential for improvement of water temperatures, spawning habitat and other habitat conditions.

Alternatives evaluated show a broad difference in effects that can be expected depending on the alternative selected. Alternatives discussed previously have been ranked to show their relative impact on: economic conditions, environmental quality, achieving desired soil loss tolerance levels, and changes in crop acreage. (Table 35) The soil loss tolerance alternative ranks highest in this analysis and has been selected as the recommended alternative for implementation.

Table 35.—Comparison of alternatives by ranking to meet various potential objectives, Southeast Washington

Alternative	Objectives					
	$1/ NED	2/ EQ	3/ T	Crop 4/ acreage	Total score	Rank
1. Maximum net income	1	5	4	6	16	4
2. Maximum net income constrained acreage	3	6	5	3	17	5
3. Soil loss tolerance	2	2	1	5	10	1
4. Soil loss tolerance(constrained acreage)	4	4	3	4	15	3
5. Soil loss tolerance (present acreage)	6	3	2	1	12	2
6. Minimum erosion	7	1	7	7	22	7
7. Present situation (do nothing)	5	7	6	2	20	6

1/ NED = best meet National Economic Development Objective
2/ EQ = best meet Environmental Quality Objectives
3/ T = alternatives that best meet soil loss tolerance objective
4/ Crop acreage = alternatives that will have least effect on shifts of crop acreage from present conditions.

Federal cost-share rates to implement an erosion control program to reduce erosion rates on cropland to soil loss tolerance levels should not be more than 65 percent. This 65 percent cost-share rate will require an estimated $6,924,000 in federal funds over a 10 year period. The cost-share would include $5,549,000 cost share assistance for construction and $1,375,000 for administrative and technical assistance. (Table 36) Costs of applying conservation practices for the soil loss tolerance alternative are shown on table 37.

Table 36.—Annual levels of funding needed for implementation of erosion control practices on cropland, Southeast Washington

	Federal			
Year	Construction	Admin. & technical assistance	Local	Total
1	205,519	137,500	110,664	453,683
2	411,041	137,500	221,328	769,869
3	616,555	137,500	331,992	1,086,047
4	616,555	137,500	331,992	1,086,047
5	616,555	137,500	331,992	1,086,047
6	616,555	137,500	331,992	1,086,047
7	616,555	137,500	331,992	1,086,047
8	616,555	137,500	331,992	1,086,047
9	616,555	137,500	331,992	1,086,047
10	616,555	137,500	331,992	1,086,047
Total	5,549,000	1,375,000	2,987,928	9,911,928

Table 37.—Cropland conservation practices, acreages and costs by watershed for the soil loss tolerance alternative, Southeast Washington[1]

	Conservation tillage		No till		Divided slope, terraces & stripcropping		Hay, pasture & seedout		Total cost
Watershed	1,000 ac	$1,000	1,000 ac	$1,000	1,000 ac	$1,000	1,000 ac	$1,000	$1,000
Tucannon-Pataha	22	127	6	91	-	-	3	105	323
Snake	69	398	44	669	-	-	-	-	1,067
Asotin	26	150	2	30	-	-	-	-	180
Alpowa	-	-	3	46	-	-	1	35	81
Deadman	23	133	-	-	-	-	4	140	273
Alkali Flat	71	410	6	91	-	-	-	-	501
Touchet	91	525	88	1,338	-	-	-	-	1,863
Dry	41	237	28	426	16	293	-	-	956
Walla Walla	11	63	5	76	9	165	-	-	304
Study area	354	2,043	182	2,768	25	458	8	280	5,549

1/ Based on additional acreage needed over present conditions.

2/ Costs computed as follows: conservation tillage, $5.77/ac; no-till, $15.21/ac.; divided slopes, terraces or strips, $18.32/ac.; seeding, $35.00/ac.

RANGELAND

Implementation programs for rangeland can best be directed at improvement of the forage resource. Increased red meat production and greater net returns from rangeland would be the primary benefit of such a program. Some minor reductions in soil erosion and sediment delivered to streams would also occur.

Total installation costs of applying needed rangeland management practices are estimated at nearly $3 million. Annual costs of applying and maintaining proper use and planned grazing systems are estimated at $1.6 million. Additional costs of technical assistance and administration of the program is estimated at $748,000.

An estimated five to ten percent of the rangeland in the area is not grazed by domestic livestock. Some of these areas are small and intermixed with cropland or forest areas. In some cases farmers have discontinued livestock production for economic or other reasons. Because of this non-use of the resource, implementation program costs can be reduced by five to ten percent.

Table 38.—Conservation practice needs, acreage and cost, by watershed, rangeland, Southeast Washington

	PU and PGS		PU and PGS 1/ & seeding			PU, PGS and 1/ brush control		
Watershed	Ac.	Annual Cost 2/	Ac.	Annual Cost 2/	Installation Cost 2/	Ac	Annual Cost 2/	Installation Cost 2/
Tucannon-Pataha	45,690	$217,027	16,420	$77,995	$574,700	--		
Grande Ronde	18,210	$86,498	4,510	$21,422	$157,850	410	$1,948	$8,200
Snake	100,880	$479,180	36,720	$174,420	$1,285,200	--		
Asotin	15,700	$74,575	5,680	$26,980	$198,800	2,100	$9,975	$42,000
Alpowa	15,800	$75,050	5,570	$26,458	$194,950	--		
Deadman	23,610	$112,148	7,370	$35,008	$257,950	--		
Alkali Flat	8,860	$42,085	3,240	$15,390	$113,400	--		
Touchet	14,830	$70,442	2,860	$13,585	$100,100	--		
Dry	1,210	$5,748	470	$2,232	$16,450	--		
Walla Walla	5,430	$25,792	1,130	$5,364	$39,550	--		
Study Area	250,220	$1,188,545	83,970	$398,858	$2,938,950	2,510	$11,923	$50,200

1/ Proper use and Planned grazing system
Cost: Total annual - 1,599,326; Total installation - 2,989,150

2/ Costs used as follows:
PU and PGS - Annual, $4.75/ac.; Installation, -0-
PU, PGS and Seeding - Annual, $4.75/ac.; Installation, $35/ac.
PU, PGS and Brush Control - Annual, $4.75/ac.; Installation, $20/ac.

FORESTED AREA

There is a demonstrated need to reduce erosion and sediment originating in the forested area. Though erosion rates seldom exceed T in the forested area, there are concentrated areas where erosion is causing problems for long range production of timber and degradation of other resource values. Sediment levels in the forested area are lower than they are in range or cropland areas. However, most of the streams in the forested area are class AA and strict water quality standards are required. A major part of the fish spawning and rearing habitat in the study area is within the forested area. Research conducted for this study and in other fisheries studies show that sediment deposition in forested area streams greatly reduces their value for fish spawning and rearing.

Forest Practice Rules and Regulations—a tool for implementation

The State of Washington developed interim forest practice rules and regulations in 1975. These rules were intended to be a tool for the Department of Natural Resources to protect such valuable forest resources as forest soils, fisheries, wildlife, water, recreation, and scenic beauty. The rules and regulations were evaluated and updated through a series of emergency orders and were published as Title 222 WAC in 1976. The Forest Practices Board has continually monitored the rules. With considerable input from the Forest Practices Advisory Committee and organizations representing a variety of concerns, the rules were updated in 1982. They are published in "Washington Forest Practices Rules and Regulations" by the Washington State Forest Practices Board. Forest practices regulations are administered and enforced by the Department of Natural Resources.

The Forest Practices Rules and Regulations were in effect for only 4 years prior to the season the inventory was conducted for this study. As a result it is difficult to evaluate the impact these regulations could have in reducing the level of erosion or sedimentation resulting from forest practices. Heavy timber cutting and high road densities and associated high sediment rates were found in the forested area in the Pataha drainage. This condition indicates that strict compliance with the rules and regulations is needed to maintain the high quality of forestry resources found in the Blue Mountains.

Federal and Industry Plans and Monitoring—more tools

Federal lands are managed under management plans that are developed by an interdisciplinary approach that is designed to offer a level of protection to all the valuable resources in the area. There are several levels of plans from regional to project levels. There is variation in the level of concern used in the execution of these plans. As a result some projects have adverse impacts to other resources.

The Umatilla National Forest maintains a specially monitored watershed called the Umatilla Barometer Watershed. The purpose of this watershed is to determine the applicability of research information to the Blue Mountain physiographic province. From studies conducted in the Barometer Watershed foresters and hydrologists are able to predict impacts on water quality and quantity from various management practices. There is a need to transfer the technology developed in the Barometer Watershed to forest managers in the remainder of the Blue Mountains.

Like federal forest lands, most industry land is managed under the direction of long range plans. These plans are generally designed to maximize the yield of timber and take advantage of favorable market periods. Protection of other resources is usually incorporated in the plans. Again, there is variation in execution of the plans and in the protection afforded other resources.

Non-industrial Forest Lands—a focus for implementation

The problem areas are primarily non-industrial forest lands that are typically managed without long term plans. Projects tend to be developed on these lands without the benefit of technical expertise available to industry or federal land managers. The non-industrial private forested area in southeast Washington is a comparatively small area that is surrounded with either state boundaries or large expanses of range and cropland. This imposes a managerial problem on the Department of Natural Resources in staffing forest practices enforcement personnel.

The non-industrial private forest land managers have a need for better access to forest land management technical expertise. Such expertise is needed to prepare forest plans designed to meet the needs of the land managers and reduce erosion and sedimentation. This is within the area of responsibility of the Washington State Department of Natural Resources and the U.S. Soil Conservation Service. Unfortunately, the small acreage of non-industrial private forest land in the area (about 90,000 acres) has been thought to be not enough to justify a full time service forester or forestry trained soil conservationist. The average annual area harvested from 1977 through 1982 on non-industrial private forest land in the study area is 3,087 acres. To provide adequate forestry technical expertise for both forest practice regulations enforcement and planning assistance would require a minimum of 1 staff year at an estimated $30,000 per year. This effort would include about 6 staff months for enforcement activities (Department of Natural Resources) and about 6 staff months for forest conservation planning (Soil Conservation Service).

Implementation for the Forested Area—priorities

Roads and streams are the sources of erosion and sediment that produce the highest rates. The study demonstrated that these are also the areas where the most cost effective remedial treatments can be applied. Table 39 shows a summary of costs for the watershed with the best opportunities for reducing sediment in the study area. There are a number of ways of developing priorities from this table. If priorities are based on the lowest installation cost for the 10 percent sediment alternative on federal land the priority watershed would be Touchet, Tucannon, Pataha, and Asotin. If the lowest installation cost for obtaining the 10 percent sediment alternative on all lands is used, the priority listing would be Tucannon, Pataha, Touchet, and Asotin. There are other obvious combinations. A priority rating that appears to be most reasonable from an economic standpoint is based on the annual cost per ton of sediment reduced. This priority basis results in Tucannon, Touchet, Dry, and Asotin as the order.

The preferred method of prioritizing drainages from this study is based on the sediment yield in tons per year from roads and streams. The rationale here is that these are the sources selected for treatment most commonly in all the watersheds. The top three priorities here are Pataha, Touchet, and Dry watersheds.

In this report the study team has identified the problems in quantitative terms, developed least cost alternatives for reducing erosion and sediment by varying increments, suggested possible alternatives for preventing reoccurrence of these problems and identified the possible sources and levels of assistance for implementation. It is now the responsibility of the sponsors and the local forestry community to develop action plans to use the tools and suggestions developed in this report.

Watersheds which can be treated at the lowest cost and have best potential for fishery habitat improvement have been selected as priority areas for implementation programs.

Table 39.—Summary costs for remedial alternatives, forested area, Southeast Washington

Item	Sediment reduction alternatives		
Watershed	10%	20%	30%
	Dollars		
Installation cost federal land			
Tucannon	13,214	82,640	404,133
Pataha	20,705	72,760	177,585
Asotin	36,080	132,540	288,242
Touchet	10,785	41,752	96,810
Installation cost non-federal land			
Tucannon	409	2,561	12,499
Pataha	11,646	40,928	99,893
Asotin	12,026	44,180	96,081
Touchet	27,734	107,880	248,941
Technical assistance			
Tucannon	40	250	1,250
Pataha	1,150	4,100	10,000
Asotin	1,200	4,400	9,600
Touchet	2,800	10,800	25,000
Installation cost per ton			
Tucannon	79.67	249.86	813.73
Pataha	179.73	316.68	514.80
Asotin	178.83	329.09	476.83
Touchet	105.81	205.82	316.62
Annual cost per ton			
Tucannon	5.58	17.66	57.75
Pataha	13.20	30.14	40.01
Asotin	12.80	23.71	34.32
Touchet	7.46	14.63	22.72

STREAM CORRIDORS

Implementation of land treatment programs on cropland will reduce erosion rates to tolerable levels, decrease the rate of declining soil productivity, reduce sediment delivered to streams and increase net farm income. However, high water temperature problems will continue and stream habitat conditions will not be improved significantly unless an improved stream corridor management program is initiated.

The Pacific Northwest Power Planning Council is presently initiating a program for fishery and wildlife enhancement. Funding for implementation of approved projects is being provided by the Bonneville Power Administration. Total cost of installing structural bank stabilization and revegetation of the stream corridor is estimated at $9,277,000 if all streams in the area with potential for improvement are treated. Those streams with highest potential are the Tucannon River, Asotin Creek, Alpowa Creek and the Touchet River. Cost of installing improvements needed on these streams is estimated at $5,175,000. Additional costs for administration and technical assistance are estimated at $1,294,000. Washington State Referendum 39 funds are another potential resource for meeting needs in this area since high water temperatures are a water quality problem.

Table 40.—Cost of installation, stream corridor management practices by watershed, Southeast Washington

Watershed	Vegetative shade		Bank stabilization		Total cost
	Miles 1/	Cost $1,000 2/	Miles	Cost $1,000 3/	$1,000
* Tucannon	40	560	5.0	1,320	1,880
Pataha	30	420	4.4	1,162	1,582
* Asotin	28	392	2.4	634	1,026
* Alpowa	8	112	1.7	449	561
Deadman	15	210	1.5	396	606
* Touchet	56	784	3.5	924	1,708
Walla Walla	50	700	4.6	1,214	1,914
Total	227	3,178	13.7	6,099	9,277

1/ Includes both banks of the stream

2/ Includes cost of planting trees, shrubs and grass with fencing at $3,500/ac = approx 4 ac/mi = $14,000/mi.

3/ Estimated cost = $50.00/linear ft. Distance shown is for entire eroded area. With site evaluation it is expected that stabilized distance will be less (only severely eroding acres will be treated).

* High priority stream with best potential for improvement because of perennial flow, remnant population of fish and generally good biological condition.

Glossary

alkalinity: The quality or state of being alkaline; the concentration of OH negative ions.

alluvium: Material, including clay, silt, sand, gravel and mud, deposited in riverbeds, lakes, alluvial fans, valleys, and elsewhere by modern streams.

amortized: equal payments over a time period at WRC current discount rate to pay off a given indebtness.

anadromous fish: Adult fish that ascend rivers from the ocean at certain seasons to reproduce; young rear partially in freshwater then in saltwater; for example, salmon, steelhead, and shad.

annual cropping: A system of growing crops on the same land each year as opposed to a system which includes alternate years of crops with summerfallow.

annual precipitation: The amount of atmospheric condensation, in the form of snow, sleet, hail, rain, dew and fog, that falls on an area during a complete year.

average annual erosion: The average amount of erosion that occurs during the period of one year.

basalt: A fine-grained, dark-colored rock commonly found beneath a large area of soils of the Palouse Country of Eastern Washington.

board feet: A unit of measure of the wood in lumber, logs, bolts, or trees; the amount of wood in a board 1 foot wide, 1 foot long, and 1 inch thick before surfacing or other finishing.

bottom land areas: Lowland areas through which a river or stream flows.

braided stream: a stream with several unstable channels; usually the result of high sediment deposition.

brush control: Management and manipulation of stands of brush by mechanical, chemical, or biological means or by prescribed burning to achieve specific management objectives.

check dams: Small dam constructed in a gully or other small watercourse to decrease the streamflow velocity, minimize channel scour, and promote deposition of sediment.

chinook salmon: A variety of Pacific salmon common to the Columbia River System that utilize tributary streams of the Columbia and Snake for spawning and early stages of the life cycle.

climatic conditions: The prevailing or average weather conditions as determined by temperature and meterological conditions over a period of years.

climax plant community: The highest ecological development of a plant community capable of perpetuation under the prevailing climatic and edaphic conditions.

commodity programs: Farm programs instituted to deal with problems of erratic crop production, changes in labor requirements and scientific and technical improvements.

compaction: The process by which the soil grains are rearranged to decrease void space and bring them into closer contact with one another, thereby increasing the weight of solid material per cubic foot.

concentrated flow erosion: Erosion that may include channels of any size but usually is located in depressional areas. It is often caused by drill rows or tillage marks which "lead" the water to these areas. It usually is found in the same area each year the field erodes. It usually is wider and deeper than rill erosion and occurs in the main stems of the topographic drainage network. It is a one year event which is removed during tillage operations. It can occur where terraces "pipe" or overtop and can occur in the bottom of gradient terraces.

conservation districts: A public organization created under state enabling law as a special-purpose district to develop and carry out a program of soil, water, and related resource conservation use, and development within its boundaries; usually a subdivision of state government with a local governing body.

conservation cropping systems: : Growing crops by using a combination of needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes, as well as rotations in which the desired benefits are achieved without the use of such crops. It is a cropping system which protects the soil from erosion while growing crops.

conservation practices: Practices used to control erosion, conserve water, protect plants, or generally improve soil, water and plant resources. A technique or measure used to meet a specific need in planning and carrying out soil and water conservation programs for which standards and specifications have been developed.

constrained: A limiting factor or an activity level which represents a physical action to be taken.

cost share programs: National farm programs developed whereby the farmer and the U.S. Government share together in the cost of applying conservation practices on the farmers' land.

crop residue: The portion of a plant or crop left in the field after harvest.

crop rotation: The growing of different crops in recurring succession on the same land.

cropping systems: A sequence of crops adapted to a particular climatic area. It may include grasses and legumes in rotation, fallow, cover crops and the cultural and management measures needed to successfully grow these crops.

cultivation: To prepare land by tilling of the soil for the production of crops.

debris: The loose material arising from the disintegration of rocks and vegetative material; transportable by streams, ice, or floods.

debris dams: A barrier built across a stream channel to retain rock, sand, gravel, silt, or other material.

deep percolation: Water that percolates below the root zone and cannot be used by plants.

dissolved oxygen levels: Amount of oxygen dissolved in water; salmonoids require at least five parts per million.

divided slope farming: Use of more than one crop or field condition to divide slopes.

drainage boundary: The topographic divide of an area measured in a horizontal plane from which direct surface runoff normally drains into a stream.

drainage ditches: A shallow graded ditch for collecting excess water within a field.

dry crops: Crops produced in low rainfall areas without irrigation.

ecology: The study of interrelationships of organisms to one another and to their environment.

ecological condition: The present state of vegetation of an ecological site in relation to the climax plant community for the site.

ecological site: A distictive kind of land that has the ability to produce similar kinds, amounts and portion of vegetation.

elevated stream temperatures: Water temperatures that are higher than they would be under normal flow conditions and normal historic stream shading.

environment: The sum total of all the external conditions that may act upon an organism or community to influence its development or existence.

erosion: The wearing away of the land surface by running water, wind,ice, or other geological agents, including such processes as gravitational creep. The following terms are used to describe different types of water erosion.

- **gulley erosion:** The erosion process whereby water accumulates in narrow channels or depressions and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 to 2 feet to as much as 75 to 100 feet.
- **natural erosion:** Wearing away of the earth's surface by water, ice or other natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man.
- **rill erosion:** An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently cultivated soils.
- **sheet erosion:** The removal of a fairly uniform layer of soil from the land surface by runoff water.
- **stream channel erosion:** Lateral recessions of the streambanks and/or degradation of the streams bottoms by stream flow action.
- **tillage erosion:** The downhill movement of soil by use of tillage implements for crop production.

erosion rate: The amount or degree of wearing away of the land surface.

erosive: Refers to wind or water having sufficient velocity to cause erosion. Not to be confused with erodible as a quality of soil.

evaporation: The process by which a liquid is changed to a vapor of gas.

farm commodity programs: National farm programs developed to alleviate economic problems resulting from over-production.
fertilizer: Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth.
fish habitat: An area in a stream or lake that is suitable for fish to live including abundant food, hiding cover, suitable water quality, spawning areas, etc.
flood control: Methods or facilities for reducing flood flows.
floodplains: Nearly level land situated on either or both sides of a channel that is subject to overflow flooding.
forage production: The weight of forage that is produced within a designated period of time on a given area; may be expressed as either green, air-dry, or oven-dry; may also be modified as to time of production such as annual, current year's, or seasonal forage production.
forbs: Herbaceous plants which are not a grass or grass like.
forest areas: A area associated predominently with trees and other woody vegetation.
forest management practices: Employing a number of practices such as planting, logging, fire and disease control in such a way that desired goals of use and conservation are achieved.
grassed waterway: A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from cropland.
gross receipts: production times current normalized prices.
habitat: The environment in which the life needs of a plant or animal organism, population, or community are supplied.
habitat degradation: The lowering of value of habitat.
headwaters: The source of a stream.
herbage: The annually produced biomass of vascular plants.
herbicide: A chemical substance used for killing plants, especially weeds.
hydromulch: A process used in seeding grass in areas with difficult access in which the seed is applied by spray with water and sawdust or other mulch material. Frequently used on road cuts.
instream structure: Features such as logs, rocks, and root wads that create pools and provide resting and hiding areas for fish.
intra-gravel: Within the gravel in the bottom of a stream.
irrigated crop: Crops grown in an area of low precipitation with the aid of irrigation.
juvenile salmonoids: salmon or steelhead from the time they emerge from the gravel until they migrate to saltwater.
key climax species: Important plant species on a specific ecological site that are used to base management decisions and determine trend.
loamy sites: Sites in which soils are intermediate in texture and have properties between fine-textured and coarse-textured soils.

loess: Material transported and deposited by wind and consisting of predominantly silt-sized particles.

mean annual precipitation: Average annual precipitation that is recieved in an area over a period of one year.

meandering pattern (stream): A stream with broad sweeping curves as opposed to straight or braided.

minimum tillage: The least amount of tillage required to create the proper soil condition for seed germination and plant establishment.

mixed conifer: A forest compound of two or more species of coniferous trees.

mulch: A natural or artificial layer of suitable materials that aid in soil stabilization and soil moisture conservation, thus providing micro-climatic conditions suitable for germination and growth.

mulch tillage: Preparation of the soil in such a way that plant residues or other mulching materials are specifically left on or near the surface.

native grasses: Grasses that are part of an area's original fauna or flora.

net returns: Returns above variable costs available to pay for land, capital, management, labor and risk.

no-till: A method of planting crops that involves no seedbed preparation other than opening the soil for the purpose of placing the seed at the intended depth.

on-site: Relates to occurring on the farm, as opposed to off-site, which relates to downstream effect of erosion or sediment.

organic matter: The organic fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population; commonly determined as the amount of organic material contained in a soil sample that passed through a 2-millimeter sieve.

oxygenated water: Water containing oxygen; in streams the result of water splashing over riffle.

pasture: An area devoted to the production of forage, introduced or native, and harvested by grazing.

peak runoff: The highest value of runoff resulting from an individual storm event.

percolation: The downward movement of water through soil, especially the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

pesticide: Any chemical agent used for control of specific organisms; such as insecticides, herbicides, fungicides, etc.

planned grazing system: A system of grazing in which two or more grazing units are alternately rested in a planned sequence over a period of years. The resting period may be throughout the year or during the growing season of the key species.

pollution: The condition caused by the presence in the environment of substances of such character and in such quantities that the quality of the environment is impaired or rendered offensive to life.

pools: Areas of a stream where the velocity of current is reduced.

pores of gravel: Spaces within the gravel.

proper grazing use: Grazing ranges and pastures in a manner that will maintain adequate cover for soil protection and maintain or improve the quality and quantity of desirable vegetation.

rangeland: Land on which the native vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs suitable for grazing or browsing use. Includes lands revegetated naturally or artificially to provide a forage cover that is managed like native vegetation. Rangelands include natural grassland, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes, and wet meadows.

range management systems: Grazing systems applied on rangeland.

range production: The herbage production on a given area of rangeland.

range seeding: Establishing adapted plant species on ranges by means other than natural revegetation.

rearing habitat: living area for juvenile salmon or steelhead.

reduced tillage: A tillage sequence that is performed in a manner to decrease soil disturbance and destruction of crop residues to reduce loss of soil or water relative to conventional tillage.

resident fish: Non-migratory fish such as trout, dace and sculpin.

riparian vegetation: A water influenced plant community; water loving plants along streambanks such as willows and cottonwoods.

river basin: The area drained by a river and its' tributaries.

root zone: The part of the soil that is, or can be, penetrated by plant roots.

runoff (hydraulics): That portion of the precipitation on a drainage area that is discharged from the area in stream channels; types include surface runoff, ground water runoff, or seepage.

sac-fry: Very young salmon and steelhead that are in the process of absorbing the yolk sac attached to their abdomen.

salinity: The concentration of dissolved solids or salt in water.

salmonoids: Trout, salmon and steelhead.

scarify: To abrade, scratch, or modify the surface, for example, to scratch the impervious seed coat of hard seed or break the surface of the soil with a narrow-bladed implement.

sediment: Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of orgin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

sediment yield: The sediment discharge from a unit of drainage area, generally expressed in tons per square mile or acre.

seedout: Planting in area currently in annual crops to perennial crops (grass or hay or retirement from cultivation).

silt: 1. A soil separate consisting of particles between 0.05 and 0.002 millimeter in equivalent diameter. 2. A class of soil texture.

silt loam: A soil texture class containing a large amount of silt and small quantities of sand and clay.

silty clay: A soil texture class containing a relatively large amount of silt and clay and a small amount of sand.

soil depth: The depth of soil to restricting or contrasting layers are measured from the surface: (1) very shallow = 5 to 10 inches, (2) shallow = 10 to 20 inches deep, (3) moderately deep = 20 to 40 inches, (4) deep = 40 to 60 inches, (5) very deep = more than 60 inches deep.

soil loss tolerance levels: The maximum rate of annual soil loss that will permit crop productivity to be obtained economically and indefinitely.

soil moisture: Water retained in the soil for use by plants.

soil organic matter: The organic fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. Commonly determined as the amount of organic material contained in a soil sample passed through a 2-millimeter sieve.

soil productivity: The inherent capacity of a soil to produce a specified crop or sequence of crops in its' normal environment.

soil slip: Areas of varying size that have become saturated, and due to excessive steepness, have slipped downhill - a small land-slide.

spawning beds: Areas within a stream containing clean gravel in which fish deposit eggs to complete their embryonic development.

stream channel erosion: The movement of material, causing a lowering or widening of a stream at a given point.

stream corridor improvements: Conservation practices used to correct problems within a stream corridor.

stream corridor management: Management of a stream, adjacent land and the entire watershed in harmony with natural processes.

stream corridors: A stream and its band of adjacent riparian vegetation.

stream habitat conditions: The condition of a stream and its ability to provide for the key activities of life for organisms that live there.

stream reach: A length of stream channel selected for use in hydraulic or other computations.

stream riffles and glides: Faster, turbulent water within a stream as opposed to a pool.

stream system: A stream and its tributaries into which water within the confines of a watershed will drain.

stripcropping: Growing crops in a systematic arrangement of strips or bands which serve as barriers to wind and water erosion.

stubble mulch: The stubble of crops or crop residues left essentially in place on the land as a surface cover during fallow and the growing of a succeeding crop.

stumpage value: The monetary value of the tree or timber stand before it is cut.

subclass e: Soil groupings within one class in which the letter e shows that the main limitation is risk of erosion.

substrate: The material in the bottom of a stream including rocks, gravel, sand and silt.

summerfallow: The tillage of uncropped land during the summer in order to control weeds and store moisture in the soil for the growth of a later crop.

table lands: A flat, elevated region; plateau; mesa.

technical assistance: Providing practical assistance to land users in planning and applying conservation practices. Technical assistance is often provided in addition to financial assistance such as ACP cost-sharing.

terraces: Enbankments or combinations of embankments and channel constructed across a slope to control erosion by diverting and temporarily storing surface runoff instead of permitting it to flow uninterrupted down the slope.

tillage: The operation of implements through the soil to prepare seedbeds and root beds.

topography: The relative positions and elevations of the natural or man-made features of an area that describe the configuration of its surface.

topsoil: The surface plow layer of a soil; also called surface soil. The original or present dark-colored upper soil that ranges from a mere fraction of an inch to two or three feet thick on different kinds of soil. The original or present A horizon, varying widely among different kinds of soil. Applied to soils in the field, the term has no precise meaning unless defined as to depth or productivity in relation to a specific kind of soil.

transpiration: To give off vapor (waste products) through plant pores.

tributary: Secondary or branch of a stream, drain, or other channel that contributes flow to the primary or main channel.

universal soil loss equation (USLE): An equation used to design water erosion control systems: A = RKLSPC wherein A is average annual soil loss in tons per acre per year; R is the rainfall factor, K is the soil erodibility factor; L is the length of slope; S is the percent slope; P is the conservation practice factor; and C is the cropping and management factor. (T = soil loss tolerance value that has been assigned each soil, expressed in tons per acre per year).

upland areas: The higher part of a region or tract of land. Inland country; upcountry.

urban area: An area predominantly occupied by manmade structures: the Bureau of Census defines communities of over 2,500 as urban areas.

vegetation: The plants of an area or region.

Washington State Conservation Commission: An agency of state government that administers legal and program activities of conservation districts located in Washington's 39 counties.

Washington State Department of Ecology: The state agency responsible for planning, management and regulation for water and related land resources of the state.

water bar: A small berm placed across a wash to divert accumulated water off the road.

water holding capacity: The amount of water that a given soil can hold.

water quality: The chemical, physical and biological condition of water related to beneficial use.

watershed area: All land and water within the confines of a drainage divide or a water problem area consisting in whole or in part of land needing drainage or irrigation.

wetland: Land where water on or near the soil surface is the dominant factor determining the types of plant and animal communities living in the soil or on its'`surface.

wildlife: Undomesticated animals.

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