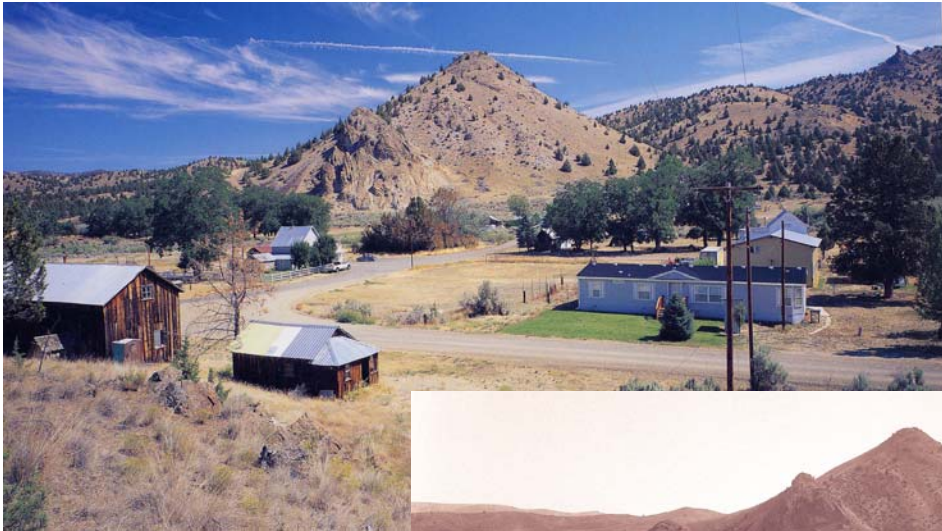


Trout Creek Watershed Assessment

Part 2: Condition Evaluation and Action Opportunities



Ashwood, August 1999



Ashwood, Circa 1897-1918
(Photos: Gifford and Terrel,
Oregon Then & Now)

August 2002

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Trout Creek Watershed Assessment

Condition Evaluation and Action Opportunities

Introduction

The Trout Creek Watershed encompasses 692 square miles. Elevations range from 1,280 feet at the confluence with the Deschutes River to almost 6,000 feet in the Ochoco Mountains. Most of the watershed (88%) is privately owned.

The Trout Creek Watershed plays a critical role in maintaining fish populations in the Deschutes River Basin. The Pelton Dam complex blocks upstream fish passage and limits anadromous fish production to the lower Deschutes River Basin. Accordingly, the Northwest Power Planning Council (2001) has determined that it is important to maintain and improve aquatic habitat and fish populations for tributaries in the lower portions of the basin that have access to the Columbia River. Historically, large numbers of wild summer steelhead trout used the Trout Creek Watershed. The system still supports a significant population of steelhead trout (particularly eastside warm water adapted trout) with most of the production and rearing in the upper areas of the watershed.

This document summarizes the Trout Creek Watershed assessment findings and evaluates opportunities for voluntary Council actions to improve watershed conditions. Information from the assessment is used to identify fish habitat and water quality issues for general areas of the watershed. This synthesis of the assessment findings will help prioritize opportunities for habitat restoration actions and information needs to be addressed through future monitoring and other studies.

Constraints on the Assessment's Conclusions

This assessment used existing information (habitat surveys, monitoring projects, aerial photography, and other sources) to draw conclusions on the status of the watershed. There was very little field-validation of the assessment components such as riparian conditions. As a result, the assessment findings are general. An in-depth assessment of watershed processes and restoration opportunities will require additional field data and monitoring. While the supporting information is limited (especially for specific areas), there is sufficient data and information to develop conclusions on the status of fish habitat and water quality over broad areas. For

Summary of Assessment Findings

The Trout Creek Watershed contains important fish habitats and populations of steelhead trout, especially in the upper watershed, and along key reaches of Trout Creek, Ward Creek, and other tributaries (Figure 1). While the watershed retains some high quality fish habitat, historical and current management impacts have adversely altered watershed processes and habitats. There are a number of opportunities and funding sources for voluntary actions to improve watershed conditions and fish populations.

example, there are reaches along Trout Creek and other important steelhead trout streams where fish habitat survey data have not been collected (Figure 1). In addition, the need to protect landowner privacy limited the collection of information on the condition of upland areas of the Trout Creek Watershed. The upland condition evaluation (for example, erosion) is based on limited information and extrapolations from studies in similar settings.

Because the assessment does not provide recommendations for site-specific areas or land ownerships, future habitat projects will require additional evaluations before a habitat improvement project can be developed and implemented. Field inventories of stream channels, riparian areas, and other habitats are necessary to assess conditions and design appropriate actions. These habitat assessments and project planning steps will require the cooperation of private landowners.

Key Watershed Characteristics and Processes

To understand present and potential fish production in the Trout Creek watershed, it is necessary to know the status of watershed processes and habitat characteristics. Complex ecological processes are created from interactions by more than one habitat component. Stream channel types, sediment transport and delivery, riparian conditions, water quality, and water quantity are all expressed as channel habitat. All of these habitat interactions influence fish populations.

To evaluate watershed conditions, the assessment team analyzed information on fish habitat and populations, channel characteristics, hydrology, riparian areas, wetland, and water quality. The assessment team concluded that, while the Trout Creek Watershed retains some productive habitats and populations of fish, historical and current management impacts have altered watershed processes and habitats. By the beginning of the last century, intense grazing had changed vegetation patterns throughout the watershed. Currently, through improved management practices, the watershed's rangelands and riparian vegetation are slowly improving. There are, however, other "historical legacies" that are impacting fish habitat and water quality and slowing the recovery of the watershed's resources. Some of these are

- Flood control berms along Trout Creek and channelization of other streams have affected areas that once had very productive fish habitat. These channel impacts are widening the streams (or causing down cutting), reducing habitat complexity, limiting riparian vegetation, and constraining interaction with the floodplain. These changes in channel characteristics can result in reduced summertime flows, increased water temperatures, less water storage in the floodplain substrate, and less productive fish habitat.
- Fish passage barriers affect the quality of and quantity of fish habitat. These barriers include permanent installations such as road and railroad crossings, or temporary barriers through water withdrawal management activities (such as pushup dams) or extreme low flow conditions that isolate stream habitats. Figure 2 illustrates how fish passage barriers are affecting the current distribution of steelhead trout.
- The road network, especially the gravel roads, can generate and deliver excess sediment to the streams. Once in the stream channel, sediment can limit the quality of fish habitat by filling pools, widening the channel, and contributing to stream warming.

- By the early 1900s, most of the Trout Creek watershed had been intensively grazed by sheep and cattle. These historic grazing management actions have reduced the quantity and quality of range and riparian vegetation

These historical conditions, combined with current factors such as reduced summertime stream flows, “flashy peak flows”, and areas where riparian vegetation are not properly managed, have reduced the quality and quantity of fish habitat in the Trout Creek Watershed. Table 1 summarizes the key findings for each of the assessment components for the entire watershed. The overall summary is followed by assessment findings for each of the five subbasins.

Figure 1. Juvenile summer steelhead trout (age 1+) habitat quality ratings for streams in the Trout Creek Watershed (based on ODFW fish habitat inventory data 1998, 2000, 2001). Note that fish habitat has not been inventoried along significant stream segments.

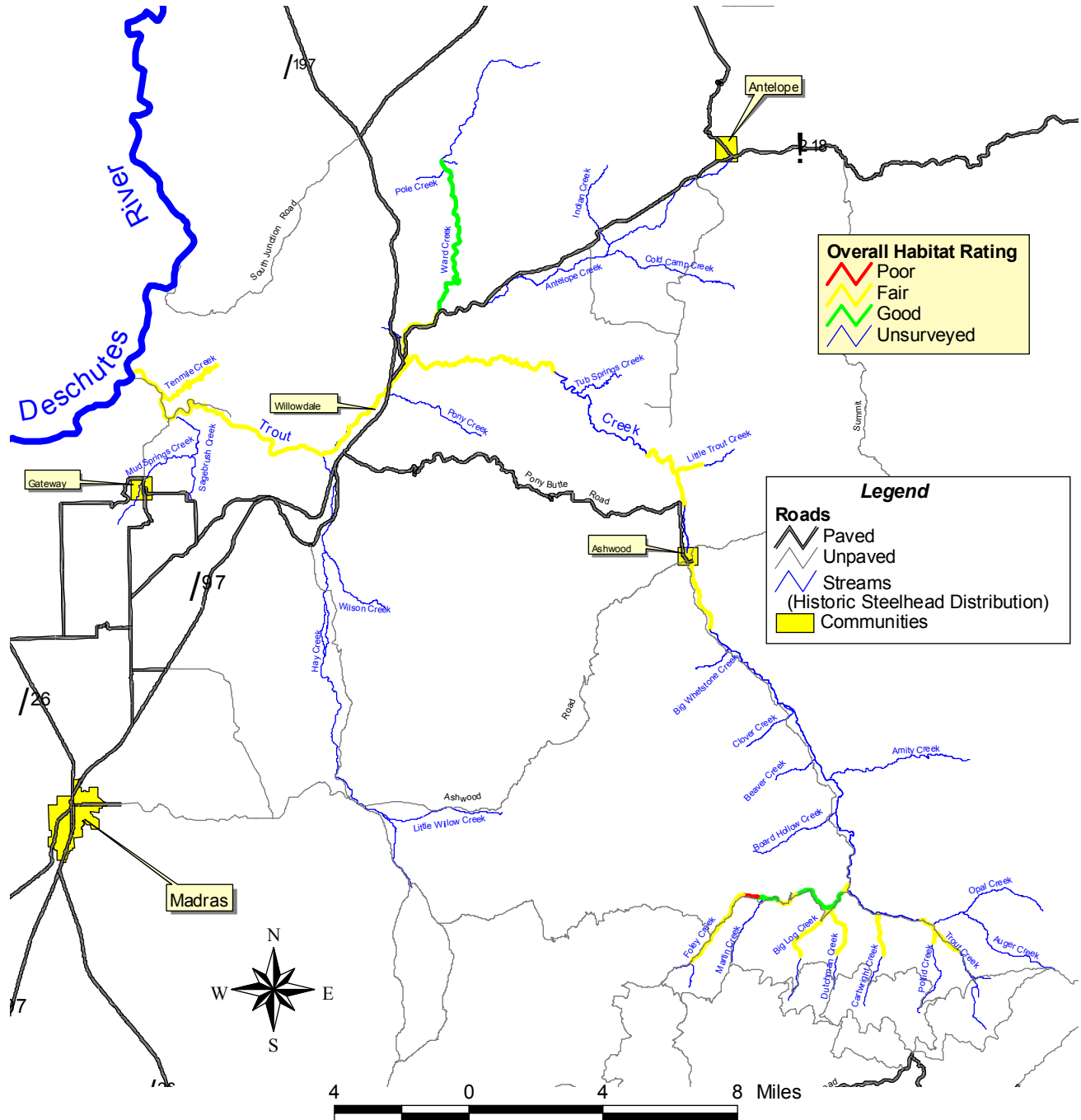


Figure 2. Historical and current steelhead trout distributions in the Trout Creek Watershed (ODFW 2002). Fish passage barriers are limiting the distribution of summer steelhead.

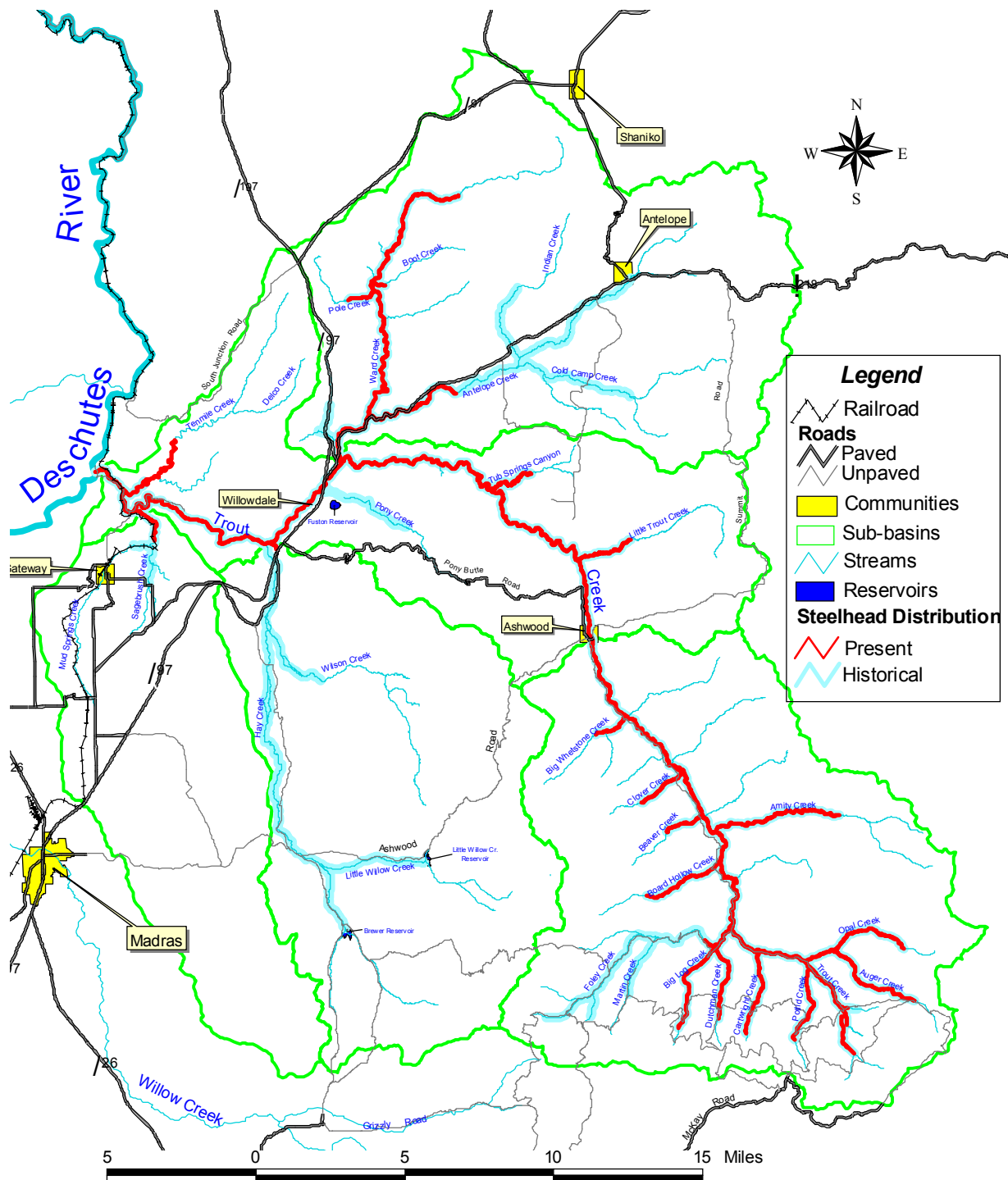


Table 1. Key assessment findings.

Assessment Component	Overall Findings
Channel	<ul style="list-style-type: none"> • Many channels have been directly modified (by straightening or flood control berms) or indirectly modified through changes in watershed processes (changes in inputs of sediment, water, and wood). • Some of the modified reaches (e.g., bermed areas on Trout Creek) are within broad valley areas that have some of the most responsive channel segments. These areas probably historically contained the best main stem habitats. Channel straightening and berms have reduced sinuosity and channel length, thus reducing fish habitat quantity and quality. • Upper Trout Creek and Degner Canyon (lower Trout Creek) retain some of the best habitat.
Hydrology	<ul style="list-style-type: none"> • Low flows have been modified through water withdrawals and loss of storage from reduced wetlands and floodplain-channel interactions. Key fish production areas impacted by reduced flows are the lower portions of Trout Creek and Antelope Creek. • Peak flows have been modified through loss of structure in the stream channels, reductions in wetland habitats, increased distribution of western Juniper and exotic plants and altered the timing in runoff from roads and other management practices. • The system has lost the ability to “absorb” high flows through the loss of floodplain connectivity (through channel straightening, and berms), reductions in wetlands, and reduction in channel complexity. • Late summer flows in Trout Creek below the confluence of Sagebrush Creek are almost solely due to discharge from Sagebrush Creek.
Riparian / Wetland	<ul style="list-style-type: none"> • Based on limited data (aerial photo interpretation), approximately 31% of the riparian areas are in satisfactory condition. • Historic grazing management has affected riparian conditions. Some current grazing management practices can limit riparian vegetation. Based on analysis of aerial photography (with limited field validation), these historic and current grazing management practices affect approximately 34% of the riparian areas. • Berms limit riparian vegetation growth along the most responsive low gradient reaches of Trout Creek. • Based on analysis of aerial photography, there is minimal shading over many of the channels in the watershed (approximately 75%). The highest shade levels are in the Upper Trout Creek Subbasin, where higher precipitation levels contribute to more vegetation and faster growth. It is difficult to assess if shade is below historic levels. However historical and current actions (roads, berms, grazing, and other impacts) are affecting riparian conditions and limiting shade levels. • Riparian fencing projects and management have significantly improved riparian conditions in key areas (for example, the upper watershed).

Assessment Component	Overall Findings
	<ul style="list-style-type: none"> • There is limited area in wetlands (1,441 acres, based on National Wetland Inventory Data), with the highest density of wetlands in the Antelope Creek Subbasin (0.5 % of the area occupied by wetlands). • It is difficult to assess the historical extent of wetlands, although areas with hydric soils appear to indicate that wetlands were more extensive. Using this indicator, wetlands occupy 15% of the area they occupied historically. This reduction in wetland area may adversely affect flood and low flows in the watershed.
Sediment	<ul style="list-style-type: none"> • Sediment transport and deposition in stream channels appears to be elevated above historic levels. • Based on limited data, it is difficult to conclude what management actions are contributing to increased sediment loads. Gravel roads can contribute sediment if there is not proper drainage. Upland management practices, in areas with erosive soils and steeper slopes can also contribute sediment. • The highest density of gravel roads with the potential to deliver sediment is in the Upper Trout Creek Subbasin.
Water Quality	<ul style="list-style-type: none"> • It is difficult to say what water temperature patterns were historically. However, water temperature patterns throughout the watershed appear to be elevated. Key factors affecting water temperatures are modifications in riparian conditions from management and roads, low flow conditions, and widening of channels.
Fisheries	<ul style="list-style-type: none"> • On the main stem, Degner Canyon and upper Trout Creek have the best fish habitat quality. • Of the subbasins, Upper Trout Subbasin has best habitat quality and the highest numbers of steelhead trout production and rearing. • Berms placed in the mid-1960s are influencing channel form, limiting floodplain connection, and reducing habitat complexity and fish habitat quality. • High water temperatures limit fish production throughout the basin. • Low summer stream flow conditions, especially in Trout and Antelope Creeks, affect habitat quality by increasing temperatures, reducing pool habitats, and limiting fish movement. • Although there have not been detailed inventories, fish passage barriers affect significant portions of the Mud Creek, Antelope, and Hay Creek subbasins.

Current Studies and Ongoing Monitoring

There are a number of ongoing monitoring projects in the Trout Creek Watershed. These data-gathering projects, managed by ODFW in cooperation with the Jefferson County Soil and Water Conservation District, include:

- Smolt trapping in lower Trout Creek.
- Redd Counts in Trout, Antelope and Ward Creeks.
- Extensive water temperature monitoring (see Part 1, Chapter 7 for site locations)
- Stream flow gage on Trout Creek below Sagebrush, Sagebrush Creek near the mouth, and at three gages maintained by the Forest Service in the upper watershed (Trout, Dutchman, and Cartwright Creeks).
- Photo points on implemented projects.

Current and Planned Watershed Enhancement Projects

A significant amount of habitat enhancement and restoration work has been completed or is planned for the Trout Creek Watershed. Before undertaking future habitat restoration project planning, it is important to understand what actions are currently underway. Tables 2 and 3 describe SWCD or Natural Resources Conservation Service (NRCS) projects that have been implemented or are planned for the Trout Creek Watershed.

Table 2. Completed and planned SWCD projects.

<p><u>Completed Projects</u></p> <p>Conservation Reserve Enhancement Program (CREP):</p> <ul style="list-style-type: none">• Approximately 10 miles in upper Trout Subbasin (main stem and 2 tributary streams).• Approximately ½ mile along lower Trout Creek. <p>Spring Developments:</p> <ul style="list-style-type: none">• 2 in lower Trout Creek• 3 in Antelope Creek <p>Infiltration Galleries:</p> <ul style="list-style-type: none">• 2 along Antelope Creek <p>Juniper Control:</p> <ul style="list-style-type: none">• Approximately 100 acres in the Lower Trout Subbasin. <p><u>Planned Projects</u></p> <p>Lower Trout Subbasin:</p> <ul style="list-style-type: none">• Remove approximately 3 miles of flood control berms on lower Trout Creek below Degner Canyon.• Remove flood control berms and the add in-stream structures on a section of Trout Creek below Highway 97. <p>Upper Trout Subbasin:</p> <ul style="list-style-type: none">• Remove flood control berms and stabilize stream banks on a section of Trout Creek above Ashwood.• Install 3 sediment basins along upper Trout Creek.• Install riparian fencing along both sides of Trout Creek over 1 mile.

Table 3. Agricultural management conservation practices implemented and planned by the Natural Resources Conservation Service (NRCS), 1998 to present.

Subbasin	Status	Conserv. Cover	Conserv. Crop Rotation	Residue Man.	Use Exclusion	Pest Nutrient Man.	Upland Wildlife Habitat Man.	Irrigation Water Conveyance Pipeline	Structure for Water Control	Irrig. System/ Sprinkler	Irrig. Water/ Sprinkler	Trough/ Tank	Water/ Sediment Basin
units		acres	acres	acres	acres	acres	acres	ft	#	#	acres	#	#
Mud Springs	Implemented	76.5			76.5								
	Planned		58			126	506	2800		125		4	
Antelope	Implemented	4125	2025	301	4079	2208	2279			2	103		1
	Planned					156	3138						
Hay Creek	Implemented		5088				6649			1			
	Planned												
Lower Trout	Implemented	1265	100		1220	275	162	13001	1	5		5	2
	Planned						5186	5980				6	1
Upper Trout	Implemented	8610	1722		819	981	982	2250		3	57		1
	Planned					50	4588	3750			40		4

Table 3 (cont.). Agricultural management conservation practices implemented and planned by the Natural Resources Conservation Service (NRCS), 1998 to present.

Subbasin	Status	Spring Dev.	Well	Pond	Brush Man.	Tree/Shrub Man. Plantings	Pasture Hay Man. Plantings	Forage Harvest Man.	Range Plantings	Presc. Grazing	Water Pumping Plant	Fencing	Irrig. Gallery	Grazing Man.
units		#	#	#	acres	acres	acres	acres	acres	acres	#	ft	#	acres
Mud Springs	Implemented													
	Planned	2		1	207		48	228		878		3300		
Antelope	Implemented	5	5			71	1070		1440	4534		71		964
	Planned								175					
Hay Creek	Implemented				2282		2544	2544		1780				482
	Planned													
Lower Trout	Implemented	3		2	21			115	1870	5542	2			1184
	Planned	5			374				286	9767				
Upper Trout	Implemented	3			1149					4800		13084	2	1720
	Planned	2			521	62	3		179	11737		5400		

Subbasin Summaries and Action Opportunities

The assessment examined watershed conditions in five subbasins within Trout Creek:

- Antelope
- Mud Springs
- Hay
- Upper Trout
- Lower Trout

Table 4 summarizes the assessment findings and voluntary action opportunities for the five subbasins.

Table 4. Key assessment finding and action opportunities by subbasin.

Antelope Creek Subbasin Key Assessment Findings and Action Opportunities

Channel

- Most of the channels (54%) are moderate gradient, confined channels. Soils are shallow, which probably results in low infiltration rates and flashy runoff during snowmelt and high intensity rainstorms.
- A significant proportion of the stream network is comprised of low gradient moderately confined channels, which are responsive to restoration.
- The stream habitat in the middle reaches (canyon area) of Ward Creek appears to be in good condition.
- Antelope Creek has undergone extensive channelization.

Hydrology

- The sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow in all months for average and dry years.
- Observations indicate that summer flows are low but present through the season.
- Loss of upland water retention, in-channel structure, and floodplain connectivity has increased the potential for “flashy” peak flow events.

Riparian / Wetland

- Based on analysis of aerial photography (with limited field validation), historic and current grazing management is constraining riparian condition (60% of riparian areas).
- Riparian fencing projects are in place along lower Antelope Creek and the upper portions of Ward Creek, and appear to be effective at enhancing riparian conditions.
- Antelope Creek subbasin has the highest proportion of area (0.5 %) currently in wetlands, although this represents what is estimated to be 20% of the historical wetland area.

Sediment

- Significant areas with moderate to high soil erosion hazard ratings.
- Unpaved roads are a potential source of sediment delivery to stream channels.

Water Quality

- High water temperatures. By late May, water temperatures appear to exceed the 64 deg. F standard.

Fisheries

- There is a potential (not inventoried) barrier on Antelope Creek.
- The habitat on Antelope Creek has not been assessed.
- There is fair fish habitat in Ward Creek.
- Steelhead redds have been observed in Antelope (lower portions) and Ward Creek.

Action Opportunities

- ✓ Work with landowners to incorporate more fencing / riparian management along Ward Creek.
- ✓ Conduct a thorough inventory of steelhead redds on Ward and Antelope Creeks.
- ✓ Assess the steelhead spawning, rearing, and upper extent on Ward and Antelope Creeks.
- ✓ Through detailed stream habitat inventories, examine the potential for stream habitat restoration.
- ✓ Increase upland water capture and retention.

Mudsprings Creek Subbasin

Key Assessment Findings and Action Opportunities

Channel

- Moderate gradient confined channels that have entrenched into subtle landscape underlain by deep loam soils.
- A significant amount of the channel network has been channelized or blocked.

Hydrology

- If all of the water is withdrawn under existing water rights, there would be no flow remaining in the stream during low flow period of the year during periods of average stream flow. Currently, there are adequate flows in the lower portions of the stream. These flows are the dominate source of water for Trout Creek below the confluence of Sagebrush Creek in late summer.
- Loss of upland water retention, in-channel structure, and floodplain connectivity has increased the potential for “flashy” peak flow events.

Riparian / Wetland

- Based on analysis of aerial photography, the subbasin has the lowest proportion (10%) of the riparian areas in “satisfactory” condition in the basin.
- Excavation maybe the key cause of wetland loss (37% of wetland area).

Sediment

- There are significant areas with moderate to high soil erosion hazard ratings.
- Unpaved roads are a potential source of sediment delivery to stream channels.

Water Quality

- High water temperatures. By late May, water temperatures appear to exceed the 64 deg. F standard.

Fisheries

- Habitat quality and flow in the lower 1.5 miles is good.
- A railroad grade has altered stream habitat, creating straight channel sections, and barriers to anadromous and resident fish movement. Removing these barriers would be very difficult and expensive, although opportunities may exist for channel enhancement above these barriers.
- Fish habitat quality above the lowest passage barrier is not known.

Action Opportunities

- ✓ Assess habitat quality above the barriers.
- ✓ Maintain riparian exclosure / and encourage management actions on the lower reach.
- ✓ Increase upland water capture and retention.

Hay Creek Subbasin

Key Assessment Findings and Action Opportunities

Channel

- Moderate gradient confined channels that have entrenched into subtle landscape underlain by deep loam soils.
- A significant amount of the channel network has been channelized.

Hydrology

- Large proportion of irrigated lands.
- The sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow in all months for average and dry years.
- Loss of upland water retention, in-channel structure, and floodplain connectivity has increased the potential for “flashy” peak flow events.

Riparian / Wetland

- Based on analysis of aerial photography (with limited field validation), the subbasin is the second lowest in riparian areas rated as “satisfactory” (17%).
- Agricultural management practices (field validation is needed) appears to be a key constraint limiting riparian condition.
- Dikes and impoundments (and the associated loss of connectivity to the floodplain) is probably the key factor limiting wetlands.

Sediment

- There are significant areas with moderate to high soil erosion hazard ratings.
- Unpaved roads are a potential source of sediment delivery to stream channels.

Water Quality

- High water temperatures. By late May, water temperatures appear to exceed the 64 deg. F standard.

Fisheries

- Based on historical use, there is potential fish habitat, but there are no current inventories.
- There appears to be a number of fish passage barriers, though they have not been inventoried.

Action Opportunities

- ✓ Assess fish passage barriers and fish habitat.
- ✓ Increase upland water capture and retention.

Upper Trout Creek Subbasin Key Assessment Findings and Action Opportunities

Channel

- The upper portion of the subbasin has moderate to high gradient (>6 %) headwater streams. There are some short low gradient reaches that flow through wetland meadows.
- In the lower portion of the subbasin, flood control berms influence channel form, reducing sinuosity, habitat complexity, floodplain interaction and riparian vegetation.

Hydrology

- Upper portions of the subbasin have minimal water withdrawals.
- There are active water withdrawals in the lower portions of the subbasin.
- Loss of upland water retention, in-channel structure, and floodplain connectivity has increased the potential for “flashy” peak flow events.

Riparian / Wetland

- Based on aerial photography (with limited field validation) this subbasin has the largest proportion of riparian stands in “satisfactory” condition.
- Berms (10%) and stream-side roads (18%) are key factors limiting riparian conditions.
- Riparian fencing is in place along significant proportions of the upper stream reaches, and appears to be effective at enhancing riparian conditions.
- Because this portion of the watershed has the highest precipitation, riparian vegetation has a faster response time to restoration actions.

Sediment

- There are significant areas with moderate to high soil erosion hazard ratings (though it is difficult to tell what the actual erosion rates are).
- Unpaved roads are a potential source of sediment delivery to stream channels. This subbasin has the highest proportion of unpaved roads, many of which are located along stream channels, with the potential to deliver sediment.

Water Quality

- High water temperatures. By late May, water temperatures in most tributaries appear to exceed the 64 deg. F standard.
- Potential turbidity issues tied to wet roads and snowmelt periods.

Fisheries

- Highest number of miles in the basin with steelhead distribution.
- The subbasin has the most miles of higher quality habitat in the basin.
- Highest steelhead production and rearing numbers in the basin.

Action Opportunities

- ✓ Remove berms and restore channel form and riparian areas.
- ✓ Restore stream flows during the summer in the Trout Creek.
- ✓ Address high water temperatures through flow restoration, channel restoration, and riparian planting / management.
- ✓ Maintain riparian exclosures / management.
- ✓ Address / monitor road-related sediment delivery to stream channels.
- ✓ Increase unland water capture and retention

Lower Trout Creek Subbasin Key Assessment Findings and Action Opportunities

Channel

- A low gradient channel set in a wide alluvial valley characterizes the lower portion of the subbasin.
- Trout Creek is moderately confined, and historically possessed a wider floodplain than present today.
- Berms placed in the mid-1960s are influencing channel form, limiting floodplain connection.
- Channel habitat in Degner Canyon appears to be in good condition, although these channels are of a more confined nature (consequently, they provide different habitat than was historically present in less-confined areas that are currently diked).

Hydrology

- There is a large proportion of irrigated lands.
- The sum of instream water rights, consumptive uses, and storage exceeds the estimated volume of natural stream flow in all months for average and dry years.
- Loss of upland water retention, in-channel structure, and floodplain connectivity has increased the potential for “flashy” peak flow events.

Riparian / Wetland

- Based on analysis of aerial photography (with limited field validation) flood control berms appear to be a key constraint on riparian condition (29 % of riparian area).

Sediment

- There are significant areas with moderate to high soil erosion hazard ratings.
- Unpaved roads are a potential source of sediment delivery to stream channels.

Water Quality

- High water temperatures. By late May, water temperatures appear to exceed the 64 deg. F standard.

Fisheries

- There is steelhead spawning and rearing habitat in Degner Canyon.
- There is steelhead spawning in reaches outside of Degner Canyon, but it is not known where they rear.
- ODFW will continue to conduct spawning surveys.

Action Opportunities

- ✓ Remove berms and restore channel form and riparian areas.
- ✓ Install a new fish smolt trap suitable for low flow conditions.
- ✓ Conduct a thorough inventory of juvenile rearing areas.
- ✓ Remove berms and restore channel form and riparian areas.
- ✓ Restore stream flows during the summer.
- ✓ Address high water temperatures through flow restoration, channel restoration, and riparian planting / management.

Priority Action Opportunities

There are a number of voluntary opportunities to improve fish habitat and water quality in the Trout Creek Watershed. However, there are limited resources and funding so it is necessary to target actions and locations where there will be the greatest success. A framework to help prioritize restoration actions takes into account three important components: 1) the response time of the system to the action; 2) the probability and variability of success; and 3) the longevity of the restoration action (Beechie and others 2002). Those watershed restoration actions that have a high probability of success, low variability among projects, and relatively quick response time should be implemented before other techniques. Table 5 lists a range of actions that could be implemented and their ranking according to this prioritization scheme. Removing fish passage barriers, for example, has a high probability of success and a fast response time. While it is important to be opportunistic with actions (for example, when there is funding and willing landowners), this framework provides some guidance for planning future projects.

It is important to emphasize that before addressing fish passage barriers it is essential to assess fish habitat quality and quantity above the barrier. Once a comprehensive inventory of barriers and habitat is completed then it is possible to prioritize fish passage barrier removal based on habitat gains and project costs.

Table 5. A framework for prioritizing possible habitat restoration actions in the Trout Creek Watershed.

Action	Probability of Success	Response Time	Longevity
Increasing in-stream flows (by purchase or lease of water rights with willing landowners)	High	Fast	Long-term (must be maintained)
Removing fish passage barriers	High	Fast	Long-term
Removing berms / adding channel sinuosity	Medium	Medium	Long-term
Riparian fencing / management	Medium	Medium	Long-term (must be maintained)
Address flashy runoff by increasing upland water storage capacity and floodplain connectivity	High	Medium	Long-term (some installations must be maintained)
Controlling sediment sources	Medium	Slow	Long-term (must be maintained)
In-stream habitat structures	Medium	Fast	Variable

A framework for prioritizing potential actions by subbasin was developed based on discussions with ODFW and Council staff (Table 6). The priority ranking of subbasins was based on the following criteria (in order):

- **Current steelhead production and areas with quality habitat.** It is important to maintain high quality aquatic habitats and areas that currently support steelhead production. The upper Trout Creek Subbasin is a priority since it has the largest steelhead production in the watershed and the most miles of quality habitat.
- **Responsiveness to restoration actions.** Those areas that currently have steelhead production or were historically high quality habitat will respond faster to habitat restoration actions. For example, many of the areas along Trout Creek where there are now flood control berms (and poor habitat quality) had good fish habitat before the berms were in place.
- **Cost versus benefits of restoration actions.** For example, removing fish passage barriers along the railroad grade in the Mud Springs Subbasin would be a very expensive undertaking with minimal increases in steelhead habitat.

It is important to note that while the assessment did not specifically (with the exception of sediment and hydrology) examine upland conditions, effective watershed restoration will require addressing stream / riparian areas **AND** upland conditions. Healthy upland conditions capture, stores, and safely release water over an extended period of time. Implementation of grazing management plans, fencing, upland water developments, juniper and weed control, and range improvement seeding are all necessary actions (Ron Graves, Wasco County SWCD, personal communication). Appropriate upland restoration actions include:

- **Installing water and sediment control basins, wetlands, and other modifications to help store flood waters.** These basins help reduce damage to riparian areas from peak flows and provide additional flow releases during low water periods. Modifying the release of water from uplands, in conjunction with increasing floodplain connectivity, will reduce flashy peak flows and improve the success of instream habitat structures.
- **Encouraging the use of conservation practices on tilled farm ground to reduce runoff and erosion.**
- **Implementing grazing management systems that will result in improvements in range conditions.**
- **Removing noxious weeds.** Invasion of weeds hampers beneficial vegetation, reducing the productivity of range and riparian areas for domestic livestock and wildlife.
- **Eliminating feral pig populations.** Feral pigs root up and destroy wetlands and riparian areas, including off-stream spring developments for livestock water.

Table 6. Restoration priorities for the Trout Creek Watershed subbasins.

Subbasin	Restoration Priority Ranking	Reason For Ranking
Upper Trout	1	Critical steelhead trout production and rearing area. Largest amounts of high quality fish and riparian habitat in the watershed. Addressing flood control berms, flow issues, and road sediment delivery to stream channels will provide a rapid positive habitat response.
Lower Trout	2	Important steelhead trout production area, especially Degner Canyon. It is important to maintain connectivity to upper watershed areas by considering flow and other issues. Addressing berms and flow issues could provide a fast positive habitat response.
Antelope	3	Some high quality habitat in Ward Creek. Assessment of conditions and addressing fish passage barriers in Antelope Creek could increase habitat connections and quality. Address upland erosion and water retention capability.
Hay	4	Potential fish habitat, but inventories required to gauge habitat quality and the utility of addressing fish passage barriers. Address upland erosion and water retention capability.
Mud Springs	5	Although there is a need for inventory information, addressing fish passage barriers along the railroad grade could be expensive. Continue to manage the riparian lower portions of the stream. Address upland erosion and water retention capability.

Habitat Restoration and Monitoring Action Opportunities

A list of high priority action items was developed based on the assessment findings and discussions with ODFW and Council staff. The following action items should be prioritized by 1) Council objectives for voluntary stewardship, 2) subbasin restoration priority rankings, 3) the need to integrate upland restoration actions (such as range improvement) with stream and riparian actions, and 4) the response of the system to the restoration action and cost-effectiveness. All of these proposed actions will require landowner cooperation, detailed field inventories, and detailed project design before implementation.

Habitat Restoration Project Opportunities

- Extend protection / proper management for currently managed riparian areas. Riparian management strategies should be tailored to the requirements of the site and the landowners needs. There are a variety of approaches, including managing livestock intensity and duration, fencing, and integrating off-channel watering. Explore voluntary programs that provide incentives for riparian management such as the Conservation Reserve Enhancement Program (CREP).
- Target road sediment inputs, especially in the Upper Trout Subbasin, by improving road drainage. The Forest Service is completing a road inventory on their lands. Use this and possibly other inventories to target road drainage issues to limit sediment inputs.
- Expand the use of riparian management and livestock control (timing and duration) to improve riparian conditions. The width of riparian buffers should be based on site-specific issues and the landowner's management goals. There are voluntary programs, such as the CREP, that offer landowners financial incentives.
- Restore wetlands by enhancing channel – floodplain interactions and natural channel morphology.
- Implement improvements in summertime stream flows through increased water use efficiency, transfer of water rights to instream uses, and other voluntary actions. There are voluntary incentive programs to assist landowners with stream flow management.
- Improve channel complexity (wood, sinuosity, floodplain connections, etc.) to moderate peak flows and increase low flows. Targeted removal of flood control berms along Trout Creek will have long-term fish habitat benefits.
- Implement more off-channel livestock watering sites and integrate these projects with other riparian and livestock management improvements.
- Restore water temperature regimes by addressing the integrated factors that are contributing to elevated water temperatures: riparian shade, flow, channel width and depth, and flow. Target actions by priority subbasins.

Assessment and Monitoring Project Opportunities

- Address physical stream habitat inventory gaps. Areas not inventoried on Trout Creek are the highest priority. Channel sections on Antelope and other stream segments should also be inventoried.
- Inventory fish passage barriers in order of priority subbasin: 1) Antelope; 2) Hay; 3) Mud Springs.
- Collect continuous water temperature data with a mid-May FLIR flight and detailed analysis. Use this information to identify springs and other thermal refugia. This information will help identify the mechanisms driving cold water seeps (for example, water returns from irrigation). Once identified, the cooler water areas in the stream network can serve as emphasis areas for projects to protect and extend the cooler water segments.
- Collect physical habitat data (for example, flow, shade, and channel width and depth) above the current water temperature monitoring sites. Perhaps integrate channel sediment measurements with these inventories. These physical habitat data will provide insights into the mechanisms driving water temperature patterns.
- Inventory and investigate smolt migration and rearing.
- Investigate wild–hatchery steelhead trout interactions.
- Investigate mechanisms for loss of flow in key stream reach areas in Trout Creek. It is important to investigate the mechanisms driving water loss (subsurface flow, evaporation, etc.) in these reaches.
- Monitor and assess the effectiveness of habitat restoration projects.
- Reinstall stream gage #14093600 (Trout Creek below Amity Creek near Ashwood). This is a key stream gage with an historical record.
- Inventory all types of water diversions (ditch, push-up dams, etc.) and assess if they are fish barriers or leading to other disruptions in fish movement or trapping.

References

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