Net Economic Benefits of Using Ecosystem Restoration to Meet Stream Temperature Requirements

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Abstract. *As stakeholders respond to temperature TMDLs, many are encountering significant compliance costs and looking for opportunities to lower them.*

Under the temperature TMDL for Oregon's Tualatin River, Clean Water Services (CWS), a wastewater-and-stormwater utility, faced the prospect of installing and operating a chiller at a twenty-year cost of approximately $104-255 million to reduce its thermal load. To lessen its costs, CWS developed an alternative plan to establish riparian forests that provide shade to water upstream of the wastewater facilities and to augment stream flows. Establishing streamside forest will reduce its costs by about $50.5 million. In 2004 the Oregon DEQ approved this plan, the first of its kind in the U.S.

This experiment with thermal-emission trading could provide a roadmap for other watersheds. The wastewater utility for the City of Centralia in western Washington, for example, faces costs of approximately $35 million to install a chiller to comply with the temperature TMDL for the Chehalis River. Using data from CWS, it estimated that it may have a comparable cooling effect on river temperatures at a lower cost by protecting and expanding riparian forest.

Centralia's enthusiasm for streamside shading involves more than the potential savings for wastewater-utility customers. The establishment of riparian forests can provide additional economic benefits besides providing a cost-effective alternative to chillers. Examples in Oregon and California demonstrate that these benefits could be significant, and communities could gain from incorporating riparian restoration as a core element of their efforts to accomplish the objectives of temperature TMDLs.

Keywords*. temperature TMDL, water-quality trading, economics, riparian forest.*

INTRODUCTION

At least 16 states have developed plans for lowering the temperature of water in rivers, streams, or lakes (U.S. EPA, 2006). These plans define the amount of thermal energy, called the temperature total maximum daily load (temperature TMDL), that can be discharged into a water body without causing temperatures to exceed standards. The plans also allocate this load amount among the various thermal sources. Such plans can require wastewater-treatment plants and other point sources of thermal pollution to reduce their thermal emissions. The cost of conventional approaches for doing so, such as installing a mechanical chiller to cool water before it is discharged to a stream, can be daunting. Several communities in the Pacific Northwest, however, are finding they can achieve their goals at a lower cost by enhancing elements of stream-related ecosystems and relying on them to keep rivers and streams cool. This approach also can generate substantial ancillary economic benefits.

COST-EFFECTIVE TMDL COMPLIANCE

Clean Water Services

Clean Water Services (CWS), a wastewater and surface-water utility in suburban Portland, Oregon, is implementing the ecosystem-enhancement approach to meet its obligations under the temperature TMDL established by the Oregon Department of Environmental Quality (ODEQ) for the Tualatin River. CWS serves a population of about 500,000 and operates four wastewater-treatment plants, which discharge into the Tualatin River. Under the temperature TMDL adopted in August 2001, CWS faced the prospect of installing and operating two chillers to reduce its thermal emissions by approximately 920 million kilocalories per day for its two facilities (ODEQ, 2005, p. 57). The chillers would cost CWS approximately $104-255 million over twenty years at present, discounted value. To lessen its costs, CWS developed an alternative plan that aims to satisfy its obligations by establishing riparian forests that will shade water in the Tualatin River upstream of the facilities, and by augmenting stream flows with releases of water from reservoirs upstream of the wastewater facilities (CWS, 2005a).

Table 1 summarizes some major elements of modeling by CWS of the impact of streamside shading on water temperatures. The modeling indicated CWS must establish streamside forests averaging 45 feet wide on each bank of small streams for a distance totaling approximately 17.5 river miles. To compensate for the unproven efficacy of streamside shading, ODEQ has required that CWS plant twice the amount indicated by the modeling, or 35 river miles (CWS, 2005a). CWS has estimated that it can plant the required forest over 5 years for a cost of $29,000 per acre, or $12 million total, and realize savings of $50.5 million, relative to the chiller alternative.

Table 1. Summary of Clean Water Services' Streamside-Forest Program

Variable	Description
Canopy height after 20 years from planting	60 ft.
Canopy density after 20 years from planting	60%
Stream aspect	45^0
Stream width	Target = 10 ft.; Individual projects vary
Location of plantings	Urban and rural areas; Public and private land
Buffer width on each side of stream	Target = 45 ft., both sides of stream; Individual projects vary
Solar energy blocked by trees	18.8 million kcal/day/mile
Thermal credit for trees if trading ratio is 2:1	9.4 million kcal/day/mile
Solar energy blocked by 1 acre of trees	1.46 –1.73 million kcal/day
Thermal credit for 1 acre of trees if trading ratio is 2:1	0.73 – 0.86 million kcal/day
Potential cost of establishing streamside forest (present value)	$12,392,311[a]
Potential saving, relative to chiller alternative (present value)	$50,593,388[a]

Source: ECONorthwest, with data from CWS (2005a), (2005b); Smith and Ory (2005).

[a] The values expressed in 2005 dollars.

This alternative plan, which ODEQ approved in 2004, is the first (and, at this time, the only) of its kind in the U.S. Apart from its financial advantages, it also provides insights into opportunities for water-quality trading. Under the plan, CWS is trading reductions in point-source emissions for upstream reductions in non-point-source emissions. The trading mechanism is entirely in-house, as CWS continues to bear full operational responsibility for satisfying its obligations under the temperature TMDL. ODEQ insisted on a 2-for-1 trading ratio to compensate for uncertainty about the efficacy of streamside shading. To address the uncertainty further, the plan incorporates extensive water-temperature monitoring (ODEQ, 2005). In addition, CWS intends to monitor each planted site's shade level every five years for a 20-year period (CWS, 2005a, pp. 31-32).

The City of Centralia

Approximately 105 miles to the north, the City of Centralia, Washington, is investigating the potential benefits of following in CWS' footsteps. With a population of about 15,000, the city faces the prospect of having to install a chiller on its wastewater-treatment plant, at a 20-year cost of $35 million, to satisfy its potential obligations under the temperature TMDL for the Chehalis River. The city estimates that, by protecting and expanding the existing streamside forest, it may lower its costs to approximately $10 million (Niemi et al., 2006). The city's plan remains preliminary and general, but, as we understand, the Washington Department of Ecology has indicated a willingness to cooperate with the plan as it fleshes out the details.

Centralia's enthusiasm for streamside shading involves more than just the potential savings for wastewater-utility customers. Expansion of forest along the banks of the Chehalis River could provide a significant scenic amenity for residents as well as opportunities for picnicking and a backdrop for a bike trail and other recreational resources. The city also anticipates that an expanded streamside forest would enhance the value of nearby residences, remove pollutants from air and water, and provide improved habitat for fish and wildlife.

EXPLORING ANCILLARY BENEFITS

The potential importance of ancillary benefits arising from the establishment of streamside forests to lower water temperatures is supported by recent modeling and analysis regarding Johnson Creek in Portland, Oregon. The creek passes through heavily developed residential, commercial, and industrial areas of the city's southeast quarter before emptying into the Willamette River. The city is developing and implementing plans to reduce water temperature and improve other aspects of habitat that Johnson Creek provides for species of salmon, which are listed as threatened or endangered under the federal Endangered Species Act. As part of this effort, the city investigated the potential economic benefits of a proposal to plant 56 acres of streamside forest in a 120-foot corridor along both sides of the creek and to reconnect the creek to its historic floodplain (David Evans and Associates and ECONorthwest, 2004).

The investigation found that the proposed steps would yield the quantifiable benefits shown in Table 2. The benefits tied directly to lowering water temperature to meet salmon-related standards constitute only 13 percent of the total. Other quantifiable benefits involve air purification, water purification, flood mitigation, improvement of avian habitat, and the expansion of natural areas and open space.

Table 2. Estimates of Value of Ecosystem Goods and Services Associated with Streamside Forest and Related Resources along Johnson Creek in Portland, Oregon.

Ecosystem Goods and Services	Value[a]
Services from Vegetation and Soils	
Reduced water temperatures	
Increased fish populations	$4.54 per month per household
Avoided costs of complying with the Clean Water Act and Endangered Species Act	Insufficient data to support a reliable estimate
Air Purification	
Reduced respiratory illness because streamside vegetation removes pollutants	CO $0.47 per lb removed per year PM_{10} $2.20 per lb removed per year SO_2 $0.61 per lb removed per year O $3.30 per lb removed per year
Avoided costs of complying with the Clean Air Act	Insufficient data to support a reliable estimate
Carbon sequestration	C $10.21 per ton removed per year
Water Purification	
Improved quality of stream water because streamside vegetation removes pollutants	$590 per year per acre of wetland
Precipitation Interception and Storage	
Flood mitigation	Residential - $71,706 per 10-yr flood event for all residences in the area Business - $491,368 per 10-yr flood event for all businesses in the area Utilities - $11,288 per 10-yr flood event Emergency Services - $5,375 per 10-yr flood event
Reduced road closures	$34.65 per vehicle-hour of delay
Biodiversity Maintenance	
Improvement of Avian Habitat	
Habitat for wintering/migratory species	$433 per acre
Refugia for at-risk species, e.g., migratory song-birds)	Insufficient data to support a reliable estimate
Improvement of Salmonid Habitat	Insufficient data to support a reliable estimate
Cultural Services	
Natural Area and Open Space	
Recreational opportunities	$4.30 per day per user
Increased value for nearby properties	$1,796 increase per property within 1,500 feet of park

Source: David Evans and Associates, Inc. and ECONorthwest (2004).

[a] Values converted to 2005 dollars.

Communities in Northern California recently incorporated ancillary benefits of efforts to lower stream temperatures in their successful application for $25 million of state funding to improve the quality and quantity of in-stream flows. Among other activities, these communities plan to establish streamside forests and wetlands to improve habitat for salmonids and other wildlife. Table 3 summarizes estimates of the quantified benefits that include carbon sequestration, water purification, and improvement of avian habitat (*North Coast IRWMP*, 2006; CDWR, 2006).

Table 3. Estimates of Value of Ecosystem Goods and Services Associated with Streamside Forests in Northern California

Ecosystem Goods and Services	Value[b]
Air Purification	
Carbon sequestration by acre of forest[a]	$376 over 20 years[c] $782 over 50 years[c]
Water Purification	
Improved quality of stream water because streamside vegetation removes pollutants	$590 per year per acre of wetland Sediment: $6 per ton removed
Improvement of Avian Habitat	$433 per year per acre of wetland

Source: ECONorthwest, with data from *North Coast IRWMP* (2006).

[a] The projects looked into establishing three types of forest: white oak woodland, valley foothill riparian, and mixed evergreen forest.

[b] Values expressed in dollars of 2005.

[c] Values expressed at present, discounted value.

CONCLUSION

Taken together, these findings from Washington, Oregon, and Northern California demonstrate the potential for communities and states to realize significant economic benefits by incorporating expansion of streamside forests and related enhancements to streamside ecosystems as a core element of their efforts to accomplish the objectives of temperature TMDLs.

REFERENCES

California Department of Water Resources (CDWR). 2006. *Grants, Integrated Regional Water Management: Step 2*. Retrieved December 5, 2006, from http://www.grantsloans.water.ca.gov/grants/integregio.cfm.

Clean Water Services (CWS). 2005a. *Revised Temperature Management Plan*. February 28. Retrieved November 29, 2006, from http://www.deq.state.or.us/wq/wqpermit/cwswatshedpermit.htm.

Clean Water Services (CWS). 2005b. *Temperature Management Plan and Water Quality Credit Trading Combined Annual Report*.

David Evans and Associates, Inc. and ECONorthwest. 2004. *Comparative Valuation of Ecosystem Services: Lents Project Case Study*. City of Portland Watershed Management Program. June. Retrieved December 1, 2006, from http://www.portlandonline.com/bes/index.cfm?&a=64845.

Niemi, E., K. Lee, C. Neculae, and T. Raterman. 2006. *Value of Forest, Open Space, and Other Assets Recently Acquired by Centralia Utilities*. ECONorthwest for Centralia Utilities. April.

North Coast Integrated Regional Water Management Plan: Implementation Proposal Step 2. 2006. Retrieved December 5, 2006, from http://www.northcoastirwmp.net/docs.php.

Oregon Department of Environmental Quality (ODEQ), Northwest Region. 2005. *National Pollutant Discharge Elimination System: Watershed-Based Waste Discharge Permit*. July 2007. Retrieved November 29, 2006, from http://www.deq.state.or.us/wq/wqpermit/IndvPermits/CWSWatershed/CWSPermit.pdf.

Smith, K. and J. Ory. 2005. *Healthy Streams Plan*. Clean Water Services. June. Retrieved November 29, 2006, from http://www.cleanwaterservices.org/PlansAndProjects/Plans/HealthyStreamsPlan.aspx.

U.S. Environmental Protection Agency (U.S. EPA). 2006. *Total Maximum Daily Loads: List of Approved TMDLs*. Retrieved November 29, 2006, from http://oaspub.epa.gov/waters/waters_list.tmdls?p_polid=493&pollutant=TEMPERATURE.