Journal of Borderlands Studies
Volume 19 • No. 2 • Fall 2004

Transboundary Environmental Management: A Study of the Abbotsford-Sumas Aquifer in British Columbia and Western Washington

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Abstract: *Political borders, which delineate divergent political, social, economic, and demographic systems, affect the management of shared natural resources. Transboundary environmental management will attract increasing global attention as trends of population growth and natural resource scarcity drive coordinated solutions for environmental problems. Water pollution, in particular, will be a high priority for many nations because of the undisputed importance of water to sustain life and the unyielding characteristic of water to flow freely across political borders. The study of the Abbotsford-Sumas aquifer offers a model to investigate the nature of shared resource management problems within two divergent cultural regions (western Washington and southern British Columbia), bisected by a political boundary (U.S.-Canada border). Using the newly developed Transboundary Environmental Management Index (TEMI), the coordinated management of the organizations was ranked according to their "institutional capacity." The research found that groups representing smaller regions were more likely to reduce pollution inputs, however, the community-based success was largely contingent on the higher-level political groups to recognize, support, and fund scientific research.*

Introduction

Political borders, which delineate divergent political, social, economic, and demographic systems, affect the management of shared natural resources. Transboundary environmental management will attract increasing global attention as trends of population growth and natural resource scarcity drive coordinated solutions for environmental problems. Water pollution, in particular, will be a high priority for many nations because of the undisputed importance of water to sustain life and the unyielding characteristic of water to flow freely across political borders.

The study of the Abbotsford-Sumas aquifer offers a model to investigate the nature of shared resource management problems within two divergent cultural regions (western Washington and southern British Columbia), bisected by a political boundary

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The authors would like to thank Don Alper of the Center for Canadian American Studies and James Loucky in the Anthropology Department at Western Washington University for their ongoing support of this project. Thanks also to Stefan Freelan for his role in producing the Abbotsford-Sumas location map. This research project was supported by a grant from Environment Canada and the American Association of University Women.

(U.S.-Canada border). The Canada-U.S. border provides an excellent opportunity to study transboundary cooperation because of its peaceful history, culturally-integrated population, and absence of language barriers, except along the U.S.-Quebec border. Political tensions or language barriers, therefore, will not complicate the analysis of the management of this resource.

While the Canada-U.S. border has long been used for the study of transboundary environmental management (Young 1998), no scholars have previously developed an index to specifically attempt to measure the institutional capacity of groups working across the border. This study introduces an index system that attempts to quantify the level of cooperation of groups working to solve a shared transboundary pollution issues. The index attempts to quantify a large amount of qualitative information based on interviews, written correspondence, archival research, meeting and conference participation, and a review of relevant literature. The index, named the "Transboundary Environmental Management Index" (TEMI), attempts to quantify the institutional capacity of groups/organizations to: 1) reduce the pollution input into the Abbotsford-Sumas aquifer, and 2) work across the political border. A review of the historical events that led to the cross-border cooperation of the aquifer augments the TEMI discussion.

The Study Area

The Abbotsford-Sumas aquifer spans the border between British Columbia and Western Washington and provides drinking water for more than 100,000 people (USGS 1999). The aquifer covers approximately 100 square miles (260 square kilometers) and provides water for rural dwellers in the District of Abbotsford, British Columbia, and rural and urban dwellers in the towns of Lynden, Everson, Nooksack and Sumas (LENS) in Whatcom County, Washington (see Figure 1).

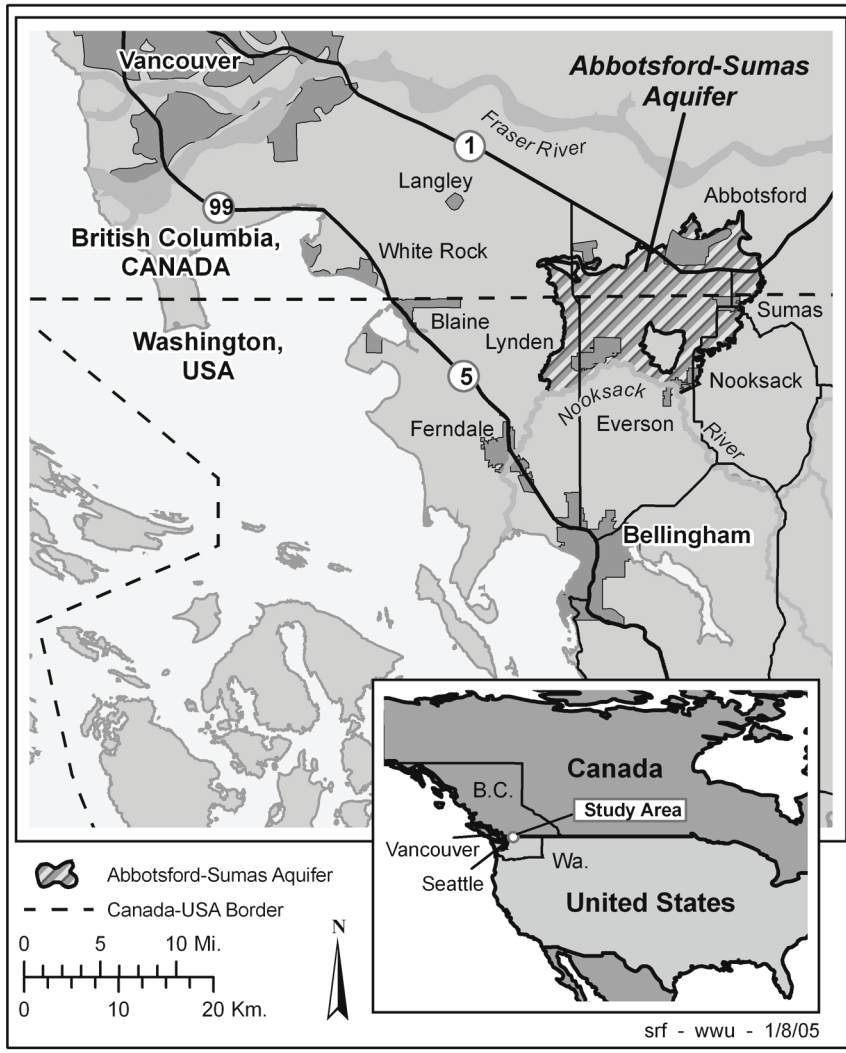
The study area is characterized by a low-lying floodplain surrounded by the mountains of the Northern Cascades. This picturesque landscape is undergoing rapid land use change due to population growth and accompanying industrial, commercial and residential development. While much of the industrial development in the region currently is related to agriculture, and residential development in Washington state is relatively low in density, there are increasing pressures on all sectors in the more populous region north of the border. The population of the southern Fraser Valley, in which Abbotsford is located, grew by more than 28% between 1991 and 2000 (McGrail 2004). This new development, in conjunction with existing agricultural activities, is producing multiple sources of nitrate pollution. Nitrate pollutants are often associated with improperly maintained septic systems, concentrated animal operations with inadequate manure management practices, and fertilizer applications.

Recent studies (Zebarth et al. 1998; Wassenar 1995; U.S.G.S. 1999) have shown that agricultural sources are the primary cause of elevated nitrate concentrations in the Abbotsford-Sumas aquifer. In particular, the leaching of manure from dairy farms in Washington and poultry farms in British Columbia is a main source of nitrate pollution in the aquifer. The application of manure to fertilize raspberry fields is another source of nitrate leaching (Zebarth and Hii 1998).

The aquifer is particularly susceptible to such contamination because of its close proximity to the surface, the area's heavy rainfall, and the geologic formations and soil type. At the central portion of the aquifer, the water table is at most 100 feet (or 30 meters) below the surface, and at the edges the water table is just 15 feet (0-5 meters)

below the surface. The pollution problem associated with high nitrate concentrations is compounded by the high annual rainfall, which leads to increased runoff of nitrates through the soil. The loose, or unconfined, soil strata surrounding the aquifer provide minimal filtration for contaminants as the water recharges. Unchecked irrigation practices and increased intensification of dairy farms further perpetuate the pollution problem (U.S.G.S. 1999).

Figure 1. Map of Abbotsford-Sumas Aquifer Across the Canada-U.S. Border



Due to high nitrate concentrations, the water quality of the Abbotsford-Sumas aquifer does not meet acceptable levels for human consumption under either Canadian or American standards (Washington State Department of Health 1998). Canada and the United States both set the Maximum Contamination Levels (MCL's) at 10 ppm or 10 mg/L of nitrate-nitrogen. A study conducted by the United States Geologic Society

revealed that 21% of the surveyed wells exceeded the aquifer's MCLs (USGS 1999). Studies indicate that better control of the application of agricultural wastes to farmland would help to improve water quality and that a decrease in nitrate leaching is crucial to maintaining the health of the aquifer (Almarasi 2004a; Almarais 2004b, Zebarth 1999). Efforts to reduce pollution entering the aquifer, however, face the added bureaucratic complexity of coordination between countries.

Management Agencies for the Abbotsford-Sumas Aquifer

Although the border between the United States and Canada "splits" the aquifer in two for political purposes, water within the aquifer flows freely across the border from British Columbia south into Washington.[1] The significance of the political border, for this study, is that it delineates different government agencies that are responsible for the management and protection of the shared resource. In an effort to transcend divergent political systems, transboundary agencies have emerged to bridge the divide associated with the political border. These agencies (listed in descending order of the geographic scope of their authority) include the North American Free Trade Agreement Council for Environmental Cooperation (NAFTA-CEC), International Joint Commission (IJC), British Columbia-Washington Environmental Cooperation Council, Abbotsford-Sumas Aquifer International Task Force (Task Force), Abbotsford-Sumas Aquifer Stakeholders Group (Stakeholders Group), Environmental Non-Governmental Organizations (ENGOs), and Industry Stewardship Groups (ISGs). To clarify the role of each management agency of the Abbotsford-Sumas aquifer, each group is described below.

North American Free Trade Agreement: The Commission for Environmental Cooperation (NAFTA-CEC)

The Commission for Environmental Cooperation (CEC) is an international organization created by Canada, Mexico and the United States under the North American Agreement on Environmental Cooperation (NAAEC). The Agreement was designed to complement the 1994 North American Free Trade Agreement (NAFTA) by incorporating provisions relating to the resolution of environmental concerns arising from free trade (Marchak 1998: 144). The CEC was specifically established to "address regional environmental concerns, help prevent potential trade and environmental conflicts, and to promote the effective enforcement of environmental law" (CEC). The formal obligations of the countries include "periodic publication of reports, education, scientific research, assessments of environmental effects and promotion of environmental goals" (Marchak 1998: 144).

The CEC has catalogued approximately 350 transboundary environmental issues along the U.S.-Mexico and U.S.-Canada borders, including the Abbotsford-Sumas aquifer. Although the aquifer is not currently under review, the council could take a role in aquifer-related issues at the request of either national government, or if a party files a petition with the CEC alleging that either country has failed to follow the requirements of its own national environmental laws with respect to the aquifer. While no party has expressed interest in CEC involvement in aquifer protection, CEC is included in this study because of its theoretical and potential role in transboundary deliberations relating to the Abbotsford-Sumas aquifer.

International Joint Commission (IJC)

The IJC was created in 1909 to review applications for transboundary water use, to investigate water pollution issues involving Canada and the United States, and to deflect and mitigate potential transboundary water conflicts (Hildebrand 1997: 2). The six-member group acts as an advisory board to the two federal governments with respect to transboundary water issues anywhere along the border (Jolly 1998). Upon request of the governments, the IJC "investigates environmental questions or matters of difference along the shared frontier; monitors and coordinates the implantation of recommendations for dams of canals in the shared waters; and approves or disapproves projects such as dams or water divisions" (Hildebrand 1997: 2).

Historically, the IJC has focused largely on the Great Lakes region and has had a minimal presence along the British Columbia-Washington state border. However, Puget Sound-Georgia Basin issues such as oil transport and the raising of Ross Dam on the Skagit River both involved the IJC (Alper and Monahan 1986: 164). Like the CEC, the IJC has the potential for involvement in the ASA if the respective parties invite the commission to intervene. At this time, however, the IJC is not involved in this particular transboundary water issue. Given that the local and state politicians prefer more local problem-solving approaches, and often view the IJC as relating to far-off national capitals than to local on the ground efforts, the IJC is not likely to become involved in this issue in the near future (Alper 1997).

British Columbia-Washington State Environmental Cooperation Council (ECC)

The signing of the Environmental Cooperation Agreement (ECA) in May 1992 by then Premier of British Columbia Michael Harcourt and then-Governor of Washington State Booth Gardner is a significant symbol of the two governments' commitment to environmental cooperation (Alper 1996: 10). The ECA committed the state and the province to "promote and coordinate mutual efforts to ensure the protection, preservation, and enhancement of our shared environment (Environmental Cooperation Agreement 1992). As a result of the ECA, the BC-WA Environmental Cooperation Council was established to oversee these coordinated environmental activities (Alper 1996: 10). The British Columbia-Washington Environmental Cooperation Council (ECC) was designed to "establish new ways of handling environmental problems of mutual concern" (ECC Meeting Notice, November 28, 2000).

Abbotsford-Sumas Aquifer International Task Force (Task Force)

The Abbotsford-Sumas Aquifer International Task Force (Task Force) was developed as a subcommittee of the Environmental Cooperation Council. Because the ECC prioritized the transboundary aquifer as one of the five highest environmental priorities, the Task Force is charged with monitoring the aquifer and developing recommendations for shared management and pollution reduction. The Task Force reports its findings bi-annually during the regularly scheduled ECC meetings.

The Task Force addresses technical, scientific, and political issues related to the transborder aquifer. The Task Force committee consists of governmental representatives from the national, state, provincial, and local (county/district and city) levels.[2] The committee also coordinates local conferences and scientific exchange in order to

foster heightened communication between key scientific, political and community players involved in the ASA. The committee meets approximately twice a year.

The Abbotsford-Sumas Aquifer Stakeholders Group (Stakeholders Group)

The Abbotsford-Sumas Aquifer Stakeholders Group (Stakeholders Group) was formed under a mandate from the City of Abbotsford in January 1997. The Stakeholders Group meets monthly to discuss its goal of "develop[ing] practical and reasonable solutions" that "lie with the voluntary actions of the stakeholders, not with the establishment of new laws and regulations and more bureaucracy" (Andzans 1998: 1). Based in the city of Abbotsford, the group is composed of local community members representing agriculture (including raspberry farmers and the poultry industry, two locally-important agricultural sectors), small business owners, urban and rural dwellers, and representatives of the city of Abbotsford, the B.C. Ministries of Environment and Agriculture, and Agriculture Canada. Agency representation is aimed at coordinating information exchange, rather than implementing regulatory approaches (Andzans 2000). Unlike most groups dealing with international environmental problems, the Stakeholders Group is comprised primarily of local citizenry who both use and pollute the aquifer (Pelley 2000).

Industry Stewardship Groups (ISGs)

A number of industry stewardship groups in the Abbotsford District of British Columbia have united under the umbrella of the ASA Stakeholders Group. Monthly meetings bring representatives of the Industry Stewardship Group together to discuss methods of reducing pollution inputs into the aquifer. The representatives act as a correspondent between the Stakeholders Group committee and its particular groups' stakeholders. The representatives relay information back to their members as well as explaining their industries' objectives to the Stakeholders Group (Andzans 2000). The goal of the ISGs is to design solutions that reduce pollution inputs while still maintaining their respective business objectives. The most active Industry Stewardship Groups include the B.C. Raspberry Growers' Association, the B.C. Auto Recyclers' Association, and the Sustainable Poultry Farming Group (Andzans 1998).

Environmental Non Governmental Organizations (ENGOs)

Historically, environmental non-governmental organizations (ENGOs) have played an important role in fostering unique grass roots solutions because of their ability to bypass the limitations posed by the red tape of governmental regulation and political bureaucracy (Alper 1997: 372-374). Funded by private sources and grants, ENGOs usually have more flexibility than government agencies in finding solutions to environmental problems. It is not a surprise, then, that ENGOs have "emerged as central players in domestic and international environmental advocacy" (Alper 1997: 372).

The role of ENGOs in transboundary environmental issues often focuses on building community relationships across the border (Andzans 2000; Gray 1999; Hinkle 1999). These relationships foster a community-oriented approach to managing resources and therefore are an essential component of managing transboundary environmental issues (Ellis 1995; Meyers 1999; Towers 2000; Waak 1995). Although as many as sixty

ENGOs are involved in transborder issues along the British Columbia and Washington border (Alper 1997: 372), the Abbotsford-Sumas aquifer has received limited attention. Transboundary ENGOs such as the People for Puget Sound and the Georgia Strait Alliance are active participants in transboundary environmental issues; their priority lists, however, do not include the Abbotsford-Sumas aquifer.

Methods: Research and Data Methodology

The Transboundary Environmental Management Index (TEMI) was designed to measure the "institutional capacity" of groups to work cooperatively across the border to reduce pollution inputs in the Abbotsford-Sumas aquifer. The TEMI methodology is based on Scheirer's (1994) work on program evaluation. The TEMI was developed following Scheirer's (1994) five-step "Impact Evaluation Process" and then modified to suit this study. The TEMI's five-step process includes:

1. Identify the population that will be evaluated (CEC, IJC, ECC, ASA Task Force, Stakeholders Group, ENGOs, ISGs).
2. Develop networks, collect data using unobtrusive measures, and recruit and select participants (see Table 1).
3. Identify characteristics (and corresponding performance indicators) that promote effective transboundary management of the shared natural resource (see table 2).
4. Assign numeric scales/points for each performance indicator based on data analysis.
5. Assign a weighting factor for each performance indicator. (This study uses equal weighting for each indicator, however, future studies might find that variable weighting more accurately reflects the importance of each indicator.)

Collectively, the performance indicators summarized in these five variables measure the capacity of each organization to alleviate transboundary pollution in the Abbotsford-Sumas aquifer. The TEMI focuses on the groups' capacity to reduce pollution, rather than attempting to measure quantifiable pollution reductions from each group's efforts, for two related reasons. First, reductions in nitrate levels will occur incrementally, over a period of years or decades. Second, the precise quantity of the reduction that is attributable to any specific group's effort will be difficult, if not impossible, to trace. These data barriers prevent mid-course assessment of groups' efforts and potentially eliminate the possibility of assessing the effectiveness of individual, as opposed to cumulative, efforts. The TEMI provides a means to assess the effectiveness of individual groups' pollution reduction efforts during the course of remediation by evaluating performance indicators that act as surrogates for measurable pollution reduction.

Table 1
Data Collection Methods

Method	Description	Examples
Indirect Unobtrusive Measures	Information obtained from records kept for other purposes	Meeting minutes, action lists, mission statements, written correspondence, website analysis
Direct Observation	Use by trained observer of specified formats and codes for recording in-person or videotaped observations	Observations of interactions between committee participants, amount of time allocated at meetings for aquifer-related agenda items
Organizational Record	Data collection forms routinely kept by an organization for purposes other than for evaluation	Number of dairy inspections, number of Industry Stewardship Groups involved, budget information
Telephone and In-Person Interviews	Procedure in which interviewer asks questions directly to providers or recipients, using either pre-structured or open-ended questions	Telephone and in-person interviews of members of specified organizations and involved community members

These performance indicators for the promotion of effective transboundary management were selected after twelve months of direct and indirect observation of the issues surrounding the aquifer. The authors observed meetings, interviewed government and non-government employees, and spoke with concerned citizens and local governmental officials. After extensive field research and a thorough literature review, the authors identified five characteristics (or variables) that embody an ideal cross-border environmental program for the Abbotsford-Sumas aquifer. These variables include: (1) adequate decision-making power, (2) an institutional structure that contributed to transboundary management, (3) the ability to modify behavior to reduce the amount of pollutants entering the aquifer, (4) a strong ability to read and modify public opinion, and (5) the ability to modify British Columbia and Washington policies. Subsequently, each of the variables was measured by performance indicators that detail the actions necessary to fulfill the variables.

The TEMI variables and performance indicators were adjusted to take into account the comments of knowledgeable observers, including three community members familiar with the Abbotsford-Sumas aquifer and four Western Washington University faculty members. A score was then assigned to each of the organizations. The faculty reviewers were also asked independently to score each of the organizations. The final score was based on the authors' scores, amended slightly in several categories to reflect consistent themes in the other reviewers' analyses.

Table 2
Numerical Scale for the TEMIs Variable and Performance Indicator

Variable	Performance Indicators	Assigned Numerical Value
1. Decision Making Power	Adequate funding	Yes = 1 No = 0
(D)	Ability to implement programs	Scale 0-3
	Ability to enforce programs	Scale 0-3
	Prioritization of the aquifer	Scale 0-3
2. Institutional Lay-Out	Committed committee members	Scale 0-3
(I)	Geographic proximity to issue	Close = 1 Not Close = 0
	Presence of strong leadership	Scale 0-3
	Longevity of program	> 5 yrs = 1, < 5 yrs = 0
	Frequency of meetings	Scale 0-3
3. Change Pollution Input	Decrease in manure N (cattle/poultry)	Yes = 1 No = 0
(MN)	Decrease N input on berry farms	Yes = 1 No = 0
	Change in business behavior	Yes = 1 No = 0
4. Public Opinion	Ability to influence public opinion	Scale 0-3
(PO)	Ability to read public opinion	Scale 0-3
5. Procedural change	Change in inspection ratio	Yes = 1 No = 0
(PC)	Increase of staff/volunteers	Yes = 1 No = 0
	Procedural change	Yes = 1 No = 0

Calculating the TEMI

The TEMI is calculated by measuring each variable by specific performance indicators. The performance indicators were assigned a value of 1,0 for yes or no questions and 0-3 for relative scale questions, where 0 indicated "no presence of performance indicator" and 3 indicates "high presence." Each group has the possibility of earning a perfect score of "5", as each of the five variables is worth one point. To receive a score of 5, the group needs to earn a perfect score for each of the performance indicators that measure the variable. For example, for the variable Public Opinion (PO) to receive a perfect score of one, each performance indicators needed to earn the highest point possible. The performance indicators for PO, "ability to influence public opinion" and "ability to read public opinion," have the potential of earning 3 points each, depending on how they were ranked by the research committee. If both of the performance indicators receive a score of three, indicating the highest potential for each, the variable Public Opinion would receive a score of one, or one hundred percent. However, as indicated in Table 3, it is more likely that the groups will receive a percentage of their possible score. For example, the NAFTA-CEC group earned a score of .33 for their ability to Influence Public Opinion as they received relatively low scores for each of the corresponding performance indicators.[3]

Table 3
Public Opinion Data Sheet and Scoring Example

	Influence Public Opinion (0-3)	Influence Score/3	*50% = Ppo1	Read Public Opinion (0-3)	Read Score/3	*50% = Ppo2	Sum of Performance Indicators
NAFTA-CEC	1	0.33	0.17	1	0.33	0.17	0.33

Each variable is then added cumulatively to form the TEMI. Drawing from the NAFTA-CEC case again, we see that this organization receives a score of 1.19 out of 5, or 24%. This score is based on the addition of all five activities (each score with the possibility of one) (see Table 4).

Table 4
Cumulative Points of Each Variable for NAFTA-CEC

	Decision Making Power Score	Institutional Lay-out Score	Nitrate/ Pollutant Input Score	Public Opinion Score	Procedural Change Score	Sum (out of 5)	*(%)
NAFTA-CEC	0.46	0.40	0.00	0.33	0.00	1.19	0.24

Thus, The TEMI can be described using the general functional relationship of equation 1:

Equation 1.
TEMI = f (D, I, MN, PO, PC)

Where D = Decision Making Power.
Where I = Institutional Lay-Out.
Where MN = Measurement of Change in Pollution Input.
Where PO = Public Opinion.
Where PC = Procedural Change in British Columbia and Washington

The organizations' total TEMI score is created by summing each Variable (V). Thus, the TEMI is represented by equation 2, where V equals the sum of the performance indicators' score (Equation 3).

Equation 2.
$$TEMI = \sum_1 (V_n)$$

Equation 3.
$$V = \sum_1 (P_n/N_n)$$

Findings

The TEMI results clearly indicate a converse relationship between geographic representation and institutional capacity to alleviate cross-border pollution (with the exception of the ENGOs). For example, the CEC and IJC (the groups with jurisdiction over the largest geographic area) scored the two lowest scores of 1.52 and 1.65 out of 5. The low scores of these two organizations can partly be explained by their current limited role in the management of the aquifer. As mentioned in the introduction, these two organizations will become active participants if (and only if) they are directly invited by the parties/countries involved. The low scores of the organizations that operate within the *next* largest area further support the conclusion that geographic jurisdiction is inversely proportional to effectiveness: The BC-WA Environmental Cooperation Council scored 2.47 out of 5 and the ASA International Task Force scored 2.54 out of 5.

The highest scores went to the organizations that represent the smallest areas. For example, the two Abbotsford, BC-based groups, the ASA Stakeholders Group, with 72%, or 3.58 out of a possible 5, and the Industry Stewardship Groups, with 68% or 3.40 points, earned the two highest scores. The high scores of these local groups can largely be attributed to the number of participants who can directly influence or instigate behavior-changing mechanisms that directly reduce pollution inputs into the aquifer. For example members of Stakeholders group and the Industry Groups had representation from Poultry and Raspberry Organizations—the two agricultural groups whose activities caused the most intensive nitrate leaching into the aquifer.

The Environmental NGO's provide the one counter-example to our findings. Despite their "local" activity areas and small geographic representation, the ENGOs did not score well. The low TEMI score is partly explained by lack of jurisdictional support (and subsequent lack of funding) for environmental projects "across the border"/ in "other" countries. Local environmental organizations often lamented in interviews that it was difficult to stretch the concept of "local" environmental problems across the border.

Table 5
TEMI Results: Highest Ranking Groups and Geographic Representation

Organizations	Points (Out of 5)	Percentage	Geographic Representation
ASA Stakeholders Group	3.58	72%	5
Industrial Stewardship Groups	3.40	68%	6
ASA International Task Force	2.54	51%	4
Environmental Cooperation Council	2.47	49%	3
Environmental NGOs	2.00	40%	7
International Joint Commission	1.65	30%	2
Commission for Environmental Cooperation	1.52	24%	1

Figure 5a. Institutional Capacity per Organization

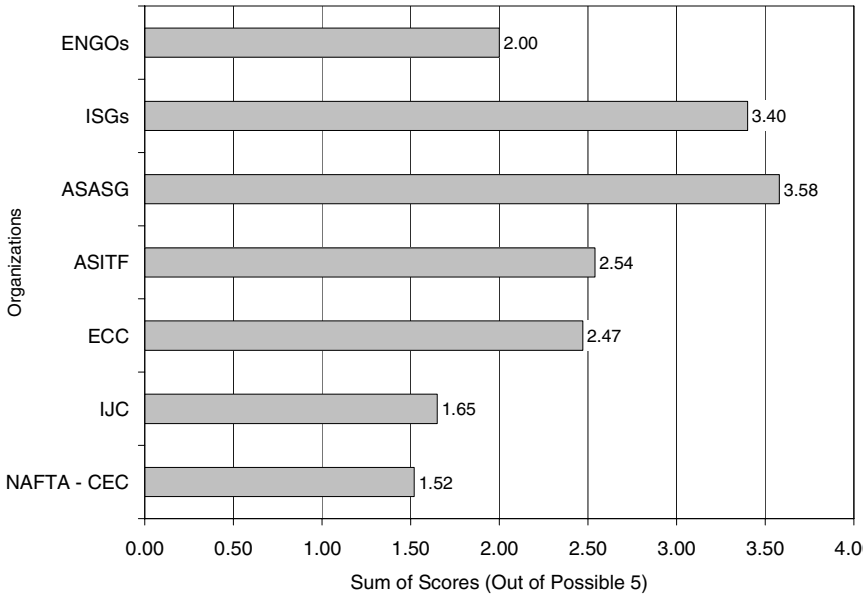
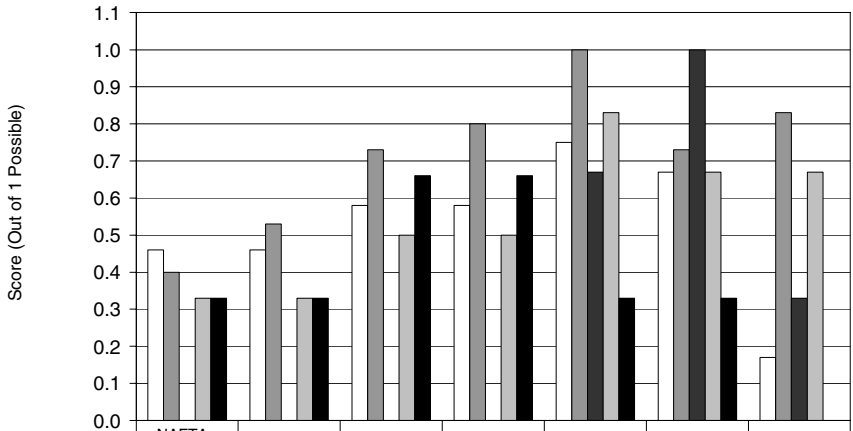


Figure 5b. Organizational Scores by Specific Variable



	NAFTA - CEC	IJC	ECC	ASITF	ASASG	ISGs	ENGOs
Decision Making Power	0.46	0.46	0.58	0.58	0.75	0.67	0.17
Institutional Lay-Out	0.40	0.53	0.73	0.80	1.00	0.73	0.83
Nitrate/Pollutant Input	0.00	0.00	0.00	0.00	0.67	1.00	0.33
Public Opinion	0.33	0.33	0.50	0.50	0.83	0.67	0.67
Procedural Change	0.33	0.33	0.66	0.66	0.33	0.33	0.00

The Need to Consider TEMI Results within a Broader Historical Framework of Transboundary Cooperation

The TEMI measures the institutional capacity of the organizations within a defined cross-section of time. During that period (1999-2001), the ASASG and the ISG revealed themselves as the most capable of reducing pollution in the Abbotsford-Sumas aquifer. However, it is imperative to situate the success of these organizations within a broader historical framework. The timeline below highlights a series of prior events and relationships that provided the foundation for the aforementioned groups to succeed.

Table 6
Timeline: Canada-U.S. Transboundary Water Issues and the Abbotsford-Sumas Aquifer

Year	Event
1907	Trail Smelter Arbitration (Canada-U.S.)
1909	Boundary Waters Treaty Enacted
	The International Joint Commission (IJC) created
1988	Oil Spill on Gray's Harbor, WA
	Washington-B.C. Joint Oil Spill Task Force created
	Exxon Valdez Oil Spill in Prince William Sound, Alaska
	Other West Coast states joined the Oil Spill Task Force
1989	States-B.C. Oil Spill Task Force issued a comprehensive report
1992	Washington and B.C. expanded coordinated trans-boundary efforts
	The Environmental Cooperation Agreement (ECA) signed by Premier Harcourt and Governor Gardner
	The BC-WA Environmental Cooperation Council (ECC) established to oversee the coordinated activities as discussed in the ECA
	The Abbotsford-Sumas Aquifer was prioritized under the ECC and the Abbotsford-Sumas International Task Force (ASITF) created
1994	NAFTA implemented
	The Commission for Environmental Cooperation (CEC) established
1996	Memorandum of Agreement (MOA) on Water Rights Applications signed by state and provincial environmental agencies
	City of Abbotsford, B.C. mandates non-regulatory solutions for reduction of aquifer's pollutant inputs
1997	Abbotsford-Sumas Aquifer Inaugural Stakeholders Meeting
1999	United States Geologic Survey Abbotsford-Sumas aquifer report published
	Environment Canada Abbotsford-Sumas aquifer report published
	2000 The Memorandum of Understanding (MOU) for the Abbotsford-Sumas aquifer signed by The Governor of Washington and The Premier of British Columbia

This time line clearly depicts the long-term interest in solving transboundary issues. The Trail Smelter Arbitration of 1907, for example, significantly affected international law and cross border cooperation by establishing the obligation of states to use their own property in such a manner as to not to injure the property of other states (Trail Smelter Arbitration 1907). With the enactment of the Boundary Waters Treaty two years later, in 1909, Canada and the United States officially recognized the importance

of coordinating decisions on shared waters This treaty was designed to resolve water disputes on the U.S.-Canada border. It also institutionalized the IJC, which was created to review applications for transboundary water use and to investigate water pollution issues involving the two countries (Jolly 1998). The IJC is the longest-standing committee between the United States and Canada with the primary purpose of addressing transboundary environmental issues.

While transboundary water quality issues along the western Canada-United States border did not receive a great deal of attention until the last quarter of the twentieth century, the pace of cooperation has accelerated over the past twenty years. Significant oil spills in 1988, including the Exxon Valdez oil spill in Alaska and an oil spill in Gray's Harbor, Washington prompted a series of actions to solidify the transboundary coordination of regional water issues between Washington and British Columbia. The Gray Harbor oil spill prompted Governor Gardner of Washington and Premier Vander Zalm of B.C. to create a Joint Oil Spill Task Force. The transboundary Task Force was charged with investigating prevention of future oils spills, coordinating emergency responses, and assessing methods for expediting compensation (Jolly 1998). This task force laid the foundation for future regional, cross-border collaboration.

These events indicate that the analysis of the aquifer in isolation may tend to downplay the significance of the foundation laid for transboundary cooperation over the past hundred years. The timeline acts as a reminder that a quantitative index such as the TEMI only represents a diminutive period of time. The TEMI is a useful, but limited, tool that is intended to relay a large amount of information in a condensed version. This information, in turn, then must be considered within the broader historical and political contexts of transboundary cooperation in the region.

An important component of this context is the role of the government in funding scientific research. Although the TEMI results did not directly divulge this outcome, individual and organizational interviews clearly recognized the role of higher political organizations. The TEMI did show, however, that the groups with a mixture of governmental and non-governmental participants (which include *all* groups, except the low-scoring ENGOs) were more successful at securing funding and support for projects. Discussions with both high bureaucratic officials and grass-roots community workers revealed that the government's support of scientific inquiry was an essential component to ensuring the eventual local support of an environmental issue (Andzans 2000; Cole 1999; Hinkle 1999; Pelley 1999; Robinson 2000).

Once a concern is validated through scientific research, the community is able to develop initiatives that are in line with the community's characteristics and goals (Paulumbo 1990; Wondolleck 1997; Uitto 2000). The institutional support can fund scientific research and provide the communities with the information needed to implement and designs site-specific solutions to remedy the issue (Andzans 1999).

The acquired (and *proven*) knowledge then acts as an impetus for communities to gain popular support for local efforts (Paulumbo 1990). Without the funding for research to prove that an environmental issue exists, local groups often experience resistance, making it difficult to gain momentum. Thus, in order for local action to operate effectively, it is imperative that organizations with larger geographic scope focus time, energy, and resources into exploring the problem.

In the case of the Abbotsford-Sumas aquifer, the problem of a polluted water source was identified by scientific research on both sides of the border. The United States Geological Service (USGS) conducted an in-depth research study that clearly identi-

fied the need for nitrate reduction in the aquifer (USGS 1999). Environment Canada also conducted a study of the aquifer, which identified the area as highly polluted with nitrates resulting from agricultural practices such as chicken manure and fertilizer pollution from raspberry productions (Hii 1999). Both scientific studies provided tools to empower communities to take action towards changing behavior to reduce groundwater pollution.

Local communities and citizens' groups often do not have the resources to fund extensive studies. Although it is unlikely that community members will read each scientific study, or perhaps even see the completed documents, it is vital that the science was conducted and that it is available for public review. The scientific verification provides the local community with the empowering knowledge to move forward and to act to reduce the pollution.

Conclusions and Recommendations

The primary research goal of this study was to assess the "institutional capacity" of organizations to reduce pollution inputs in the Abbotsford-Sumas aquifer. Seven organizations were ranked using the Transboundary Environmental Management Index (TEMI). The TEMI measured the groups' ability for: (1) adequate decision-making, (2) institutional contributions to transboundary management, (3) modification of behavior to reduce the pollutants entering the aquifer, (4) modifying public opinion, and (5) modifying British Columbia and Washington policies. A secondary goal of this study was to offer a critique of the applicability and effectiveness of the TEMI. The authors suggest that the TEMI is most effective when nested in its historical context; augmented by a temporal analysis.

The TEMI results generally found that groups *representing the smallest area* had the *most* ability to reduce pollution inputs in a transboundary setting. The groups' success primarily relied on the ability to receive political support, but not directives, while maintaining a strong community focus. The groups that could enjoy the benefits of structure (through political involvement) and the benefits of local support (through community-involvement) ranked the highest with the TEMI. For example, the Abbotsford-Sumas Aquifer Stakeholders Group and the Industry Stewardship Groups scored the highest because the local government supported their efforts to design and implement initiatives without limiting its regulatory authority. Furthermore, the two local groups succeeded because their members were directly involved in the pollution or effects of the pollution in the aquifer. The "closeness" to the problem, motivated the participants to design (and implement) strategies for reducing pollution in the aquifer in a timely and efficient manner.

In general, the TEMI found a converse relationship between geographic representation and institutional capacity. The ENGO sector was the only significant variance to this trend. Despite the very active participation in environmental stewardship activities within each respective border community, the non-profit and local grass roots organizations did not score well with the TEMI. The ENGO's lack of institutional capacity to work on transboundary issues was primarily a regional phenomenon, limited by the lack of funding for cross-border environmental projects and the lack of constituent support.

Although the respective communities were interested in ensuring clean water in *their* neighborhoods, on *their* side of the border, constituents surrounding the Abbotsford-

Sumas aquifer were not willing to allocate funds towards local transboundary environmental issues. However, transboundary issues with a larger scale, such as water pollution in Georgia-Strait-Puget-Sound received more generalized constituent support because of the larger scope of the issue. Although localized issues such as the Abbotsford-Sumas aquifer receive support from the community, the support does not transcend the political border despite its international setting.

On the other side of the geographic spectrum, the larger-scoped Environmental Cooperation Council and the International Joint Commission also received low scores. Consistent with the TEMI trend (converse relationship between geographic representation and institutional capacity) the ECC and IJC did not score well because of their overly broad commitment to transboundary problem solving and their lack of attention to localized cross-border issues.

In order for the analysis to be more comprehensive, however, it is important to look at the long-term involvement of each group. For example, although the ECC did not score well with the TEMI, they have historically played a crucial role in laying the foundation for cross border cooperation. It could be argued that without the presence of groups such as the ECC and IJC, local groups would not have as much long-term success. Although it is correct to give the ECC and IJC a poor score on the TEMI—because they did not fit into the characteristics of having a strong institutional capacity to help alleviate the pollution in the Abbotsford-Sumas aquifer—their story is more complete when the TEMI score is augmented with a historical perspective.

An accurate and thorough temporal analysis is an important supplement to the TEMI. A qualitative analysis is particularly important in the case of transboundary issues, where two countries dealing with a singular issue could react with significant variance. Transboundary management of the Abbotsford-Sumas aquifer is a success because of the presence of strong leadership to coordinate efforts, the foresight of governments to set up task forces, and the unyielding dedication of local communities.

The questions posed, therefore, should not only have been "*which organization* possesses the most institutional capacity to alleviate groundwater pollution?" But also, "*in what capacity* did institutions work together?" The relationships between the organizations are an essential component in transboundary management analysis. Efforts, ideas, and programs trickle down (and up) between organizations. This movement, albeit somewhat invisible, is a crucial mechanism of communication that ultimately leads to instigating change.

So, is the TEMI a worthwhile tool? Does the TEMI system merit replication in other cross-border studies? One of the main assets of the TEMI is its ability to effectively and efficiently quantify a large amount of qualitative data. Condensing a large amount of information into a standard format, makes the assessment of transboundary groups straightforward; it becomes simple to compare groups' strengths and weaknesses and quickly surmise which group has a higher capacity for transboundary management. The TEMI is particularly useful for audiences with limited time to read through extensive qualitative descriptions. What the TEMI provides to the reader is a condensed version of each groups' strengths and weaknesses and a glimpse of their potential.

What the TEMI does not provide is a historical context for the scores. Thus, by augmenting the TEMI's result with a historical analysis of the groups, the scoring is more comprehensive. With the augmented information, readers decide whether they want a quick overview (TEMI), or the more comprehensive analysis (temporal analysis). In short, we feel that the TEMI will prove to be a useful tool for other groups or

individuals working on transboundary environmental management issues. The TEMI will undoubtedly evolve as it is applied to different settings, but it certainly merits replication.

Endnotes

[1] The rate of flow varies depending on the depth of the aquifer and the consolidation of the bedrock in the aquifer. For the local, shallow systems the flow path, or residence time of ground water, is in the order of months to years; compared to the residence of regional ground-water system, which can be from ten to thousands of years.

[2] The Task Force includes representatives from the United States Geologic Service, Environmental Protection Agency, Environment Canada, Washington Department of Ecology, British Columbia Ministry of Agriculture and Forestry, Whatcom County Health Department, and City of Abbotsford.

[3] However, if the performance indicators do not receive a perfect score, then each indicator is divided by the amount possible, in this case three, and added to the other performance indicators. This gives us a fraction of the performance indicator's score. For example, NAFTA-CEC received a score of .33 for the variable Public Opinion. This score was based on its score of one (out of three) for the ability to influence public opinion, plus its score of one (out of thee) for its ability to read public opinion. The score was calculated by dividing the first performance indicator score by the points available (1/3 = .33), then dividing it by the number of performance indictors (.33/2 = .17). The second performance indicator also earned a score of 1, so the same process applies: dividing the score by the amount available (1/3 = .33), and then dividing it by the number of performance indictors (.33/2 = .17). The two indicators are added together only after 1) the performance indicators scores are divided by points available and then 2) divided by the total number of performance indicators. In the NAFTA-CEC case, the variable (A) receives a score of .33 (.17 points for each indictor). This analysis is repeated for every performance indicator for each variable.

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