

Red River Basin Reference Condition

Workshop

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Summary and Recommendations

To the

International Red River Board

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Introduction

The International Joint Commission (IJC) is an independent bilateral U.S. and Canadian committee established in 1909 to resolve water and water quality disputes on international boundary waters and to advise the respective governments on related matters (IJC 2004).

An IJC directive on February 7, 2001 established the International Red River Board (IRRB) by combining the International Souris-Red River Engineering Board and the International Red River Pollution Board. The IRRB was formed to ensure a more systematic approach to transboundary water issues and to assist the IJC in preventing and resolving transboundary disputes in the Red River of the North Basin. The IRRB's activities focus on factors that affect the Red River's quality, quantity, and aquatic ecological integrity (IJC 2004b).

The IRRB established an Aquatic Ecosystem Committee (AEC) in July 2001. The AEC includes state and federal agency and other stakeholder membership from North Dakota, Minnesota, and Manitoba. The committee was formed to develop basin-wide recommendations and implementation details on:

- Biological monitoring
- Monitoring non-native and invasive species
- Integrated monitoring
- Establishing and maintaining a central water quality database.

In July 2002, the AEC published a work plan to address the directives of the IRRB. The work plan included a conceptual framework to monitor and assess the aquatic ecosystem of the Red River of the North Basin (Red River Basin) and articulated an aquatic ecosystem health goal to “*assure that water resources of the Red River of the North Basin support and maintain a balanced community of organisms with species composition, diversity and functional organization comparable to the natural habitats within the Basin without regard to political boundaries*” (AEC 2002). The AEC also identified five main aquatic ecosystem health monitoring categories: 1) current status; 2) future trends; 3) early warning indicators; 4) cause and effect; and 5) socioeconomic.

A first step in any ecological assessment effort is the establishment of “reference condition”. Defining and quantifying reference condition by establishing a common set of reference sites through a coordinated monitoring program is necessary to collectively assess the condition of the Red River of the North Basin. Reference sites provide resource managers with a foundation for establishing biological indicator development, nutrient and sediment criteria development, setting realistic stream restoration goals or targets, and developing attainable Total Maximum Daily Load (TMDL) goals or targets.

In April of 2003, the International Water Institute (IWI) hosted an International Water conference in Moorhead, MN. During this conference, workshop sessions were dedicated to gaining a better understanding of the “current status” and “future trends” categories identified in the work plan. Local, regional and national experts (Appendix B and C) convened at this workshop to synthesize existing information on biological monitoring and explored how this knowledge would be applied to efforts in the Red River Basin (Arscott 2003).

In 2004, the IWI was contracted by the IJC to convene a workshop aimed at developing consensus among the various state, federal and local agencies responsible for biological monitoring and assessment on several reference condition concepts. It is the AEC’s goal that the results of this workshop form the foundation of a basin-wide biological monitoring and assessment framework which is necessary to assess the Red River of the North basin. Objectives of the workshop included:

1. Define reference condition for the Red River basin.
2. Identify the predominant anthropogenic stressors affecting aquatic ecosystems in the basin.
3. Identify appropriate reference site screening tools (e.g. GIS layers, analyses)
4. Describe appropriate biological assemblages for use in biological condition monitoring and assessment.
5. Develop standard methods to implement a biological monitoring and assessment program.
6. Prepare a report to the IRRB that summarizes the workshop and objectives 1-5.

7. Develop a conceptual framework for basin-wide biological monitoring based on reference sites to describe reference condition which incorporates the realities of each agency's mission and current program.
8. Identify specific steps for implementing a monitoring program which recognizes the need to coordinate among and between agencies to determine what, when, where, how and why for sampling, data sharing and production of reports incorporating the monitoring network.

This document summarizes the outcomes of this workshop, reviews existing agency responsibilities and monitoring activities, describes an approach to assess the aquatic health of the Red River Basin's riverine system, and makes recommendations to ensure the Red River's aquatic resources are consistently and adequately monitored in the future. The primary audience for this information is the International Red River Board and its parent committee - the IJC.

Responsibilities of Existing Agencies

Federal, state and provincial governments have developed legislation aimed at protecting and improving aquatic resources (ecosystems and biota) and how society should deal with known impacts to these systems. The U.S. Congress passed the *Clean Water Act* in 1972 with the goal "to restore and maintain the chemical, physical, and biological integrity" of the nation's waters (U.S. Gov. Print. Off. 1988). The Canadian government established similar legislation in 1985 with passage of the Canada Water Act (Government Canada 2004). Through this legislation, governments are charged with developing monitoring, regulatory and incentive programs to identify and mitigate adverse anthropogenic impacts to aquatic ecosystems.

Most existing water quality monitoring programs and water quality standards are aimed at controlling and managing point sources of pollution. Historically, monitoring focused on water chemistry parameters meant to ensure that established designated uses are being met. While information of this type is sufficient for the identification and regulation of point source pollution discharges, it is inadequate for use as an ecological assessment tool. Furthermore, these chemical data cannot measure impacts from non-point pollution sources such as increased sedimentation due to human activities, sheet/urban runoff, or atmospheric deposition.

Existing Biological Monitoring in the Red River Basin

Many federal, state, provincial, tribal, and local governments in the Red River Basin are monitoring fish and macroinvertebrates. Sampling ranges in purpose and intensity - from periodic catfish sampling on the Red River to evaluate fishing regulations, to systematic sampling of stream invertebrates on North Dakota streams. To date, the most comprehensive basin-wide biological sampling has been conducted in 1993 and 1994 (USEPA 1998). This monitoring resulted in the development of an Index of Biological Integrity (IBI) for the Lake Agassiz Plain Ecoregion in the U.S. portion of the basin. Since then, efforts by the North Dakota Department of Health have built on this work and expanded the use of IBI within the North Dakota portion of the basin.

Historically, biological monitoring programs have focused on fish communities; however, some aquatic invertebrate communities have also been sampled. During the workshop, each agency presented information on current biological monitoring programs in the Red River Basin and discussed how reference condition is (or isn't) used in their respective programs. Although the respective programs vary in scope and intensity, the scientific foundation for these efforts are consistent and provide substantial opportunities to develop common basin-wide monitoring goals and objectives. A summary of federal, state, provincial and local biological monitoring programs is provided in Appendix D.

Methods to Assess Ecosystem Health

“Natural” aquatic ecosystems have connected habitats, water quality, and hydrologic conditions that support diverse fish and invertebrate communities for the long term. The Red River is a large river that is supported by numerous major and minor tributaries through a network of streams and waterways within tributary watersheds. The Red River Basin's aquatic resources cannot be assessed by only monitoring the mainstem or at one point on the mainstem. Rather, the Red River basin needs to be assessed as a system which includes the mainstem, its tributaries and its headwaters.

Biosurveys and biocriteria development are recognized tools for ecological assessment of aquatic water resources (USEPA 1990). Information of this type provides a quantitative measure of ecological condition that can enable regulatory agencies responsible for administering environmental policy (i.e. issuing permits) to concentrate on the environmental “health” of the system in question as criteria for success or failure of future projects (Karr 1994, Davis and Simon 1995). Along with chemical criteria, biocriteria will allow agencies to identify impairments to beneficial use and prioritize abatement efforts by providing:

- an index of water resource condition,
- early detection of pollution impacts,
- a measure of success or failure of water resource management programs,
- evaluation procedure for 404 permit impacts, and
- measure status and trends over time (USEPA 1997).

Numerous local, state/provincial, tribal, and federal agencies have an interest in assessing the Red River Basin ecosystem and there are many water resource monitoring programs underway. Although the methods and rationale vary somewhat depending on the jurisdiction or agency program, the information is commonly used to develop environmental indicators such as the Index of Biological Integrity (IBI).

The IBI is a quantitative tool to describe the relative condition of a biological community at an individual location. An IBI value is a multi-metric index related to the ability of a habitat to support and maintain a balanced, integrated, adaptive biological system having a full range of elements expected in a region’s natural habitat (Barbour et, al, 1995, Karr, et, al. 1986, Karr, 1991 and 1994). Sites with a higher score have greater biological integrity than sites with lower scores. In order to collectively evaluate the entire river system, numerous sites (i.e. river reaches) are sampled to ensure a wide range of conditions (stressor gradient) are evaluated and specifically included in the monitoring plan.

Another method of assessing ecological systems is through the use of sophisticated mathematical techniques such as multivariate statistics. This method uses statistics to develop environmental indicators by determining the statistical relationship between measures of

biological communities and environmental gradients. One such multivariate approach is the Canadian Aquatic Biomonitoring Network (CABIN) developed by Environment Canada (Environment Canada 2003).

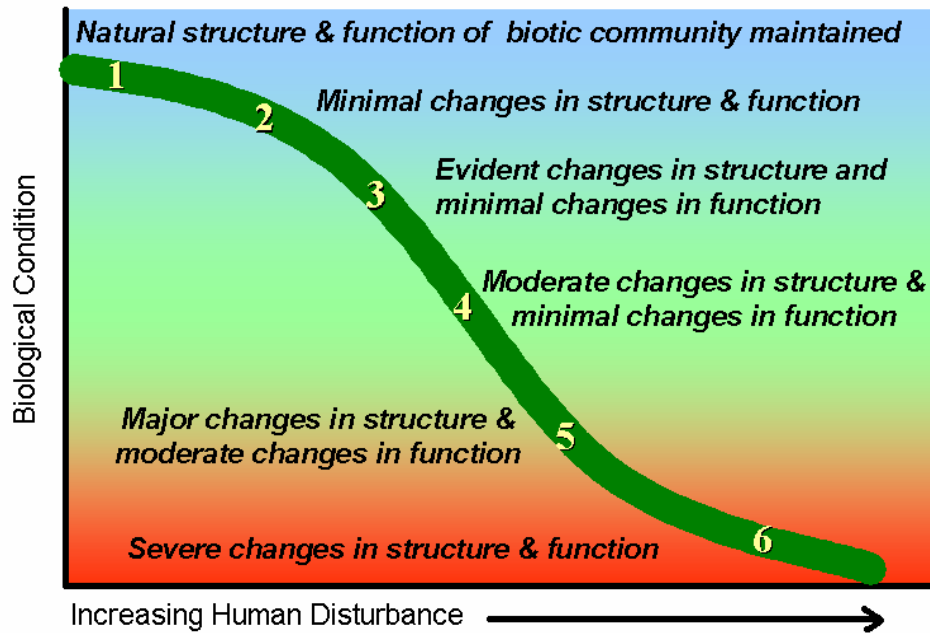
Reference Condition

In order to assess the ecological an aquatic resource, it is important to clearly define reference condition and what reference condition represents in a given region (Arscott 2003). Therefore, one of the main workshop objectives was to reach consensus on a common definition for the term “reference condition” for aquatic resource types in the Red River Basin and to identify stressors to the Red River mainstem and its tributaries which can be scaled across a gradient of human disturbance.

To characterize reference condition in a biological monitoring and assessment program, a set of reference sites are monitored. Biological community attributes are measured with known precision and accuracy to characterize the potential biological condition in the region being assessed. Results from reference sites are then compared to results from sites from rivers and streams in the region which are similar in size (i.e., wadable, non-wadable) and hydrologic regime (i.e., perennial, intermittent, ephemeral).

An appropriate definition of reference condition requires understanding the relationship between human disturbance and biological condition and how these concepts should be incorporated when defining reference condition (Figure 1). Biological condition of an aquatic resource is exhibited along a gradient, from pristine (top left corner), to severely impaired (bottom right).

Figure 1. The Biological Condition Gradient - Concept



Source: Jackson, 2004

There are two similar terms that require clarification prior to establishing reference condition. A reference site is a specific location on a river or stream which is least disturbed and is representative of the expected ecological integrity of the region for the same waterbody type. A reference site is a physical location on a particular waterbody. The term is not restrictive and is used to provide descriptive information (i.e. minimally or least disturbed) regarding the waterbody in question.

Reference condition is an expression of the benchmark biological condition based on a set of selected measurements or biological community attributes for a set of reference sites for a specific waterbody type in a region (USEPA 2004b). Reference condition is used by scientist in a relatively restrictive sense to describe the concept of biological condition given no human disturbance (Larsen 2004)

Consensus was reached on the following reference definitions. These terms and definitions will serve as the foundation for the AEHC efforts to assess ecosystems in the Red River Basin.

“Best available condition” describes reference sites in the Red River Basin that represent the best available physical, chemical and biological habitat condition given the present-day extent of human activities. These (reference) sites should exhibit a number of criteria describing the degree of exposure to stressors of interest. A site’s final classification as “best available” will be verified using biota endpoint values (e.g. IBI) determined by on-site monitoring of biological communities. These conditions are found where the lowest amount of anthropogenic disturbance is occurring today and will change as land management and other factors change over time with respect to aquatic condition (Bailey 2004).

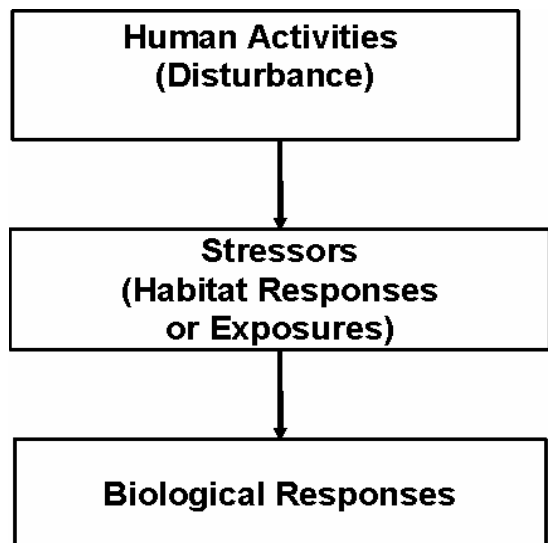
“Best attainable condition” can be “better” than current-day conditions on the landscape. This implies there is a societal component that may change over time as society’s will to improve (or degrade) conditions change. By the nature of its definition, “best attainable condition” does not currently exist in the Red River Basin. It was the consensus of the AEHC that this biological condition be used as a goal for ecological restoration in the Basin.

These common definitions establish a foundation for jurisdictions in the Red River Basin to develop standard benchmarks.

Stressors in the Red River of the North Basin

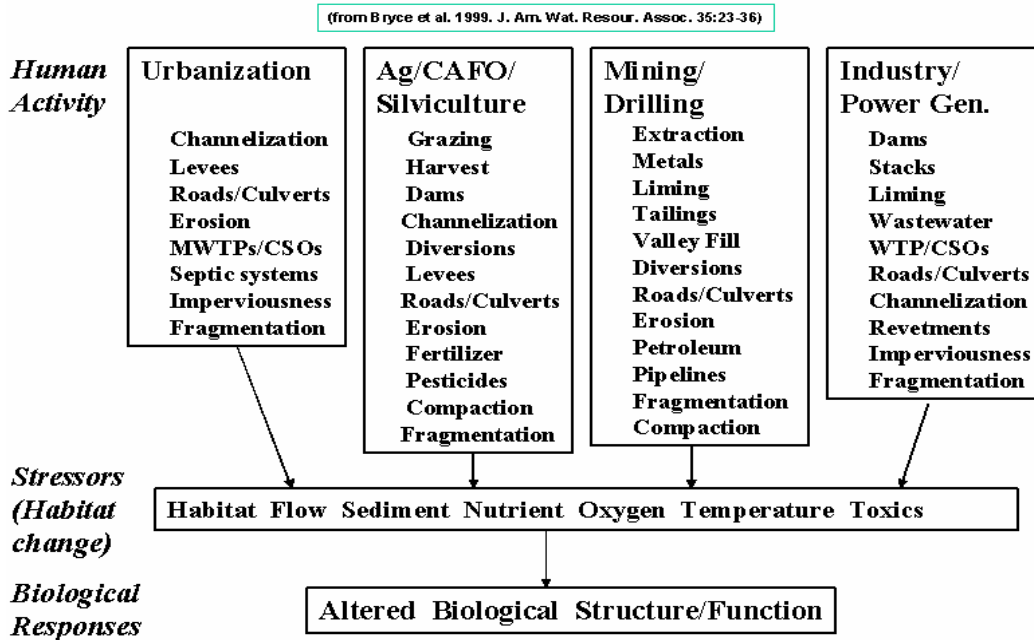
In order to identify best available condition in the Red River Basin which will be used to describe reference condition, it is necessary to identify and categorize stream reaches or sites which span a gradient of human disturbance (i.e., stressor gradient). Human activity often causes some disturbance that imparts stress on biological communities, usually through some form of habitat alteration or chemical exposure. Biological communities “respond” to this stress in a number of ways that can be quantified allowing comparative determinations of ecological condition to be made (Figure 2).

**Figure 2. Simple Stressor Model
Larsen 2004**



Human activity is pervasive in the Red River Basin (Figure 3). Arguably, there are few if any aquatic ecosystems that have no anthropogenic stressors. This poses some interesting and perplexing challenges related to characterizing reference condition and finding a collection of reference sites which exhibit “best available” characteristics (Aadland and Friedl 2004, Donald 2004, Chirhart 2004, Ell, 2004, Hughes 2004).

Figure 3. Stressor Model (Larsen 2004).



A common method of partitioning potential reference sites is to identify regional-scale stressors which impact resident biological communities and to establish an acceptable level of “least disturbance” in order to characterize reference condition (USEPA 2004). One problem with establishing reference condition is the large degree of natural variation that can and does occur. This natural variability makes it difficult to distinguish between anthropogenic and “natural” effects on biological communities. One method to minimize natural variability is to partitioning the resource using abiotic classification criteria such as geomorphology, climate, and hydrologic conditions.

Workshop participants were asked to identify considerations relevant to defining actual best available reference sites in the Red River Basin and how the aquatic resource should be stratified to partition natural variability. Workshop participants were also asked to articulate the

natural gradients in the Red River Basin controlling this biological condition and how existing information might be used to best account for them (Barbour 2004).

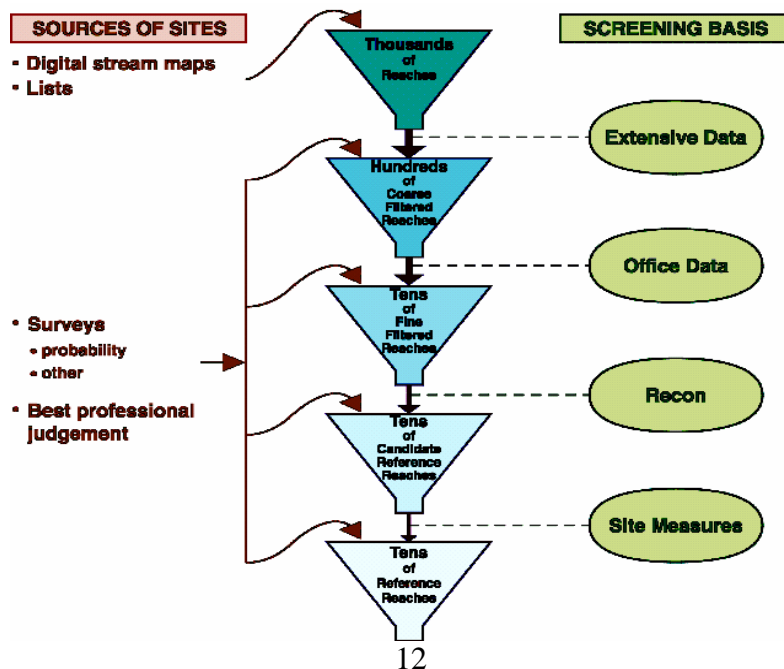
Identified stressors included a wide range of known human induced impacts to the aquatic ecosystem. Workshop participants synthesized the list of common stressors down to five categories: 1) function and habitat, 2) sediments, 3) nutrients, 4) temperature, and 5) dissolved oxygen (Arscott 2004). Invasive species were also identified as important potential stressors.

Participants agreed that stressors were common throughout the Red River Basin; however, they also agreed that the relative impacts of these stressors change in various geographic regions. For example, anthropogenic activity resulting in function and habitat stress in areas close to the mainstem Red River may be greater when compared to the upper reaches of tributaries (Arscott 2004).

Classification and Stratification

In order to select potential reference sites from the existing range of natural conditions and settings, a method to classify the reaches is needed (Figure 4). Classification explains the natural biological condition from of a region based on selected physical characteristics and combines reaches with similar ecological characteristics (USEPA 2004).

Figure 4. Hierarchical Screening Process (Larsen 2004)



Prior to screening, common physical and environmental features of the region are identified to classify the resource and narrow the natural variability. Workshop attendees agreed to separate the basin’s river reaches into three distinct geomorphic regions. The Agassiz Lake Plain is represented by the flat valley floor extending laterally (east and west) from the mainstem Red River. The Agassiz Lake Plain transitions to parallel Beach Ridges extending along each side of the Agassiz Lake Plain. Glaciated Plains make up the furthest eastern and western portions of the Basin (Arscott 2004).

Participants also were asked to identify other natural gradients that defined similar geomorphic regions. These provide the basis for a number of stratification criteria to identify potential reference sites (Table 1).

Table 1. Natural Gradients

• Ecoregions (Level 3 and/or 4)	• Geomorphology (lake bed, beaches, etc.)
• Drainage Area	• Soils/geology
• Stream Order (ranging from 1-8)	• Rosgen Channel Types
• Water Temperature	• Climatic Delineation
• Stream Gradient	• Watershed (8 – digit HUC)
• Physiography	• Latitude
• Wetland/bogs (eastern portion of basin)	

Screening Process to Select Reference Sites

The large number of stream miles in the Red River Basin makes finding “best available” sites for reference characterization a daunting task. Identifying stressors and using them to filter potential sites is an important step in characterizing best available condition.

Establishing a reference site framework in the Red River Basin will require developing a common screening process to identify potential reference sites. All bioassessment efforts use some form of screening process to facilitate site selection in their monitoring programs (Meek 2004, Niemela 2004, Larsen 2004, Hanson 2004, and Schindler 2004). A variety of spatial data are incorporated into geographic information systems (GIS) software to screen potential reference sites and limit the natural variability.

After the screening criteria are established and used to identify potential reference reaches, further screening is done using available spatial data sets such as digital orthoquads and land feature maps to identify any additional human disturbances.

Another step in the screening process is field verification. Upon visiting the site, other factors such as the presence of livestock or recent human alterations may also be used to further filter sites from the Reference site pool. Once a site is sampled, a whole suite of physical and chemical parameters are used to make a final reference site determination. Since changes in resident biological communities provide the ultimate the response variable in biological assessments, quantitative or qualitative measures of resident biological communities must not be used to filter potential reference sites.

Biological community measurements at a given site are often variable and may exhibit stress because of natural events (i.e. drought, wet cycles). One way to address this natural variability is to establish an “index period” that considers the expected temporal variation of the biological indicator communities. Sites are sampled at the same time each year (i.e. the third week of June) to limit the natural variability that occurs throughout the season.

Additional screening criteria were identified based on the stressors identified during the workshop (Arscott 2004). Using GIS tools, and available spatial data, potential reference sites can be further screened by filtering using land features such as:

- Percentage of agricultural cropland
- Road densities
- Percent impervious area
- Connectivity of riparian corridors
- Percent hydrologic altered
- Prevalence and location of dams
- Point sources (NPDES location)
- CAFOs/feedlot locations
- Vacation homes
- Grazing Intensity

Recommendation for the Implementation of a Biological Monitoring and Assessment Framework in the Red River Basin

In order for entities in the Red River Basin to address the IRRB directives and to assess the aquatic ecosystem, a number of tasks need to be accomplished. Some require additional resources while others rely only on the willingness and ability of respective jurisdictions to work together towards a common goal. In many cases there are agencies and organizations which have the resources to complete the necessary tasks. In other cases additional resources will be required for an agency or organization to implement these recommendations and to complete the tasks.

Recommendation 1: – Complete a Red River Basin bioassessment framework that moves from the current conceptual description to details of monitoring and assessment

Agencies should adopt a common framework for assessing ecosystem health in the Red River Basin. Like most efforts which address resource management issues that span jurisdictions, success requires a commitment and a willingness to work together towards a common goal. The hurdles to overcome are compounded by the number and scope of governments involved. These hurdles are not insurmountable however, as much of the ground-work needed to establish a basin-wide framework for addressing this issue has already been done through the work of the IRRB and the AEC.

The AEC committee is charged with addressing directives from the IRRB with no additional time or financial resources. It is not reasonable to expect fulfillment of IRRB directives and AEC work products from staff with 100 percent of their time dedicated to other jurisdictional activities. Staff assignments and time commitments must be explicit and dedicated to determining the aquatic ecosystem health of the Red River Basin while using the AEC as the coordinating body for activities. If it is not possible to commit a percentage of existing staff time, then resources must be provided to support the AEC and address the directive from the IRRB.

The AEC membership and jurisdictions should be responsible for those tasks which are needed in order to coordinate monitoring activities in the Red River Basin. These tasks would not circumvent or replace existing monitoring efforts. Instead, the AEC's efforts would facilitate integration of state, federal and local monitoring efforts by providing a common basin-wide goal, objectives and framework. Key elements to successful framework implementation include:

- **A Common Reference Condition Definition** – Basically this is a summary of what was discussed earlier – “best available” and “best attainable
- **The Need to Establish “Best Available” Reference Sites** – Each jurisdiction must establish and agree to a series of reference sites for priority waterbody types in the Basin. Priority waterbody types identified in the workshop include the mainstem Red River and the major tributaries. North Dakota and Minnesota plan to conduct biological monitoring in the Red River Basin during the spring/summer of 2005 and will be selecting reference sites based on a screening process. North Dakota, Minnesota and Manitoba should meet to review this process and should strive for consistency across jurisdictional boundaries.
- **A Common Classification Scheme for Partitioning Natural Variability** – The steps necessary to classify and partition river reaches were discussed earlier. Although the process has generally been established and (should be), easily implemented, the resources to assess biological integrity in a large watershed such as the Red River Basin are limited. The IRRB should further prioritize resource types and direct agencies to focus activities accordingly. Agencies should also establish common indexing periods for the best available reference sites to limit the natural variability.
- **Screening tool development** – A standardized best available reference site filter must be developed using the geomorphic regions and stressors identified in the workshop. The filter will be applied to select the most likely reaches for further investigation and verification as best available sites. The screening tool would not necessarily replace the screening methods or the established sites used by each of the jurisdictions, but should incorporate a common set of criteria to serve as a basic premise for filtering sites. Scott

Niemela (MN Pollution Control Agency) and Mike Ell (ND Department of Health) were identified as leads. An individual from Manitoba should be identified to participate in this effort.

- **Develop a core set of standardized biological indicator communities** – Workshop attendees indicated there was consistency regarding the indicator biological communities sampled throughout the Red River Basin. North Dakota, Minnesota, and Manitoba use macroinvertebrates and fish as the indicator communities. Jurisdictions should explicitly agree on the communities that will be used to characterize best available and best attainable reference and eventually assess the Red River Basin's ecosystem.

Develop comparable sampling methods (wadeable and non-wadeable) – There are a wide range of biological communities scientists can use to assess the ecosystem. There are also many accepted field sampling techniques for wadeable streams. Once the jurisdictions agree on the communities to monitor, standardized methods for sampling must be developed and implemented. The method of sampling biological communities must be consistent in order to compare data from throughout the Red River Basin. It would be difficult to compare macroinvertebrate data from artificial substrates with data from D-frame dip nets. Jurisdictions should also develop indexing periods to limit the natural variability of the biological indicators. If jurisdiction cannot agree on and incorporate common sampling procedures, then methods should be developed that enable the IRRB and jurisdictions to normalize and compare data from existing programs that use varying sampling methods.

There are currently few commonly accepted methods of characterizing macroinvertebrates and other biological communities in non-wadeable rivers (i.e. mainstem Red River). A standardized method for sampling communities in non-wadable streams must be developed and incorporated into monitoring programs on the Red River mainstem. William “Bill” Franzin (Canada Fisheries and Ocean) agreed to serve on a subcommittee to review and propose common sampling methods for the Red River mainstem. Others identified or volunteered that would provide valuable input to this

effort were Cheryl Podemski, Colin Hughes, Scott Niemela, Nick Proulx, Tom Groshens, and Mike Ell. Another individual identified as having valuable input was Luther Aadland.

- **Establish standardized indicator development methods and study designs-** Jurisdictions should agree on standard data analysis methods to compare reference and “test” sites. Some jurisdictions use multivariate statistics while others use multi-metric methods. There are valid arguments for using both methods and one method can be used to further validate the other. However, for the purposes of assess the aquatic ecosystem of the Red River Basin, a common analysis method must be developed and employed.
- **Establish data archival and dissemination protocols** – Jurisdictions currently report on water related monitoring activities annually to the IRRB. Each jurisdiction prepares a report independently using information distributed in a variety of locations that may or may not be accessible. Each jurisdiction’s report is synthesized into an annual summary document by IRRB secretariats and presented to IRRB members at their annual meetings. A standardized data archival and storage protocol would enhance the ability of jurisdictions to jointly assess the aquatic ecosystem of the Red River Basin.

There is currently no international data collection and archival medium established for the Red River Basin to facilitate data sharing. The Red River Basin Decision Information Network (RRBDIN) was developed to provide a basin-wide source for information archival and dissemination. RRBDIN is a virtual database capable of gathering information from a variety of internet accessible locations and displaying the information. Developing the functionality through RRBDIN to provide this data archival and dissemination is necessary. Jurisdictions should allow access to information and provide resources to build aquatic ecosystem assessment tools in the RRBDIN.

- **Develop standardized IRRB reporting protocols** – A standard reporting protocol for the IRRB should be developed. Standard reporting protocols will enable the IRRB and its members to consistently monitor the Red River Basin’s aquatic resources over the long

term. Standardized reporting would increase efficiency and enhance the respective agencies ability to effectively communicate to the IRRB and ultimately, the IJC.

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Appendix A. Conference Program

Wednesday, March 10 th	
8:00a.m. - 8:30a.m.	Registration
8:30a.m. - 8:45a.m.	Welcome and Introductions (Fritz)
8:45a.m. - 9:00a.m.	IRRB/AEHC Background/Workshop (Nelson/Donald)
9:00a.m. - 9:15a.m.	Review of Mini Workshop outcomes/Meeting Objectives (Nelson/Donald)
SESSION I - Defining "Reference"	
9:15a.m. - 10:15a.m.	Panel - The "concept of Reference" (Drs. Barbour, Larsen, Arscott, and Bailey) Reference sites and their relationship to biological assessment/criteria
10:15a.m. - 10:40a.m.	Break
10:40a.m. - 12:00p.m.	Panel - Existing Biological Monitoring Programs (Goal, Objectives, Methods) in the RRB (how existing programs define and rely on reference condition) U.S. Federal (Larsen) CA Federal (Donald) North Dakota (Ell) Minnesota (Niemeck) Manitoba (Hughes) Tribal/Local (Hanson)
12:00p.m. - 1:00p.m.	Lunch (Provided)
1:00p.m. - 2:00p.m.	Panel - Identification of factors needed to DEFINE reference sites/conditions (Larsen, Barbour, Bailey, Arscott)
2:00p.m. - 3:00p.m.	Break - Out/small-group Discussion Objective: Consensus (common definition(s)) of reference in the RRB
3:00p.m. - 3:30p.m.	Break
3:30p.m. - 5:00p.m.	Panel - Overview/presentation of break-out discussions (Barbour, Larsen, Arscott, Bailey)
6:00p.m. - ?	Mixer/Social
Thursday, March 11 th	
8:00a.m. - 8:30a.m.	Topic/special speaker or overview of yesterday outcomes/today's schedule
SESSION II - Stressors	
8:30a.m. - 10:00a.m.	Panel - Stressors on aquatic ecosystem in the RRB: causes, sources and effects (Aadland, Ell, Donald, Hughes)
10:00a.m. - 10:15a.m.	Break-out guidance/overview
10:15a.m. - 10:30a.m.	Break
10:30a.m. - 11:30a.m.	Break-out small group discussions Objective: articulate stressors impacting ecosystem health
11:30p.m. - 12:30p.m.	Panel - Overview/presentation of break-out discussions (Barbour, Bailey, Larsen, Arscott)
12:30p.m. - 1:30p.m.	Lunch (Provided)
SESSION III - Tools/methods for identifying potential reference sites on the landscape	
1:30p.m. - 2:30p.m.	Panel - Available tools/strategies/methods used to characterize and identify potential reference sites (Johnson, Meek, Niemeck, Larsen)
2:30p.m. - 2:45p.m.	Break
2:45p.m. - 3:45p.m.	Break-out/small group discussion Objective: articulate common methods (or commonalities in existing programmatic efforts) for identifying reference
3:45p.m. - 5:00p.m.	Panel - discussion/presentation of break out results (Barbour, Bailey, Larsen, Arscott)
5:00p.m. - 6:30p.m.	Supper (on your own)
Friday, March 12 th	
8:00a.m. - 9:00a.m.	Panel session Review/outcomes
9:00a.m. - 10:00a.m.	Next steps/strategy/funding needs (Panel - ND, MN, MB, Federal): a cursory look at indicator communities.
10:00a.m. - 10:30a.m.	Break
10:30a.m. - 11:30a.m.	International Joint Commission/International Red River Board reporting, funding strategies/needs, and expectations
11:30a.m.	Adjourn

Appendix B. Lead Facilitators

Dr. Phil Larsen is a senior research aquatic biologist at the USEPA's research division in Corvallis, Oregon. As part of a research team that develops aquatic resource monitoring tools, he conducts research at the interface between aquatic ecology and survey design (application of statistical theory) and on the implementation of design principles for lakes and streams. His research includes the development of physical, biological, chemical, riparian, and landscape indicators and relationships among them.

Dr. Robert Bailey is the Director of the Environmental Research Western and professor in the Department of Biology at the University of Western Ontario. He is also Director of UWO's Environmental Science Graduate and Undergraduate Programs, and is Secretary/Treasurer of the Association of Canadian Universities for Northern Studies. Dr. Bailey's primary research interest is in biological assessment of freshwater ecosystems using benthic macroinvertebrates. He has spent several years developing and applying new techniques of biological assessment and monitoring in freshwater ecosystems and investigating hierarchical structuring of biological communities and their habitats in freshwater systems.

David Arscott is a Research Scientist and Project Coordinator at the Stroud Water Research Center in Avondale, Pennsylvania. The Stroud Water Research Center is a research and education institution dedicated to the study of streams and rivers. Dr. Arscott was involved as primary or co-author on 33 scientific publications, abstracts and presentations on freshwater systems. Dr. Arscott is currently working on watershed water research for potable water supply, fish ecology and management, riparian and wetland ecology, and water resources management.

Dr. Michael Barbour is the Director for the Center for Ecological Services for Tetra Tech Incorporated. Tetra tech is an environmental consulting firm for the US Environmental Protection Agency. Dr. Barbour supervises a staff of ecologists and toxicologist who provide technical support for assessing the water quality and ecological health of the nation's waters. Dr. Barbour has published over 30 scientific publications and is nationally known as the primary author of the US EPA's bioassessment protocols which is being used throughout the country for assessing the condition of rivers and streams.

Appendix C. Workshop Attendees

LAST NAME	FIRST NAME	AGENCY NAME	PHONE	EMAIL
Aadland	Luther	MN DNR	218-739-7449	luther.aadland@dnr.state.mn.us
Arscott	David	Stroud WRC	610-268-2154	darscott@stroudcenter.org
Bailey	Robert	Univ. W. Ontario	519-661-2111	drbob@uwo.ca
Barbour	Micheal	Tetra Tech, Inc.	410-356-8993	Michael.Barbour@tetrattech.com
Botnen	Lisa	EERC	701-777-5144	lbotnen@undeerc.org
Carter	Chandra	MN PCA	651-297-1347	chandra.carter@pca.state.mn.us
Chirhart	Joel	MN PCA	651-296-7210	joel.chirhart@pca.state.mn.us
Donald	David	Environment Canada	306-780-6723	david.donald@ec.gc.ca
Ell	Michael	NDDH	701-328-5214	mell@state.nd.us
Erickson	Stacey	EPA Region VIII	303-312-6692	eriksen.stacey@epamail.epa.gov
Feist	Mike	MN PCA	651-296-9210	mike.feist@pca.state.mn.us
Frazin	William	Fisheries and Oceans	204-983-5082	franzinw@dfo-mpo.gc.ca
Frederick	Jack	MN PCA	218-846-0734	john.frederick@pca.state.mn.us
Fritz	Charles	RRBI	701-231-9747	charles.fritz@ndsu.nodak.edu
Giedt	John	EPA Region VIII	303-312-6692	giedt.john@epa.gov
Genet	John	MN PCA	651-296-7240	john.genet@pca.state.mn.us
Gerla	Phil	UND/TNC	218-857-3305	phil.gerla@mail.und.nodak.edu
Glozier	Nancy	Environment Canada	306-975-6057	nancy.glozier@ec.gc.ca
Groshens	Tom	MN DNR	218-755-4488	tom.groshens@dnr.state.mn.us
Hanson	Corey	RLWD	218-681-5800	coreyh@wikel.com
Haugerud	Neil	NDDH	701-328-5253	nhaugeru@state.nd.us
Hughes	Colin	MB Water Stewardship	204-945-7096	chughes@gov.mb.ca
Johnson	Rex	USFWS	218-739-2291	rex_johnson@fws.gov
Kowalchuk	Michael	IRRB	204-983-5500	michael.kowalchuk@ec.gc.ca
Larsen	Phil	US EPA	541-7544362	Larsen.Phil@epamail.epa.gov
MacGregor	Molly	MN PCA	218-846-0494	molly.macgregor@pca.state.mn.us
Meek	James	NDDH	701-328-5230	jmeek@state.nd.us
Nelson	Rick	US BOR	701-250-4242	rnelson@gp.usbr.gov
Niemela	Scott	MN PCA	651-296-8878	scott.niemela@pca.state.mn.us
Norland	Jack	NDSU	701-231-9428	jack.norland@ndsu.nodak.edu
Kiers North	April	RRBC	218-291-0422	april@redriverbasincommission.org
Proulx	Nick	MN DNR	651-284-3589	nick.proulx@dnr.state.mn.us
Rush	David	RRRC	701-352-3550	drush@state.nd.us
Schindler	Darrell	Red Lake DNR	218-679-3959	dschindl@paulbunyan.net
Steele	Bruce	NDSU NRM	701-231-8543	bruce.steel@ndsu.nodak.edu
Thompson	Shirley	Univ. of Manitoba	204-474-7170	s_thompson@umanitoba.ca
Vavricka	Mike	MN PCA	218-846-0494	Mike.vavricka@pca.state.mn.us
Waters	Alicia	US BOR	701-250-4242	awaters@gp.usbr.gov
Weitzell	Roy	MN PCA	651-296-7872	roy.weitzell@pca.state.mn.us

Appendix D. Existing Biological Monitoring Efforts

United States Fish and Wildlife Service (USFWS)

History: The USFWS has sampled a limited number of streams in the Red River Basin. In 2003, USFWS staff sampled fish at 17 sites in six ditches that are located in the Glacial Ridge area near Crookston. Some invertebrate and fish sampling has also been conducted to evaluate the impacts of fish on wetland invertebrates.

Purpose: Collect baseline data that describes the fish community (species present, relative abundance) and to evaluate the impacts of fish on wetland invertebrates

Scope: Backpack electrofishing at stream stations.

Future plans:

Contact: Scott Yess (scott_yess@fws.gov), Lacrosse District, 555 Lester Avenue, LaCrosse WI 54650 (608) 783-8405

United States Environmental Protection Agency (USEPA)

History: USEPA has primarily been involved with two efforts to assess the aquatic health of the Red River Basin. USEPA Region 5 funded and published an Index Of Biotic Integrity (IBI) investigation and report for the Lake Agassiz Plain ecoregion in 1998. This report was based on fish sampling conducted throughout the basin in 1993 and 1994. This was a collaborative effort among USEPA, North Dakota Department of Health, Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, the USGS and the North Dakota Game and Fish.

More recently the USEPA Office of Research and Development has initiated the Environmental Monitoring and Assessment Program Western Pilot Project (EMAP-Western Pilot Study). The primary goal of the EMAP Western Pilot Study is to generate state and regional scale assessments of the condition of ecological resources in the western United States, and to identify stressors associated with the degradation of these resources. Beginning in 1999, EMAP embarked on a five-year effort to demonstrate the application of core monitoring and assessment tools across a large geographical area of the western United States. The EMAP Western Pilot Study encompasses the “lower” states of EPA Regions 8, 9 and 10 (i.e., Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming).

The survey design developed by EMAP, which relies on randomly selected sites, provides a rigorous way to sample a subset of all waters and then provide an estimate of the quality of all waters along with a statement about the uncertainty surrounding that estimate.

EMAP has developed a core set of indicators of ecological condition and environmental stressors. These include:

- Biological assemblages (fish, macroinvertebrates and algae)
- Ambient water chemistry- Year 1 sampling (nutrient, cations/anions, trace metals)
Fish tissue contaminants (mercury, metals, PCB congeners, persistent organics)
- Physical habitat (sedimentation, in-stream and riparian habitat structure)
- Watershed characteristics (landcover/landuse, road density, population density)

Within North Dakota USEPA is collaborating with the North Dakota Department of Health and the USGS. Personnel with these two agencies are collecting field data and will be responsible for data analysis and the preparation of the state assessment report for North Dakota.

Field sampling for the EMAP Western Pilot Project was conducted from 2000 through 2003. A total of 98 sites have been sampled in North Dakota. Of those 44 sites (18 reference sites and 26 randomly selected sites) are located in the North Dakota portion of the Red River of the North Basin.

Methods: Peck, D.V., J.M. Lazorchak, and D.J. Klemm (editors). Unpublished draft. Environmental Monitoring and Assessment Program -Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams. EPA/XXX/X-XX/XXXX. U.S. Environmental Protection Agency, Washington, D.C.

Contact: Karl Hermann, EPA region 8, Denver, CO
Mike Ell, North Dakota Department of Health

Minnesota Department of Natural Resources (DNR)

History: DNR fisheries staff have sampled fish in at least 150 sites in the Red River basin. These efforts include sampling individual sites on ditches and streams near flood control projects, sampling major tributaries from mouth to headwaters, sampling a variety of sites on many waterways in a subwatershed, and sampling the main stem of the Red River. DNR ecological services staff have investigated microhabitat use of fishes in some tributaries as part of instream flow evaluations. In addition to this fish sampling, DNR has collaborated with ND Game and Fish to conduct angler surveys on the Red River. Stream invertebrates have been sampled rarely as part of these assessments.

Purpose: To describe fish communities in Red River Basin streams (species present, relative abundance, size and age distribution, growth rates). Angler surveys were designed to assess the harvest and angler use of the Red River of the North.

Methods/Scope: Sampling is conducted following methods identified in the Minnesota DNR stream survey manual. Backpack, tow-barge, and mini boom electrofishing are the primary sampling method; however, trap nets (fyke), trot lines, and gill nets have also been used in larger sized reaches of the rivers. IBI values have also been estimated in most recent subwatershed sampling.

Future plans: Stream sampling will be conducted on major tributaries and the Red River every five or ten years. Sampling throughout each tributary subwatershed will be conducted every ten years to correspond with watershed district planning. Creel surveys are planned for at least once every 10 years.

Contact: Henry Drewes (henry.drewes@dnr.state.mn.us), Regional Fisheries Supervisor, Bemidji, MN, 651-297-8237

Minnesota Pollution Control Agency (MPCA)

History: In 1993 and 1994, the MPCA cooperated with other agencies to develop a fish based IBI for the Red River Basin. The IBI was published in a 1998 EPA report entitled "Development of Index of Biotic Integrity Expectations for the Lake Agassiz Plain Ecoregion". MPCA has also developed IBI methods and criteria for several other river basins in Minnesota including the St. Croix, Upper Mississippi, and Minnesota River basins.

Purpose: To develop regional indices of biological integrity (IBI's) using attributes of fish and macroinvertebrate communities for eventual adoption of biological criteria into state water quality standards.

Methods/scope: Sampling is conducted following methods identified in MPCA IBI reports and standard operating procedures. Backpack, tow-barge, and boat electrofishing gear is used as appropriate for stream size and conditions. A multi-habitat sampling method using D-frame kick nets is used to collect macroinvertebrates. Standard operating procedures for fish, and invertebrate collection, habitat assessment and site reconnaissance may be found on the MPCA website at <http://www.pca.state.mn.us/water/biomonitoring/index.html>

Future plans: MPCA plans to conduct a full survey of the Minnesota portion of the Red River basin in cooperation with MN DNR in 2005. The survey will include an assessment of fish and macroinvertebrate assemblages, habitat, and water chemistry.

Contact: Scott Niemela (Scott.Niemela@state.mn.us), Minnesota Pollution Control Agency Research Scientist, 651-296-8878.

North Dakota Department of Health (NDDH)

History: In response to a growing need for better water quality assessment information, the ND DOH initiated a biological monitoring program in 1993 and 1994. This initial program, a cooperative effort with the Minnesota Pollution Control Agency, the Minnesota Department of Natural Resources and the USGS's Red River National Water Quality Assessment Program, involved approximately 100 sites located in both the North Dakota and Minnesota portions of the Red River Basin. The result of this initial program was development of the IBI for fish in the Lake Agassiz Plain Ecoregion portion of the Red River Basin (as published by EPA Region 5). The ND DOH continued this program in the Red River Basin in 1995 and 1996. The Upper Red River Basin, including the Sheyenne River and its tributaries, was sampled in 1995, while the Lower Red River Basin was sampled in 1996. Beginning in 1995, biological monitoring was expanded to include macroinvertebrate sampling. A total of 114 sites have been sampled by the ND DOH in the Red River Basin.

This basin approach to biological monitoring allows for more intensive water quality monitoring and assessment. The result has been better resolution in the Health Department's monitoring program, an increase in the percentage of rivers and streams assessed, and a direct assessment of aquatic life use support for the state's rivers and streams, rather than relying on surrogate measures such as chemical concentration data. The purpose of this biological monitoring program is to: 1) develop an IBI for fish and macroinvertebrates; and 2) provide an assessment of aquatic life use attainment for those stream reaches which were assessed.

Methods: Fish sampling was conducted following methods described in the North Dakota Department of Health's "Standard Operating Procedure for the Collection of Fish in Wadable Rivers and Streams" (January 2002). Macroinvertebrate samples were collected and processed following the procedures described in the Department's "Standard Operating Procedure for the Collection of a Macroinvertebrate Sample in Wadable Rivers and Streams" (January 2002) and in the Department's "Standard Operating Procedure for the Laboratory Processing of Macroinvertebrate Samples" (January 2002).

Future plans: Following the completion of ND DOH's commitment to the EMAP Western Pilot in 2004, the Department plans to re-initiate its "rotating basin" biological monitoring program. The Department plans to conduct biological monitoring in the Red River Basin in

2005 and 2006. Biological assemblages targeted for sampling will include fish, macroinvertebrates and possibly periphyton. This program will include the probabilistic sample design employed by EMAP along with the selection and sampling of targeted reference sites in the basin. The goals of this effort will be 1) an improvement of existing macroinvertebrate and fish IBIs for the Red River Basin; and 2) a description of the condition of the aquatic community in the North Dakota portion of basin.

Contact: Mike Ell, North Dakota Department of Health, 701-328-5214, mell@state.nd.us.

North Dakota Game and Fish Department (ND G&F)

History: North Dakota Game and Fish has assessed fish populations as part of an IBI investigation, surveys of the Red River, and through angler surveys. In 1993 and 1994 ND G&F cooperated with other agencies in fish sampling for the 1998 EPA report. In 1996, 1997, and 1998 fish sampling was targeted at Red River catfish population assessment. In 1999, ND G&F also cooperated with MN DNR to conduct a general fish survey on the main stem of the Red River. Spring angler surveys were conducted in 1998, 1999, and 2003. Angler surveys were also conducted for the entire fishing season in 2000.

Purpose: The purpose of the EPA based sampling was to develop an index of biotic integrity for fish in the Red River of the North basin. The purpose of Red River sampling was to assess the catfish population and/or describe the fish community of the Red River. Angler surveys were designed to assess the harvest and angler use of the Red River of the North and evaluate fishing regulations.

Methods/Scope: Fish sampling was conducted following methods identified in the EPA report and in ND G&F reports. Backpack, tow-barge, and mini boom electrofishing gear were used as appropriate for stream size and conditions. Trap nets (fyke), hoop nets, and trot lines have been used to sample fish in the Red River.

Future plans: ND G&F will sample fish populations on the Red River on a regular basis in the future to evaluate the fish populations. Future plans include collaboration with ND DOH on 2005 IBI based fish sampling and collaboration with MN DNR fisheries on future fish and angler surveys.

Contact: Lynn Schlueter, ND Game and Fish Department, Special Project Biologist, Devils Lake, ND. 701-662-3617, lschluet@state.nd.us.

Manitoba Water Stewardship (MBWS)

History: Biological monitoring for the assessment of ecosystem health by the Province of Manitoba has emphasized macroinvertebrate biological integrity. Provincial sampling and analysis of invertebrate data specifically for this purpose was initiated in 1995 and has been carried on annually in wadable since then (Hughes 2004). Since its inception this program has included annual sampling for macroinvertebrates in at up to 27 streams per year on 28 wadeable streams and two non-wadeable sites on Red River main stem. This invertebrate monitoring has been carried out in the Red River basin in six to seven tributary streams per year, of which five of these streams are located upstream of the confluence of the Assiniboine River. In 2003 annual invertebrate monitoring was initiated on the main stem of the Red River in 2002. Except for one stream where a sampling site had to be moved due to sampling problems the same sampling sites on these streams were sampled year after year. Three Assiniboine River basin tributaries have also been sampled annually since 1995 and main stem sampling on the Assiniboine River initiated in 2002.

Provincial sampling of fish in the Red River basin was generally done for other purposes. Historically, provincial “biomonitoring” of fish in the Red R. basin has been carried out to assess concentrations of contaminants in fish flesh with respect to the effect of consumption on human health, with the emphasis on mercury. Other fish sampling has done in response to fish kills and other issue related responses.

Purpose: The purpose of this sampling is to describe the invertebrate communities in the Red River basin and estimate IBI values.

Methods: Invertebrate sampling on wadeable streams included five one square meter standard kick-net samples per site from 1995 through 2001 and four one square meter kick-net samples and one qualitative sample per site in 2002 and 2003. Invertebrate sampling at two Red River main stem sites included five standard Ponar dredge samples per site.

Future plans: Sampling at these sites will continue with a report in preparation. Any program expansion which may occur is dependant on other priorities.

Contact: Colin Hughes, Water Quality Specialist, Water Quality Management Section, Manitoba Water Stewardship, 204-945-7096, chughes@gov.mb.ca.

Red Lake Watershed District

History: RLWD staff began a fish and invertebrate sampling program in 2003 based on recommendations from the Clearwater River Non-point study. Sixteens sites on the Clearwater River have been sampled.

Purpose: The purpose of this sampling is to describe the fish and invertebrate communities of the Clearwater River.

Methods: Fish and invertebrates were sampled using EPA Rapid Bioassessment Protocols for wadeable streams. IBI values were estimated for fish and invertebrates.

Future plans:

Contact: Corey Hanson, Water Quality Coordinator, Thief River Falls, MN. 218-681-5800. coreyh@wiktel.com.

Red Lake Band of Chippewa

History: Red Lake Band Biologist began a fish and invertebrate sampling program in 1998 after receiving an EPA 106 grant. Since 1998, 62 sites on waterways on or near the Red Lake reservation have been sampled.

Purpose: The purpose of this sampling is to describe the fish and invertebrate communities on streams in watersheds where the band holds land.

Methods: Fish were sampled using a standard back pack electrofishing unit. EPA Rapid Bioassessment Protocols were used for invertebrate collection.

Future plans: Prepare report from previous data collection efforts and continue sampling at selected locations.

Contact: Darrell Schindler, Aquatic Biologist, Red Lake, MN. 218-679-3959. dschindl@paulbunyan.net .

U.S. Geological Survey

History: The U.S. Geological Survey (USGS) has been collecting and analysis data and information from 50 major river basins and aquifers in the U.S. since 1991.

Purpose: The National Water Quality Assessment Program (NAWQA) goal is to develop long-term consistent and comparable information on streams, ground-water and aquatic ecosystems to support sound management and policy decisions. The NAWQA programs is designed to determine the condition of the Nation's streams and groundwater, assess trends to this condition and better understand the natural features and how human activities affect them.

Methods: <http://water.usgs.gov/nawqa/protocols/>

Future Plans: <http://water.usgs.gov/nawqa/>

Contact: <http://water.usgs.gov/nawqa/contacts.html>