Y2Y AQUATICS STRATEGY WORKSHOP

SPONSORS:

YELLOWSTONE TO YUKON CONSERVATION INITIATIVE

FLATHEAD LAKE BIOLOGICAL STATION

AMERICAN WILDLANDS

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INTRODUCTION

The Yellowstone to Yukon Conservation Initiative (Y2Y), Flathead Lake Biological Station and American Wildlands sponsored this aquatics workshop with the goal to develop a science-based conservation strategy for freshwater ecosystems throughout the Yellowstone to Yukon region. Nine scientists met with five Y2Y activists and staff to identify important features, issues and sources of information that would guide conservation planners in incorporating aquatic considerations into a Conservation Area Design (CAD) for the entire region.

The CAD, and the science to build it, constitutes a critical focus for the Y2Y Initiative over the next several years. Recommendations from this workshop will provide a preliminary scientific basis for protecting aquatic biodiversity and the natural resiliency of river basins within the Yellowstone to Yukon region.

Until recently, Y2Y's conservation efforts have been terrestrially-focused and only indirectly concerned with our inland fisheries. Many questions relating to aquatic integrity remain largely unanswered, i.e., Where are the aquatic strongholds? How impacted are our watersheds? What aquatic features do we want to protect? And how aren't they being preserved with protections focused on wildlife?

This aquatics workshop begins an on-going dialogue of aquatic scientists informing Y2Y on the status of freshwater ecosystems and priorities for protection and restoration. It is the first in a series designed to engage scientists in advising Y2Y and contributing important knowledge to Y2Y's CAD.

During the course of the workshop, it became apparent that the caliber of information exchange would be seminal in advancing the Y2Y network's understanding of the importance of aquatic systems and should be captured in a summary report. Information in this document is intended to assist conservation planners in protecting and restoring specific species of concern and significant aquatic refugia and features which are integral to conserving the ecological integrity of the Y2Y region as a whole.

In summary, workshop participants recommended Y2Y conservation planning focus in six main areas:

- water quality
- watershed integrity
- biodiversity
- native populations
- special features
- impoundments, dams and other forms of hydrologic alterations

TOPICS COVERED IN THIS SUMMARY DOCUMENT

YELLOWSTONE TO YUKON
AN AQUACENTRIC VIEW

From an aquatic ecologist's viewpoint, the Yellowstone to Yukon region consists of approximately 230 watersheds (fourth to sixth order) distributed among continental basins draining to six seas: the Bering Sea, the Beaufort Sea, Hudson's Bay, the Gulf of Mexico, the Gulf of California, and the Pacific Ocean.

The region can be viewed as a skeleton, with the Continental Divide as the spine, from which diverge a pelvic girdle (the Colorado-Columbia and Colorado-Missouri divides), a pectoral girdle (the Yukon-Pacific and Yukon-Mackenzie divides), and ribs comprised of divides between the major river basins flowing east and west from the Continental Divide. (See Figure 1).

The main skeletal elements (the major divides) group naturally- and hierarchically-related sub-drainages. Note that the major drainages are open-ended; thus the Y2Y region has no rigidly defined outer limits. This feature is a realistic manifestation of the fact that the Y2Y region is ecologically an integral part of its surrounding lands and waters: it influences— and is influenced by—the lands and waters surrounding it. Note also that (from an aquatic point of view) the Y2Y region does not constitute a natural "super ecosystem": it is instead a collection of at least six distinct major drainage basin "greater ecosystems" relatively unrelated to one another except, for example, through their postglacial history of faunal inter-basin transfers. From a terrestrial point of view, however, the drainage basins are intimately connected by the drainage divides, or more correctly, by their shared uplands and passes over the divides.

Aquatic systems in the Y2Y region fall into several categories, but are united in being parts of large catchments (watersheds), or unitary ecosystems with inseparable aquatic and terrestrial elements.

Y2Y AQUATIC SYSTEMS

- **Large rivers and lakes**, not surprisingly, occupy main valleys. All are rare by definition, and therefore tend to be unique (they have low redundancy). They are the areas of lowest elevation in their basins, and therefore tend to have the longest growing seasons. Their associated riparian zones tend to be large, diverse and relatively productive. It was along the main valleys that native fishes and some other aquatic organisms invaded the region after the last Ice Age (or in which they survived it south of the glacial limits), and to which they were often restricted by barriers to dispersal. It follows that the aquatic habitats that are associated with large valleys in the region will be different from, and rarer than, those in the much more numerous, smaller tributary valleys. Similarly, most critical habitat for native species must be in the main valleys in association with the larger rivers and lakes. Unfortunately, human development in Y2Y has been concentrated in these larger valleys. Thus the greatest damage, or potential for damage, has been concentrated where many of the scarce, critical or unique aquatic habitats are located.

∑ In contrast to large rivers and lakes, **small streams, small lakes and small aquatic habitats** of all kinds (small ephemeral, intermittent and permanent streams, ponds, puddles and damp areas) are very abundant in the Y2Y region. These waters have high redundancy.


Yellowstone to Yukon
An Aquacentric View of Major River Basins
YUKON TERRITORY
NORTHWEST TERRITORIES
ALBERTA
BRITISH COLUMBIA
MONTANA
WASHINGTON
OREGON
IDAHO
WYOMING
Yukon
Mackenzie
Liard
Stikine
Skeena
Peace
Athabasca
North Saskatchewan
Saskatchewan
Fraser
Columbia
South Saskatchewan
Missouri
Yellowstone
Salmon
Snake
Green
Yellowstone to Yukon Conservation Initiative
LEGEND
Major Basin Boundaries
50 0 50 100 150 Miles
75 0 75 150 225 300 Km
Dave Mayhood
Freshwater Research Limited
Ecology Center
GIS

Figure 1

- **Springs** (hot and deep-source cold types), geysers and wet caves are relatively rare and unique aquatic habitats. Geysers are restricted to Yellowstone National Park. Hotsprings and wet caves are widely but sparsely distributed throughout Y2Y. Deep-source cold springs (as opposed to shallow groundwater discharges from, e.g., riparian alluvium) are widespread and more common, but still tend to exist as isolated features. All tend to have high rates of endemism or "disjunctivity." Hotsprings, because they invariably attract intensive human development, are certainly among the habitats most at risk in the region. For example, the most endangered animal in Canada, the Banff springs snail (*Physella johnsoni*), is now restricted to the Middle Hotspring in the town of Banff, and one of the three extinct fishes in Y2Y, the Banff longnose dace (*Rhinichthys cataractae smithi*)[1], was restricted to the Cave and Basin Hotsprings in Banff.

- **Shallow-source groundwater** (e.g., on alluvial plains) sustains riparian zones, and its discharges provide much critical habitat for fish (e.g., overwintering, spawning and egg incubation, refuge) and other animals, vertebrate and invertebrate. Shallow groundwater sustains unique interstitial communities that extend great distances (kilometres) from the nearest surface water sources, and their ecological importance has been only recently investigated.

- **Riparian zones** are the great connectors of landscapes, linking terrestrial habitats of hillslopes and uplands with aquatic ones in the valley floor. Water, air, dissolved and particulate matter, plants and animals move into and along the riparian corridor into the drainage system. Frequent disturbances maintain an ever-changing mosaic of physical habitats, which serve as a template for diverse plant and animal communities. As a result, the riparian zone generally supports the most abundant, productive and diverse associations of animals and plants in the watershed. Because they are in valley bottoms where most roads, urbanization and other human development are placed, they are also the landscape element most at risk in watersheds.

- **Man-made reservoirs** are common in Y2Y. Many very large reservoirs are found behind high dams on large river mainstems. They only superficially resemble natural lakes; in function they often differ dramatically from their natural cousins. There are literally thousands of smaller reservoirs behind small dams on every sort of watercourse, from ephemeral channels and intermittent brooks to perennial streams and mid-size rivers. Moreover, roads create additional thousands of small artificial reservoirs by blocking natural surface and subsurface drainage behind road fill.

- All of these aquatic features exist in **catchments** (watersheds) that are whole, complete ecosystems with tight integration among their terrestrial and aquatic elements. Catchment ecosystems provide a natural, hierarchically-organized way of conceptualizing Y2Y as a whole.

Y2Y AQUATIC PROBLEMS

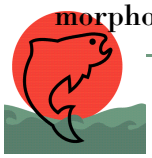
There are prodigious human impacts on aquatic systems in the Y2Y region, but almost all fall into one of six broad categories.

- **Habitat Destruction** includes the negative effects of such human activities as mining, logging, urbanization, agricultural cultivation and grazing. Most of these require intensive development of roads and other similar linear surface disturbances (e.g., railways, pipelines, transmission lines, seismic and exploration trails, logging trails). All land uses disrupt watersheds to some extent, so that at some level of land use intensity, standing and running waters, groundwater and atmospheric water — the drainage and aquatic processing systems of the watershed — will be affected. Many of these effects are very subtle but highly destructive, ranging from destruction of critical habitat for aquatic organisms to blockage of animal movements to changes in evapotranspiration and runoff, to a complete transformation in the processing of sediment and organic matter by streams and lakes.

- **Over-exploitation** in this context means primarily overfishing. Heavy exploitation of both inland and anadromous fish stocks began with human settlement of the region, and has continued to the present day on those stocks that have survived. Not only have many valuable food sources been nearly destroyed from overfishing, but stock losses have had subtle and often profound effects on the watercourses and waterbodies once occupied by the fish. Fish are often a keystone species in inland waters, so that the loss of fish can trigger dramatic changes in the food web. Salmon are important suppliers of nutrients to streams, and can even affect stream geomorphology. When salmon stocks disappear, stream productivity declines and channel morphology may change.

- When fish stocks are overexploited, there are inevitable demands for certain **fish management practices** to be implemented. Hatchery stocking and predator or competitor control are the favorites. In retrospect, one is impressed more by the astonishing number of failures of such programs, than by their occasional successes. The successes of establishing widespread exotic rainbow trout, brown trout, brook trout and non-native cutthroat populations throughout much of the southern Y2Y region, for example, are far less impressive than the concomitant massive losses of native cutthroat and bull trout stocks throughout much of the same area. The concern must be even greater when it is realized that most of the remnant cutthroat stocks have been severely damaged by genetic introgression with introduced non-native cutthroat and rainbow trout hatchery stocks. Where rainbow trout are native, these stocks have almost invariably been exposed to genetic introgression from non-native rainbow and cutthroat hatchery stocks. Some salmon fisheries now depend almost entirely on hatchery-produced fish, native Y2Y stocks having been decimated by various combinations of overfishing, habitat damage from poor land-use practices, and dams. Moreover, many inland waters in Y2Y with unique fish populations have been deliberately treated with toxicants to eliminate supposed predators or competitors. Many unique or otherwise valuable native fishes have been forever lost at the cost of protecting what was invariably an introduced, widely-available game fish species. Finally, fish introductions have, and are, killing off valuable native invertebrate and amphibian communities.

- Many Y2Y waters, especially in the southern half of the region, are exposed to potential **contamination** from urban runoff and domestic and industrial sewage. Mine sites and pulp mills are contamination threats wherever they occur.



Y2Y AQUATIC PROBLEMS (CONT'D)

- **Dams and road crossings**, if they are of any size, are almost inevitably damaging to the aquatic ecology of a watershed. For example, they block or impede fish movements, gene-flow, transform flowing (lotic) habitats to standing-water (lentic) ones, or cause geomorphic, thermal and other profound ecological changes downstream. The presence of dams on a river dramatically alters the physical, chemical and biological features of the river both upstream and downstream to such a degree that such rivers deserve to have a separate name to distinguish them. "Regulated rivers" seems somehow inadequate. The reservoirs formed beyond dams in Y2Y are used mainly either for hydroelectric power production or irrigation water supply. In either case they are subjected to large-amplitude water level changes, often over a period of a few days. Many are drained hypolimnetically, an uncommon feature among natural lakes, especially large ones. (Bottom-drained Medicine Lake, a large karst lake on the Maligne River in Jasper National Park with a dramatic seasonal drawdown, is perhaps the only example in Y2Y of a large natural lake with a hydrologic regime similar to that of many large reservoirs.) Such waters are commonly productive, with highly artificial, often highly unstable biotic communities.

- **Global climate changes** like atmospheric warming, ozone depletion and atmospherically-transported contaminants pose the most intractable environmental problems to Y2Y. Contaminants trapped in glacial ice will continue to pollute our waters for decades into the future. Global warming can be expected to cause strong range retractions of coldwater organisms, causing their populations to become more fragmented and placing them at greater risk of extinction.

INTERCONNECTEDNESS OF AQUATIC AND TERRESTRIAL SYSTEMS — FACTORS TO KEEP IN MIND

- River corridors provide wildlife travel routes.
- Intact watersheds preserve stream and water quality.
- Headwaters to sea connections enable important fish life-cycles and whole system nutrient cycling.
- Smaller predators like osprey and otter live at the land-water interface.
- Some amphibians depend on water during a portion of their life cycle.
- Roads negatively impact both grizzlies and fish.

Reserve designs worldwide have generally been conceived as either strictly terrestrial or aquatic in their concept, development and intended scope. However, it is clear that freshwater and coastal marine ecosystems nest within the same landscape as terrestrial systems, and that these systems are highly connected in many ways. For various biophysical reasons it is not certain that a design based on terrestrial taxa and habitats will meet the conservation needs of aquatic systems, nor is the converse necessarily true. Because regional decisions about resource allocation and management are proceeding apace, it is critical that terrestrial and aquatic considerations and objectives be deliberately integrated in general, spatially comprehensive conservation plans. Accomplishing this across the usual wide range of ownerships and jurisdictions entails significant scientific, disciplinary and institutional challenges.

ISSUES OF SCALE

In terms of aquatic systems, there are two kinds of units that correspond to different levels of scale: watershed and big rivers/big lakes scales. First, the watershed scale is best measured by the sixth code hydrologic unit (6HUC) which tends to encompass a longitudinal sequence of aquatic habitats, including wetlands, and allows for diversity of species. The 6HUC also allows full expression for hydrological processes, concordant with a lot of spatially-explicit data sets.

Second, the big rivers/big lakes scale has unique properties and intrinsic processes and linkages. This large scale means connectivity of big systems with long sections that need to be dealt with substantially differently than a watershed-by-watershed approach. For example, salmon populations that are (or should be) connected with the ocean provide scale that goes beyond our Y2Y boundaries.

- Process indicators that are sensitive to change and human effects are necessary to consider; however, in aquatics systems, measurement of processes is not the most sensitive thing to measure. We need to develop more sensitive indicators that are helpful (often critical) to inform decisions related to mapping scale;

- Selecting the appropriate landscape scale and mapping resolution is critical when relating terrestrial conditions with aquatic ones. Analysis at the "right" scale will allow us to develop an integrated viewpoint and recommendations, and convey useful information about aquatic and terrestrial systems;

- The tasks at hand are to define connectivity conceptually, and then scientifically test the effects of scale on linkages in order to establish rule sets. In a geographic context like the Swan River drainage in western Montana where semi-isolated populations of grizzly bears and bull trout occur, the US Fish & Wildlife Service had an opportunity to design movement corridors for grizzlies across the valley bottom to allow passage between the Swan and Mission Mountain Ranges. An analysis comparing the requirements of the two threatened species found that stream connectivity for bull trout to move between watersheds could have been protected with minor boundary adjustments and changes in management rules. Thus the grizzly corridors could have been very effective in protecting high value aquatic systems in the same landscape. Without a lot of extra effort or required land set aside, by overlapping the needs of grizzlies and bull trout, large chunks of linkage areas would have remained unoccupied by humans for the benefit of both terrestrial and aquatic connectivity.

FEATURES OF AQUATIC INTEGRITY

High priority features of aquatic integrity in the Yellowstone to Yukon region are characterized by:

- Systems with an absence of stocking, and absence or rarity of introduced species.
- Stable populations of regionally declining species.
- Populations at the periphery of their taxon's geographic distribution, and especially populations in ecologically-marginal habitats for the taxon.[2]
- Where the fishing for natives is "good.".
- Representative assemblages or taxa.
- "Last examples" (unique habitat types or features).
- Areas of multiple occurrences of rare and sensitive species indicate areas of high ecological significance based on the overlapping distribution of unique species assemblages.
- Key (critical) habitat—for spawning, overwintering, rearing, summer use, feeding, and refuge.
- Large numbers of native salmon spawning, or juveniles overwintering or rearing.
- All intact low-elevation mainstem rivers, or any intact reaches of otherwise heavily-impacted low-elevation mainstem rivers.
- Upstream-downstream connection does not diminish aquatic resources, i.e., migratory fish do not become contaminated in downstream areas and carry the contaminants into upstream habitats or, minimal sediment released from upstream sources is carried downstream and degrades spawning areas in the lower reaches.
- Largest available "intact" (roadless) or minimally impacted (minimally roaded, restored) watersheds.
- Isolation from sources of invasion.
- Rare elements and special hydrologic features: hot springs, groundwater upwellings.
- Culturally/historically significant areas that celebrate the natural character.

WHAT TO LOOK FOR

Migratory species habitat.

Natural thermal regimes.

High water quality.

Presence of wetlands and estuaries.

Natural hydrologic conditions.

Natural floodplain complexity and stream morphology.

Absence of, or minimal, human exploitation of aquatic populations.

MOST IMPORTANT FEATURES OF AQUATIC INTEGRITY IN THE YELLOWSTONE TO YUKON REGION:
RECOMMENDATIONS FOR SCIENTIFIC SUPPORT FOR AQUATIC CONSERVATION.

∑ = MEASURES ♦ = DATA SOURCES

Linear Disturbance and Degraded Watershed Integrity

- ∑ Interior Watershed Assessment Procedure (IWAP) and Coastal Watershed Assessment Procedure (CWAP) models for cumulative effects analysis.
- ♦ Canada: necessary digital (GIS) data for IWAP and CWAP are available through Canadian land management agencies.

Natural Hydrologic Regime

- ∑ presence/density of dams, diversions, migratory barriers, linear disturbance
- ∑ density of dams & diversions per linear river mile (km).
- ∑ identify dams that are migratory barriers
- ∑ changes in flow volume (before vs. after diversions or extractions)
- ∑ changes in hydrographic patterns (before vs. after an alteration)
- ♦ US: Gauging station information available in real time USGS internet site.
- ♦ Canada: Water Survey of Canada; or possibly hydroelectric companies.

Aquatic Diversity Areas for Common Indices of Watershed Integrity Based on:

- ∑ no stocking
- ∑ native species abundance
- ∑ roadlessness
- ∑ special elements
- ∑ classification of sub-standard watersheds
- ♦ US:

a) ADA watershed index available for MT, ID, WY, e.WA, e.OR.
b) Special elements data available through MT and WY Natural Heritage Programs or ID Conservation Data Center.
c) Interior Columbia Basin Ecosystem Mgmt. Plan (ICBEMP) has sub-standard waters color-coded by stream sections.

- ♦ BC: has some "at risk" type of data.
- ♦ AB and YK lack data.

Definitive Evaluation of Salmon Status (past & present)

- ∑ escapement
- ∑ catch per unit effort
- ♦ AB: fish and wildlife offices have hard copy data related to specific geographic areas of interest. Request information through the local biologists.
- ♦ BC and YK:

a) escapement and other fisheries data found in Fisheries Information Summary System (FISS) and related databases found on websites[4].
b) fisheries report[5] contains the status of anadromous salmon and trout.

Critical Hotspots

- ∑ places with high conservation value due to rare or sensitive species/communities.
- ∑ centers of endemism
- ∑ presence of unique habitats, e.g., wet lands, bogs
- ∑ "last examples," e.g., lakeshore marshes
- ♦ US: special elements data available through MT and WY Natural Heritage Programs or ID Conservation Data Ctr.
- ♦ US/Canada: obtain information from local & regional experts
- ♦ BC: see research papers —

a) indigenous fish species potentially at risk in BC with recommendations and prioritizations for conservation, forestry/ resource use, inventory and research. Fisheries management report.[6]

b) literature reviews of the life history, habitat requirements and mitigation/ compensation strategies for 13 species of sport fish in the Peace and Columbia drainages of BC. Fisheries mgmt. report.[7]

Diversity of Aquatic Invertebrates & Non-fish Taxa

- ∑ high rates of endemism (may reflect glacial refugia, long isolation or unusual habitats)
- ∑ species-level distribution data on ecologically-dominant organisms like Plecoptera (stoneflies), Ephemeroptera (mayflies), Trichoptera (caddis flies), Mollusca, crustaceans, zoo plankton, phytoplankton, Coleoptera, Odonata (damselflies and dragonflies) and Chironomidae (midges)
- ♦ US/Canadian: obtain information from local and regional experts.
- ♦ BC: see research papers—

a) terrestrial and freshwater invertebrates of BC: Priorities for inventory and descriptive research.[10]

b) distribution of the freshwater clam, *Pisidium ultramontanum*.[11]

c) selection of candidate species of freshwater mussels (Bivalvia, Unionidae) to be considered for national status designation by COSEWIC.[12]

d) summary of North American Blancan non-marine molluscs.[13]

Fish Assemblages/HUC

- ∑ species overlays (multiple occurrences)
- ∑ catch per unit effort
- ∑ information on out-plantings & native stock
- ∑ life histories of fish species in response to impact assessments
- ♦ US/Canada:

a) Y2Y has started to map the entire ranges of 128 fish species from Yellowstone to Yukon

b) historical/anecdotal (old timers & naturalist accounts archived in fishing logs); field notebooks and National Parks documents; consolidate data from private consultants; unpublished reports and "gray" literature.

- ♦ BC: several species distributions are summarized and overlayed in GIS available to the public.[8]

Wetlands Inventory

- ∑ wetlands classification system
- ∑ assess application of mitigation for degradation and improvement over time.
- ∑ EPA National Wetlands Inventory Assessment: all states have them; but MT, ID, WY may not be in digital form.
- ♦ US/Canada: obtain aerial photos to assess status of long-term changes to rivers and wetlands over time.
- ♦ AB:

a) mapped by Canadian Forest Service (Dale Vitt).

b) Alberta Special Places Report

- ♦ BC: new classification system. Dennis de Marchi has detailed digital information maps from satellite imagery.
- ♦ YK/NWT: check with David Mossop, YK wildlife branch

Ecological Forecasting

- ∑ sediment and ice core analysis (further consideration required)

Water Quality

- ♦ AB: printed summaries of historical water quality data were produced by the (defunct) Inland Waters Branch of theWater Survey of Canada and are available through major university libraries. Current data may be available from Alberta Environmental Protection for some rivers.
- ♦ BC: environmental trends in BC.[9]

Indicator Species

(further consideration required)

Places Critical for Waterfowl

- ∑ nesting areas
- ∑ overwintering areas
- ∑ migrational stopovers
- ♦ US/Canada: contact waterfowl agency biologists, university professors, organizations like Ducks Unlimited and Audubon Society, and local birders.

Special Aquatic Features: Hot and Cold Springs, Caves

- ∑ endemic taxa
- ∑ rare taxa (i.e., rare invertebrate occurrences) and assemblages
- ∑ peculiar physical habitats
- ∑ unusual energy sources
- ♦ US: for springs and some caves check with Jack Stanford at the Flathead Lake Biological Station, MT.
- ♦ AB: for caves check with Holsinger at Old Dominion University.

WHAT CAN Y2Y ACCOMPLISH BY 2001?

KEY RECOMMENDED ACTIONS TO MOVE CONSERVATION PLANNING FORWARD WITH AN INFORMED AQUATICS COMPONENT.

- Obtain delineated watershed layer: 6th code hydrologic unit compartment (HUC) data for the US; and 1:50,000 BC Watershed Atlas.
- Overlay watershed layer with Mayhood's 1999 map of the great basins in the Y2Y.
- Map linear disturbances using IWAP, CWAP.
- Use a survey similar to the Old Man-Livingstone-Crowsnest IWAP survey to demonstrate watershed integrity of important systems.
- Map Aquatic Diversity Areas (ADA) for the entire Y2Y region.
- Obtain ICBEMP layers that show sub-standard waters to give a picture of trends.
- Finish species range maps for the 128 species Y2Y has data for, then combine ICBEMP and NRIS data.
- Conduct information GAP analysis to find out what information is available.
- Generate a reliable evaluation on the status of salmon—assess past and present (interview old timers, particularly in areas where there are not published studies, use old fishing logs and photos and produce an information layer). (See reference in endnote #4)
- Map information on past hotspots and compare with present day hotspots. (See reference in endnote #5)
- Conduct a catch per unit effort survey.
- Research and generate list of special habitats where rare species found (hot springs caves lists in guidebooks).
- Compile aquatic invertebrates research (Alberta has a lot of retired entomologists, see Dr. Nimmel on entomological survey papers; at MSU-Bozeman Dan Gustafson on macroinvertebrates). (See reference in endnote #9).
- Map dams, especially small ones, and assess if they are migratory barriers — all dams are impediments but determine which ones are migratory barriers.
- Catalogue US, Canadian and International laws and regulations that protect aquatic resources.

GENERAL ADVICE TO Y2Y CONSERVATION PLANNERS

- Acknowledge constraints unique to aquatics: 1) water flows one-way, 2) the biophysical isolation of water sheds can prevent species exchange; and 3) the Continental Divide and major mountain ranges separate large river systems and force them to flow primarily east-west rather than north-south.
- Understand the complexities of aquatic connectivity. Stream connectivity within the Y2Y region is challenging because activities occurring within the Y2Y study area boundary influence downstream resources that occur outside our 'lines'; and conversely, activities occurring downstream (i.e., stocking) may have effects on upstream resources within the Y2Y study area.
- Isolation in some cases may be desirable, such as an instream barrier that protects upstream populations from exotic species, contaminants and diseases.
- Use flagship species such as salmonids and certain types of invertebrates as surrogate species for representing health of freshwater habitat and functioning. Find the best local indicator(s) to use as surrogates. Within all of Y2Y, selected species may differ from east to west of the Continental Divide, and from north to south.
- Assess in-stream and watershed biointegrity using common indicators such as the extent of roading and fish stocking, the presence of barriers, and water quality.
- Protect and manage roadless watersheds as wilderness because aquatic health and species diversity is dependent upon intact uplands.
- Give protection priority to watersheds that are roadless; watersheds that run from the mountains to the ocean; watersheds occurring in the US/southern Canada transboundary area that contain representative native species associations.
- Bigger is better because we do not know exactly how much of a stream reach is needed to enable fish populations to move into and occupy a new niche.
- Invest in restoration because re-establishing aquatic functions provides local and potentially basin-wide benefits.
- Make the case for local versus regional triage. In the case of bull trout, protective measures should occur at a watershed scale because each drainage counts.
- Allow for normal stream fluctuations and encourage stream stabilization by minimizing abnormal increases in frequency and amplitude of changes.
- Document trends using historical information and compare it with present day accounts. Identify: 1) historical hotspots; 2) historical species distributions; 3) responses to past disturbances; and 4) conditions before versus after dams, roads, forest cuts, fish stocking, etc.
- Identify special habitats by producing individual species distribution maps and composite, multi-species maps.
- Use anecdotal information of locals and old timers and informal expert review to verify maps.

LEVERAGE POINTS FOR FURTHERING US-CANADIAN COLLABORATION

Research shortfalls
Monitoring weaknesses
Inventory gaps
Policy changes
Reference relicensing of dams in Columbia River Basin

DISCUSSION ON A TRANSBOUNDARY POLICY INITIATIVE

Take the interconnections of US/Canadian aquatics to the CEC. The connecting "hook" between the US and Canada for aquatics is not apparent because most water does not flow north-south.

Demonstrate that something done in country A is affecting country B (direct effect relationship).

Use stories that illustrate transboundary connections.

Base connections on story/policy basis of declining freshwater ecosystems and loss of inland fish and invertebrate species.

IMMEDIATE THREATS & OPPORTUNITIES FOR TRANSBOUNDARY PROTECTION

Mainstem of the Columbia and several of its major tributaries flow north-south between the US and Canada. Salmon and steelhead traditionally accessed many of the Canadian systems but are now largely gone due to dam construction in the US. Nutrients brought by the salmon are also lost to the system.

Upper Flathead River is a major bull trout spawning and rearing system in Canada with its headwaters in Montana.

Taku River flows through the Alaska panhandle to near Juneau. BC is considering roading a long section parallel to the river to access a mine planned for the headwaters.[13]

Wigwam River[14] is a major bull trout spawning and rearing system in Canada with its headwaters in Montana. The Wigwam represents one of Montana's healthiest bull trout stocks. BC is planning to log the watershed. The Canadian Department of Fisheries and Oceans is on the verge of giving final approval for new bridges in the watershed.

For other examples in BC:
Haas, G.R. 1998. Indigenous fish species potentially at risk in BC with recommendations and prioritizations for conservation, forestry/ resource use, inventory and research. Fish. Mngmt. Rep. 105. BC Min. Fish., Res. Section, Univ. B.C., Vancouver, Canada. 168 p.

BRAIN-STORMING: ACTIONS RESULTING FROM THIS WORKSHOP

OPPORTUNITIES TO WATCH FOR:

Monitoring the Columbia Basin dam re-licensing over the next 20 years.

Re-establishment of salmon to previously accessible BC drainages.

- Propose to host a special workshop at the June 2000 Society for Conservation Biology Annual Meeting in Missoula, MT. The workshop would integrate terrestrial and aquatic considerations in reserve design. Chris Frissell and Marcy Mahr will organize this event. The session will provide a forum for discussion of technical and strategic hindrances and opportunities to achieving integrated landscape designs for conservation purposes. The discussions will be informed by examples and concepts posed by several speakers.
- Perspectives paper that provides a synthesis of existing research and rational and justification for aquatic considerations in a protected areas strategy.
- David Schindler offered to write a paper on the effects of climate change on hydrologic systems.
- Transboundary policy initiatives: take the interconnections on US/Canadian aquatics to CEC.

NEW RELEASES

- Haas, G.R. In press. Freshwater fish and aquatic systems at risk in British Columbia: overview, patterns, unrecognized differences, and why present conservation methods and protected areas do not work. In Conf. Proc.- Biology/Management of species/habitats at risk. Kamloops, BC, Canada.[15]
- Haas, G.R. In press. Freshwater species and ecosystems are less understood, more at risk, and less protected: a representative case study using fish in British Columbia, Canada. *Cons. Biol.*
- Trombulack, S.C. and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. *Cons. Biol.* 14(1):18-30

SOURCEBOX

KEY SOURCES OF INFORMATION FOR Y2Y CONSERVATION PLANNING

- Manuals for both CWAP and IWAP procedures, plus the Level 2 analysis and other methods used under BC's Forest Practices Code, can be found at www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/guidetoc.htm
- Sierra Institute has a very accurate roads layer.
- Frank Rail has stocking information for WY.
- Montana and Idaho River Information Systems.
- Idaho is in the planning stages of Aquatic GAP Analysis.
- Ducks Unlimited Western Boreal Initiative (Gary Stewart, DU, Edmonton).
- Habitat Conservation Trust Fund, BC Environment Office, 201-3547 Skaha Lake Rd., Penticton, BC V2A 7K2.
- Habitat Atlas for Wildlife at Risk: South Okanagan & Lower Similkameen, BC Ministry of Environment Lands and Parks. Habitat atlas website: www.elp.gov.bc.ca/sir/wld/
- University of Lethbridge climate change project. This is a repository of data, mapping responses, projection of what's going to happen.
- Dennis deMarchi has done an ELU (Ecological Land Unit) classification map for B.C.
- Flow data—changes in hydrologic regime from US gauging stations are accessible in "real time" measures on USGS internet site.
- Jill Baron, US Biological Survey, Colorado State University—putting together a book on Rocky Mountain aquatics systems.

KEY REPORTS AND STUDIES

- Western Montana Report.
- Northern River Study for Alberta.
- Peace-Athabasca Study.
- Freshwater Research has several reports available for downloading: www.fwresearch.ab.ca
- Sustainable Ecosystem Management in Clayoquot Sound: Planning & Practices (April 1995) by The Scientific Panel for Sustainable Forest Practices in Clayoquot (also on BC government website).

SOURCEBOX

IMPORTANT REFERENCES WHICH ADDRESS THE ECOLOGICAL CONNECTIONS BETWEEN AQUATIC AND TERRESTRIAL SYSTEMS.

Frissell, C. A. and D. Bayles. 1996. Ecosystem management and the conservation of aquatic biodiversity and ecological integrity. *Journal of the American Water Resources Association* 32:229-240.

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Pacific Rivers Council. 1993. The new watershed imperative: a new approach to restore America's river ecosystems and biodiversity. The Pacific Rivers Council, Inc., Eugene, OR. 11 p.

Stanford, J. A. and J. V. Ward. 1992. Management of aquatic resources in large catchments: recognizing interactions between ecosystem connectivity and environmental disturbance. pp. 91-124. *In* R. J. Naiman [ed.]. Watershed management: balancing sustainability and environmental change. Springer-Verlag, Inc., New York, NY, USA. xii+542 p.

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SOURCEBOX
FUNDING IDEAS

National Science Foundation (NSF) is an independent US government agency responsible for promoting science and engineering. The NSF Guide to Programs is a compilation of funding opportunities for research and education.
See **www.nsf.gov**

NSERC International Opportunity Fund promotes new international research collaborations of significant benefit to Canada. Fund is designed to support non-research costs associated with Canadian researchers' collaborative projects/networks abroad. Applications accepted from groups only and principal investigator must be eligible for NSERC funding. Collaborative Research Opportunities (CRO) Grant. Priority given to projects that enable Canadian researchers to make significant contributions to major international efforts or that present important multidisciplinary challenges. See www.nserc.ca for further info and forms. There are spring and fall grants available.

The Endangered Species Recovery Fund is soliciting proposals for funding. Species listed by COSEWIC as Endangered, Threatened, Vulnerable or Extirpated are eligible for funding.
See www.wwfcanada.org/library_esrf.htm

The Environmental Defense Fund awards for Environmental Science Programs.
Funded by Packard Foundation and aims to increase ability of non-governmental enviro organizations to utilize scientific expertise and engage academic scientists in activities that further goals of environmental community. Types of activities this grant supports include partial salaries for academics, grad students, interns, & science fellows, meetings, travel expenses, and other costs that further a research project.
See www.edf.org/sciencegrants/ngo.html for details on application guidelines & next Letter of Inquiry due date.

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Rob is the executive director of American Wildlands (AWL). AWL is actively involved in native fish and clean water issues in Montana, Wyoming and Idaho. For 17 field seasons he was a terrestrial ecologist in Alaska, Utah, Oregon, Montana, Idaho and Wyoming studying forest, range and subalpine ecosystems. His master's thesis was a study of the plant communities' response to the 1988 Yellowstone fires. He co-authored the fisheries chapter in the Y2Y Atlas.

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Suzanne is a wetland ecologist whose interests and experience include wetland ecosystem biology, biogeochemistry, production, decomposition, nutrient dynamics, acidification, modelling, designing for water treatment, habitat restoration, and national park management. She is currently studying the effects of highway/railways on the hydrology, water chemistry and plant communities of the Athabasca montane floodplain in Jasper National Park. Suzanne was a panel member of the Banff-Bow Valley Task Force, and has advised Jasper National Park on management of the Athabasca River and its riparian lands.

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A freshwater ecologist keenly interested in biodiversity and sensitive fishes & amphibians, Chris' work focuses on importance of biophysical processes, landscape pattern, and nuances of human use in determining dynamics of freshwater ecosystems and sensitive populations of animals that depend on them. He directed or collaborated on regional assessments of priority areas for aquatic diversity protection in western Montana, eastern Washington, Puget Sound, and Oregon. Recent field research by Chris and his students concern assemblage structure & habitat use by fish and amphibians on riverine floodplains, invasion processes of introduced brook trout in streams and lakes, seasonal movements & habitat use of bull trout, and determinants of temperature regime in montane streams. He serves on the ecological working group for the Multispecies Framework Process in the Columbia River Basin—another multi-agency (but uni-national) effort to evaluate several comprehensive alternatives for management of the Columbia River Basin. Chris is on the board of editors for the journal *Conservation Biology*.

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Gordon is a fisheries biologist best known for his definitive taxonomic study of bull trout and Dolly Varden, and for his work on native fishes of western North America. His dissertation investigates the unique evolution of the Umatilla dace (*Rhinichthys umatilla*). He presently conducts research and workshops, and acts as reviewer on fish biogeography/ecology/evolution, conservation biology, and the complex interactions of fish assemblages with physical habitat changes caused by resource extraction. He recently produced a catalogue of native BC fishes potentially at risk, with detailed recommendations for resource use practices, inventory and research to conserve them. He was the scientific organizer of last fall's very successful bull trout conference held in Nelson, BC.

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A fisheries biologist known for his work on salmonid-habitat relationships, Gordon was formerly a research scientist at the Pacific Biological Station where he was responsible the Carnation Creek Project, a major long-term study of the effects of forestry practices on a small coastal stream ecosystem. He was fisheries advisor to the Canadian Government's Oldman River Dam Review Panel in 1991 and the fisheries expert on the BC Government's multi-disciplinary Clayoquot Sound Scientific Review Panel. He maintains an active research program and consulting practice in western Canada.

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Don is a fisheries biologist who worked on the International Joint Commission's Flathead River Study set up in the mid-1980s. He helped develop the stress index approach to evaluating the effects of suspended sediment on fish, and recently organized a major international workshop on ecosystem-based management of the upper Columbia River basin. Don also maintains an active consulting practice. The SFF, of which Don is the Canadian Executive Director, is an international foundation which promotes the sustainable use of Pacific salmon and steelhead stocks.

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Tom teaches graduate and undergraduate courses in fisheries management, fish ecology, and research methods at MSU. Much of his and his graduate students' research has centered on ecology and conservation of native salmonids in Montana. Recent projects have

focused on the effects of grazing and high sedimentation on trout populations, winter ecology of bull trout and cutthroat trout, thermal tolerances of bull trout, and effects of whirling disease on wild trout. Past work has involved conservation of desert fishes in Arizona and Mexico, and fish-forestry interactions in British Columbia and Oregon.

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Marcy is coordinating the development of a Conservation Area Design for the Y2Y ecoregion. She works with ecologists, conservationists and First Nations to integrate existing ecological information at landscape and Y2Y-wide scales in order to assemble an interconnected wildlands network of protected core habitat areas and corridors from one Y to the other. She also facilitates the development of innovative scientific research and applications designed to meet the informational and technical challenges of covering such a large land area and broad scale. Prior to joining Y2Y, she spent five years as a plant ecologist on GIS mapping projects for the USFS Upper Columbia Basin Assessment and, more recently, as a project leader of the Craighead Wildlife & Wildlands Institute's Grizzly Bear Recovery team. In both projects, she designed field methods to sample plant communities and ground-truth Landsat imagery in order to build comprehensive vegetation classification systems.

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Dave is an aquatic ecologist with interests in the ecology, conservation biology and natural history of western Canadian lakes, streams and their inhabitants. His work includes status surveys of westslope cutthroat trout, the fishes of Y2Y, the Central Canadian Rockies Ecosystem and Jasper National Park; a review of fish management approaches used in North American parks; and GIS-based analyses of cumulative effects of land-use on numerous drainages in southwestern Alberta.

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Troy is an independent landscape ecologist with extensive experience in developing conservation strategies for large carnivores in the USA, Canada and Russia. He has 10 years professional experience in GIS and remote sensing. In addition, to being a Research Consultant for LTB Consulting, he maintains professional affiliations with Hornocker Wildlife Institute (HWI) and Craighead Environmental Research Institute (CERI).

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As Environmentalist for the Hatcheries Division, Hal is responsible for dealing with the impacts of salmonid hatcheries on the environment and the environment's impact on the hatcheries. The primary focus over the past several years has been the development of programs to return salmon carcasses (from the hatcheries) to the environment in order to provide the nutrients necessary to drive the ecosystem. This work has led to 1) the development of models which can be used to set spawner escapement goals based on nutritional needs of organisms within the ecosystem and 2) a holistic review of activities within a watershed and their impact on the continued existence of wild salmon in Washington.

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Bart, as Y2Y's first full-time employee, has been the Initiative's Coordinator since January 1997. His background includes academic training as a political scientist, 20 years as an author, journalist and editor (he was founding editor of *Equinox*, at one time Canada's sixth largest consumer magazine), a short stint as a business consultant, and 30 years as an ardent conservationist.

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Dave is an aquatic ecologist perhaps best-known for his whole-lake experiments in northwestern Ontario. His current research interests include limnology and fisheries management of mountain lakes, biomagnification of organochlorines in food chains, effects of climate change and UV radiation on lakes, and global carbon and nitrogen budgets. Among many projects in Y2Y, he and some of his students have been doing experimental studies and restoration work on alpine lakes in Banff, on historical changes in mountain lakes due to fish introductions, and on organochlorine contamination of mountain lakes and their inhabitants. He has served as a member of several high-profile public study panels on environmental issues in Canada.

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Louisa is the Ecosystems & Endangered Species Specialist for the Sierra Club's Grizzly Bear Ecosystems Project. She coordinates education and advocacy efforts on behalf of endangered species and ecosystems throughout Montana, Wyoming and Idaho. Louisa is an active founder of Y2Y and serves on the board of The Wildlands Project.

ENDNOTES

[1] Extinct since 1986 according to COSEWIC.

[2] For example, see Scudder, G.G.E. 1989. The adaptive significance of marginal populations: a general perspective. pp. 180-185. In C.D. Levings, L.B. Holtby and M.A. Henderson [eds.]. Canadian Special Publication of Fisheries and Aquatic Sciences 105. 199 p.

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[13] Available at www.state.ak.us/adfg/geninfo/hot/takuriv.html

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[15] Available from BC Min. of Environment, Wildlands Branch, Victoria, BC, Canada at www.cariboo.bc.ca/speciesatrisk

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www.freshwaters.org/ccwp/home.html
The Nature Conservancy website has a Freshwater Initiative area with documents andlinks listing some excellent online data sources, a manual describing how to identify and evaluate freshwaters at risk, descriptions of software forevaluating effects of flow control on hydrology, and other good infromation.

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