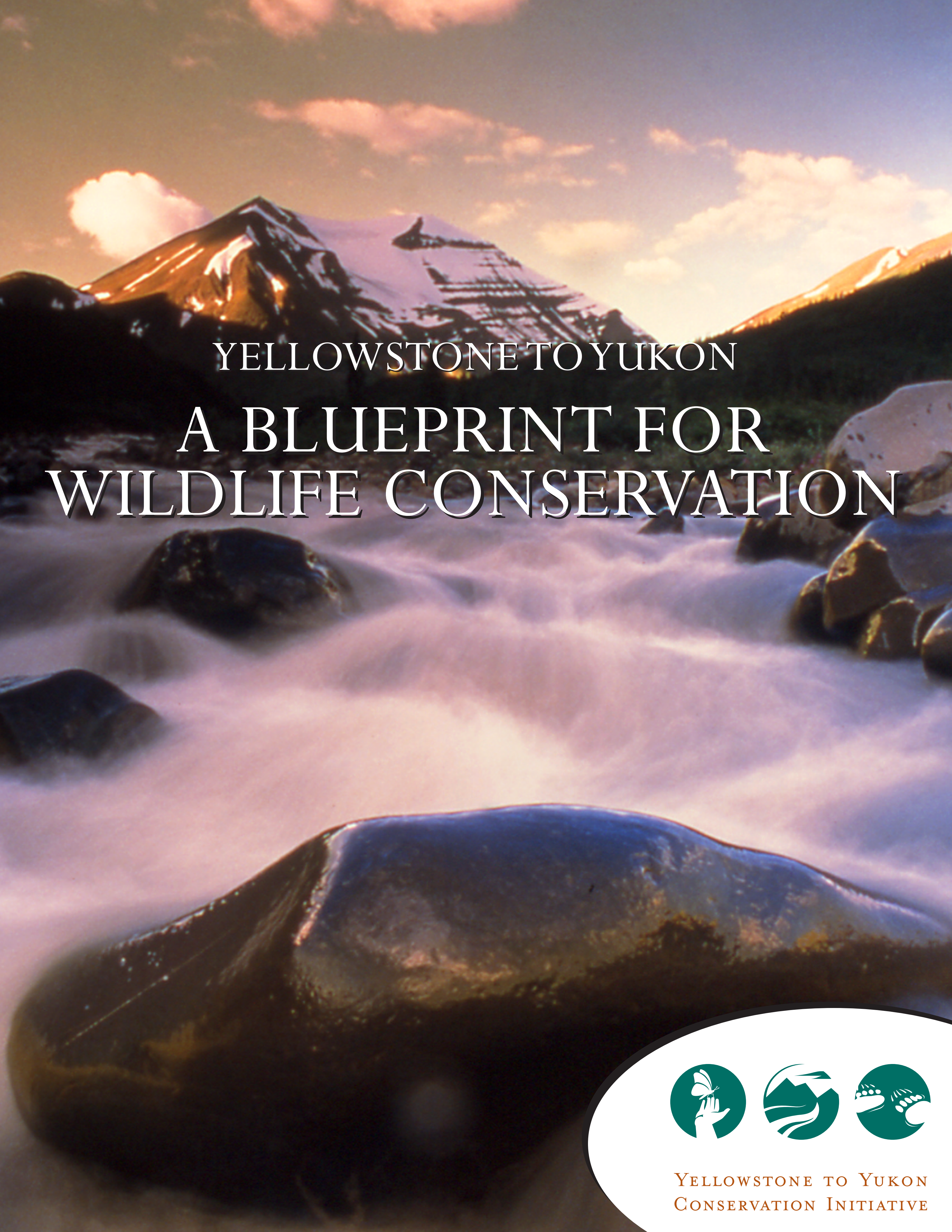

YELLOWSTONE TO YUKON

A BLUEPRINT FOR WILDLIFE CONSERVATION

Yellowstone to Yukon Conservation Initiative

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INTRODUCTION

Ten years ago it became clear to scientists and conservationists that to conserve nature in the Rocky Mountains effectively, it was necessary to think and act at a larger scale than was occurring. As a consequence of this realization, the Yellowstone to Yukon Conservation Initiative (Y2Y) was born, opening its first office and hiring its first staff in 1997. However, many of the underpinnings of this new way of thinking were theoretical. Y2Y needed to identify with some confidence the key places on which to focus conservation efforts in order to keep the entire landscape intact. Some of these priorities emerged quickly from ongoing scientific work. Others have been revealed through rigorous, large-scale assessments which Y2Y has commissioned, collaborated with or inspired.

Y2Y's Conservation Science Program has been designed to inform conservation and land management strategies that will ensure the preservation of biodiversity across this vast landscape. Since it is not possible to understand the conservation needs of every species that lives in the Rocky Mountains, Y2Y has taken an "umbrella" species approach to conservation planning. Umbrella species are the most sensitive species requiring the largest land base for survival and the most careful management. It is assumed that if land is managed to meet the long-term needs of umbrella species, the needs of species that are more tolerant or need less land to meet their daily survival requirements also will be met. However, no single species is effective as an umbrella for all species. In order to ensure that conservation planning within the Yellowstone to Yukon region results in land use management prescriptions that maintain all biodiversity over time, Y2Y is developing conservation science for a suite of carnivore, bird and fish species that will ensure the needs of all species are met.

This report is a summary of the status of Y2Y's Conservation Science Program to the end of 2003. It includes a short history of the Y2Y science program and a discussion of Y2Y's Wildlife Network – a large-scale design of core reserves, connecting linkages, and transition areas from Yellowstone to Yukon – and the various components of which it is composed.

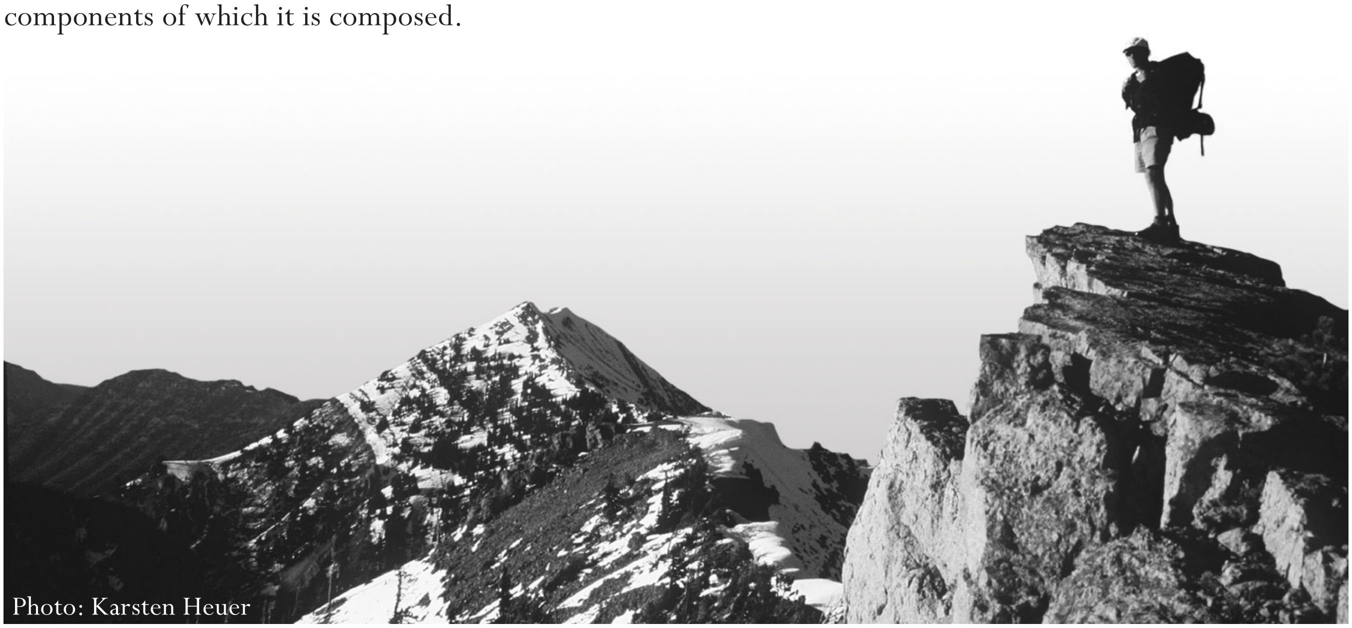
Photo: Karsten Heuer

HISTORY: WHY Y2Y?

The region called Yellowstone to Yukon exists in multiple realms. On a map it is a loosely defined area, spanning the long spine of the Rocky Mountains from the southern edge of the Wind River Range to the Mackenzie Mountains in the north. One can find numerous ways to define Y2Y physically, culturally, or politically: as one or several ecoregions, by latitude and longitude, or by a description of the presence of indigenous cultures and groups that inhabited the area long before the borders of Canada and the United States were drawn. Perhaps more important than any of its physical attributes is the fact that Y2Y is an endeavor – an attempt to preserve the richness of one of the largest contiguous landscapes left on any continent, an integrated conservation effort that is taking place on an unprecedented scale, in North America and perhaps, in the world.

In 1999, the Coordinating Committee (CC) of the Yellowstone to Yukon Conservation Initiative decided that one of the most important ways to preserve the biodiversity of the Y2Y region would be through a strategy of science-based mapping. More specifically, the goal was to identify remaining critical wildlife habitat and learn more about how the ecology of the region functions to support healthy wildlife populations.

In line with this decision, a so-called "blue ribbon" panel of scientists was assembled in Jasper National Park, Alberta in November of that year. During the resultant workshop, the Science Advisory Group came up with a list of recommendations that has served ever since as a blueprint for the direction of Y2Y's science program. This blueprint was loosely structured because it was meant to function as a set of guidelines, not as a step-by-step handbook dictating exactly what or when research was to be done.

Since the formation of the Science Advisory Group – many workshops, datasets and models later – some of our questions have been answered and some are still open, or have given rise to entirely new questions which are themselves in the process of being answered. Since our understanding of the Y2Y region and its conservation needs has grown and evolved, some of our goals and strategies are different than those with which we began, though the philosophical underpinnings of the science program – to protect an interconnected web of life – has not changed. The fact that the science program has responded to new information by changing some of its research priorities and outputs is a very good thing, for scientific inquiries must be able to adapt themselves to novel situations, unexpected opportunities, and changing information in order to survive and thrive.

One of the reasons such flexibility is crucial is the huge scale of Y2Y. A coordinated conservation effort on so large a scale is a foray into uncharted waters, and the novelty of this enterprise means that as we learn more, we must also change what it is we are trying to find out. Another key to understanding how research occurs over a large geographic area is to realize that "Y2Y Science" is compiled of many different research efforts occurring simultaneously on many different scales – a patchwork of projects that, when they are stitched together, will form a quilt that is the conservation plan for the entire Y2Y region. Some of the projects span large swaths of Y2Y, and some focus on only a small corner of it. But all of the data and results are vital rivulets that will end up streaming into the larger river that is our attempt to preserve Y2Y as a contiguous functioning landscape.

When Y2Y's science program started in 1999, the main product was to be a single definitive map that would identify priority habitats for protection in the Y2Y region; the building blocks of the map were to be existing protected areas. However, when we began to gather data to see what habitats – where, how large and in what configurations – and which species in the region needed protecting first and foremost, it became obvious that the concept of 'one map' was painting the picture with too broad of a brush. Clearly, certain species needed to be studied at local scales, while other species and their conservation needs could be understood only by gathering data on continental or large landscape scales. In addition, the quality and depth of available datasets varied greatly by region, jurisdiction, species and just about any other variable one could think of, so there was no good way to directly layer and integrate different map sections into one map. Thus, rather than produce a single map of the entire region, we decided to initiate research projects at multiple scales that would themselves embrace the various questions that we were attempting to answer.

Existing research studies also pointed out that, although our protected areas system is extensive and world-renowned, we should not assume that these areas provide the best possible protection for wildlife. Instead, we needed to test the inconvenient hypothesis that existing protected areas might not be providing adequate habitat for a wide range of mammalian carnivores, native fish and birds. Part and parcel of this thinking was the decision to devote funds to researching not only terrestrial systems and species, but also to exploring what questions needed answering in order to insure that aquatic systems were adequately protected. In addition, we acknowledged that Y2Y's bird species are an important component of the region's biodiversity, and that the lack of good data on birds and fish was hampering our attempts to come up with a holistic conservation plan for the Y2Y region.

Investigating these questions led to the "parallel tracks" approach (proposed in June 1999), which meant funding researchers to work at a variety of mapping resolutions, depending on the species, habitat and ecological processes of concern. Because the science program is coordinated by only one staff member, this has meant relying on expert working groups related to carnivores, aquatics, birds and GIS information. Each group has an action plan for how it will contribute to Y2Y's evolving Wildlife Network, and share resources and information. The participatory and decentralized nature of this research method reflects Y2Y's spirit of working in networks, and contrasts with a more traditional arrangement of having a few in-house scientists and a GIS lab charged with producing a conservation area design.

Since it was founded four years ago, Y2Y's science program has directly funded a dozen research projects that analyze habitat core areas and corridors at the Y2Y scale. Concurrently, through Y2Y's partnership with the Wilburforce Foundation, Y2Y's science program has helped fund more than 45 local research projects – from sage-grouse in Wyoming to woodland caribou in the Yukon – with the goal of acquiring better information and tools to strengthen the scientific justification for a connected network of core wildlife habitats, movement corridors and transition areas accommodating certain human activities. As a result, we have gone a long way toward accomplishing two of Y2Y's key organizational objectives: (1) to develop and promote improved techniques for assessing the effectiveness of wildlife corridors, and (2) to demonstrate that connectivity achieves measurable progress in wildlife conservation and recovery. Each of these objectives is an integral stepping stone on the road to developing a region-wide Wildlife Network and establishing conservation policies that protect wide-ranging species and prevent further habitat loss in the entire Yellowstone to Yukon ecoregion.

WHAT IS Y2Y'S WILDLIFE NETWORK?

As originally conceived, Y2Y's Wildlife Network is a large-scale, map-based design of core reserves, connecting linkages and transition areas from Yellowstone to Yukon, based on the long-term integrated conservation needs of carnivores, birds and aquatic species, as well as areas of cultural, spiritual and recreational importance. Originally called Y2Y's Conservation Area Design, this project is now called Y2Y's Wildlife Network, and focuses solely on the ecological components, omitting the cultural, spiritual and recreational aspects for now.

IS Y2Y'S WILDLIFE NETWORK COMPLETE?

The initial Wildlife Network is in hand, as evidenced in this report. But the Network will continue to evolve as other science research pieces are completed and integrated.

WHAT SCIENCE HAS Y2Y COMMISSIONED THAT CONTRIBUTES TO THE WILDLIFE NETWORK?

There are many products that inform Y2Y's initial Wildlife Network. Primarily, these products consist of reports describing the results of specific research and the maps that accompany them.

The most significant pieces of research commissioned by Y2Y that constitute the initial Wildlife Network include:

1. **Y2Y's Grizzly Bear Conservation Area Design**
   This is Dave Mattson and Troy Merrill's model of the land needed to support evolutionarily robust populations of grizzly bears in the Y2Y landscape. Mattson and Merrill's work has expanded over the years from predicting the current relative capacity of the Y2Y landscape to sustain grizzly bears, to projecting how many grizzly bears the region *could* sustain, to projecting how many grizzly bears the region *must* sustain, how much area is required to support them, where those areas should be located, and how they should be managed if bears are going to exist over evolutionary time (i.e., millennia). [*Products*: a report, a map of the core areas needed to sustain evolutionarily robust populations (see map below), and a table of the *prescriptions* needed to permit the linkage of the demographically robust populations (individual populations of 400 to 450 bears) to evolutionarily robust populations (connected populations totaling several thousand individuals).[1]]

Photo: John Marriott

[1] *For example, prescriptions may include closing roads in one area, and restricting humans with guns in another.*

2. **The Rocky Mountain Carnivore Project**
World Wildlife Fund Canada[2] commissioned Paul Paquet, Reed Noss and Carlos Carroll to develop a computer model of the landscape needs of a suite of carnivore species.[3] In the first phase of this project, they developed habitat suitability models for all nine species stretching from the southern extent of the Greater Yellowstone Ecosystem to the north boundary of Jasper National Park. In phase two, they extended the study area north to the Yukon boundary, and developed a dynamic computer model for predicting population trends (i.e., future source and sink areas) for five of these species, projected over the next 25 years. They then developed a model that maps the lands that need to be managed for conservation if these species are to persist over time. [*Products*: Rocky Mountain Carnivore Project report and maps.]

3. **The Aquatic Integrity Areas Analysis**
The Aquatic Integrity Areas Analysis is a computer model that ranks sub-watersheds based on four integrity factors[4], for the Upper Columbia, Upper Yellowstone and Upper Missouri River Basins. It compares the relative integrity of sub-watersheds within those basins (i.e., compared to each other, which tributaries are in better or worse shape from an ecological integrity perspective?) [*Products*: Three separate reports, one on the Upper Columbia, one on the Upper Missouri, and one on the Upper Yellowstone, each with a map that shows the rankings (from high to low) of sub-watersheds for both basins.]

4. **Jones-Hansen Bird Diversity Model**
This bird habitat model was created by Kingsford Jones and Andy Hansen. Based on a pilot project in the Y2Y portion of western Montana, they demonstrated that satellite imagery and Breeding Bird Surveys can be used to predict bird habitat accurately. [*Product*: A report including a map of predicted bird habitat quality for the Y2Y portion of western Montana.]

5. **Muir-Bailey Bird Habitat Suitability Model**
This bird habitat model was created by Judy Muir, a graduate student at the University of Alberta. The model uses a vegetation layer commissioned by Y2Y and Breeding Bird Surveys to extrapolate geographic, habitat and topographic features associated with high concentrations of birds to predict relative habitat quality for 20 focal species, identify areas of high bird species richness (i.e., concentrations of bird species), and areas of concentrations of species at risk. It applies to the entire Y2Y landscape. [*Product*: A report and seven maps[5]]

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[2] *Y2Y contributed directly to this project. WWF presented the results to Y2Y in 2002 and invited us to utilize them in our planning and communications. WWF has not made it a priority to publicize the results of this project.*

[3] *Black and grizzly bears, wolverine, fisher, marten, lynx, bobcat, cougar, and wolf.*

[4] *The four factors are: road density or roadlessness (habitat condition), fish stocking history (introductions of exotics, hybridization), fish population integrity (native species richness, genetic purity of native fishes), and Natural Heritage score (occurrence of non-fish aquatic species that are dependent upon aquatic and riparian environments).*

[5] *The seven maps are: (1) predicted species richness throughout Y2Y; (2) predicted number of species at risk throughout Y2Y; (3) predicted avian habitat quality throughout Y2Y using a 50:50 weighting of species richness to species at risk; (4) predicted avian habitat quality throughout Y2Y using a 75:25 weighting of species richness to species at risk; (5) predicted relative avian habitat quality ranked within each broad-scale habitat type in Y2Y; (6) predicted relative avian habitat quality ranked within each broad-scale habitat type in northern Y2Y; and (7) predicted relative avian habitat quality ranked within each broad-scale habitat type in southern Y2Y.*

In addition to these major building blocks of the Wildlife Network, other analyses will contribute to refining the conservation design.

1. **Umbrella Effects Analysis**
   The base layer for the Wildlife Network is the grizzly bear model. Grizzly bears are widely understood to be an effective umbrella for a variety of other species. However, that assumption has been based on the wide-ranging nature of grizzlies' travels. (It is assumed that *protecting the land* necessary for grizzly bear persistence will also protect the variety of other species that live on that land.) Merrill and Mattson have tested this assumption on a pilot basis in Montana and Idaho by also looking at the *management prescriptions* that are applied for grizzly bear conservation (i.e., how impacts of human activities on bears are reduced, e.g., road closures) and determining whether or not those management tools also provide protection for other species.

   The Mattson and Merrill analysis demonstrated that managing the landscape for grizzly bear conservation provides adequate umbrella protection for 14 of 21 carnivore species in Montana. The seven species that did not receive umbrella protection included wolves, lynx, and wolverine, among others.

   For aquatic species, grizzly bear source areas contained more than 80 per cent of the highest ranked watersheds (the most pristine). When enough of the aquatic integrity areas were selected having a combined area equal to that of grizzly bear source areas, overlap was reduced to 55%.[6]

   By grouping species together based on their sensitivities to management factors, Merrill and Mattson were able to predict that all carnivore species would receive adequate umbrella benefits from the management of protected or special status species (specifically fisher and marten) EXCEPT grizzly bears, wolves and wolverines. To ensure complete protection of all species, specific management plans for those three carnivores also need to be developed.

   This project has initiated the transition of Y2Y products from the *descriptive* (what needs to be protected) to the *prescriptive* (how to protect it), with a high degree of confidence that what is prescribed will be effective.

   [*Products*: A report and tables showing all of the carnivore species in a matrix with all of the management stressors, and the species' response to each one of the stressors; grouping the species into similar clusters based on responses to management action; and clustering those proximal stressors into groups of ultimate stressors.]


Photo: Wayne Sawchuck

WHAT OTHER RESEARCH INFORMS THE Y2Y WILDLIFE NETWORK?

1. **Corridors of Life Project**
   American Wildlands undertook its "Corridors of Life" project in the mid-1990s, inspired by the Y2Y vision. It modeled a "least cost path"[6] approach to reconnecting the Greater Yellowstone Ecosystem to northern Montana and northern Idaho, using grizzly bear and elk. The product is a map predicting linkages that could be used by wildlife occupying the lands between these core areas.

2. **Canadian Rocky Mountain Ecoregion Conservation Assessment**
   The Nature Conservancy of Canada developed a map of lands important to conservation in the Central Rockies. It used three layers to construct these maps: ecosystem representation, special elements (usually threatened or endangered species), and focal species. The goal was to select multiple representatives of all ecosystem types and occurrences of special elements within the least area possible. Focal species were used to establish scale and connectivity. Based on these criteria, more than 50 per cent of the land in the region is included in the portfolio.

3. **The Rocky Mountain Elk Foundation Elk Habitat Map**
   The Rocky Mountain Elk Foundation mapped high quality elk habitat and elk locations in North America. They met with wildlife agencies, hunters and landowners to gather first-hand knowledge about where elk were using the landscape, especially wintering and calving areas and migration routes. The results are extremely useful for the Alberta and U.S. portions of the Y2Y landscape; they are less so for British Columbia. Within the U.S. Northern Rockies, there was a high degree of correspondence between this "traditional" knowledge and the predictions of the Corridors of Life project.

4. **The Wilburforce-Y2Y Science Grants**
   The Wilburforce-Y2Y Science Grants annually produce a dozen or more projects that are contributing to the finer-scale analysis necessary for identifying the boundaries of cores, linkages and buffers and the location of wildlife corridors.

WHAT REMAINS TO BE DONE TO COMPLETE Y2Y'S WILDLIFE NETWORK?

Grizzly Bears

The map of landscapes required for evolutionarily robust grizzly bear populations (i.e., connected populations totaling several thousand animals) extends only to the British Columbia/Yukon border. It must be extended to the northern and northwestern edges of the Y2Y study area in the Yukon and its northeastern edge in the Northwest Territories. This has not been completed due to technical problems with processing satellite data. These problems can and will be resolved. At present, priority has been given to completing and refining the analysis in the area for which data exists. That analysis is nearly complete.

[6] *The "least cost path" model predicted which routes elk and grizzly bear could take through the intervening landscapes that required them to use the least amount of energy.*

In addition, the data used to inform the model in northern Canada is sparse and must be supplemented by further field work. Y2Y cannot undertake this work but is hopeful that other agencies and organizations will eventually fill these gaps.

Ultimately, Y2Y intends to apply the umbrella effects technique across the entire Y2Y landscape to provide general management prescriptions. Further steps depend on an ongoing scientific review process as well as adequate funding.

Aquatics

The Aquatic Integrity Analysis must be finished for the two other watersheds in the U.S. portion of Y2Y – the Upper Yellowstone and Upper Green River basins – as well as the Kootenay River Basin. This work is projected to be completed by early 2004.

Applying the Aquatic Integrity Area Analysis to Canadian watersheds has not been possible. The British Columbia and Alberta governments have been unable to provide the data sets necessary to run the computer model, and the data sets simply do not exist in the Yukon. In 2004, Y2Y will explore alternatives for mapping the most ecologically important watersheds in the Canadian portion of Y2Y.

Another analysis is near completion that will give us a different picture of aquatic systems in Y2Y. Dave Mayhood has been contracted to provide an analysis of fish species diversity, concentrations of native fish species, and the percentage of exotic species for each of the dozen river basins in the Y2Y landscape. This work will be summarized in a report and projected on a map to give us our first picture of the health of aquatic systems from Yellowstone to Yukon.

Birds

The Jones and Hansen model needs to be applied to the rest of the Y2Y landscape (Idaho, Washington, Oregon, Alberta, British Columbia, Yukon and the North West Territories.)

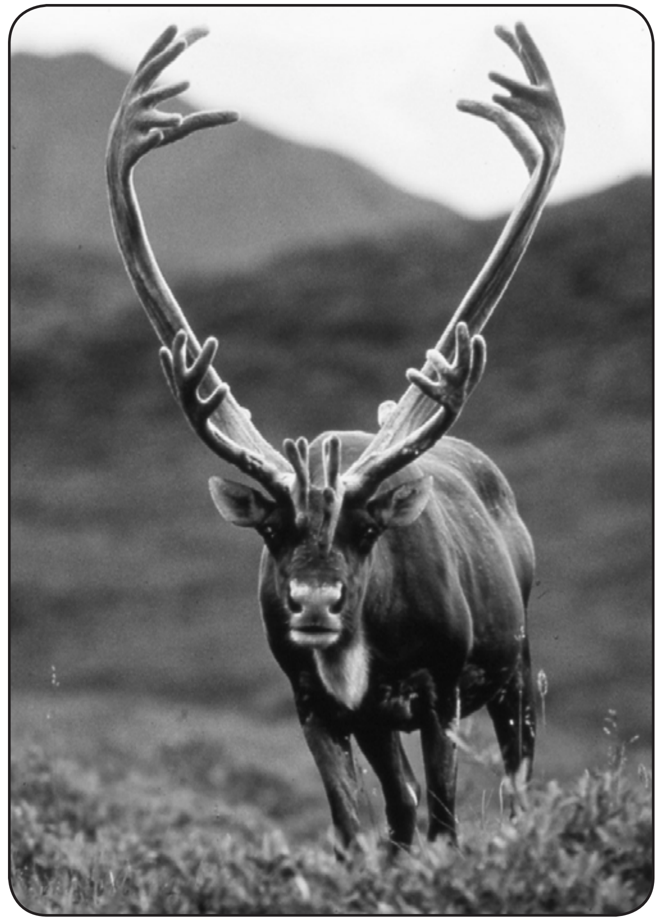
As thorough as is Judy Muir's model, it still has limitations. Breeding Bird Survey routes are biased toward areas that are accessible by roads. Therefore, higher elevations, roadless areas (i.e., the North), and other inaccessible places are inadequately represented. Further, the northern Breeding Bird Survey routes have not been sampled in the past six years. This lack of data means there is less certainty for model predictions in alpine tundra, sub-alpine, northern shrub fields, and boreal spruce habitats, and in northern regions of Y2Y. Muir's future work will address this by incorporating more indicators of bird habitat quality and data sets that represent alpine, sub-alpine, and northern habitats.[7]

In addition, Judy's conclusions could change depending on the relative importance Y2Y places on conserving areas of species richness (i.e., areas of high bird species concentrations) versus habitats for species at risk. All work remaining to be done by Muir is scheduled for completion in early 2004.

[7] *The Jones and Hansen model also relies on Breeding Bird Survey data and suffers from the same limitations as Judy Muir's work.*

The North

From Jasper northward, we have not secured Y2Y-scale research sufficient to identify critical linkages, i.e., the Peace River gap in northeastern British Columbia. An opportunity may exist to partner with the Nature Conservancy of Canada, which wants to complete a conservation plan for the Peace River area as part of a larger project. We are also currently helping shape the conservation area design being prepared for Muskwa-Kechika Management Board, which will extend south of the Peace River.



North of the Muskwa-Kechika, there are different challenges. Most conservation biology is a response to fragmented landscapes. From the Muskwa-Kechika north, the landscape is largely intact. CPAWS Yukon has completed some drainage-specific conservation planning. The Deh Cho and Sahtu First Nations also have done some conservation planning in the Northwest Territories part portion of Y2Y. As part of the Y2Y North gathering in September, we need to fully inventory what has been completed and determine whether it is sufficient for our purposes, or whether more needs to be done.

CARNIVORES IN YELLOWSTONE TO YUKON: THE BUILDING BLOCKS OF A CONSERVATION PLAN

WHY FOCUS ON CARNIVORES?

Y2Y's Conservation Science Program is studying carnivores, birds and watersheds to identify and map the most important landscapes for the long-term conservation of biodiversity in this vast region. But for a variety of reasons, it is the habitat needs of carnivores that provide the base map for conservation design.

Most importantly, carnivores generally are wide-ranging and sensitive to human disturbance. Therefore, managing for the conservation of large carnivores provides conservation benefits to many other species. Carnivores also tend to be relatively well-studied, providing enough information for computer modeling. In addition, large carnivores are "charismatic" – many people are interested in their conservation. Finally, and perhaps most importantly from a conservation perspective, there is ample evidence that large carnivores may be essential to maintaining a balance within ecosystems. Other studies have demonstrated that through their predation on grazing species, carnivores influence the balance between grazers and plants, which in turn impacts the balance between various species down the food chain. Therefore, preserving healthy populations of carnivores is essential to maintaining intact, healthy ecosystems.

WHAT DID Y2Y DO?

Predicting Grizzly Bear Habitat Suitability

For several years, the Yellowstone to Yukon Conservation Initiative has been funding the ground-breaking work of Troy Merrill and David Mattson. These researchers have been charting new territory in grizzly bear conservation by developing modeling techniques to reveal how many grizzly bears landscapes the Yellowstone to Yukon region can sustain. It is unlikely this research would have been conducted without Y2Y's leadership.

Grizzly bears are difficult to study. They are secretive, they exist in low densities in remote areas, and they avoid people whenever possible. Therefore, it is challenging to estimate the number of individual bears in a given landscape or determine the boundaries of their movement patterns.

Using information from many field studies of bears across the Y2Y region, Merrill and Mattson analyzed the relationship between animals in these study areas and the features of the landscapes in which they exist. They used this information to develop computer models of where grizzly bears are likely to occur in a much larger area. They then used estimates of grizzly bear densities to develop a computer model of potential grizzly bear concentrations that could be applied to all of the Y2Y landscape. Finally, a similar method was used to develop a computer model to estimate the rate at which grizzly bears are killed. By combining the estimate of how many bears an area can support with the estimate of how rapidly they are killed, the model identified areas where grizzlies are likely to reproduce faster than they can be killed.

These are called "source" areas, and their protection is essential to grizzly bear conservation.

Testing the "Umbrella Effects" of Grizzly Bears

One of the more recent and novel studies Merrill and Mattson have undertaken regards the extent to which management to conserve one species (grizzly bears) can benefits a myriad of other species. Grizzlies are known as "umbrella" species because management that results in grizzly conservation provides an "umbrella" of protection for many other species that share their habitat. Scientists and conservationists have long assumed that grizzly bear conservation provides umbrella benefits. But no one had tested that theory before Y2Y funded the Merrill-Mattson study.

Mapping Suitable Habitat for a Suite of Carnivore Species

Four years ago, Y2Y partnered with World Wildlife Fund Canada (WWF) to fund an important study suitable habitat for nine carnivore species[8] from south of Yellowstone National Park to north of Jasper National Park. This work has allowed biologists to understand the availability of habitat for these carnivores over a landscape large enough to contain populations of sufficient size for long term survival, including the ecological processes on which they depend.

To develop a multi-carnivore computer model of the southern half of the Yellowstone to Yukon landscape, researchers divided the region into planning units of 650 km^2. (This area approximates the home range[9] of a female grizzly bear.) The computer models were then used to estimate the amount of suitable habitat for each of the nine carnivores within each planning unit. The amount of suitable habitat in turn was used to estimate the number of home ranges the unit contained for each of the nine species. Assuming each home range is occupied by one individual, the minimum number of animals the unit might contain was calculated. Finally, researchers calculated the number of animals each unit ought to contain if viable, long-lasting populations are to exist.

In a second phase of its study, WWF expanded the study area north to the Yukon border, and developed a computer model to predicts future population scenarios for grizzly bear, wolf, lynx, bobcat and fisher. They also used a computer to select the best configuration of habitat that, if appropriately managed, would ensure the long-term survival of these species.

Identifying Land Necessary for Grizzly Bear Survival

Based on the information about how many grizzly bears could live in each planning unit and the landscapes containing the best habitat for other species, the computer model was then asked to identify the land base necessary to support 5,000 grizzly bears – the number of bears thought to be necessary for the survival of grizzly bears over centuries, if not millennia, in the study area. The computer was also asked to maximize the number of the other eight carnivores that also could live on the lands chosen for grizzly bears.

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8 *The nine species are: grizzly and black bear, bobcat, mountain lion, fisher, lynx, marten, gray wolf and wolverine.*

9 *"Home range" is the estimate of an area of land a given animal will wander in her search for food and the other necessities of survival over a one-year period.*

WHAT DID Y2Y FIND OUT?

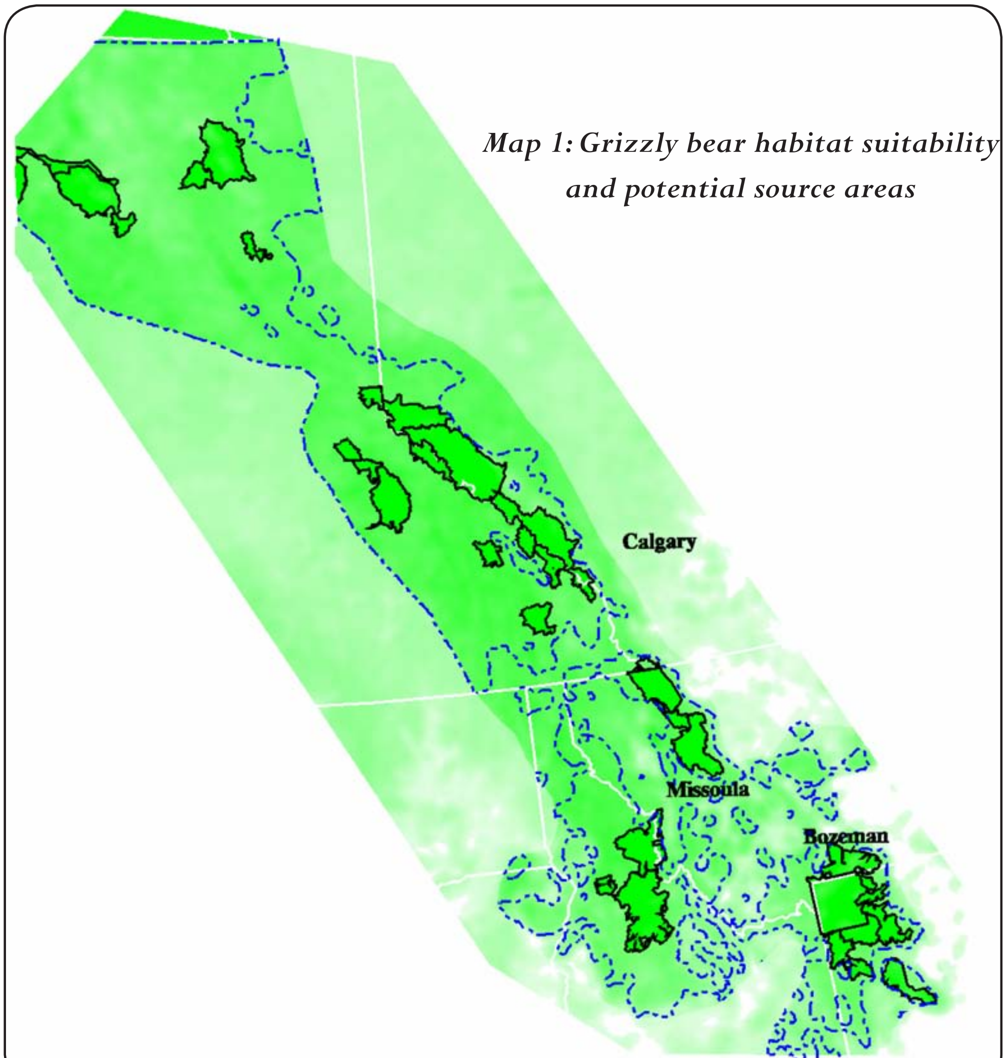
Predicting Grizzly Bear Habitat Suitability

Map 1 illustrates the potential for the Yellowstone to Yukon landscape (from the Yukon border south) to support grizzly bears. The darkest green areas could support the greatest concentration of bears, while areas trending to lighter green will support increasingly lower bear numbers. The map confirms that the Canadian portion of the Y2Y landscape remains capable of supporting the greatest number of grizzly bears. However, in the southern Canadian portion of the landscape and the U.S. Northern Rockies, the ability of the landscape to support grizzly bears is diminished. In fact, some places cannot support grizzlies at all – for example, between the northern boundary of the Greater Yellowstone Ecosystem (Yellowstone National Park and surrounding wild lands) and the southern boundary of the Northern Continental Divide Ecosystem (Glacier National Park and surrounding wild lands).

Areas that are potential source populations for grizzly bears (where more grizzly bears are born than killed) are outlined by blue-dotted lines. Again, the entire Canadian landscape south of the Yukon border (with the exception of the Peace River gap, the Rocky Mountain Trench in southeastern British Columbia, and the Highway 3 region in southeast British Columbia and southwest Alberta is capable of supporting source populations of grizzly bears. In the U.S. portion of the Yellowstone to Yukon landscape, northern Idaho, the Northern Continental Divide Ecosystem anchored by Montana's Glacier National Park and the Greater Yellowstone Ecosystem are capable of supporting source populations.

Mapping Suitable Habitat for a Suite of Carnivore Species

Map 2 illustrates the configuration of contiguous habitat that is necessary to support a sustainable population of 5,000 grizzly bears and as many



Map 1: Grizzly bear habitat suitability and potential source areas

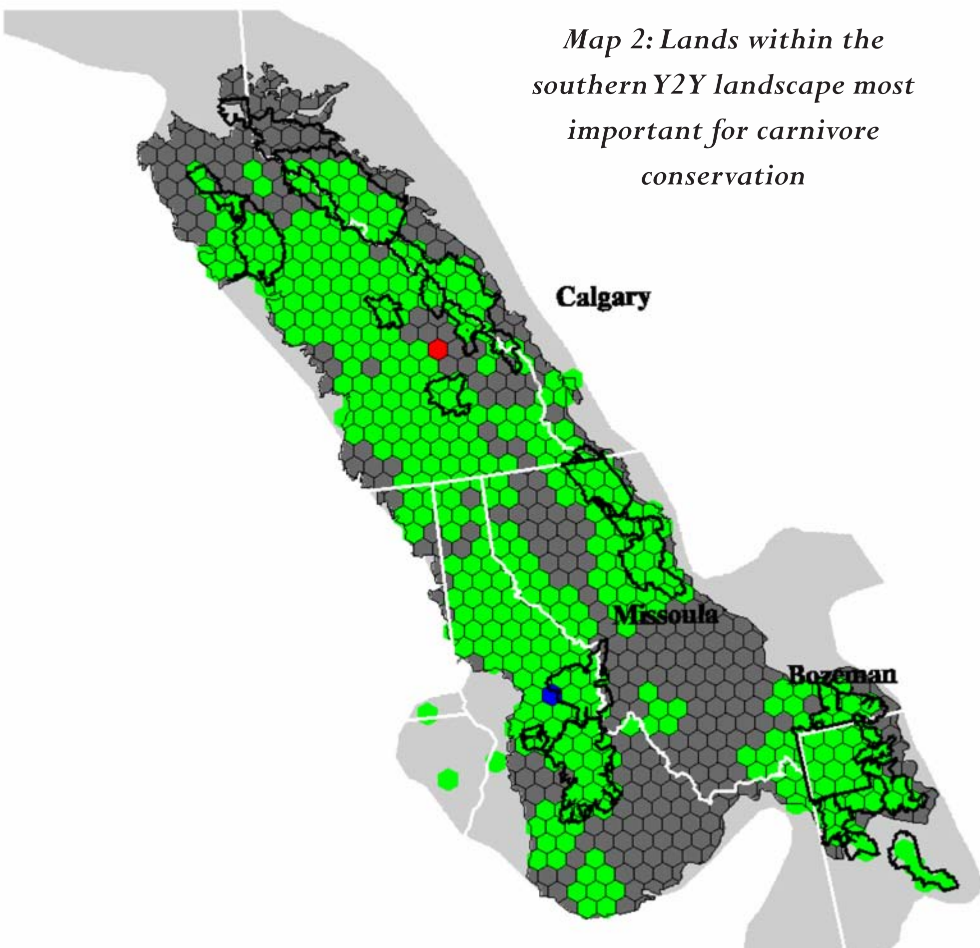
of the other eight carnivore species as possible. According to this analysis, the landscapes that are most important for carnivore conservation include most of the Central Canadian Rockies from Jasper National Park west to British Columbia's Wells Gray Provincial Park and south to the U.S. border, including the interior Columbia and Selkirk Mountains, Banff, Kootenay and Yoho National Parks, and the southern Canadian Rocky Mountains. In the U.S., the lands with the potential for long-term carnivore conservation include the Northern Continental Divide and Greater Yellowstone Ecosystems and northern Idaho.

Identifying Land Necessary for Grizzly Bear Survival

As Map 3 shows, the Canadian portion of the Yellowstone to Yukon landscape essentially is intact and capable of supporting sufficient grizzly bears (connected populations of between 500 and 700 individuals) to ensure their survival over the coming centuries. These northern landscapes need careful management and protection, as they harbor the source populations for the rest of the Yellowstone to Yukon region. (There are exceptions, such as the Peace River break and the Rocky Mountain Trench, where connections between grizzly bear populations are tenuous or grizzly bears no longer live on the land.[10] Land use in these areas needs to change so that bears can return and connectivity between populations can be restored.)

There also are places on the Y2Y Canadian landscape, especially from Jasper southward, where grizzly populations are smaller than the land is capable of supporting, largely due to habitat fragmentation and management practices that lead directly or indirectly to bear mortality.

Map 2: Lands within the southern Y2Y landscape most important for carnivore conservation



[10] *The farther north one goes, the less on-the-ground observational data is available and the more Y2Y depends on satellite information and computer modeling. As satellite data is extremely imprecise at the scale at which conservation planning must take place (i.e., boundaries of management units) and as models are only predictors rather than actual data, on-the-ground field work is still needed in northern landscapes to validate and fine-tune the models.*

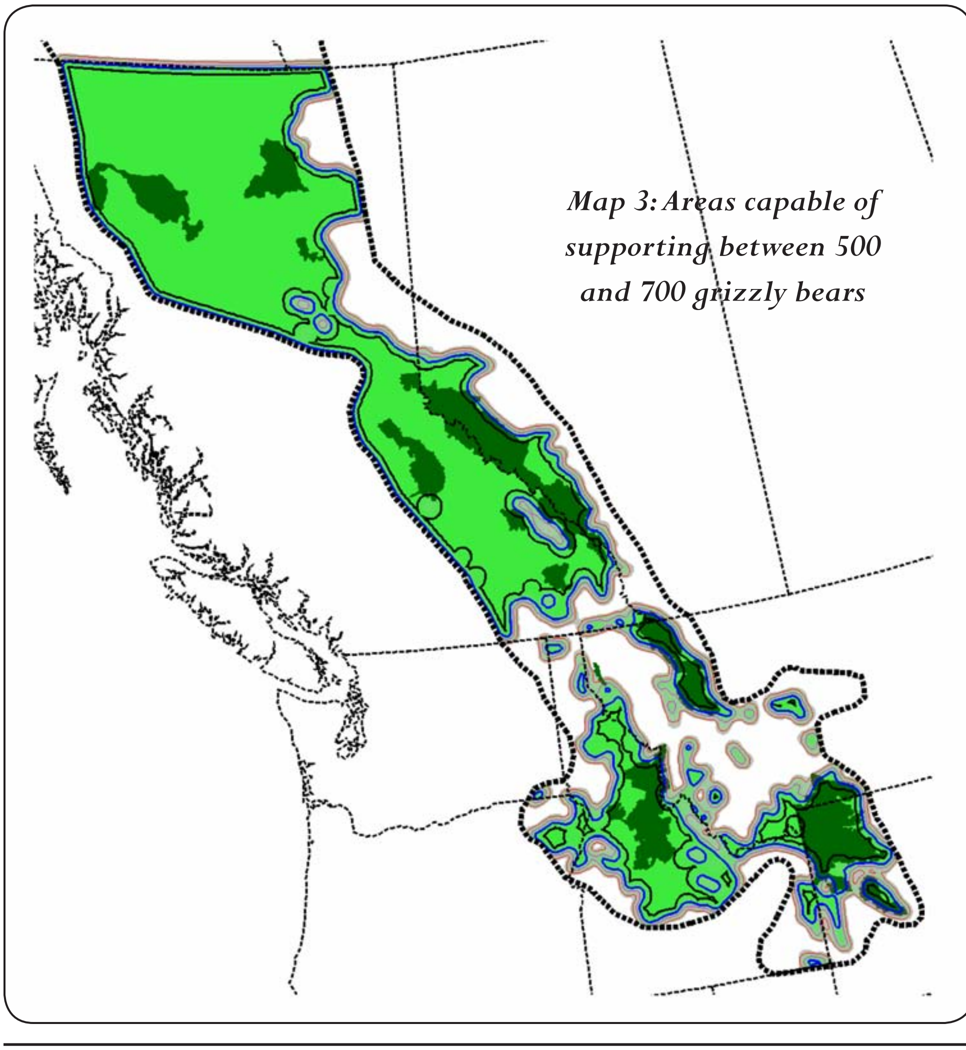
The southern third of the Yellowstone to Yukon region, from the region of Alberta and British Columbia's Highway 3 south to the southern end of the Greater Yellowstone Ecosystem, is a picture of fragmented or unoccupied grizzly bear habitat where much restoration is needed to allow grizzly populations to grow to sustainable numbers and to reconnect to each other.

For example, the model predicts an almost complete genetic break between grizzly populations in the Canadian central Rocky Mountains and those in the U.S. Northern Continental Divide and Cabinet-Yaak ecosystems (in northwestern Montana and northern Idaho). (On-the-ground DNA research and radio-collared tracking of grizzly bears has confirmed that the break is not absolute. A few grizzly bears are still making it across Highway 3 to continue the exchange of genes between U.S. and Canadian populations.)

Furthermore, the predicted grizzly populations of the Northern Continental Divide Ecosystem and of the Greater Yellowstone Ecosystem, at 125 and 341 animals respectively, are neither large enough to persist over time nor connected genetically to other populations. Finally, although the habitat of central Idaho is sufficient to support a sustainable population of 639 grizzlies, no bears live there currently and reintroduction efforts have stalled because of differing opinions between scientists about bear management policies.

Long-Term Grizzly Bear Conservation

For the grizzly bear specie to survive thousands of years, it must be able to adapt to environmental changes over time. This requires genetic and behavioral diversity that can be achieved only if several thousand individuals are interacting and exchanging genes and behaviour. Therefore, the populations of 500 to 700 animals must be connected to and have interactions with other populations of similar size, to constitute a stable, interconnected population.



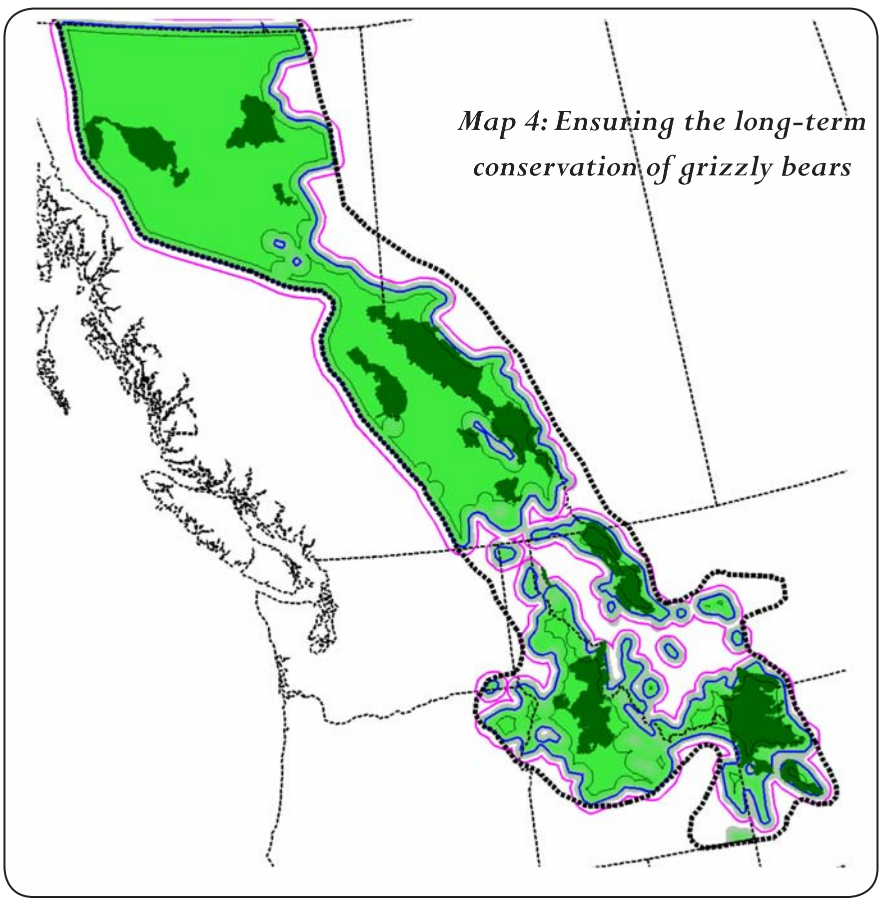
Map 4 shows that potential populations in the Greater Yellowstone and Northern Continental Divide Ecosystems are not large enough to support long-term survival and are isolated from other regional populations. Consequently, restoring grizzly bears to the Salmon-Selway Wilderness of north Central Idaho, reconnecting that landscape through the Cabinet-Yaak and maintaining grizzly bear connections across Highway 3 are currently the top conservation priorities in the entire Yellowstone to Yukon region.

Testing the "Umbrella Effects" of Grizzly Bears

The Y2Y-funded umbrella species research confirmed that management practices designed to conserve grizzly bears also have beneficial effects for many other species. But there are some species – especially lynx – that do not benefit from the umbrella protection of grizzly bears. Management practices that promote the conservation of these species will be needed on lands not managed to protect grizzlies.

WHAT WILL Y2Y DO WITH THIS KNOWLEDGE?

The Yellowstone to Yukon Conservation Initiative is gathering scientific knowledge at a scale never before attempted, analyzing the science in terms of its lessons for biodiversity conservation, and sharing that information with activists, other scientists, landowners and decision-makers. The carnivore conservation information that Y2Y has commissioned will also help determine Y2Y conservation priorities and will be combined with ongoing bird and aquatics research to reveal an overall picture of the conservation needs of the entire Yellowstone to Yukon landscape. Strategies and campaigns to ensure the long-term habitat needs of wildlife will then be crafted and implemented.



Map 4: Ensuring the long-term conservation of grizzly bears

AQUATIC INTEGRITY AREAS: A CONSERVATION TOOL FOR FISH AND FRESHWATER-ASSOCIATED SPECIES

WHAT IS AQUATIC INTEGRITY?

Aquatic integrity is a measure of the overall health and quality of an entire aquatic system, including the water, the associated uplands, and the diversity of life that the water and uplands sustain. Indicators of aquatic integrity include the presence of native species, a natural diversity of habitat types, and the full array of ecosystem functions that natural waters provide.

WHAT IS THE AQUATIC INTEGRITY AREAS MODEL?

The Aquatic Areas Integrity (AIA) Model is a computer modeling program that assesses the relative ecological health of each tributary (10,000-40,000 acres) within an entire river basin, or watershed. The model uses four criteria to assess and compare the ecological integrity of the tributaries within an entire river basin:

- the proportion of roadless land in the tributary[11]
- the number of times non-native fish species have been introduced[12]
- the ratio of native to non-native fish species, and
- the presence of threatened, endangered or sensitive fish and other freshwater-dependent species such as mollusks and sedges

The products of the analysis are maps that reveal the relative health of each tributary when compared with the others in the river basin, ranging from those with high ecological integrity, where native fish and aquatic communities are primarily intact, to those with low ecological integrity, where native communities and watershed conditions have been degraded or destroyed.

HOW IS AQUATIC INTEGRITY AREAS MODELLING NEW?

Conservation efforts depend on knowing where ecological integrity exists, where it is threatened, and where it has been lost. Yet, until Y2Y's efforts, no systematic study had been done in the Yellowstone to Yukon landscape to identify the freshwater systems with the best ecological integrity and native fish species diversity. For the first time, Y2Y's results provided reliable tools to help determine which watersheds to protect and which to restore.

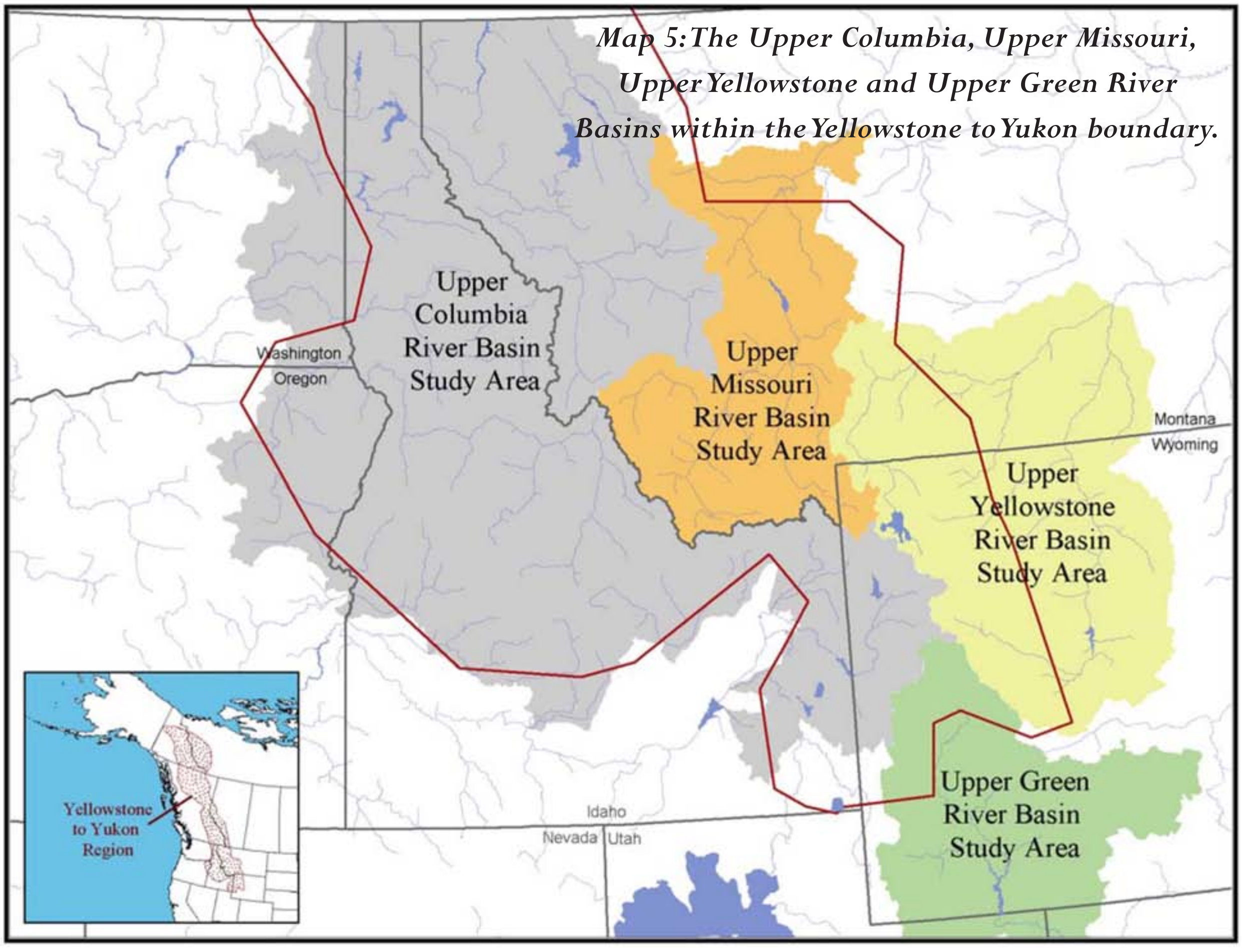
WHAT DID Y2Y DO?

American Wildlands, a Y2Y network participant, in conjunction with Dr. Chris Frissell of the Pacific Rivers Council, developed and is applying the AIA model to the Upper Missouri[13], Upper Columbia, Upper Green and Upper Yellowstone River basins within the Y2Y ecoregion (see Map 5). The Yellowstone

[11] *Areas greater than 400 hectares (988 acres) without a road were considered roadless. The number of roadless areas compared to the total area of the tributary resulted in a roadless value for that tributary.*

[12] *In the Upper Columbia River, data was not sufficient to include the history of non-native fish introductions in the model.*

[13] *The Upper Missouri River watershed constitutes some 12 million acres in the southwestern corner of Montana, from its headwaters on the Continental Divide downstream to Great Falls, in the center of the state. The Upper Columbia River watershed ranges from Yellowstone National Park to include most of northern Idaho.*



Map 5: The Upper Columbia, Upper Missouri, Upper Yellowstone and Upper Green River Basins within the Yellowstone to Yukon boundary.

to Yukon Conservation Initiative funded this research. The Upper Columbia and Upper Missouri River Basin analyses are complete. The Upper Yellowstone and Green River Basin analyses are near completion.

WHAT DID Y2Y FIND OUT?

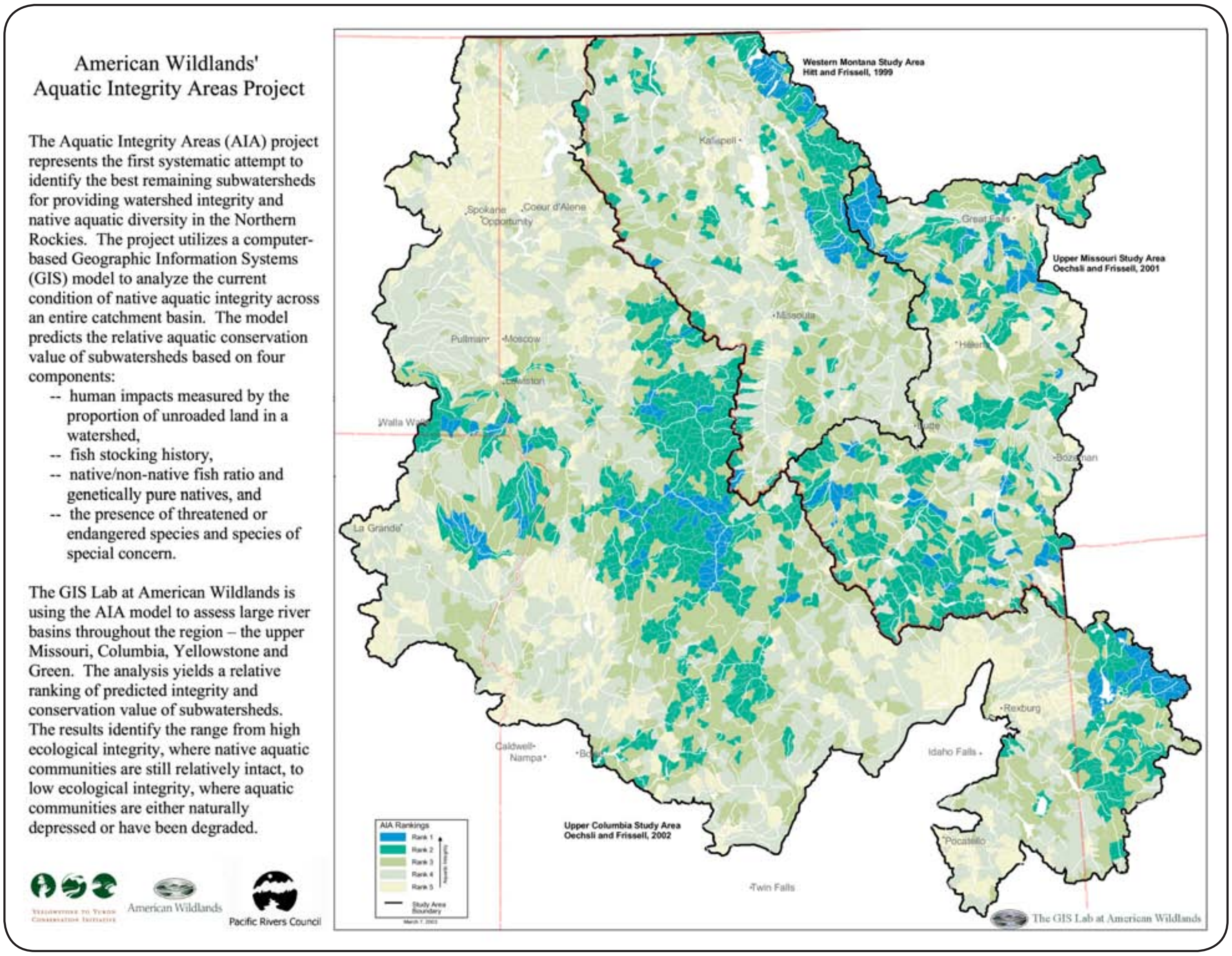
The results can be seen in Map 6. The areas in blue and green reveal the highest ecological integrity, while those in gray and white are significantly degraded.

The analysis reveals that much of the ecological integrity has been lost from freshwater ecosystems in the Upper Missouri and Upper Columbia watersheds. Although there are no large clusters of tributaries with high ecological integrity, there are some fairly large configurations of high to medium integrity – sufficient to form a foundation for conservation planning based on protection, restoration and management strategies.

Within the **Upper Missouri River basin**, five tributaries – the Sun, the Upper Missouri/Dearborn, the Big Hole, the Red Rock and the Beaverhead Rivers – have high or relatively high ecological integrity. Three other tributaries – the Boulder, Jefferson and Gallatin Rivers – have the lowest overall ecological integrity.

Within the entire Upper Missouri River Basin, only 7% has the highest ecological integrity ranking. An additional 30% of the Upper Missouri River basin has the second highest ranking of ecological integrity.

By far the majority of the Upper Missouri River basin – a full 62 per cent – is in poor to moderate ecological condition.



Map 6: The results of the Aquatic Integrity Areas Analysis for the Upper Missouri and Upper Columbia River Basins

The conservation picture in the **Upper Columbia River basin** is even more challenging. Only three per cent of the basin as a whole earned the highest ecological integrity ranking – the Snake River headwaters, the Lower Middle Fork of the Salmon River, and the Middle Salmon-Chamberlain River. An additional 16 per cent of the basin has the second-highest aquatic integrity ranking.

A full 81 per cent of the Upper Columbia River basin is in either moderate or poor ecological condition. Significantly more effort will need to be focused on restoration if the Y2Y portion of the Upper Columbia watershed is to provide a long-term conservation benefit to aquatic species.

HOW DO THE AIA ANALYSES INFORM CONSERVATION STRATEGIES?

Aside from the ecological criteria listed earlier, the AIA model incorporates data regarding tributary ownership and management, which permits a comparison of the relationship between ecological integrity and ownership. For example, the analysis shows that while only seven per cent of the Upper Missouri basin has the highest ecological integrity, a full 60 per cent of that small proportion is publicly-owned and managed.

Applying such comparisons across both the Upper Columbia and Upper Missouri River Basins reveals the importance of federally-designated wilderness to freshwater ecological integrity. While overall only five per cent of the Upper Missouri River Basin is contained within designated national Wilderness, a much higher proportion of the tributaries with the highest ecological integrity (and a much lower proportion of those with the lowest ecological integrity) are found within Wilderness Areas.[14] The analysis also confirms the importance of the size and configuration of wilderness areas to the ecological integrity of rivers that run through them. The large Bob Marshall and Scapegoat Wilderness Areas contain tributaries of much higher relative ecological integrity than the smaller Red Rocks Lakes, Anaconda-Pintler, and Spanish Peaks and Taylor-Hilgard units of Lee Metcalf Wilderness Areas. (Some smaller Wilderness Areas, such as the Monument Mountain and Beartrap Canyon units of Lee Metcalf also have high proportions of relatively high integrity areas.)

Within the Upper Columbia watershed, designated wilderness areas also contain a greater proportion of high integrity sub-watersheds and a lower proportion of degraded areas than the study area as a whole.

WHAT WILL WE DO WITH THESE RESULTS?

The Aquatic Integrity Areas analyses are a crucial tool for designing conservation strategies, based on questions that the model can answer. For example, the model can identify tributaries in which non-native species introduction or the presence of roads are the most significant factors contributing to a lower integrity score, and conservation strategies can be developed to address these conditions. Alternatively, the model can highlight unprotected watersheds having high integrity on public lands.

Therefore, the Aquatic Integrity Areas analyses for the Upper Missouri and Upper Columbia River basins provide information that land management agencies, conservationists and private landowners can use to determine where conservation activities, including protection, restoration and new management practices, should be focused. American Wildlands already has launched its "Living Waters" program to educate these audiences about the aquatic integrity analysis and the steps can that be taken to improve the ecological health of these watersheds. In the near future, American Wildlands will identify unprotected watersheds with high integrity for protective designation, and target degraded systems for restoration.

WHAT WILL WE DO NEXT?

Assessments of the Upper Yellowstone and Upper Green River basins are near completion, and will provide an aquatic integrity assessment of all watersheds within the U.S. portion of the Yellowstone to Yukon landscape. The next phase will look for clusters of tributaries with high ecological integrity whose native fisheries would benefit from restoration of adjacent tributaries with lower ecological health. A configuration of connected, healthy sub-watersheds is essential to ensure the survival of viable populations

[14] *Of approximately 58,000 ac. of designated Wilderness, 32,500 ac., or 56%, had the highest aquatic integrity, 24,000 ac., or 41% had medium aquatic integrity, and only 3,500 ac., or 6% had the lowest aquatic integrity.*

of native fish species. This configuration will form one component of the Yellowstone to Yukon Conservation Initiative's Wildlife Network.

WHAT ABOUT CANADA?

The Aquatic Integrity Areas analysis has not yet been applied to the Canadian portion of Y2Y, because of the difficulty of obtaining data regarding Canadian freshwater ecosystems. Y2Y's staff and contract scientists continue to develop alternative strategies to estimate the ecological health of freshwater systems in Canada.

In the meantime, Y2Y is completing a report that estimates the ratio of native fish species to non-native species in Canadian watersheds. This report confirms that Canada's northern rivers still contain primarily native fisheries, while those closer to human settlement have increasing numbers of introduced species.

Photo: Christine Elmgren

MAPPING BIRD ABUNDANCE AND HABITAT DIVERSITY: A NEW METHOD OF BIRD CONSERVATION PLANNING FROM YELLOWSTONE TO YUKON

WHAT IS IT?

Effective conservation planning requires knowledge of the distribution of target species and their habitats across the landscape. However, because of the high number of bird species and the localized nature of their habitats, it would be most difficult to map bird biodiversity for all of the Yellowstone to Yukon region at a local scale.

Y2Y has thus commissioned researchers from Montana State University to take what they have recently learned from modeling bird diversity across the northwest U.S. and apply their methodology across the entire Y2Y region.[15] Their model provides an accurate new way to plan for bird conservation at the regional scale without detailed local evaluations.

The model predicts the quality of bird habitats by using satellite imagery in combination with climate information, landscape properties and Breeding Bird Survey (BBS) data.[16] Since satellite images are generated at a continental scale, and BBS data are readily available throughout the Yellowstone to Yukon region, this model provides an efficient, consistent and cost-effective means to identify and map bird diversity hotspots in Canada and the U.S. The maps will identify locations in the Y2Y region where biophysical conditions favor high bird species richness.

WHAT DID Y2Y DO?

Initially, Y2Y's researchers conducted a comparison of the satellite/BBS predictions of high-quality bird habitat against fine-scale diversity maps built from more detailed bird survey data, called Point Count surveys,[17] within forests of the Montana portion of the Yellowstone to Yukon region.

The researchers found the satellite-based diversity maps and the point count diversity maps corresponded very well, confirming the satellite model's ability to identify accurately important bird habitat and predict hotspots for birds, including rare and endangered species.

WHAT DID Y2Y FIND OUT?

There were several very important outcomes from this study. First, it was demonstrated that the maps based on the satellite images and Breeding Bird Surveys are very accurate predictors of bird habitat and the presence of birds, when compared to point count bird survey results. Second, the study highlighted the areas within this portion of the Yellowstone to Yukon region that are most

[15] *This research was funded, in part, by Y2Y directly and in part by a Wilburforce Foundation Y2Y Science Grant.*

[16] *During Breeding Bird Surveys, a volunteer bird observer stops every 0.8km/0.5 mi along a 39.4 km/24.5 mile route and records all birds heard or seen during a 3 minute period. BBS surveys are conducted under the auspices of the U.S. Geological Survey.*

[17] *With Point Count data surveys, field crews from the Landbird Monitoring Program, sponsored by the US Forest Service, make observations of birds heard or seen at ten points located 300m apart during ten minute periods.*

preferred by birds. Areas at low elevation with warmer temperatures, higher precipitation, and more available food are the major hotspots of overall bird concentrations as well as concentrations of rare or endangered bird species. These hotspots generally are located in forested valley bottoms along the major rivers of northwest Montana. Lowlands in the Flathead Valley were revealed to contain the highest concentration of key areas of bird diversity.

Areas predicted to have medium to high concentrations of birds are valley bottoms in the south and east portion of the study area (i.e., along the Montana/Wyoming border), especially the edges where grasslands and forests meet. The highlands of the southern Montana portion of the Y2Y region are predicted to have the lowest quality habitat for birds.

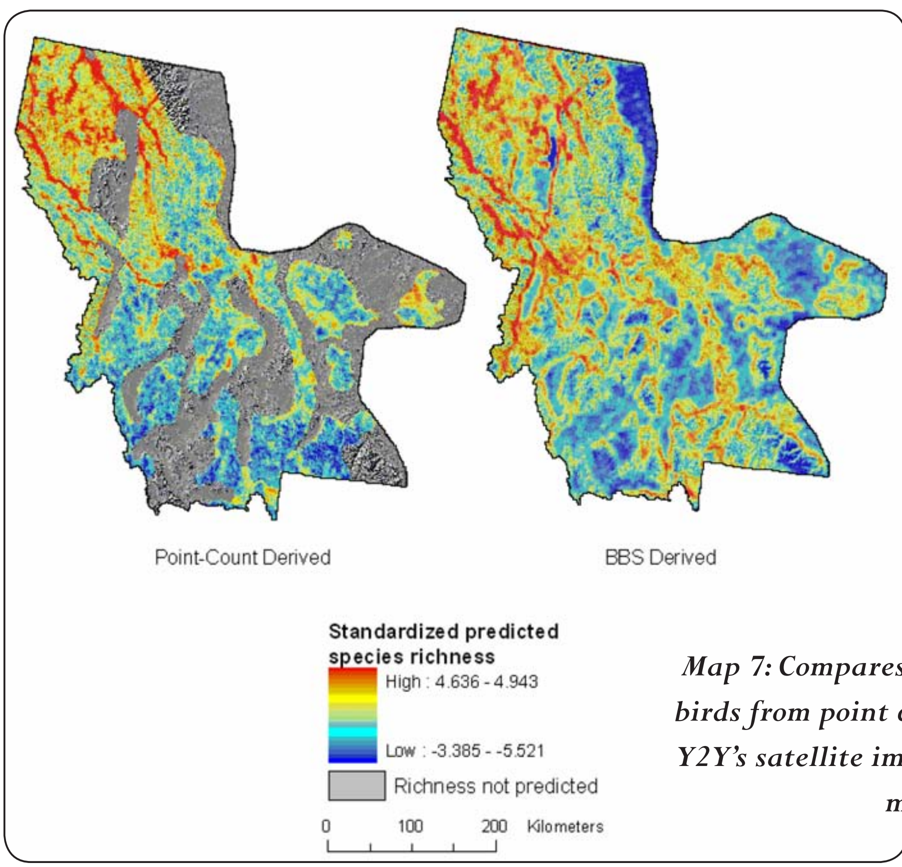
WHAT WILL WE DO WITH THIS KNOWLEDGE?

The low-elevation valleys of northwest Montana – the most important habitats for birds generally and for sensitive species in particular – are undergoing rapid human development. (Flathead, Lake, Missoula and Ravalli counties in northwest Montana averaged 30 per cent growth during 10 years ending in 2000.) This study highlights the need for Y2Y and its Network participants to focus conservation efforts in those areas.

WHAT WILL Y2Y DO NEXT?

This method of using satellite imagery and Breeding Bird Survey data to map bird habitats and areas important to birds has already been applied to the Montana, Idaho, Washington and Oregon portions of the Yellowstone to Yukon landscape. Now that the method has been proven successful, it will be applied to remaining areas of the U.S. portion of the Y2Y landscape, and then to the entire Canadian portion, so that a complete map of bird habitats for the Yellowstone to Yukon region is created.

The mapped areas of high concentrations of birds and sensitive bird species will identify other priority areas for bird conservation from Yellowstone to Yukon. They also will form one of the layers of the Wildlife Network for the entire Yellowstone to Yukon region.



Map 7: Compares predicted concentrations of birds from point count survey data (left) with Y2Y's satellite imagery/Breeding Bird Survey model (right)

YELLOWSTONE TO YUKON CONSERVATION SCIENCE GRANTS PROGRAM

From sage-grouse in Wyoming to woodland caribou in the Yukon, from river systems of Montana to whitebark pine forests that skirt the ridges of the continental divide, the research and conservation efforts of the Y2Y Conservation Science grantees encompass terrestrial and aquatic species and systems, and are sprinkled throughout the length and breadth of the Y2Y region.

The Yellowstone to Yukon Conservation Science Grants Program is a collaborative grant making effort of the Yellowstone to Yukon Conservation Initiative and the Wilburforce Foundation. Initiated in 1999, the goals of the Conservation Science Grants Program are to add to the scientific understanding of conservation issues in the Y2Y region and to enhance the abilities of organizations to use scientific data and analysis to advocate for conservation of critical wildlife habitat cores, corridors and transition areas. To this end, the program funds research partnerships between scientists and conservation organizations that lead to increased understanding of ecological connectivity in the Y2Y region, enhanced advocacy efforts, and policies that benefit wildlife and critical habitats.

The specific objectives of the Y2Y Conservation Science Grants Program are to:

- Enhance the scientific knowledge base of conservation activism in the Yellowstone to Yukon ecoregion.
- Establish bridges between the conservation non-profit community and the region's academic and research institutions.
- Foster support for young scientists to participate actively in the region's conservation community.

The priority research focus for 1999-2003 has been science that addresses ecological connectivity. Funded projects have examined habitat fragmentation, reconnection or restoration; species migration, dispersal or recolonization; and the use of indicators of ecological connectivity.

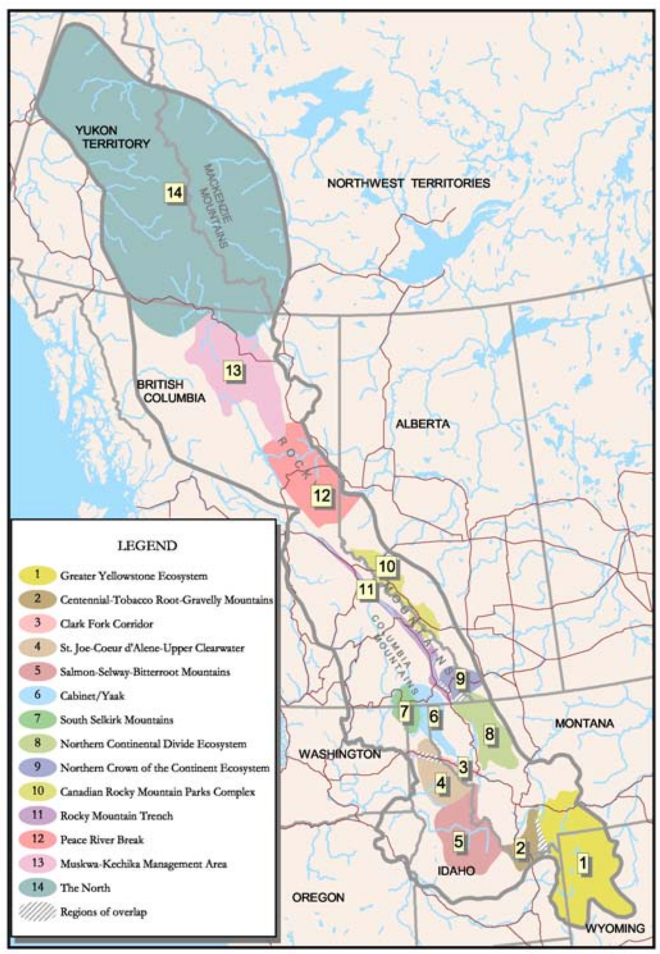
For more information, visit the Y2Y website (www.y2y.net), where the projects are organized by the following topics: grizzly bears, carnivores, avian species, aquatic systems and species, ungulates and roads.

FROM CONSERVATION SCIENCE TO CONSERVATION ACTION

Y2Y's cutting-edge carnivore, aquatics, and bird research has identified important landscapes for conserving these species throughout the Y2Y ecoregion. Ongoing research will compare the conservation needs of carnivores, birds and fish, and result in a combined picture of the conservation needs for all three species – Y2Y's Wildlife Network – and a subsequent blueprint for conservation in the Yellowstone to Yukon landscape.

In the meantime, Y2Y has analysed these studies to glean the important lessons for conservation:

1. The remaining secure habitat for carnivores is, in many cases, outside of existing protected areas; conservation efforts must focus on understanding the management of lands adjacent to protected areas and making sure they can sustain wild populations.
2. There are clusters of intact watersheds in the U.S. Northern Rockies, many of which originate in roadless areas and could be part of efforts to better protect roadless lands. The aquatic analysis occurs at a fine enough scale to distinguish between landscapes where maintaining integrity is necessary versus those where restoration is required.
3. In Canada, everything west of the continental divide and in the North (northern British Columbia and the Yukon and Northwest Territories) is most important from an "avian hotspots" perspective. In the U.S., high-quality bird habitat is scattered and generally in low-elevation, forested valley bottoms on the western slope.
4. To prevent a steady decline in carnivore populations, the amount of land in the Central Rockies (from Jasper south to Yellowstone) that is managed for protection must increase from 20 to 37 per cent.
5. To maintain grizzly bears over the long term, all remaining suitable habitat must be occupied by bears, protected from activities that cause bears to die, and connected by linkages and corridors. It is estimated that about 50 per cent of the Y2Y landscape from Jasper south must be managed for conservation to meet this goal.
6. The single most important factor for preserving grizzly bears is to reduce their chances of being killed.



Map 8: Critical Cores and Corridors

Yellowstone to Yukon
Conservation Initiative

7. Human settlement is another key issue for grizzly bears. In order to succeed, Y2Y must begin to influence patterns of settlement.

8. Highway 3 through the Canadian Selkirks already is a barrier for grizzly bears; no female bears and very few male bears are making it across this highway. Bear populations are becoming genetically isolated, which will ultimately lead to extinction

When combined with other ecological analyses, Y2Y's carnivore research reveals 14 conservation priorities – what Y2Y calls "Critical Cores and Corridors, (CCCs)" – that warrant greater protection or restoration. While the research to date has identified these broad landscapes, it is not refined enough to be used to set the exact boundaries at a local scale (particular parcels of land needing protection or restoration). More local-scale analysis is needed within the 14 landscapes to determine exactly where conservation efforts should be focused. Fortunately, in some areas like the Flathead and Crowsnest Pass, such fine-scale analysis is well underway. In others, like British Columbia's Peace River break, much more must be done. But we know where to focus and can begin to act with confidence that we are targeting our energies in key places.

As a result of this work, the Yellowstone to Yukon Conservation Initiative is engaged in conservation strategies in a number of priority landscapes where wildlife populations must remain connected if their long-term survival is to be secured: the Canadian portion of the Crown of the Continent Ecosystem (including Highway 3 through the Crowsnest Pass in Alberta and British Columbia and lands to the north and south of there); the Clark Fork River Corridor of northwest Montana, an important area for birds and a critical linkage for wildlife between the identified carnivore conservation landscape in central Idaho and the Northern Continental Divide Ecosystem of Montana, and the Cabinet-Yaak area. Y2Y is also working to maintain connectivity across the Trans-Canada Highway in Banff National Park and to help to develop a comprehensive recovery plan for Alberta's threatened grizzly bear.

Although more research is essential, particularly to fill gaps related to aquatics and birds in Canada and to extend the grizzly bear and carnivore modeling into the Yukon and Northwest Territories, we are confident that the Y2Y's science results justify beginning to take action in those landscapes most at risk. Therefore, placing the science results in the hands of conservationists and land use managers and working with them to catalyze conservation strategies in some of the landscapes where conservation or restoration are required most urgently, is now a major objective for the Yellowstone to Yukon Conservation Initiative.