

THE TRACKER



YERC'S NEWSLETTER

"Conservation is a state of harmony
between men and land."

ALDO LEOPOLD

IN THIS ISSUE:

**ENVISION YELLOWSTONE: BRINGING
TRANSPARENCY TO SCIENTIFIC DATA**

**RIVERNET: FRESHWATER FORECASTING
ENABLES SMART DECISION MAKING**

**WILDNET: WARBLERS AND WADERS
ARE KEY TO THEIR ECOSYSTEM**

**LANDNET: SOLVING THE CLIMATE CRISIS IN
COLLABORATION WITH WSE**

**YELLOWSTONENET: LINKING PEOPLE TO EPIIC'S
INTERNET OF NATURE'S THINGS**





The Yellowstone River winding through Paradise Valley. Photo by Chloe Lo Faro.

BRINGING TRANSPARENCY TO SCIENTIFIC DATA

YERC's Envision Yellowstone Summit explores ways to use the greater Yellowstone ecosystem as a role model for how we can restore the planet's ecosystem as a whole

In October 2017, YERC's Envision Yellowstone Summit brought together a resolved team of private-sector leaders from around the continent to define and scope a sustainable plan for a healthy **GREATER YELLOWSTONE ECOSYSTEM (GYE)**. Prior to the Summit, participants read extracts from EO Wilson's best-selling book, *Half Earth: Our Planet's Fight for Life*. Wilson challenges humanity to set aside half the Earth to sustain biodiversity. This challenge set the premise for the summit's goal: how to protect 99% of species while maintaining and restoring ecosystem health for both humans and the other 10 million species on Earth- using the

GYE as a role model. We further challenged ourselves as to how we can take the most 'pressing issues' in each of GYE's six major watersheds and forge sustainable solutions and coexistence strategies based on science to also benefit humans.

Pioneering a 'diagnostic analysis' approach, which consists of long-term monitoring and research, YERC has taken advantage of some of the most informative ecosystem experiments in history. From the great fires of 1988, to the wolf reintroduction in 1995, to the 100-year drought from 2001-2005,

YERC has gained a deeper understanding of how ecosystems work. Using our diagnostic analysis, we are creating a preventative health care plan, similar to that for humans but for our home ecosystems, watersheds, and landscapes. This health care plan involves making both long-term projections and, more importantly, short-term ecological forecasts with "What-if-Scenario" tools for preemptive action. This is collectively called **PRECISION ECOLOGY**. It is the culmination of YERC's past adaptive approach to solving environmental issues using the GYE as a grand, open laboratory for the entire

ENVISION YELLOWSTONE

community of stakeholders, and combining it with our community science approach. We have integrated solid field techniques with

USING OUR DIAGNOSTIC ANALYSIS WE ARE CREATING A PREVENTATIVE HEALTH CARE PLAN, SIMILAR TO THAT FOR HUMANS BUT FOR OUR HOME ECOSYSTEMS, WATERSHEDS, AND LANDSCAPES.

emerging technologies to create a field and cloud-based platform, giving everyone access

to verifiable ecological information to make educated decisions. Building trust in data collected by all shareholders will ensure its value as information useful to restore, recover, and maintain healthy landscapes for humans and nature.

We have developed four new programs based on a variety of pertinent projects across the 6 major watersheds of the GYE- beginning with the Upper Yellowstone River Watershed. This is RiverNET, a project idea I conceived 10 years ago as part of a NSF grant with the university system in Montana. In the last two years, three other programs have been created: LandscapeNET or 'LandNET', Wild-

lifeNET or 'WildNET', and YellowstoneNET which features a network of people (citizen stewards) and our emerging cloud-based computer platform called EPIIC (Ecosystem Prognosis, Impacts, and Information Cooperative). Given all the wonderful NGOs, federal and state agencies, universities, and concerned private sector groups--landowners, producers, businesses and corporations, we further honed YERC's unique niche: to provide a collective source of independent, non-partisan, science-based information. We hope to work together to further become a voice of the other ~10,000,000 species and countless natural resources that we humans rely upon.

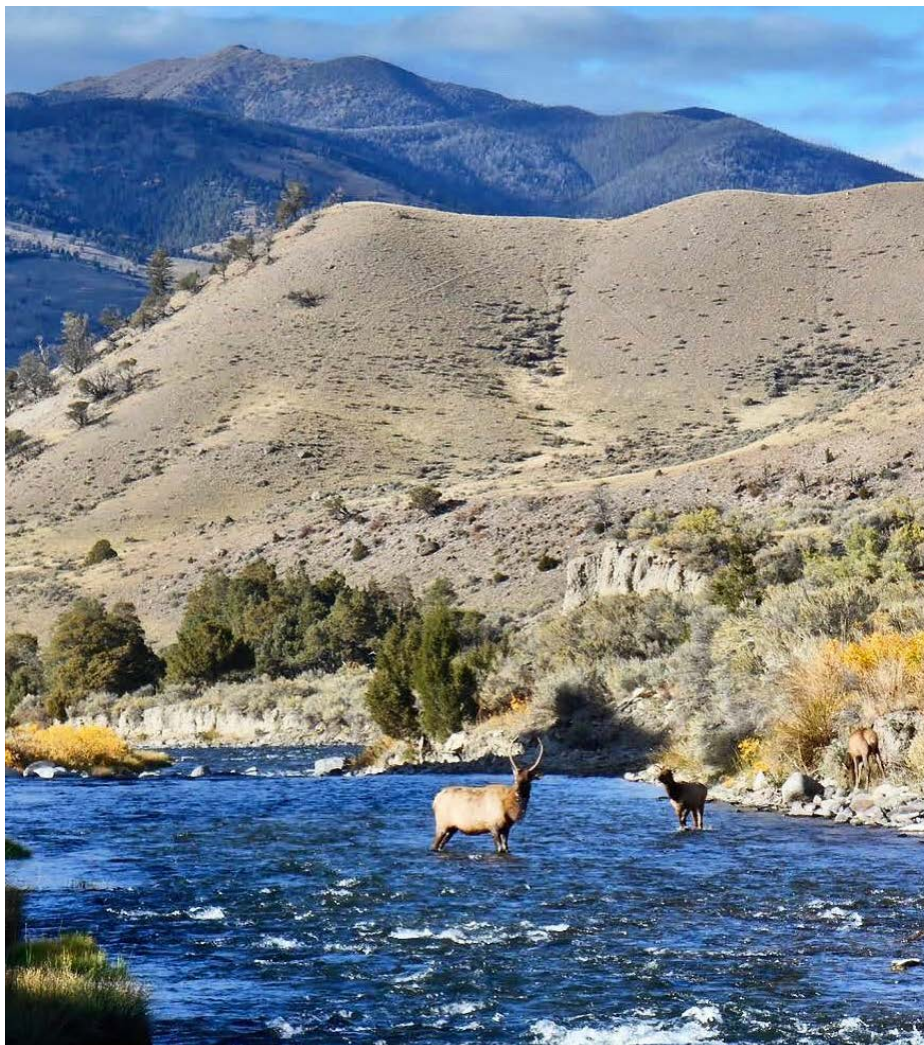
Robert Crabtree
YERC Founder and Chief Scientist



[Help support our Envision Yellowstone efforts by donating today.](#)

YERC-ING AND FIELD WORKING DURING COVID-19

At YERC, we believe in protecting our environment, and each other. These values resonate strongly with us and we have been maintaining a strict COVID-19 protocol as a result. Office work has been mostly restricted to remote working from home. Meetings are conducted over Zoom or Teams. When conducting fieldwork we wear masks if closer than 6 feet. Lets keep each other safe!



Elk near Boiling River Hot Springs in Yellowstone National Park. Photo by Mikaela Howie.



Lead RiverNET Field Technician Spencer Link collects river quantity data along a transect. Photo by Chloe Lo Faro.

it will be capable of predicting both human or natural impacts as all water can be accounted for. This includes below ground flows and ground water recharge that feed our incredible spring creeks.

THIS FORECASTING SYSTEM WILL ALLOW FOR INFORMED DECISION MAKING, WHETHER IT IS FOR TROUT CONSERVATION, OR FOR A RANCHER ON HOW TO TAKE PREEMPTIVE DROUGHT MEASURES, OR AS SIMPLE AS WHAT RIVER TO FLOAT ON.

We have jump-started our freshwater forecasting (RiverNET Phase II) by building a total water budget on one of the major tributaries of the Upper Yellowstone River! We have applied a widely used model called SWAT-MODFLOW developed by the USDA. It now consists of a large stakeholder development team so that the private sector, academia, and government agencies can work together for a vitally important common cause: freshwater. The initial application of this modeling tool for YERC in the Yellowstone River watershed was done by Kyle Robets, a Montana State University student, as an independent study project.

With three years of water quality and quantity monitoring data, we are ready to begin our innovative freshwater forecasting system of a large-scale watershed: the Upper Yellowstone! Dr. Dean Koch, a mathematical biologist from Canada, will lead this initiative. He will be modifying the snowpack and snowmelt runoff portion of the model and customize it to the Upper Yellowstone, all the way from the

FRESHWATER FORECASTING

Rivernet Phase II enables smart decision making

Drastically changing weather patterns and climate change are providing many new formidable environmental challenges. At the top of the list is the availability of freshwater. Freshwater is essential for agricultural production, drinking water, healthy trout populations, and managing drought. Inspired by the advancement in accuracy of weather forecasting, we at YERC have been building the foundation of a freshwater forecasting

system. We began by initiating RiverNET Phase I monitoring, which is now in its third year of monitoring water quality and quantity!

In order to create these forecasts, a consistent input of freshwater is needed, as well as a statistical model capable of forecasting that accounts for all inputs and outputs- a total water budget. Once it is tuned to input real data, such as precipitation and evaporation,

RIVERNET

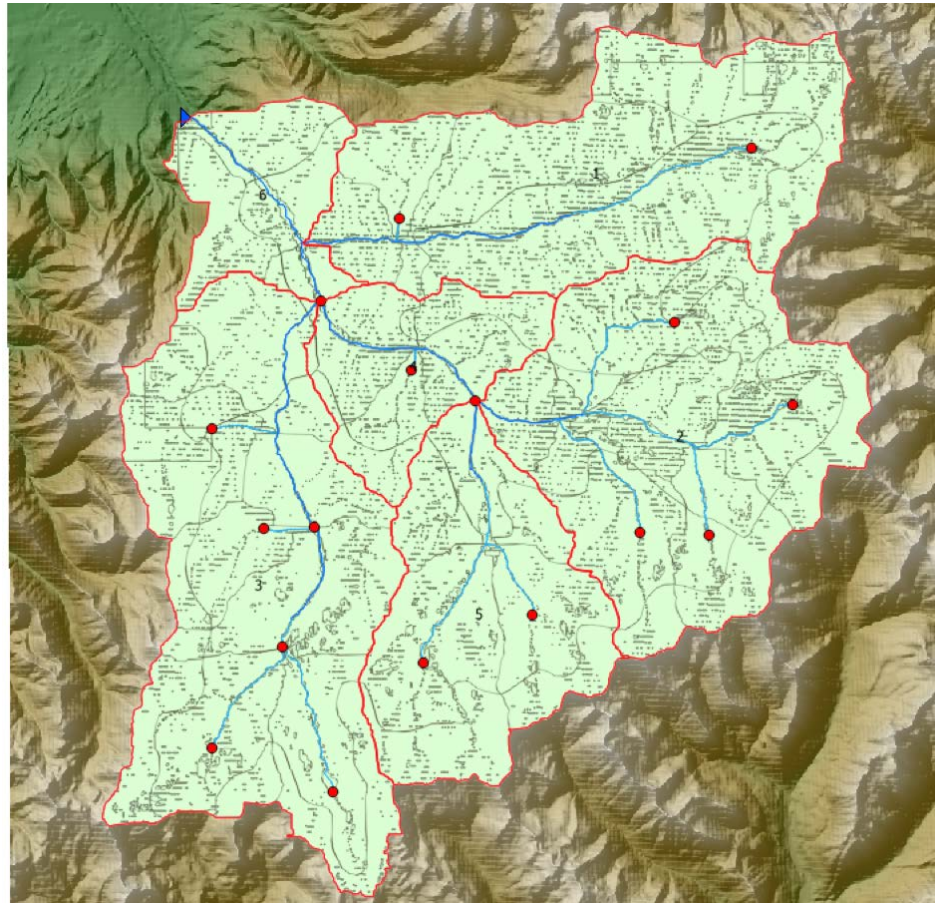
tributaries of Yellowstone Lake to Livingston, Montana. When completed, RiverNET Phase II will execute 36-hour and 5-day forecasts of water quantity for all tributaries and turbidity, which is an index of sediment transport and water quality. This forecasting system will allow for informed decision making, whether it is for trout conservation, or for a rancher on how to take preemptive drought measures, or as simple as what river to float on.

Robert Crabtree
YERC Founder and Chief Scientist



Become a supporter of Rivernet today.

[Adopt a river for \\$500 here.](#)



This figure depicts the Mill Creek drainage basins in Paradise Valley, MT. YERC is pioneering the creation of a total water budget model to aid in smart decision-making that results in vigorous agricultural production as well as a healthy population of spawning cutthroat trout.

WOLF DEN AND RAVEN'S NEST

WELCOME TO OUR NEW FIELD STATION

Earlier this year, YERC signed a lease agreement with Northern Yellowstone BaseCamp to provide a newly renovated wet and dry lab facility in Paradise Valley. It also includes short-term housing for field techs and guests as well as comfort services for researchers- a shower, cooking facility, equipment storage, education opportunities, and a maintenance shop. Operations began June 1st- just in time for the field season! The success of the decisions has been due to the hard work of YERC Board member Steve Attell and his group of architects and engineers that build off-the-grid, self-contained field stations in developing countries!

Richard Rich, expert field ornithologist and YERC field biologist assists during moving in and inventory research equipment.





Clark's Nutcrackers are an iconic species of the high country with their ability to withstand the winters and alpine winds. They take part in a unique commensalistic relationship with local bears and white-bark pines where all benefit from each other in their alpine community.
Photo by Richard Rich

WARBLERS AND WADERS ARE KEY TO ECOSYSTEM HEALTH

Determining breeding pair density across our landscapes

In field ornithology, early mornings are common—like a modified version of the old adage “the early bird gets the [data]”. This is especially so with our WildNET program and our ‘early bird’ field technician, Richard Rich. Beginning in early May when breeding songbirds arrive from their southern winter range, Richard has his binoculars (and often waders) ready by 5:30am. He roams through Paradise Valley and Yellowstone National Park and listens for various bird melodies and fluttering feathers. When Richard detects a bird, either through its song or by spotting it, he must decipher its species, sex, and distance.

USING OUR DIAGNOSTIC ANALYSIS WE ARE CREATING A PREVENTATIVE HEALTH CARE PLAN, SIMILAR TO THAT FOR HUMANS BUT FOR OUR HOME ECOSYSTEMS, WATERSHEDS, AND LANDSCAPES.

We had received a request to expand our WildNET program to work with park biologists and to conduct breeding songbirds surveys on Yellowstone Park’s northern range. This was timely since riparian (streamside) and

grassland birds on private lands were already a focus of our LandNET program so we combined the two projects to examine how changes in habitat affects breeding songbird density. Across the Greater Yellowstone Ecosystem (GYE) riparian and wetland habitats include the greatest biodiversity in the entire Greater Yellowstone Ecosystem. GYE is a semi-arid ecosystem and riparian and wetlands areas are three hotspots for biodiversity because they harbor the key ingredient: water. GYE is a snow-sensitive ecosystem because a majority of precipitation comes in the winter as snowpack and as well as in the spring. Thus,

WILDNET



YERC avian technician, Richard Rich, conducting an early morning bird point count and prepared with waders and layers for cold creek crossings. Photo by Richard Rich

the key to understanding the consequences of drought impacts is through long-term monitoring of how vegetation moisture stress affects vegetation structure and composition that in turn, provides essential habitat and food for breeding songbirds. Across the terrestrial landscape birds have been chosen as the best of the indicators and why Richard has to get up early and ‘catch’ the songbirds when they sing in the morning.

Monitoring breeding songbird communities gives us a clear indication of overall ecosystem health and community dynamics, especially in our drought-vulnerable riparian, wetland and adjacent grassland habitats. Understanding our ecosystem on a bioregional level down to a molecular level

is one of YERC’s four foundation pillars: long-term monitoring, multi-scale—from genes to ecosystems, collaborative partnerships (e.g. agencies, landowners), and finally our adaptive approach that delivers data to all stakeholders in a timely manner to make smart and preventative decisions. WildNET’s bird study embodies these core principles.

[Read Richard’s notes from the field here.](#)

Richard Rich
2020 YERC Avian Field Technician



LANDNET

SOLVING THE CLIMATE CRISIS WITH SOIL HEALTH

A powerful partnership with Western Sustainability Exchange

LandNET is collaborating with Western Sustainability Exchange and ranchers of Paradise Valley to collect ecological data about soil and vegetation health. LandNET makes the data available to ranchers through a membership program so they can make informed management decisions. LandNET field technician, Pat Jackson, collects soil carbon, soil moisture and vegetation data by using soil moisture probes and setting up transects. Using quadrants LandNET field technicians collect data on the relative abundance of plants. Monitoring species distribution and abundance can notify ranchers of any invasive plant species, such as cheat grass. WildNET birding data, collected by Richard Rich, will also be availa-

ble to ranchers. Ranchers and landowners will have access to their data through Yellowstone-NET EPIIC Center and will be able to monitor and predict soil and plant health.

This knowledge will help ranchers and landowners increase agricultural productivity and take preventative measures, thus making them more resilient to disturbances such as a drought. YERC is excited to work with Western Sustainability Exchange towards preserving ranchers’ livelihood and heritage, supporting rural economies, and conserving our land.

Chloe Lo Faro
Outreach and Communications Coordinator



Above: Pat Jackson and Mikaela Howie examining a quadrant on a collaborating ranch in Paradise Valley. Photos: Above by Chloe Lo Faro, Below by Karolina Grabowska

EPIIC SCIENTIFIC INNOVATION

YERC's Envision Yellowstone Summit explores ways to use the greater Yellowstone ecosystem as a role model for how we can restore the planet's ecosystem as a whole

We are in an environmental crisis, amongst many natural occurring disturbances the added impact of humans has largely amplified that effect. How we respond and react to these environmental issues is largely dependent on how data is collected and shared. How can we create change or act preemptively to preserve our ecosystem, our livelihood, and those inhabiting it without the specific knowledge on how to do so?

Robert Crabtree, YERC's founder, recognized the challenges in accessibility to reliable,

scientific data and how crucial it is to not only environmental and conservation work but also supporting people's livelihood through real-time data that pertains to their land. This is where EPIIC (Ecosystem Prognosis, Impacts, and Information Cooperative) stemmed from. EPIIC is a novel cloud-based computer platform in which shareholders, such as ranchers and trout conservationists, will have access to timely, quality, and science-based data. This key innovation within YellowstoneNET creates a community science cooperative of citizen stewards.

This community science initiative creates transparency in data unlike ever before as data-scientists will be able to contribute data.

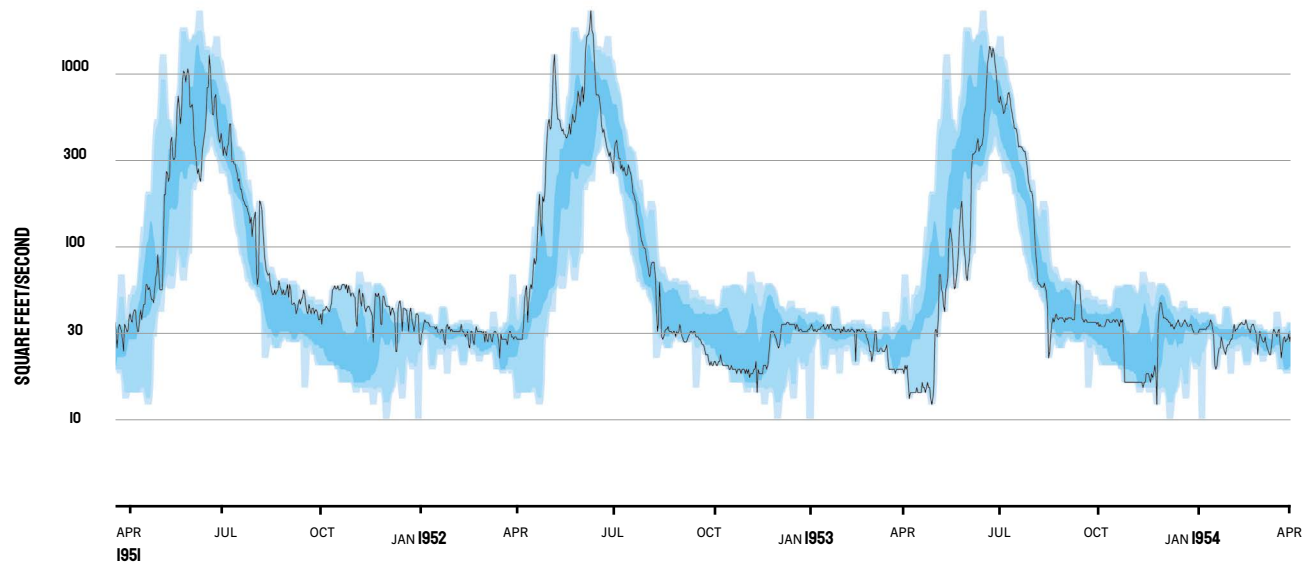
THIS COMMUNITY SCIENCE INITIATIVE CREATES TRANSPARENCY IN DATA UNLIKE EVER BEFORE

After processing this data, datasets will be available on the EPIIC platform for all shareholders to have access to and partake in

Mill Creek Outlet

Historical Mean Daily Stream Flow 1951-1954

USGS site #06192000 (45°21'34.04"E, 110°37'3.61"W)



Historical USGS measurements of average daily water flow, or discharge, through the mouth of Mill Creek in Paradise Valley (with 5-year ranges in background). Discharge from streams and groundwater help stakeholders gauge the availability and sustainability of a water supply. EPIIC facilitates access to this critical information.

informed decision making and preventative ecosystem care. Having reliable and accessible data raises the value of the data for all, for both community science stakeholders and data scientists, as our depth of understanding and creating reliable ecological predictions increase with larger and stronger datasets.

As an emerging cloud-software platform, EPIIC has many phenomenal contributors and individuals driving its progress. Through the hard work of YERC board members Andy LaMora and Dave Messinger we have forged an alliance with TopCoder and Wipro. These high-tech companies bring valuable crowd-sourcing and innovation to build out the architectural design of our EPIIC platform. Microsoft's AI has gifted YERC another grant

which will give us access to many analytic tools and needed Azure cloud-computing time. YERC's IT director, Roby Roberts, has forged a partnership with an Australian company called Amphora. They provide the latest data curation and storage capabilities for data-sharing and innovations related to our programs. Additionally, a group of MSU computer science students are gaining real-world experience by contributing to the development of EPIIC. This partnership will lay the foundation for our EPIIC platform and planned set of applications for timely decision making and badly needed short-term forecasts.

Chloe Lo Faro
Outreach and Communications Coordinator



WHAT IS A WATER BUDGET?

A water budget is a full accounting of all water inputs and outputs in a particular watershed or catchment area. In our case, it is all the upstream water inputs that arrive at one point near Livingston on the Yellowstone River (Carter's Bridge river gauge station) that measures discharge. Inputs include rain and snow and outputs include evaporation, transpiration from plants, and discharge (flow) that runs past Carter's Bridge.



YERC's RiverNET field crew taking measurements on Mill Creek in Paradise Valley to convert stream depth to discharge (flow) for dissemination on RiverNET's web platform. Left to right: Mikaela Howie, Kyle Roberts, Spencer Link, and Morgan Squires.

BECOME A MEMBER OF YELLOWSTONENET TODAY!

Upon becoming a member, you'll receive:

A high quality 27x40 map of the Greater Yellowstone Ecosystem

Access to our EPIIC data sharing platform as launched

Our quarterly newsletter and email updates

Sign up today!
www.yellowstoneresearch.org



OTHER WAYS TO CONTRIBUTE

Come and volunteer with us!

We need *your* help collecting data and keeping us running. Help out on our WildNET, LandNET, or RiverNET programs.
[Join or team of volunteers here](#)

Become a sponsor of one of our hard working teammates!
[Sponsor an intern](#) or [Sponsor a Field Tech](#)

Fund a wildlife camera!
[Fund your first camera here](#)

Adopt a river!
[Adopt your river here](#)