Title: *AN ETHOS OF RIVERS: CONNECTING ECOHYDROLOGICAL UNDERSTANDING WITH ETHICS.*

Author: Dr. Mark S. Lorang

INTRODUCTION

Healthy river ecosystems sustain life (Fig. 1). To appreciate how a healthy river ecosystem can sustain life requires an ecohydrological understanding of rivers. The relationship begins with physical structure of the river channels and floodplains and the hyporheic exchange between surface water and ground water. Those foundational elements and processes are made more complex upon consideration of the river channel's aquatic habitat, which is subject to changes caused by the rise and fall of discharge and how those changes influence flow complexity in the channel and connections to off-channel floodplain habitat (Fig. 1). The role of the floodplain in an ecohydrological system is intertwined with other systems. Floodplains accommodate freshwater run-off provided by a coupled ocean-atmospheric system, and drainage of that water through Earth materials and soils where a system of chemical weathering coupled with biotic process control chemistry of streams and rivers.[1] This linkage directly ties river ecosystems to mountains, oceans, and the air we breathe. Natural events, such as flooding, are essential to the process of shaping river channels and floodplains and provide the water and sediments to sustain floodplain soils and the vegetation of the river corridor, which further drive cycles of growth and decay. The river ecosystem is home to fish, which migrate to and from the sea carrying marine derived food and nutrients back to the river. Cumulatively, the many physical and ecological synapses–when allowed to function properly–sustain and supports a web of life including people and animals (Fig. 1).

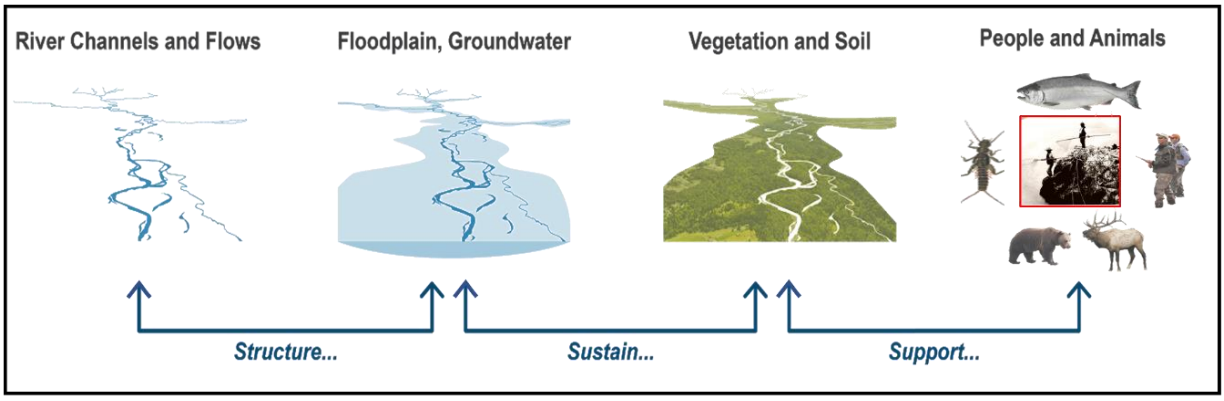

Figure 1. This schematic represents a river ecosystem as a series of connected components.

As the advanced apex species in this web of life, humans are uniquely situated to determine how the resources in a regulated river ecosystem are managed. Historically–and currently–rivers have been viewed by western society as a resource to be captured and manipulated in the name of human demands (e.g. flood control, hydropower, agriculture, shipping and recreation), justified by the benefits

these uses provide society.[2] I reject this view in favor of an ethical approach to river management that more equitably balances human need for resources without compromising the integrity of essential ecosystems. An ethical approach recognizes that each sentient creature, indeed all living things, has an inherent value; acknowledges the need to bring disenfranchised communities to the table; appreciates the intangible value of all human culture. This goal can be accomplished by entering an "ethical space" where we view river management through a holistic "systems" approach, which more broadly defines benefit and harm. Via this lens, we can more readily see, for example, that destruction of salmon habitat for the purpose of generating power, which disregards the value of the species to various cultures and wreaks environmental harm, is unethical. Coming to these conclusions, however, is not possible without a guiding principle–an "ethos of rivers." By defining this ethos, society can begin to accomplish the goal of holistic, ethical river management.

RIVER ETHOS

Nearly two decades ago the Roman Catholic bishops of the United States, Pacific Northwest, issued a pastoral letter regarding the framework or guiding principles for ethical river management: *The Columbia River Watershed: Caring for Creation and the Common Good*.[3] They wrote, "*We hope that we might work together to develop and implement an integrated spiritual, social and ecological vision for our watershed home, a vision that promotes justice for people and stewardship of creation*". Recognizing the complexities and competing interests regarding the regulation of the Columbia River Basin they went on to state, "*Those involved with the debate and decisions must consider scientific studies, community needs and ecological impacts in making decisions which are ultimately political but must stem from a spiritual and ethical base….Those discussions must always maintain a proper respect for God's creatures and a prudent consideration of the common good for the people of the area*." The bishops were calling for a common ethos of rivers to drive sound management of the Columbia River.

The 10-year agreed upon period of negotiation for the Columbia River Treaty (CRT) between the United States and Canada is well underway, but that negotiation began with flood control and hydropower generation as the only topics of negotiation. Not simultaneously including ecosystem function as part of the negotiation of the CRT is a fatal ethical flaw because it favors the needs of the people and institutions who hold power and control, those who have "Captured the River," as factually and eloquently described by Eileen Delehanty Pearkes in her book *A River Captured*.[2] Neglecting ecosystem function from onset of negotiation is not an approach based on an ethos or an ecohydrological understanding of rivers; it is one based on laws, treaties and power aimed at keeping the river captured to serve first those currently in control. In my opinion, this is clearly an unethical view of rivers and river management.

The Merriam Webster dictionary defines ethics as a set of moral principles, a theory or system of moral values; the principles of conduct governing an individual or a group. Whereas the Oxford dictionary defines ethics as being concerned with distinguishing between good and evil in the world, between right and wrong human actions and between virtuous and non-virtuous characteristics of people. Dr. Willie Ermine, an ethicist/researcher with the Indigenous People Health Research Center and Assistant Professor with the First Nations University in Canada, defines ethics as the "*capacity"* to know what harms or enhances the well-being of sentient creatures.[4]

The word ethics is troubling to some, especially the legal profession where laws rule the actions of people, corporations, institutions and treaties between countries. It is a troubling word because ethics are moral principles that derive from the eyes of the beholder, rather than one universal human belief. Some people tend to prefer the use of *Natural Law*, rather than the use of the word ethics. *Natural Law* as defined by Britannica, is a system of right or wrong justice held to be common to all humans and derived from nature rather than the rules of society including religion. Similarly, Merriam-Webster defines it as a body of law, or a specific principle held to be derived from nature and binding upon human society in the absence of or in addition to law established or recognized by governmental authority. This latter view of *Natural Law* seems fair and equitable and aligned with ecohydrological understanding of rivers. When paired with Dr Ermine's definition of ethics it provides a *Natural Law* based approach to defining an ethos of rivers.

Many in western society believe that capturing a river is an ethical pursuit, one that serves a higher good for all of society. Indeed, many people argue that dams are a carbon neutral "green" alternative use of renewable energy, and hence, an ethical approach to managing rivers. However, these views lack, or ignore, the "*capacity"* to know, for example, what harms or enhances Salmon or those human cultures dependent on them. Unfortunately, this is a ubiquitous approach to justifying human actions that are harmful to others. Ultimately it must arise from a perspective that lacks an altruistic view of the world, a view that choses instead an egoistic driven view that benefits them, based on a divine or an economic justification. Every human has an ego, that voice in our head that constantly talks to us. If we lack the presence of mind to recognize how our egos can drive our actions and justify those that we "know" to be wrong, then we will miss an opportunity to enter an ethical space and make altruistic decisions.

The spiritual leader Eckart Tolle, explains the role of ego in personal lives, as well as, in the collective of human society in the following manner: "*The ego always wants something from other people or situations. There is always a hidden agenda, always a sense of not enough…. It uses people and situations to get what it wants and even when it succeeds, it is never satisfied for long…. The unchecked striving for more, for endless growth, is a dysfunction and a disease. It is the same dysfunction the cancerous cell manifests, whose only goal is to multiply itself, unaware that it is bringing about its own destruction by destroying the organism of which it is a part….. Recognize the ego for what it is: a collective dysfunction, the insanity of the human mind… When you recognize it for what it is, you no longer misperceive it as somebody's identity. Once you see the ego for what it is, it becomes much easier to remain nonreactive toward it... Compassion arises when you recognize that all are suffering from the same sickness of the mind, some more acutely than others….Another word for nonreaction is forgiveness.".*[5] In the context of this opinion paper, Tolle's analysis helps explain why we capture and manage river systems in the absence of a guiding ethos of rivers. Yet Tolle's words, and those of the Catholic Bishops, and Dr. Ermine also offer hope for a solution: a path towards an ethos of rivers.

Many scientists and researchers have suggested that the path to understanding and managing coupled human-water systems is to take into account human factors related to socioeconomics, technology, as well as cultural and societal values that exist within the system of the water basin as well as the global connections.[6] Indeed, Reynard et al., 2014, conclude that the interdisciplinary assessment of complex regional water systems depends more on socioeconomic factors than climatic factors.[7] Wesselink et al., 2017, argue that understanding water and human-water systems requires combining both socio-hydrology and hydro-social analysis without a need to antagonistically question respective fundamental assumptions.[8] These authors are calling for an academic equity across disciplines in hope that it will improve understanding of rivers through research and analysis. I agree with this conclusion but

recognize that without defining an ethos of rivers more research will not achieve ethical river management.

Controlling river flow for human uses is a monumental task, a testament to western society's power over nature.[2] Sadly, that accomplishment seems to be much easier to accomplish than defining an ethos of rivers guided by not harming sentient creatures and human cultures. Destruction of human cultures dependent on salmon and the extinction of river species is not an ethical outcome of human freshwater use, yet it has happened and is continuing to happen at an astonish rate in rivers throughout the world.[9] Hence, when it comes to river management ethics do matter. A "systems" approach to river management is a vital first step to discovering equitable solutions to our environmental problems. That view needs to be much more than a socio-ecological or economic-hydraulic view where domination and control of a resource rule action but an ethical approach that includes an adoption and reverence for ancestral wisdom.[10] This system based first step, requires accepting that there are many ways to understand rivers and a western ecohydrological understanding of rivers is just but one.

ECOHYDROLOGICAL UNDERSTANDING OF RIVERS

The essence of ecology is to understand the distribution and abundance of biota in the context of how and why organisms are dependent on specific biophysical space (habitat) to complete one stage or another in their life cycles.[11] The primary lens of ecohydrology is focused on understanding aquatic habitat beginning with the river channel, its connection with groundwater and relationship with riparian habitats along the river corridor from the headwaters to the ocean (Fig. 1).

Ironically, aquatic habitat is the least empirically quantified attribute of rivers and stream channels and we know even less regarding their connection to groundwater that together forms the structure that sustains river ecosystems. Alternatively, we know quite a bit more about the vegetation and soils that sustain and support people and animals (Fig. 1). New advances in hydro-acoustic river mapping allows direct empirical measurement of aquatic habitat from the site scale to the river corridor scale covering 100's of km.[12] In this way we can directly measure and inventory river habitat and with repeated measurement we can quantify both change and rate of habitat change by measuring the primary drivers of river systems (Fig. 2). Hydro-acoustic river mapping allows us to use habitat as a currency, count how much is in the river as if it were the *bank*, add up how much we gain or lose depending on how we regulate the flow of water.

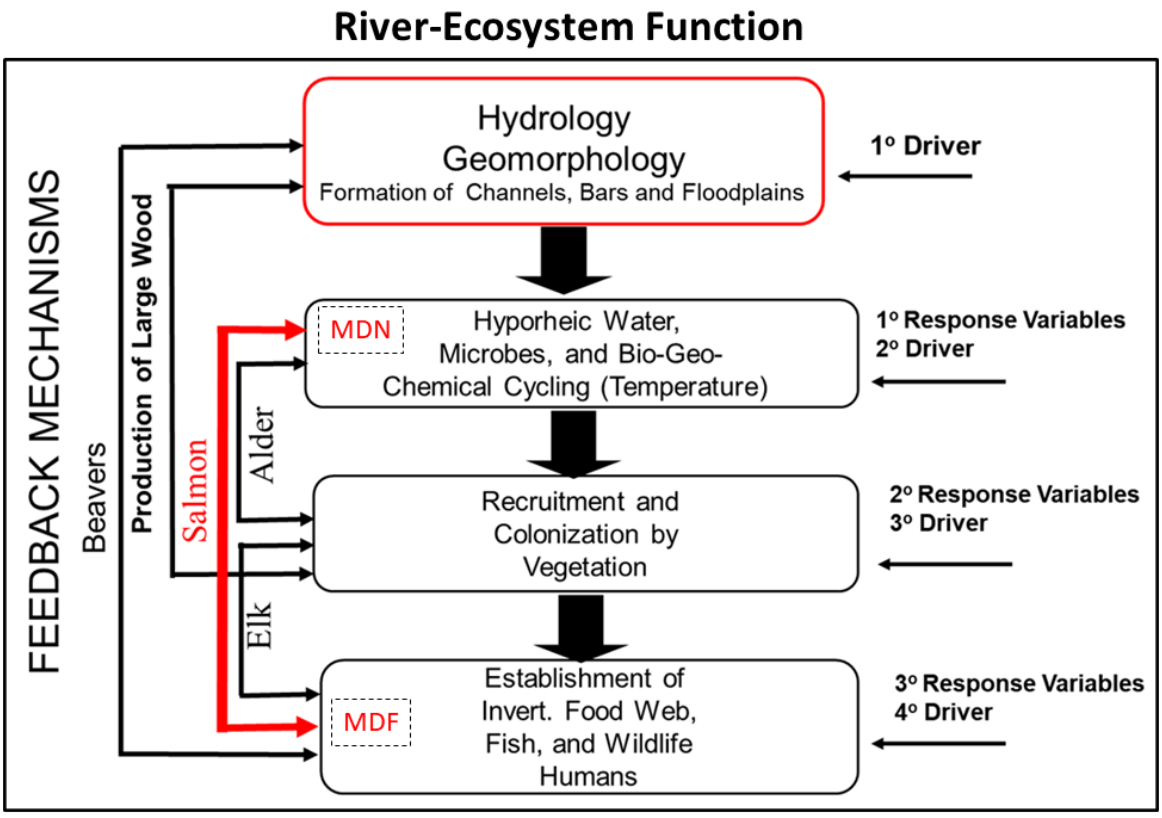

Figure 2. This schematic shows a conceptual view of river ecosystem function composed of a hierarchical sequence of linear drivers and response variables as they relate to a complex, nonlinear system of feedback mechanisms, both physical and biological, interacting with the linear component at different levels and with different degrees of impact depending on how far back into the linear hierarchy they reach.

At first order, I view the relationship between hydrological drivers and ecosystem response as a hierarchical, linear system coupled to a suite of highly dynamic nonlinear feedback mechanisms because it helps me to begin to understand rivers (Fig. 2). In this view, hydrologic and geomorphic processes (e.g., flooding, cut-and-fill alluviation, channel avulsion) are the primary drivers for the shifting habitat mosaic of rivers.[11] These primary drivers shape the physical template of the river system that eventually leads to the formation of soils, microbes, and related processes of bio-geo-chemical cycling that are themselves primary response variables that become secondary drivers for recruitment and colonization of the riparian vegetation (Fig. 2). The colonization of riparian vegetation is then a secondary response variable that becomes a third order driver for the establishment of invertebrate food webs that support a host of fish and wildlife (Fig. 2). At this stage it is easy to begin to think of fish and wildlife as third order response variables that then become fourth order drivers through a complex array of interrelated feedback mechanisms (Fig.2). For, example Salmon upon their return from the sea provide both Marine Derived Food (MDF) but also Marine Derived Nutrients (MDN). Likewise, beavers acting as bioengineers, harvest trees and make dams an action that reaches back in the hierarchy to the primary drivers. Clearly, rivers are not just a linear series of connected components but rather a complex structure of interdependent and subordinate elements and functions interconnected through an array of bio-physical feedback mechanisms. This kind

of ecohydrological understanding of rivers allows one to view rivers as a living organism where floodplains are keystone landscapes that function much like human kidneys (Fig. 3). Viewing rivers as a resource to be captured rather than as a living organism leads to unethical decision making. Alternatively viewing the river as an organism, perhaps as your relative, allows a more altruistic approach to a river ethos that benefits all life.

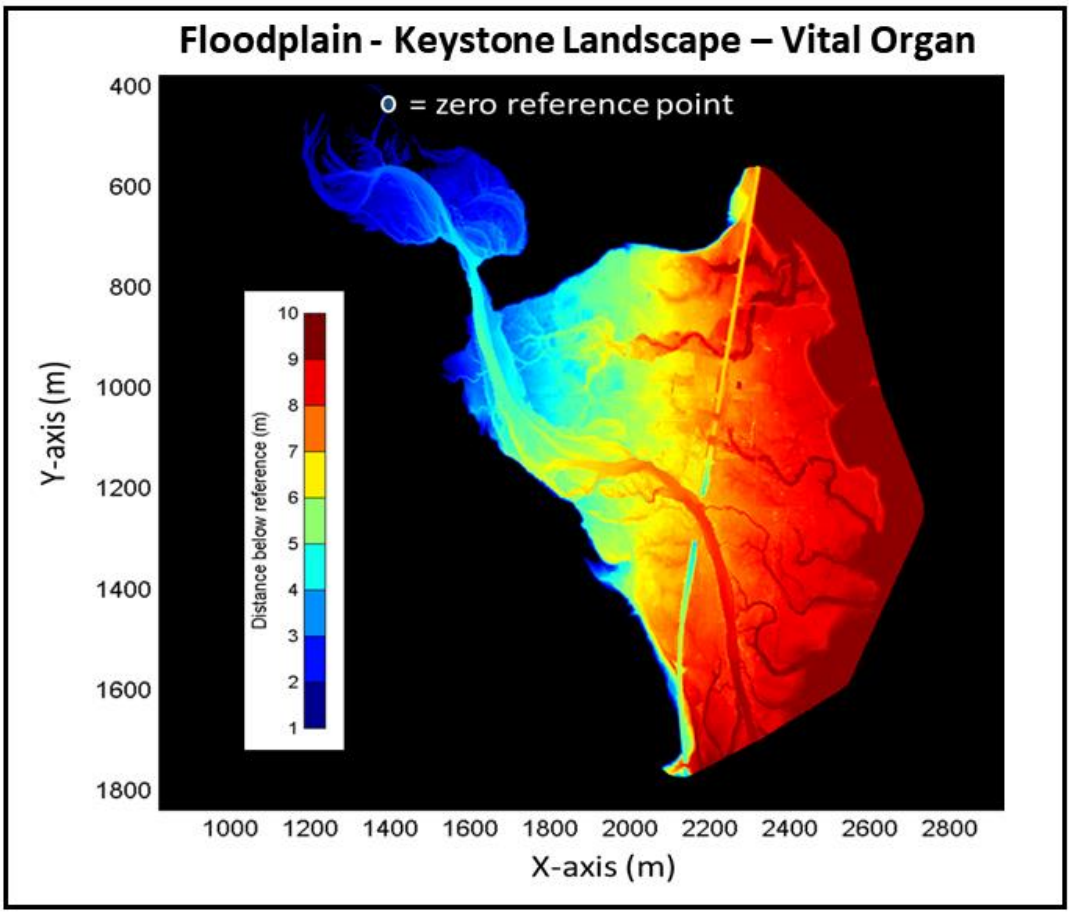

Figure 3. A plan-view plot of Lidar data from a gravel-bed river floodplain using color to signify elevation in meters below a zero-reference point located at the top of the incoming river channel. The linear feature is a highway built across the flood plain with gaps representing bridges. The colors and channel features are floodplain structures seen in the lidar data that resemble arteries composing organs that with the help of microbes and bacteria cleanse the hyporheic water providing a similar function for the river as kidneys and livers do for humans and other animals.

Floodplains are among the most dynamic landforms on earth. And river systems can only be as healthy as the degree to which their floodplains can maintain a shifting mosaic of habitat.[11] Not only are natural floodplains among the most biologically complex and diverse landscapes on earth, but they also contribute more than 25% of all terrestrial ecosystem services, although they cover only 1.4% of the land surface area.[9] Important services provided by these systems include (but are not limited to) flood control, water supply, and removal of nitrogen. The total global economic value of floodplains has been calculated at $3,920 billion dollars per year.[9] With increasing human population along river corridors,

spawned by the creation and operation of dams, floodplains are rapidly being degraded or lost altogether as well as both the economic and ecosystem services they provide, free of charge. This cost savings to society is rarely included in the cost benefit analysis of river regulation. Hence, floodplains are now among the most threatened landscapes worldwide with 47% of all animals federally endangered in the US being freshwater species that occupy floodplains.[9] The take-home value is that river ecosystems and human economic systems cannot function without floodplains, just as humans cannot function without their kidneys. Treating and healing a sick human requires a system of medical ethics. Likewise restoring rivers requires a river ethos which can happen by first entering an "ethical space" where we expect ethical river management to follow a holistic "systems" approach one that recognizes all forms of ecohydrological understating of rivers.

ETHICAL SPACE

Many ancient cultures have a system of beliefs based on the concept that everything, all matter, living or not, has an internal spirit that is not only connected to everything else but also connected with the source of all life out of which it came. Chief Alfred Joseph, chief of the, akisq'nuk, Ktunaxa First Nation in southeastern British Columbia of Canada, said that every grain of sand has a role to play in the river, the life of salmon and the life of his people. The Gaia hypothesis proposes that all organisms and their inorganic surroundings on Earth are tightly integrated to form a single and self-regulating complex system, maintaining the conditions for life on the planet.

It is interesting to note that Indigenous people of the Pacific Northwest did not need to write a Clean Water Act simply because freshwater, rivers and streams were, and still are, viewed as a sacred living creature (Fig. 4). Because of their beliefs it would be immoral to pour pollutants into the river or degrade freshwater in any way. Rather they immerse their very essence and culture in praise and gratitude to honor water because it has sustained them for generations, sustains them now and, if taken care of today, will sustain them seven generations into the future (Fig. 4). This timeframe is beyond the capacity of much of western society to appreciate.

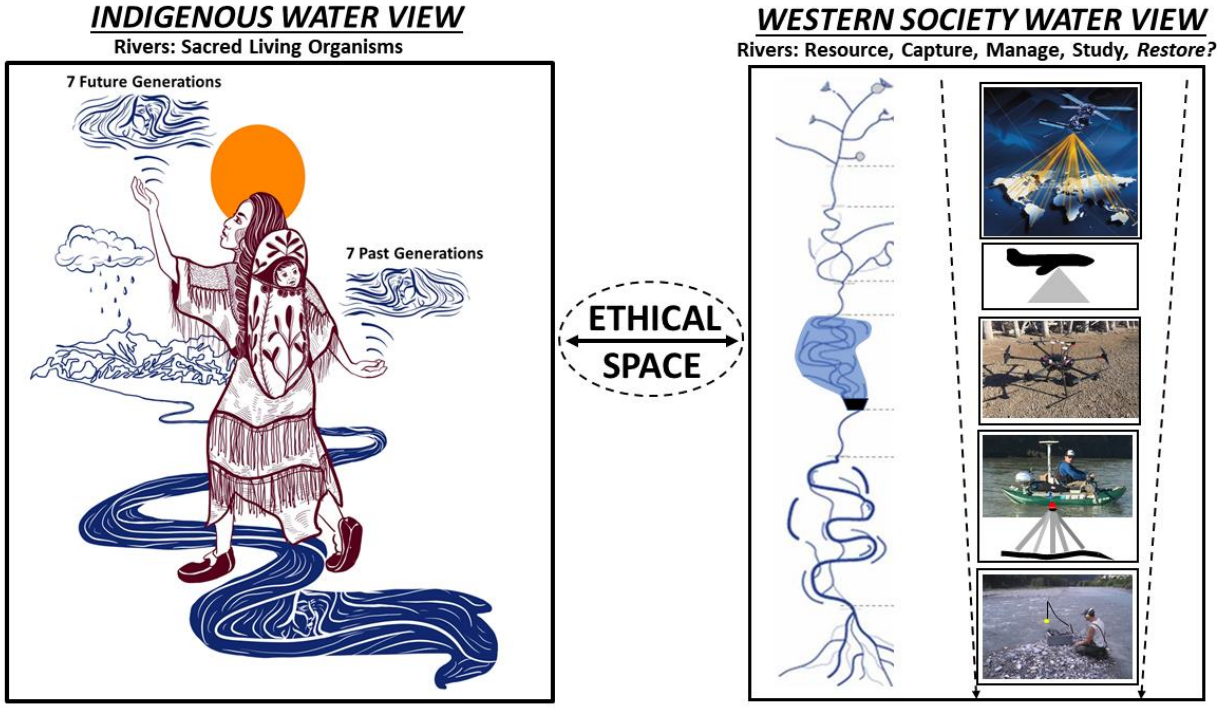

Figure 4. A schematic comparing different societal views of water and rivers separated by an "*ethical space*".

In contrast, the western societal water view looks at rivers as a resource and wonders how to capture and manage that resource for what "*they*" believe is the greater good of society. Their "*ethical*" perspective is that societal needs for hydropower, flood control, agriculture, shipping and recreation outweighs and justifies the impacts to fish and "other" humans. However, it is not quite that simple or one sided as western society does create laws to protect water quality and endangered species and it uses an array of high-tech approaches to measure important aspects of rivers and river basins using that data to study rivers, test hypothesis and direct restoration efforts for damaged rivers (Fig. 4).

The commonalities between the world views arises from equivalent ecological understanding of rivers. The western view of rivers evolves from a theoretical driven science perspective dependent on hypothesis testing using measurements spanning scales from watersheds to genes. That view however comes to the same conclusion as indigenous understanding, that rivers can be thought of as an organism. This is the foundation for an ethical space, a common ground of understanding between world views where everything, all matter living or not, is not only connected to everything else but also connected with all life. Hence, ethical space is a theoretical space between world views which have the capacity to know what harms or enhances the well-being of sentient creatures. It is a place where solutions to impacts that harm life can be found. It is my opinion that it all begins with defining an ethos of rivers.

CONCLUSIONS

Rivers must flood. Fish must have safe passage past all dams. Without those basic components there cannot be ecosystem function occurring in regulated rivers. The river must be free to maintain a shifting mosaic of habitat, one that is constantly renewing habitat through processes of erosion and deposition. We must stop armoring channel banks to control the very processes that keep rivers alive. In all our efforts to restore a river we must strive to let the river do the work, making sure it has the power afforded by floods, a supply of sediment and wood. If we let rivers do the work, then life knows what to do next.

We must not build more dams. We must remove as many as possible, restore both fish passage and normative flow as best we can with those that remain until we can remove them all. We must stop polluting the river and control the introduction and spread of invasive species, manage for native species and high biodiversity.

Clearly, these objectives point to the need to have humans act as central players in our captured river systems that follow an agreed upon ethos of rivers. The starting point is to first individually be aware of our ego, forgive that in others, and strive to accept differing opinions so that we can enter the ethical space that naturally forms from cultural tension. If we do that together, at every opportunity, then we can agree upon a legally binding *Natural Law* agreement that supports and defines an ethos of rivers. Once we define and agree on an ethos of rivers then we can embark on the restoration of rivers with ethical guidelines that tell us exactly what to do, and when, in all situations. To accomplish this lofty goal, we must first have the capacity to recognize what harms or enhances the well-being of sentient river creatures, especially human beings. And that capacity must never be shoved under the table with non-ethical justifications based solely on the consumptive demands of western society. Aquatic habitat is the common currency that can be quantified through the type of hydro-acoustic river mapping that Freshwater Map undertakes and promotes. If we would map all rivers that would allow decisions of flow regulation to be equitably agreed upon among differing stakeholder concerns because we would all know what the “cost” to the river might be and the “cost” to all of society based on the goods and services that free-flowing river systems provide, for free.

ACKNOWLEDGMENTS:

I want to acknowledge the organizers of the ongoing conference series; *One River: Ethics Matter*, and the organizers of the *Siwłw (Water) For All – Our Responsibility* conference, held in Kelowna, British Columbia Canada, for providing an opportunity to develop a deeper understanding of rivers. I would especially like to thank Pauline and Tessa Terbasket, Syilx woman of the Okanagan Nation Alliance and Kelly Terbasket, a member of the Lower Similkameen Indian Band that I met at these conferences. These proud First Nations women profoundly influenced and strengthened my passion for rivers. I thank Pauline for speaking truth to power with polite courage, Tessa for defining a relationship with water by viewing rivers as a relative and Kelly Terbasket for creating a p?ax moment during a group session that lead to figure 4. The nsyilxcen word p?ax means to spark a flash of insight, a mind-aware "ah-ha" moment. Kelly asked everyone, attending the *Siwłw (Water) For All – Our Responsibility* conference, to stand and extend one arm behind and the other out in front explaining that the hand extended behind connects to ancestral knowledge and the hand extended in front passes knowledge to people in the future and that we and our families are the bridge between the past and future. She then asked what within us inspires hope and personal motivation? That experience touched me and provided the inspiration and motivation to write this paper. Peter Obermeyer created the original version of figure 1 which I modified. It communicates the linear core of figure 2 with pictures which is intended to reach a larger audience that might not connect to figure 2. My friend and colleague Ric Hauer drew a simple version of figure 2 on my white board during one of our many conversations regarding river ecology which I modified to fit this paper. Thank you Holly White, my niece, for creating a beautiful drawing of that p?ax moment that appears in figure 4. The concept of ethical space was first introduced to me by Gwen Bridge at the *One River: Ethics Matter* conference held in Castlegar, British Columbia Canada, thank you Gwen. That was another p?ax moment that helped me solidify the direction of this paper. Madeline Lorang, my daughter, and river buddy edited the final drafts of this paper, greatly improving it, thank you Maddie. Lastly, I would like to thank my dad for teaching me to fish, my son Ian for fishing with me, my wife Vicki for sharing our float through life and rivers for continually teaching me how to row. I can only hope that my great-great grandchildren learn how to fish, and that fish remain in all our rivers.

REFERENCES

1. Amundson R, Richter DD, Humphrey GS, Jobbágy EG, Gallardet J. Coupling between biota and Earth materials in the critical zone*. Elements.* 2007, 3:327–332
2. Delehanty Pearkes, E. A River Captured: The Columbia River treaty and catastrophic change*. Rocky Mountain Books, Ltd /British Columbia, Canada* 2016.
3. Brunett AJ, Vlaznay JG, Cooney EJ, Driscoll MP, Morlino RC, Sevilla CA, Skylstad WS. The Columbia River Watershed: Caring for Creation and the Common Good. An International Pastoral Letter by the Catholic Bishops of the Region*, Self-Published. 2001*.
4. Ermine W. The ethical space of engagement. *Indigenous Law Journal*. 2007, 6:1: 193-203.
5. Tolle E. A New Earth: Awakening to your life's purpose. *New York, N.Y: Dutton/Penguin Group*. 2005.
6. Pande S and Sivapalan M. Progress in socio-hydrology: a meta-analysis of challenges and opportunities. *WIREs Water.* 2017, 4:e1193. doi: 10.1002/wat2.11932017.

7. Reynard E, Bonriposi M, Graefe O, Homewood C, Huss M, Kauzlaric M, Liniger H, Rey E, Rist S, Schädler B, Schneider F, Weingartner R. Interdisciplinary assessment of complex regional water systems and their future evolution: how socioeconomic drivers can matter more than climate. *WIREs Water* 2014, 1:413–426. doi: 10.1002/wat2.1032.
8. Wesselink A, Kooy M, Warner J. Socio-hydrology and hydrosocial analysis: toward dialogues across disciplines. *WIREs Water* 2017, 4:e1196. doi: 10.1002/wat2.1196.
9. Tockner K, and Stanford JS. Riverine Flood Plains: Present State and Future Trends. *Environmental Conservation. 2002, 29. 308 - 330. 10.1017/S037689290200022X.*
10. Wilson NJ, Walter MT, Waterhouse J. Indigenous knowledge of hydrologic change in the Yukon River Basin: A case study of Ruby, Alaska. *Arctic.* 2015, 68:1: 93 – 106. http://dx.doi.org/10.14430/arctic4459.
11. Stanford JS, Lorang MS, Hauer FR. The shifting habitat mosaic of river ecosystems. *Verh. Internat. Verein. Limnol*., 2005, 29:123-136.
12. Marotz B, and Lorang MS. Pallid Sturgeon larvae: The drift dispersion hypothesis. *J Appl Ichthyol.* 2017, 00:1–9. https://doi.org/10.1111/jai.