The Value of Lakes Around the Secwépemc Territory

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Contents

Foreword

Foreword to *The Value of Lakes Around the Secwépemc Territory*

I am pleased to provide a brief forward to the book, *The Value of Lakes Around the Secwépemc Territory*, by Peter Tsigaris and his graduate students. Firstly, I am not an economist, nor am I knowledgeable about the field of environmental economics. I do, however, have some experience, from a First Nations perspective, on the importance of having a way of valuing natural resources within First Nations territories that is understood and agreed on by First Nations and various levels of government.

The book examines and valuates several lakes in the Kamloops area, using an internationally established valuation system to provide a basis from which both the public and government policymakers can logically approach the challenge of maintaining or improving the ecological benefits of these resources. The selection of the benefit transfer valuation method is appropriate for the research, and the assumptions utilized in this method are clear. I believe most people are familiar with the notion of cost/benefit in making personal decisions and also understand government agencies using a similar approach for developing public policy. I agree with Peter that "even using the most conservative valuation, lakes

constitute a very large and important part of our total wealth." The valuations of the lakes in this book give greater meaning to the common view that lakes are valuable assets.

The attention given to Indigenous views in this book, concurrent with the recent recognition of First Nations rights by federal and provincial jurisdictions, is a welcome addition. As issues related to the negotiation of First Nations titles and rights gain prominence in public and inter-governmental discourse, the requirement for assessing the value of natural resources within First Nations' traditional territories becomes increasingly relevant. The valuation methodology applied in this book can contribute to negotiations related to natural resource benefit sharing and redress. The methodology can quantify restitution and compensation when implementing Article 28 of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) which states, "Indigenous peoples have the right to redress, by means that can include restitution or, when this is not possible, just, fair and equitable compensation, for the lands, territories and resources which they have traditionally owned or otherwise occupied or used, and which have been confiscated, taken, occupied, used or damaged without their free, prior and informed consent."

Considering the pressures to develop areas in and around lakes, the subject matter and research methodology of this book are particularly timely. The placing of a monetary value on lakes that includes the value of ecosystem services clearly shows that lakes provide more economic value than adjacent real property. The research completed and data produced for

this book provide useful tools in lakes-related planning in the future.

Dr. Nathan Matthew
Former Chancellor of Thompson Rivers University and currently Chancellor Emeritus

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Acknowledgements

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The TRU Open Press combines TRU's open platforms and expertise in learning design and open resource development. TRU Open Press supports the creation and reuse of open educational resources, while encouraging open scholarship and research.

Land Acknowledgement

Thompson Rivers University (TRU) campuses are situated on the traditional lands of the Tk'emlúps te Secwépemc (Kamloops) and the T'exelc (Williams Lake) within Secwépemcúl'ecw, the traditional and unceded territory of the Secwépemc. The rich tapestry of this land also encompasses the territories of the St'át'imc, Nlaka'pamux, Tŝilhqot'in, Nuxalk, and Dakelh. Recognizing the deep histories and ongoing presence of these Indigenous peoples, we express gratitude for the wisdom held by this land. TRU is dedicated to fostering an inclusive and respectful environment, valuing education as a shared journey. The TRU Open Press, inspired by collaborative learning on this land, upholds open access principles, and freely accessible education for all.

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Disclosure

The authors of this book contributed to the concept, writing, and editing and take full responsibility for the book's content, accuracy, and integrity. Some authors used ChatGPT as a tool to search for information and for readability and language in their chapters. All errors, biases, and omissions are the authors and not the AI tool.

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Preface

This book was written jointly with my graduate students during the 2023 Winter semester. It is about the natural asset values of a number of lakes in the unceded land of the Secwépemc People and the annual flow of ecosystem services they provide to the communities. The book evolved from a graduate course I started teaching two years ago in the Master of Science in Environmental Economics and Management at Thompson Rivers University in Kamloops, British Columbia. The course is entitled Valuation Methods for Cost-Benefit Analysis and builds on the Foundations of Cost-Benefit Analysis course. In this course, students explore advanced techniques to assess nature and the impacts it experiences using methods such as benefit transfer, hedonic pricing, experimental design, contingent valuation, choice experiments, and market estimation (e.g., defensive expenditures, travel costs, and shadow pricing).

Last year, my graduate students explored the value of a number of Kamloops parks, from the smallest Prince Charles Park to the largest Kenna Cartwright Nature Park (Tsigaris et al., 2022). The value of these parks was estimated at CDN $3.8 billion, with a yield in terms of ecosystem services they provide at CDN $133 million per year. The Kenna Cartwright Nature Park, the largest urban park in British Columbia, has an estimated value of CDN $3 billion. On a per capita basis, Kenna Cartwright Nature Park represents an asset worth CDN $30,000 to each Kamloops resident. The annual flow of

ecosystem services of the Kenna Cartwright Park was estimated at CDN $45 million and assumed to rise by two percent yearly (Truscott & Tsigaris, 2022).

A similar study was conducted by Sutton and Anderson (2016). Sutton and Anderson placed a value on the iconic New York Central Park and its ecosystem services. A real estate appraisal firm assessed the 341-ha park at $500 billion as an opportunity cost of the land not being developed. Sutton and Anderson (2016) assumed a 5% yield from the asset, thus providing annual ecosystem services worth $25 billion each year to the community. According to BC Assessment (2023), the value of Kamloops housing and commercial buildings is estimated at $24 billion as of 2022 and can be compared to the value of parks. When all parks around Kamloops are included, their valuation could easily exceed CAD 24 billion. As assets, parks provide regulating, maintaining, supporting, and cultural services. They provide opportunities for tourism, recreation and culture, air quality regulation, and habitat for plants and animals. Valuations of nature are high because they account for the interaction of social, natural, human, and built capital. Value does not mean commodification but measuring a form of capital preserved for the benefit of its people.

My past work in this area includes exploring the factors underlying public support and willingness to pay to preserve the agricultural land reserve (ALR) in British Columbia (Androkovich et al., 2008). The ALR, established in 1973, encompasses 4.76 million hectares. The reserve aims to preserve agricultural land for farm use and to establish and maintain family farm businesses (Agricultural Land

Commission Act). We distributed a contingent valuation survey to elicit peoples' preferences towards preservation across the province (Androkovich et al., 2008). After analyzing 267 surveys, we found that British Columbians know "the economic importance of British Columbia's agriculture sector," and they place importance on the preservation of ALR to ensure that local food production is maintained" and "to protect the environment" (Androkovich et al., 2008). The view "to protect the environment" makes sense since most of the ALR is in northern rural areas of the province. Provincewide, people were willing to pay to maintain the land reserve, with a conservative estimate of CAD 91.18 million per year. For further reading, Tsigaris (2014) provides a critique of introducing Bill 24 for the ALR.

In this book, I asked my students to conduct a study by selecting a lake within the Secwépemcul'ecw territory and around the city of Kamloops to write a chapter in this book about the lake's value. There are around 70 lakes surrounding Kamloops, but this project has selected a few cases to examine. They discuss the lake's geophysical structure, history, name origin, Indigenous values, environmental and ecological concerns, and its valuation in terms of ecosystem services that the lake provides and its value as a natural asset. The students submitted drafts throughout the semester, and I provided feedback to improve their research. This review process improves their research and the final output (Tsigaris, 2021).

Given that the lakes are located on the unceded land of the Secwépemc people, Secwépemcul'ecw, which covers a vast

area in the south-central part of British Columbia, I asked my students to include a discussion on Indigenous values. In their language, the word Kw'seltktnéws means that we are all related and interconnected with nature (Ignace & Ignace, 2017). The Secwépemc's ceremonies, language, legends, and rituals deeply connect to nature. Shuswap Lake and other lakes provide food, spirituality, and history (Ignace & Ignace, 2017). The Secwépemc people take only what they require from the lakes, protecting the ecosystem and passing on sustainability knowledge to future generations. However, industrialization, pollution, and climate change threaten our lakes, and we, the settlers, can learn from the Secwépemc people about environmental protection and sustainability to conserve these vital water systems for future generations.

Dr. Panagiotis (Peter) Tsigaris

June 10, 2024

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Introduction

PANAGIOTIS TSIGARIS

Secwépemc People & Lakes

As stated in the preface, the Secwépemc People have a strong connection and friendship with nature. This relationship is rooted in their cultural beliefs, practices, and traditional role as stewards of the land (Ignace & Ignace, 2017). Their views on nature are shaped by living in harmony with the environment. The health and well-being of their people are intricately connected to the health of the land. The key principle is to have a harmonious interconnectedness of nature with human activity and to respect the land by using sustainable practices to ensure its health. This respect is evident in their hunting, fishing, and gathering practices, where they only take what they need and express gratitude for what the land provides. They also learn from nature as nature is a teacher, which offers lessons on living, adapting, and thriving. They deeply understand the ecosystem services provided by lakes and place equal importance on their provisioning, regulating habitat, and cultural and recreational services.

> "As Secwépemc, we are collectively responsible to take care of our land and water, to uphold all of our responsibilities and follow our Natural Laws, as was passed down to us from Tqelt Kukpi7 and our ancestors. Therefore, we will not, under any condition, compromise the health of our water and our future generations."
>
> — **Secwépemc Sacred Water Declaration at Neskonlith** (February 8, 2013)

Threats to Lakes

Lakes are enduring tough times, grappling with vast changes brought on by human activity in the modern age. Heino et al. (2020) have pointed out that our lakes are not spared from the environmental pressures that have reshaped marine and terrestrial environments. These pressures come from a mix of rapid economic growth, ballooning populations, and technology from the industrial revolution that haven't always considered the environmental cost. As a result, lakes are suffering. They're experiencing a loss in biodiversity and a breakdown in ecosystem services that used to naturally occur. Climate change is making the waters more acidic and nutrient-loaded, invasive species are moving in, and human alterations are changing the very shape and volume of these

bodies. These impacts are a fundamental disruption that threatens the health and function of lake ecosystems (Albert et al., 2021; Birk et al., 2020; Dudgeon, 2019; and Smol, 2019).

Valuation of Lake Ecosystem Services

Lakes provide numerous ecosystem services to humans directly through provisioning (e.g., water supply, fish catch), indirectly through cultural services (e.g. recreation, aesthetic appreciation), and through regulating and maintenance services (e.g., water purification by removing excess nitrogen by microorganisms, maintaining humidity patterns for climate equilibrium, habitats for marine life). Most of the ecosystem services lakes provide cannot be directly traded on the market to estimate their scarcity through the price system, so assessing them poses difficulties (Reynaud & Lanzanova, 2017). As a result, economists have developed valuation methods to value these services to assist policymakers in addressing biodiversity and ecosystem degradation losses as markets fail to value these services and regulate their over-consumption.

Given the importance of measuring the value of natural assets, economists have developed valuation methods to support the conservation of nature, ecosystem restoration, and sustainable land management decisions. Valuing ecosystem services and natural capital is not commodification. Instead, it shows the value of society's most important asset; without it, we all would be dead. Economists

can value ecosystem services through revealed preference from market transactions (e.g., home prices capture environmental amenities such as clean air) and stated methods through surveys such as the contingent valuation methods (e.g., asking people how much they are willing to pay to preserve nature).

However, another method used in this book is to place a value using the benefits transfer method (BTM). This method is the least expensive and utilizes the information from prior studies to predict the welfare estimates on other sites (Johnston & Rosenberger, 2010). The BTM utilizes approaches such as average valuation from various studies or using a statistical functional transfer (Boyle et al., 2010). The sites should be similar in characteristics to transfer value. However, functional transfers are generally preferred as they are based on a meta-analysis of various studies (Boyle et al., 2010). Due to time and money constraints, policymakers unavoidably utilize the BTM for cost-benefit analysis (Johnston & Rosenberger, 2010). Also, this method is utilized to value large-scale ecosystem services, such as the world's ecosystem services (Costanza et al., 1997; Costanza et al., 2014). The valuation of large-scale ecosystem services of biomes (e.g., lakes and rivers, open sea, wetlands, and grasslands) cannot rely on a few studies or non-market valuation methods, making the BTM applicable.

Two types of errors can arise from the method: measurement errors from the original study site and transfer errors from the mismatch between the evaluation site and reference site (Boutwell & Westra, 2013). A wider confidence interval can

account for these errors that practitioners and scholars might face. Due to these potential errors, a conservative assessment is preferred as this assessment removes studies with significant outliers, uses the median, or uses a value from the lower end of the estimate distribution. This research takes a conservative approach by excluding estimates that arise from one or two studies and hence underestimates the value of ecosystem services per year. Although all methods have shortcomings, the BTM offers the opportunity to assess the value of ecosystem services of lakes globally. Valuing the ecosystem services of the world's lakes involves transferring an estimate of the price per hectare per year, found through assessing the values from numerous studies, and multiplying this price by the area (in hectares) of the lakes.

Ecosystem System Valuation Database

This book utilizes the Ecosystem System Valuation Database (ESVD) to assess the value of ecosystem services per year and the asset value of lakes (Brander et al., 2023). The database provides information on the economic benefits of ecosystems and biodiversity and the costs of their loss. It collects monetary economic welfare values for ecosystem services from over 1,100 studies from all biomes, ecosystem services, and geographic locations, contributing 9,500 value records to the database.

We extracted data for freshwater lakes that focused on lakes

in Canada. Additionally, we added lakes studied in the US and the UK to increase the size, as researchers have only assessed a few freshwater lakes in Canada. In total, there were 81 studies assessing the lakes provisioning services, such as food, water, and raw material; habitat services, such as maintenance of genetic diversity and life cycle; and cultural services, such as aesthetic information, opportunities for recreation and tourism, and inspiration for culture, art, and design. There were no values for regulating services such as water purification, decomposition, and cycling of nutrients.

Table I shows the values of the different services on a price per ha per year in 2020 International $. The most significant valuation is for cultural services, particularly opportunities for recreation and tourism. The total value using averages within each category is $78,804 per ha per year. Meanwhile, the value using the median is lower at $57,726 as outliers do not receive weight. Finally, the most conservative valuation is the modified median estimated at $23,543, which excludes values from one or two studies. Although using the latter value will underestimate the valuation of the lake services, it gives a minimum valuation that policymakers can use as a benchmark for decision-making and minimum asset valuation. As this research will show, even the most conservative valuation shows that lakes constitute a large and important part of our total wealth. We will use the prices in **Table I** to study lakes in the area.

Table I: Value of Ecosystem Services of Lakes in Canada, UK, & US

Ecosystem Service	# of Values	Average	Median	Modified Median
Food	21	1,206	136	136
Raw Material	4	201	191	191
Water	2	19,111	19,111	—
Total	27	20,517	19,437	427

Ecosystem Service	# of Values	Average	Median	Modified Median
Maintenance of Genetic Diversity	1	1,050	1,050	—
Maintenance of Life Cycle	2	742	742	—
Total	3	1,792	1,792	—

Ecosystem Service	# of Values	Average	Median	Modified Median
Aesthetic Information	8	9,695	1,422	1,422
Opportunities for Recreation & Tourism	40	33,518	21,794	21,794
Inspiration for Culture, Art, & Design	1	12,743	12,743	—
Total	49	55,956	35,959	23,216

Ecosystem Service	# of Values	Average	Median	Modified Median
Moderation of Extreme Events	2	538	538	—

Skip Table IE			
# of Values	**Average**	**Median**	**Modified Median**
81	78,804	57,726	23,542

Note. Adapted from Ecosystem System Valuation Database by Brander et al. (2023).

In summary, this book is about the importance of lakes as a natural asset contributing to our total wealth. During the Winter 2023 semester, students, alone or in pairs, wrote a

chapter about a lake in British Columbia. Students selected a lake for their course project at the beginning of the semester and worked on their research throughout the semester. Each chapter contains the lake's geophysical attributes, history, name origin, Indigenous value, environmental and ecological issues with the lake, and valuation. These lakes surround Kamloops, and the region has at least 70 lakes (Kamloops Trails, n.d.a).

What is the value of a lake? This is an important question to answer for all those who enjoy and use them now, but also future generations who will realize these benefits and the supportive and regulatory eco-system services from all lakes in the future. It is a particularly important question for indigenous nations because they also realize current and future cultural services from lakes which enhances their value.

This book represents an accessible application to this question at a global level and at an individual lake level in the Kamloops, BC region. It uses the natural capital accounting framework within environmental economics and the comprehensive ecosystem services approach endorsed by the United Nations. It begins with an excellent introductory chapter about this valuation methodology and discussion about appropriate discount rates to estimate the global value of lakes by Peter Tsigaris. It then turns to a

series of descriptions and valuations of specific regional lakes developed by students of environmental economics at Thompon Rivers University.

The analysis and research in this book are valuable and interesting to indigenous nations and other governments, students of environmental sciences and economics and anyone who appreciates and wants to protect the value of our natural resources. It is also a fantastic example of how to practically connect universities to their regional economies, ecosystems, and indigenous nations.

— Dr. Andre Le Dressay, Director, Tulo Centre of Indigenous Economics

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1. Value of Lakes as a Natural Asset

PANAGIOTIS TSIGARIS

Introduction

We cannot image a world without freshwater lakes. Without such lakes, the planet's ecosystems and the life they support would be drastically affected. Freshwater lakes offer numerous benefits to humans and other living forms. For humans, they encompass vital services providing clean water for consumption and irrigation, fish, natural buffers against flooding, and recreational, spiritual, and cultural opportunities. Moreover, lakes play a pivotal role in the earth's biogeochemical processes by maintaining the planet's water, carbon, and nutrient balances. This maintenance ensures environmental equilibrium and supports the biodiversity of life forms. In this chapter, we describe how to place a value on Lakes and its ecosystem services.

In a recent paper, Li and Tsigaris (2024) estimated the value of freshwater lakes worldwide. The viewpoint article was published in the prestigious journal *Ecology Letters*, and the perspective article is titled: "The Global Value of Freshwater Lakes". In the paper, we addressed the threats faced by lakes due to human activities and their implications on the

ecosystem services of lakes. The research estimates the global ecosystem services of lakes to be within USD 1.5 to 5.5 trillion annually, with their natural asset value being comparable to the global real estate market using a relatively high social discount rate. However, due to environmental degradation and the possibility that future generations may not be better off than the current generation, the global value of lakes today rises to be at least equal to the global wealth created which is estimated at 1,500 trillion. This valuation emphasizes the shared wealth of our natural resources, contrasting the skewed distribution of created wealth. In this chapter, we are addressing the methodology we used to estimate the value of lakes which will be used in this book.

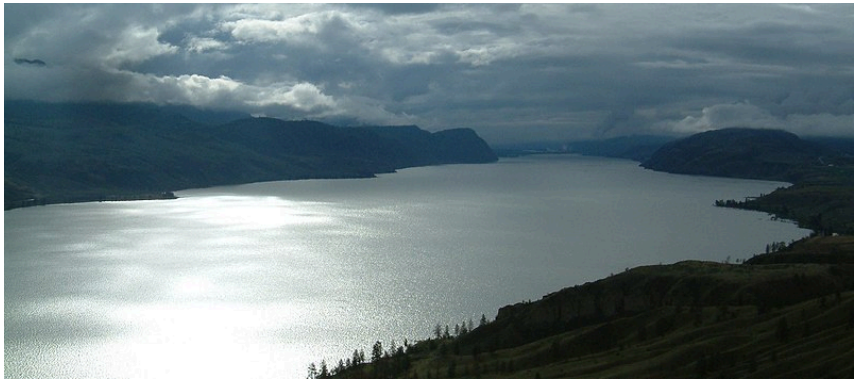

Figure 1: *Kamloops Lake (Hedwig Storch/Wikimedia Commons) CC BY-SA 4.0*

Social Discounting of Ecosystem Services

Lake ecosystem services are a perpetual flow that happen every year. Because ecosystem services accrue over time, we discount their valuation of future monetary benefits in order to determine the lakes' current value. Discounting the values ecosystem services to future generations can be contentious and potentially go against Indigenous principles. Prominent philosophers and economists have discussed and puzzled over this matter. A 3.5% annually has been the traditional discount rate used to discount future ecosystem services and changes arising from policy such as restoration of degraded natural assets (Boardman et al., 2010; Haacker et al., 2020).

Purpose of Social Discounting

From a social standpoint, there are several reasons why we undervalue the future today. Two common reasons to discount from a social perspective is due to the social rate of time preference (i.e., social impatience) and economic growth.

$$r = \rho + ng$$

where, ρ is the social rate of time preference, g is the growth rate of income (consumption) per person, and n measures the elasticity of marginal utility of income from a rising income,

which marginal utility diminishes as income increases. Namely the fact that an extra $ to a rich person is worth much less than extra $ to a poor person. The extra utility (happiness) a billionaire gets from one extra $ is much lower than the extra happiness a homeless person will get from an extra $. The evidence indicates that elasticity of marginal utility of income is elastic, n >1. However, discounting based on impatience for intergenerational distribution of public projects is morally wrong.

Famous Economists on Social Discounting — Not discounting impatience is also in line with the views of most famous economists, who stated the following:

- **Ramsey (1928)** said it is "ethically indefensible and [arising] merely from the weakness of the imagination."
- **Pigou (1932)** referred to it as implying that "our telescopic faculty is defective."
- **Harrod (1948)** described it as a "human infirmity" and "a polite expression for rapacity and the conquest of reason by passion."
- **Solow (1974)** wrote "we ought to act as if the social rate of time preference were zero (though we would simultaneously discount future consumption if we expected the future to be richer than the present)."

For social rate of time preference, we use a rate similar what

Stern (2007) used which is 0.1% in case a catastrophic event happens over the next 1000 years destroying all living beings. The question is what to use for the economic growth, n*g for discounting based on the assumption that future generations will be richer than the current generation. This assumption may be false given the significant environmental and ecological damage the Industrial Revolution is causing to the planet. It could be the case that future generations may be worse off than the current generation. Maybe the economic trajectory is towards a lower standard of living. If there is no long-run economic growth, then the appropriate social discount rate is 0.1%. In the case where there is economic growth, we will use a 3.5% as the social discount rate with the elasticity of marginal utility of income at 1.7 and growth of income or consumption at 2%.

Value of Lakes with Social Discounting

The value of ecosystem services lakes provide will increase over time as the standard of living increases. It is reasonable to assume that the value of yearly services of lakes grows around g% per year. This figure could be the average growth rate of the world's standard of living as measured by the growth rate of GDP per capita worldwide over the long run. Thus, the value of lakes today is the present value of the value of ecosystem services per year discounted:

$$V = \frac{ES_t}{r - g}$$

The formula represents the valuation using the Gordon Growth Model, where V is the lake's intrinsic value, *ES* is the yield that that lakes provide to society in terms of ecosytem services measured at time *t*, *r* is the social discount rate, and *g* is the growth rate of the value of ecosystem services per year. We assume that the value of ecosystem services also grows at the rate of consumption per person at the rate of 2% per year. Hence, this book will use two social discount rates to assess the value of lakes: 1.5% which is obtained from 3.5% minus 2% and 0.1%. The latter rate assumes that we have done serious harm to nature and the future generations will not be richer than the current generation. Worth quoting Oren Lyons:

> "The Peacemaker taught us about the Seven Generations. He said, when you sit in council for the welfare of the people, you must not think of yourself or of your family, not even of your generation. He said, make your decisions on behalf of the seven generations coming, so that they may enjoy what you have today."
>
> — **Oren Lyons**, Faithkeeper, Onondaga Nation (Public Broadcasting Service, n.d.)

Media Attributions

Figure 1: "Canada, British Columbia, Kamloops Lake" by Hedwig Storch (2006), via Wikimedia Commons, is under a CC BY-SA license.

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2. Lakes in British Columbia

XINGMING LI AND PANAGIOTIS TSIGARIS

About Lakes in British Columbia

British Columbia's lakes are mirrors that magnify the immense beauty and intricacy of this region. These water bodies are woven into the very tapestry of the land, ranging from calm coastal recesses to harsh mountainous hollows. Additionally, these lakes have more value than just their breathtaking views. They act as environmental sustainability, cultural diversity and economic resilience in a nutshell. For Indigenous peoples, they remain sacred areas that interweave spiritual with cultural and practical dimensions of existence. In this chapter, we intend to delve into what holds British Columbia's lakes so tightly together with their integral worth. By looking through an indigenous lens which is often underrepresented in environmental discourse, we hope to unmask the real story behind these lakes; not simply as parts of an ecosystem but as fundamental tenets that give life meaning.

The value of British Columbia's lake ecosystems can be estimated using the size of the surface area of lakes and the value of various ecosystem services per ha per year. The

surface area of 7,121 named lakes is 1,740,861 ha, with the smallest lake being Bray Lake (close to the community of Chase) at 0.08 ha and the largest lake being Williston Lake at 172,669 ha (GeoBC, n.d.). The average surface lake is 244 ha, and the median is 25 ha, indicating a skewed distribution of significantly smaller lakes. There are 378,855 unnamed lakes with a total surface area of 506,969 ha. The unnamed lakes, as expected, are very small, with the average size being 1.34 ha. The total surface area of all 385,976 lakes is 2,247,830 ha.

Figure 1: *Garibaldi Lake (Seattle Skier/Wikimedia Commons)* CC BY-SA 3.0

Table 1 shows the regional distribution of named and all lakes

regarding their surface area and the number of lakes. Bulkley-Nechako northeast region has the largest surface area of named lakes (GeoBC, n.d.). Thompson-Nicola's total surface area of all 861 named lakes in the region is 79,355 ha. Cariboo has the most named lakes at 1,015 relatives to any other region. Including small unnamed lakes, Bulkley-Nechako still maintains the largest surface area, but in terms of the number of lakes, Northern Rockies has 43,310, which surpasses Cariboo's 42,986 lakes. Thompson-Nicola has 21,697 lakes occupying 102,329 ha of space. **Table 1** provides a larger breakdown.

Table 1: Lakes in British Columbia by Region

Region	# of Lakes	Area (ha)
Alberni-Clayoquot	137	27,880
Bulkley-Nechako	695	427,524
Capital	86	1,925
Cariboo	1,015	177,480
Central Coast	127	31,367
Central Kootenay	226	114,175
Central Okanagan	101	38,343
Columbia-Shuswap	155	81,898
Comox Valley	129	3,417
Cowichan Valley	57	8,062
East Kootenay	248	16,295
Fraser Valley	163	35,763
Fraser-Fort George	436	92,014
Greater Vancouver	103	10,010
Kitimat-Stikine	335	67,000
Kootenay Boundary	79	3,576

Mount Waddington	158	23,785
Nanaimo	70	2,949
North Okanagan	127	12,524
Northern Rockies	105	32,086
Okanagan-Similkameen	188	5,962
Peace River	328	173,814
Powell River	87	20,786
Skeena-Queen Charlotte	187	25,315
Squamish-Lillooet	193	21,929
Stikine	407	175,617
Strathcona	255	25,185
Sunshine Coast	63	3,821
Thompson-Nicola	861	79,355
Total for All Regions	137	1,740,861

Region	**# of Lakes**	**Area (ha)**
Alberni-Clayoquot	2,618	30,788
Bulkley-Nechako	28,144	480,844
Capital	887	2,220
Cariboo	42,986	238,579
Central Coast	15,288	57,119
Central Kootenay	3,378	117,092
Central Okanagan	631	38,656
Columbia-Shuswap	5,714	89,761
Comox Valley	1,278	3,825
Cowichan Valley	624	8,372
East Kootenay	3,904	21,815
Fraser Valley	2,987	39,295
Fraser-Fort George	16,417	118,025
Greater Vancouver	989	10,577
Kitimat-Stikine	50,545	127,753
Kootenay Boundary	1,251	4,111
Mount Waddington	7,425	35,853
Nanaimo	950	3,282
North Okanagan	1,239	14,443

Northern Rockies	43,310	82,536
Okanagan-Similkameen	1,705	6,788
Peace River	35,452	205,443
Powell River	1,069	23,597
Skeena-Queen Charlotte	18,215	50,535
Squamish-Lillooet	4,354	26,098
Stikine	66,074	268,431
Strathcona	5,554	33,288
Sunshine Coast	1,291	6,373
Thompson-Nicola	21,697	102,329
Total for All Regions	385,976	2,247,830

Note. Adapted from Freshwater Atlas by GeoBC (n.d.).

Value of Ecosystem Services

This research attempts to place a conservative value of ecosystem services per hectare per year using the benefit transfer method (BTM) and provide a first approximation of valuation. The value of ecosystem services per hectare per year for lakes is extracted from studies in Canada, the US, and the UK from the Ecosystem Services Valuation Database (ESVD) (Brander et al., 2023). **Table I** in this book's Introduction summarizes the value of lakes' ecosystem services.

The total ecosystem value per hectare per year is estimated at an average of $78,804, while the median is $57,726. After removing some low-count ecosystem services, a conservative reference to the total median value would be $23,542/ha/

year. The total valuation is an underestimate for two reasons. First, the studies from the ESVD have not assessed many ecosystem services, especially in the regulation service. Second, the price reflects the marginal consumer for the benefits lakes provide and thus does not capture all consumer surplus but only the producers' surplus from the natural asset.

However, consumers can freely enjoy all the producers' surpluses since these services are not market-traded goods or services. Even so, these values are much smaller than the $108,361/ha/year value Brander et al. (2023) estimated for lakes and rivers. The highest value is observed in the category "opportunities for recreation and tourism," followed by the category water provision. However, only one regulatory service is priced that of moderation of extreme events, which will become more important with intensifying climate change. When 132 values across 16 ecosystem services from various North American, Europe, and Oceania are added, the valuation is higher since these values are additive. Including all countries in the three continents, the estimated value per hectare is an average of $158,876/ha/year, a median of $107,449/ha/year, and a modified median, which removes the low-count ecosystem services values, of $41,250/ha/year.

Valuation of Lakes in BC

To get to a very conservative assessment of the value of ecosystem services of lakes in British Columbia, we will use

the modified median from the Canada, US, and UK studies. The total surface area of all lakes in BC is 2.248 million hectares. Hence, the value of ecosystem services of all BC lakes would produce a minimum of $53 billion, a median of $129.8 billion, and a maximum of $177.2 billion per year for British Columbians. By only including the 7,121 named lakes, the estimated valuation becomes $41 billion, $100.5 billion, and $137.2 billion per year of benefits. In comparison, British Columbia's GDP was USD 284.8 billion in 2022 (Statistics Canada, 2023).

Hence, even at the most conservative estimation, named lakes provide benefits equal to 14.4% of British Columbia's GDP. The BC population reached 5.3 million in 2022 ("British Columbia," 2023). The per capita benefits of the ecosystem services of named lakes are approximately $7,736 at the minimum. Using Costanza et al.'s (2014) value of lakes and rivers at USD 15,517/ha/year, the benefits of the 7,121 named lakes is USD 27 billion per year, or USD 5,096 for each British Columbia. British Columbians and visitors collectively enjoy these huge ecosystem benefits.

> "We are almost all bodies of water, we use water to ground ourselves, we use water spiritually, to get food from the water, to drink we sleep better by the water. We live in a beautiful closed system, if we pollute the water, we desecrate our precious water and

ourselves. We not only harm ourselves, but we harm others and our children, and their children."

— **Indigenous Elder Joanne Brown**, Member of the Cheslatta Carrier Nation, L'silu clan, A longtime employee of Thompson Rivers University and now one of TRU's Indigenous Elders.

Natural Asset Value

Thus, the value of all lakes as a natural asset is USD 3.5 trillion at a minimum. For named lakes specifically, they have a value of USD 2.7 trillion with a 1.5% discount rate to account for a growing value to the ecosystem services per year. BC Assessment reviews 2,160,828 properties across the province, and as of July 1, 2022, the value of these properties is CAD 2.72 trillion (Ali, 2023). Hence, the value of our lakes exceeds the value of all properties across the province. Using a 0.1% discount rate, the value of lakes in BC increases to USD 53 trillion.

Table 2 provides a summary of the value of ecosystem services and natural assets.

Table 2: Value of Ecosystem Services of Lakes in British Columbia (in billions of USD)

Valuation Type	Average	Median	Modified Median
Ecosystem Services	53	130	177
Natural Asset	3,533	8,667	11,800

Skip Table 2B			
Valuation Type	**Average**	**Median**	**Modified Median**
Ecosystem Services	41	100	137
Natural Asset	2,733	6,700	9,133

Valuation Type	Average	Median	Modified Median
Ecosystem Services	1.9	4.6	6.2
Natural Asset	127	307	413

Conclusion

As we conclude this exploration of British Columbia's lakes, we come to understand that these waters are far more than ecological assets; they are treasures that have life, history, and the promise of the future. These lakes do more than support biodiversity and regulate climate — they are sanctuaries that nurture the human spirit and fortify the bonds within communities, particularly among Indigenous peoples. The words of Indigenous Elder Joanne Brown remind us that our relationship with these lakes is deeply personal and inherently communal, influencing who we are and how we live. Protecting these lakes goes beyond environmental

stewardship — it is a moral duty, ensuring that the rich cultural narratives and the pristine natural beauty they hold are preserved for future generations. Emphasizing Indigenous values and wisdom in our approach to managing these resources is essential. It is through this respectful partnership with nature and acknowledgment of traditional knowledge that sustainable and meaningful preservation can be achieved. This is not just about conservation; it is about honoring and sustaining a legacy of interconnectedness with our natural world.

Media Attributions

Figure 1: "GaribaldiLake-PanoramaRidge" by Seattle Skier (2004), via Wikimedia Commons, is used under a CC BY-SA license.

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3. Lac Le Jeune

ADEWALE ADEWUNMI AND OLANIKE ONASILE

About Lac Le Jeune

A series of services provided by the environment make Earth habitable for humans. Human existence depends directly and indirectly on the services provided by lakes. The services include provisioning, recreational, regulation, and maintenance functions. Although we value some of the direct services provided by lakes due to the economic importance of water, we do not acknowledge other services that affect us indirectly. Humans are rational and tend to appreciate materials with monetary value, but most of the services provided by various lakes are considered gifts from nature; hence, humans place a higher priority on human capital and physical capital than the free services that they get from the environment. Assessing the economic values of lakes is not straightforward due to the non-availability of a specific market for trading the services provided by the biome (Reynard & Lanzanova, 2017). In this chapter, we attempt to assess the value of ecosystem services and Lac Le Jeune as a natural asset (capital).

Through traditional knowledge and use of the Rivers and Lakes within Secwépemcúlucw, my ancestor Antoine Lampreau, contributed to the trade economy within our region. Our waterways were an integral part of life and were used for trade, fishing, gathering and connection to surrounding communities.

— Kaleena Carriere (*she/her*), Advancement Officer — Indigenization & Williams Lake Campus, Thompson Rivers University

Lac Le Jeune is a lake located within Lac Le Jeune Provincial Park near Kamloops, British Columbia, Canada ("Lac Le Jeune," 2022). The lake is named after Father Jean Marie Raphael Le Jeune, a well-respected priest of the indigenous population since 1880, who spent most of his life there (Balf, 1978). The Lac Le Jeune Provincial Park, which was established in 1956, is a 213-ha park located 37 km south of Kamloops and 47 km north of Merritt. The lake, with approximately 147 ha surface area, is also called "Batchelor" which means trout and "Chuhwels." The lake has a 240-ft fishing wharf that caters to physically challenged anglers, and it is famous for producing fighting rainbow trout with an average size of 1.5 kg (BC Parks, n.d.).

Figure 1: *Lac Le Jeune (Paul Mannix/Wikimedia Commons) CC BY 2.0*

Valuation of Lac Le Jeune

Reynaud and Lanzanova (2017) categorized the cultural services lakes provide into several sub-services, including fishing, boating, camping, sightseeing, and swimming. Lac Le Jeune is a popular recreational lake that provides a series of ecosystem services, including provisioning, regulating, cultural, and supporting, to residents and non-residents of the area. The lake's most evident service is the cultural services, and it provides all the recreational sub-services highlighted by Reynaud and Lanzanova (2017). Kamloops This Week (2018b) reported that the City of Kamloops awarded a

contract worth $899,000 to a local contractor to reconstruct the surface of Lac Le Jeune Road, which leads to the lake. The decision consequently makes the trip much easier for tourists.

The total economic value of the lake can be grouped into use value and non-use value. Lac Le Jeune's direct use value (mostly in the summer) has to do with the direct satisfaction that residents and tourists derived through its use, such as fishing, irrigating, taking pictures, camping, and breathing fresh air; meanwhile, the indirect use value has to do with the indirect benefits the lake offers to the society (BC Parks, n.d.). For instance, Lac Le Jeune serves as a source of water storage, which automatically helps reduce the risk of downstream flooding. It also serves as a water supply for the vegetation, such as lodgepole pine, marshland, and pinegrass forest surrounding the lake, providing good air and temperature for the tourists. It serves as a habitat for aquatic animals that comprise the food web and hosts terrestrial animals such as moose, bears, and lynxes (British Columbia, n.d.).

In addition to the indirect use value, the lake also helps reduce human activities' impact on nature by absorbing pollutants. Furthermore, the non-use values of Lac Le Jeune are the benefits that residents and tourists derive from the existence of the lake, which is not recreational nor commercial related, such as nature appreciation, conservation, and cultural significance of the lake. For instance, Lac le Jeune is well known for its fighting rainbow trout, making trout fishery very significant to the province (British Columbia, n.d.).

This study uses the benefit transfer method (BTM) described by Sun Oh et al. (2014) to estimate the value of freshwater lakes. Recent estimates on freshwater lakes were obtained from the Ecosystem Services Valuation Database and compared to the previous studies carried out by Constanza et al. (1997) and Constanza et al. (2014) (Brander et al., 2023).

Benefit Transfer Method

The benefit transfer method (BTM) is the process of applying valuation results, functions, data, or models obtained from the study of a resource (study site) to evaluate the economic values of another resource (policy site). (Sun Oh et al., 2014). This makes it possible to estimate the monetary value of Lac Le Jeune with the value of the lake surface area and the value of various ecosystem services of lakes in Canada, the UK, and the USA (study site).

Ecosystem Services Valuation Database

The Ecosystem Services Valuation Database (ESVD) is an online database that was created to provide robust and accessible information on the economic benefits and biodiversity (Brander et al., 2023). It contains over 8,000 value records from over 1,100 studies from various biomes, ecosystem services, and geographic locations.

Table 1 demonstrates that by multiplying the size of Lac Le Jeune, which is an approximately 147-ha surface area, with the per hectare values of lakes in Canada, the UK, and the US (Angler's Atlas, n.d.f). The value of ecosystem services provided by lakes in Canada, the UK, and the US is estimated at a conservative value of $23,542/ha/year, which is less than what Brander et al. (2023) estimated at $108,361/ha/year and the $41,251/ha/year conservative estimate for lakes in North America, Europe, and Oceania. There are two reasons our figure for these lakes is less than Brander et al.'s (2023) value. First, our value does not capture many sub-categories services, especially the regulation service, and second, it does not include all consumer surplus from the natural asset. Thus, using the median approach, the total value of economic service provided by the lake can be estimated as $11.6 million, $8.5 million using the average value, and $3.5 million using the modified median that removes low-count ecosystem service.

Table 1: Total Value of Lac Le Jeune Ecosystem Services

Ecosystem	Average	Median	Modified Median
Provisioning	3,015,999	2,857,239	62,769
Maintenance and supporting	263,424	263,424	—
Regulation	79,086	79,086	—
Cultural and recreational	8,225,532	5,285,973	3,412,752
Total	11,584,188	8,485,722	3,460,674

Note. Adapted from Brander et al. (2023). See Table A for a full breakdown

Applying a simple annual interest of 1.5% to the total ecosystem service value (median approach) gives a value of the Lac Le Jeune at $773 million, $567 million (median approach), and $233 million for the conservative approach. However, the value of Lac Le Jeune as a natural asset is a minimum of $3.5 billion and a maximum of $11.6 billion using the lower 0.1% discount rate. Compared to the 2022 value of British Columbia's Gross Domestic Product (GDP), which is $284.8 billion, at the maximum estimation, Lac Le Jeune provides benefits equivalent to 4.1% of the province's GDP (Statistics Canada, 2023).

Table 2 shows a breakdown of the value of Lac Le Jeune as a natural asset.

Table 2: Value of Lac Le Jeune as a Natural Asset

Valuation	Ecosystem Services per year (in millions of USD)	1.5% Discount Rate (in millions of USD)	0.1% Discount Rate (in millions of USD)
Average (per hectare per year)	11.6	773	11,600
Median (per hectare per year)	8.5	567	8,500
Conservative/Modified Median (per hectare per year)	3.5	233	3,500

Note. Calculated using data from Table 1

Concluding Remarks

This chapter has helped to place a monetary value on the ecosystem services provided by Lac Le Jeune. The study uses two different social discount rates (1.5% and 0.1%) to evaluate the value of the lake. The two discount rates place different weights on future generations. The lower discount rate places a higher weight on the future generation and allocates a much higher value to the resource than the 1.5% discount rate. The maximum value of the lake using the lowest discount rate, which portrays the sustainability goals of the indigenous community, is $11.6 billion, almost 5% of the province's GDP.

It is important to note that the estimates from this study only provide comprehension of Lac Le Jeune's monetary value; further estimation, such as contingency valuation analysis, travel cost, and hedonic pricing evaluation, may be required for decision-making. This value may provide some insights to policymakers on the lake's economic value and consequently influence them to enact regulations that protect the lake from development or other activities that may harm its value.

Appendix

Table A: Value of Ecosystem Services of Lakes in Canada, UK, & US

Ecosystem Service	# of Values	Average	Median	Modified Median
Food	21	177,282	19,992	19,992
Raw Material	4	29,547	28,077	28,077
Water	2	2,809,317	2,809,317	—
Total	27	3,015,999	2,857,239	62,769

Ecosystem Service	# of Values	Average	Median	Modified Median
Maintenance of Genetic Diversity	1	154,350	154,350	—
Maintenance of Life Cycle	2	109,074	109,074	—
Total	3	263,424	263,424	—

Ecosystem Service	# of Values	Average	Median	Modified Median
Aesthetic Information	8	1,425,165	209,034	209,034
Opportunities for Recreation & Tourism	40	4,927,146	3,203,718	3,203,718
Inspiration for Culture, Art, & Design	1	1,873,221	1,873,221	—
Total	49	8,225,532	5,285,973	3,412,752

Ecosystem Service	# of Values	Average	Median	Modified Median
Moderation of Extreme Events	2	79,086	79,086	—

Note. Adapted from **Table I** in the Introduction.

Media Attributions

Figure 1: "Lake View, Lac Le Jeune, Canada" by Paul Mannix (2006), via Wikimedia Commons, is used under a CC BY 2.0 license.

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4. Edith Lake

ANDREA L. CASTRO AND YUHUSURU RATHNAYAKE

About Edith Lake

The name Edith came from the daughter of Fred Humphrey, son of James Humphrey who settled in 1887, but could be the name of Edith's grandmother (Balf, 1978). Edith Lake, situated 12 km south of Kamloops, is a popular local attraction, especially for fishing and camping enthusiast (Backroad Maps, n.d.). The lake is well-equipped for recreational fishing, featuring two fishing docks, two boat launches, and ample space for those who prefer not to utilize these facilities (Chrome Catchers, n.d.a).

With a mean depth of 5.8 m and a maximum depth of 11.6 m, Edith Lake spans approximately 3.5 km in perimeter and covers an area of 25 ha (Chrome Catchers, n.d.a; Backroad Maps, n.d.). The lake is part of the Fish Zone Region 3-Thompson-Nicola and is situated at an elevation of 1,025 m (Backroad Maps, n.d.). Due to its low elevation, ice begins to break on Edith Lake in early April, providing one of the longest open water seasons, which also accommodates ice fishing (Angler's Atlas, n.d.a). Consequently, the lake attracts a steady stream of fishermen.

In addition to being a prime spot for anglers, Edith Lake offers

an excellent camping experience with 14 designated sites (Recreation Sites and Trails BC, n.d.a). However, it is important to note that there is no reservation system for these sites, which operate on a first-come, first-served basis. The lake's suitable water temperature makes it popular among swimmers; the kayaking community also frequents Edith Lake (Kamloops Kayak, 2022).

Figure 1: *Edith Lake (Murray Foubister/Flickr) CC BY-SA 2.0*

Value of Ecosystem Services

Ecosystem assessments have often led to comparing ecosystem services by incorporating a monetary value.

Ledoux and Turner (2002) mention that the monetary value of each ecosystem service should be equivalent to the cost of replacing it with another, which gives the same benefits. However, as Grant et al. (2013) described, value is difficult to place in most cases since those ecosystem services are non-substitutable. The total economic value framework is widely used since it captures an ecosystem's monetary and non-monetary aspects.

Direct use values are the benefits directly perceived and gained by natural resources, and most of the time, they are consumptive; in contrast, indirect values are not directly used by people (Saunders et al. 2010). Ledoux and Turner (2002) define a non-use value as the value given by natural resources spontaneously due to their mere existence. According to Saunders et al. (2010), non-use value can be again subdivided into existence value (knowledge that benefits accrue to every generation) and bequest value (the value is passed on to future generations).

Figure 2 shows a breakdown of the total economic value and its branches, including option value with examples. Notice that the total economic valuation captures Indigenous use and non-use values, particularly preserving the benefits of lakes for future generations to use.

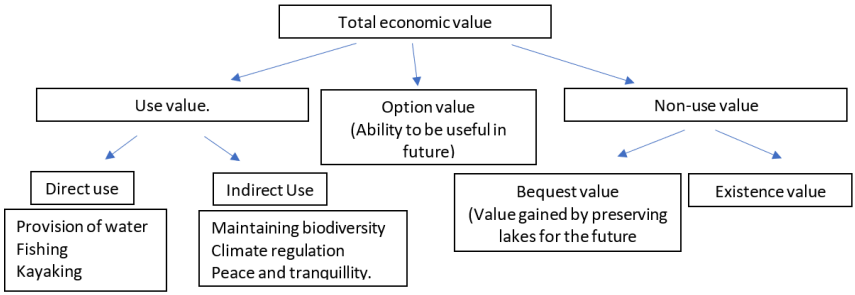

Figure 2: *Breakdown of total economic value [Long Description]* CC BY-NC-SA 4.0

"Traditionally, Secwépemc would bathe, whatever the season, each day, in whichever body of water they were camped at during their seasonal rounds. This bathing was more than just for cleanliness, but also for cultural and spiritual reasons. I was taught this by my aunt on the banks of the Quesnel Lake, where she made me bathe each morning we were camped there."

— **Marie Sandy (Secwecwpemc-ken)**, Manager, Indigenous Student Development Department at Cplúl'kw'ten, Faculty of Student Development, Thompson Rivers University

Valuation of Edith Lake

Table 1 attempts to come up with a valuation for Edith Lake based on the BTM, where we multiplied the number of hectares (25) covered by Edith Lake by the value per hectare derived in the introduction in **Table I** (see **Table A** for a full breakdown).

Table 1: Total Value of Edith Lake Ecosystem Services (2020 International $/ha/year)

Skip Table 1			
Ecosystem	**Average**	**Median**	**Modified Median**
Provisioning	512,925	485,925	10,675
Maintenance and supporting	44,800	44,800	—
Regulation	13,450	13,450	—
Cultural and recreational	1,398,900	898,975	580,400
Total	1,970,100	1,443,150	588,550

Note. Adapted from Brander et al. (2023). See Table A for a full breakdown

Measuring the value of natural assets like this lake is crucial to protect them from being abused or overexploited. Edith Lake is a natural asset with a long history, and it is where people come to relax and enjoy outdoor activities with their families. Valuing this asset will help internalize the benefits provided by the lake, thereby conveying how important it is for society. As visible from the above table, using a modified median has given us a conservative estimation compared to average and

median valuation because the modified median omits outliers during derivation. The conservative valuation based on all the ecosystem services provided by Edith Lake would be $588,550, while it is $1,970,100 and $1,443,150 for average valuation and median valuation, respectively.

As mentioned in the introduction of this chapter, Edith Lake is generally not used for provisioning, such as water or food, except for fishing. Reflecting the same idea, the estimation for the provisioning service category based on the modified median is only $10,675. This figure again proves the value of using a conservative estimation instead of average and median estimations in this study. In the meantime, the cultural category is the main component in value generation at $544,850, mainly due to opportunities created by Edith Lake for recreation and tourism. Therefore, when looking at **Table 1**, we believe the flow of value generated by each service conveys an accurate idea; our reasoning is that Edith Lake is commonly used for aesthetic and recreational purposes rather than commercialized activities, such as food provisioning.

Table 2 uses two social discount rates: 1.5% and 0.1%. The latter assumes that there will be no economic growth in the future.

Table 2: Values of Edith Lake as a Natural Asset

Skip Table 2			
Value Type	**Value of Ecosystem Services per year**	**1.5% Discount Rate**	**0.1% Discount Rate**
Average	1,970,100	131,340,000	1,970,100,000
Median	1,443,150	96,210,000	1,443,150,000
Modified Median	588,550	39,236,667	588,550,000

The social discount rate used to calculate the lake's value over the years is 1.5% and 0.1%. Using the lower 0.1 % rate aligns with how Indigenous peoples value nature; they consider natural assets very important resources that cannot be easily substituted for other forms of capital, such as physical and human. The value of the lake at the 1.5% discount rate is $39.24 million, and it is $588.55 million at the 0.1% rate.

Concluding Remarks

We hope that this chapter helps people understand the benefits a lake and its ecosystem services can bring to society. Indigenous peoples have been aware for a long time how important it is to take care of this ecosystem since it can provide the population not only with water, food, and a source of great spiritual energy. We must learn to value the amount of benefits these lakes can offer us a little more so that we take care of and protect the environment.

Appendix

Table A: Value of Edith Lake Ecosystem Services

Ecosystem Services	Average	Median	Modified Median
Food	30,150	3,400	3,400
Raw Material	5,025	4,775	4,775
Water	477,775	477,775	—
Total	512,925	485,925	10,675

Ecosystem Services	Average	Median	Modified Median
Maintenance of Genetic Diversity	26,250	26,250	—
Maintenance of Life Cycle	18,550	18,550	—
Total	44,800	44,800	—

Ecosystem Services	Average	Median	Modified Median
Aesthetic Information	242,375	35,550	35,550
Opportunities for Recreation & Tourism	837,950	544,850	544,850
Inspiration for Culture, Art, & Design	318,575	318,575	—
Total	1,398,900	898,975	580,400

Ecosystem Services	Average	Median	Modified Median
Moderation of Extreme Events	13,450	13,450	—

Note. Adapted from **Table 1** in the Introduction.

Media Attributions

Figure 1: "IMG_1989.jpg" by Murray Foubister (2018), via Flickr, is used under a CC BY-SA 2.0 license.

Figure 2: "Breakdown of total economic value" by the author is under a CC BY-NC-SA 4.0 license.

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Long Descriptions

Figure 2 Long Description: The tree diagram shows the different categories total economic value can be broken down into. At the top is Total Economic Value. The next level shows Use Value, Option Value (ability to be useful in future), and Non-Use Value. Use value can be further divided into Direct Use (e.g., provision of water, fishing, and kayaking) and Indirect Use (e.g., maintaining biodiversity, climate regulation, and peace/tranquility). Non-use value can also be further divided into Bequest Value (value gained by preserving lakes for the future) and Existence Value. [Return to Figure 2]

5. Pinantan Lake

BILL V. DEL ROSARIO

About Pinantan Lake

Pinantan Lake is situated approximately 33 km northeast of Kamloops through Highway 5 and Paul Lake Road (Travel British Columbia, n.d.). In the traditional Aboriginal language, Pinantan means shoe or moccasin, which the lake was named after due to the lake's shape ("Pinantan Lake," 2023). The lake is around 68 ha in size, with a surface area of 12 ha (British Columbia Adventure Network, n.d.b). It has an average and maximum depth of 10.6 m and 18.5 m, respectively.

Some activities that can be done in the lake are swimming, kayaking, and canoeing during summer (Travel British Columbia, n.d.). It is also popular for fishing, specifically the rainbow trout. Outdoor activities are also available within the vicinity due to the rich wildlife. During winter, the lake is frozen, but fishing is still manageable. Harper Mountain is also within reach for skiing, snowboarding, and cross-country skiing.

Figure 1: *Pinantan Lake from (Kamloops Trails, 2014) Used with permission.*

Valuation of Pinantan Lake

Costanza et al. (1997) have summarized 17 ecosystem services. **Figure 2** shows data on the value of ecosystem services lakes provide using the Ecosystem Services Valuation Database (ESVD) (Brander et al., 2023). We can clearly infer that the most important service for lakes would be the opportunities for recreation and tourism at approximately $1,481,992. Following this, but not close enough, is the existence, bequest, and aesthetic value at $96,696. The least valued ecosystem service would be providing raw materials, water, and food at $22,236. This clearly shows that people value the lake more through its direct use and non-consumptive value

rather than its existence value and indirect use, as seen in **Figure 2**.

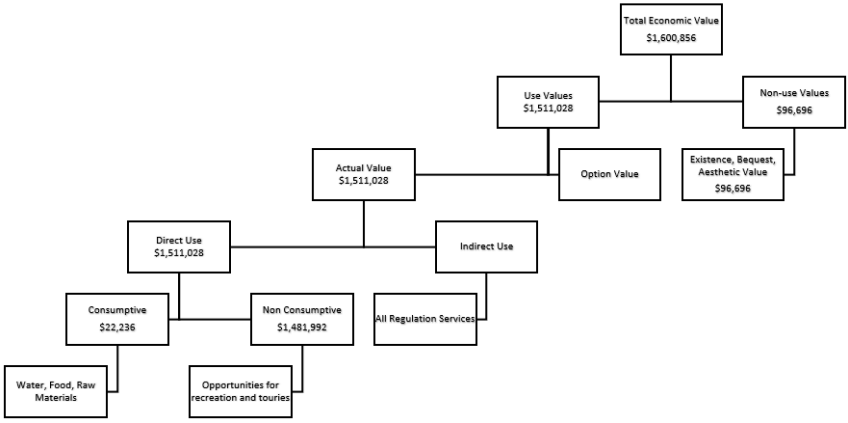

Figure 2: *The value of Pinantan Lake per year (US$ 2020 PPP) using the Modified Median of ESVD [Long Description] CC BY-NC-SA 4.0*

The values are derived from studies conducted in Canada, the US, and the UK. The average value per hectare per year across ecosystem services is $78,804. Meanwhile, the median is lower, as it is not influenced by outliers, at $57,726. Lastly, the most conservative value is $23,542 after removing values based on one or two studies. These prices are multiplied by the number of hectares of the lake to get **Table 1**.

Table 1: Total Value of Pinantan Lake Ecosystem Services

Ecosystem	Average	Median	Modified Median
Provisioning	1,395,156	1,321,716	22,236
Maintenance & Supporting	121,856	121,856	—
Regulation	36,584	36,584	—
Cultural & Recreational	3,805,008	2,445,212	1,578,688
Total	5,358,672	3,925,368	1,600,856

Note. Calculated using data from **Table I** in the Introduction. See **Table A** for a full breakdown

The conservative value of Pinantan Lake would be approximately $1,600,856 per year using the Total Economic Value without maintenance that we have in **Figure 2**. This figure also states that people using Pinantan Lake value fishing, kayaking, and other recreational activities at around $1,481,992 per year, which is its direct use and non-consumptive value. The ecosystem services flow occurs every year; to find the value of the lake as a natural asset, we will use 1.5% and 0.1% social discount rates. The former assumes that the demand for and value of these ecosystem services increases at a rate of 2% per year; however, this rate is discounted at the social discount rate of 3.5%, which is standard for assessing public projects in Canada. The latter assumes no increasing standard of living and an egalitarian view between the current and future generations. The value of the lake at the 1.5% discount rate is $106.7 million; at 0.1%, the lake is valued at $1.6 billion.

"Without Pinantan Lake, there would be no community."

Using the BC Assessment (2023) website and comparing 111 lakefront properties in Lake Pinantan, the total value (building and land) of these properties is approximately $61,504,200 at 22.1 ha, constituting $2,790,077 per hectare. Notably, the lake is priced into the land value rather than the building. The lake value can be thought of as the difference between the lakefront and non-lakefront properties with a total value average difference of $713,490 per hectare, a land value average difference of $712,523 per hectare, and a building value average difference of $967 per hectare. Such a difference in land value could imply that people value the lake at approximately $712,523 per hectare or a total value of $3.23 billion and $48.5 billion (1.5% and 0.1% social discount rates, respectively). The value of the lake, even at the higher social discount rate, is 1.7 times the value of the lakefront properties; if the lower discount rate is used, the lake is 26 times higher than the value of the lakefront properties.

Table 2 shows a summary of the value of lakefront versus non-lakefront properties at Pinantan Lake.

Table 2: Value of Lakefront and Non-Lakefront Properties at Pinantan Lake

Property Type	# of Properties	Total Average Value ($/ha)	Land Average Value ($/ha)	Building Average Value

				($/ha)
Lakefront	111	2,790,077	1,421,917	1,386,160
Non-Lakefront	137	2,076,587	709,394	1,367,193
Difference (Between Lakefront and Non-Lakefront)	—	713,490	712,523	967

Note. Adapted from BC Assessment (2023)

Table 2 clearly shows that people see the value of PinantanLake as much higher than their land properties. Without Pinantan Lake, there would be no community. The community settled there because of the lake.

Concluding Remarks

Pinantan Lake is a marvelous place for recreational activities such as, but not limited to, fishing, kayaking, and swimming. People value the lake based on its use or non-use value, but the former has a higher value due to the previously mentioned recreational activities. Unfortunately, there is a low perception of value for the consumptive use and regulation activities of the lake, such as animal habitat, cleaning the air, and providing water. On the other hand, the value of this lake is higher than that of its land counterparts. We hope that after this information is disseminated to the public, the value lakes provide will be appreciated more. All lakes have been helping sustain life in general.

Appendix

Table A: Value of Pinantan Lake Ecosystem Services

Ecosystem Services	Average	Median	Modified Median
Food	82,008	9,248	9,248
Raw Material	13,668	12,988	12,988
Water	1,299,548	1,299,548	—
Total	1,395,156	1,321,716	22,236

Ecosystem Services	Average	Median	Modified Median
Maintenance of Genetic Diversity	71,400	71,400	—
Maintenance of Life Cycle	50,456	50,456	—
Total	121,856	121,856	—

Ecosystem Services	Average	Median	Modified Median
Aesthetic Information	659,260	96,696	96,696
Opportunities for Recreation & Tourism	2,279,224	1,481,992	1,481,992
Inspiration for Culture, Art, & Design	866,524	866,524	—
Total	3,805,008	2,445,212	1,578,688

Ecosystem Services	Average	Median	Modified Median
Moderation of Extreme Events	36,584	36,584	—

Skip Table A5		
Average	**Median**	**Modified Median**
5,358,672	3,925,368	1,600,856

Note. Calculated using data from **Table I** in the Introduction.

Media Attributions

Figure 1: "Pinantan Lake" by KamloopsTrails is used with permission.

Figure 2: "The value of Pinantan Lake per year (US$ 2020 PPP) using the Modified Median of ESVD" by the author is under a CC BY-NC-SA license.

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Long Descriptions

Figure 2 Long Description: A diagonal tree diagram that breaks down the total economic value of Pinantan Lake into categories with monetary values (in 2020 USD). Starting at the top right corner, Total Economic Value ($1,600,856), which is broken down into Use Values ($1,511,028) and Non-Use Values ($96,696). For Non-Use Values, they are broken down into a combined category of Existence, Bequest, and Aesthetic Value ($96,696). For Use Values, they can be divided into Actual Value ($1,511,028) and Option Value (no monetary value). Actual Value is further divided into Direct Use ($1,511,028) and

Indirect Use (no monetary value) (e.g., all regulation services). Direct Use is broken down into Consumptive ($22,236) (e.g., water, food, and raw materials) and Non-Consumptive ($1,481,992) (e.g., opportunities for recreation and tourism). [Return to Figure 2]

6. Inks Lake

IMESHA FERNANDO

About Inks Lake

The name Inks originated from J.F. Inks who was a rancher near the Iron Mask Mine (Balf, 1978). Inks Lake is a natural freshwater lake surrounded by mountain peaks and has a size of approximately 4.3 ha (equivalent to 11 ac or 43209 m2) and a maximum depth of about 8 m (Angler's Atlas, n.d.c). It is located in British Columbia, Canada, around 20 minutes south of Kamloops, off the Coquihalla Highway; the coordinates are 50.6189° N, 120.4454° W. Inks Lake has an elevation of 850 m and is situated in a shallow glacial valley with steep cliffs and hills (Bos et al., 1996). It was formed by a massive landslide, which created a large dam that blocked the flow of the nearby river, leading to the lake's formation (N. Baptiste, personal communication, February 20, 2023). The lake's water levels are subject to seasonal fluctuations as it is fed by snowmelt and precipitation from the surrounding mountains.

Figure 1: *Inks Lake (Murray Foubister / Flickr) CC BY-SA 2.0*

Recreational Activities

Inks Lake has a rich history of human use, dating back thousands of years, and is now a popular destination for logging, kayaking, biking, camping, boating, swimming, hiking, and scuba diving (Trailpeak, n.d.). These activities benefit the local community economically through tourism and outdoor recreation. However, the most important recreational activity this lake provides is skating. Almost every year in the peak of winter, when the ice is at its toughest, local skating and ice hockey enthusiasts travel to Inks Lake to create rinks for them (and others) to use, which is assisted and supported by the community (Schulze, 2021). These rinks strengthen the

community by bringing different people with similar interests together to offer their time and effort for a greater cause. Also, due to its wide diversity of animal species, it is a popular destination for fishing and birdwatching (Hook and Bullet, n.d.; Lapierre, 2014).

Indigenous Value

The region's Indigenous peoples have a strong spiritual connection to Inks Lake, as it provides them with food, water, and spiritual renewal (N. Baptiste, personal communication, February 20, 2023). They would come to the lake for fishing, hunting, and gathering, and the area was an important center of trade and commerce. The settlers who arrived in the late 1800s and early 1900s were attracted to the area's abundant natural resources and established homes, farms, and logging operations. Inks Lake later became a popular destination for recreational activities, and several campgrounds were established along its shores (KamloopsTrails, 2019).

Ecosystem Services

Inks Lake provides many benefits, with the most critical ecosystem services likely to be those related to regulation, as it plays an important role in regulating the water cycle, maintaining water quality, and managing the risk of floods and

droughts. Regulating services related to biodiversity and the carbon cycle are also important, as well as cultural services related to recreation and tourism and supporting services related to maintaining the overall health and resilience of the ecosystem. Some of the more notable ecosystem services the lake provides are:

- **Water supply** — Inks Lake is a groundwater-fed lake that provides water for various uses, including irrigation, industrial purposes, and water supply to those who camp there (KamloopsTrails, 2017).
- **Recreation and tourism**— Inks Lake is a popular destination for many recreational activities such as camping, boating, swimming, and hiking. These activities benefit the local community economically through tourism and outdoor recreation.
- **Biodiversity** — Inks Lake supports a variety of aquatic plants and animals, including fish, amphibians, reptiles, and invertebrates. This biodiversity provides important ecological functions, such as nutrient cycling, pollination, and pest control, and supports other recreational activities like fishing and bird-watching (Lapierre, 2014).
- **Climate regulation** — The surrounding vegetation of Inks Lake helps regulate the local climate by absorbing carbon dioxide, reducing greenhouse gas emissions, and providing shade and cooling.
- **Cultural and spiritual values** — Inks Lake has cultural and spiritual values for Indigenous communities in the region, who have historical and contemporary connections to the lake and its surrounding landscape (N. Baptiste, personal

communication, February 20, 2023).

Potential Ecological Issues

Although there are many, the main threat to Inks Lake is water pollution. As with many other lakes, pollution from agricultural runoff, urban development, industrial activities, and improper waste disposal can introduce contaminants into the lake, impacting water quality and the health of aquatic organisms (Carpenter et al., 1998). Improper waste disposal is the primary cause of pollution at Inks Lake, and measures should be taken to rectify this as this considerably reduces the ecosystem services the lake provides (Charbonneau, 2020). Other common threats to lakes include:

- **Invasive species** — Introducing non-native species, such as aquatic plants or fish, can disrupt the natural balance of the lake ecosystem, out-competing native species and altering the habitat (Simberloff, 2009).
- **Habitat loss and fragmentation** — Encroachment of urbanization, agriculture, or infrastructure development near the lake can lead to habitat loss and fragmentation, disrupting natural ecosystems and reducing biodiversity (Fahrig, 2003).
- **Climate change** — Alterations in temperature, precipitation patterns, and hydrological cycles due to climate change can impact the lake's water levels, water quality, and overall ecosystem dynamics (Core Writing Team et al., 2015).

Valuation of Inks Lake

The use value of Inks Lake includes direct benefits from lake resources, like fishing and water supply, as well as indirect benefits, like nutrient cycling and carbon sequestration. Non-use value includes benefits like biodiversity preservation and aesthetic/cultural benefits. The non-use value of Inks Lake can be broken down into existence value, bequest value, and option value. Hedonic pricing is one of the methods of assigning a value to a lake using revealed preferences. However, due to no residents living near Inks Lake, this cannot be used. The travel cost method would require a survey to be conducted.

The valuation will be done with the benefit transfer method as a first approximation. With the range of values for lakes being a high of $78,804/ha/year and a low of $23,542/ha/year and the total area of Inks Lake being 4.3 ha, it yields benefits of USD 338,857 and a conservative value at USD 101,230 per year. Using a discount rate of 1.5% yields a natural asset value for the lake equal to USD 22.6 million and USD 6.75 million, respectively. Using the low rate of 0.1% to place importance on Indigenous people's valuation of water becomes USD 339 million and $101 million.

Table 1 shows a summary of the value of Inks Lake and its ecosystem services.

Table 1: Value of Inks Lake as a Natural Asset

Skip Table 1			
Valuation	**Ecosystem Services per year (in millions of USD)**	**1.5% Discount Rate (in millions of USD)**	**0.1% Discount Rate (in millions of USD)**
Average	338,857.2	22,590,480	338,857,200
Median	248,221.8	16,548,120	248,221,800
Conservative/ Modified Median	101,230.6	6,748,706	101,230,600

Concluding Remarks

From a practical standpoint, Inks Lake's existence supports the region's water security and enhances the quality of life for local residents. Furthermore, the recreational opportunities offered by Inks Lake cannot be overstated. The lake attracts outdoor enthusiasts, offering a myriad of activities. These activities foster a strong connection to nature and contribute to the local economy through tourism and outdoor recreation. Ecologically, Inks Lake supports diverse plant and animal species, forming a thriving habitat. This biodiversity plays a crucial role in maintaining essential ecological functions. Lastly, but most importantly, Inks Lake holds cultural and spiritual significance, particularly for Indigenous communities with historical and contemporary ties to the area. It serves as a place of cultural heritage, reflection, and connection to the land, reinforcing the intrinsic value of preserving and respecting these natural spaces.

In conclusion, Inks Lake is a scenic water body providing valuable ecosystem services. Its provision of water, recreational opportunities, biodiversity support, climate regulation, and cultural significance highlight the relationship between human well-being, sustainable development, and the health of natural ecosystems. Preserving and cherishing Inks Lake ensures the continued enjoyment of its ecosystem services for present and future generations.

Media Attributions

Figure 1: "FOU08056-Pano.jpg" by Murray Foubister (2021), via Flickr, is used under a CC BY-SA 2.0 license.

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7. Johnson Lake

CHUKWUEMEKA IKEGWU AND MARK BUTLER

About Johnson Lake

Johnson Lake is a secluded and relatively small alpine lake in British Columbia's Thompson-Nicola region (Angler's Atlas, n.d.d; Best Sun Peaks, n.d.b). It is located approximately 100 km northeast of Kamloops and takes around 70 to 90 minutes to drive there one-way (Best Sun Peaks, n.d.b). Dominating the landscape adjacent to the lake is the Samatosum Mountain peak, which provides breathtaking views of the surrounding area (Johnson Lake Resort, n.d.a).

Indigenous Value

The lake rests on the traditional lands of the Simpcw First Nation (British Columbia Assembly of First Nations, n.d.a). "The Simpcwúl'ecw are part of the Secwépemc, or Shuswap Nation- one of 17 Bands who historically (and currently) lived in the Thompson River Valley" (British Columbia Assembly of First Nations, n.d.a). The Simpcw people were traditionally renowned for their hunting capabilities and would lead nomadic lifestyles that depended greatly on the seasonal climate of the region (Simpcw First Nation, n.d.). In the

summer months, hunting camps were established where Simpcw people would use nets, spears, and weirs to fish, primarily for salmon. In addition to fishing, they would also hunt for wildlife in forests and fields and smoke or dry their meat for storage, which would last them well into the winter months until it was time to hunt again. Another common activity was plant harvesting, which played an integral role in procuring medicines and agricultural purposes.

Name Origin

The origin of Johnson Lake's name is unknown as it lacks any historically valid or official verification tools to authenticate claims that attribute its name to specific nomenclature. However, it can be inferred that First Nations people had previously named the lake, but, subsequently, a settler, newcomer, or explorer (presumably of Anglo-Norman descent) in the region had renamed the lake after their surname 'Johnson.' This assumption is based entirely on conjecture and supposition, as no evidentiary claims support or corroborate this assertion.

Geophysical Attributes

Johnson Lake's remarkably clear and vibrant blue-green hue is a product of water gradually seeping through its limestone

rock formation from the surrounding year-round subsurface springs and winter snowpack (Johnson Lake Resort, n.d.b). The lake is also in a riparian zone, characterized by "direct interaction between terrestrial and aquatic habitat," where trees grow right up to the lake's edge (Johnson Lake Resort, n.d.b; Swanson et al., 1982). This type of ecological zone is very sensitive to disturbances.

There are two bodies of water comprising Johnson Lake: Little Johnson Lake, which is designated for Johnson Lake resort guests, and Big Johnson Lake, which is open to the public (Hannah, 2023). There remains a severe lack of official data for assessing Johnson Lake in its entirety. There is insufficient evidence pertaining to Little Johnson Lake, in particular, as much of the information about Johnson Lake refers to Johnson Lake and Big Johnson Lake interchangeably. This confusion renders the generation of an accurate assessment that encapsulates Little Johnson Lake extremely difficult. In addition, extensive and exhaustive research only revealed the length of Little Johnson Lake and its respective depth; however, it lacked any specification regarding its width, which makes ascertaining its surface area problematic.

For simplicity's sake, the analysis will concentrate on Big Johnson Lake as synonymous with Johnson Lake. Johnson Lake is approximately 5 km long and 0.5 km wide, covering a total surface area of 2.5 km^2 (Johnson Lake Resort, n.d.b). The lake is elevated at 3,800 ft and is symptomatic of its cooler water temperatures (Best Sun Peaks, n.d.b). It maintains a maximum depth of up to 200 ft with an estimated average depth of 46.9 m. The total volume of water contained within

the lake is unknown, but it is roughly assessed to hold around 117.25 million cubic meters of water.

In addition, a protected narrow gravel-lined waterway (acting as a spawning channel) connects one end of Big Johnson Lake to Little Johnson Lake (Johnson Lake Resort, n.d.b). Every summer, Kamloops rainbow trout hatch and subsequently, the 'fry' travel to Big Johnson Lake using a specially built fish ladder in the spawning channel. This journey is nothing short of a magnificent spectacle that visitors can marvel at.

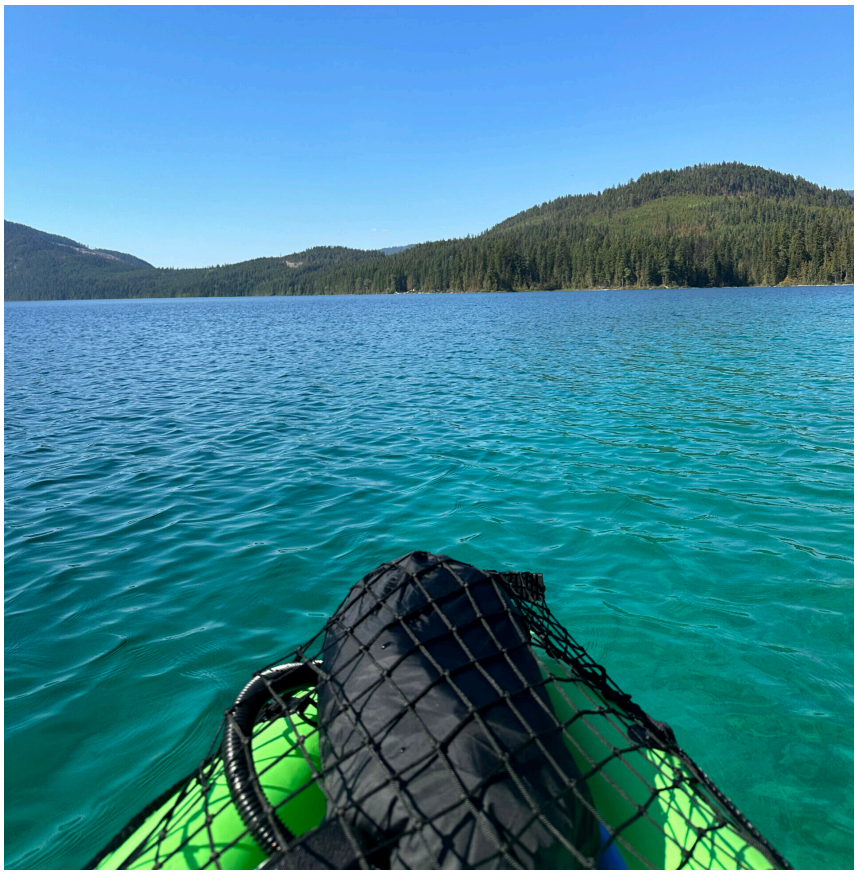

Figure 1: *Johnson Lake kayaking (Jessica Obando Almache)* CC BY-NC-SA 4.0

Recreational Activities

The Johnson Lake Resort, opened in 1952, is a quaint and private resort beside Little Johnson Lake offering visitors accommodation at one of the six self-contained cabins or one of their eight campsites that vary in size (Johnson Lake

Resort, n.d.b). Visitors to the lake can engage in various activities during the spring, summer, and even fall seasons. However, one emphasized caveat is the zero tolerance and strict adherence to rules prohibiting the use of high-powered motorboats, jet skis, motorbikes, and ATVs (Johnson Lake Resort, n.d.a). Some popular activities at Johnson Lake include fishing (fly, spin, troll), swimming, bird watching, wildlife viewing, canoeing, kayaking, hiking, mountain biking, and scuba diving.

Potential Ecological Issues

Regarded on social media as the "Caribbean of the North" (Kamloops This Week, 2015), Johnson Lake has garnered significant attention due to its isolated location, unique colour, and pristine water. This recent publicity has increased its popularity and attractiveness to many visitors seeking to marvel at the lake and capture a picture for social media.

Unfortunately, this sudden popularity has greatly increased the number of visitors coming to the lake, resulting in a massive strain on the ecosystem and interfering with the preservation of the surrounding area. The excessive increase in visitors also overloads the existing infrastructure's capacity because the facilities, including the public camping sites and the private resort, are not meant to handle that many people at once.

This development has sparked controversy concerning

overcrowding and negative environmental impacts on the delicate lake and its ecosystem that accompany increased traffic to the area (Daybreak Kamloops, 2015). A pattern of destructive behaviour has been observed with the increase in tourism, including smouldering fires left at campsites, trash (including toilet paper and feces) being scattered nearby campsites, and the creation of unsanctioned and unauthorized trails, which greatly disturb the integrity of the ecosystem.

In 2020, CBC News' Daybreak Kamloops wrote an article regarding the recent concerns about Johnson Lake recently and interviewed people familiar with the spot before it became an overnight sensation (Daybreak Kamloops, 2020). Kamloops resident Kathleen Karpuk told CBC's Daybreak Kamloops she was shocked by what she saw when she went to Johnson Lake for a paddle last weekend; there were dozens of tents pitched along the road outside the packed overnight campground and day-use area, new trails to the lake cut through the forest, and evidence of campfires.

CBC's publication highlights the shameful, depraved, and abhorrent behaviour that many ecologically fragile areas are subjugated to. The unsolicited and unsanctioned activities of ignorant or arrogant visitors propagate ecosystem destruction for the sake of social media validation and show a disregard for preserving nature. Newspaper articles with eyewitness accounts and anecdotal personal testimony are unlikely to impact the policies that govern natural resources, such as Johnson Lake, and may be dismissed as hyperbole. However, we believe that placing an undeniable and relevant

economic value on the lake (such as this publication strives to do) may sway the narrative towards inspiring concrete and decisive action to ensure its rights and existence are protected.

Ecosystem Services

Costanza et al. (1997) identified 17 ecosystem services of importance in their study. Every lake can concurrently supply a variety of ecosystem services; however, their exact output is determined by the physical attributes of the basin as well as the quantity, quality, and timing of water flow (Sterner et al., 2020). Johnson Lake provides a variety of significant ecosystem services that are critical for the overall health and wellbeing of the environment. Examples of the primary ecosystem services provided by Johnson Lake include

- **Water provision** — The lake provides potable drinking water and supplies untreated spring water to the Johnson Lake Resort (Johnson Lake Resort, n.d.b).
- **Recreational opportunities** — As a popular recreational destination, the lake and its surroundings offer visitors opportunities to engage in various activities such as wildlife viewing, camping, and hiking (Johnson Lake Resort, n.d.a).
- **Climate regulation** — The high elevation is responsible for cooler water temperatures, and this helps manage the local climate by providing humidification and reducing the impact of heat waves and extreme weather events (Best Sun Peaks, n.d.b).

- **Habitat for wildlife** — Johnson Lake is home to several fish, including rainbow trout, and other wildlife species, such as moose, deer, black bears, Canada lynx, and bald eagles (Best Sun Peaks, n.d.b).
- **Carbon sequestration** — Johnson Lake, sitting in a riparian zone with adjoining forested areas, including the Samatosum Mountain range, contributes to processes of carbon storage and conversion to oxygen, which are significant for reducing the effects of climate change (Johnson Lake Resort, n.d.a, n.d.b).

It is difficult to identify which of the lake's ecosystem services is considered the least vital because they all play an important role in contributing to the region's biodiversity. However, it is crucial to highlight that, under different conditions, the relative value of different ecosystem services can alter over time. As a result, they should all be considered precious and protected to ensure the delicate balance of human interaction and the conservation of Johnson Lake.

Valuation of Johnson Lake

Figure 2 represents the linkages between use and non-use values in the makeup of the total economic value of Johnson Lake. Use values, including direct and indirect use values, can be attributed to both economically based production and consumption values as well as non-consumptive values where benefits are generated from interaction (Armstrong et al., 2017) with the lakes. Non-use values occur innately from

nature itself, do not require interaction, and are merely speculated from its very existence or the value placed on the utility that may be extracted from future generations (Laurans et al., 2013).

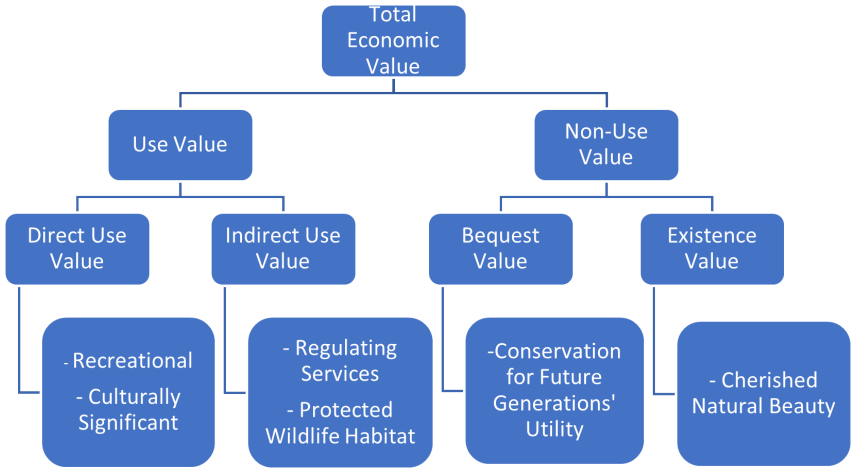

Figure 2: *Breakdown of the total economic value hierarchy of Johnson Lake, BC [Long Description]* CC BY-NC-SA 4.0

Understanding these economic values is critical to making informed decisions about managing and conserving the lake for future generations. Emphasizing these traits will assist in advocating the assortment of benefits ascribed to Johnson Lake and ensuring that their social, economic, and environmental value is safeguarded.

Methodology

Policymakers deploy various valuation methods to estimate the value of ecosystem services and address losses related to ecosystem degradation. These methods include contingent valuation, choice experiment, travel cost method, hedonic pricing, and benefit transfer method (BTM). For this study, we applied BTM because it's the most cost-effective method, and policymakers often utilize it because of constraints in time and funding (Johnston & Rosenberger, 2010). According to Plummer (2009), the BTM is a technique that estimates the overall economic value of one site by using the value of another site, known as the study site. The BTM allows you to apply previously acquired information about the cost per hectare of other lakes to Johnson Lake.

Value of Ecosystem Services

Determining a quantifiable economic value for Johnson Lake is essential for conveying the categorical importance of the ecosystem services it provides. This estimated value can be useful for policymaking in resource management, land usage extensions, and other functions that may influence the ecosystem's biodiversity. The estimations can portray a compelling rationale for prioritizing responsible environmental stewardship and sustainability in the face of trade-offs that underpin consequential decisions and

commitments for economic development and environmental conservation. Using the BTM to establish numerical benchmarks in a temporal economic assessment will reinforce Johnson Lake's position of significance. Using the estimated values of freshwater lakes derived from the Ecosystem Services Valuation Database (ESVD) was essential to commission an appropriate and tangible estimated economic value for Johnson Lake (Brander et al., 2023). The ESVD estimates the value of ecosystem services of Canada, the UK, and the USA in International dollars per hectare per year, which can be found in **Table I**.

We extrapolated the total estimated economic values of ecosystem services by ascertaining the surface area of Johnson Lake in hectares and multiplying that area by the totals in each ecosystem services category in **Table I**. Then, we discounted the values accordingly. We implemented two social discount rates to determine the quantitative value of Johnson Lake as a natural asset. The first was an upper-end, but still relatively modest, social discount rate of 1.5%. The second was a very low rate of 0.1%, which accounted for the importance of Indigenous people's valuation of water streams. We used these rates to calculate the present value of future flows based on a long-term evaluation of the lake's ecosystem services.

Table 1 shows a summary of the value of Johnson Lake using these rates.

Table 1: Value of Johnson Lake as a Natural Asset

Valuation	Ecosystem Services per year (in millions of USD)	1.5% Discount Rate (in millions of USD)	0.1% Discount Rate (in millions of USD)
Average	19.7	1,313	19,701
Median	14.4	962.1	14,431
Conservative/ Modified Median	5.8	392.3	5,885

In **Table 1**, the 1.5% discount rate used in the analysis generated a more conservative valuation, whereby the value of Johnson Lake is, on average, $1,313 million, the median valuation being $962.1 million, and the modified median valuation sitting at $392.3 million. Applying the lower-end discount rate of 0.1% resulted in higher economic values attributed to Johnson Lake for an average of $19,701 million, a median of $14,431 million, and a modified median of $5,885 million, respectively. These numbers depict an unequivocal basis for the importance of the ecosystem services hosted by Johnson Lake, without the use of hyperbole, and are part and parcel of the overall basis for the need to protect, preserve, and maintain the lake.

Concluding Remarks

Johnson Lake provides immensely valuable ecological services that benefit humans, wildlife, and the environment. However, due to the lake being in a riparian zone and recent public

exposure, Johnson Lake is vulnerable and prone to environmental depredation and misuse/mistreatment, resulting in the deterioration of the lake and its surrounding areas. By emphasizing the importance of advocating for policies to protect the environment and the related services they provide, efforts can be made to assure sustainability for future generations. The valuation of Johnson Lake's ecosystem services is significant because it helps users comprehend its economic value and, ideally, persuades policy and development considerations towards a stance emphasizing preservation. In conclusion, Johnson Lake is a treasured part of nature and one example of the immense potential of natural resources and a plethora of ecosystem services that people can experience from the lake.

Media Attributions

Figure 1: "Johnson Lake kayaking" by Jessica Obando Almache (2024) is used under a CC BY-NC-SA 4.0 license.

Figure 2: "Breakdown of the total economic value hierarchy of Johnson Lake, BC" by the authors is under CC BY-NC-SA 4.0 license.

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Long Descriptions

Figure 2 Long Description: A tree diagram that breaks down the total economic value of Johnson Lake. Starting from the

top, Total Economic Value is broken down into Use Value and Non-Use Value. Use Value is divided into Direct Use Value and Indirect Use Value. For Direct Use Value, examples include recreational and culturally significant. For Indirect Use Value, examples include regulating services and protected wildlife habitat. Non-Use Value is divided into Bequest Value and Existence Value. Bequest Value includes conservation for future generations' utility, while Existence Value includes cherished natural beauty. [Return to Figure 2]

8. Stump Lake

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About Stump Lake

Situated along the old Princeton Kamloops Highway (Highway 5A), Stump Lake lies 40 km south of Kamloops and 40 km north of Merritt (Stump Lake Life, n.d.a). As shown in Figure 1, the lake is about 11 km long and surrounded by rolling hills in the Nicola Valley grasslands (BC Geographical Names, n.d.). The coordinates of Stump Lake are 50°22'59" N and 120°20'04" W. According to the inventory carried out by the Ministry of Environment, Lands, and Parks, the surface area of water is 708 ha, with a maximum depth of 6.9 m and a minimum depth of 2.2 m, and a shoreline perimeter of 2,218 m (Hoffman & Jantz, 1999).

According to belief, Stump Lake is a relatively recent lake that emerged in the late 1700s after a spruce swamp survived natural flooding (Stump Lake Life, n.d.a). The name "Stump Lake" originated from the dead stumps of spruce trees that became visible after the swamp became submerged in water (Balf, 1978). Stump Lake holds significance in the history of the Indigenous people as it served as one of the primary settlement locations for the alliance between the Okanagan and Nlaka'pamux tribes, later known as the Nicola people.

Figure 1: *Stump Lake (Eric Ens/Wikimedia Commons) CC BY-SA 4.0*

Recreational Activities

Stump Lake was once known for its huge trout fish of 15 lb (British Columbia Adventure Network, n.d.c). The lake is home to rainbow trout, Brook Trout, and Kokanee. Some fish species, like Kokanee and rainbow trout, have been released into the lake to test survival (Kamloops This Week, 2006). The lake still produces large amounts of fish. Spring and fall are the best fishing seasons (British Columbia Adventure Network, n.d.c). Out of 110 lakes in British Columbia that harbour Kokanee Salmon fish, Stump Lake was placed among the Top 10 most productive sites for Kokanee (Fougere, 2022). The main reasons for this productivity were the nutrient-rich water and lower angler pressures. It also provides an opportunity for angling.

Stump was once known for Force Ten Summer Class, a major sailing event. Activities like windsurfing and ice fishing were conducted there (Atkinson et al., 1999). Experts reported that Stump Lake has 20 species of waterfowl, as many as 5000 birds some days, and many grass species such as Tullee, Napier, Richie, Trap, and Shumway.

Fun Fact — Stump Lake was a filming location for a few films and advertisements, including for Toyota, Hummer, Ford, and Harley Davidson (Chrome Catchers, n.d.b).

The scenic beauty of the lake is wonderful because grasslands surround it (Stump Lake Life, n.d.b). Because the lake is home to many game fish, fishing is a major attraction for visitors. Boating is also preferable when the day is not windy. Boating was once banned in Stump Lake as the water rose to a dangerous level (Kamloops This Week, 2017). The ban was lifted once the water level was normal, with caution regarding the speed limit and a towing policy.

Ecosystem Services

The materials, energy, and information from the lake ecosystem, in addition to human and physical capital, can bring about human welfare; however, when these lakes are

very remote, they are unlikely to be in human interest (Costanza et al., 1997). Using ecosystem services found by Costanza et al. (1997), some of the more prominent ecosystem services and goods provided by Stump Lake have been listed in **Table 1**.

Table 1: Stump Lake Ecosystem Services

Ecosystem Service	Function	Examples
Climate Regulation	Regulation of local temperature, precipitation, and other biologically mediated climatic processes	Greenhouse gas regulation, Cloud formation
Water Regulation	Regulation of hydrological flows	Water cycle, Retention of water, Aquifers
Nutrient Cycling	Nutrient storage, internal cycling, processing, and acquisition	Nitrogen fixation, Other elemental cycling (e.g., phosphorus)
Biological Control	Trophic-dynamic regulation of populations	Habitat for aquatic species (e.g., fish)
Genetic Resources	Source of unique biological material and products	Products for science, Genes for resistance, Ornamental species
Recreation	Opportunities for recreational activities	Ecotourism, Sport fishing, Boating, Sight-seeing
Cultural	Opportunities for non-commerical uses	Aesthetics, Education, Research
Food Production	Primary production of something extractable as food	Fish, Game crops, Nuts, Subsistence farming or fishing
Refugia	Habitat for resident and transient population	Habitat for locally harvested species

Note. Adapted from Costanza et al. (1997).

There is no denying the existence of other ecosystem services (e.g., waste treatment and raw materials) not included in **Table 1**; however, these services seem less significant in the context

of Stump Lake. Possible reasons for this insignificance can be the lake not having an outlet for water to leave the lake as well as increasingly severe and harsh environments (e.g., droughts, high pH values, and high mineral concentrations) (Kamloops This Week, 2006). The total economic value is the sum of the use and non-use values. Pearce (1987) defined total economic value as the sum of three distinct categories: actual use value, option value, and existence value (Thomas et al., 1991).

Figure 2 shows a breakdown of the ecosystem services and economic applications that can be extracted from Stump Lake.

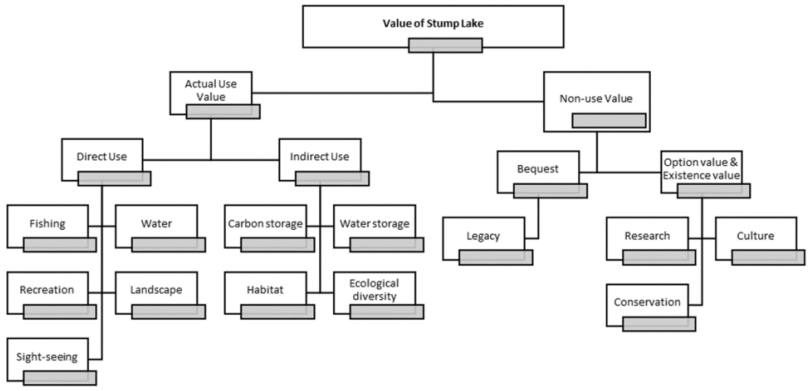

Figure 2: *Value of Stump Lake ecosystem services [Long Description]* CC BY-NC-SA 4.0

Valuation of Stump Lake

Methodology

Freshwater lakes have tremendous ecosystem services to human beings, including market goods (e.g., water) and non-market goods and services (e.g., biodiversity) (Schallenberg et al., 2013). However, all of the services provided by freshwater bodies are not easily observable, often difficult to monetize, and not given adequate weightage in policy formulation (Costanza et al., 1997; Schallenberg et al., 2013). Meanwhile, there has been a significant body of works by natural scientists such as Costanza et al. (1997), Daily (1997), and Pimental et al. (1997), helping us understand the value of invaluable services provided by ecosystem functions (Pimentel, 1998).

The benefit transfer method (BTM) has been used to estimate the value of ecosystem services provided by Stump Lake. The BTM involves using information on the economic value of ecosystem services from a similar ecosystem and applying it to the target site, in this case, Stump Lake. Plummer (2009) defines the benefit transfer method as a technique for estimating the total economic value of a site. The benefit transfer method is advantageous because it allows for using previously collected data on the estimated value of other ecosystems, which is readily available and cost-effective when working with limited resources.

Results & Discussion

Table 2 presents the value of ecosystem services per year and the value of the Stump Lake. It is not easy to put dollar value to natural goods and services. However, measuring their values is essential to use them wisely and properly and to protect the lake from overexploitation. When considering the history, area, and varied ecosystem services that Stump Lake provides, the value of resources in a conservative way was found to be approximately USD 17 million per year. The ecosystem services keep on rendering its services continuously. The Table also shows the value of Stump Lake. Using a 1.5% discount rate, the conservative estimate of the value of the lake is $1.1 billion; meanwhile, a 0.1% rate that places importance on the long term, including Indigenous usage, yields a value of USD 17 billion.

Table 2: Value of Stump Lake as a Natural Asset

Value Type	Ecosystem services per year (710 ha)	1.5% Discount Rate (in millions, USD)	0.1% Discount Rate (in billions, USD)
Average	55,950,840	3,730	56
Median	40,985,360	2,732	41
Modified Median	16,714,820	1,114	16.7

Concluding Remarks

Stump Lake is an important and beautiful place for Kamloops and British Columbia due to its location, size, and many different ecological services it provides. Although the lake provides an opportunity for fishing and boating, there is a fairly low turnout of visitors due to a lack of information and no promotional events. The valuation method employed here makes a rational inference about the value of Stump Lake based on previous studies of similar ecological sites. Using the travel cost or hedonic price method would give us more accurate and reliable information than the lake actually renders. We hope that after revealing valuable information and insights about the lake, the value of the lake will be appreciated, and proper initiatives will be taken in general to sustain ecosystem services and the lives that rely on them.

Media Attributions

Figure 1: "0200809-104923-Original" by Eric Ens (2020), via Wikimedia Commons, is used under a CC BY-SA 4.0 license.

Figure 2: "Value of Stump Lake ecosystem services" by the author is under a CC BY-NC-SA 4.0 license.

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Long Descriptions

Figure 2 Long Description: A tree diagram that breaks down the value of Stump Lake. Starting at the top, the Value of Stump Lake is broken down into Actual Use Value and Non-Use Value. Actual Use Value is further divided into Direct Use and Indirect Use. For Direct Use, examples include fishing, water, recreation, landscape, and sight-seeing. For Indirect Use, examples include carbon storage, water storage, habitat, and ecological diversity. Back to Non-Use Value, it is further

divided into Bequest and Option Value/Existence Value. Bequest includes legacy, while Option Value/Existence Value includes research, culture, and conservation. [Return to Figure 2]

9. Paul Lake

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About Paul Lake

The name of the lake orginated from the nickname of the fur trader Jean Baptiste Lolo (Balf, 1978). Paul Lake is a picturesque destination that captures the attention of all its visitors. Located in the Thompson-Nicola region of BC, a traditional territory of the Secwépemc Indigenous people, it is just a 30-minute drive away from northeast Kamloops (BC Parks, 2022). The lake is easily accessible via two routes, either 5 km along Highway 5 followed by 19 km along Pinantan Road or directly off Highway 1.

Surrounded by beautiful forests of Douglas fir, pine, and aspen, the lake spans 6.1 km in length and 0.48 km in average width, with a surface area of 390 ha and a maximum depth of 55.5 m (BC Parks, 2022). The lake is named after Jean-Baptiste Lolo St. Paul, a French-Canadian Iroquois man who worked as an interpreter at the Hudson's Bay Company (HBC) during the fur trade era and was given a chief title by HBC in 1841 (Kamloops This Week, 2022).

The lake and its surrounding area offer a unique experience for visitors, allowing them to enjoy the natural beauty of the ecosystem. The site is home to abundant wildlife, including

mammals, raptors, songbirds, reptiles, and amphibians (BC Parks, 2022). As a popular recreational destination, it also provides activities such as fishing, hiking, cycling, boating, camping, swimming, and wildlife viewing for visitors. With its variety of potential ecosystem services, this lake delivers tremendous benefits to society and the environment.

Indigenous Value

In BC, lakes hold important cultural, spiritual, and practical value for Indigenous people. Indigenous communities, such as the Secwépemc Nation, deeply connect to the land and its water bodies, using them for sustenance, transportation, and cultural practices. Indigenous perspectives focus on harmony between humans and the environment, recognizing the interconnections of all living beings (Ignace & Ignace, 2017). They believe in maintaining the health and wellbeing of lakes as part of their responsibilities for the land. Indigenous communities also advocate for sustainable practices and responsible resource management, calling for collaboration between Indigenous groups, government agencies, and environmental organizations to address ecological issues that threaten the wellbeing of these lakes (Simms al., 2016).

> "My community is one of the 32 traditional campfires that make up the Secwépemc nation. My community is called Simpcw First Nation which means "People of the Rivers" because there are so many lakes and rivers in our territory that we are responsible for. Traditionally, the waterways were our highways, and they kept us connected to other communities and nations."
>
> — **Tina Matthew**, Executive Director, Office of Indigenous Education, Thompson Rivers University

Potential Ecological Issues

Paul Lake is also susceptible to the ongoing ecological problems the world faces today. Climate change is one of the most dangerous threats to Paul Lake (Government of British Columbia, n.d.). Increasing temperatures, along with shifting precipitation patterns, can lead to water level imbalances, causing damage to the overall health of the aquatic ecosystem. As a result, the livelihood of native fish species and other aquatic life could decline.

Moreover, Paul Lake could also face the risk of pollution from human activities, such as littering. While Paul Lake is a popular tourist spot for activities such as boating, fishing, and camping, the volume of waste generated by tourists has

increased substantially over the years (Kamloops Trails, n.d.b). Recreational trash, including plastic bottles and food wrappers, seriously threatens local species (Government of Canada, 2010). Aquatic life, such as fish, turtles, and waterfowl, may accidentally ingest small pieces of plastic or become entangled in discarded fishing lines.

Invasive species pose another significant ecological challenge for Paul Lake (Government of Canada, 2017). The introduction of non-native plants and animals, either deliberately or accidentally, can lead to the disruption of the native ecosystem. Newcomers may outcompete local species for resources, eventually leading to a decline in biodiversity and a destabilized ecosystem.

Figure 1: *Paul Lake Provincial Park (Koppertone/Wikimedia Commons) CC BY-SA 4.0*

Valuation of Paul Lake

In regard to Paul Lake, it is essential to consider its unique ecological makeup, which can provide specific ecosystem services. According to Costanza et al. (1997), 17 potential ecosystem services can be estimated for a lake. For Paul Lake, the most important ones include water regulation and supply, biodiversity and refugia, food production, climate regulation, cultural significance, recreation, and biological control. On the other hand, services such as raw materials and soil formation may not be applicable.

Table 1 briefly explains the inclusion and exclusion of these ecosystem services in the context of Paul Lake.

Table 1: Importance of Paul Lake Ecosystem Services

Ecosystem Services	Importance	Reason
Water Regulation & Supply	Yes	It is quite self-explanatory that lakes can regulate hydrogen flow and provide water for agricultural, industrial, and human needs.
Biodiversity & Refugia	Yes	The Paul Lake region and its environs provide a habitat for a wide variety of mammalian, plant, and aquatic species. The area's diverse range of temperatures and nutrient levels also create favorable conditions for many different types of organisms.
Food Production	Yes	Many fish species live in Paul Lake, such as rainbow trout, kokanee salmon, and redside shiner, that are used for food.
Climate Regulation	Yes	Paul Lake can regulate local and regional climates by modifying air temperature, humidity, and other climate factors.
Culture	Yes	Paul Lake's ecosystem has educational, aesthetic, and scientific purposes. It can teach people in the community to appreciate the values brought by the lake that support their livelihood.
Biological Control	Yes	Paul Lake offers an important setting to form the prey and predator food chain and maintains the population balance among various species.
Recreation	Yes	Paul Lake can offer a range of recreational activities, including fishing, hiking, cycling, boating, camping, swimming, and observing wildlife.
Raw Materials	No	Paul Lake does not provide a sufficient amount of raw materials for extraction, but its surrounding forests can provide log supplies.
Soil Formation	No	Soil is mainly produced by the process of weathering and natural erosion on rocks.

Note. Adapted from Paul Lake Provincial Park Management Plan by BC Parks (2022).

Total economic value can typically be broken down into use and non-use values. Bastien-Olvera and Moore (2021) noted

that use values can arise when natural resources are used as input for economic activities. On the other hand, non-use values (e.g., bequest value — the ability for future generations to benefit from nature, and existence value — the knowledge of the existence of certain species and ecosystems) can arise from knowing or preserving the existence of natural systems and species, regardless of whether they are consumed or not.

Figure 2 shows the general breakdown of total economic value in a tree diagram.

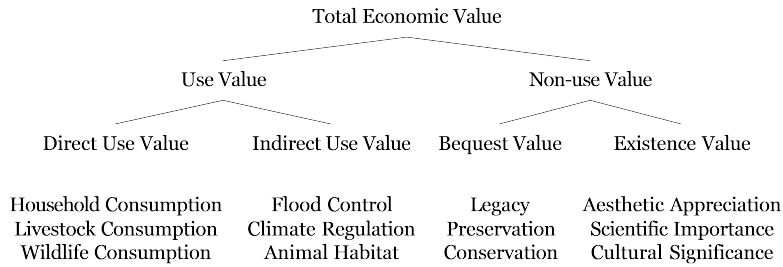

Figure 2: *Breakdown of total economic value [Long Description]* CC BY-NC-SA 4.0

Regarding the direct use value of Paul Lake, the lake can be used for household, livestock, and wildlife consumption. The concept of direct lake usage is pragmatic and illustrates that humans and other species are dependent on the lake for survival or, sometimes, for enjoyment. For instance, the lake can offer a range of recreational activities for humans to enjoy and provide freshwater consumption to alleviate dehydration. However, the indirect value may refer to the utilities an

individual may obtain without using the resource (Humphreys & Fowkes, 2006). Flood control, climate regulation, and animal habitat fall under this category. Without these natural barriers from lakes, humans and other species may suffer from the environmental hazards that lakes could have mitigated. In the case of extreme heat during the summertime, animals can resort to the lake to cool themselves down.

Finally, in terms of bequest value, conserving the lake could preserve its historical heritage and leave rich natural resources for future generations to consume. If younger generations can still enjoy a similar level of utility brought by the lake in the future as today, it would ensure that the benefits of the lake are sustained. The existence value could be intrinsic in nature. To the extent that people believe that the ecosystem has intrinsic value, this would partially reflect the existence value they are willing to pay for (Davidson, 2013). For example, Paul Lake has significant scientific research value. As a case study, learning how it functions could be an example applicable to other lake sites. In this regard, ecologists might place a high value on the lake.

Methodology

Lakes provide ecosystem services that are not usually traded in the market, making it challenging to determine their value through the price system (Reynaud & Lanzanova, 2017). Various valuation methods have been developed to help

policymakers address losses related to biodiversity and ecosystem degradation. These methods include revealed preference, contingent valuation, and the benefit transfer method (BTM) (Johnston & Rosenberger, 2010). The BTM is the most cost-effective method, relying on information from previous studies to estimate welfare at different sites (Boyle et al., 2010). It employs value or statistical functional transfer approaches, generally favouring equation transfers when valuation sites share similar characteristics (Boyle et al., 2010). Policymakers often utilize the BTM for cost-benefit analysis due to constraints in time and funding (Johnston & Rosenberger, 2010).

In this study, we apply the hedonic benefit transfer function (specifically, the ML3 specification) from Reynaud and Lanzanova (2017) to estimate the use value of Paul Lake, along with the average and median values from the Ecosystem Services Valuation Database (ESVD) to evaluate the total value (Brander et al., 2023). By using both methods, we can obtain a comprehensive understanding of the economic benefits associated with Paul Lake.

Results & Discussion

Paul Lake offers a range of crucial benefits to society and the environment, but accurately estimating their economic value can pose significant challenges due to the complex and interconnected nature of natural ecosystems. These

valuations could serve as perpetuities that return money every year. **Table A** in the appendix presents a conservative estimate of approximately $901,000 per year for the lake's total use value. However, this value is substantially lower than the total economic value of $6.3 million per year in **Table B** in the appendix. The low estimate is primarily attributable to the uncertainty and lack of data regarding the characteristics of Paul Lake, which necessitated substituting several variables with a value of zero.

Additionally, this measurement does not account for the non-use value of ecosystem services provided by the lake. In contrast, **Table I** presents a more extensive study sample size of lake ecosystem services and provides a mean, median, and modified median of the total economic value per hectare. A broad estimation, ranging between $6.3 million and $21 million, can be obtained by multiplying the total lake area by the economic value per hectare value.

Table 2 provides a summary of all of the results described above.

Table 2: Value of Paul Lake as a Natural Asset

Value Type	Ecosystem Services per year	0.1% Discount Rate	1.5% Discount Rate
Use Value	901,689	901,689,000	60,112,600
Average	6,309,256	6,309,256,000	420,617,067
Median	15,470,569	15,470569,000	1,031,371,267
Modified Median	21,119,472	21,119,472,000	1,407,964,800

These valuations of Paul Lake can also serve as perpetuity estimations that return a percentage of investment each year. I include both a low discount rate of 0.1% and a high discount rate of 1.5% for the total value estimation. A low discount rate places more emphasis on the value for future generation. At 0.1%, the total value of the lake can range between $901 million and $15 billion, with the median being $6.3 billion. On the other hand, at 1.5%, the total value of the lake can range between $60 million and $1.4 billion, with the median being $420 million.

The research aims to showcase the potential of assigning a monetary value to a lake, considering both tangible and intangible economic values it offers to the surrounding communities. By quantifying a lake's benefits, the study seeks to raise awareness among local stakeholders about the importance of these natural resources. The investigation reveals two conservative estimates of the lake's worth: the use value, which encompasses direct and indirect benefits, stands at $1.35 million, while the total value, incorporating the intrinsic and existence values, amounts to an impressive $6.3 million. These findings emphasize lakes' crucial role in supporting local economies and promoting their overall well-being.

Concluding Remarks

In conclusion, the study of Paul Lake highlights lakes' diverse

ecosystem services and values, including water regulation, biodiversity, food production, cultural significance, recreation, and biological control. The analysis underlines the significance of direct use values, indirect use values, bequest values, and existence values in the economic assessment of these natural resources. The study quantifies these benefits and highlights lakes' essential role in supporting the environment and local communities. The monetary valuation of Paul Lake ranges from a conservative estimate of $901,000 per year to a more extensive evaluation of up to $21 million per year, emphasizing the importance of incorporating a range of methodologies to capture the complexity of ecosystem services. Moreover, examining ecological challenges, such as climate change, pollution, and invasive species, as well as integrating Indigenous perspectives, adds to the holistic understanding of lake conservation and management.

Appendix

Table A: Hedonic Benefit Transfer Function of Ecosystem Services

Ecosystem Services	ML3	Mean	Product
Constant	1.40	1	1.40
Peer Reviewed	-0.78	0	0
Scenario Improve	0.56	0	0

Scenario Location	-1.43	0	0
Scenario Quality	-0.94	0	0
Scenario Quantity	-5.45	0	0
Scenario Ecological	-0.16	0	0
Scenario View	3.18	0	0
Scenario Other	2.00	0	0
Substitute Included	1.80	0	0
Spatial Model	0.16	N/A	0

Ecosystem Services	**ML3**	**Mean**	**Product**
Natural	-0.45	0	0
[1,20] km2	-0.2	1	-0.2
[20,1000] km2	0.44	0	0
> 1000 km2	1.56	0	0
UNESCO Heritage	-1.63	0	0
Special Area	0.83	0	0

Ecosystem Services	**ML3**	**Mean**	**Product**
In GDP per capita	0.42	10.79	4.53
Water Stress	0.36	0	0
Drought Index	0.05	0	0
In Lake Abundance	0.19	0	0
Europe Region	1.9	0	0
North America Region	1.4	1	1.40
Pacific Asia Region	1.58	0	0

Sum of Product	**Value (per unit per year) (in 2020 USD)**	**# of Properties**	**Total Recreational Value**
7.13	1,248.88	722	901,689.17

Note. Properties located within a 5-mile radius of the lake were gathered using ArcGIS (geoprocessing software). This crosswalk was achieved by placing the centre of the properties within the defined radius. 722 units were successfully located. This information is from ParcelMap BC Parcel Fabric by Data Systems and Services (DataBC) (2016).

Table B: Value of Paul Lake Ecosystem Services

Ecosystem Service	# of Values	Average	Median	Modified Median
Food	21	1,206	136	136
Raw Material	4	201	191	191
Water	2	19,111	19,111	—
Total	27	20,517	19,437	427

Ecosystem Service	# of Values	Average	Median	Modified Median
Maintenance of Genetic Diversity	1	1,050	1,050	—
Maintenance of Life Cycle	2	742	742	—
Total	3	1,792	1,792	—

Ecosystem Service	# of Values	Average	Median	Modified Median
Aesthetic Information	8	9,695	1,422	1,422
Opportunities for Recreation & Tourism	40	33,518	21,794	21,794
Inspiration for Culture, Art, & Design	1	12,743	12,743	—
Total	49	55,956	35,959	23,216

Ecosystem Service	# of Values	Average	Median	Modified Median
Moderation of Extreme Events	2	538	538	

Total	Average	Median	Modified Median
Value per year	21,119,472	15,470,568	6,309,256

Note. Adapted from **Table I** in the Introduction.

Media Attributions

Figure 12: "Paul Lake Provincial Park, British Columbia" by

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Figure 13: "Breakdown of total economic value" by the author is under a CC BY-NC-SA 4.0 license.

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Long Descriptions

Figure 2 Long Description: A tree diagram shows the breakdown of total economic value. Starting from the top, Total Economic Value is broken down into Use Value and Non-Use Value. Use Value is broken down into Direct Use Value and Indirect Use Value. For Direct Use, examples include household consumption, livestock consumption, and wildlife consumption. For Indirect Use, examples include flood control, climate regulation, and animal habitat. Back to Non-Use Value, it is broken down into Bequest Value and Existence Value. For Bequest Value, examples include legacy, preservation, and conservation. For Existence Value, examples

include aesthetic appreciation, scientific importance, and cultural significance. [Return to Figure 2]

10. Heffley Lake

SHIRLENA J. OUDITH AND TEMILOLUWA M. AKINOSHO

About Heffley Lake

Stunning mountains and thick forests surround Heffley Lake. The lake is named after Adam Heffley, a mining prospector who arrived in British Columbia during the gold rush of 1858 (Stewart & Broadfoot, n.d.). Located in the Thompson-Nicola Region of British Columbia, Heffley Lake is easily accessible by road and is approximately 40 minutes northeast of Kamloops, north of Highway 5 (Yellowhead Highway) (Angler's Atlas, n.d.b).

Heffley Lake was created by building a dam, which caused two lakes to merge (Best Sun Peaks, n.d.a). As a reservoir lake, it can store water and provide irrigation for the surrounding farms and ranches. In dry summers, like in 2017, the water level at Heffley Lake may be significantly lowered; during this time, surrounding ranches utilize the reservoir lake for their water needs.

The lake covers an area of approximately 195.4 ha and has a length of 7 km (Angler's Atlas, n.d.b; HookedOnBCLakes.com, n.d.). Its maximum depth is around 27, and it can be located on a map at the coordinates 50°50'6.000" N and 120°3'55.440" W (Best Sun Peaks, n.d.a; HookedOnBCLakes.com, n.d.).

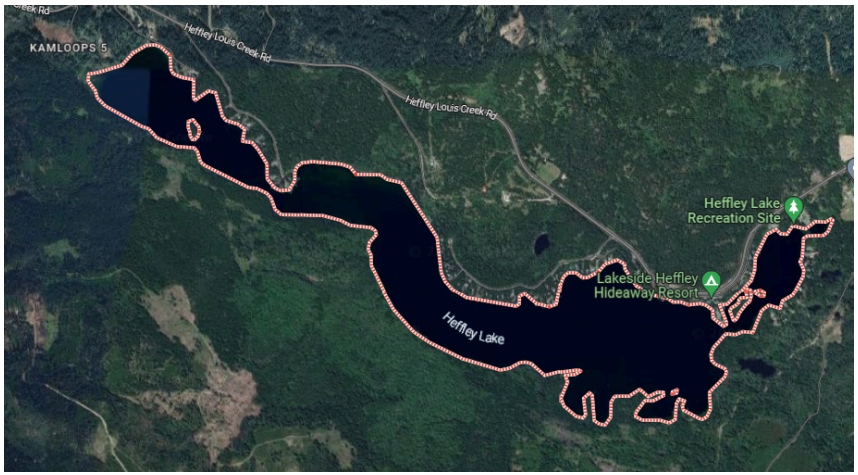

Figure 1: *Heffley Lake, Thompson-Nicola, BC (Airbus, CNES / Airbus, City of Kamloops, Maxar Technologies, Province of British Columbia / Google Maps) Google's Geo Guidelines*

Heffley Lake is a well-known recreational destination that offers a variety of outdoor activities throughout the year. In the summer, visitors can enjoy swimming, canoeing, kayaking, and other similar activities; in the winter, they can try ice fishing for the elusive Kamloops rainbow trout (Recreation Sites and Trails BC, n.d.b). The lake's narrowness and abundance of shoreline, featuring multiple islands and bays of various sizes, provide high-quality habitats for a diverse range of fish and wildlife species, including waterfowls (Heffley Lake Community Association, n.d.). Moreover, Heffley Lake is a popular fishing spot and home to sensitive breeding grounds on its shore for different wildlife and waterfowl (Best Sun Peaks, n.d.a; Heffley Lake Community Association, n.d.).

Heffley Lake is located near Sun Peaks, its neighbouring resort, and offers visitors stand-up paddle-boarding lessons and rentals (Best Sun Peaks, n.d.a).

Valuation of Heffley Lake

According to an article by Costanza et al. (2014), Heffley Lake provides several ecosystem services. Its primary ecosystem service is recreation and tourism. The lake and the neighbouring Sun Peaks resort offer various recreational activities and services that attract visitors year-round. Another service the lake provides is water, which is used for flow regulation, with a seasonal creek flowing into Heffley Lake and for irrigation purposes for nearby ranches and farms during dry summers (Stewart & Broadfoot, n.d.). In addition, the lake serves as a breeding ground for wildlife species and waterfowl, providing diverse food for these animals (Best Sun Peaks, n.d.a). The lake's aesthetic beauty is also an ecosystem service that provides cultural benefits to its visitors. Finally, Heffley Lake offers food production ecosystem service by being home to the Kamloops rainbow trout and other fish species for human consumption.

Figure 2 shows some of the total economic value with use and non-use values provided by Heffley Lake from this research.

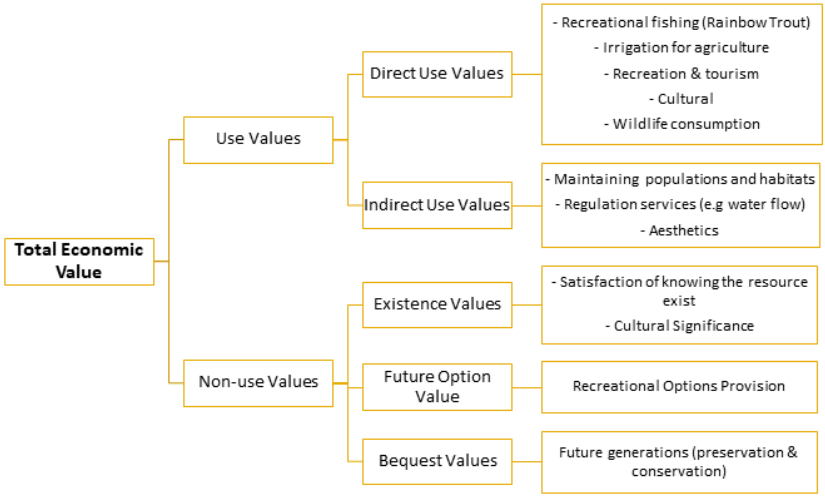

Figure 2: *Breakdown of Heffley Lake's total economic value [Long Description] CC BY-NC-SA 4.0*

Based on data from the Ecosystem Services Valuation Database, the value of lakes is estimated at $23,542/ha/year (Brander et al., 2023). The value of Heffley Lake with this figure is estimated to be $4.6 million (in 2020 USD value) per year. However, this is a conservative estimate as many ecosystem services are not included in the assessment. To properly assess the value of the lake as a natural asset, a discount rate of 1.5% is appropriate, given the increasing demand for these services over time. The value of the lake using this rate is estimated to be USD 307 million. Furthermore, if economic growth is limited due to the intensification of climate change, the asset value of the lake could increase to USD 4.6 billion using a discount rate of 0.1%. The latter valuation is more in line with Indigenous values

since they view nature not as a substitute for other forms of capital but as a natural asset and emphasize coexistence and respect between humans and nature.

Figure 3: *Canoe (Mike McHolm / Flickr)* CC BY-ND 2.0

Strong (2020) reported that Heffley Lake faced challenges in August 2020 due to large crowds exceeding the lake's traffic capacity during a heatwave. As a result, the local community

association and Kamloops Recreation District began to consider managing vehicular traffic. The increased number of visitors also led to increased waste, noise pollution, and theft, particularly affecting those living on the lake. The Recreation Sites and Trails BC division of the Kamloops Recreation District is working to address these issues by developing sites that balance carrying capacity, sustainability, and other locally and provincially available opportunities.

Concluding Remarks

In conclusion, Heffley Lake is a valuable natural asset that provides various ecological services to all its users, including recreation and tourism, water regulation, wildlife habitat, aesthetic benefits, and food production. The estimated value of the lake is significant, surpassing the average cost of real estate within the area. This figure highlights the importance of Heffley Lake and its ecosystems for the current and future generations. It is essential for policymakers to consider the value of Heffley Lake in developing policies that promote sustainability, conservation, and preservation of the lake and its environs.

> "Séwllkwe (water) is an important aspect of our lives for ceremony, healing, our livelihoods and survival. Séwllkwe brings forward and sustains life in powerful ways."
>
> — **Tina Matthew**, Executive Director, Office of Indigenous Education, Thompson Rivers University

It should be noted that this study employed the benefit transfer method to assess the value of the ecosystem services provided by Heffley Lake. Nevertheless, to obtain a more precise value for these services, future studies may consider using the hedonic or travel cost methodology and comparing those results with this study. With more research and data available, the importance of the lake's ecosystem can be emphasized, leading to the development of new policies and the strengthening of existing ones to improve the management and preservation of this natural asset.

Media Attributions

Figure 1: "Heffley Lake, Thompson-Nicola, BC" by Airbus, CNES / Airbus, City of Kamloops, Maxar Technologies, Province of British Columbia (2023), via Google Maps, is used under Google's Geo Guidelines.

Figure 2: "Breakdown of Heffley Lake's total economic value" by the authors is under a CC BY-NC-SA 4.0 license.

Figure 3: "Canoe" by Mike McHolm (2013), via Flickr, is used under a CC BY-ND 2.0 license.

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Long Descriptions

Figure 2 Long Description: A sideways tree diagram showing the breakdown of total economic value with examples from Heffley Lake. Starting on the left side, Total Economic Value is broken down into Use Values and Non-Use Values. Use Values can be further divided into Direct Use Values and Indirect Use Values. For Direct Use Values, Heffley Lake examples include recreational fishing (rainbow trout), irrigation for agriculture, recreation and tourism, cultural, and wildlife consumption. For Indirect Use Values, Heffley Lake examples include maintaining populations and habitats, regulation services (e.g., water flow), and aesthetics. Back to Non-Use Values, they can be further divided into Existence Values, Future Option Value, and Bequest Value. For Existence Values, Heffley Lake examples include satisfaction of knowing the resource exists and cultural existence. For Future Option Value, Heffley Lake examples include recreational options provision. For Bequest

Values, Heffley Lake examples include future generations (preservation and conservation). [Return to Figure 2]

11. Jacko Lake

STEPHANIE E. PAUL AND SARA S. NATEA

About Jacko Lake

The name of the lake originated in and around 1855 from Alex Jacko a shadowy half-breed person who worked sometime for the Hudson Bay company (Balf, 1978). Jacko Lake is located 7 km south of Kamloops. The entire area surrounding the lake is known as "Pipsell" to the Secwépemc people (Rothenburger, 2015). The lake is 40.5 ha with a mean depth of 8.8 m (29 ft) and a maximum depth of 22.9 m (75 ft). It lies 891 m (2923 ft) above sea level and flows into Peterson Lake, exiting the lake south into downtown Kamloops and eventually to Thompson River (British Columbia Adventure Network, n.d.a). The biome supports a high biodiversity of red- and blue-listed endangered birds and animals. It is home to 13 bird species, 90 different medicinal plants, 45 distinct food plan species, and 39 species of animals — 13 of which humans use as food sources (Stk'emlúpsemc te Secwépemc Nation, 2017).

Recreational Activities

In less than half an hour, this is an ideal fishing destination. The province has been stocking Jacko Lake with fish,

primarily rainbow trout, since the 1950s (Brothen, 2015). In the past, it was well-known for huge fish. The chemistry in Jacko Lake is superior to most lakes, with rainbow trout reaching 76 cm (30 in) and weighing over 4.5 kg (10 lb) (Brothen, 2015; Lund, 2017). The lake has two boat launches with exceptional fishing and paddling conditions (Kamloops Kayak, n.d.). It contains small bays bordered by grasslands with little tree coverage, allowing for the easy 3.5-km trail walk to cast at various locations (KamloopsTrails, 2013). "One of the biggest misconceptions is this lake is man-made. It's not; it's man-enhanced," says Stephen Maricle, a biologist with the Department of Fisheries and Oceans (Brothen, 2015).

Indigenous Value

The Pipsell cultural area holds historical significance to the Tk'emlupsemc te Secwépemc and Skeetchestn Indian Band, also known as Stk'emlupsemc of the Secwépemc Nation (SSN). (Ignace & Ignace, 2017). It was one of the first places in spring where the Secwépemc people came to get their food, medicine, and plants (Klassen, 2016). KGHM Ajax applied to develop a copper and gold mine in the Jacko Lake area (Brothen, 2015). In 2016, the project was estimated to cost about CA$1.3 billion (Zeidler, 2017). The project did not proceed because the Secwépemc people claimed the area had high cultural value (Rothenburger, 2015). SSN made a Declaration of Title on Pipsell (Jacko Lake) to continue to hold and benefit from the lands for its current and future members and other local communities.

"Pípsell is a cultural keystone area that must be preserved in a state consistent with the traditional importance of the site to the Secwépemc people. Pípsell must only be used in ways that preserve and sustain the area, and which allow for the culture of the Secwépemc people to be exercised and maintained."
Stk'emlúpsemc te Secwépemc Nation (SSN) (2017)

Ecosystem Services

The ecosystem services valuation by lakes depends on the lake's location and the physical, economic, and geographic characteristics (Reynaud & Lanzanova, 2017). It is the many direct and indirect benefits that nature provides to society. The direct uses include:

- **Usage for recreation** — Jacko Lake is well-liked for outdoor pursuits like boating, paddling, and fishing. The many lakes and their surroundings provide natural beauty that attracts visitors from all over the world.
- **Wildlife habitat** — Fish, amphibians, and birds are just a few of the natural species that benefit from the lake's crucial ecosystem (Stk'emlúpsemc te Secwépemc Nation, 2017). This environment promotes crucial biological processes and supports biodiversity.
- **Cultural use** — The nearby Indigenous people, who have long-standing uses for the lake and its surroundings, place high cultural significance on Jacko Lake (Ignace & Ignace, 2017; Klassen, 2016). Fishing and gathering of plants and other natural resources are examples of this.
- **Aesthetic Value** — The lake and the surroundings contribute to the aesthetic significance, providing a lovely backdrop for artwork like paintings and photographs. It is a perfect lake for wildlife, watching the various birds and animals in the area.

On the other hand, indirect uses of the lake include:

- **Water supply** — The neighbouring city of Kamloops receives

some of its drinking water from Jacko Lake (Kamloops This Week, 2020a). The lake aids in replenishing the aquifer that feeds the city's wells with water, which is necessary for uses like agriculture and industry.

- **Climate control** — By absorbing carbon dioxide and other greenhouse gases, the lake and its surroundings assist in controlling the local climate, which lessens the effects of climate change.
- **Flood prevention** — During heavy rainfall or snowfall, the lake can help prevent flooding by regulating the flow of adjacent streams and rivers (Kamloops This Week, 2020a). In addition, it provides drought recovery for years of low annual rainfall.

Non-use options of bequest and existence values benefit others now and in the future. The importance of the continence of Jacko Lake includes the protection and restoration of habitat, aesthetic values for scenic beauty, and cultural significance.

Figure 1: *Jacko Lake (Kamloops Daily News/ArmchairMayor.ca) Used with permission.*

Valuation of Jacko Lake

The Ecosystem Services Valuation Database (ESVD) was created from academic literature reviews of various ecosystem studies (Brander et al., 2023). The studies were screened according to the specific ecosystem services and identified people's trade-offs and willingness to pay for the ecosystem. The introduction of this book summarizes the monetary value for each service per biome based on the average, median, and modified median of the Canada, US, and UK studies. There is a variance between the three valuations based on the number of values produced from the ecosystem services database and those used per biome. The average is an optimistic valuation, while the median provides a more conservative assessment by removing the influence of

outliers. Finally, the modified median removes values occurring in only one or two studies to provide the most conservative value of ecosystem services per hectare per year.

These three assessments provide a range of lake valuations per hectare per year of $23,542, $57,726, and $78,804 for the modified median, median, and average, respectively. Applying these values to Jacko Lake, the total valuation of ecosystem services is $2,168,451, $2,337,903, and $3,191,562 each year.

A relatively high social discount rate of 1.5% is applied to assess the value of the lake as a natural asset; however, a very low rate of 0.1% is also used to respect the valuation of Indigenous people on water streams. The latter determines the present value of future flows from a long-term ecosystem assessment. The value of Jacko Lake with the 1.5% discount rate is USD 212.8 million, the median valuation is USD 155.9 million, and with the most conservative valuation, the modified median valuation is USD 144.6 million. However, using the low rate of 0.1%, the value of Jacko Lake is USD 2.17 billion for the most conservative estimate, USD 2.34 billion for

the median, and USD 3.19 billion using the average ecosystem services per year.

"This land is one of the first areas in spring that we come to to get our first proteins of fish, our medicine, our plants. All of that is important to us." Skeetchestn Indian Band Chief Ron Ignace (Klassen, 2016)

These amounts show that Jacko Lake's value alone surpasses the estimated value of KGHM Ajax's open pit copper and gold mine at CAD 1.3 billion when the lower discount rate is used (Zeidler, 2017). This analysis shows that the local SSN was right to reject the project as it would destroy this value of nature, which is worth more than what the project would replace. This figure also shows the importance for decision-makers to use the economic values of nature to assess trade-offs when determining whether to develop or protect and not assume they have a zero value. Failure to calculate the economic value of ecosystems that provide many benefits to the community will result in the price being zero and thus exploited by profit-maximizing corporations. This exploitation would result in the diminishment and loss of the total value of ecosystems (Jacko Lake).

However, the Pipsell area faces new threats. The Canada Energy Regulator recently approved Trans Mountain Corp.'s request to alter a 1.3 km pipeline route in the Jacko Lake area (Pipsell) near Kamloops due to tunnel construction challenges (Stephenson, 2023). The Stk'emlúpsemc te Secwépemc Nation, who holds spiritual and cultural values for the Pipsell area, opposed the change, having previously agreed only to the

original route. Trans Mountain Corp. noted that a rejection would mean a nine-month delay and cost an extra $86 million. This research shows that the additional $86 million is nothing when there is a significant risk of losing a natural asset valued conservatively at USD 2 17 billion.

Concluding Remarks

"Harmony means all things ringing true together."
Richard Wagamese (2013)

Indigenous people have strong ties to the natural world and all living creatures (Ignace & Ignace, 2017). The land and its natural resources, including lakes, connect spiritually and culturally to many Indigenous civilizations. Many Indigenous communities revere lakes as spiritual locations with healing and energy qualities. For instance, several Indigenous communities believe lakes either serve as the home of spiritual beings or as a connection to the spirit world. Additionally, Indigenous peoples rely on lakes for food, water, and other resources for survival. As a result, they frequently have a profound understanding of how crucial it is to preserve the health and well-being of the lake ecosystem. Overall, it is accurate to say that many Indigenous peoples place a high value on lakes and ecosystems because of their cultural and spiritual significance and importance to maintaining their identity.

Valuation is not commodification, but instead, signifies scarcity and importance. The benefits from the ecosystem services the lake provides are collective, just like the benefits of clean air. However, the market vastly undervalues these benefits; even this chapter undervalues them using conservative estimates representing a minimum valuation. Also, Indigenous peoples may have an implicit discount rate that approaches zero for this particular area. This rate means that the valuation of the land and lake approaches an infinite value, which allows nature to be in harmony with communities.

It is challenging to broadly generalize who might place little value on lakes because attitudes about natural resources can differ greatly depending on various factors, such as culture, geography, and economic situations. Nevertheless, some patterns involving this topic appear worldwide, especially in industrialized nations that consider lakes and other natural resources more as commodities used for financial benefits. These nations place less emphasis on safeguarding the lakes and precious ecosystems for current and future generations. Additionally, people frequently destroy lakes and other natural resources for short-term gains, such as through commercial development, water diversions, and overgrazing.

It is crucial to remember that these are generalizations and that opinions on lakes and other natural resources can differ significantly based on the unique cultural and socioeconomic setting. Their direct and indirect uses will ultimately influence the value people assign to lakes. The non-market valuation provides empirical evidence using a transparent, structured

system for public policymakers to use in all planning and decision-making stages to ensure the lake's sustainability.

> "Pipsell is a cultural keystone area which must be preserved in a state consistent with the traditional importance of the site to the Secwépemc people. Pipsell must only be used in ways which preserve and sustain the area which allow for the culture of the Secwépemc people to be exercised and maintained and which preserve the use of Pipsell for all Canadians in accordance with Secwépemc law."
>
> — **Pipsell Decision Declaration by the Stk'emlupsemc te Secwépemc Nation** (2017)

Media Attributions

Figure 1: "Jacko Lake" by Kamloops Daily News (2015), via ArmchairMayor.ca, is used with permission.

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12. Shuswap Lake

GISELE SHEMA

About Shuswap Lake

Shuswap Lake is a lake situated in the Shuswap region, British Columbia. It is named after the Shuswap people of the Interior Salish band, and the name may be derived from “sixwt”, meaning downriver (Akrigg & Akrigg, 1997). The region around the lake is home to the Little Shuswap Indian Band and the Adams Lake Indian Band, which are the First Nations band government of the communities of the Secwépemc (Adams Lake Indian Band, n.d.; British Columbia Assembly of First Nations, n.d.b).

Shuswap Lake is located approximately 347 m above sea level, and it forms an atypical H shape comprised of four long protrusions called Salmon Arm, Main Arm, Anstey Arm, and Seymour Arm (Ministry of Environment and Climate Change Strategy, 2022). The lake has an average depth of 62 m, a perimeter of 342 km, a surface area of 310 km^2, and a volume of 19 km^3. The Shuswap Lake has three relatively large drainage sources (Adams, Mabel, and Sugar Lakes) and flows into Little Shuswap Lake via the Little River from the Main Arm.

Ecosystem Services

Shuswap Lake offers many ecosystem services. The lake serves as a cultural and spiritual place for the Salish people, who live in the region, offers recreational activities (and park services), and serves as a water and food supply for the locals (Ministry of Environment and Climate Change Strategy, 2022). The city of Chase also uses the lake for water regulation and wastewater treatment. Those who use the lake for recreational purposes can enjoy many activities, including boating, fishing, canoeing, kayaking, swimming, whitewater rafting, birdwatching, and camping, along the many provincial parks on the lake shore. Shuswap Lake is part of the salmon life cycle that supplies the lakes in the regions with sockeye salmons as it serves as their home for the first year of life (Fisheries and Oceans Canada, 2019).

Potential Ecological Issues

In the news, Kamloops This Week (2020b) reported that an invasive species of Asian clam has been found in Shuswap Lake. Those clams can potentially impact the safe usage of the lake ecosystem services, mainly boat maintenance and fish abundance in the lake. Additionally, Wickett (2022b) reported the effect of climate change on the lake and the prevention of salmon spawning that was caused by low water levels. Furthermore, Wicket (2022a) reported an emerging algae

bloom in Shuswap Lake that resulted in drinking water advisory and suspension of activities such as swimming and a high level of E. coli that was found in the water sample near Sunnybrae Beach.

Figure 1: *Shuswap Lake (The Interior/Wikimedia Commons)* CC BY-SA 4.0

Valuation of Shuswap Lake

Shuswap Lake provides us with ecosystem services that are unique and beneficial to humans. However, since lakes are common goods, Shuswap Lake may be subject to

overexploitation and misuse, resulting in deterioration. Salles (2011) argues that "there is then a need, like for many assets involving public good aspects, to implement public policies based on efficiency considerations. In this perspective, evaluating ecosystems to improve information for decision-making has been repeatedly proposed." Valuation of ecosystem services provided by Shuswap Lake is important because it helps the users to understand its value, which is needed to develop systems to use it efficiently. This valuation will hopefully steer efforts toward conservation.

Total Economic Valuation

Patterson and Cole (2013) argue that the "TEV (Total Economic Valuation) of ecosystems, like any resource, consists of use value and non-use (passive) value. The passive-value component can be subdivided into option, bequest, and existence-value components." Shuswap Lake will probably derive most of its value from use values through many of its ecosystem services, especially recreation activities and from the non-use value of bequest for the Indigenous people who champion its conservation for the next generations. Additionally, the value of Shuswap Lake will be derived from areas outside the economic evaluation, such as nonmaterial human-nature connections (Gould & Schultz, 2021).

Figure 2 details the total economic value of Shuswap Lake in relation to the different values.

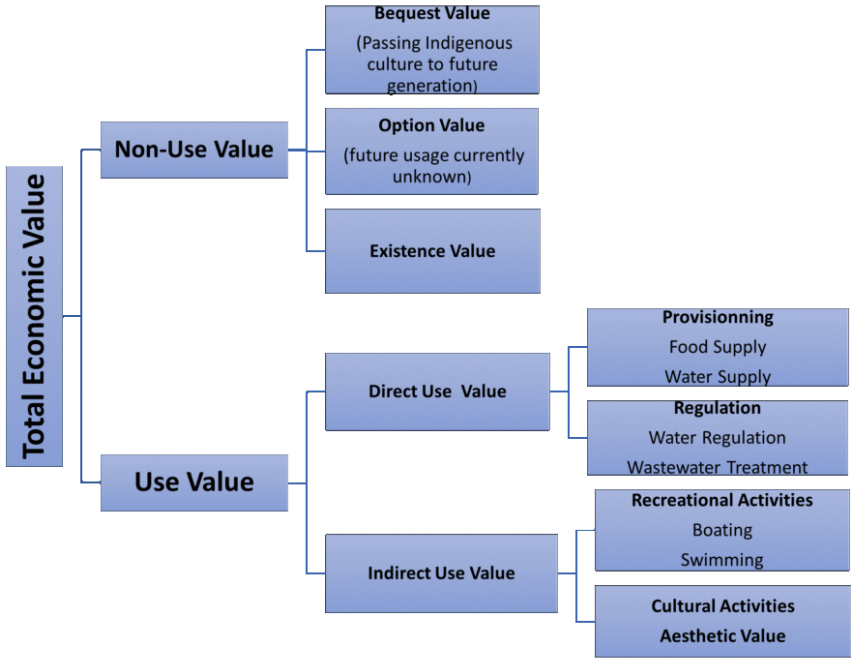

Figure 2: *Breakdown of Shuswap Lake's total economic value [Long Description]* CC BY-NC-SA 4.0

Methodology: Benefit Transfer Method

Many valuation methods exist, such as contingent valuation, market price, travel cost, choice experiments, replacement cost, and factor income methods, that can be used to estimate the value of ecosystem services. This chapter will use the benefit transfer method (BTM) to estimate the value of ecosystem services provided by Shuswap Lake.

Plummer (2009) defines the BTM as a technique that estimates the total economic value of one site by using the value from another site called the study site. BTM allows using previously gathered information about the cost per hectare of other lakes and applying the value to Shuswap Lake. The advantage of using BTM is the availability of data for the estimated value of different lakes and the feasibility when there is a limited budget.

With the BTM, the value of Shuswap Lake, which has a total area of 31,000 ha, will be estimated using the range of values with a low of $23,542 and a high of $78,804 per hectare for lakes in the countries mentioned above. Additionally, this chapter will use the discount rates of 3%, 1.5%, and 0.1% to estimate the lake's intrinsic value. Many valuation studies about the environment usually use a high discount rate of 3%; however, lower discount rates are usually advised when environmental damages are of concern and when considering the future generation's benefits.

Table 1 shows the yearly and intrinsic asset value of Shuswap Lake using 3.0% and 0.01% discount rates.

Table 1: Shuswap Lake Yearly & Intrinsic Asset Value

Value Type	Yearly Value (in millions of USD)	Intrinsic Asset Value – 3.0% (in billions of USD)	Intrinsic Asset Value – 1.5% (in billions of USD)	Intrinsic Asset Value – 0.01% (in billions of USD)
Lowest Value	729.8	24	49	730
Highest Value	2,443	81	163	2,443

Shuswap Lake has a yearly value ranging from $729.8 million to $2.44 billion, and its intrinsic value ranges from $24.3 billion (high discount) to $2.4 trillion (low discount). As such, the lake holds almost the same value as all the private property in British Columbia, which the Land Title and Survey Authority of British Columbia (n.d.) assessed at $2.72 trillion as of January 2023. The revelation indicates that the lake is an important element of those who use all its services, and thus, it should be properly managed and protected to ensure that it is used efficiently.

Concluding Remarks

Shuswap Lake's yearly value indicates that it is significant to those living in the region and beyond. The lake offers many

valuable ecosystem services that are important to humans. It is one of the most important recreational spaces to carry activities such as swimming, boating, and kayaking in the region for residents of Salmon Arm, Chase, and other communities. Climate change has started to impact the lake negatively and may further lead to the loss of some ecosystem services such as food supply and water supply. It is imperative that all stakeholders invest in sustainable usage and prioritize its conservation to ensure that all ecosystem services remain uninterrupted.

In the newsletter issued in March 2023, Joyce Kenoras, one of the chiefs at the Adams Lake Indian band, said, "In our role as stewards of Timcw and Sawllkwe, we must pay close attention to wastewater and how we mitigate risk and impact to our land. We must use a blend of science and technology to advance and preserve water and land in Secwépemculecw" (Kenoras, 2023). Technology has evolved to help people access the different ecosystem services provided by Shuswap Lake, and it can be used further to ensure the lake is used efficiently by all the stakeholders: the government, the private sector, and the public. It is of the utmost importance that natural assets are protected because they provide us with services that lack substitution and, thus, must be preserved for future generations.

Media Attributions

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Figure 2: "Breakdown of Shuswap Lake's total economic value" by the author is under a CC BY-NC-SA 4.0 license.

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Long Descriptions

Figure 2 Long Description: A sideways tree diagram breaks down the total economic value of Shuswap Lake. Starting on the left side, Total Economic Value is broken down into Non-Use Value and Use Value. Non-Use Value is divided into Bequest Value (passing Indigenous culture to future generation), Option Value (future usage currently unknown), and Existence Value. Use Value is divided into Direct Use Value and Indirect Use Value. For Direct Use Value, it is broken down into Provisioning (e.g., food supply and water supply) and Regulation (e.g., water regulation and wastewater treatment). For Indirect Use Value, it is broken down into Recreational Activities (e.g., boating and swimming) and Cultural Activities/Aesthetic Value. [Return to Figure 2]

13. Tk'emlúps Lake

PANAGIOTIS TSIGARIS

About Kamloops Lake

The beautiful and panoramic Kamloops (or Tk'emlúps) Lake in British Columbia, Canada, is located west of Kamloops and east of the Savona community. Kamloops in the Indigenous language is Tk'emlúps, meaning the confluence of the North and South Thompson River waters (Wonders, 2010). The dimensions of the Lake are 29 km long and 1.6 km wide, with a shoreline length of 60.5 km (World Lake Database, n.d.). The lake's average depth is 71 m, with a maximum depth of 143 m. The surface area is 52 km^2 or 5,200 ha and averages 3.7 km^3 of water. The lake's water volume fluctuates year-round due to the Thompson River usually rising in the summer from winter lows. The normal range of annual level fluctuation is 5 m.

Bunchgrass and sagebrush hillsides with steep embankments surround the Lake with pockets of Douglas fir, Ponderosa pine, and spruce trees ("Kamloops Lake," 2023). Wildlife is abundant, including the endangered mule deer and rocky mountain sheep. The Canadian National and Pacific railways pass along the north and south hillsides of the Lake. Thompson River flows into the Lake at the east end and exits at the west end.

The Domtar pulp mill discharges daily treated effluent to the Thompson River (Kamloops This Week, 2018a). Also, the City of Kamloops discharges tertiary treated domestic effluent into the River from the Kamloops Sewage Treatment plant (City of Kamloops, n.d.). In the early 1970s, major water quality problems were observed due to effluent discharges; however, government regulations and state-of-the-art wastewater treatment technology led to a significant improvement in water quality.

Direct & Indirect Value

The lake has a direct use value to humans for recreational activities, such as boating with two boat launches available and fishing for rainbow trout, northern pikeminnow, and bull trout (Angler's Atlas, n.d.e). Other activities at the lake include swimming, hiking, and wildlife watching (Tobiano, n.d.b). The approximately 400 ha (1000 ac) Tobiano resort community is a recent development of mostly single-family homes with an internationally renowned golf course overlooking the Lake (Tobiano, n.d.a). In addition, the community of Savona's water supply comes from the Lake, adding to provisional services (Thompson-Nicola Regional District, n.d.). Kamloops Lake also provides researchers with opportunities to explore nature.

The important ecosystem services include indirect benefits through regulation and maintenance services, such as water purification, erosion prevention, flood protection, carbon

sequestration, air quality, local climate regulation, habitat to marine life and maintenance, and biological control. Finally, the Lake provides the non-use options such as bequest, and existence values, which are difficult to measure yet still important to the community. For further discussion on these ecosystem services, see Costanza et al. (1997).

Figure 1: *Kamloops Lake (Orange Suede Sofa/Wikimedia Commons) CC BY-SA 3.0*

Valuation of Kamloops Lake

Table IE reproduces the values transferred from studies of lakes in Canada, the US, and the UK, as reported in the Introduction and accessed from Brander et al. (2023). There

are 81 values provided across only eight ecosystem services out of 17. Hence, the prices per hectare per year of lakes are underreported since many important functions' lakes provide to us and to future generations have missing values. The average gives the highest valuation at $78,804/ha/year, followed by a lower value of $57,726/ha/year for the median since outliers are not weighted more heavily, and lastly, the most conservative valuation is $23,542/ha/year due to the removal of ecosystem services that had only one or two values. Most of the valuation is based on provisioning and cultural services. However, regulation and maintenance services are absent from the assessment and hence, the previous figures are an underrepresentation of the valuation of Kamloops Lake in terms of the annual ecosystem services it provides.

Table IE: Total Value of Ecosystem Services (2020 International $/ha/year)

# of Values	Average	Median	Modified Median
81	78,804	57,726	23,542

Note. Adapted from Ecosystem System Valuation Database by Brander et al. (2023).

Table 1 transfers these prices to Kamloops Lake. The highest assessment is $410 million per year, followed by the median price per hectare per year, which has a value of $300 million per year of ecosystem services, and the most conservative

estimate shows benefits in the order of $122 million per year (all figures in 2020 USD values). Kamloops' Gross Domestic Product (GDP) was estimated at $4.61 billion in 2020 (Venture Kamloops, 2018). Thus, Kamloops Lake represents, at minimum, 2.6% of Kamloops GDP. The value of the lake as a natural asset is at the minimum USD 8.2 billion using the 1.5% social discount rate and USD 122.4 billion using the lower discount rate of 0.1%. This natural asset value represents USD 82,000 per person living in Kamloops at the lower end and USD 122,400 at the higher end of an already conservative assessment of the value of ecosystem services. We are all rich in the collective goods of our natural assets; hence, we need to protect and maintain their functioning for the future generations of all species.

Table 1: Value of Kamloops Lake as a Natural Asset

Valuation	Ecosystem Services per year (in millions, USD)	1.5% Discount Rate (in millions, USD)	0.1% Discount Rate (in millions, USD)
Average	409.7	27,319	409,700
Median	300.2	20,013	300,200
Conservative/ Modified Median	122.4	8,160	122,400

Valuation of Tobiano Community

The Tobiano community is located on the southwest hillside

of Kamloops Lake (Tobiano, n.d.b). New custom and semi-custom houses are designed to harmonize with the surrounding beautiful natural landscape. The lifestyle is tranquil and invigorating; residents can gaze at the starry night sky, take in the panoramic scenery every day, go on an outdoor adventure, or play golf on an 18-hole championship golf course.

Figure 2: *Tobiano golf course (Murray Foubister/Flickr)* CC BY-SA 2.0

We can assess if land values or housing prices capitalize on the stunning view using the BC Assessment (2023), which provides property assessments as of July 1, 2022 (downloaded on April 9, 2023). There were 179 properties, of which 77.7% had a house built on the land. Based on 174 properties, the

average land value was $431,109, with a minimum of $286,000 and a maximum of $827,000. Meanwhile, out of 173 buildings, their average valuation was $913,203 (excluding land value), with a minimum of $365,000 and a maximum price for a building at $3,426,000. The average size of the lot was 0.191 ha, with the smallest at 0.56 ha and the largest lot at 0.809 ha. The total land valuation of 174 lots at 33 ha total is estimated at $75 million. The total value of the 173 buildings is estimated at $121.45 million. Both land and building valuation totals to approximately $200 million.

The hedonic price technique, whereby land values (in logs) depend on land size (in logs), can be used to examine if land or housing prices incorporate the stunning lake view. The lots included for this method are the ones on the west edge, east edge, interior north, and interior south zones. The base case was lots adjacent to Canadian Highway 1. Findings from the estimation suggest that lakefront properties within the Tobiano property command a 57.5% premium relative to those lots that are closest to the highway 95% CI [52.2%,62.8%]. The next most highly valued lots were at the east edge towards Kamloops commanding a premium of 29.9% relative to close highway lots with a 95% CI [26.6%,33.3%], followed by the interior middle closest to the lakefront at a 24.4% premium with 95% CI [20.4%, 28.6%], and then those lots at the west edge of the community at an 18.4% premium always relative to those lots closest to the highway 95% CI [15.5%,21.2%]. Finally, the lots across from the interior middle south were at a premium of 9.2% with CI [4.0%,14.4%].

Basically, all lots relative to those closest to the highway were

at a premium. Land values increase at a decreasing rate with respect to land size, which is expected. A small parcel has a higher price per square footage than a larger parcel. Land prices with respect to lot size are inelastic. A 10% increase in lot size increases land value by 2.0% with a 95% CI [1.6%,2.3%]. Land with a view of the lake is capitalized into land values relative to any other zone within the Tobiano community. A building on the property was not statistically significant. Everyone in the Tobiano community is willing to pay a very high price to be close to nature with outdoor adventure, golfing, lake activities, and stunning views.

Table 2 provides a summary of the factors that influence land values in Tobiano.

Table 2: Factors Influencing Land Values in Tobiano

Factors	Coefficient	Robust HC3 Standard Errors	T-stats	Lower 95% CI	Upper 95% CI
Constant	13.0734	0.0381	343.35	12.9985	13.1488
Land Size (in logs)	0.1961	0.0185	10.59	0.1595	0.2326
Lakefront	0.5749	0.0268	21.48	0.5220	0.6277
West Edge	0.1837	0.0145	12.63	0.1550	0.2124
East Edge	0.2992	0.0169	17.69	0.2658	0.3326
Interior South	0.2448	0.0209	11.72	0.2036	0.2860
Interior North	0.0924	0.0263	3.51	0.0404	0.1443
Number of obs	—	—	—	—	173
R-Sq	—	—	—	—	0.9414
Root MSE	—	—	—	—	0.0658

Concluding Remarks

The Tk'emlps Lake is very important to the Secwépemc people and their nation (Wonders, 2010). From the point of view of ecosystem services, the lake has many visible and intangible benefits. It is an important place for fish, birds, and other animals to live, showing the importance of maintaining biodiversity. Fishing has always been a big part of Secwépemc culture, and the lake's water has always been good for this activity. In addition to providing food and water, the Tk'emlps Lake is very important for controlling the weather, cleaning the water, and reducing the risk of flooding. In addition, the lake's peaceful beauty offers cultural and recreational benefits to the Secwépemc people and the settlers. Before establishing the reserve in 1877, the Secwépemc people spent the winter in many pit house villages on both sides of Kamloops Lake and where the lake empties into the Thompson River, while during the other seasons, they gathered resources travelling throughout the territory.

> "Lakes have held special meaning for the Secwépemc; the mystery, power and life found in our lakes has never been taken lightly. Many ancestral stsptekwll ("story" – a translation that is not inclusive of all that stsptekwll are to the Secwépemc) are based on and revolve around pespésellkwe (lakes). Pespésellkwe have given us life as in our origin stsptekwll, "Pípsell"

— a stsptekwll that is an epic tale of our people; they are a source of mystery as in another stsptekwll of "mermaids" in Ximétkwe (Kamloops Lake). Pespésellkwe are truly wonderful beings to the Secwépemc."

— **Ted Gottfriedson**, M.A., Secwépemc Cultural Advisor, Office of Indigenous Education, Thompson Rivers University

The importance of the lake in terms of ecosystem services it yields annually is significant. At the most conservative valuation, the lake provides USD 122 million of ecosystem services annually with a valuation of USD 8 billion with a 1.5% discount rate and a $122 billion valuation using the 0.5% discount rate that, in our opinion, respects Indigenous values towards the future unborn generations in providing them with ecosystem services of close to a similar valuation that the current generation receives from the lake. The latter valuation is five times the value of all properties in Kamloops, estimated at $24 billion and 33% of the former valuation of USD 8 billion. It is important to keep the lake in its natural state, protecting biodiversity, and in particular reducing human-induced stressors in order to learn and align our ethical ideals with those of the Secwépemc people (Smol, 2019; Birk et al., 2020; Albert et al., 2021).

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14. Conclusion

Concluding Remarks

The conclusion of the book has been reached. Upon commencing the investigation with my students, I lacked precise knowledge regarding the appropriate methodology to evaluate the lakes within this beautiful, unceded Secwépemc territory. Initially, a cautious methodology was employed to evaluate the annual value of ecosystem services rendered by lakes to the community and beyond. This technique involved utilizing the benefit transfer method, which relies on values derived from previous research that may not be directly applicable to the present analysis. Hence, this enabled us to establish a baseline (minimum) assessment of the ecosystem services rendered by these significant biomes within the Earth's inhabited environment.

Furthermore, the students actively integrated and engaged in the exploration of Indigenous values within their own chapters. One of the most challenging aspects of this study involved determining the intrinsic value of lakes as a prominent component of our natural resources. The annual flow of ecosystem services provided by lakes undergoes a process in which economists apply the social discount rate to ascertain the present value of the natural asset. Determining a

suitable discount rate is a matter of subjectivity and has been a topic of contention within academic discourse.

An inverse relationship exists between the discount rate and the perceived value that the present generation assigns to the provision of environmental services for future generations. The concept of discounting the future at significantly high rates is a challenge when considering Indigenous values, as it contradicts their perspectives. I have spent considerable time contemplating how to include a social discount rate that aligns with Indigenous principles regarding the well-being of future generations and the preservation of natural assets. I have debated with my students about this issue, and we have arrived at a potential solution to use the lowest possible discount rate.

From an economic standpoint, there are two prevalent factors that contribute to the act of discounting: the social rate of time preference, also known as social impatience, and economic growth that presumes an increase in the standard of living for us humans. Nonetheless, as elucidated in the aforementioned chapter on the evaluation of lakes' global significance, it is imperative that we refrain from regarding the element of impatience when addressing matters that have repercussions for forthcoming generations.

Famous Economists on Social Discounting — Accounting for social impatience when addressing social discounting is view negatively by famous economists, who stated the following:

- **Ramsey (1928)** stated that the act of discounting for social impatience can be deemed ethically unjustifiable and attributed solely to a lack of imaginative capacity.
- **Pigou (1932)** described this phenomenon as suggesting a deficiency in our ability to perceive distant events accurately.
- **Harrod (1948)** stated that the phenomenon in question might be characterized as a "human infirmity" and a "polite expression for rapacity and the conquest of reason by passion."
- **Solow (1974)** advised to behave in a manner that assumes a social rate of time preference of zero, while concurrently discounting future spending if there is an expectation that the future will be more prosperous than the present.

However, it is important to consider why an economist may disregard discounting. If one holds the belief that future generations will experience greater wealth than the present generation, then, in accordance with the principle of intergenerational equity, the value of a dollar today surpasses the value of a dollar in the future. This perspective allows for

the application of a discount to the benefits enjoyed by future generations. In his work on the economics of climate change, Stern (2007) employed a discount rate of 1.4%, mainly to incorporate per capita economic growth. In his integrated assessment model for climate change policy, Nordhaus (2008) employed a social discount rate of 6%. The observed rate bears resemblance to the actual historical rate of return of the Dow Jones Industrial Index or the Standard & Poor 500 Index. Nordhaus (2008) recommended adopting a gradual approach towards addressing climate change due to the significant discount rate, while Stern (2007) argued for immediate and strong action to contain climate change.

The utilization of a falling social discount rate has been advocated by Weitzman (1994, 1998) and Arrow et al. (2013) due to the uncertainties present pertaining to future interest rates and economic growth. According to Fleurbaey and Zuber (2012), there is contention around whether the application of a negative social discount rate could be warranted when evaluating the enduring consequences of climate policy. The presence of uncertainty around future growth necessitates the consideration of climate policies, as they tend to yield greater benefits in scenarios characterized by adverse climatic consequences.

It is reasonable to argue that individuals experiencing the highest levels of vulnerability to climate change are often those belonging to the most economically disadvantaged segments of society. The authors contend that policy priority should be directed towards enhancing the wellbeing of individuals who will experience the most adverse impacts of

climate change rather than being determined only by traditional utilitarian social welfare principles. There is evidence to suggest that the overall quality of life has not experienced significant improvement, and may have even deteriorated, over the past four decades when evaluating it through the lens of the genuine progress index rather than relying solely on GDP per capita (Kudishzewski et al., 2013).

Therefore, within the context of this literary work, we employed two distinct rates in order to evaluate the significance of lakes. Firstly, it is proposed that a high rate of 1.5%, akin to the perspective put forth by Stern (2007), be considered. Secondly, it is suggested that a social discount rate of 0.1% be adopted, based on the premise that significant damage has been inflicted upon the natural environment. Utilizing a very minimal discount rate also aligns with Indigenous perspectives on the intrinsic value of nature.

Oren Lyons' comment regarding the teachings of the Peacemaker emphasizes the significance of the concept of the Seven Generations (Public Broadcasting Service, n.d.). According to his statement, it is imperative to refrain from prioritizing personal interests, familial considerations, or even the concerns of one's own generation when participating in a council dedicated to the wellbeing of the community. He advocated for making decisions considering the wellbeing of future generations, spanning seven generations, in order to ensure their ability to appreciate the benefits and resources available in the present. Oren Lyons, a prominent figure within the Onondaga Nation, holds the esteemed position of Faithkeeper.

In his work on the Economics of Climate Change, Stern (2007) employed a social rate of time preference of 0.1% to account for the potential occurrence of a catastrophic event during the next millennium, leading to the extinction of humanity. The integration of Indigenous values into conventional economic assessment was a prospect I had not previously considered, and I remain uncertain as to whether we have successfully achieved this integration. Nevertheless, when employing a relatively high discount rate of 1.5%, it is evident that all lakes across the globe possess an asset worth comparable to the whole value of global real estate, exceeding US$300 trillion and ecosystem services in the range of at least US$5 trillion annually (Li and Tsigaris, 2024). When equally distributed among all individuals, the total valuation comes to more than $37,500 per person.

However, it should be noted that the distribution of real estate values among humans is skewed and unequal. The collective possession of abundant natural resources is a shared attribute among individuals, although frequently, there exists a lack of knowledge or recognition regarding the significance of this valuable endowment. When using a discount rate of 0.1%, the worth of all lakes increases significantly to USD 5,500 trillion, equivalent to USD 687,500 per capita (Li and Tsigaris, 2024). This valuation is almost 3.57 times greater than the combined value of all real and financial assets created globally by humans, which is estimated at $1,540 trillion and primarily attributed to personal wealth creation. We should not forget that the valuation of ecosystem services provided here is a conservative value

since many ecosystem services, such as regulating (e.g., water purification, decomposition, cycling of nutrients) and habitat (e.g., maintenance of genetic diversity), were not assessed.

When assessing all lakes in British Columbia, similar results were obtained in that the asset value of the lakes was higher than the value of all real estate in British Columbia. If we use the relatively high discount rate of 1.5%, the value of BC lakes is estimated at the minimum at $3.5 trillion; this figure exceeds the value of real estate properties valued at $2.72 trillion in 2022 by the BC Assessment. When examining the 11 lakes in the Secwépemc territory, from the smallest Inks Lake to the largest Shuswap Lake, the conservative valuation of annual flows of ecosystem services is estimated at approximately US$900 million, with a valuation of USD 60 billion at the 1.5% discount rate and $890 billion at the 0.1% discount rate. Taking even the lower valuation of $60 billion exceeds the value of all Kamloops properties, valued at $24 billion, by a factor of 2.5 times. Kamloops Lake alone is conservatively estimated to yield $122.4 million annually, with an estimated value of $8 billion at the 1.5% discount rate and $122.4 billion at the 0.5% discount rate, representing an asset worth $80,000 ($122,000) to each person living in Kamloops.

Finally, I want to thank all my graduate students for their dedication, work ethic, and engagement in this project. It would not be possible without their participation. Thank you! They used the most convenient and easiest method, the benefit transfer, but made a very conservative baseline assessment. It would be impossible to study each lake by each student using other methods, such as travel cost, contingency

valuation, hedonic pricing, as that would be eleven theses and would require a longer period of time to conduct relative to the period they took the course.

> "Scientists say that the human body consists of approximately 90% water. Perhaps this explains why so many of us humans go to the water when we seek solace, strength, balance and emotional, psychological, or spiritual cleansing."
>
> — **Rod McCormick**, Kanienkehaka, Professor and BCIC Research Chair in Indigenous Health, Faculty of Education and Social Work Thompson Rivers University

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