TITLE: Community-Based Monitoring as the practice of Indigenous governance: A case study of Indigenous-led water quality monitoring in the Yukon River Basin

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ABSTRACT

Indigenous peoples are increasingly developing Community-Based Monitoring programs to protect the waters and lands within their territories in response to multiple ecological and political stressors. CBM tends to focus on Indigenous peoples' role as 'knowledge holders.' This paper explores CBM through a governance lens by understanding CBM as a strategy for the assertion of Indigenous sovereignty and jurisdiction. We examine how Indigenous peoples conceptualize the relationship between CBM and water governance processes to improve the linkages between monitoring and Indigenous governance. Our findings suggest that data quality and credibility, trust and legitimacy and relevance to decision contexts are key to mobilizing CBM data in relevant decision-making processes. We provide three recommendations to improve linkages between CBM programs and Indigenous governance: Indigenous governments must take a leading role in CBM programs; Networked capacity between Indigenous governments can be built using a bridging organization; and CBM programs should be closely coupled with Indigenous water governance strategies. All research herein is collaborative and is based on our engagement with the Indigenous Observation Network – an Indigenous-led community-based water quality monitoring network involving Yukon and BC First Nations as well as Alaska Native Tribes. It is considered the largest Indigenous water quality network in the world and is coordinated by the Yukon River Inter-Tribal Watershed Council and the United States Geological Survey. Results are derived from interviews with twenty samplers and ten other stakeholders with attention to ways to better inform internal and external decision-making processes.

HIGHLIGHTS (must be less than 85 characters including spaces)

- Indigenous peoples' engagement in CBM is not limited to knowledge input
- CBM should be understood as an emerging expression of Indigenous governance
- CBM is conceptualized as governance through both stewardship and decision-making
- Indigenous-led CBM is critical to improving needed uptake in decision-making

KEYWORDS

Community-Based Monitoring**;** Indigenous knowledge**;** Indigenous governance; Transboundary Watershed; Water governance; Yukon River Watershed

1. INTRODUCTION

Indigenous peoples, or those communities that claim a historical continuity with their traditional territories (Corntassel, 2003), have been governing the waters and lands within their territories since time immemorial. Indigenous governance systems have, however, been disrupted or constrained by colonial forms of governance despite enduring knowledge of such systems in practice and oral history (Borrows, 2002; Napoleon, 2013). Governance is understood, for many Indigenous people, as involving a sacred responsibility for water stewardship that stems from their reciprocal relationships to water as a living entity (Anderson et al., 2013; McGregor, 2014; Sam and Armstrong, 2013; Wilson, 2014). However, governance constraints, including water rights and access, deeply affect Indigenous peoples ability to protect the waters that are important to their ways of life, health, and culture. An emerging solution to these pressures and those introduced by resource development and global environmental change are Community-Based Monitoring (CBM) programs, which seek to document the changes occurring within their

93 territories (Kotaska, 2013; Lowe, 2016; Parlee et al., 2012). CBM is a process where parties
94 "collaborate to monitor, track and respond to issues of common community concern" (Whitelaw
95 et al., 2003, p. 410). Although a large majority of CBM programs involve "citizen volunteers" of
96 settler origin, there are a growing number of CBM programs involving Indigenous peoples
97 globally. Such programs can be found in Canada (Berkes et al., 2007; Gearheard et al., 2011;
98 Kotaska, 2013; Parlee et al., 2012); the USA (Johnson et al., 2015); Australia (Wiseman and
99 Bardsley, 2016); New Zealand (Harmsworth et al., 2011) and across the polar regions due to the
100 disproportionate effects of climate change at high latitudes (Alessa et al., 2015).
101
102 The value of Indigenous Knowledge (IK) for understanding environmental change,
103 especially in response to a changing climate, has been widely acknowledged (e.g. Reidlinger and
104 Berkes 2001, Nichols et al. 2004, Herman-Mercer et al. 2011, Wilson et al. 2015). Berkes and
105 others (2007) suggest that involving Indigenous 'stakeholders' in CBM can "bring a wider range
106 of knowledge to understand ecosystem change" (p.145). In large part, Indigenous peoples are
107 considered 'knowledge holders' whose engagement in CBM can improve understanding of
108 environmental change and increase the benefits of CBM for communities (Johnson et al., 2015;
109 Wiseman and Bardsley, 2016). Yet, Indigenous peoples are seldom referred to as governing their
110 traditional territories; thus the potential for CBM as a tool for asserting Indigenous governance,
111 sovereignty and jurisdiction has rarely been explored (c.f. Parlee et al. 2012, Kotaska 2013).
112
113 In this paper, we seek to challenge the very notion of CBM as knowledge input alone and
114 instead consider it an important emerging expression of Indigenous governance itself. We
115 examine a case study of the Indigenous Observation Network (ION) – an Indigenous-led

116 community-based water quality monitoring network involving First Nations in Canada and
117 Alaska Native Tribes (Indigenous governments), coordinated by the Yukon River Inter-Tribal
118 Watershed Council (YRITWC) – in the Yukon River Basin (YRB). A case study approach is
119 used to analyze Indigenous peoples' conceptualizations of CBM in relation to water governance
120 including responsibilities for water stewardship, Indigenous governance perspectives and the
121 broader governance landscape, shaped by settler approaches to governance. Next, we examine
122 the opportunities and challenges faced in engaging CBM data within decision-making processes
123 relevant to Indigenous peoples. This includes the importance of data quality, trust and legitimacy
124 of the organizations and people involved in CBM programs as well as the accessibility and
125 relevance of the data to the Indigenous communities for specific decision contexts. Lastly, we
126 discuss the elements of CBM program design that can improve linkages to Indigenous
127 governance processes including, the role of leadership, networked governance and capacity, as
128 well as tighter integration of governance strategies with CBM.
129

130 **2. RESEARCH SETTING**

131 The ION is a transboundary Indigenous initiative that aims to combine Western Science and IK
132 to research, sustain and protect the YRB and the Indigenous people who reside in the watershed.
133 ION is facilitated by the YRITWC – an Indigenous grassroots organization, consisting of 75
134 First Nations and Alaska Native Tribes signatories dedicated to the protection and preservation
135 of the YRB. Thirty-four Indigenous governments in Yukon and British Columbia are actively
136 participating in ION to conduct water quality monitoring at 54 sites from the headwaters to the
137 mouth across the entire YRB (Schuster and Herman-Mercer, 2015). ION is supported by a
138 Memorandum of Understanding (MoU) between the United States Geological Survey (USGS)

and the YRITWC. The MoU represents a formal agreement to cooperate and engage in research to develop and continue a baseline water quality monitoring program based on protocols and methods derived from the USGS and that acknowledges Indigenous culture, knowledge and perspectives (USGS, 2009). At present, ION is considered the largest Indigenous water quality network in the world (Figure 1) and it incorporates IK in conjunction with high-quality field, laboratory, and data analysis methods.

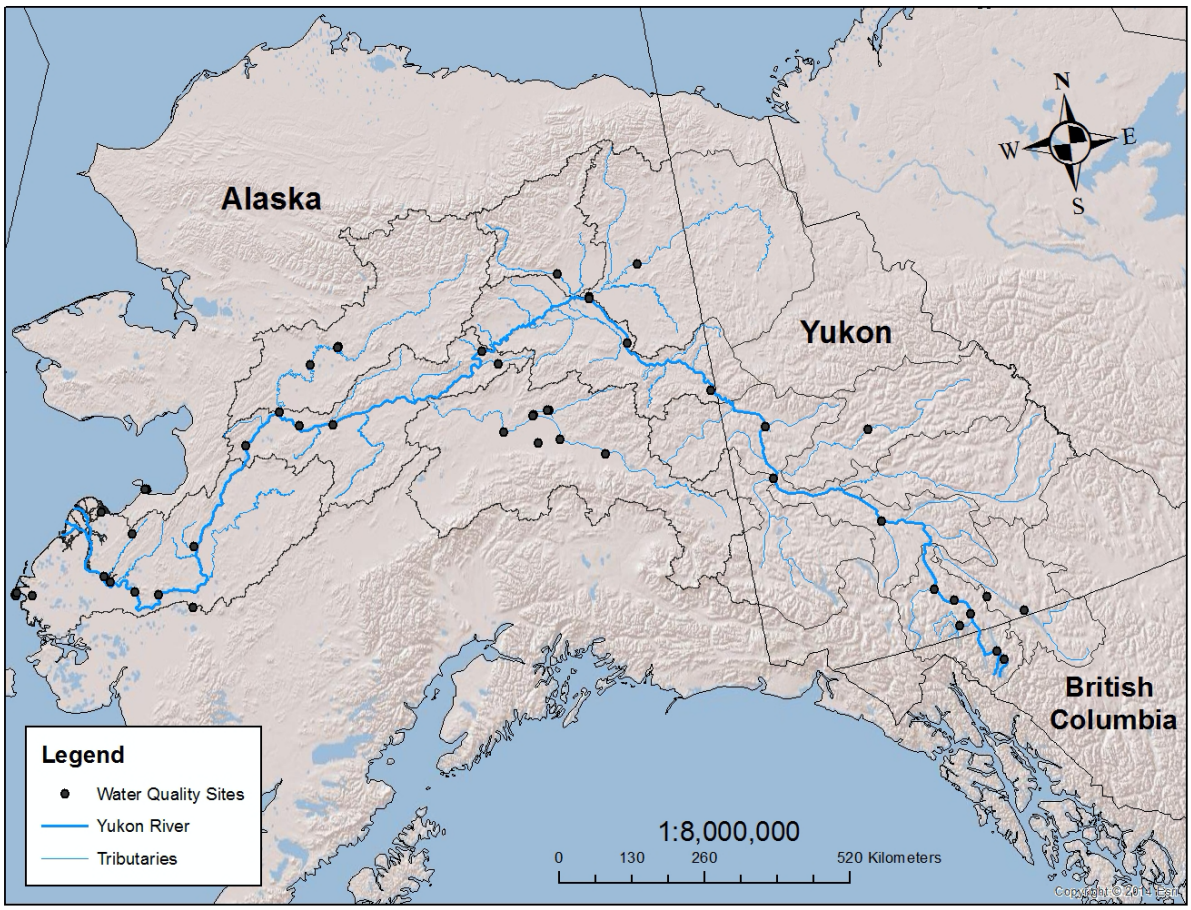


Figure 1 Map of ION water quality sites within the YRB

As of 2015, thirty-six samplers from thirty Indigenous governments dedicated their time to the collection, processing, and shipping of water quality samples for ION. Samplers include the U.S. Environmental Protection Agency funded Indian General Assistance Program (EPA

IGAP) Coordinators from Alaska Native Tribes as well as First Nations youth and environmental staff, whom together conduct bi-weekly surface water sampling during the open water season (June to October) and in some cases during the winter months (Figure 2). USGS and YRITWC research scientists train samplers following USGS protocols and field methodologies. Water quality monitoring includes *in situ* measurements of pH, dissolved oxygen, conductivity and temperature in addition to the collection of surface water samples for chemical analysis (YRITWC, 2014). A variety of biogeochemical parameters are collected to investigate the effects of climate change on river water quality including dissolved organic carbon, dissolved greenhouse gases, major ions (anions and cations), nutrients, trace metals and stable water isotopes (YRITWC, 2014). YRITWC staff process water samples and ship them to the USGS National Research Program (NRP) laboratory in Boulder, Colorado for analysis.

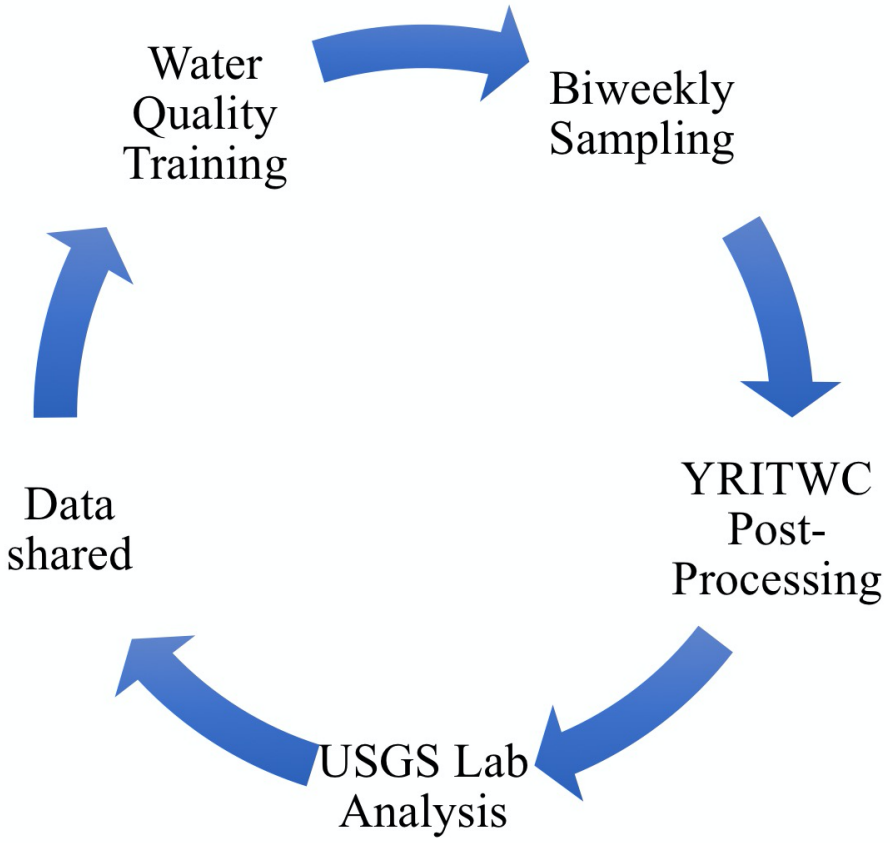


Figure 2 Water Quality Sampling for the ION takes place in several stages including sampling, training, laboratory analysis and returning the data to communities

The raw data (QA/QC) procedure is performed by USGS NRP, the Alaska Climate Science Center (ACSC) and YRITWC before data interpretation is completed and made available to participating Indigenous governments for their use. The water quality data are shared with participating communities in the form of plain language reports (2013 and 2015) summarizing the spatial and temporal trends seen at each water monitoring sites and an assessment of the results relative to federal or state water quality guidelines or standards. Data from 2006 to 2014 are also publicly available for all sites at the USGS ScienceBase website (https://www.sciencebase.gov/catalog/item/573f3b8de4b04a3a6a24ae28).

3. METHODS

This research was designed using an approach known as Community-Based Participatory Research (CBPR), which focuses on issues of real importance to communities, involves community members in all phases of the research process and centres on the goal of social change (Minkler and Wallerstein, 2008). CBPR is not a research method in itself, but an ethical philosophy that promotes shared decision-making power and ownership over the research process, co-learning, the co-creation of knowledge and its dissemination in a mutually beneficial manner (Castleden et al., 2012). CBPR has been used to decolonize conventional relationships between university researchers and Indigenous communities (Castleden et al., 2008) and to avoid reproducing the negative histories of research between Indigenous peoples and external researchers (Denzin et al., 2008; Smith, 1999; Wilson, 2009). The use of CBPR was facilitated by the long-term relationship between the lead author and the YRITWC (since 2009), and the research design is informed by this ongoing collaboration.

Semi-structured interviews were conducted with First Nation and Alaska Native Tribal samplers. Interviews were organized around the themes of Indigenous peoples' relationships to water, concerns about environmental change and evaluation of their experience sampling for ION (e.g. capacity, training sessions, sampling challenges, the relevance and accessibility of sampling protocols and results as well as data use). Samplers were provided a small gift card (valued at $30 CAD) to thank them for their participation and acknowledge their contribution. Semi-structured interviews were also conducted with other stakeholders, which included YRITWC staff, Executive Council members and USGS staff. Interviews were conducted

196 between August and December of 2015. Interview participants were recruited in a targeted
197 manner by using the list of current samplers. The lead author interviewed samplers who were
198 present at two events including YRITWC's Summit in Minto, Alaska in August 2015, the Alaska
199 Tribal Conference on Environmental Management Water Quality Training (ATCEM) in October
200 2015 in Anchorage, Alaska. To increase the number of samplers from Yukon and British
201 Columbia, interviews were conducted in their communities or by telephone between August and
202 September 2015. Samplers from the same community were often interviewed together. A total of
203 20 samplers and ten stakeholders were interviewed (Table 1). Interviews were audio-recorded,
204 transcribed and coded using NVivo, utilizing thematic qualitative coding techniques (Saldaña,
205 2013).

Region	Canada (YT and BC)	USA (Alaska)
Samplers	7 (57%)	13 (43%)
Other Stakeholders	6	4
Sub-Total	13	17
Total	30	

206 ***Table 1 Summary of interviews conducted with Samplers and Other Stakeholders in Canada***
207 ***(Yukon and British Columbia) and Alaska, USA. Interviews were conducted with a subset of***
208 ***the thirty Tribal and First Nation samplers who were active in 2015 (4 of 7 Yukon and British***
209 ***Columbian First Nations and 10 of 23 Alaska Native Tribes). Percentages were calculated***
210 ***after adjusting for cases with more than one interview per community.***

211 **4. RESULTS**

212 A better understanding of CBM and its connection to governance is essential to Indigenous
213 sovereignty and to the success of the ION as the network is itself nested within the complex
214 water governance landscape of the YRB. This includes multiple, overlapping jurisdictions
215 (British Columbia, Yukon, Alaska as well as the Canadian and US Federal governments) and the
216 role of two general types of land claims as central to water policy. These are the Alaska Native
217 Claims Settlement Act (1971) and the Yukon Umbrella Final Agreement (1993) (eleven

218 comprehensive land claims and self-government agreements). Furthermore, there are several
219 First Nations with unceded territories in Yukon and British Columbia.
220
221 Indigenous jurisdiction over water is acknowledged to varying extents in these contexts,
222 which have different mechanisms for decision-making about water. It is not the purpose of this
223 paper to provide a systematic analysis of the governance context of the YRB or the opportunities
224 to use CBM data. Instead, our analysis of the governance dimensions of CBM for Indigenous
225 peoples draws on contextual examples to illustrate the linkages between CBM and Indigenous
226 peoples' engagement in water governance. Water governance, for our purposes, is understood as
227 the set of regulatory processes, mechanisms and institutions through which political actors,
228 including communities, influence water-related decisions, actions and outcomes (Bridge and
229 Perreault, 2009).
230
231 Two distinct but related themes linking CBM to Indigenous governance emerged through
232 our analysis. First, the ways in which CBM can be understood as a practice of governance itself
233 as Indigenous understandings of stewardship, kinship and responsibility to water that inform
234 CBM are fundamental to Indigenous governance. Second, the opportunities and challenges for
235 using CBM data to influence governance outcomes within both internal and external decision-
236 making processes.
237 **4.1 Responsibility and kinship motivates CBM**
238 Indigenous peoples in the YRB have a sacred responsibility for water stewardship, and this
239 responsibility to protect water has been a key motivation behind the ION. As one Yukon First
240 Nation sampler noted,

> I'm an environmental monitor for my First Nation. And I think water is very important to First Nations people because our elders always tell us that water provides life and it's very important for us to make sure that the water is always clean, always running clean, free of contaminates and whatnot. And that is what the First Nations does to monitor the water quite steadily, on a routine basis.

In the same vein, samplers discussed the importance of ION at the watershed-scale, including downstream communities. An Alaska Native sampler raised a concern about the effects of upstream communities on water quality near their community: **"**Being a community at the mouth of the Yukon, we're downstream from all the rest of the Yukon River villages. It's kind of a concern about the water quality because what happens up there comes down to us." Similarly, samplers from upstream First Nations also considered protecting water quality for downstream communities an important motivator for their participation in the ION.

Indigenous stewardship is fundamentally about a responsibility to care for water as a living entity. These powerful statements of responsibility contribute to the enactment and coupling of Indigenous governance and stewardship through a politics of kinship (See Manson 2015). Applied to CBM, stewardship is not separate from governance, but rather CBM is itself the practice of Indigenous governance. Indigenous samplers engage in sampling to fulfill their responsibility to care for the waters within their territories, and these acts of care for other-than-human relations engage the politics of kinship on the ground. Moreover, one sampler noted their government conducts monitoring which includes but is not limited to ION to keep other governments and industry "honest" as they operate within their traditional territory. For example, to ensure that legacy contaminated sites are properly monitored and remediated by the Canadian Federal government. CBM has similarly been called a form of "direct action" (Lowe, 2016)

where Indigenous peoples need "moccasins on the ground" to know what is going on in their territories (Thomas, 2016). CBM is used to assert Indigenous jurisdiction over land and water and to fulfill the responsibility for water stewardship, regardless of the extent it is acknowledged by settler governments. In this sense, CBM is viewed as a means to counter unequal power relationships by using independent, Indigenous-led CBM to collect environmental data (Kotaska, 2013).

4.2 Improving linkages between Indigenous CBM and water governance

While CBM can itself be considered an Indigenous governance practice, the data gathered through CBM programs are also used by Indigenous governments as a tool to inform a wide range of decision-making processes. Indigenous peoples engage in various levels of decision-making due to their Nation-to-Nation relationships with other Indigenous governments, federal governments as well as state, provincial or territorial governments. Furthermore, Indigenous peoples engage in planning and decision-making processes at the scale of traditional territory. Specific decision contexts include land use planning, environmental assessment, source water protection and water licensing. For example, several Yukon First Nation samplers stated, they used ION water quality sampling results in their submissions to the Yukon Environmental and Socio-Economic Impact Assessment process. The influence of CBM on decision-making processes has been noticeably absent (Buckland-Nicks et al., 2016; Buytaert et al., 2016; Conrad and Hilchey, 2011; Hunsberger, 2004). Similarly, the influence of CBM programs on decision-making processes relevant to Indigenous peoples is limited. The following section discusses the challenges and opportunities faced by Indigenous governments in using CBM data in these decision-making processes based on this research.

287 *4.2.1 Data quality and credibility*

288 Where CBM data might be used for legal or decision-making purposes, data quality assurance
289 and control (QA/QC) protocols as well as standardized operation procedures (SOPs) must be a
290 priority for CBM programs as the rigour of the dataset will likely be challenged. The ION water
291 quality program's SOPs and QA/QC protocols across the YRB has been a priority for the
292 YRITWC. During interviews, YRITWC and USGS staff members discussed how ION's
293 program design actively seeks to resolve concerns about data quality through the use of the
294 sampling methodologies SOPs and QAQC procedures based on the USGS protocols and an EPA
295 approved quality assurance project plan (QAPP) (Wilde, 2015). Both the USGS protocols and
296 EPA QAPP provide guidelines for sampling methodologies, handling, and sample processing
297 from the field to the laboratory. While data quality can be a challenge in CBM programs, the
298 close collaboration between the USGS, EPA, YRITWC and participating Tribes and First
299 Nations to implement field and laboratory QA/QC creates higher confidence in the ION water
300 quality data.
301
302 Decision-makers often disregard the credibility of CBM data (Bradshaw, 2003; Conrad,
303 2006; Conrad and Hilchey, 2011; Gouveia et al., 2004). Given widespread skepticism about the
304 ability of non-professionals to produce high-quality environmental data (Cohn, 2008; Legg and
305 Nagy, 2006), the quality of CBM data is significant to its use in decision-making. CBM studies
306 are often lacking in program design, SOPs or QA/QC protocols and training, which limit data
307 accuracy, comparability, and completeness (Conrad and Hilchey, 2011). Yet, recent studies
308 suggest 'volunteers' can and do collect high-quality data that are comparable to professional
309 datasets given adequate program design (Danielsen et al., 2014; Jollymore et al., 2017; Shelton,

2013; Storey et al., 2016). Bonney and others note (2014, p. 1436), "with appropriate protocols, training, and oversight, volunteers [non-professionals] can collect data of quality equal to those collected by experts." Statistical analysis reveals that ION's program design has the appropriate level of support to achieve high data quality (Herman-Mercer et al., Under Review).

The level of rigor required in CBM programs depends on the intended decision context (Hunsberger, 2004). Official monitoring determines whether regulations are being broken, and therefore needs to rely on high-quality data obtained through accurate measurements following "court-acceptable procedures." Similarly, the objective of CBM programs is often to establish a baseline to determine whether a site is impacted by natural and/or anthropogenic sources. In the latter context, establishing a baseline of pollution can be done using a variety of methods as long as they are considered scientifically reliable (reproducible, sufficiently accurate, with adequate controls) and sufficiently reliable for the intended application (Au et al., 2000). In other words, if the methods match the program objectives, it is not necessary to have the same level of rigor as professional environmental monitoring (Bliss et al., 2001). When CBM seeks to establish a baseline to identify the mere presence of pollution, programs can employ a lesser level of rigor than monitoring that might be used as legal evidence. Nevertheless, it is not sufficient to demonstrate that your program can produce high-quality data. It is important to consider aligning sampling methodologies and procedures with the QA standards employed by settler governments. Non-compatible QA procedures are a major barrier to statistically comparing different datasets; a necessary step to provide evidence that CBM data should be integrated into government agencies database, hence used in decision-making broader processes.

4.2.2 Trust and legitimacy

Trust and legitimacy were identified as critical factors for linking CBM to decision-making concerning Indigenous territory and jurisdiction due to the legacy of colonialism. ION quality samplers indicated they value the program due to their ability to trust the resulting data. They also noted higher confidence in data collected by members of their community or within the ION network than other sources of data including settler government or industry data. When asked how they thought ION data compared to other sources of water quality data, one sampler stated,

> Because I did it, I guess! You know it's a good question, because if you're told how to do it and you do it in the same fashion every time, you know that those kind of results are going to stay pretty consistent. You have to put on gloves, you got to wash the bottles and all that; you've got to calibrate before you get out there. And if people don't do that, and they just walk out, then everything might be way off. And if you find out that oh, it wasn't calibrated, the equipment, then how can you trust the equipment, I mean the results that you get back.

When asked, in follow-up, how their view of ION data compares to industry collected data, such as that collected by a mining company, they replied emphatically, "I wouldn't trust them! You got my answer, I wouldn't trust them!*"* Additionally, the legitimacy of the organization coordinating the CBM program has a significant effect on the extent to which communities trust the data (Hunsberger, 2004). For the Indigenous governments involved with ION, there were two factors affecting the perceived legitimacy of the YRITWC. First, as a treaty-based organization, which takes its direction from its Indigenous signatory governments and two executive boards in Alaska and Yukon, that are made up of representatives from these communities, Indigenous leadership of the YRITWC, and ION by association, meant that the program's mandate was

356 consistent with community goals and was perceived as independent from the influence of settler
357 governments or industries. Second, according to USGS and YRITWC Science staff, the strength
358 of relationships between samplers and staff was fundamental to inspiring trust. In other words,
359 social capital – or the relationships along with shared norms and values that contribute to social
360 trust and facilitate cooperation among or between groups for mutual benefit (Putnam, 2000) – is
361 critical to the success of CBM programs (Conrad and Hilchey, 2011).
362
363 CBM groups often emerge out of public distrust of governments and industry (Au et al.,
364 2000; Bliss et al., 2001; Irwin, 2002; Savan et al., 2003), where government enforcement and
365 compliance measures are considered inadequate or industry cooptation of scientists is a concern
366 (Savan et al., 2003). Against this backdrop, CBM is often motivated by an interest in holding
367 governments and industry accountable (Bliss et al., 2001). Indigenous peoples' distrust of
368 external data sources has been demonstrated. In a study of colonial and Indigenous water
369 governance, conducted in partnership with the Lower Similkameen Indian Band in British
370 Columbia (LSIB), Canada, Simms (2014) discusses the First Nation's distrust of data originating
371 from governments and industry. With both the LSIB and ION, the source of the water quality
372 data was a significant factor affecting trust. Relationships between Indigenous peoples and settler
373 governments suffer from a "crisis of confidence" (Goetze, 2005, p. 23) and are characterized by
374 unequal power relationships and a profound sense of distrust as the result of historical and
375 ongoing colonialism. It is not surprising that samplers expressed both a distrust in external
376 sources of data and a greater trust in CBM data collected by their community or government.
377 Just as trust and legitimacy positively influence the extent to which Indigenous governments
378 might rely on CBM data in governance processes, these factors will also be likely to increase the

379 extent to which these data influence decision-making processes involving both Indigenous and
380 settler governments, especially around contentious issues. While representatives from settler
381 governments were not interviewed as part of this study, previous studies suggest settler
382 governments tend to distrust the data generated by CBM programs (Buckland-Nicks et al., 2016;
383 Hunsberger, 2004). Distrust of CBM data is linked not only to concerns about data quality, but
384 also influenced by their trust in the data and the perceived legitimacy of the organization
385 coordinating the CBM program (See Hunsberger 2004).
386
387 *4.2.3 Relevance to decision context*
388 The use of data in decision-making processes requires relevance to those contexts to address
389 community concerns and questions. Identifying the information needs of communities and
390 decision-makers is a key challenge faced by CBM programs seeking to influence decision-
391 making processes (Buckland-Nicks et al., 2016; Hunsberger, 2004). Yet, the 'wrong data' might
392 be collected; many CBM groups focus on monitoring tasks as opposed to considering potential
393 applications (Conrad, 2006). In this section, we discuss the relevance of ION to decision-making
394 in the Yukon River Basin, including the relevance of the sampling protocols and sample sites.
395 Many of the samplers interviewed indicated their Tribe or First Nation had other site-
396 specific concerns that are not addressed by the ION water quality parameters (e.g. concerns
397 about heavy metals and sediment loads from mining runoff or leachate from local sewage
398 lagoons or landfills (Mutter, 2014)). While several samplers critiqued ION for failing to address
399 site-specific contaminant concerns within their traditional territory, another sampler noted that
400 the baseline information collected by ION is still valuable for their First Nation:
401 [My First Nation government] has always been clear that we think it's important to have

402 baseline information, and I think the water quality sampling program does provide that
403 baseline information. And it doesn't always have the specific needs that we have, but it's
404 still a good way to compare. I think it's important to feed into the bigger regional aspect
405 of things. Looking at the Yukon River watershed as a whole is really important.
406 Especially because we are in the headwaters, it's important to see how the [water] quality
407 is changing from the headwaters down lower in the river.

408 While ION monitors water quality at the basin-wide scale of the YRB, it would be challenging
409 and perhaps unnecessary to monitor all the parameters of local concern on a watershed basis.
410 Baseline monitoring through ION is important and can be used to 'signal' any variation in water
411 quality to identify site-specific monitoring needs. For Alaska Native Tribes wishing to do more
412 monitoring, the EPA IGAP requires several years to create a baseline of water quality data before
413 funding can be requested for advanced site-specific monitoring (US EPA, 2007). In this sense,
414 ION assists Alaska Native Tribes with obtaining the baseline data required to proceed with site-
415 specific monitoring. Furthermore, participation in ION contributes to the capacity building
416 needed to conduct site-specific monitoring. In the Canadian portion of the YRB, the YRITWC
417 has worked with Indigenous governments to conduct some site-specific monitoring. Five Yukon
418 First Nations (Carcross/Tagish, Kluane, Selkirk, Tr'ondëk Hwëch'in and White River)
419 participated in site-specific contaminants monitoring between 2012 and 2015 (heavy metals,
420 hydrocarbons, nutrients, and bacteria). In British Columbia, Taku River Tlingit First Nation
421 worked with the YRITWC to conduct site-specific monitoring related to concerns about placer
422 mining impacts within their traditional territory water resources in 2016.
423
424 For the ION water quality monitoring program, each Alaska Native Tribe or First Nation

425 monitors a site upstream from their community (Tribal or First Nation administrative
426 headquarters). If a second sample site exists, it is located downstream from the community. For
427 Tribes and First Nations, who have geographically expansive traditional territories, throughout
428 which their communities continue to rely on water, there are many other sample sites where it
429 would be pertinent to establish a water quality baseline. For example, the Yukon First Nations
430 with comprehensive land claim and self-governance agreements, retain rights and title to
431 settlement lands (roughly 10% of their traditional territory) face increasing environmental
432 pressure from resource development and climate change. Chapter 14 of their land claim
433 agreements, acknowledges First Nation authority to protect water quality, quantity and flows of
434 water adjacent to or flowing through settlement lands (Government of Canada et al., 1993).
435 Furthermore, Yukon First Nation governments have the ability to create laws in contexts where
436 there are jurisdictional gaps (e.g. on settlement lands) (Natcher and Davis, 2007), which could
437 include water quality standards. Baseline water quality data for each of the parcels of settlement
438 land would likely be needed to enforce water quality standards.
439
440 Currently, there exists a ten-year baseline database to study the effects of climate change
441 on the water quality on the Yukon River and its tributaries. In the absence of many other data
442 sources, this study provides a picture of environmental change at a basin-wide scale. Yet, the
443 ION samplers see this record as failing to meet local level community concerns as it serves
444 broader research objectives about the effects of global environmental change at a watershed
445 scale. Specifically, current parameters (e.g., water temperature, dissolved organic carbon, etc.)
446 and sample site locations (e.g., upstream and downstream from communities) are not alone ideal
447 for decision-making. Furthermore, while IK informs the development and management of ION,

448 there are no IK indicators are included in the program. These challenges in program design are
449 due in part to a lack of input by Indigenous governments into determining the monitored
450 parameters, which are currently based on USGS sampling protocols. However, the diversity of
451 site-specific concerns across the watershed, and even within the traditional territories of specific
452 nations, means that it is not likely strategic or financially viable to monitor and address all
453 concerns at the watershed scale. However, First Nations and Tribes should be consulted as to
454 how to adapt the current program design or develop new supplementary programs to better meet
455 their information needs. The use of existing ION data in decision-making processes is limited
456 due to sample site location and monitored parameters and the program should adapt to meet
457 community data needs. The program continues to have great value for Indigenous governments
458 as their goals are not entirely at odds, by providing high-quality baseline data that addresses
459 some of their broader concerns and needs.
460

461 **5. DISCUSSION**

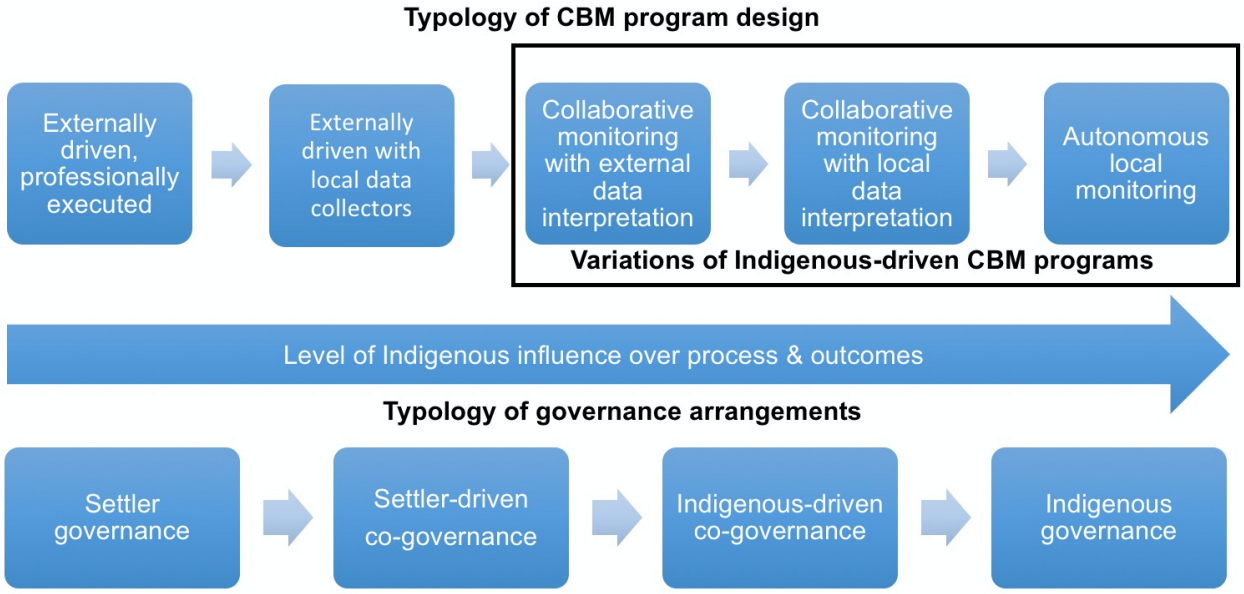
462 Monitoring is much more than data collection and dissemination; Indigenous peoples' roles in
463 monitoring go well beyond their cited role as 'knowledge holders.' Rather it is an everyday act
464 that has been reconceptualized as an important practice for the assertion of Indigenous
465 sovereignty and jurisdiction. Indigenous peoples also aim to use CBM data in decision-making
466 processes. CBM program design influences community ability to meet their monitoring goals
467 including the ability influence decision-making processes (Buckland-Nicks et al., 2016; Conrad
468 and Hilchey, 2011; Danielsen et al., 2010, 2005). Given the challenges discussed above, the
469 following discussion considers how CBM programs could be designed to increase influence on
470 governance processes.

5.1 Indigenous-led CBM

Indigenous leadership is fundamental to ION's success. While ION strategically engages external parties, for Indigenous peoples, who are working to protect the waters within their territories, taking a leadership role in CBM programs is essential to ensuring that the data are relevant to the decision-making processes and that, from their perspective, the data are rigorous, trustworthy, relevant and accessible. While much of the CBM literature focuses on the need for rigour, this study suggests that for Indigenous peoples in the YRB the ability to trust water quality data is also directly linked to the sense of ownership over ION. An assessment of the strengths and weaknesses of CBM suggests that community participation in monitoring enhances community capacity and the scale and speed of implementation of decision-making directly linked to environmental trends at a local scale (Danielsen et al., 2010, 2009). Building on these findings we suggest that Indigenous leadership is a key element of program design required to achieve desired governance outcomes.

Danielsen and colleagues (2009) developed a typology of community participation in monitoring programs, where program designs range from externally driven, professionally executed monitoring to autonomous local monitoring programs (Figure 3). While not specific to Indigenous CBM, these categorizations are useful when considering the degrees of engagement and control Indigenous peoples have within a spectrum of monitoring programs. This better specifies the range of possibility for CBM, but is not specific to the ways in which Indigenous peoples are engaging CBM as a tool to assert their sovereignty and jurisdiction. Toward that end, we juxtapose the typology of program design with a rough typology of governance arrangements where the latter ranges from settler governance to co-governance arrangements (settler and

494 Indigenous drive co-governance) through to Indigenous governance arrangements (Figure 3
495 bottom) (Adapted from Hill et al., 2012). Indigenous-led CBM programs take the form of both
496 collaborative and autonomous monitoring, with varying levels of involvement for external
497 parties, and tends to correspond with Indigenous-led co-governance or Indigenous governance
498 (Figure 3, top – black box).
499



500

501 ***Figure 3 Typology of CBM program design compared to the typology of governance***
502 ***arrangements involving Indigenous peoples. Each depicts increasing levels of Indigenous***
503 ***leadership or control. Programs designs on the far right (red box) can be considered***
504 ***Indigenous-led CBM, and with varying levels of involvement from external parties (Adapted***
505 ***from Danielsen et al., 2009; Hill et al., 2012).***

506 ***5.2 Networked governance and capacity***

507 The capacity of diverse Indigenous nations to conduct water quality monitoring in their
508 traditional territories has been greatly increased by the ION's program design. While the

YRITWC and the USGS coordinate monitoring efforts, field measurements, and water sampling are conducted by individual Indigenous governments. This network was developed and maintained through continuous relationship building. Face-to-face meetings at water quality training sessions and the YRITWC's biennial summits have been key to building increased understanding of the unique water challenges experienced by Indigenous nations. These engagements also build linkages at the watershed scale. In the transboundary context of the YRB, which spans Alaska, Yukon and British Columbia, ION has also increased connections among Tribes and First Nations who may not otherwise have had the opportunity to work collaboratively on water issues.

Capacity building is critical to linking CBM to governance processes including the ability to conduct, analyze and use CBM data in a way that is considered reliable and legitimate. Partnerships have been noted to play an important role in capacity building, particularly where partners, like the USGS and YRITWC, provide technical support which can increase the legitimacy of CBM (Hunsberger, 2004). IONs networked program design contributes to capacity building, by distributing technical and financial capacities through strong collaborative relationships with Indigenous governments. Without these relationships, the ION would not exist because of the complex logistics of this large-scale, transboundary network, where sample sites are in relatively remote locations. For example, many of the participating Alaska Native Tribes are in villages which are not connected to the road system. During an interview with one ION stakeholder, it was noted, that while the samplers were the main strength of the program, the YRITWC's role as a facilitator along with the technical support provided by the USGS were key to the ION's success:

> I think the samplers have been the main strength. I think the fact that they've been committed to going out on a bi-weekly basis for the better part of this program is the biggest strength. I also think that the cost sharing of us running the samples at the USGS, and then the Watershed Council managing the logistics and sample shipment is another big strength. I think it would be really hard for either organization to do it on their own, but the communities are the biggest strength.

While the samplers are critical to the ION's success, the role played by the YRITWC also draws our attention to the role of bridging organizations in capacity building. Bridging organizations, or organizations whose work serves to mediate connections between previously unconnected actors or actor groups, including different levels of governance and resource and knowledge systems (Berkes, 2009). By occupying a mediating position, bridging organizations can play an important role in capacity building by facilitating coordinated actions between actors and groups who lack the trust, capacity, resources, mandates or interest in connecting directly (Armitage and Plummer, 2010; Rathwell and Peterson, 2012). Linkages both across landscapes and between actors, from the local to watershed scale, is particularly important for shared resources, such as water, whose users operate at multiple spatial scales (Rathwell and Peterson, 2012). Indigenous peoples often develop bridging organizations. Specific to CBM, the Coastal Stewardship Network (CSN) – a regional monitoring program, is housed by the First Nations alliance of Coastal First Nations. The CSN is a network of Coastal First Nation stewards (also called "guardian watchmen") who collect their data for their own resource planning, management, and decision-making purposes (Kotaska, 2013). The CSN coordinates local First Nation stewardship offices that collect information based on some common protocols, along with other context specific indicators of concern, to facilitate regional governance initiatives. While the case study

555 of ION suggests that bridging organizations such as the YRITWC improve the potential for
556 CBM programs to increase Indigenous peoples influence over water governance processes,
557 further research is needed to examine this topic.
558
559 ***5.4 Integration of governance strategies and CBM***
560 A tighter integration of Indigenous water governance strategies and CBM will also improve the
561 influence these programs have on decision-making involving Indigenous peoples. The YRITWC
562 aims, for example, to link ION to Indigenous water rights and governance through the Yukon
563 River Watershed Plan (YRWP), which describes the Tribes' and First Nations' long-term vision
564 and objectives for the YRB. The plans' objective is to maintain "water quality, water quantity
565 and river flows [...] substantially unaltered from natural conditions" (YRITWC, 2013). The
566 centerpiece of the plan is set of measurable and specific water quality standards required to
567 achieve the plan's vision and objectives for the watershed. The water quality standards aim to
568 improve and protect existing water quality to sustain the health of the people, animals, and plants
569 in the watershed. While the plan has yet to be implemented, the water quality standards could be
570 applied in various locations across the watershed, regardless of the differences in standards or
571 guidelines across borders, and are intended to be consistent with the legal and regulatory regimes
572 of settler governments throughout the YRB including the United States, Canada, Alaska, Yukon
573 and British Columbia.
574
575 The YRWP aims to link directly to the water quality data collected through ION to
576 establish baseline conditions, against which to monitor for potential future degradation of water
577 quality. However, some of the water quality standards recommended for the YRWP are based on

parameters that are not currently monitored in the ION and have never been monitored in the YRB. To better link ION and other site-specific monitoring to the YRWP, water quality sampling protocols would need to address these additional water quality/contaminant standards. Regardless of the stage of implementation, the intentional linkages between ION and YRWP represent an attempt to directly link CBM with decision-making relevant to Indigenous peoples.

The ION water quality reports apply relevant water quality standards (Alaska) and guidelines (Canada) from settler governments. Guidelines or standards are applied to determine whether water is suitable for a specific water use (e.g. for aquatic life habitat, recreation and drinking water). Currently, water quality in Alaska is evaluated using the Alaska Department of Environmental Conservation's Water Quality Standards (ADEC, 2016) and Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances (ADEC, 2008). Drinking water is evaluated using the EPA's Drinking water standards (US EPA, 2015). Whereas, water quality in Yukon and British Columbia are evaluated using the Canadian Guidelines for the Protection of Aquatic Life (CCREM, 1987). Applying standards/guidelines to the ION's data supports Tribal and First Nation decision-makers put data in a format that makes Tribes and First Nations aware of water quality exceedances in a way that could be used in decision-making.

6. CONCLUSION

This case study of ION highlights the importance of a governance lens for understanding Indigenous peoples' participation in CBM programs. While the inclusion of IK in monitoring is a priority for Indigenous peoples, it is important not to limit their role in CBM to that of

601 'knowledge holders' who contribute to improved understanding of global environmental change;
602 this obscures Indigenous people's motivations for engaging in CBM. Other scholars have
603 similarly acknowledged that CBM is highly political and can work counter to the goals of local
604 and Indigenous peoples (Noble and Birk, 2011; Staddon et al., 2014), and that weakness of
605 linkages between CBM and decision-making are common (Buckland-Nicks et al., 2016; Buytaert
606 et al., 2016; Conrad and Hilchey, 2011; Hunsberger, 2004).
607
608 Instead, this paper argues that a governance lens illuminates the potential for CBM as a
609 tool for asserting Indigenous sovereignty and jurisdiction and as a way of understanding CBM as
610 more than data gathering -- as a form of Indigenous water governance. The ION samplers and
611 program partners certainly view water quality sampling as governance tool wherein CBM is a
612 means to assert sovereignty, through the practice of stewardship, and by gathering data that
613 inform internal and external planning and decision-making. Furthermore, research findings
614 suggest data quality and credibility, trust and legitimacy, relevance to decision contexts are key
615 to linking CBM data to decision-making. Finally, three recommendations to better link CBM
616 programs and Indigenous governance emerged: Indigenous governments must take a leading role
617 in CBM programs; Networked capacity between Indigenous governments can be built using a
618 bridging organization, and CBM programs should be closely coupled with Indigenous water
619 governance strategies.
620

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