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A Shared Vision for Improving Arctic Observing Systems for Societal Benefits of Arctic Indigenous Communities

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ABSTRACT. "What does success look like in improving Arctic observing?" We posed this prompt to focus groups tasked with discussing the development of success metrics for creating a sustained, coordinated Arctic observing system. The focus groups were composed of members of the Research Networking Activities for Sustained Coordinated Observations of Arctic Change (RNA CoObs) and the Indigenous-led Food Sovereignty Working Group (FSWG). These groups had come together to pilot the Sustaining Arctic Observing Networks (SAON) Roadmap for Arctic Observing and Data Systems (Arctic ROADS) process. Our four-person research team used the Rapid Assessment Approach with nine focus groups. Based on this data, we developed twenty Themes of Success that outline the dimensions of a successful observing system, processes in improving observation, and values of the process in improving observing. We defined each theme based on perspectives of the RNA CoObs scientists and Indigenous-led FSWG members. We also compared points of alignment between these two groups and areas of misalignment between them. Our team identified a set of seven tensions between RNA CoObs and FSWG that illustrate ongoing barriers to the improvement of Arctic observing. The goal of recognizing misalignments and tensions was not to create division between the two groups, but to allow space for each to express themselves so that a shared understanding and vision could emerge. Co-production of knowledge literature emphasizes the need to address these misalignments and tensions to support better collaboration and actionable outcomes.

Keywords: Arctic observing; Arctic Indigenous Peoples; equity; research coordination; success metrics; societal benefit

RÉSUMÉ. « À quoi ressemble la réussite en matière d'amélioration de l'observation de l'Arctique ? » Nous avons consulté des groupes de discussion dont le mandat consistait à discuter de la conception d'indicateurs de réussite pour la création d'un système d'observation durable et coordonné de l'Arctique. Les groupes de discussion étaient composés de membres de Research Networking Activities for Sustained Coordinated Observations of Arctic Change (RNA CoObs) et du Food Sovereignty Working Group (FSWG) dirigé par des Autochtones. Ces deux groupes travaillent de concert pour piloter le processus du carnet de route pour l'observation et les systèmes de données de l'Arctique (Roadmap for Arctic Observing and Data Systems – Arctic ROADS) relevant des réseaux Sustaining Arctic Observing Networks (SAON). Grâce à sa méthode d'élaboration accélérée, notre groupe de recherche, composé de quatre membres, a pu mener à bien neuf séances de discussion. À partir des données recueillies, nous avons articulé 20 « thèmes de réussite » communs faisant ressortir les dimensions d'un système d'observation, les processus nécessaires à son amélioration et les valeurs à intégrer au processus d'amélioration. Nous avons défini chaque thème en fonction des perspectives des scientifiques de RNA CoObs et des membres du FSWG. Nous avons également comparé les points de convergence et de divergence entre ces deux groupes. Notre équipe a déterminé sept points de friction entre RNA CoObs et FSWG, mettant en évidence les obstacles persistants à l'amélioration de l'observation de l'Arctique. L'identification des points de divergence et des points de friction n'avait pas pour but de créer de la dissension entre les deux groupes, mais plutôt de permettre à chacun de s'exprimer pour aboutir à une compréhension et à une vision communes. L'élaboration conjointe de documents intégrant les connaissances souligne la nécessité de résoudre les points de divergence et les points de friction afin de favoriser la collaboration et des résultats pragmatiques.

Mots-clés : observation de l'Arctique; peuples autochtones de l'Arctique; équité; coordination de la recherche; indicateurs de réussite; avantages sociétaux

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INTRODUCTION

Arctic observing systems bring together participation from diverse contributors and users. These actors include observers from many disciplines: modelers and climate service providers; users, including decision makers from international to local scales; and funders and operational agencies (Huntington, 2013; IDA, 2017; Starkweather et al., 2021). Coordination efforts for Arctic observing also have a history of Indigenous participation through community-driven observing initiatives and the involvement of Indigenous experts, as Indigenous Knowledge systems are akin to observing systems (Arctic Observing Summit, 2020, 2022). This diversity is a strength for Arctic observing, as the different perspectives bring innovation, creativity, and engaging dialogue, but also give rise to misunderstandings, misalignments, and tensions. This project aims to create a clear framework for shared success metrics for Arctic observing, while also bringing attention to sources of tension between western and Indigenous perspectives. Such an approach provides a clear starting point for collective efforts to improve the system and is consistent with calls for greater equity in planning for Arctic observing systems. This work presents a snapshot of the status of shared success metrics and tensions as of its initial writing in 2023. Because these groups continue to work together, some themes are expected to shift over time. These findings capture one step in the long process of meaningful collaboration within Arctic observing.

BACKGROUND

Three complementary bodies came together between 2019 and 2022 to advance equitable and structured planning for Arctic observing systems. They include the 1) governing bodies related to the Arctic Roadmap for Arctic Observing and Data Systems (Arctic ROADS) process of Sustaining Arctic Observing Networks (SOAN); 2) Indigenous-led Food Sovereignty Working Group (FSWG); and 3) Research Networking Activity for Sustained Coordinated Observations of Arctic Change (RNA CoObs) funded by the U.S. National Science Foundation. RNA CoObs was created to address intersecting issues related to Arctic observing, with a significant effort dedicated to working in partnership with the FSWG to pilot SAON's Arctic ROADS process. The focus groups for this research drew from these three bodies; understanding their purposes and histories sets the context for the results of this work.

SAON, the parent body for Arctic ROADS, is an international joint initiative of the Arctic Council and the International Arctic Science Committee. It was created in 2011 as a legacy of the International Polar Year (2007–09) to facilitate coordination between new and emerging observing networks and data systems with national partners from both Arctic and non-Arctic countries (Arctic Council, 2011). SAON operates under a collaborative, non-hierarchical governance structure that draws from polycentric governance principles in framing problems, setting norms, and influencing discourse (Starkweather et al., 2021).

The concept for an Arctic Observing Network (AON) was articulated in the U.S. National Academies study (NRC, 2006:1) that called for a "framework within which existing [Arctic observing] programs can be linked and supplemented." While the report clarified that the AON concept was needed to advance observations, monitoring, data integration, and sharing in the region across a broad array of stakeholders, a central challenge is that the concept and coordination were largely led from academia. The study contributed to the creation of a U.S. National Science Foundation program by the same name (NSF-AON) aimed at developing longer data records for climate and ecosystem-relevant variables for research understanding. The AON concept grew through frequent principal investigator workshops of the NSF-AON program (AON, 2010) and the efforts of the Study of Environmental Arctic Change (SEARCH) Observing Change Panel (Payne et al., 2013). These efforts collectively contributed to a relatively coherent academic AON concept without ever articulating a succinct definition for the AON.

SAON draws guidance for its role as a regional facilitator from its board, which includes nationally-appointed members from research and funding organizations, representatives of Arctic Indigenous Peoples organizations, and working groups of the Arctic Council. In addition, SAON serves as a founding partner of the biennial Arctic Observing Summit (AOS), where it draws guidance from a greater observing community that engages in its work. The AOS plays a crucial role in the history of these three complementary bodies, which were inspired via its working groups and side meetings. Initiated in 2013, the AOS has since convened every even-numbered year during the annual Arctic Science Summit Week (ASSW), the annual meeting of Arctic Council and the International Arctic Science Committee partners, who co-convene the summit with SAON. The AOS is action-oriented, with working groups that develop sets of recommendations summarized within synthesis reports and conference statements (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016; 2018; 2020; 2022). It was through the AOS that the concerns of Indigenous communities, the need for community-led monitoring programs, and concepts related to data sovereignty and Indigenous Knowledge systems became more explicit aspects of AON discourse. Within the AOS discussions, a growing dialogue emerged about the need for co-production of knowledge (CPK), with a recognition of the mutually beneficial potential of linking scientific and Indigenous observations.

Through its board and the AOS, SAON recognized that its partners, funding agencies, and regional actors needed greater support to advance planning for observational and data systems. SAON also perceived that Indigenous-led monitoring and Indigenous Knowledge systems should be

an important focus in this work. In 2018, SAON initiated a concept for coordinated planning that evolved into its Arctic ROADS process. A SAON-appointed task force set forth proposed guiding principles for ROADS, which were presented for comment during the 2020 AOS (AOS, 2020). The guiding principles are:

- Indigenous Peoples' equitable partnership and funding for their active participation is critical to ROADS;
- All aspects of the ROADS process should support broadly shared benefit from the observing and data systems;
- The ROADS process should complement and integrate, without duplication, the current planning approaches used by existing networks, activities, and projects;
- ROADS should support stepwise development through a flexible and evolving structure that allows grassroots identification of themes, infrastructures, and regional foci.

Starkweather et al., 2021:59

The task force recommended a governance structure for ROADS envisioned as an Integrated Advisory Process with iterative support and co-learning between the SAON-appointed Advisory Panel and the multiple grassroots, thematic Expert Panels comprised of relevant subject matter experts. Expert Panels are asked to develop requirements and implementation strategies for observing and data systems to meet one or more societal benefit(s) within their thematic area (e.g., harmful algal bloom monitoring for paralytic shellfish poisoning within Bering Sea communities). The ROADS Advisory Panel was formed in late 2021. At AOS 2022, a working group developed detailed recommendations for the ROADS Expert Panels' initiation and progress.

The ROADS process has also introduced several planning tools, such as Shared Arctic Variables (SAV) (Bradley et al., 2021). These tools will help coordinate requirements and implementation planning between community or Indigenous leaders, researchers, and agencies. At the initial time of writing (early 2023), the first thematic Expert Panels are starting to be formed, with the expectation of accepting Expert Panel proposals every six months. To understand the types of expertise needed to foster success in the integrated advisory process, it is important to emphasize that "The ROADS process is first and foremost oriented towards generating societal benefit within the Arctic region, with an emphasis on the inclusion of Indigenous worldviews in assessing that benefit" (Starkweather et al., 2021:59).

RNA CoObs (Chythlook et al., 2022), led by the International Arctic Research Center at the University of Alaska Fairbanks, was organized to fund relevant expertise to pilot Arctic ROADS and to support Indigenous perspectives within AOS, particularly those related to food security. The proposal for CoObs was written in 2019 and funded in 2020, before the ROADS Advisory Panel was formed and explicit guidance for Expert Panels was formalized. CoObs became a place for dialogue and to foster concepts within the project and through the AOS concerning Arctic ROADS principles, governance, and tools. This dialogue included exploring the expert panel process and examined how to engage Indigenous communities respectfully. While ROADS is pan-Arctic and open to diverse thematic scopes, CoObs focuses on the North Pacific region and themes related to food security.

The Indigenous-led FSWG started as the Food Security Working Group at AOS 2020 and grew into an informal network (Chythlook et al., 2022), although its initial roots can be traced to AOS 2016. Its members are Indigenous scholars and community leaders, liaisons, and researchers who work for Indigenous tribes and organizations. They also saw themselves as part of the broader Arctic observing community. This group is focused on subsistence, traditional fish, animal, and plant harvesting, and the inherent sovereignty rights of Indigenous Peoples over their lands and waters. In 2021, CoObs funded three Indigenous liaisons to support the FSWG, CoObs, and ROADS initiatives. The majority of FSWG members are from Alaska, with limited participation from other Arctic Indigenous groups. Therefore, drawing focus group participants from CoObs and FSWG biases the research towards Alaskan perspectives, and further research is needed to generalize these findings to other Arctic Indigenous groups.

AUTHORSHIP

The four authors conducted the focus group research, but the content represents the collective knowledge of CoObs and FSWG members. Due to these collective knowledge contributions, we want to properly recognize the participants. Authors: Margaret Rudolf, Sandy Starkweather, Craig Chythlook, and Ryan Cody. CoObs participants (alphabetical): Will Ambrose, Maureen Biermann, Cecilia Bitz, Alice Bradley, Amber Budden, Hajo Eicken (PI), Patrick Heimbach, Matt Jones, Craig Lee, Hank Loescher, Bill Manley, Maribeth Murray, An Nguyen, Peter Pulsifer, Scott Rupp, Josie Sam, Craig E. Tweedie, Kelly Uhlig, and Sergio Vargas. Editing support: Emily Lescak. FSWG participants (alphabetical): Jessica Black, Eva Dawn Burk, Victoria Buschman, Nikoosh Carlo, Raychelle Aluak Daniel, Lauren Divine, Kaare Sikuaq Erickson, Nicholas Parlato, Julie Raymond-Yakoubian, Harmony Jade Wayner, Simone Whitecloud, and Brooke LaRae Woods. Rudolf led the research and writing as part of her doctoral dissertation (Rudolf, 2023).

METHODS

Following the co-production of knowledge methodological approach (Ellam Yua et al., 2022), lead

author Rudolf joined the FSWG and worked with them for a year before taking one of the Indigenous liaison positions. She worked with CoObs for six months before starting her research. This early relationship-building work was crucial in developing trust and understanding the context and goals of the research partners. She informally identified misunderstandings between the two groups, as well as general frustrations from FSWG members with Arctic researchers. While this project did not conduct co-analysis with the participants and therefore is not knowledge co-production, it is a tool to support future work of that kind through boundary spanning, which both ROADS and CoObs aspire to follow in future initiatives. Boundary spanning facilitates work and communication between groups like CoObs and FSWG (Bednarek et al., 2018). Boundary work is led by boundary spanners, who have some understanding of both worldviews, such as FSWG Indigenous Liaisons.

The focus group research followed the rapid assessment process (Beebe, 2001). RAP supports developing an exploratory understanding of different perspectives to develop themes or frameworks. It uses a team-based approach, with members representing each of the anticipated insiders' perspectives. The research team members for this project were Rudolf, Chythlook, Starkweather, and Cody. Rudolf and Chythlook are both Indigenous, representing Indigenous perspectives. Chythlook is a commercial and subsistence fisherman with an understanding of food sovereignty. Rudolf has expertise in CPK and boundary spanning. Starkweather is part of the leadership of SAON, the ROADS Task Force, and the U.S. Arctic Observing Network (US AON), with expertise and contextual knowledge of Arctic observing coordination. Cody, a CoObs member and GIS analyst, brings the perspective of an observing technical practitioner. Following the rapid assessment process (Beebe 2001), this research team diversity provides triangulation and robustness between disciplines, insider/outsider perspectives, and multiple perspectives while conducting the focus groups and analysis. While the research team do offer diverse perspectives, they cannot fully represent all participants' diverse expertise and knowledge. Iterative participant feedback was therefore built into the data analysis.

Following the rapid assessment process, data collection should support understanding the insiders' perspectives, and participants should be able to communicate freely (i.e., through open-ended interview versus close-ended surveys). Homogeneous focus groups best fit the context of CoObs and FSWG, so participants could explore topics relevant to their expertise freely and in a shared language (compared to a group of mixed expertise). There were 34 focus group participants, including the research team as participant–researchers (Wilson, 2008), with 20 from CoObs and 14 from the FSWG. The research team conducted nine focus groups: four from each body (CoObs and FSWG), and one for the four-person research team (authors). Rudolf grouped CoObs members based on expertise and roles within the project, including (1) observing coordination, (2) system requirements capture, (3) information services, and (4) monitoring and modeling. FSWG members were grouped based on whether participants were (1) Indigenous community members, (2) policy experts, and (3) researchers, and (4) second group of researchers. While expertise did overlap categories, each participant only took part in one focus group.

Focus groups were asked to respond to one prompt: "What does success look like in improving Arctic observing?" The open-ended question encouraged participants to contribute and lead the discussion based on their own priorities (Beebe, 2001). The hour-long focus groups took place over Zoom between November 2021 and January 2022, with each recorded and transcribed with Zoom. The research team conducted each focus group together, taking notes and providing limited facilitation to ensure participation from everyone and to keep discussions on topic. The goal was to create success metrics, so when needed, the research team also asked follow-up questions to solicit metrics from what was being discussed.

Iterative analysis is another key principle of the rapid assessment process (Beebe, 2001). This form of analysis supports convergence over the themes and representation of the data. Rudolf corrected the Zoom transcriptions of the focus groups. The research team individually conducted textual analysis (Saldana, 2017) using MAXQDA software. The team used hand coding (i.e., highlighting sections and labeling them with themes) to inductively identify themes and categories into a codebook (i.e., the list of labeled themes). MAXQDA supported organizing and sharing the codebook, so the research team could review one another's identified themes and categories. The research team met nine times to iterate over the data analysis and work towards convergence. Significant time was spent aligning the different conceptual language each researcher had used, iterating until we found the right word(s) to accurately represent the identified theme. Initially the group members presented their codebooks to each other, discussing differences in themes that emerged for each researcher, and patterns in themes between the focus groups. Tensions between CoObs and FSWG members were evident at this stage, and the research team weighed the merits of focusing on the themes of success against the need to capture these tensions. It was decided to focus on both with another review of the data. Later meetings were focused on grouping the themes into categories and subcategories. The team developed the data representation framework to present the differences between CoObs and the FSWG. The group iterated until each research team member's emergent themes were represented within the categories and framework. This method fits with the rapid assessment process (Beebe, 2001), as the process is an exploratory qualitative method that gains rigor from triangulation of different perspectives of the research team, rather than through repeatability and theory verification.

The resulting themes, categories, and frameworks were presented back to participants for feedback in three cycles. For each cycle, a Word document was sent to the participants via email and returned with comments. Since comments were minimal, Rudolf compiled them and made the corresponding changes. The first feedback cycle focused on a list of "themes of success for improving Arctic observing," presented as the main themes without sub-categories or definitions. The goal was to solicit feedback on significant gaps, which resulted in adding "multidisciplinary" as a theme. The second round of review included rough draft versions of Figures 1 and 2, including the subcategories and an introduction to concepts of misalignments and tensions. In addition, the second round solicited definitions of "Arctic observing" from a cross-cultural, multidisciplinary perspective. The goal for the second round was to solicit feedback on missing definitions under each theme, and whether each participant felt their perspective was being represented within the framework of data representation. The last round of feedback was circulation of a draft of this paper.

RESULTS

We present our results as themes covering both successes and tensions. Narrative descriptions describe which perspectives were shared between CoObs and FSWG, and which differed. Our goal in addressing differences was not to create division between these groups, but to allow space to make both perspectives visible. Together, the themes of success and tension can serve as a foundation for a shared vision of improving Arctic observing. Leaving out power dynamics, politics, and differences in ontology and epistemology, as well as success metrics, can lead to partners disengaging from collaborative projects (Lövbrand, 2011; Turnhout et al., 2020). Quotes are from focus group transcripts. While quotes provide nuance to the concepts we present, they are not meant to capture consensus or all perspectives on themes that arose during the focus groups.

Defining "Arctic Observing"

Many FSWG members questioned the exact meaning of "Arctic observing." This suggested that terminology and lack of a common definition were a foundational barrier. While the definition and focus group prompt were intentionally left open to interpretation, there was a perceived tension within FSWG focus group discussions concerning what would count as observations, similar to tensions that arise around what counts as science. By contrast, many CoObs members drew their understanding of Arctic observing from three sources: AON work by the National Academies (NRC, 2006); principal investigator workshops by the NSF AON program (AON, 2010); and the Study of Environmental Arctic Change (SEARCH) observing change panel (Payne et al., 2013). Collectively, these sources contribute to a coherence academic AON concept popularized following International Polar Year 2000–09. While the academic literature on AON was robust, there was still no set definition of what is and is not Arctic observing, which compounded confusion across focus groups. Even between disciplines, scientists probably had different perspectives based on their interactions with the field.

Based on our research with FSWG and CoObs members, and derived from the second cycle of feedback, Arctic observing can be defined as observations made in the Arctic on the Arctic environment or about the state of the Arctic, the boundaries of which vary depending on disciplinary and political contexts. In scientific terms, observations are made through humans collecting, gathering, measuring, and monitoring. In Indigenous terms, observations are rooted in the deep reciprocal relationship with the environment, which is spiritual and cultural. The observations themselves, in either scientific and Indigenous contexts, can be counts, estimates, video, audio, photos, voice recordings, stories, noticing presence or absence. Observations can be sensory, artistic, and both quantitative and qualitative. Observations can be on phenomena, flora, fauna, weather, seasonality, climate, water, ice, air, non-human beings, and human impacts. These observations are then preserved, reported, shared, and archived for analysis, whether through scientific analysis or Indigenous oral traditions. While short-term observations have a place in the Arctic observing system, long-term monitoring with repeated observations over a long period is crucial to track changes over time to understand climate drivers. Again, long-term monitoring can be conducted with scientific methods or as part of Indigenous Knowledge systems. Lastly, it was expressed that the understanding of Arctic observing is changing on both the personal and community levels. The participation of Indigenous individuals and other disciplines is causing the change, as well as the variability of the Arctic itself.

> Arctic observing is not theoretical, frameworks for engagement, and/or the extraction of information; this is a byproduct of a disconnect to place, where it makes the most sense to discuss how to observe, instead of listening, acting, and observing changes recognized by thousands of years of Indigenous and local knowledge. I think Arctic observing is multi-generational, it is forward-looking, while recognizing oral tradition and history. Observing is understanding that our western understanding and baseline of knowledge is so far inferior to those living full-time on the land, and that we as a research society are not yet ready to accept and understand what our regional youth, Elders, and advocates are trying to tell us by fighting and advocating for the protection of their lands and resources. Arctic observing is action oriented; we are beyond our useful life as researchers to do work that

> no longer contributes to advocacy and the political and regulatory conservation efforts being led by local and regional Indigenous leadership.
>
> Craig Chythlook

Themes of Success

We identified 20 themes we call *Themes of Success*, presented here in three categories: dimensions of a successful observing system, processes for improving observing, and Values of the Process. Figure 1 depicts a Venn diagram that shows overlap and separate perspectives about these themes among RNA CoObs scientists and members of the Indigenous-led FSWG.

Coordinated: Arctic observations currently proceed under a wide range of independently funded efforts, with no specific mandate to coordinate. This, despite the fact that coordination is recognized as an important means to leverage related efforts to fill observing system gaps and more efficiently share data (Eicken, et al., 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016; 2018; 2020; 2022). In response, the primary purpose of SAON ROADS and RNA CoObs is to create a more coordinated Arctic observing system. In general, focus group members described coordination as greater *awareness*, and seeing everything that is happening (See Figure 1 for important italicized concepts). Discussions also brought up the idea that coordination would mean having *better communication to prevent duplication of efforts*, and *interconnecting* projects, rather than projects unfolding separately. The FSWG discussions focused more on the *inclusivity of community-based monitoring* in the broader observing system, which was a minor point of interest to CoObs members. For example, they discussed the idea of observations being *interoperable* for better data sharing. The FSWG members commented that the current state of uncoordinated efforts makes Arctic observing not *accessible* and too confusing to understand who is doing what, and to keep track of moving parts.

> [Coordination is to have] a day or situation where all the various projects working in observing projects and programs can see each other and interact with each other more effectively.
>
> Peter Pulsifer

Sustained: Many observing systems in the Arctic currently operate under revolving research funds, are proposed ad hoc, and subject to peer-reviewed competitions. A driving purpose of ROADS and CoObs is to have sustained observing networks of importance, specifically *continuity of long-term funding from federal agencies*. CoObs members focused more on federal agencies operating observing networks, specifically the National Oceanic and Atmospheric Administration. CoObs members also discussed the importance of sustained networks that are essential to *climate-scale observations*. The FSWG members discussed how Indigenous Knowledge systems are observing systems, with observations, analytic processes, and sharing that are culturally different from western scientific methodologies. The term "methodology" refers to how research is designed from a philosophical framework of a discipline or culture (i.e. western science versus Indigenous) (Wilson 2008; Kovach 2009). Methods, meanwhile, are the specific activities within a project. Indigenous Knowledge systems also pre-date scientific measurement, making them sustained observing systems. Therefore, *funding should support Indigenous ways of life*. These ways of life play a vital role in an Indigenous-led observing system, such as the Canadian Guardians program (Reed et al., 2021). Another way to support Indigenous Knowledge systems is by funding Indigenous-led observing networks, as they fully utilize Indigenous Knowledges, and often blend with scientific observations identified as crucial by Indigenous Knowledge holders. *Funding long-term relationships and relationship building* supports the Indigenous methodologies concept of relationality (Wilson 2008; Kovach, 2009).

> Some of the conversations leading up to the last Arctic Observing Summit [2020], somebody said "Oh, but you know I'm an observing system, right?" because that represents my knowledge system. "That I hold from a millennia to today," and part of that [observing system] should encompass that knowledge system and represent that knowledge system. So building equity across the different knowledge systems would be a success to me. The real success would be building an observing system from an Indigenous perspective. Where you're integrating all of the science pieces into that [Indigenous] observing system. If you think about it being from the observing system being that interconnected [Indigenous] knowledge system and scales right down to an individual who is part of that system and is an observing system themselves.
>
> Raychelle Aluak Daniel

Transparent: Transparency is a cross-cutting theme as both a critical dimension of an observing system, as well as a process value. Transparency relates to *documentation* practices. Both groups discussed creating documentation for *decision making* and *processes used*. CoObs members discussed documenting collection methods to support interoperability. FSWG members discussed documentation of ethics and Indigenous methods, as they show credibility from an Indigenous perspective. Amber Budden, a CoObs member, pointed to the need to implement CARE principles (collective benefit, authority to control, responsibility, ethics) (Carroll et al., 2020) in the name of Indigenous data governance within metadata documentation in the name of transparency:

> We are just beginning to introduce information into our metadata around data sensitivity and CARE principles; as a check that you can run across the metadata to look

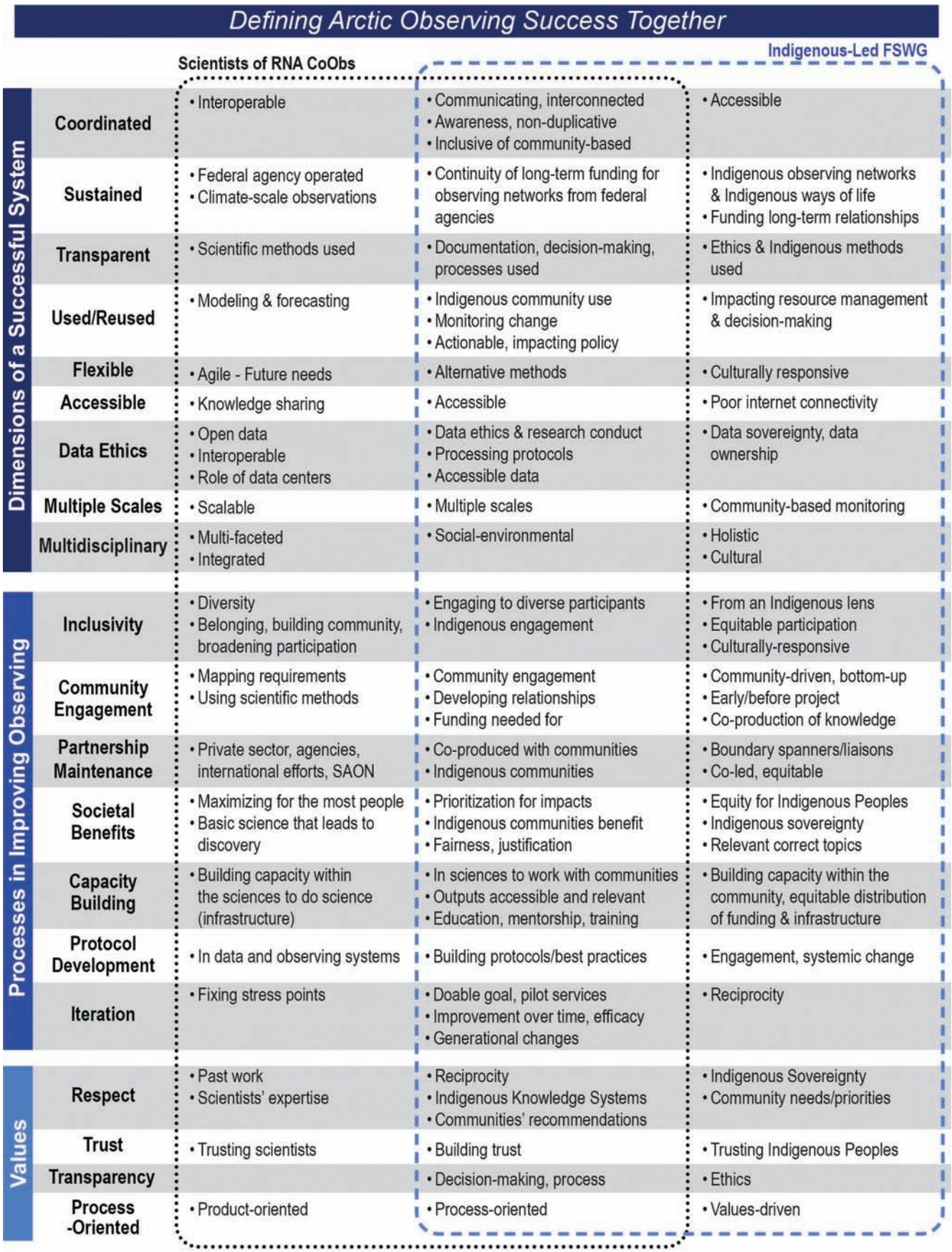

FIG. 1. Defining Arctic observing together. Themes of Success (left) are presented in three sections. The Venn diagram shows RNA CoObs scientists' perspectives (left-side black-dotted cluster) and those of the Indigenous-led FSWG (right-side, blue-dotted cluster), including shared discussion points (center).

> at adherence or support for the CARE principles, or Indigenous data sovereignty and co-production. That's not [currently] written into the metadata so maybe it is something as a community we need to think about. How do we express this in a way, not for the sake of metrification, but so that we have transparency and consistency in the way we're thinking about these issues and how we're reporting it as part of the data record.
>
> Amber Budden

Used/Reused: The use of observing systems data is the underlying driver of ROADS and CoObs. Both the immediate use, and later reuse, of the data were discussed as being part of evaluative metrics for the justification of observing systems. Specifically, focusing on use by Indigenous communities was the top priority, as both groups strive to partner with Arctic Indigenous communities. Both groups also prioritized use and reuse leading to actionable outcomes, including those that impact policy. Both groups discussed using observing data to identify anomalies and monitor change, while CoObs focused more on using the data for modelling and forecasting. Regarding impacts on policy, FSWG focused more specifically on impacting resource management and decision making.

Flexible: Both groups talked about searching for alternative methods for data collection that are more fitting for remote Arctic environments or use by community members, like technology that's low-cost, accessible, or able to withstand weather and cold. CoObs members discussed how systems need to be flexible enough to meet future needs, using the technical term "agile" to describe this flexibility. FSWG members discussed the need for researchers to be flexible enough to include *culturally responsive methods* and funding strategies; researchers have to be able to shift proposed methods to better meet community needs, hire local, and fund training for local observers and research professionals.

Accessible: Both groups widely expressed ideas about the concept of accessibility. This was a cross-cutting theme that touched on coordination and tensions, with multiple meanings in different contexts. For CoObs members, accessibility was framed in terms of accessible communications, including plain-language *knowledge sharing* between research groups and Indigenous communities, and accessibility in coordination to better understand the Arctic observing system. Being accessible to rural Alaska Native communities with poor internet connectivity was a crucial issue for the FSWG members.

Data Ethics: Both groups discussed the use of data ethics and research conduct broadly in the context of FAIR (findable, accessible, interoperable, and reusable) and CARE principles for data governance (Carroll et al., 2020), as well as other relevant protocols and ethics. These frameworks establish processing protocols and data *accessibility standards*. CoObs members focused more on open access data frameworks for interoperability. For long-term data storage that supports data use/reuse, CoObs members made reference to data centers. FSWG members focused more on data sovereignty and data ownership for both sensitive data, as well as observing data collected within Indigenous lands and waters.

Multiple Scales: Both groups discussed the relevance of multiple scales to observing systems, including pan-Arctic, regional, and local community scales. CoObs discussed this in technical terms of systems and models being scalable, while the FSWG was more focused on prioritizing community-based monitoring.

Multidisciplinary: Due to the focus of ROADS and CoObs on societal benefits, both groups discussed how observing systems interface with social-environmental interface factors. For CoObs, discussions focused on climate change impacts on Indigenous communities. FSWG members focused on how Indigenous Knowledge Holders are central to the observing system, and how people are part of the ecosystem of the Arctic. CoObs members described observing systems as inherently multi-faceted, with multiple disciplines interacting, and the scientific concept of integration. FSWG members described the need for observing systems to be *holistic* and inclusive of *cultural* perspectives, rather than just disciplinary.

Inclusivity: All groups discussed how the process of improving Arctic observing should engage diverse participation, particularly focusing on Indigenous engagement. *Indigenous engagement* being the primary theme of the focus groups allowed for more detailed elaboration on this area of discussion than just the idea of inclusivity. CoObs members focused more on diversity and the sense of belonging, building community, and broadening participation. FSWG members focused more on equitable Indigenous participation, and the process being Indigenous-led and culturally responsive, from an Indigenous lens with Indigenous Knowledge systems.

Community Engagement: Inherent to the process is community engagement from groups intended to benefit from Arctic observing systems. All groups discussed developing relationships with community members and the lack of funding needed for engagement. CoObs members discussed using typical scientific methods and mapping requirements (a method of describing needed requirements for an observing system), with researchers leading community engagement projects and interpreting community members' contributions. FSWG members talked about the process being community-driven from the bottom-up and following a co-production of knowledge methodological approach that requires *engagement early* in a project or before it has been funded. This misalignment on community engagement methods is due to the fact that not many CoObs members are well-versed in co-production of knowledge, and are therefore reliant on typical scientific methods, which are often seen by Indigenous peoples as top down. FSWG members did have one example of better knowledge co-production in observing:

> Who's going to be the team analyzing, interpreting, and writing up that information? Even in an ideal scenario, you know, we have a great relationship with [name] and his team just to give a concrete example. We have the conductivity temperature depth sensors. We do the casts. We send them the information, they process it, and then together we sit down and look at the patterns and trends. We get to ask the questions, answer questions, look at weather data together. Our island sentinels are able to contribute their knowledge to possible patterns and trends. Possibly contradicting thoughts around what is observed and historical data or whatever. So there's more an open conversation, but that all takes time.
>
> Lauren Divine

Partnership Maintenance: Functionally, the ROADS expert panel process and motivation for CoObs is to build partnerships that equitably include Indigenous communities and are a co-produced process with communities (Starkweather et al., 2021; Chythlook et al., 2022). CoObs members highlighted the additional value of partners in the ROADS process from the private sector, agencies, international efforts, and SAON, as well as other non-governmental organizations. FSWG members discussed approaches that are co-led, have co-management, and are equitable partnerships. They also discussed the need for boundary spanners, liaisons, and established relationships at the center of developing partnerships to lead the process.

Societal Benefits: Societal benefit frameworks (Inuit Circumpolar Council-Alaska, 2015; IDA Science and Technology Policy Institute and Sustaining Arctic Observing Networks, 2017) have emerged in relation to Arctic observing as a means to generate greater equity in research planning through orienting outcomes toward societal benefit rather than towards the results of discovery-driven questions exclusively (Meadow and Owen, 2021). The purpose of ROADS and CoObs is to have recommendations for funders and partners engaged in observing based on prioritizing networks for their societal benefit impacts, specifically prioritizing for Indigenous community benefits. FSWG members discussed the process of understanding Indigenous societal benefits through supporting Indigenous sovereignty with existing Indigenous-led initiatives. Using the societal benefits as the justification of investment was seen as providing fairness for funding distribution across observing systems. CoObs members discussed prioritizing by maximizing observing that benefits the most people, while FSWG members discussed prioritizing equity for Indigenous Peoples. Another misalignment is that FSWG members talked about prioritizing the correct topics based on relevance to Indigenous communities, while scientists in CoObs brought up the need to still fund basic science that leads to scientific discovery, which has proven in the past to lead to societal benefits. Some CoObs members discussed having their eyes opened to the value of noticing and valuing Indigenous-led observation and knowledge:

> With sea ice, it's often said: "hey if you measure anything, if you're interested in sea ice properties, you've got to have the temperature, you've got to have the salinity, and you've got to have the density of the ice." And any measurements beyond that, those are extras. But to somebody who's worked with Iñupiaq knowledge holders, those variables don't necessarily mean much. They are very low priority. And I was shocked to learn that even ice thickness under certain conditions is not a high priority variable for coastal Indigenous users of sea ice. To me, an important part of success in Arctic observing is that different users of ice or different people who are somehow linked to Arctic observing, because they are interested in or need or generate observations, have a better understanding and appreciation of the different approaches that can be used to determine what is important to measure and what is not.
>
> Hajo Eicken

Capacity Building: Both groups discussed building capacity within the sciences that requires a better understanding of the Indigenous lens on observing, as well as being able to make outputs that are accessible and relevant. Capacity also related, for both groups, to succession in Arctic observing, fostered through *education and mentorship*. Discussions within CoObs centered on building capacity within the sciences to do science (e.g., infrastructure). Several CoObs members were also teaching faculty and brought up the need to include education and mentorship for an Arctic observing system to be sustained and outlive one project or person. FSWG members centered their discussions around building capacity within communities, with equitable distribution of funding and infrastructure, and highlighted mentoring and training youth from the community to take over for outside researchers.

Protocol Development: Both groups discussed needing to build protocols and best practices as central to the process of improving Arctic observing. CoObs discussions were focused on the more technical protocols and best practices in data and observing systems. In comparison, FSWG discussions focused more on protocols and best practices for Indigenous engagement based on Indigenous values, and hopefully leading to systemic change.

> One thing that we've encountered a lot at Kawerak [nonprofit Tribal consortium] is just kind of disorganized approach to engaging with communities when it comes to observing. There is a lot of agencies that like "want our observations." But aren't necessarily willing to enter into some formalized, structured process to get those observations. That is something that our communities are always advocating for and asking for. They want to be a formal part of whatever process, and they want to be helping to lead that process. So the unstructured, disorganized, piecemeal approach is

> unsuccessful, I would say, and something opposite of that is success.
>
> Julie Raymond-Yakoubian

Iteration: CoObs, in partnership with the FSWG, is a pilot project exploring the initial steps of the iterative development process of ROADS. Both groups discussed needing to focus on doable goals within each project that lead to improvements over time. The groups emphasized piloting services for usability and societal benefits, including webtools, data portals, and other tools to make scientific information more accessible. Part of the process is to build iterative efficacy checks into the system, where the metrics would be updated to handle generational changes within the sciences and influenced by broader societal issues. Through this pilot work, CoObs members aspire to find and fix stress points, or close gaps in Arctic observing systems. FSWG members pushed for more of an Indigenous methodological approach within an iterative process that practices reciprocity to build trust over time. One CoObs member described the justification for an iterative process.

> I think success looks like actionable change right now in pursuit of generational change, but this is one of those times where we are balancing competing interests. While on some level "blow it all up" might be the fastest way to get more generational change, it isn't practical in the immediate term or in the scope of a project or individual researchers or even institutions. The structures that have determined research and observational priorities are historical, political, entrenched, and have a lot of momentum. CoObs was meant to focus on what observations – from the research community and the operational agencies – can contribute to practical change now, but this can contribute to larger scale change through capacity sharing and building relationships within the agencies in positions of authority.
>
> Alice Bradley

Respect: Respect and trust are intertwined, with shared definitions, but also nuanced differences and key points. Within a partnership and process, a sign of respect is to observe reciprocity, mutually beneficial exchange, and caring for one another (Ellam Yua et al., 2022). Both groups would like to see more respect for Indigenous Knowledge systems and recommendations put forward by community residents (e.g., research recommendations, project improvements). FSWG members specified the need to respect Indigenous sovereignty and community needs/priorities (e.g., flood maps, harmful algal bloom monitoring). CoObs members discussed not reinventing the wheel by respecting past work and current and past scientists' expertise.

Trust: Building trust is a foundational value of the process. FSWG members spoke about trusting Indigenous Peoples to lead and trusting Indigenous Knowledges as equivalent to scientific knowledge. CoObs members spoke about wanting to be trusted as scientists and individually, as coming in with good intentions, with imperfect execution.

Transparency: The transparency theme is focused on the process of improving Arctic observing. Both groups discussed transparency in the process and decision making. FSWG members also brought up documenting the implementation of Indigenous and research ethics.

Process-oriented: While discussions in both groups were process-oriented, CoObs also spoke about being product-oriented, with a focus on utilization of the research outputs. In comparison, FSWG members focused more on the process of improving Arctic observing being values driven, specifically centering on Indigenous values.

Tensions in Collaboration

An outcome of the focus group analysis was finding recurring tensions between RNA CoObs and FSWG perspectives, represented in Figure 2. These tension themes were not related to themes of success but were important to acknowledge so they could be addressed appropriately, and the work could move forward.

Use of Western, Established, Current Methodology: This tension emerges from the history of academia-driven, decision-making processes, which has created barriers to both new participants and Indigenous worldviews. The implicit expectation is that Indigenous worldviews need to fit into the structures and decisions previously made by academics. Examples of alternatives to this approach include having the Arctic Observing Summit agenda set by Indigenous peoples, and Arctic observing centered on Inuit food security (Inuit Circumpolar Council – Alaska, 2015; AOS, 2020). Several CoObs members are motivated to not reinvent working approaches, along with methods and outcomes, that have been scientifically proven. Under this theme, there are tensions in differences in worldviews and methodological approaches rooted in research paradigms. These paradigms include trained processes, methods, and assumptions (Wilson, 2008; Kovach, 2009). Discussions that fell under this theme illustrated the inherent *exclusion of Indigenous methodologies* because Indigenous individuals were not involved in developing the current methodologies. For background information, Indigenous methodologies are rooted in Indigenous worldviews and ways of knowing, thinking, and doing research, which look culturally different from western scientific methodologies (Kovach, 2009). The criticism of the current methodologies is based on the lack of co-production of knowledge and the sense of extractive practices that do not give Indigenous community members decision-making power within the project and over outcomes.

Lack of Indigenous Participation: While Arctic observing does have high Indigenous participation compared to other fields, there is still not enough engagement to achieve the level of collaboration aspired to. CoObs members discussed that it is still difficult to get

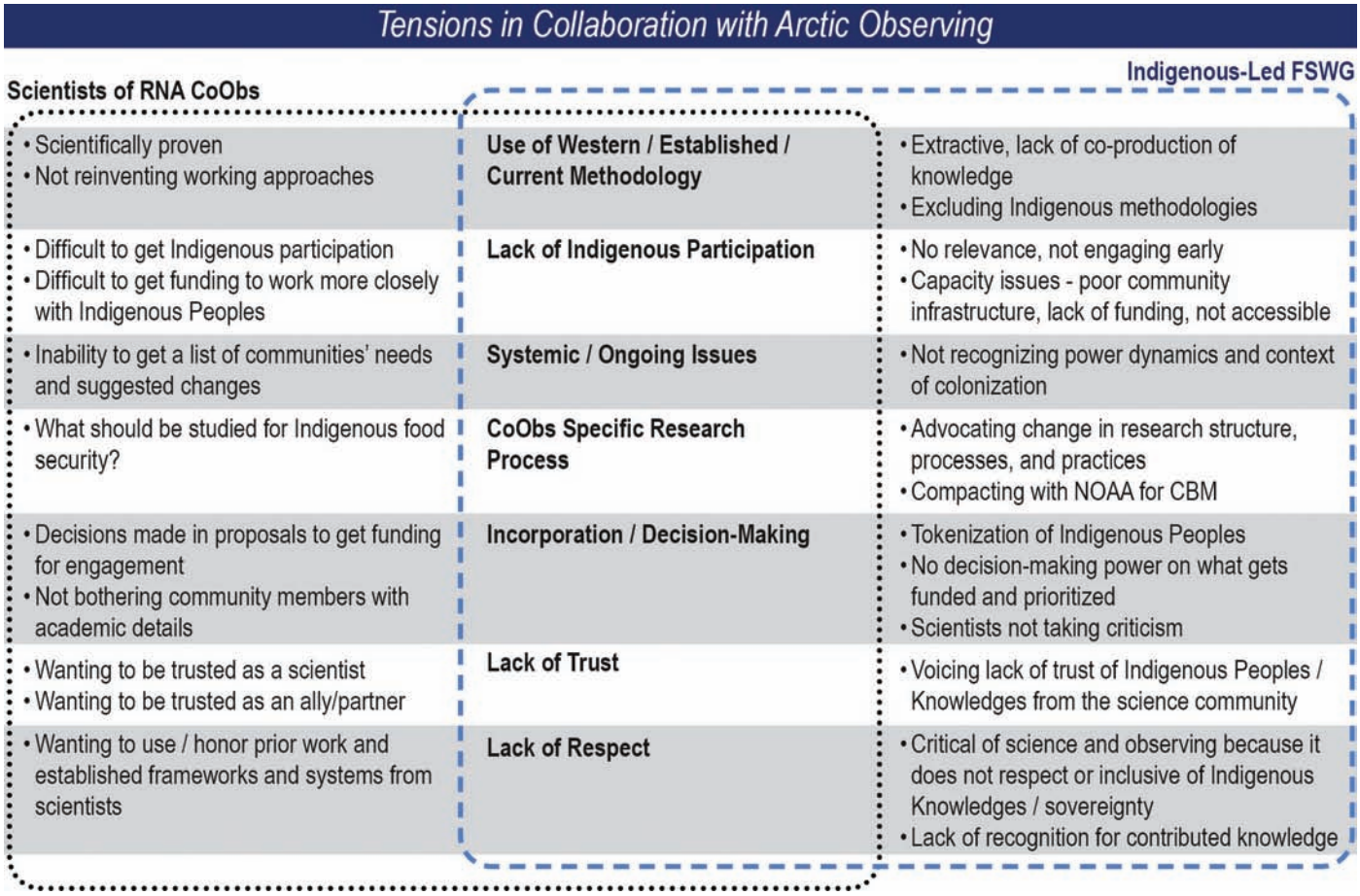

FIG. 2. Tensions in collaboration with Arctic observing. The Venn diagram depicts tensions perceived by RNA CoObs scientists (left) and by members of the Indigenous-led FSWG (right), with shared in the middle. Acronyms: CBM (Community-based monitoring).

Indigenous participation in specific projects and initiatives. In general, it is difficult to get funding to work more closely with Indigenous Peoples, as it is not seen as part of research. From the FSWG perspective, the issue of the lack of participation stems from the projects having no relevance or applicability to the community. In some circumstances, the project could have been co-designed but did not engage early enough in the research design process to impact the scope and relevance for the community. Even with relevance, there are capacity issues due to poor community infrastructure, lack of funding, a lack of accessibility, and timeline misalignments.

Systemic and Ongoing Issues: A systemic and ongoing barrier for collaboration between scientists and Indigenous leaders within Arctic observing is the role of scientists and Indigenous Peoples. This barrier is linked to the use of western, established, and current methodologies. The main barrier, in the CoObs' perspective, is the inability to get a list of communities' needs and suggested changes to research outcomes needed to make it actionable. The scientists' perspective shows the implicit assumption by scientists that they can be told what the issues are, and then they can solve them for the community. However, Indigenous Peoples do not want their problems solved for them and instead want to be part of the research team. From the FSWG perspective, the systemic, ongoing issue is researchers not recognizing power dynamics and the context of colonization. The concept of outsiders solving Indigenous problems undermines self-determination and is part of the larger context of colonization of Indigenous Peoples. To give more conceptual background, the majority of natural scientists are trained that science is separate from society, and that separation produces objectivity (Pielke, Jr., 2007). In contrast, Indigenous methodologies support deep self-reflexivity within the concept of positionality, where only by exploring subjectivity can objectivity be achieved (Wilson, 2008; Kovach, 2009). The rigidity of the current dominant, scientific methodologies seems like a barrier to change.

> I think the challenge is that some of these processes are so ingrained. These institutions are so set and inflexible, and have been determined a long time back with a very narrow set of participants. [Inflexibility] raises the question about how you undo that, or how do you try and move forward and be transparent given that there are these monolithic challenging institutional structures that often prevent that.
>
> Maureen Biermann

CoObs-Specific Research Process: Building on the last three themes is the specific tension within CoObs' approach to Indigenous engagement. CoObs members assumed they could ask Indigenous communities, "What should be studied for Indigenous food security?" FSWG members collaborating on CoObs pulled the work back to addressing those assumptions by advocating for change in the research structure, processes, and practices. Instead of building a list of topics to study, FSWG members discussed *compacting* with the National Oceanic and Atmospheric Administration and other agencies for community-based monitoring. Compacting is an arrangement where funding is given directly to tribes and tribal consortia to administer programs, rather than federal agencies running programs. This tension fundamentally concerns how work should proceed, rather than what should be studied, which implicitly questions how scientists are trained to do research.

Incorporation and Decision Making: Building on the previous themes, this theme is focused on the actionable steps for equal decision-making power that lead to co-production of knowledge. Getting research funds is a competitive process. Proposals have a low chance of getting funded, and the process is not in the control of scientists applying for funds. CoObs members discussed not bothering (or burdening) community members with academic details when there is a good chance the project might not be funded. Because of the lack of funding for engagement and co-design, scientists have to make decisions within the proposals in order to get funding for engagement based on their educated, experienced assumptions. While a researcher may have the competency and expertise to make the right assumptions within the proposal, it does create a sense of tokenization of Indigenous Peoples and engagement, as expressed by the FSWG members. This tokenization frustrates FSWG members, who pointed to the lack of decision-making power on what gets funded and prioritized. Sometimes, a scientist applying for funding might underestimate or assume levels of engagement or volunteering by Indigenous communities, thereby limiting funding and failing to build in a position that would guarantee participation. While it is common practice for scientists to leverage their non-project salary time or work on non-paid overtime because they gain academic rewards on their CVs or future funded projects, Indigenous individuals not in academia do not have the same rewards or ability to leverage their jobs. In these discussions, FSWG members expressed frustration with scientists not taking criticism, which is an interpersonal and project structure issue. If Indigenous partners did have equal decision-making power or led projects, we can assume this would circumvent the decision-making tension and there would be no criticism. The following quote expresses the interest and investment Indigenous Peoples have in regard to environmental monitoring as it impacts their food security.

> We don't have food sovereignty in terms of accessibility or decision-making power. But in terms of the environment, the health of it, and the availability of animals, that's where Indigenous Peoples can take a role in making sure that the environment is healthy. Because our lives depend on our foods, that's the grocery store basically [in reference to the environment]. So we need to take care of the land, because the land takes care of us, the lands and the waters.
>
> Eva Dawn Burk

Lack of Trust: Both trust and respect were identified as needed Values of the Process. Both groups expressed a concern with lack of trust, as well as lack of respect. CoObs members spoke about trust in the sense of wanting to be trusted as a scientist, an individual scientist specifically, and wanting to be trusted as an ally and partner. CoObs members also expressed wanting to be seen as individuals, rather than being held accountable for the missteps of the broader scientific community. FSWG members voiced lack of trust from the scientific community towards Indigenous Peoples and Indigenous Knowledges, specifically, in regard to Indigenous project leadership using Indigenous methodologies and trusting the credibility and legitimacy of processes built into Indigenous Knowledge systems.

> That our Indigenous Peoples across Alaska have been doing this for thousands of years. We have such intimate connections to the land, and we watch it all the time. Like every single day. We watch how the river is changing, how the bank is falling into the river with rising water. In my experience, there has been an improvement of partnering with Indigenous communities, but I don't know that scientists fully and openly trust Indigenous communities to lead the work. We need to be doing that because we have such intimate and close connections to the land. We're always on it, just growing up in the village, like every single day you're out on the land. Just by observing, you see everything that is happening.
>
> Jessica Black

Lack of Respect: Relating to a point made earlier in the themes of success, CoObs members want to use and honor prior work, and established scientific frameworks and systems that have worked, while FSWG members are critical of science and observing because that framework does not respect Indigenous Knowledges and sovereignty and is not a system they belong to. Therefore, pushing the use of established and current methodologies is seen as disrespectful, because their formation did not include Indigenous participation. Even when there was advice and contributions from Indigenous individuals, FSWG members discussed the general lack of recognition of contributed knowledge and experiences.

DISCUSSION

Based on our results, we want to identify the alignment between the Themes of Success, key pieces of literature, and past AOS recommendations. The focus groups referenced numerous publications, workshops, initiatives, and AOS recommendations. The rapid assessment process (Beebe, 2001) assumes that what is contributed during the focus groups is what the participants think is the most important. Focus group participants represent many of the co-authors within these publications, so we can assume that focus group outcomes are a prioritized list of the themes and concepts from this body of literature.

Arctic Observing Summit Recommendations

Earlier AOS reports compiled recommendations to work towards solving gaps and supporting interoperability, which led to more calls for platforms and committees to generate integration and coordination (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016, 2018, 2020). With Arctic ROADS being a central topic in AOS 2022, there was a distinct shift in discussions toward prioritization of planning and implementation strategies (Arctic Observing Summit, 2022).

Almost all of the Themes of Success that we identified in our work are evident within the AOS recommendations (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016, 2018, 2020, 2022), indicating that they are aligned with the broader Arctic observing community. The only theme we identified not distinctly present within the AOS recommendations was "Transparent." The focus group prompt, "What does success look like in improving Arctic observing?" may have caused participants to realize the need for transparency when setting priorities and evaluative metrics for the broader Arctic observing community.

The tensions in collaboration we identified are too complex to directly compare to the AOS recommendations because they are identified issues, rather than recommendations. Within the AOS recommendations, there are consistent references to the need for Indigenous participation, Indigenous Knowledges needed alongside scientific knowledge, funding for Indigenous participation and building local capacity, co-design and co-production of knowledge, development of ethics and data ethics, Indigenous Peoples being grouped with other stakeholders, and designing projects from an Indigenous lens (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016, 2018, 2020, 2022). The lack of action based on these AOS recommendations was expressed within FSWG focus group discussions, as seen in our theme, Lack of Respect.

There are several AOS recommendations not represented within the focus group outcomes. The first is the need for planning and integration of tools and processes (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016, 2018, 2020). This recommendation could be implicit, as the focus groups occurred in the context of ROADS. Emerging technologies and unmanned, autonomous sensors, along with communication through cyberinfrastructure, are also present in the earlier AOS recommendations (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016) and not mentioned in the focus group discussions. There was more discussion of the engagement of other stakeholders in the AOS recommendations, like the private sector, international funders, private funders, the Arctic Council, and other users (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016, 2018, 2020, 2022). The 2016 recommendations focused on the Eurasian and Russian Arctic, while in 2020, the regional focus shifted to the Bering Sea, the Beaufort/Mackenzie Delta area, Baffin Bay and surrounding coasts, and the Barents Sea (Arctic Observing Summit, 2016, 2020). There are contextual references to other committees, organizations, agencies, meetings, initiatives, and protocols, which are valuable details for those within the Arctic observing community.

In the Process of SAON ROADS

SAON ROADS is an evolving initiative at the initial time of writing (early 2023), so this comparison to our focus group outcomes is expected to change. There are two publications on ROADS, the first on the ROADS framework (Starkweather et al., 2021), and the second on the process and reasoning for developing shared Arctic variables (Bradley et al., 2021). As ROADS has been building from AOS recommendations, overall, our Themes of Success align fairly well with the literature. As in the previous discussion, the theme of Transparent is mentioned but not well defined. The AOS recommendations on Indigenous engagement are present in both papers and ROADS.

ROADS is a flexible framework (Starkweather et al., 2021) that allows for adapting methods to fit the context of the Expert Panels, including encouraging the societal benefit assessment to be culturally responsive to Indigenous partners. Beyond stating the need to make the process inclusive, there is no guidance on how to make it inclusive to Indigenous Peoples. The FSWG definition under the theme of Inclusivity from an Indigenous lens with Indigenous Knowledge systems is missing from existing ROADS literature (Bradley et al., 2021; Starkweather et al., 2021). An example of how to create a framework that is inclusive to an Indigenous lens is the Ellam Yua et al. (2022) co-production of knowledge conceptual model. Co-production of knowledge is also a flexible scientific approach blended with Indigenous values, equity, and ethics to be culturally reflective of the Indigenous worldview. Some of the tensions would be relieved if Indigenous Peoples could see themselves within the ROADS and

CoObs processes. ROADS has a built-in evaluation, so the process could change with more Indigenous participation (Chythlook et al., 2022).

The ROADS principle, "all aspects of the ROADS process should support broadly shared benefit from the observing and data systems" (Starkweather et al., 2021:59), is a representation of the misalignment of prioritizing by maximizing for the most people and prioritizing equity of Indigenous Peoples. There is a history within society and research of omitting Indigenous Peoples due to their small population, as well as systemic racism and colonization (Tuck and Yang 2012; Fryberg and Eason, 2017). The development of the ROADS principle may have been rooted in the belief that benefits should be shared with Indigenous Peoples, and not just scientists. Reading that principle in isolation could mean that a specific community's need might not be addressed because it is not a broadly shared benefit, and as expressed within the tensions we delineate, raises the question of who decides what is a broadly shared benefit. The most plausible case is that what will benefit one community will also benefit a nearby community likely dealing with the same regional environmental issue.

Our Accessible dimension of a successful observing system was discussed as an important aspect of ROADS (Starkweather et al. 2021), and was included in the AOS recommendations (Eicken, et al., 2013; Huntington, 2013; Sagen, 2013; Murray and Ibarguchi, 2014; Arctic Observing Summit, 2016, 2018, 2020, 2022). However, none of the cited literature, nor the focus groups, discussed what that looks like in depth. There are discussions of the poor internet connectivity in rural Indigenous communities and the need for better communication, but there is no mention of the protocols, processes, or best practices to make observing and data accessible. The ROADS Expert Panel is an opportunity to push forward practices that make observing and data accessible for Arctic Indigenous Peoples.

CONCLUSION

Arctic observing has had consistent Indigenous participation within projects (Oozeva et al., 2004; Krupnik et al., 2010) and within the Arctic Observing Summit. When groups ask for new disciplines and worldviews to be part of strategic planning initiatives like SAON ROADS, the prior role of science begins to change to be culturally inclusive and focused on utilization (Lövbrand, 2011). Tensions and misalignments are a typical part of the process of transformation into being inclusive of other worldviews, as described in Indigenous critical methodologies (Smith, 2012; Tuck and Yang, 2012; Nadasdy, 2003) and co-production of knowledge literature (Lövbrand, 2011; Daly and Dilling, 2019; Turnhout et al., 2020; Chambers et al., 2021). The recommendation from this literature is to lean into the tensions and misalignments to gain an understanding of the different perspectives and complexity, to overcome them and build trust and respect. There is invested participation from both scientists and Indigenous Peoples into SAON ROADS and RNA CoObs. Identifying shared themes for success is an important first step for any effort that attempts to span worldviews to advance collective decision making. For the RNA CoObs project, this work revealed that there are common themes for success, but that delving into deeper meanings and definitions is still a vital step in the research process, because concepts can vary across groups. More importantly than themes of success, perhaps, this research revealed that exploring tensions is vital to building trust and understanding power dynamics in co-production of knowledge.

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