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# CBMP-Freshwater Arctic Freshwater Biodiversity Monitoring and Assessment Progress Report 2020

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## 1. Introduction

CBMP-Freshwater is the freshwater expert group of the Circumpolar Biodiversity Monitoring Program (CBMP). The CBMP is the cornerstone program of the Conservation of Arctic Flora and Fauna (CAFF), the biodiversity working group of the Arctic Council that is working with partners to harmonize and enhance long-term Arctic biodiversity monitoring efforts. A major goal of CBMP-Freshwater is to facilitate the detection and communication of environmental and biological change in the Arctic, to support adaptive holistic decision making and stimulate societal responses to significant trends and pressures. This is accomplished by an international group of experts that forms the Steering Group (SG) and Freshwater Expert Networks (FENs) in the Arctic States.

The work of CBMP-Freshwater began with the development of an Arctic Freshwater Monitoring Plan (CBMP-Freshwater Plan), which was endorsed by the CAFF Board in 2012. This plan addresses the rationale and framework for improvements related to the monitoring and assessment of Arctic freshwaters, including ponds, lakes, rivers, their tributaries and associated wetlands. The framework represents an agreement among the Arctic States that aims to facilitate circumpolar assessments by providing Arctic States with a structure and a set of guidelines for initiating and developing monitoring activities that employ common approaches and indicators.

The CBMP-Freshwater Plan identifies important elements of Arctic freshwater assessment, i.e., stressors, Focal Ecosystem Components (FECs: biotic or abiotic elements, such as taxa or key abiotic processes, which are ecologically pivotal, charismatic and/or sensitive to changes in biodiversity), parameters, and indicators, which were determined through expert consultation at a series of workshops. These elements were designed to form the basis for future assessments of Arctic freshwater biodiversity through implementation of the CBMP-Freshwater Plan, including the testing of mechanistic linkages between stressors and FECs. These biotic-abiotic connections are described

by impact hypotheses, which are predictive statements that outline the potential ways in which selected stressors might impact the structure or function of FECs. By establishing common approaches for monitoring and assessment, the plan is intended to improve our ability to detect changes to biodiversity and evaluate stressor-impact relationships on a circumpolar scale, thus mapping ongoing change and facilitating more effective management of these systems.

In the first phase of CBMP-Freshwater Plan implementation, the Freshwater SG designed a series of six projects, culminating in the publication of the first State of Arctic Freshwater Biodiversity Report (SAFBR) in 2019. The SAFBR assessed current and historical status and trends in Arctic freshwater biodiversity and provided a baseline for future assessments. With the completion and publishing of the SAFBR, the Freshwater SG held a scoping meeting in October 2019 to develop projects for the next phase of implementation (2020–2024) that align with the CBMP strategy for 2018–2021. These are centred on the goals of (1) improving visibility and uptake of CBMP-Freshwater products; (2) promoting and supporting harmonized monitoring protocols; (3) adding to and further developing the CBMP-Freshwater database; (4) continuing the assessment process for Arctic freshwaters; and (5) increasing cooperation with other CBMP SGs and CAFF groups, with AMAP and other Arctic Council working groups, and with relevant external organizations. This report provides an update on the status of work in the 2020-2024 work plan.

## 2. Updates from the CBMP-Freshwater Plan Implementation Teams

CBMP-Freshwater has entered the next phase of CBMP-Freshwater Plan implementation as it aims to increase the visibility of its work and products, strengthen its collaborations with other CBMP working groups and AMAP, and promote more harmonized monitoring with larger coverage of the Arctic region. The work plan for this phase was developed around 6 work projects that were designed to address these goals while maintaining alignment with the CBMP strategic plan:

1. Promotion and Outreach;
2. Summary of Sample Methods;
3. Handbook of Standardized Methods for Freshwater Monitoring in the Arctic;
4. Publication, Maintenance, and Development of the CBMP-Freshwater Database;
5. Continued Reporting; and
6. Collaborations

In 2020, work began on Project 1, Project 2, Project 4, and Project 6, although progress on each project was limited due to the impacts of the COVID-19 pandemic, which eliminated in-person meetings, and led to constraints on FSG members with respect to their time and ability to contribute to these efforts.

Project 1 received the greatest amount of focus in 2020 because of the need to promote the results of the recently-completed SAFBR. To increase the effectiveness of promotional activities, CBMP-Freshwater acknowledged the importance of identifying regional, national, and international audiences for CBMP-Freshwater outputs and creating targeted materials for each audience. The Freshwater SG developed a communication plan, including a budget, to detail the promotional products and the target audience for each. This plan is a living document, informing communications and promotional material development in the coming years.

Efforts to share the findings of the SAFBR were focused on scientific publications, social media, interviews with journalists and bloggers, and virtual presentations at conferences, workshops, and meetings. Throughout the year, the Freshwater SG and FENs have worked on publishing scientific papers as part of the SAFBR special issue in *Freshwater Biology*. After the acceptance of the first special issue paper in 2019 ([circumpolar fish](#)), 7 other papers have been published online in 2020, including [circumpolar water chemistry](#), [circumpolar diatoms](#), [Fennoscandian rivers](#), [Fennoscandian](#)

[lakes](#), [Russian plankton](#), [North American rivers](#), and a literature review of [Indigenous Knowledge](#).

The introduction paper for the issue has been accepted for publication but will not be finalized until all special issue papers have been accepted. The remaining papers (Norway/Iceland fish, circumpolar plankton, circumpolar macrophytes, circumpolar benthic macroinvertebrates, and the special issue conclusion paper) are all in revision or under review and expected to be accepted in early 2021. The Freshwater SG has worked to arrange for these papers to be open access (e.g., openly available online with no journal subscription) to increase the reach of the material. We have successfully argued to several countries to redistribute funds previously marked for travel to CAFF and CBMP meetings in 2020 to help cover most of these costs. Work is ongoing to secure open access funding for the remaining papers.

Members of the Freshwater SG and FENs have also published a [policy paper](#) in the Journal of Applied Ecology that built on the results of the SAFBR and provided advice for improved monitoring and management in the face of irreversible changes to Arctic freshwater biodiversity. The paper was highlighted in the journal's [blog](#) as an Editor's Choice paper. Similarly, the Indigenous Knowledge paper from the special issue was highlighted in a story on [The Freshwater Blog](#) that featured an interview with the lead author. The Freshwater SG's Coordinator was interviewed for a story in [Landscape News](#) (Global Landscapes Forum) about the effects of climate change on biodiversity in the Arctic and Antarctic, providing another opportunity to promote the findings of the SAFBR.

Though several conferences planned for 2020 were cancelled due to the COVID-19 pandemic (including the joint annual meeting of the Society for Freshwater Science and the Association for the Sciences of Limnology and Oceanography, in which an Arctic freshwater-focused special session was planned), virtual meetings provided alternative opportunities to present the work of CBMP-Freshwater. In particular, the Freshwater Coordinator represented the group at the GEO BON All-Hands Meeting and Open Science Conference in June 2020, giving a presentation on the major findings of the SAFBR and leading a special session focused on opportunities for collaboration between CBMP-Freshwater (part of the Arctic BON) and the Freshwater BON of GEO BON. Presentations on SAFBR findings were also made at the Arctic Change 2020 conference, held virtually in December 2020.

Projects 2 and 4 both involve work on the CBMP-Freshwater database. Project 2 includes summarizing sampling methods from the database and using this information as a foundation for a CAFF report describing the predominant methods used across the Arctic. Project 4 includes the publication of the CBMP-Freshwater database on the ABDS, which requires securing permissions from all data providers. To complete both these tasks, there is a need to ensure all metadata are complete for all database entries, and this work was ongoing in 2020, albeit at a lower capacity due to time restrictions caused by the pandemic. These tasks are expected to be completed in early 2021.

The final project to which Freshwater SG members have contributed in 2020 is Project 6, which is focused on collaborations. The Freshwater Coordinator worked to strengthen connections to the Freshwater BON of GEO BON in 2020 and will continue to explore opportunities for collaboration with this group. Members of the Freshwater SG took part in meetings to advice the CAFF-AMAP scoping process on *climate change impacts on Arctic ecosystems and associated climate feedbacks*; and future CAFF-AMAP collaborations, while the Canadian FSG co-chair led a Freshwater-Terrestrial session for this meeting and sat on the CAFF-AMAP Advisory Group. Connections with AMAP were further strengthened through participation by AMAP representatives on Freshwater SG teleconferences and in Freshwater SG virtual meetings. Finally, the Freshwater SG co-chairs worked with the co-chairs of the Terrestrial SG plan for collaboration between the two CBMP groups, following the publication of the Terrestrial SG's State of the Arctic Terrestrial

Biodiversity Report (START) report. A joint virtual meeting was held in the fall, and the two groups discussed potential avenues for cross-FEC comparisons and joint product development.

### 3. Status of Work Plan

Project/ Milestone	Activities & Deliverables	Timeline
0. SAFBR published	a. SAFBR endorsed by CAFF board	Completed 2019
	b. SAFBR published by CAFF	Completed 2019
	c. SAFBR printed for distribution	Funding not obtained
	d. Publication of special issue papers	Ongoing o 9 papers published online or accepted o 5 papers in revision
1. Promotion and Meetings	a. Scoping workshop for implementation phase 2	Completed 2019
	b. FSG Annual meeting	Completed virtually May 2020 and November 2020
	c. Presentations at national and international meetings and conferences	o GEO BON (presentation and special session) o Arctic Change 2020 (presentation)
	d. Scientific publications (outside of special issue)	o Policy paper in Journal of Applied Ecology and Editor's Choice blog post
	e. Promotion of SAFBR findings	Ongoing 2019-2021 o Social media (Facebook, Twitter, Instagram) o Interviews with journalists/bloggers
	f. Promotion of harmonized monitoring	Ongoing
	g. Promotion of the Freshwater Database	Ongoing
2. Sampling Methods	a. FSG summarizing sampling methods from Freshwater Database	March 2021
	b. CAFF Report summarizing sampling methods	June 2021
	c. Journal article about Arctic sampling methods	June 2022
3. Protocol Handbook	a. CAFF Freshwater Sampling Protocols Handbook	Dec 2022
4. Freshwater Database	a. Identify data sources and obtain data permissions for current data	March 2021
	b. Integrate Freshwater Database into ABDS	December 2021
	c. Identify and obtain additional data to be added to Freshwater Database	Ongoing - Dec 2022
	d. Harmonize data and process for inclusion in Freshwater Database	Jan 2022 - De 2023
	e. Creation/Implementation of database working group	Jan 2023 -Dec 2024
	f. Development of database interfaces	Ongoing from 2024
5. Reporting	a. 2020 annual performance report submitted to CAFF	Jan 2021

	b. 2021 work plan submitted to CAFF	Jan 2021
	c. Creation of short SAFBR update	Dec 2021
	d. Expert workshop to discuss follow-up to AMAP assessment	TBD 2022
	e. Report on biotic response to changing abiotic environment	Dec 2023
	f. Analysis of new Freshwater Database data	2023 - Oct 2024
	g. Indicator report(s) for each FEC related to database updates	March 2025

The Freshwater SG work has been coordinated through monthly telephone meetings (except in May, July, and November 2020) and virtual multi-day meetings and workshops (originally planned to be held in person; May and November 2020), where progress and directions of work were communicated. The co-chairs of the Freshwater SG and the Freshwater Coordinator participated in virtual meetings of the CBMP co-Leads and the four CBMP SGs. The Swedish co-chair of FSG participated in the CAFF Board meetings in Gällivare (February) and online (September) and presented the FSG’s workplan for 2020–2024 and the status of work, while also presenting requests from the group to the CAFF Board. During the fall of 2020, FSG members contributed with input and feedback to CAFF’s strategic Plan for 2021–2025.

## 4. Freshwater Steering Group Update

### 4.1. Membership

Since its creation, the Freshwater Steering Group (Freshwater SG) has been co-chaired by Canada and Sweden. Membership of state representatives in the Freshwater 2020: Joseph Culp (Canada; Environment and Climate Change Canada and Wilfrid Laurier University), Willem Goedkoop (Sweden; Swedish University of Agricultural Sciences), Kirsten S. Christoffersen (Denmark/Greenland; University of Copenhagen and the University Centre in Svalbard), Petri Liljaniemi (Finland; Ministry of the Environment), Jón S. Ólafsson (Iceland; Marine and Freshwater Research Institute), Steinar Sandøy (Norway; Norwegian Environmental Agency), Elena Fefilova (Russia; Institute of Biology, Komi Science Centre of RAS) and Anna Novichkova (Russia; Lomonosov Moscow State University and the Severtsov Institute of Ecology and Evolution of RAS), Christian Zimmerman (USA; USGS Alaska Science Center). AMAP was represented in the Freshwater SG by Janet Pawlak (AMAP Secretariat). CBMP co-leads were represented in the Freshwater SG by Tom Christensen (Denmark/ Greenland, University of Aarhus) and Catherine Coon (US. Bureau of Ocean Energy Management). Jennifer Lento (Canada; Canadian Rivers Institute, University of New Brunswick) continued as Freshwater Coordinator. The CAFF Secretariat provided support to the Freshwater SG through coordination, communications, reporting, etc.

### 4.2. Challenges

#### *Funding*

One of the most significant challenges for the Freshwater SG has been to secure funding for the Freshwater Coordinator and priority activities of the CBMP-Freshwater workplan. One year of partial funding (15,000 USD, approximately ¼ time) for the Freshwater Coordinator was secured by CAFF in early 2020 through contributions by the countries a second year of partial salary funding for this position through contributions by the countries. This funding will support the coordination role and help the group continue to function effectively and work towards its goals, but it does not include

funding for the Freshwater Coordinator to travel to CBMP meetings (when in-person meetings resume) or funding to support scientific activities in the work plan. CAFF's ambitions to monitor, assess, and communicate the expected rapid change in biodiversity of Arctic ecosystems call for sustainable, long-term funding (circa 35,000 USD/year) to support the coordination and scientific work as well as the travel requirements of the Freshwater Coordinator in this phase of implementation (2020-2024) and beyond. It is also important to ensure adequate funding is provided to support Freshwater SG members' travel to annual meetings and writing workshops, and their time to contribute to CBMP efforts, as outlined in the budget for 2020-2024. CAFF's initiative to establish base funding for the coordination of all four CBMP-working groups is a welcome step towards a more sustainable CBMP.

### **Representation**

The Freshwater SG has had full representation of all countries since 2017. Representatives from AMAP began regular participation in teleconferences in 2020 to help increase collaboration. However, a large challenge is to ensure representation from Permanent Participants. As part of the CBMP-Freshwater special issue of *Freshwater Biology*, members of the Freshwater SG and the FENs published a literature review that catalogued documents containing records and summaries of Indigenous Knowledge (IK) relevant to Arctic freshwaters. This paper highlighted the important contributions to diversity estimates that can be obtained from these documented sources of IK, which ranged from scientific literature to grey literature and videos, including documents produced by Indigenous Peoples and Indigenous organizations. The paper also provided advice for future efforts to examine documented IK or to work directly with IK holders, based on the findings of the literature review. The Freshwater SG intends to build from these recommendations to more actively work with Indigenous Knowledge holders, but such work requires guidance and co-development from Permanent Participant representatives. The Freshwater SG will continue to work with CAFF in 2021 to secure participation of Permanent Participants in the SG and implementation process.

## **5. Freshwater Expert Network (FEN) Country updates**

### **5.1. Canada**

#### *Network*

Members include: Joseph Culp (Lead, Environment and Climate Change Canada and Wilfrid Laurier University), Krista Chin (Government of the Northwest Territories), Jennie Knopp (Trent University, Oceans North, and APECS), Jennifer Lento (Canadian Rivers Institute, University of New Brunswick, and APECS), Michael Power (University of Waterloo), Milla Rautio (Université du Québec à Chicoutimi), and Heidi Swanson (University of Waterloo).

#### *Accomplishments*

Activity of the Canadian FEN was very limited during the year as the COVID pandemic prevented face-to-face meetings. As the Freshwater Coordinator, Jennifer Lento continued to provide database and analytical support to CBMP Freshwater as the *Freshwater Biology* special issue neared completion. FEN members contributed to the production of journal articles for this special issue. Jennifer Lento and Joseph Culp also continued to act as co-editors of the special issue. The Freshwater Coordinator also helped to organize virtual monthly teleconferences for the Freshwater SG, contributed to a virtual AMAP-CAFF workshop, and organized two virtual meetings of the Freshwater SG. The Canadian co-chair of CBMP-Freshwater participated in quarterly telephone meetings with the CBMP co-leads, CAFF Secretariat and co-chairs for the other CBMP-groups and provided input to CAFF and CBMP documents, and memos to the CAFF-board. Discussions were initiated with the Director General, Water Science and Technology Directorate, Environment and

Climate Change Canada (ECCC), and the Canadian CAFF Board representative to develop plans to increase the relevance of Canadian Freshwater CBMP work to outputs needed by ECCC.

#### *Challenges/Risks*

The primary challenge for the Canadian FEN remains secure funding to support this effort, particularly during the COVID-19 pandemic. The current funding model requires annual renewal of support with non-salary support mostly in the form of funding for travel to Freshwater SG meetings. Funding to support greater engagement with Permanent Participant representatives, Indigenous Knowledge holders and northern communities remains a challenge and should be addressed in future years.

## **5.2. Kingdom of Denmark**

#### *Network*

Members include: Kirsten S. Christoffersen (Lead, Dept. of Biology, Freshwater Biology, University of Copenhagen), Torben L. Lauridsen (Dept. of Bioscience – Arctic Research Centre, University of Aarhus), Dean Jacobsen (Department of Biology, Freshwater Biology, University of Copenhagen), Nikolaj Friberg (Norwegian Institute for Water Research, Oslo, Norway), Ole Geertz-Hansen (Rambøll Group A/S, Copenhagen), and Frank F. Riget (Department of Bioscience - Arctic Research Centre, University of Aarhus).

#### *Accomplishments*

The Kingdom of Denmark FEN contributed to analyses and writing of several manuscripts for the special issue of Freshwater Biology. The SG member took part in the monthly phone calls and the two annual Freshwater SG meetings (held virtually).

#### *Challenges/Risks*

The most pressing challenge has been to ensure funding for data analysis and writing as well as to find the necessary time to contribute. Funding included support for participation in monthly phone meetings, an annual physical meeting, and other input to SG work. Time spent on ad hoc meetings and scientific writing was un-supported.

## **5.3. Finland**

#### *Network*

Members include: Petri Liljaniemi (lead, Ministry of the Environment), Jaakko Erkinaro (Finnish Game and Fisheries Research Institute), Jani Heino (Finnish Environment Institute), Seppo Hellsten (Finnish Environment Institute), Satu-Maaria Karjalainen (Finnish Environment Institute) and Laura Forsström (Academy of Finland).

#### *Accomplishments*

The Finnish FEN contributed to the analyses and writing of several articles in the forthcoming special issue of Freshwater Biology. Seppo Hellsten acted as a lead author for the circumpolar macrophyte article, and Jani Heino led the policy paper published in the Journal of Applied Ecology. The Ministry of the Environment was prepared to support the work of the Finnish FEN by paying for travel expenses, but the COVID-19 pandemic inhibited all activities requiring travel. No funding was allocated for the actual work of Finnish FEN. Finland is prepared to fund Open Access for one article in the special issue of Freshwater Biology.

#### *Challenges/Risks*

The greatest challenge is the lack of time for analyses and writing. All members of the FEN are permanently engaged in other duties and FEN work is done on a voluntary basis. Larger commitment for the work will require more solid funding.

## 5.4. Iceland

### *Network*

Members include: Jón S. Ólafsson (lead; Marine and Freshwater Research Institute), Árni Einarsson (Myvatn Research Station), Thora Hrafnsóttir (Icelandic Museum of Natural History), and Guðni Guðbergsson (Marine and Freshwater Research Institute).

### *Accomplishments and Challenges*

The Icelandic FEN did not have formal meetings in 2020 but kept in contact by correspondence. The Icelandic Freshwater SG member took part in two virtual steering group meetings in 2020. Members of the FEN contributed to several of the papers in the Freshwater Biology Special Issue.

### *Challenges/Risks*

There is no secure funding for the participation and work of the Icelandic FEN other than covering attendance at two annual FSG steering group meetings. Other work is completed through in-kind support from the FEN members' institutes. This creates challenges for allocation of work, e.g., compiling data and data analyses.

## 5.5. Norway

### *Network*

Members include: Steinar Sandøy (lead, Norwegian Environment Agency), John Brittain (University of Oslo), Marit Mjelde (Norwegian Institute for Water Research), Ann Kristin Schartau (Norwegian Institute for Nature Research), Martin Svenning (Norwegian Institute for Nature Research, FRAM - High North Research Centre on Climate) and Nikolai Friberg (Norwegian Institute of Water Research).

### *Accomplishments*

During 2020 the members of the Norwegian FEN were involved in the papers for the special issue of Freshwater Biology, including co-leading a paper on Fennoscandian rivers and co-leading the circumpolar plankton paper and Norway/Iceland fish paper, both of which are in revision. The members of the network also contributed in monitoring activities in Norwegian Arctic lakes. Members of the expert network published a report on the status of freshwater biodiversity on Svalbard and an overview of freshwater monitoring sites on the Svalbard Islands.

### *Challenges/Risks*

A primary challenge for the group is to secure the resources and time necessary to complete the papers for the special issue of Freshwater Biology within the set timeline.

## 5.6. Russia

### *Network*

Members include scientists from research organizations of the Russian Academy of Sciences (RAS): Elena Fefilova (lead; Institute of Biology of Komi Science Centre of the Ural Branch of the Russian Academy of Sciences), Olga Dubovskaya (Institute of Biophysics, Siberian Branch of RAS); state universities: Anna Novichkova (alternate lead; Moscow State University), Larisa Frolova (Institute of Geology and Petroleum Technologies, Kazan Federal University); and a nature protection organization: Ekaterina Abramova (Lena Delta Nature Reserve).

### *Accomplishments*

Russian FEN members have completed an inventory of the freshwater plankton fauna and proxy groups of benthic invertebrates of European and Siberian Arctic regions. They have contributed to the analysis and writing of several of the journal articles for the Freshwater Biology special issue, including the article on the spatial and temporal trends of planktonic and meiobenthic fauna diversity in water bodies of the Russian Arctic. Anna Novichkova represented the Russian FEN in two virtual Freshwater SG meetings in 2020 and participated in monthly telephone meetings.

### *Challenges/Risks*

The principal problem is lack of financial support.

## **5.7. Sweden**

### *Network*

Members include: Jan Karlsson and Danny C.P. Lau (both Umeå University, Dept of Ecology and Environmental Science), Johan Östergren and Kerstin Holmgren (Swedish University of Agricultural Sciences – SLU, Dept of Aquatic Resources), as well as Maria Kahlert, Brian Huser, and Tobias Vrede (SLU, Dept of Aquatic Sciences and Assessment). Willem Goedkoop (SLU) is the Swedish co-chair for CBMP-Freshwater and leads the Swedish FEN.

### *Accomplishments*

In 2020, the Swedish FEN members contributed to several of the manuscripts that will be published in the special issue of Freshwater Biology. Several of these papers have been accepted for publication. The FEN has not met for several years and will require reactivation to contribute to new initiatives of CBMP-Freshwater. Communication between the Swedish co-chair and national authorities, i.e., the Swedish EPA (CAFF rep) and SWAM (Swedish Agency for Marine and Water Management), has been by e-mail and online meetings. The Swedish co-chair of CBMP-Freshwater has also participated in the CAFF-board meetings (February and September), in a workshop about collaborations with AMAP, and in quarterly telephone meetings with the CBMP co-leads, and provided input to CBMP reports, the 2021–2025 strategy document, and memos to the CAFF Board.

### *Challenges/Risks*

As the Swedish CAFF representative is at the EPA, while CAFF-related work is funded by SWAM (Swedish Agency for Marine and Water Management), there is a strong need for regular meetings for the planning and evaluation of work between both organizations and the CBMP-Freshwater co-chair. External funding for the work (from SWAM) has decreased successively over recent years and was at a minimum level of 100,000 SEK/y in 2020.

## **5.8. USA**

### *Network*

Members include: Christian Zimmerman (lead; U.S. Geological Survey), Matthew Whitman (Bureau of Land Management), and Sarah Laske (U.S. Geological Survey).

### *Accomplishments*

During 2020, the USA FEN members continued to contribute to manuscripts that will be published in the special issue of Freshwater Biology.

### *Challenges/Risks*

Lack of secured funding to support FEN activities continued to be an issue in 2020.

## 6. Financial report

### 6.1. Status of Funding for 2020 and outlook for 2021

- a. **Canada** – Environment and Climate Change Canada (ECCC) supported Canada’s participation by continuing to undertake the Freshwater SG co-chair activities and to provide approximately \$10K USD travel support related to this work. Because travel was restricted by the pandemic, approximately half of these funds were used to fund the open access of a Indigenous Knowledge paper in the Freshwater Biology special issue. A similar amount of Canadian funding is expected for 2021, with most of this used to fund workshop and annual meeting travel.
- b. **Kingdom of Denmark** – Funding for 2020 was provided by the Danish Environmental Research Agency through the DANCEA program (USD \$12.8 K) as part of the collective application for support to all the national CBMP activities. This amount provided support for travel and for the time spent at FSG meetings but not for scientific writing and editing. An application for support for 2021 was submitted in the fall of 2020.
- c. **Finland** – The Ministry of the Environment of Finland was prepared to support CBMP work in 2020 by covering the travel costs. However, no travel or in-person meetings took place in 2020. Some of the allocated funds will be redirected to support the cost of open access for one paper in the special issue. Application to cover some travel and other expenses have been made for 2021.
- d. **Iceland** – There were no travel costs in 2020 due to the COVID-19 pandemic. There is no secure funding for the work of Freshwater CBMP other than what is needed to attend at least one Freshwater SG meeting annually.
- e. **Norway** – The Ministry of Climate and Environment supported the Norwegian activities of the Freshwater SG in 2020. This funding covered some monitoring activities in Arctic freshwater sites, ‘open access’ costs of Freshwater Biology papers and preparation of communication products on CBMP-activities in Norway. The total budget available from the Ministry of Climate and Environment for the Norwegian FEN work for 2020 was approximately USD \$30K. The work-hour costs for the Freshwater Steering Group members from Norway are covered by the Norwegian Environment Agency (NEA).

In 2021 we will focus on preparing monitoring activities in the Arctic regions and contribute to the Freshwater SG work on standardizing monitoring methods appropriate for the Arctic. Ongoing monitoring will provide data that will be available for future assessments of Arctic biodiversity and the effect of climate change. Norwegian Environment Authority cooperates with several authorities in planning freshwater monitoring in the Arctic region.

**Russia** – There was no need for travel funding in 2020. A request was made to the Russian CAFF representatives to use funds previously allocated to travel to support open access for the Russian paper in the special issue. There remains a need for funding to support activities of the Russian FEN and SG member.

- f. **Sweden** – Sweden’s participation and co-leadership of CBMP-Freshwater is funded through annual contracts from SWAM. External funding of the work (from SWAM) has decreased successively over recent years and was at a minimum level of 100,000 SEK/y in 2020. In recent years, part of this work has been supplemented by the “authority support,” i.e., the university’s funding aimed at supporting SWAM and the Swedish EPA with specific expertise in freshwater issues that is annually agreed upon between SLU and SWAM. Funding for 2020 was \$23K USD of which 50% came from external funding. In addition to this, travel costs for participation in CAFF Board meetings for the Swedish Freshwater co-Chair have been

provided by the Swedish EPA. The support for 2020 was not sufficient for the extra work that came along with CAFF/AMAP collaboration, collaborations with CBMP-terrestrial and extra meetings associated with meetings and work on the CAF-strategic plan for 2020–2025.

- g. USA** – There was no direct funding in 2020 for involvement in the Freshwater SG from US authorities. The US Geological Survey provided in-kind personnel support for Freshwater SG member activities and travel support. In 2021, US Geological Survey will continue to provide in-kind personnel support and travel support so the US representative can participate in Freshwater SG meetings and activities.
- h. Others (as applicable)** – Through the CAFF Secretariat, the CAFF Board supplied funds to provide part-time support for the Freshwater Coordinator to continue to coordinate the Freshwater SG. Funds were received for the period of June 2020-June 2021, and partial funds have been secured for 2021-2022. These funds cover part-time salary (approximately ¼ time) and do not include travel costs or Science Analyst work by the Coordinator. There is a need to establish long-term support for the Freshwater Coordinator position to ensure continued productivity for CBMP-Freshwater.

## 6.2. Looking ahead

The FSG has a detailed work plan for 2020–2024 that has been approved by the CAFF Board. This sets the stage for the upcoming years with several work items (see above). There are a range of anticipated challenges for the next phase of implementation for CBMP-Freshwater, including long-term funding to support its activities. Several other challenges relate to data and assessments. Data collection, compilation, and harmonization (including quality assurance) for the SAFBR has been a tedious process that involved the assistance of data engineers and assistants in several countries. If CAFF's ABDS is intended to host a database of Arctic biodiversity that builds on external data extracted from reports and national monitoring databases in the different countries, automated procedures for doing this should be developed by professional database managers. Such procedures facilitate both the updating of time series data for sites currently in the freshwater database and the addition of data for new sites. Access to quality-assured data is key for future assessment of Arctic biodiversity.

The Freshwater SG will continue to work to enhance recognition of the SAFBR through general communications, scientific publications, presentations at regional, national, and international meetings, and contributions to national and international efforts. We envision that CAFF-board members and Freshwater SG members will have ongoing communication to guarantee secure funding from national and international organizations, to ensure the sustainability of CBMP-Freshwater and continued implementation of the CBMP-Freshwater Plan.

The Freshwater SG is also eager to contribute to joint work with the terrestrial group of CBMP and CAFF's joint assessments with AMAP. Catchment- and/or ecoregion-based assessments have been identified as appropriate scales for joint analyses and assessments. The group would, however, need support from States and through support for funding applications such as a CAFF-led application to the Nordic Council of Ministers to provide appropriate funding for this work.

Looking ahead to 2021, the Freshwater SG plans to continue progress on each of its 6 projects in the 2020-2024 work plan. With help from the CAFF Board, the Freshwater SG also hopes to gain regular representation from Permanent Participant groups, to facilitate greater engagement and collaboration in this implementation phase.

### 6.3. Budget for 2020-2024

The following is the CBMP-Freshwater SG budget for 2020 to 2024, including the total cost (in USD) and person-hours (in weeks) required for each of six projects for this phase of implementation. Costs and person-hours are provided for the SG (SG; 8 State representatives), Freshwater Coordinator (FC), and Science Analyst (SA). Work has been split between the FC and SA to indicate time spent on administrative/coordination/communication tasks, and time spent on tasks related to expansion and maintenance of the database, analysis of data, and creation of scientific reports and manuscripts. Person-hours for the FC and SA are summed in the total rows, as they are currently the same person. Note: the costs outlined in the table are focused on new work items for the coming years to harmonize freshwater biodiversity monitoring, data management and reporting. They do not reflect actual ongoing monitoring costs.

Project	Task	Total Cost (in USD) or Person-Hours (in weeks)														
		2020			2021			2022			2023			2024		
		SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA
1: Promotion and Meetings	Attendance at one annual planning meeting (5k per country + 1 wk/country + mtg costs) <sup>1</sup>	45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk	
	Attendance at one project implementation meeting (5k per country + 1 wk/country + mtg costs)	45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk		45k + 8 wk	5k + 2 wk	
	Production of promotional materials for Project 1 (1 wk/country + coordinator)	8 wk	2 wk		8 wk	2 wk		8 wk	2 wk		8 wk	2 wk		8 wk	2 wk	

<sup>1</sup> For for each annual meeting there is roughly 5k travel per person (lower for some countries, depending on meeting location is held) , a total of circa 40k, and an additional 5k for meeting costs (facilities, coffee breaks and lunches, other administrative costs).

Project	Task	Total Cost (in USD) or Person-Hours (in weeks)														
		2020			2021			2022			2023			2024		
		SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA
	Promotional activities related to Project 1(1 wk/country + coordinator)	8 wk	2 wk		8 wk	2 wk		8 wk	2 wk		8 wk	2 wk		8 wk	2 wk	
	Annual Performance Report (0.5 wk/country + coordinator)	4 wk	1.5wk		4 wk	1.5 wk		4 wk	1.5 wk		4 wk	1.5 wk		4 wk	1.5 wk	
	Printing costs for promotional material (1k/country)	8k			8k			8k			8k			8k		
	SAFBR printing costs	10k														
2: Sampling Methods	CAFF report summarizing sampling methods (1 wk/country + analyst)	8 wk		4 wk												
	Arctic sampling methods manuscript (3 wks/country + analyst) (may vary from country to country)	12 wk		4 wk	12 wk		4 wk									
3: Protocol Handbook	Sampling Protocol Handbook creation (3 wks/country + analyst)				24 wk		6 wk									
4: Database	Finalize database and add to ABDS (2 wks/country + analyst)	16 wk		12 wk												

Project	Task	Total Cost (in USD) or Person-Hours (in weeks)														
		2020			2021			2022			2023			2024		
		SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA
	Identification of data to add to the database to fill gaps and extend time series (2 wk/country + analyst)	16 wk		4 wk	16 wk		4 wk	16 wk		4 wk						
	Processing of new data and the addition of data to database (6 wks/country/yr + analyst)				48 wk		24 wk	48 wk		24 wk	48 wk		24 wk			
	Creation/Implementation of database working group (4 people total + analyst + ABDS Manager)										8 wk		2 wk	4 wk		2 wk
	Develop data interfaces													CAFF		
5: Continued reporting	Creation of short SAFBR update (1 wk/country + coordinator)				8 wk		2 wk									
	Expert workshop to discuss follow-up to AMAP assessment (1 wk/person and total venue costs indicated; travel costs to be requested from external granting authorities).							5 k + 8 wk	3 wk							

Project	Task	Total Cost (in USD) or Person-Hours (in weeks)														
		2020			2021			2022			2023			2024		
		SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA
	Report on biotic response to changing abiotic environment (follow-up to AMAP; 1.5 wk/country/yr + analyst)							12 wk		4 wk	12 wk		4 wk			
	Indicator report(s) for each FEC related to database updates (1 wk/country/yr + analyst)										8 wk		3 wk	8 wk		8 wk
6. Collaborate with AMAP	Collaborate with AMAP on 2021 report chapter (number of people and time commitment to be determined)	tbd		tbd												
<b>Total cost (all countries summed)</b>		108k	10k		98k	10k		103 k	10k		98k	10k		98k	10k	
<b>Total person-hours (wks; all countries summed)</b>		88 wk	9.5 wk	24 wk	144 wk	11.5 wk	38 wk	120 wk	12.5 wk	32 wk	112 wk	9.5 wk	33 wk	48 wk	9.5 wk	10 wk
<b>Total cost (per country)</b>		13.5k	10k		12.2 5k	10k		12.9 k	10k		12.2 5k	10k		12.2 5k	10k	

Project	Task	Total Cost (in USD) or Person-Hours (in weeks)														
		2020			2021			2022			2023			2024		
		SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA	SG	FC	SA
Total person-hours (wks; per country)		11 wk	33.5 wk		18 wk	49.5 wk		15 wk	44.5 wk		15 wk	42.5 wk		5 wk	19.5 wk	

## 7. Workplan for 2021-2024

Project/ Milestone	Activities & Deliverables	Timeline
0. SAFBR published	a. SAFBR endorsed by CAFF board	Completed 2019
	b. SAFBR published by CAFF	Completed 2019
	c. SAFBR printed for distribution	Funding not obtained
	d. Publication of special issue papers	Ongoing through 2021
1. Promotion and Meetings	a. Scoping workshop for implementation phase 2	Completed 2019
	b. FSG Annual meeting and workshop	May 2021 - Nov 2021
	c. Presentations at national and international meetings and conferences	Ongoing
	d. Promotion of SAFBR findings	Ongoing 2019-2021
	e. Promotion of harmonized monitoring	Ongoing
	f. Promotion of the Freshwater Database	Ongoing
2. Sampling Methods	a. FSG summarizing sampling methods from Freshwater Database	March 2021
	b. CAFF Report summarizing sampling methods	June 2021
	c. Journal article about Arctic sampling methods	June 2022
3. Protocol Handbook	a. CAFF Freshwater Sampling Protocols Handbook	December 2022
4. Freshwater Database	a. Identify data sources and obtain data permissions for current data	March 2021
	b. Integrate Freshwater Database into ABDS	December 2021
	c. Identify and obtain additional data to be added to Freshwater Database	Ongoing - Dec 2022
	d. Harmonize data and process for inclusion in Freshwater Database	Jan 2022 - Dec 2023
	e. Creation/Implementation of database working group	Jan 2023 Dec 2024
	f. Development of database interfaces	Ongoing from 2024
5. Reporting	a. 2020 annual performance report submitted to CAFF	Jan 2021
	b. 2021 work plan submitted to CAFF	Jan 2021
	c. Creation of short SAFBR update	Dec 2021
	d. Expert workshop to discuss follow-up to AMAP assessment	TBD 2022
	e. Report on biotic response to changing abiotic environment	Dec 2023
	f. Analysis of new Freshwater Database data	2023 – Oct 2024
	g. Indicator report(s) for each FEC related to database updates	March 2025