

Full Proposals for International Polar Year 2007-2008 Activities

Proposed IPY Activity Details

1.0 PROPOSER INFORMATION

(Activity ID No: 439)

1.1 Title of Activity

Temporal and spatial distribution of mercury and methylmercury source types, transfer and impact in the North American arctic and sub-arctic food web using seabird eggs and feathers.

1.2 Short Form Title of Proposed Activity

MERSAM (MERcurySeabirdArcticMonitoring)

1.3 Activity Leader Details

Paul R. Becker

National Institute of Standards and Technology (NIST)

USA

1.4 Lead International Organisation(s) (if applicable)

AMAP (Arctic Monitoring and Assessment Programme)

CAFF (Conservation of Arctic Flora and Fauna)

1.5 Other Countries involved in the activity

France

Canada

1.6 Expression of Intent ID #'s brought together in this proposed activity

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1.7 Location of Field Activities

Arctic

1.8 Which IPY themes are addressed

1. Current state of the environment
2. Change in the polar regions
4. Exploring new frontiers

1.9 What is the main IPY target addressed by this activity

1. Natural or social science
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2.0 SUMMARY OF THE ACTIVITY

Mercury (Hg) in the arctic has received considerable attention since several investigations have shown an increase in Hg concentration in various biota samples, including marine mammal

tissues and seabird eggs which were mainly enriched in methylmercury (MeHg). These relatively high concentrations of Hg represent an important health issue for the rural indigenous native arctic communities consuming these products. The distribution of Hg in the top level of the arctic food web is well mirrored by the concentration of Hg in seabird eggs, where spatial differences exist between the Alaskan and Canadian arctic, with a marked Hg increase observed since 1975 in the Canadian arctic and distinct Hg signatures that are measured between seabird colonies residing in the Gulf of Alaska and Bering Sea, signatures that are subject to an apparent year-to-year variability and species specific effects. These spatial and temporal patterns as well as the levels of Hg in the food web prompt several fundamental questions on the nature of the sources of Hg that need to be answered through research, namely relative anthropogenic/natural contributions of Hg throughout and across ecosystems, the processes driving these patterns (i.e., sources, atmospheric transport and deposition, ocean currents, and evolution of the food web structure), their linkages and their respective contributions over time.

All these processes need to be assessed on a spatial scale (considering arctic and sub-arctic regions) as well as on a temporal scale to evaluate the amplitude of these factors over time. In the absence of extensive Hg atmospheric monitoring stations in Alaska and also considering the variability and scarcity of data on Hg and MeHg levels in snow and seawater in Alaska, no direct temporal and spatial approaches can be conducted. In this proposal we utilize an indirect approach consisting of:

(1) Tracking the sources of Hg and assessing regional differences by analyzing seabird eggs and feathers collected on a regular basis at several locations in the North American arctic and sub-arctic regions. These samples are archived at the Marine Environmental Specimen Bank (Charleston, SC, USA) administrated by the National Institute of Standards and Technology (NIST), at the Canadian Wildlife Service Specimen Bank (Ottawa, ON CANADA) and are housed in various collections curated by University of Alaska Fairbanks (UAF) Museum of the North and independent UAF researchers.

(2) Assessing the long-term temporal trend of Hg in the top marine food web using time series of collections of seabird eggs and feathers.

The spatial and retrospective approaches for monitoring Hg and MeHg in the samples will be coupled with several other sources of information including food web tracers (C and N stable isotopes ratios), as well as tracers of atmospheric transport/sources such as lead isotope ratio patterns in seabird eggs and feathers, and organic contaminant patterns in seabird eggs. Alone, all these data are valuable, but the power exists to collectively investigate the spatial/temporal relationship existing between the nature of Hg sources, their geographical extent and their accumulation/transfer in the arctic/sub-arctic foodweb.

2.1 What is the evidence of inter-disciplinarity in this activity?

The fundamental questions considered in this proposal are structured around several interactions between different disciplines such as biology/ecology, environmental and analytical chemistry. The interactions between biology/ecology and environmental chemistry research groups with analytical chemistry disciplines are an important part of this research initiative because new, accurate and high throughput analytical procedures are required to determine Hg species and others environmental tracers in a large set of biological matrices. Further, the coupling between Hg speciation/levels/distribution and environmental tracers of key processes such as atmospheric influence (Pb isotopes) and the ecological structure of the food web (stable isotopes), build the basis of a collaborative framework capable of focusing on discovering the main routes/processes driving the mobility and impact/transfer of Hg in the arctic food web. Technically, this collaborative research initiative is constructed on the basis of the existing collaborations in the ongoing Seabird Tissue Archival and Monitoring Project (STAMP) administrated by the U.S. Fish and Wildlife Service Alaska Maritime National Wildlife Refuge (USFWS-AMNWR), the U.S. Geological Survey Biological Resources Division (USGS-BRD), the Bureau of Indian Affairs Alaska Regional Subsistence Branch (BIA-ARSB), and the National Institute of Standards and Technology (NIST). These partners already interact strongly in field collections; sample processing, specimen archival, chemical analysis, statistical analysis and interpretation and communication of data in the investigations of contaminants in seabirds.

2.2 What will be the significant advances/developments from this activity? What will be the major deliverables? What are the outputs for your peers?

This initiative will provide information relevant to the polar research community in three themes considered in this IPY activity:

Theme 1. Current state of the environment:

One of the important deliverables of the project will be a description of the current contamination state of Hg in the Alaskan arctic and sub-arctic food web that has been poorly studied. The spatial extent of this study will cover several latitudes and longitudes ranging from the Beaufort Sea, Chukchi Sea, Bering Sea, and Gulf of Alaska and east-west along the Aleutian Islands, with future collections of biological material at the Komandorski Islands in partnership with Russia. In addition, several colonies in the eastern Canadian arctic and sub-arctic will be included. The high spatial resolution of the seabird colonies and collected eggs/feathers archived in various specimen banks, will allow precise assessment of north/south and east/west gradients providing a relevant set of information to better characterize the spatial extent of the contamination, the different potential sources and the local impact of Hg at the apex of the food web, where piscivorous avian, marine mammal and humans forage.

Theme 2. Change in the polar regions

The second deliverable of this project will assess this theme by studying the distribution of Hg on a temporal scale at different Arctic locations. This approach will be conducted by using seabird feathers as a sample resource covering several decades.

Theme 4. Exploring new frontiers

It is now well established that the quality and precision of data is a critical factor to assess the questions related to the distribution and impacts of contaminants in the environment. The analytical chemistry institutions involved in this proposal (National Institute of Standards and Technology (NIST, USA) and the Laboratoire de Chimie Analytique BioInorganique et Environnement (LCABIE, France) interact strongly with researchers of different disciplines to develop new sensitive and standardized protocols allowing multi-parameter tracer analyses that require micro-sized quantity samples. The sample size is a critical issue as most of the sample resources considered in this proposal are valuable and unique, and quantities available in museums are very limited. A new aspect of this research initiative consists of developing new emerging isotopic standards and protocols for environmental analysis based on non-destructive methodology such as laser ablation-inductively coupled plasma mass spectrometry (LA-ICPMS). These interactions are fundamental for several groups of researchers considering that they can provide an analytical basis to explore and investigate the potential of new isotopic tracers in the context of historical data evaluations.

The work proposed in this activity is focused on understanding the impact and dynamics of Hg in the arctic and sub-arctic food web. The approach adopted consists of working in both temporal (retrospective) and spatial scales, combined with multi-specific tracer information. This is complementary to other IPY core projects that focus on climate change since it likely will influence the fate of Hg in polar regions. It will also provide a snapshot of the Hg contamination across one of the world's largest nature refuges (AMNWR).

Data obtained through this proposal will be published in peer-reviewed journals, internal reports (freely available to the public) and presented at scientific meetings and in sensitive terms to the public through appropriate local experts, with particular emphasis given to native communities that rely on seabirds for subsistence food and any communities that have taken an active role in Alaskan research.

2.3 Outline the geographical location(s) for the proposed field work (approximate coordinates will be helpful if possible)

Locations	Coordindates
Alaskan arctic	
Alaskan sub-arctic	
Eastern Canadian arctic	
Eastern Canadian sub-arctic	

2.4 Define the approximate timeframe(s) for proposed field activities?

Arctic Fieldwork time frame(s)	Antarctic Fieldwork time frame(s)
06/07 - 09/07	MM/YY - MM/YY
06/08 - 09/08	MM/YY - MM/YY
	MM/YY - MM/YY

2.5 What major logistic support/facilities will be required for this project?

Further details – No specific additional fieldwork is required for this activity. Seabird eggs and feathers will be collected for the ongoing Seabird Tissue Archival and Monitoring Project (STAMP) during each summer field season in the context of the normal sampling program. Most of the samples required by this activity are archived samples of the Marine Environmental Specimen Bank (Charleston, SC USA), the Canadian Wildlife Service Specimen Bank (Ottawa, ON CANADA), samples holdings of research groups at the University of Alaska Fairbanks (UAF), and samples from the collection of the Museum of the North (UAF).

2.6 How will the required logistics be supplied? Have operators been approached?

Source of logistic support	Likely potential sources	Support agreed
Consortium of national polar operators		
Own national polar operator		
Another national polar operator		
National agency		Y
Military support		
Commercial operator		
Own support		Y
Other		

2.7 If working in the Arctic regions, has there been contact with local indigenous groups or relevant authorities regarding access?

Numerous indigenous groups, tribal governments, and relevant authorities are already partners in the STAMP program. The STAMP program already maintains an ongoing communication and outreach program through these groups which will be utilized for the proposed project

3.0 STRUCTURE OF THE ACTIVITY

3.1 Origin of the activity

This is a pulse of activity during 2007-2009 within an existing programme

If part of an existing programme please name the programme – Seabird Tissue Archival and Monitoring Project (STAMP)

3.2 How will the activity be organised and managed? Describe the proposed management structure and means for coordinating across the cluster

The activity of this proposal will be managed toward three different clusters.

(1) Sample collection/resource and management

The activity leader will coordinate the use of the different resources of samples between the partners and will formalize the procedures of organizing sample identification and traceability during this IPY activity. The seabird egg sample collection, processing, and archival is performed

in the context of a regular research function. This project was implemented in 1999 to monitor long-term trends in environmental quality by collecting, processing and cryogenically banking the eggs of several Alaskan seabird colonies ranging from the Chukchi Sea south to the Aleutian Islands and east through the Gulf of Alaska. Future collections aim for approximately 300 clutches banked per year and include partnering with Russian investigators, for collections on the Komandorski Islands. All the eggs of this project are banked at the Marine Environmental Specimen Bank (Charleston, SC USA) administrated by NIST. In addition, seabird eggs archived at the Canadian Wildlife Service Specimen Bank (Ottawa, ON Canada) will be accessed according to established access guidelines.

Seabird feather collections of the University of Alaska Fairbanks (UAF) Museum of the North (Fairbanks, AK USA) will be accessed following the guidelines and the policy of the museum.

(2) Sample analysis

All the sample analyses will be performed by federal agencies and internationally recognized research institutions following specific requirements in terms of QA/QC validation, results traceability and issuance of reports of analysis and peer reviewed publications.

Hg speciation analysis and organic contaminants determinations are routinely performed by NIST as part of STAMP. For that purpose, NIST has developed and validated specific reference analytical procedures allowing accurate measurements of organic contaminants (polychlorinated biphenyls [PCBs], organochlorine pesticides [e.g., DDT, hexachlorobenzene (HCB), hexachlorocyclohexanes (HCH), and chlordanes], and polybrominated diphenyl ethers [PBDEs]), trace levels of mercury and organomercury speciation determinations in seabird eggs matrices. A newly developed Hg speciation procedure for keratin-based biological material will be employed for seabird feathers analysis.

- The information on atmospheric transport sources and Hg signatures will be collected indirectly by using lead isotopes as tracer of source fingerprints and distribution/impact. This is required due to the lack of atmospheric monitoring stations for Hg throughout the study area. The measurements of lead isotope ratios will be performed by Multicollector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS), allowing sufficient resolution to track significant temporal/spatial differences in the source of pollution. This part of the proposal will be conducted in collaboration with the Laboratoire de Chimie Inorganique et Environnement (LCABIE, France) led by Olivier F. Donard. This research initiative follows the collaborative framework currently existing with NIST based on a guest scientist program designed to improve speciation analysis at both institutions and the development of new emerging technologies for environmental analysis. The international expertise of this laboratory in the field of trace element speciation by isotope dilution approaches is well recognized through the publication of several peer-reviewed papers.

- Food web structure can significantly influence contaminant patterns in biological matrices. The research group of Todd O'Hara (UAF) will perform C and N stable isotope analyses. This feeding ecology tool is particularly well adapted to elucidate the ecological linkage and the structure of the food web. This research group is extremely knowledgeable about arctic and sub-arctic food webs and works intimately within the study area on various science and health research initiatives impacting Native populations

(3) Data treatment, interpretation and communication

The activity leader will coordinate the management/update of a database providing a common resource of information between participants. The statistical analyses and interpretation of data will involve all research partners in an effort to determine the spatial and temporal trend data generated for Hg in arctic food web through an interdisciplinary approach consistent with the fundamental questions proposed in this study, namely studying the coupling between the main factors driving Hg patterns such as ecological, biological, chemical or transport and sources processes. The communication of results will be issued first through internal reports and secondly by scientific peer reviewed articles. The main results as well as project advancements will be communicated in various meetings, symposiums and international conferences.

3.3 Will the activity leave a legacy of infrastructure and if so in what form?

This activity already has a legacy of cooperation with numerous indigenous Alaskan groups and tribal governments. This cooperation was initiated in 1987, through several related ongoing monitoring/archival programs that have focused on marine mammals such as Alaska Marine

Mammal Tissue Archival Project (AMMTAP) and seabirds (STAMP). This proposal strengthens and develops a new aspect to the legacy of cooperation between scientists and archival institutions by establishing a framework based on sample tissues/access policy between US and Canadian specimen banks/museums. All samples collected for this project will be archived for future research.

3.4 Will the activity involve nations other than traditional polar nations? How will this be addressed?

All the countries involved in this research activity (USA, Canada, Russia) are traditional polar nations. However, France is represented in this proposal by providing cutting edge analytical resources such as Multicollector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS). This analytical resource is particularly important as it provides sufficient isotopic resolution to provide new insights on the processes governing the fate, cycling and impact of Hg in the polar ecosystem.

3.5 Will this activity be linked with other IPY core activities? If yes please specify

Yes, this activity is similar to IPY project COPOL (initially activity number 175) managed by Nico van den Brink. Further, some partners of this activity are also involved in other IPY projects, allowing links and exchanges.

3.6 How will the activity manage its data? Is there a viable plan and which data management organisations/structures will be involved?

Data management will follow IPY Data Policy guidelines and the organization will follow the guidelines established by the existing STAMP program. Data from STAMP is also provided to the Arctic Monitoring and Assessment Programme as part of its reporting activity.

3.7 Data Policy Agreement

Will this activity sign up to the IPY draft Data Policy (see website)

Yes

3.8 How will the activity contribute to developing the next generation of polar scientists, logisticians, etc.?

The activity will help contribute to developing the next generation of polar scientists and logisticians by first exchanging knowledge and experience in the interpretation of data. Second, this research initiative will promote scientific exchange by facilitating also the link between research groups with providing internal grants for several guest researchers. Further, this activity contributes also to provide information to indigenous Alaskan groups and increasing their awareness and interest in science.

3.9 How will this activity address education, outreach and communication issues outlined in the Framework document?

Graduate and post-graduate students will be involved in conducting research associated with this proposal. The University of Alaska Fairbanks (UAF) has established fellowships for post-graduate students conducting IPY research.

Outreach to the native communities will continue to occur through community liaisons and easy to understand flyers about this research and the results. Information will also be disseminated through Alaska Native Science Commission.

More traditional scientific communications will occur via peer-reviewed journal articles and presentations at scientific meetings.

3.10 What are the proposed sources of funding for this activity?

USGS

USFWS

NIST Internal Funding

NIST Guest researcher grants

3.11 Additional Comments

4.0 CONSORTIUM INFORMATION

4.1 Contact Details

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4.2 Other significant consortium members and their affiliation

Name	Organisation	Country
Geoff York	USGS, Alaska Science Center	USA
Kristin Simac	USGS, Alaska Science Center	USA
Dr. Todd O'Hara	Institute of Arctic Biology- University of Alaska Fairbanks	USA
Dr. Olivier F.X. Donard	Laboratoire de Chimie Bioinorganique et Environnement-UMR 5034	France
Dr David Point	National Institute of Standards and Technology	USA
Russell D. Day	National Institute of Standards and Technology	USA
Stacy VanderPol	National Institute of Standards and Technology	USA
Dr Steven Christopher	National Institute of Standards and Technology	USA
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Dr. Birgit Braune	Canadian Wildlife Service, National Wildlife Research Centre	Canada
Dr. Alan Springer	Institute of Marine Science- University of Alaska Fairbanks	USA