

ARCTIC 2022 – IMPLEMENTED PROJECTS

ECOTIP

PI, LEAD INSTITUTION

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ABSTRACT

Background

At present, the Arctic ecosystems are fundamentally changing as a consequence of the pronounced climate warming in this area. Among the most drastic changes are the gradual sea ice loss, the strengthening of the water column stratification due to more meltwater, and an altered biodiversity due to species invasion [1,2]. The currently conducted project ECOTIP (EU Horizon 2020, #869383) focusses on one pressing question associated with these changes and estimates the dynamics of ecological tipping cascades in (among others) the Greenland Sea. This is crucially needed, because passing a tipping point presumably causes a cascade of changes in the ecosystem and results in a marine system that provides considerably different ecosystem services (e.g., in terms of carbon sequestration and fisheries).

ECOTIP uses different approaches to achieve its goal and relies in subtasks heavily on field data.

First, new field observations (hydrography, nutrient data, abundance, and composition of planktonic organisms) are combined with existing data in a Bayesian modelling approach to gain a general better understanding of mechanisms in and drivers of the pelagic ecosystem. As the Arctic changes fast, present-day data are here essential for ground-truthing of the modelling work. The overall goal of this approach is to estimate the potential of a physical factor triggering an ecological tipping cascade in the Greenland Sea. For example, meltwater can, via a tipping cascade of stronger water column stratification, reduced surface nutrient concentrations, and modified abundance and composition of functional plankton types, reduce the efficiency of the carbon pump [3]. Ultimately, this cascade would have consequences on the nutritional input to the benthic ecosystem (and local Greenlandic demersal fisheries) as well as the carbon sequestration (and the CO₂ drawdown from the atmosphere), and thus have far-reaching consequences on a local and a global scale.

Second, ECOTIP also investigates the potential of biological factors initiating ecological tipping cascades, and here in particular the role of nonindigenous species (NIS), meaning non-native and invasive species. With rising temperatures and more shipping traffic in former ice-covered waters, NIS are likely to enter the Arctic: They may cause huge ecological damage and potentially trigger tipping cascades if they for example become very abundant in the absence of natural predators and overexploit prey species. A fast detection of NIS is therefore a highly



important prerequisite to estimate their potential to trigger of a tipping cascade, but this is currently difficult. Taxonomic identification of organisms is usually time consuming [4], and therefore ECOTIP examines if environmental DNA (eDNA) can be used for fast and precise surveillance of NIS. The principle of eDNA bases on the assumption that every living organism leaves its DNA in the environment and can thus be traced in an environmental sample (e.g., water sample) [5]. ECOTIP aims therefore to develop a method to quickly detect NIS within a large geographical and temporal range.

Due to the Covid-19 pandemic, ship-time has been reduced in ECOTIP, and now the project can only conduct one research cruise to the region between Ittoqqortoormiit and Dove Bay (western Greenlandic Sea) in August 2022 to collect both present-day ecosystem data and eDNA. Thus, scientists in ECOTIP currently have to accomplish their estimates of the potential of ecological tipping cascades based on summer (August) data only. This will be challenging, because a) data from the western Greenland Sea are generally rare (remote area with heavy ice), b) the ice extend is varies strongly between year-to-year.

Research objectives and expected outcomes

With the support of the ECOTIP lead, I apply hereby for two scientific berths on the "Le Commandant Charcot" on the leg 10-22 May 2022 (alternatively, leg 22 May-3 June 2022) to gather observational data (hydrography, water samples for eDNA, phytoplankton and other parameters, zooplankton samples) in the ice-covered pelagic ecosystem in the western Greenland Sea. At the same time as the expedition takes place, the annual ice algae and phytoplankton spring bloom occurs, tightly followed by an efficient carbon pump and a build-up in zooplankton biomass. These events are a key period of primary and secondary production in the Arctic and observations from this time of the year would provide a great, complementary data set to the one to be gathered by ECOTIP in August 2022 (in the same area). Further, data from spring (May) and summer (August) would be an excellent basis for ECOTIP to estimate the potential of ecological tipping cascades in the western Greenland Sea during different seasons.

In detail, ECOTIP aims to collect hydrographical data (CTD) and water samples (Niskin bottle, surface and 3-4 water depths in the upper 200 m, dependent on available ship time) during the "Le Commandant Charcot" expedition. The water samples will be analysed for nutrients, particulate organic carbon and nitrogen, chlorophyll a, phytoplankton abundance and composition and eDNA. If possible, also zooplankton samples (upper 100-200 m) will be collected (plankton net WP-2).

Interested guests will be invited to participate in the CTD, water and plankton sampling, and they could have a look at collected hydrography data and the plankton samples after the sampling.

The data from the expedition will be used in ECOTIP

1) to improve the Bayesian modelling approach. Present-day data are essential to estimate the potential of physical factors triggering ecological tipping cascades and additional spring data would allow a seasonal understanding. (Potentially weather, ice thickness, and EK-80 echosounder data from the "Le Commandant Charcot" would also be beneficial for this work)

2) as ground-truthing data for developing satellite remote sensing algorithms, which will improve future investigations from space, and

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*Access to the Arctic Ocean on board the Polar Expedition
Ship "Le Commandant Charcot" (PONANT, France)*



3) to identify nonindigenous species in the Greenland Sea and estimate their potential to trigger ecological tipping cascades.

References

[1] Meier et al. (2021) <https://www.arctic.noaa.gov/Report-Card/Report-Card-2021/ArtMID/8022/ArticleID/945/Sea-Ice>

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[3] van Appen et al. (2021) <https://doi.org/10.1038/s41467-021-26943-z>

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[5] Taberlet et al. (2012) <https://doi.org/10.1111/j.1365-294X.2012.05542.x>