Scientific projects

NATIONAL ANTARCTIC PROGRAM
2022-2025

This document summarizes the scientific projects that Uruguay is currently developing in Antarctica. They are structured around four major areas of work: Geosciences, Life Sciences, Physical Sciences, Humanities and Social Sciences and Environmental Monitoring, constituting the first four, areas of high priority study for the Scientific Committee on Antarctic Research (SCAR).

GEOSCIENCES

SCAR-GIANT (Development of the Antarctic Geodetic Infrastructure) and SCAR-KGIS (King George Island Geographic Information System) projects.

Responsible: Tte. Cnel. Gustavo Caubarrere
Institution: Instituto Geográfico Militar (IGM)
Contact: gustavo.caubarrere@igm.gub.uy

The activities to be developed are framed in two international cooperation projects promoted by SCAR: SCAR-GIANT (Antarctic Geodetic Infrastructure) and SCAR-KGIS (King George Island Geographic Information System). The main objective is to establish and maintain a High Precision Geodetic Infrastructure, in order to be able to georeference any geographical object located on the earth's surface. With the installation of semi-permanent and permanent Passive (boundary markers) and Active (CORS) Stations, it is possible to study different geodesic and geophysical components (tides, movements and cortical deformations, marine currents, wind, temperature, atmospheric pressure, humidity, others) as well as to carry out topographic, geodesic, photogrammetric and geophysical surveys for different technical and scientific purposes. At the same time, it is intended to implement a Geographic Information System of King George Island (KGIS) with the main purpose of maintaining an integrated and updated cartographic and geospatial information base regarding King George Island. It is expected to make a digital surface model, a digital terrain model, contour lines every one meter (1m), an ortho-mosaic, and a 3D reconstruction of the environment of the Artigas Antarctic Science Base.

Monitoring of the average sea level in Peninsula Fildes, King George Island.

Responsibles: Tte. Cnel. Gustavo Caubarrere - CF Niki Silvera
Institution: Instituto Geográfico Militar (IGM) - Servicio de Oceanografía, Hidrografía y Meteorología de la Armada (SOHMA)
Contact: gustavocaubarrere@gmail.com; sohma_oce_jefe@armada.mil.uy

This project encompasses two sub-projects that are carried out by the Military Geographic Service (MGS) and the Navy Oceanographic, Hydrographic and Meteorological Service (SOHMA). Through the installation of sensors and passive (landmarks) and active (CORS) stations, the aim is to determine with precision the variability through time of the Mean Sea Level (NMM), in the first instance until completing a nodal cycle (18.6 years), mainly in Maxwell Bay near the Artigas Scientific Antarctic Base (BCAA). The data obtained will allow to know the tidal regime in the area, help in the prediction and publication of the tide table for the BCAA, contribute to the historical database of mean sea level, and support logistic activities related to the coastline.

Extreme Environments in Planetary Exploration: geolipids, stable isotopes and associated mineralogy on King George Island.

Responsible: PhD. Daniel Carrizo
Institution: INTA-CSIC
Contact: carrizodan@gmail.com

The ExoMars mission is scheduled for March 2022 with the main objective of detecting possible evidence of past or present life on Mars and knowing the geological history of water on the red planet (ESA, 2013). Collecting the most valuable samples on Mars requires the ability to recognize the traces of habitability, their modifications over time, their significance and their preservation potential. A current and innovative approach to detecting past biological activity is the use of molecular markers as proxies. Molecular biomarkers are natural products that can be assigned to a particular origin, the most useful being organic compounds with high taxonomic specificity (limited number of sources and well defined) and high conservation potential (recalcitrant against

geochemical changes). The structural and isotopic information in biomarkers allows them to be distinguished from abiogenic organic compounds, thus constituting an important tool in the search for extraterrestrial life. The main objective of this project is to characterize geochemically (biomarkers, isotopes and minerals) extreme environments present in King George Island and to use them in space research activities. The data set generated will be used to expand the spectrum library and validate the data obtained by Raman instrument from the rover vehicle of ESA's ExoMars 2022 mission.

LIFE SCIENCES

AntarPLAST: Plastic and microplastic waste in marine and coastal areas of Fildes Peninsula, King George Island (Antarctica).

Responsibles: PhD. Juan Pablo Lozoya - PhD. Franco Teixeira de Mello
Institution: Centro Universitario Regional del Este (CURE)
Contact: jplozoya@gmail.com; frantei@fcien.edu.uy

Since the late 1980s, plastic waste has been identified as hazardous materials and a threat to the coasts and seas where it tends to accumulate. Constituting 80% of marine litter, plastic waste is transported long distances by ocean currents, trapped in ocean currents, stranded on beaches and/or degraded into micro (and nano) plastics. This accumulation of plastic waste is beginning to alter the physical, chemical and ecological functioning of marine and coastal ecosystems around the planet. While this pollution is a global threat, very little is known about the distribution and sources of plastics and microplastics in the polar regions, including Antarctica, which does not escape this problem. Although not a significant source of plastics, these residues (macro- and microplastics) are accumulating along Antarctic coastal marine ecosystems, becoming a significant threat to their fragile biota and ecosystems.
Within the framework of this project we will generate an integral diagnosis (for a future monitoring program) of plastic and microplastic residues in Antarctic marine-coastal areas, focusing on the Fildes Peninsula but extending the study radius to other islands of the South

Shetland and Antarctic Peninsula in coordination with other Antarctic Programs. To this end, the presence of these residues will be evaluated on beaches and rocky coasts, in surface marine waters, and on the seabed. We will also analyze the terrestrial contribution of these residues through the glacier melting ravines, as well as the consumption of microplastics by zooplankton and seabirds, as well as the composition and concentrations of contaminants in the plastic residues found. In this way, from the data of occurrence, abundance and distribution of macro and microplastics, their possible sources, and their interactions and consequences with marine and terrestrial biota, we will know the current levels of this contamination in our study area. Through the generation of this new baseline information we seek to contribute to the objectives and challenges that the Antarctic Treaty System currently faces due to this 'common global evil'.

Effects of the Collins Glacier melting on the Antarctic marine coastal ecosystem.

Responsible: PhD. Natalia Venturini

Institution: Facultad de Ciencias

Contact: rulo@fcien.edu.uy

The increase in freshwater intake due to glacial melting is a consequence of Climate Change and the reduction in ice cover on the Antarctic Peninsula in recent decades. Increased freshwater discharge increases the stratification and turbidity of Antarctic coastal marine waters, as well as the transport of sediment and organic matter from land to sea. Marine organic matter represents a protein-rich food source for marine consumers, while terrestrial organic matter has a low food value. The quantity and quality of organic matter available to marine consumers is controlled by various environmental and biological factors that act both locally and regionally, and are also dependent in the long term on global processes such as Climate Change. Therefore, in a scenario of continuous glacial melting, a decrease in the quality of food available to marine consumers in Antarctic coastal waters is possible. It is necessary to first understand the local scale variability in the composition of organic matter

(terrestrial vs. marine) and its potential ecological and functional consequences in Antarctic coastal marine ecosystems as an input to reach a perspective of future regional and global patterns. The main objectives of this work are (i) to characterize the quantity and composition of organic matter exported by melting the Collins Glacier towards the adjacent marine environment (both through surface runoff and ice block detachments); (ii) to establish its influence on the quality and availability of food for marine consumers (zooplankton, macro and meiofauna); and (iii) the effects on the ecological and functional structure of these communities.

Evaluation of the structure of the sound landscape and the incidence of anthropogenic noise on Ardley Island (Maxwell Bay).

Responsible: PhD. Lucía Ziegler
Institution: Centro Universitario Regional del Este (CURE)

Contact: lucia.ziegler@gmail.com

It is very well reported in the literature that anthropogenic sounds present diverse threats to the species, mainly due to the disruptive effect on their communication systems that in turn affect social interactions, reproduction and care of offspring, feeding, among others. Recent research shows that the responses of organisms begin to manifest at sound levels that humans consider comfortable. In addition, many systems that seem to have little alteration present significant anthropogenic background noise profiles. In this context, this project proposes to focus on carrying out a baseline of the spatial and temporal extension of anthropogenic sounds and associated noise levels in the Fildes Peninsula (King George Island), with projection to an acoustic monitoring system in this Antarctic island. A second objective focuses on exploring the potential effect of noise generated by human activities on local biological communities. This project aims to obtain quality information that contributes to understanding the magnitude and severity of noise impacts, broadening the taxonomic, geographic and ecosystem range of which information is currently available. On the other hand, the spectrum of scientific information generated in Antarctica will be amplified, with an important potential to improve the management of human activity in

that continent.

Production of polymers from Antarctic microorganisms.

Responsibles: MSc. Laura Camesasca - PhD. María Eugenia Vila
Institution: Facultad de Ingeniería
Contact: lcamesas@fing.edu.uy; mvila@fing.edu.uy

In recent years, awareness of pollution caused by plastics has led researchers to focus on biomaterials that are more environmentally friendly. Polylactic acid (PLA), a biopolymer obtained by polymerising lactic acid units, has become one of the most studied and promising options to replace plastic, compared to other bioplastics such as PHB (polyhydroxybutyrate) or PBS (polybutylene succinate). PLA is the only bioplastic produced on an industrial scale, as it is much cheaper to produce than the other biopolymers mentioned above. However, what makes this polymer really interesting is the possibility of being completely degraded under composting conditions, or converted to its monomer for reuse. The current techniques of polymerization of lactic acid to give PLA, require the use of solvents, high temperatures and organometallic catalysts that result in the generation of chemical effluents, not very friendly with the environment. For this reason, the possibility of using enzymes for the polymerization of LA to PLA could result in a more environmentally friendly option, avoiding the generation of toxic residues.
Lipases from Antarctic microorganisms can maintain high levels of enzymatic activity at low temperatures. This feature would reduce or even avoid the generation of toxic residues on the polymer, as well as reduce the amount of chemical effluents and avoid the use of excessive amounts of energy. The general objective of this proposal is to select and obtain lipases from Antarctic microorganisms, capable of polymerizing LA in the production of PLA biopolymer, as well as to contribute to the knowledge of Antarctic microbial populations and their potential biotechnological application.

Distribution, ecology and abundance of cetaceans in the Southern Ocean.

Responsibles: PhD. María Cecilia Passadore - PhD. Caterina Dimitriadis
Institution: Centro Universitario Regional del Este (CURE-UDELAR)
Contact: cecipass8@gmail.com

The Southern Ocean is a highly productive ecosystem. Fundamentally in the summer months, in Antarctic waters the optimal conditions of light and nutrients are generated that allow to sustain a high concentration of primary producers. It promotes the development of primary consumers and organisms belonging to higher trophic levels including krill, seabirds, pinnipeds and cetaceans. Like other top predators, cetaceans play a key role in Antarctic ecosystems by structuring communities. Several species of cetaceans, particularly whales, migrate to polar waters during the summer months to feed in their productive waters. The distribution of different cetacean species and their use of Antarctic waters will be influenced by a combination of their evolutionary history, resource requirements, intra- and inter-specific interactions and environmental conditions, as well as by disturbances that may occur through human actions (e.g., Antarctic tourism, krill fishing, pollution). In turn, there is empirical evidence showing how variation in productivity affects marine mammal communities, and its importance in assessing the effects of climate change. It is hypothesized that changes in climate would have an important effect on marine productivity and on the structure of communities belonging to low, medium and high trophic levels. Understanding the distribution patterns of species and identifying their drivers, as well as knowing their density and abundance patterns and how they vary over time, is therefore essential to understanding the effects of climate change on the Antarctic ecosystem and informing spatial conservation planning.

This project aims to contribute to a broader understanding of the basic patterns of diversity, distribution, ecology and abundance of cetaceans in Antarctic waters. Data for this project will be obtained from sightings of cetaceans recorded aboard opportunity platforms, i.e., boats sailing in Antarctic waters. The study area will include the proximities of the Antarctic Peninsula, mainly the areas of the Bransfield Straits, Gerlache

and the area to the east of that peninsula. Using a cluster modeling approach, which combines different species distribution modeling methods, the distribution patterns of cetaceans in relation to environmental variables in the Southern Ocean will be investigated. At the same time, estimates of density and abundance of cetaceans in different areas of Antarctica will be carried out, depending on the available logistics. Finally, synergies will be generated with other international projects in order to contribute with population studies of cetacean species found in Antarctic waters through sampling (photo-identification and collection of biopsies) at points of opportunity. It is expected that the results generated throughout this project will contribute to the monitoring of the different populations of cetaceans, improving the understanding of the effects of climate change on cetacean communities in particular, and the Antarctic ecosystem in general. Finally, it is intended to contribute useful information for the prioritization of spatial conservation in Antarctica.

Multi-compartmental study of persistent organic pollutants in Fildes Peninsula, King George Island, Antarctica.

Responsibles: PhD. Andrés Pérez - PhD. Franco Teixeira de Mello - Lic. Germán Azcune

Institution: Facultad de Ciencias - CURE - DINAMA

Contact:aperez@cure.edu.uy;frantei@fcien.edu.uy; german.azcune@gmail.com

Persistent organic pollutants are man-made toxic substances and, as their name implies, they are persistent because they are difficult to degrade. This characteristic makes them a group of pollutants of international interest due to the impact they have on the environment. Their persistence and toxicity added to the fact that they are transported globally mainly by atmospheric and maritime means that they are present in systems or regions that are very isolated geographically, such as Antarctica. In this context, this project proposes to study the transport and destination of several organic pollutants of international priority in the Antarctic continent. The objective of the proposal is to know and characterize the main persistent organic

compounds and their concentrations in different environmental compartments (air, lagoon sediments, marine sediments, sea water and snow) and plastic residues that are originated and/or transported to Fildes Peninsula on King George Island in Antarctica. The aim is to establish current levels as a baseline for the generation of a monitoring program to study the evolution of this type of pollutants in Antarctica.

New strategies for the control of the non-native diptera Trichocera (Saltrichocera) maculipennis Meigen, 1818 (Diptera: Trichoceridae) at the Antarctic bases of King George Island and its surroundings.

Responsibles: PhD. Enrique Morelli - PhD. Mónica Remedios-De León
Institution: Facultad de Ciencias
Contact: emorelli@fcien.edu.uy; mremedios@fcien.edu.uy

In recent years the presence of non-native species has been recorded in Antarctica, *Trichocera maculipennis* being one of them. This insect belongs to the non-native Diptera Order of Antarctic ecosystems, and its presence has been documented in that continent since 2013. Its biology, physiology, adaptation to the cold environment and the observation of adult specimens since 2006 in different bases suggest an apparent successful adaptation in the natural Antarctic environment. However, in accordance with Antarctic policies it is necessary to make the greatest effort to eradicate or control the populations of non-native organisms in the area. In view of this situation, this project proposes providing useful information for the eradication and/or control of this invasive species in the Antarctic ecosystem. The objectives are: continuous monitoring of *T. maculipennis* in the BCAA; description of the life cycle of *Trichocera maculipennis* under controlled laboratory conditions for the BCAA; analyze the possible existence of morphological heteromorphisms in the populations of *Trichocera maculipennis* on King George Island, using geometric morphometry; estimate the genetic diversity of *Trichocera maculipennis* in the populations of King George Island.

SOCIAL AND HUMAN SCIENCES

Strategies of human occupation of King George Island during the 19th century and first half of the 20th century.

Responsible: Msc. Diego Aguirrezábal
Institution: Laboratorio de Arqueología del Paisaje y Patrimonio del Uruguay, Facultad de Humanidades y Ciencias de la Educación, Universidad de la República
Contact: diego.aguirrezabal@lappu.edu.uy

There are several documents that demonstrate the strong impact of extractive activities by human groups during the nineteenth and early twentieth centuries in the South Shetland Islands. Since the first recorded sighting by the English Captain William Smith in 1819, the abundance of sea lions and whales attracted various crews that generated a rapid reduction in the number of species in the area. In this sense, the project seeks to understand the processes of exploration and human colonization in the Fildes Peninsula during the 19th and early 20th centuries. Taking as a reference the archaeological antecedents on sites of 19th century fishing and whaling camps in other islands of the archipelago, and incorporating new methodologies and techniques of approach, we will try to interpret the processes of adaptation and subsistence that can be observed in the archaeological sites in the peninsula. In this sense, the different occupation strategies of the Fildes Peninsula will be analyzed, seeking to know the different uses of space, the specific social activities linked to these camps, whether these strategies are opportunistic or specialized and to discuss, based on the elaboration of chronological models, the possible variations of these occupation processes within the selected period. The importance of the Fildes Peninsula as a strategic place for the establishment of fishing and whaling camps during the 19th century will be analyzed.

ENVIRONMENTAL MONITORING

Penguins as sentinels of anthropic impact and climate change in the Antarctic ecosystem.

Responsible: Lic. Ana Laura Machado
Institution: IAU - Museo Nacional de Historia Natural-CSIC (España) - Instituto de Ecología (Universidad de Jena, Alemania)
Contact: almachado90@gmail.com

Penguins are considered sentinels of the marine environment, since due to their status as top predator, they are capable of rapidly reflecting environmental changes in the marine environment. The rapid global warming observed in the Antarctic Peninsula region, the greater inter-annual variability in the concentration and extent of sea ice and the reduction in the abundance of Antarctic krill (Euphausia superba), have resulted in significant changes in population trends of penguins of the genus Pygoscelis. Ardley Island, southeast of Peninsula Fildes, on King George Island, is a Specially Protected Antarctic Area (ZAEP No. 150) and one of the few areas in Antarctica where three species of penguins of this genus reproduce sympatrically. Particularly on this island, there has been a 90% decrease in the number of breeding pairs of Adelie and Barbijo penguins, while Papua has increased by almost 80% since the 1980s. On the other hand, Peninsula Fildes represents an important logistic centre for the South Shetland Islands and the Antarctic Peninsula, being the area with the highest density of scientific stations and refuges in Antarctica, and a high level of navigation activity in its surroundings. In this context, these penguin colonies can be used as sentinels to understand the effects of different sources of anthropogenic pressure, such as tourism or fishing and climate change, in an area heavily subjected to these pressures.

Monitoring and control of a non-native diptera in the BCAA and its zone of influence.

Responsible: Tec. Eduardo Juri
Institution: Instituto Antártico Uruguayo
Contact:cientifica.ambiente@iau.gub.uy

Biological invasions are produced by non-native species and are one of the most important threats to biodiversity worldwide, threatening the survival of native species and responsible for major changes in ecosystem structure and functioning. In Antarctica, despite the isolation and harsh climatic conditions, the spread of non-native species also occurs. Particularly on King George Island, a species of non-native diptera (Trichocera maculipennis) originating in the northern hemisphere has spread to most bases, including the Artigas Antarctic Science Base. This activity aims to better understand the life cycle of the species for information on which are the critical sites and moments in which it is best to implement control measures to prevent its growth and dispersion. At the same time, work will be done to generate new control measures that are compatible with the environmental regulations that govern Antarctica.