

**Oceans
Past IX**

INTERNATIONAL CONFERENCE

**Historical Perspectives on Marine Ecosystems, Fisheries,
and Futures**

BOOK OF ABSTRACTS

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Day 1. Monday 22 June

[ESSAS] indicates presentations submitted by registrants of the Ecosystem Studies of Subarctic and Arctic Seas Annual Science Meeting, “Bridging the past and present to manage the future of northern fisheries and ecosystems”.

KEYNOTE: Mesopelagic fish size response to Pleistocene climatic variability

Konstantina Agiadi^{1*}, Frédéric Quillévéré², Rafal Nawrot¹, Theo Sommeville^{1,3}, Marta Coll⁴, Efterpi Koskeridou⁵, Jan Fietzke⁶, Martin Zuschin¹

¹ Department of Palaeontology, University of Vienna, Althanstrasse 14, Geozentrum, UZA II, 1090, Vienna, Austria; ² Université Claude Bernard Lyon 1, ENS de Lyon, CNRS, UMR 5276 LGL-TPE, F-69622 Villeurbanne, France; ³ IMBRSea Program, Ghent University - Marine Biology Research Group, Krijgslaan 281/S8 - 9000 Ghent, Belgium; ⁴ Institute of Marine Sciences (ICM-CSIC), Passeig Marítim de la Barceloneta 37-49, 08003, Barcelona, Spain; ⁵ Department of Historical Geology and Paleontology, National and Kapodistrian University of Athens, Panepistimioupolis 15784, Athens, Greece; ⁶ GEOMAR, Helmholtz Centre for Ocean Research Kiel, Wischhofstrasse 1-3, 24148 Kiel, Germany

Contact: konstantina.agiadi@univie.ac.at

Body size is a very important biological trait of fishes, which controls the structure and functioning of marine ecosystems, and it is strongly affected by the temperature of the water in which the fish lives. However, evaluating and predicting the effect of climate change on the size structure of modern fish assemblages is challenging, because it is difficult to disentangle from the impacts of other anthropogenic stressors like size-selective harvesting. Furthermore, mesopelagic fishes are an important element of marine food webs, but the impact of climatic variability on their body size is hampered by the lack of long-term monitoring data. In this study, turning to the fossil otolith record, we investigated the impact of climate warming ~750 ka ago on mesopelagic fish size in the eastern Mediterranean Sea. Particularly, we focused on the MIS 20–18 glacial–interglacial–glacial transition of the Middle Pleistocene, which included a 4°C increase of global seawater temperature equal to that predicted by the IPCC high-emissions scenario. Although, overall mesopelagic fish median size decreased from the MIS 20 glacial to the MIS 19 interglacial, the trends of the individual species were different and often opposing.

The Demise of the Atlantic Grey Whale

Youri van den Hurk¹, Matthew Collins^{2,3}, Marie-Josée Nadeau⁴, and James H. Barrett¹

¹ Department of Archaeology and Cultural History, NTNU University Museum, 7491 Trondheim, Norway; ² McDonald Institute for Archaeological Research, University of Cambridge, Cambridge, UK; ³ Section for Evolutionary Genetics, GLOBE Institute, University of

Copenhagen, Copenhagen, Denmark; ⁴ National Laboratory for Age Determination, NTNU University Museum, 7491, Trondheim, Norway

Contact: yourivandenhurk@gmail.com

The grey whale (*Eschrichtius robustus*) is a baleen whale species currently confined to the northern Pacific Ocean. Palaeontological and archaeological bone remains have however determined that the species was also present in the Atlantic Ocean. The spatiotemporal range of this Atlantic population is poorly known. During the medieval period a number of cultures, including the Basques, Normans, Norse, Flemish, and Portuguese, performed whaling. Coincidentally the species is assumed to have disappeared during or right after the medieval period, raising the possibility that anthropogenic pressure played a role in the extirpation event. Through an interdisciplinary approach, combining zooarchaeological, historical and biomolecular analyses, the demise of the Atlantic grey whale will be reconstructed. A large number of palaeontological and archaeological whale bone samples were analysed using Zooarchaeology by Mass-Spectrometry (ZooMS) in order to assess the spatiotemporal range of the species. Several selected grey whale specimens were subsequently dated using radiocarbon-dating. Future analyses will employ stable isotopes and ancient DNA. An optimized understanding of the extirpation of the grey whale from the North Atlantic is more vital than ever. This past summer a juvenile grey whale individual was sighted in the Mediterranean, possibly signalling a recolonization of the species in the Atlantic Ocean.

Devilfish Coast: Mapping the History of Gray Whales and People in the North Pacific

Jason Colby¹, Timothy Cunningham¹, Ryan Tucker Jones²

¹ *University of Victoria, Canada,* ² *University of Oregon, US*

Contact: jcolby@uvic.ca

This presentation will explore the near-extinction and extraordinary recovery of eastern Pacific gray whales from the mid-nineteenth to late-twentieth century. After US whalers discovered their calving lagoons in Baja California in the late 1840s, the population plummeted, and by the 1910s some experts declared the “California gray whale” extinct. Yet following World War II, amid booming commerce, naval traffic, oil spills, and other ecological stress, the population made an astonishing comeback. By the 1970s, migrating grays had become icons of the changing human relationship with cetaceans and assets in the transnational tourist economy. At the heart of this transformation were changes in cultural and spatial relations along the Pacific Coast. This presentation draws upon interdisciplinary research—including historical archives, oral history, marine biology, and historical ecology—to juxtapose human and gray whale history. Its centerpiece is an animated digital map that graphically visualizes the shifting relations of gray whales and people on the Pacific Coast since 1840.

Trapped in ambergris: can preservation of digestive tract metagenomes shed light on sperm whale health and symbionts?

Ruairidh Macleod^{1,2}, Ian Barnes³, Steve Rowland⁴, Morten Tange Olsen¹, Matthew James Collins^{1,2}

¹ GLOBE Institute, University of Copenhagen, Denmark; ² Department of Archaeology, University of Cambridge, UK; ³ Natural History Museum, London, UK; ⁴ Department of Chemistry, University of Plymouth, UK

Contact: r@palaeome.org

Ambergris is an enigmatic natural product only known to be produced in the colon of sperm whales (*Physeter macrocephalus*). Our initial results demonstrate ambergris preserves endogenous sperm whale DNA¹ due to the unique chemical properties of ambergris (resistant to seawater, microbial and photo- degradation for up to millennia²). Our unpublished findings indicate DNA preservation from whale prey (cephalopods), parasitic nematodes (*Anisakis physteris*) and prokaryota from the whale gut microbiome. Commercial whaling of sperm whales in the 18th-20th Centuries decimated populations and likely produced a major bottleneck effect on intraspecific diversity (though lack of samples prevents a detailed assessment of impacts of whaling, beyond population declines). Understanding past diversity and ecology through population genomics and metagenomics of gut microbiomes is important for assessments of population health and recovery. The gut microbiome plays a vital mutualistic role in the metabolic health of the host, and knowledge of past microbial diversity may contribute to understanding the legacy of population bottlenecks on whale health. Efforts to successfully rejuvenate whale populations would also benefit from a fuller understanding of the effects of the population bottleneck of whaling for gauging population monitoring. We hope our further research into DNA extracted from ambergris will contribute to this.

[ESSAS] KEYNOTE: Taking the long view: Integrating marine historical ecology and natural resource management in the Gulf of Alaska

Catherine West

Department of Anthropology and Archaeology Program, Boston University.

Contact: cwest@bu.edu

Natural resources across the Gulf of Alaska are under threat from climate change, invasive species introductions, coastal erosion, and other hazards. In the face of such change, resource managers in this region are increasingly looking to Indigenous knowledge, historical archives, and archaeological and paleoenvironmental data to understand long-term variability in ecosystems and human-animal interactions. Drawing on examples from migratory bird rehabilitation, invasive species eradication, and fisheries management in a marine historical

ecology framework, this paper addresses how such interdisciplinary, collaborative work might inform management by: a) constructing a common vocabulary; b) integrating across time scales; and c) establishing common goals based in management concerns.

[ESSAS] Fish otoliths from medieval archaeological excavations provide exploitation effect baselines

Torstein Pedersen¹, Colin Amundsen², Stephen Wickler³

¹ *Department of Arctic and Marine Biology, UiT The Arctic University of Norway Tromsø, Norway,* ² *Museum of Archaeology, University of Stavanger, Peder Klows gate 30 A, 4010 Stavanger, Norway,* ³ *Tromsø University Museum, N-9037 Tromsø, Norway*

Contact: Torstein.Pedersen@uit.no

We compared stock origin, size, age and growth rates from archaeological excavation at two sites in northern Norway to those of cod catches from the early and late part of the 20th century. Samples of well-preserved cod otoliths were available from excavations at Storvågan in Lofoten (68° 12'N) (A.D. 1156-1285) close to the present major spawning grounds of Northeast Arctic and another sample from ca. AD 1450- 1680 from Værbukta (70° 57' N). For comparison, modern otoliths were sampled from areas situated close to Storvågan and Værbukta. Zone numbers and increments (mm) were calculated from images of the cut otoliths and stock origin Northeast arctic cod (NAC) or coastal cod (CC) were determined. Fish lengths-at-age from pre-20th century samples were back-calculated from zone increments and nonlinear relationships between fish length and otolith size from modern cod.

The pre-20th century cod from Storvågan was dominated by NAC (mean age = 12.0 years, mean length = 82.9 cm) of age 9-16 years and were much older and larger than the early cod from Værbukta which were dominated by CC of age 2-6 years (mean age = 4.4 years, mean length = 53.4 cm). Pre-20th century cod from Storvågan had shorter back-calculated length-at-age than modern cod from Lofoten, indicating slower individual growth than in modern NAC. In contrast, cod from Værbukta had similar length at age as in modern samples. Age-distributions from pre-20th century from Storvågan cod and from the 1930s from Lofoten, suggests that both age at maturity and mortality rates were similar for these time periods, but strongly contrast the truncated and young age-distributions of spawning NAC after 1980 that reflect the high fishing mortality rate after 1950 and decrease in median maturation age to approximately 7 years.

[ESSAS] Time Trawlers: An archaeological examination of the fishing station at Smuttynose Island and its implications for the ecosystem of the Isles of Shoals and the Gulf of Maine

Megan R Victor

Anthropology Department, Queens College, CUNY.

Contact: megan.victor@qc.cuny.edu

Humans have indeed engaged with marine ecosystems for subsistence, transportation, and profit. During the seventh century and eighteenth centuries, when ‘cod was king,’ the codfish trade in the North Atlantic interwove skilled knowledge of the local marine ecosystem, international trade with its promises of sustenance and luxury, and the particular pressures of the frontier to produce a unique tableau of information. Through community-based, collaborative archaeology, these intricate threads of data can be teased apart, as was done at the site featured in this paper: the former fishing settlement on Smuttynose Island in the Isles of Shoals, off of the Maine /New Hampshire border (1623-1780). The team conducted the excavations through the Shoals Marine Laboratory in partnership with the community-based Smuttynose Island Stewardship Program. During the course of the project, which ran from 2009 to 2012, the team examined climate change at Shoals, with a careful eye toward current conditions, while also noting changes in the codfish populations and the larger ecosystem, including invasive species. Although rather isolated, the project found ways to record, excavate, and preserve this archaeological site *with* input from the community whose heritage was most tied to it. The historical and ecological impact of the fishermen at the Isles are inextricably entwined; by including the local and descendant communities in the examination and preservation of the site, they are actively connected to its future – and the larger future of the Gulf of Maine.

[ESSAS / OPI] Was there a Pleistocene North Pacific fishery? The evidence for boat use, maritime subsistence, and subarctic settlement around the North Pacific Rim.

Ben Fitzhugh

Department of Anthropology, University of Washington, Seattle, WA, USA

Contact: fitzhugh@uw.edu

This talk reviews the available evidence for maritime adaptations around the coasts of Northeast Asia from 40,000 years ago to the end of the last Ice Age. Drawing on the archaeological records of Northeast Asia and recent genetic and palaeoceanographic discoveries, I examine the probability of cryptic Maritime Beringian occupation in the Late Glacial Maximum (LGM) – whether it could have been a continuation of earlier more temperate and subtropical coastal adaptations or where it could have formed, if not. Recent evidence suggests the LGM North Pacific climate was milder in both winter and summer than the continental interiors of Beringia, making it plausible for maritime communities to form in areas of above average productivity such as the now submerged Pacific coasts of Hokkaido, Kamchatka and the north shore of the Alaska Peninsula/eastern Aleutians. With circumstantial evidence leaning heavily on the side of a coastal route for post-glacial settlement of the Americas, the question is no longer whether or not a Maritime Beringian population existed in the LGM but how people crossed the Bering Land Bridge, and – if by boat – how they manufactured their watercraft in a Beringian environment lacking abundant

live trees. Future work - including by members of the PESAS WG - could focus on: improved physical models of the Northeast Asian/Beringian paleoshorelines and ocean dynamics to refine predictions on likely places to prospect for submerged evidence; marine coring of submerged but protected paleolakes, ponds and lagoons in those locations in search of evidence of human presence in the most likely productive “hotspots” for maritime settlement (e.g., sterols, sedDNA, etc.); and refinement of submarine archaeological techniques to survey those locations for positive archaeological evidence.

[ESSAS] Historical and contemporary concerns about the consistency of Atlantic cod ecotypes around Iceland.

Guðbjörg Ásta Ólafsdóttir

University of Iceland, Research Centre of the Westfjords, Hafnargata 9b, 415 Bolungarvik, Iceland.

Contact: gaol@hi.is

Atlantic cod is a keystone species that remains among the most economically important demersal fish in the North Atlantic despite severe stock depletion resulting from overexploitation. Throughout its distributional range Atlantic cod is composed of populations or ecotypes that vary across environmental gradients, such as temperature or salinity, across geographical regions and in phenotypic traits, importantly, in migratory propensity. This variation has repeatedly been linked to genetic divergence on several genomic inversions or “supergenes”. The origin of these supergenes is ancient and variation in cod migratory behavior has been noted throughout historical times. This life-history variation is likely to have contributed to the relative resilience of Atlantic cod to environmental change and exploitation. In the sub-arctic North Atlantic cod ecotypes exhibiting longer foraging migration and preferentially seeking cooler temperatures, or migratory cod, are present both around Iceland and Norway. Icelandic migratory cod seek cooler arctic waters for feeding but they are currently dependent on warmer nearshore waters for spawning, transport of eggs and larvae and, critically, growth at nursery grounds. Here, data on the consistency, growth, foraging ecology and movement of Atlantic cod ecotypes in Icelandic waters in historical times will be presented and discussed in the context of how current anthropogenic stressors may differently affect the ecotypes, specifically at early life-stages.

Estimating ocean temperature trajectories from ancient Indigenous fishery catch records: an archaeological case study from the northeast Pacific

Iain McKechnie¹, Dylan Hillis¹, Robert Gustas¹, Daniel Pauly², William Cheung², Anne Salomon³

¹ *Historical Ecology and Coastal Archaeology Laboratory, Department of Anthropology, University of Victoria, Canada,* ² *Institute for the Oceans and Fisheries, University of British*

Columbia, Canada, ³ School of Resource and Environmental Management, Simon Fraser University, Canada

Contact: iim@uvic.ca

Climate change is altering the distribution and composition of marine fish populations globally but comparatively little is known about preindustrial fisheries with respect to climatic variability. Here, we develop and extend the Mean Temperature of the Catch approach (Cheung et al. 2013) to ancient Indigenous fisheries catch records at two coastal archaeological sites on western Vancouver Island, Canada. We devised an analytical process that calculates 'ancient Mean Temperature of the Catch' (aMTC) from zooarchaeological data, temperature preferences, and proportional biomass estimates. We observe an increase in aMTC over a 5,000-year period at two contemporaneously occupied archaeological sites with comparatively cooler catches from 5,000-3,000 cal yr BP and warmer catches during 1,800-250 cal yr BP. These are consistent with palaeoceanographic sea surface temperature reconstructions from sediment cores off British Columbia and in the Gulf of Alaska. Because this method requires converting measures of fish bones into estimates of fish size structure, abundance, biomass, and finally aMTC, opportunities exist to account for both variation and uncertainty at every step. Nevertheless, given that preindustrial fisheries data are ubiquitous in coastal archaeological sites, this method has the potential to be applied globally to broaden the temporal and geographic scale of ocean temperature baselines.

Using ancient DNA to uncover the history of Atlantic herring exploitation and its impact on herring evolution and demography

Lane M. Atmore¹, Carl André², Inge van der Jagt³, Daniel Makowiecki⁴, Pernille Bangsgaard⁵, Rachel Bleviss⁶, Lembi Lõugas⁷, James H. Barrett⁸, Bastiaan Star¹

¹ Department of Biosciences, Centre for Ecological and Evolutionary Synthesis, University of Oslo, Oslo, Norway; ² Department of Marine Sciences, University of Gothenburg, Gothenburg, Sweden; ³ Cultural Heritage Agency of the Netherlands, Amersfoort, Netherlands; ⁴ Department of Archaeology, Nicolaus Copernicus University, Toruń, Poland; ⁵ Globe Institute, University of Copenhagen, Copenhagen, Denmark; ⁶ Department of Archaeology, University of Cambridge, Cambridge, UK; ⁷ Archaeological Research Collection, Tallinn University, Tallinn, Estonia; ⁸ Department of Archaeology and Cultural History, Norwegian University of Science and Technology (NTNU), Trondheim, Norway

Contact: lane@palaeome.org

Atlantic herring has long been an important commercial species in Europe, facilitating the development of modern commercial trade networks and the rise of some European states. Today, the herring industry is still crucial for the economic wellbeing of many regions, with the Norwegian spring-spawning herring industry ranking as the 4th largest fishery in the world. Despite their large numbers, herring stocks have collapsed multiple times in the 20th century due to overexploitation, prompting extensive research into modern herring ecology. Yet, the long-term impact the industry has had on this species is still poorly understood. We have

sequenced whole-genome ancient DNA from Atlantic herring bones found in archaeological sites around Europe, providing the first comprehensive ancient genomic database for Atlantic herring. Using these data, we analyze the advent of the herring industry in Europe. We use novel software programs to explore trade route development over time and model past demography to assess the potential anthropogenic impact on this species. We incorporate archaeological, ecological, and historical evidence to contextualize the genomic analysis. Finally, we place these results in the context of 20th century stock collapses and current management policies for various herring stocks in the Atlantic Ocean and Baltic Sea.

Global Leviathan Database - extractions through the modern and early modern periods

John Nicholls¹, Laoise Dillon¹, Matthew Ayre²

¹*Trinity College Dublin, Ireland;* ²*Arctic Institute of North America, Canada*

Contact: johnnicholls1963@gmail.com

Compiling a novel database of global exploitation of whales is necessarily a compound task that draws heavily on many different resources, and unavoidably deploys many varied methodologies. In conjunction with partners who are experts in the field of whaling data collection, and from ground-breaking new information developed through dedicated research, a once fuzzy vision of what might have been comes into focus and enables scientific and academic assessments to be applied. Existing data, such as the American Offshore Whaling project's outputs, and the developing British Arctic Whaling project, along with various other data sources, are being transformed into a single entity that will provide a universal portal for global insights. Adopting the Darwin Core data management standard and compiling the data in line with accepted Big Data norms will result in a database that provides - thus far - unavailable outputs that may be adapted to individual and group research in the public domain, affording the opportunity to assess the global impacts of humanity's manipulation of the oceans and its largest marine mammals.

Portuguese whaling history: a digital data management journey

Nina Vieira¹, Cristina Brito¹, Laoise Dillon², John Nicholls²

¹*CHAM-Centre for the Humanities, NOVA FCSH, Portugal;* ²*Trinity College Dublin, Ireland*

Contact: ninavieira@fcsb.unl.pt

The 4-Oceans project seeks to locate and quantify the extent of global marine exploitation over two millennia. As an element of the project, we incorporate diverse historical evidence to examine the 'whale fishery' in early modern Brazil which operated under a Portuguese royal monopoly from 1614 to 1801. Baleen whales, primarily Southern Right Whales (*Eubalaena australis*) and Humpback Whales (*Megaptera novaeangliae*) were taken along

coastal Brazil, and for a short period Sperm Whales (*Physeter macrocephalus*) were targeted out to sea. Oil and baleen were shipped to Lisbon, providing contextual evidence and quantified data that informs the numbers that were taken. The information, focused on the period 1765-1776, is sporadic with some erratic occurrences recorded both earlier and later. Based on archival documents that have been transcribed and digitised, a combination of raw data ranging from weights to monetary values, as well as anecdotal and purely qualitative commentary emerged. We will trace the largely qualitative data as they are processed and converted to formats available for publication and dissemination. By standardising historical data, qualitative information that was formerly unrepresented can progress the project's primary research motivations and inform and inspire the global research community.

A high-resolution historical faunal archive from British Arctic whaling logbooks

Matthew Ayre¹, John Nicholls², Laoise Dillon²

¹*Arctic Institute of North America, Calgary, Canada*, ²*Trinity College Dublin, Ireland*

Contact: matthew.ayre@ucalgary.ca

The British Arctic whaling trade persisted from the very first voyages of commercial discovery seeking to exploit the mercantile value of the Arctic's largest cetacean, *Balaena mysticetus* – the Bowhead whale. From the 17th Century through to the industry's cessation at the beginning of the Great War, the trade was lighting and lubricating the advance of Britain and Europe's industrial revolution. Despite the boom-and-bust nature of the trade, Arctic whaling effort once employed ships from every major port in the British Isles. The devastating effect on the populations of bowhead whales can still be seen today and historical customs records detailing tonnes of oil harvested are testament to the size of pre-exploited populations. The extant logbooks and journals from these largely independent voyages, though few in number, survive for the majority of the 19th Century. They provide a unique and detailed window into the size and location of whales harvested, the environmental conditions encountered, and observations of other passing or harvested fauna. Through the mining of these daily observations, a high resolution spatial and temporal dataset of faunal observations can be created with which to evaluate the long-term impacts from commercial whaling pressures set in the context of current population distributions.

Whales at the Ends of Worlds

Dr Sophia Nicolov

Independent scholar, UK

Contact: sophianicolov@gmail.com

In 2015 a team of researchers studying marine invertebrates stumbled across the largest baleen whale mass stranding recorded. Over 300 sei whales were discovered on the coasts of Chile's remote southern Patagonian fjords. Across international media it was rendered an apocalyptic manifestation of anthropogenic induced degradation. Interdisciplinary investigations revealed that the whales were killed by the infamous 'red tide', a globally recurring phenomenon of marine toxic algae blooms. This mass stranding was framed by many as a narrative about ecological disaster. This recent mortality event is worth considering together with another mass stranding preserved in the fossil record. In 2011, a fossil graveyard with over 40 long-extinct baleen whales that had died several millions years ago was unearthed in the Atacama Desert in Northern Chile, during the expansion of the Pan-American Highway. Zooarchaeologists excavated the site, *Cerro Ballena* (Whale Hill), and investigations revealed that harmful algae blooms had similarly played a role. Approached together, the recent mass stranding and the ancient whale graveyard offer insights into fluctuations in and the temporal scales of our oceans and the planet. Moreover, they help us think through both real and narrative ends on human and planetary scales, including apocalypse, extinction and deep time.

Scrimshaw: unlocking the cultural and biological archive of sea mammal art

Laura Courto

University of Cambridge, United Kingdom

Contact: lec71@cam.ac.uk

During the 19th century a folk-art tradition—scrimshaw—using the teeth of sperm whales (*Physeter macrocephalus*) flourished among the crews of industrial whaling ships. It is best known from New England whalers, but a London-based South Sea sperm whale industry resulted in many objects incorporating recognizably British motifs. An important selection is now held by the Scott Polar Research Institute (SPRI), University of Cambridge, providing a unique pre-industrial biological archive of the cetacean population(s) exploited by whalers before the use of steamships and exploding harpoons. This research provides a case study demonstrating the interdisciplinary analysis of cultural/historical material through creating an artefact-based biological history of Britain's 19th century sperm whaling industry. The SPRI scrimshaw collection was first examined utilising micro-computed tomography (micro-CT), to both age whales based on growth-layer-groups (GLGs) and examine the internal morphology of the teeth to identify pieces for biomolecular sampling. Genetic analysis has the potential to evaluate the time-depth of the extremely low genetic heterogeneity of modern sperm whales and potentially aid in provenancing the scrimshaw pieces. This research is part of the SeaChanges Marie Skłodowska-Curie Innovative Training Network of Horizon 2020, which aims to address human impacts on European marine species through combined archaeological and biological research.

[ESSAS] Stakeholder perspectives on the response of the Barents Sea to multiple pressures

Benjamin Planque¹, Nina Mikkelsen^{1,2}

¹ IMR, Tromsø, Norway, ² Arthur Valance, Ifremer, Nantes, France

Contact: benjamin.planque@hi.no

Human activities, climate variability and change, and other drivers affect the structure and dynamics of the Barents Sea, as well as the ecosystem services it provides. Anticipating the combined effects of these multiple drivers is required to support management decisions, but stakeholder groups, managers and scientists may hold different points-of-view on the functioning of the Barents Sea and may therefore have distinct anticipations. This contribution explores how stakeholders can anticipate the consequences of changes in multiple drivers on the Barents Sea ecosystem and its associated services. The approach is based on a scoping exercise followed by qualitative modelling. The scoping exercise was conducted with six stakeholder groups representing different sectors (fishing, shipping, tourism, oil and gas) and interest (environmental protection), during a 2-day workshop and subsequent dialogues. From this, several hierarchical conceptual models of the Barents Sea were constructed. The conceptual models were then used to develop qualitative models that predict how different components of the Barents Sea may respond to changes in one or several driving forces. We applied selected scenarios of changes in human activities and changes in the biomass of animal groups to assess the effects of cumulative impacts. These modelling experiments were conducted on a synthesis model common to the stakeholder groups and on stakeholder-specific models. The model results indicate that cumulative impacts are mostly additive. The comparison of results across models reveals that the conclusions derived from the synthesis model are robust and reflect well the perspectives of the various stakeholders. This suggests that there exists a common understanding of the Barents Sea functioning across stakeholder groups and that, at least in some instances, a common representation of the system may be used to support ecosystem-based management.

[ESSAS] The next decade of ocean acidification research in the Bering Sea: what we've learned and what's coming next

Jessica N. Cross¹, Darren Pilcher^{2,1}, Hongjie Wang^{2,1}, Elizabeth Siddon³, Natalie Monacci⁴, W. Christopher Long⁵, Esther Kennedy⁶

¹ NOAA Pacific Marine Environmental Laboratory, Seattle, WA, USA, ² University of Washington Cooperative Institute for Climate, Oceans, and Ecosystem Science, Seattle, WA, USA, ³ NOAA Alaska Fisheries Science Center, Juneau, AK, USA, ⁴ University of Alaska Fairbanks Ocean Acidification Research Center, ⁵ NOAA Alaska Fisheries Science Center, Kodiak, AK, USA, ⁶ University of California, Davis, Davis, CA, USA

Contact: jessica.cross@noaa.gov

Over the last decade, ocean acidification (OA) has emerged as one of the most prominent issues in Alaskan marine research, and a possible threat to culturally and commercially important marine resources. Multiple communities around the state are now engaged in their

own OA studies and monitoring, and are asking a common question: what risks does my region face? These are especially salient questions for Alaskans because the intensity, duration and extent of OA events have been greater here than other ocean basins. Given the pace of the observed changes due to OA around Alaska, the area is commonly referred to as a bellwether and the proverbial “canary in the coal mine” for the rest of the global ocean. Here, we will take a look back at the last ten years of OA research in the Bering Sea, and highlight new, cutting-edge synthesis and biogeochemical modeling, forecasting, and projection efforts that have dramatically increased our capacity to understand Alaskan OA from a large-scale perspective. For example, multi-decadal projections provide spatio-temporal information for how OA conditions may evolve throughout the Bering Sea shelf and highlight key differences between climate emissions scenarios, providing a regional perspective for the impact of climate mitigation strategies. Meanwhile, near-term products provide fisheries stakeholders with updated environmental information for stock assessment and the fisheries management process. This effort recently culminated with the development of an indicator for the Eastern Bering Sea Ecosystem Status Report (ESR) and input into the Ecosystem and Socioeconomic Profiles (ESPs) for two crab stocks. Our vision is to continue developing and refining this approach and to expand available products to identify new risks and emerging resilience of Alaskan ecosystems. Ultimately, we hope these products guide sound, evidence-based decisions that support sustainable marine resource management for the largest U.S. fishery

[ESSAS] Climate change impacts on marine light in Arctic ecosystems

Trond Kristiansen^{1,2}, Øystein Varpe³, Benjamin J. Laurel⁴, Elizabeth Selig⁵, William J. Sydeman¹, Michaela I. Heggin⁶, Kenneth F. Drinkwater⁷, Phil Wallhead²

¹ Farallon Institute, Petaluma, USA, ² Norwegian Institute for Water Research, Oslo, Norway, ³ Department of Biological Sciences, University of Bergen, Bergen, Norway, ⁴ Alaska Fisheries Science Center, NOAA, Newport, USA, ⁵ Center for Ocean Solutions, Stanford University, Stanford, USA, ⁶ Department of Meteorology, University of Reading, Reading, UK, ⁷ Institute of Marine Research, Bergen, Norway

Contact: trondkr@faralloninstitute.org

Climate change will affect light across Arctic ecosystems, impacting productivity, phenology, and recruitment. We quantify seasonal variation in light in the water column in response to changes in sea ice and snow, storm-driven waves, cloud cover, ozone, and chlorophyll content, which change both absorption and reflection. Using CMIP6 inputs and a simplified radiative transfer model, we find that increased open water and ocean warming will lead to increases in both visible light (PAR) and UV light by 2100. These increases in PAR and UV light result in greater irradiance in the water column, and changes in productivity depending on species and life stage. These changes vary spatially and temporally across ecosystems, with greater light in the spring and summer for the Barents Sea and in the fall for the Chukchi Sea. Changes in the light regime in the Arctic will have major impacts on the survival and distribution of species like polar cod by affecting sea ice, temperature, and food availability. For example, a decrease in sea ice will result in less protection and lower survival rates for

eggs. Larval growth will be affected both by greater growth rates due to temperature, but potentially less available food due to changes in productivity. Together, these impacts will likely result in major changes to Arctic species and overall food-web structure.

Day 2: Thursday 23 June

KEYNOTE: Mapping the Environment and Economics of Ireland's Marine Fisheries, 1400 to 1600.

Patrick Hayes

Trinity College Dublin, Ireland

Contact: hayes.patrick6@gmail.com

This presentation uses material from my upcoming book, *Ireland's Sea Fisheries, 1400-1600 Economics and Ecology* (due to be published by Boydell and Brewer Press in autumn 2022), to spatially trace the rise and decline of Ireland's sea fisheries from 1400 to 1600. Using GIS techniques and historical cartography, this presentation explores how fisheries grew over the fifteenth century to become the largest export industry in Ireland at the time. Spatial data can show us the different areas and species targeted by Spanish, French, English, and Irish fishers along the coast. Historical maps also provide evidence for the types of boats, fishing gear and methods employed by this diverse range of fishing fleets. Historical data can also allow us to map the fishing industry's decline at the end of the sixteenth century. A plethora of historical maps illustrate how war and conflict increasingly plagued Ireland toward the end of the century. We can also visualise how violence at sea damaged and deterred fisheries by mapping out instances of piracy. Finally, using cartography and GIS, we can trace how English colonists gradually took control of fishing resources in Ireland and fundamentally changed the nature of the industry.

Learning about Marine Animals in the Middle Ages: Methodological Issues

Polina Ignatova

Tema Q / COMPASS Research Hub, Linköping University, Sweden

Contact: polina.ignatova@liu.se

Medieval period saw considerable interest in marine animals, especially following the re-discovery and translation of Aristotle's works in the twelfth century. Scientific treatises produced by Hildegard of Bingen, Alexander Neckam, Thomas of Cantimpré, and Albert the Great contain detailed discussions of various aquatic organisms, their anatomy, appearance, and behavioural patterns. These texts offer a great potential for studying the past of marine ecosystems and tracing the changes they have undergone over the centuries. However, these works as well as other medieval sources influenced by them contain a significant amount of misinformation about marine animals. The first part of the proposed presentation will discuss the factors which had contributed to the emergence of false knowledge about aquatic organisms in the Middle Ages, such as mistakes in translation, lack of visual representations, the influence of Christian religion, and the role of pre-existing cultural constructs. The second

part of the talk will demonstrate how medieval misrepresentations of water-borne species complicate the process of studying oceans' past today. It will address such issues as identifying the animals described in medieval sources as particular species we know today, access (and the lack of it) to historical sources featuring aquatic organisms, and medieval representations of water-borne animals in modern media.

They look like birds, but they couldn't fly because they had no feathers on the wings: Perceptions of Southern African nature in the early modern age and its contribution to environmental history.

Ana Cristina Roque

CH-ULisboa. Faculdade de Letras. Universidade de Lisboa.

Contact: anaroque1@campus.ul.pt

In the 16th century, sailing in South Atlantic, was a challenge to European navigators both in the art of sailing and in the recognition of the navigation signals guiding them in the sea or when approaching land. Among the usual signs, maritime fauna was one of the most significant and it was extensively mentioned in Logbooks and diaries of navigation. Although the registries had practical purposes, they include details of the species observed revealing the way 16th century seamen perceived and reacted to the unknown species and their behavior. They were exotic, monstrous, beautiful and strange, but... they were all useful. They could be used to "solve" human problems / purposes. What they observed and how they did the register reveals much on their insight on human – nature relation. Using the 16th century Portuguese Logbooks and Diaries of navigation, this paper addresses the relation human-nonhuman species through the way Southern African maritime fauna was perceived, described and compared with the one known by the Europeans. Additionally, it will discuss how the new descriptions contributed to deconstruct the European imaginary, to build a new world's global vision, and to draft a first approach to Southern Africa's environmental history.

Adaptation when it was First Cool: Scottish Maritime Salvaging during the Little Ice Age

Patrick J. (PJ) Klinger

Virginia Military Institute, United States

Contact: klingerpj@vmi.edu

In seventeenth century Scotland, timber was a limited natural resource, especially timber necessary for building maritime vessels. Increased storminess during this period in parts of the North Sea brought greater risk for ship owners and sailors. Despite these risks and limitations, overall merchant activity in most Scottish ports increased throughout the century.

This paper focuses on how maritime societies adapted to limited resources and climatic changes during the seventeenth century by exploring three themes. The first briefly examines the frequency and plots a large number of shipwrecks near the Scottish coast during the seventeenth century, arguing that increased storminess, warfare, and merchant activity all played a significant role in the increase of shipwrecks in Scottish waters. The second theme studies efforts to mitigate shipwrecks along the Scottish coast during this period and motivations for implementing those strategies. The final theme explores how Scottish, Dutch, and Hanseatic mariners, the Scottish Parliament, and the larger North Sea community that actively traded with Scotland viewed ownership of shipwrecks, largely merchant vessels, the efforts they went through to salvage those shipwrecks, and the motivations behind salvaging ships during the early modern period.

POSTER: Q-MARE: a new PAGES working group on pre-industrial climate and human impacts on marine ecosystems

Konstantina Agiadi

Department of Palaeontology, University of Vienna, Austria

Contact: kagiadi@gmail.com

Marine ecosystems are deteriorating worldwide, but scientific monitoring time-series postdate the industrial revolution. Pre-industrial baselines are therefore necessary to understand the true magnitude and rate of change induced by modern anthropogenic activities, including climate change. Disentangling however pre-industrial human impacts from those of natural climate variability remains a challenge. The Q-MARE working group brings together scientists from vastly different disciplines, historians, archaeologists, paleontologists and ecologists to explore the impacts of climate and human activities on the environment during the pre-industrial era, targeting biodiversity loss and the sustainability of ecosystems and societies. Our goals are to answer the following questions: How did climate and human activities affect marine ecosystems in the pre-industrial Holocene and the Pleistocene? When did humans start having a significant impact on the marine environment? How can data from different sources be combined to inform environmental conservation targets and model marine ecosystems?

POSTER: Effective Management of Archaeological and Historical Shipwreck Sites in the Red Sea, Egypt

Alicia Johnson

Alexandria Centre for Maritime Archaeology & Underwater Cultural Heritage

Contact: alicia.johnson.underwater@gmail.com

Each year, the SCUBA industry creates a billion-dollar economy and numerous job opportunities; many of which are in developing countries. Popular diving attractions, such as the Thistlegorm in Egypt, or the Pacific's Chuuk Lagoon, are UCH sites and attract many visitors. Each year, the Thistlegorm generates €5,000,000 and attracts thousands to the Egypt's Red Sea. When managed effectively historic shipwrecks, can be intellectually, culturally, and financially enriching. Seemingly, the lack of oversight, regulation, and education of divers places these UCH sites at-risk against illegal salvage, looting, destruction of archaeological integrity, and increased decomposition of the wreck sites. Effective project management plans can be devised and implemented via evaluating different traits, conditions, and circumstances of three at-risk UCH wreck sites of the Red Sea: the Roman wreck at Fury Shoals, the 18th C Ottoman merchant ship of Sadana Island, and the Thistlegorm WWII shipwreck.

POSTER: National Fishing Charter, step by step to improve fisheries management in Mexico

Esteban Bada Sánchez¹, Ilse Alejandra Martínez Candelas²

¹ *Instituto Nacional de Pesca y Acuicultura, Mexico*

² *University of Victoria, Canada*

Contact: estebanba@hotmail.com

Fishing has been relevant in Mexico since prehispanic times, there is evidence of its economic and cultural importance. Fishing management and policy has gone from intense exploitation to comprehensive management where conservation and use are equally important. From 2001 to this day public policies have aimed to achieve sustainability, creating management instruments like the National Fishing Charter (CNP). The first version of the CNP was published in 2000, with the purpose of regulating fishing exploitation through several Mexican Official Standards (NOMs). To date, there have been five other CNP updates (2004, 2006, 2010, 2012 and 2018). The CNP contains the following information: a brief description of the fishery, the normativity, the fishery status, and management recommendations. Since the first CNP to the actual one, it contains 83 charts with 535 stocks assessed and 415 species evaluated. Of the 535 stocks, 66 % are at the maximum sustainable yield (MSY), 15% with development potential, 18% overexploited and 1% in recovery. There is a positive trend of stocks at the MSY from 2000 to 2018. With the advancement of fisheries science, the stock assessment methods used in the CNP have improved. The CNP has been key to control of fishing effort.

POSTER: Tuna and other fish: Human communities and sea resources, interactions and interdependencies in 16th Century Algarve (Portugal)

Brígida Baptista; Ana Catarina Garcia; Cristina Brito

CHAM - Centre for the Humanities, NOVA FCSH, Lisbon, Portugal

Contact: bbaptista@fcs.unl.pt

In the work '*Corografia do Reino do Algarve*' by Friar João de São José (1577) we find the description of the Algarve, its landscape, territory and fortifications, as well as its natural resources and exploitation values for the kingdom of Portugal (16th century). Here, practices and technologies of coastal fishing are described and discussed in detail, as well as economic value, trade, different resources, their abundance and seasonality. Tuna fish, dolphins, croakers, and sturgeons, among others, are mentioned as the most important marine resources of the time. Besides showing dependency of fishers and Portuguese crown in these resources, we also find events of interspecific interactions, such as 'dolphins' or orcas preying on tuna catches, a behavior that still occurs today as has been (apparently) practiced for many centuries. In this scope, we are analyzing, in detail, all Book 4, on the Particularities of the Kingdom of Algarve ('*Das Particularidades do reino do Algarve d'aquém-mar*'), focused specifically on aspects related with tuna fish and fisheries.

POSTER: Evidencing Europe's lost native oyster (*Ostrea edulis*) habitat

Ruth H. Thurstan^{1*}, Philine S.E. zu Ermgassen^{2*}, Hannah McCormick, Elizabeth Ashton, Floris Bennema, Ana Bratos Cetinic, Janet H Brown, Tom Cameron, Fiz da Costa, David Donnan, Christine Ewers-Saucedo, Tomaso Fortibuoni, Anamarija Frankic, Eve Galimany, Otello Giovanardi, Romain Grancher, Daniele Grech, Maria Hayden-Hughes, Luke Helmer, K. Thomas Jensen, José A. Juanes, Thomas Kerkhove, Janie Latchford, Alec Moore, Dimitrios K. Moutopoulos, Pernille Nielsen, Henning von Nordheim, Bárbara Ondiviela Eizaguirre, Corina Peter, Bernadette Pogoda, Bo Poulsen, Stéphane Pouvreau, Joanne Preston, Callum M. Roberts, Cordula Scherer, David Smyth, Ioannis A. Theodorou.

**Joint lead authors*

1 University of Exeter, UK

2 University of Edinburgh, UK

Contact: r.thurstan@exeter.ac.uk, philine.zu.ermgassen@ed.ac.uk

The native oyster has been the subject of significant commercial fisheries from ancient times until the early 20th century. Historically, it was an important source of sustenance and supported livelihoods for coastal communities. Since the 19th century, increased fishing pressure combined with disease and other problems led to wild fisheries for native oyster all but collapsing across Europe, with its habitat now entirely extirpated or under severe threat in many regions. Due to the early loss of many wild oyster habitats we still do not fully know where oyster habitat used to occur, what that habitat looked like, how much area it covered and what associated species occurred on these beds. This presentation describes the efforts made by members of the Native Oyster Restoration Alliance Historical Ecology Working Group to combine our collective knowledge to address these information gaps at the European scale, with the aim to inform restoration and policy goals, now and in the future.

Reconstructing the Historical State of Marine Capture Fisheries from British Malaya

NG Zhong Wang Clement

Nanyang Technological University, Singapore

Contact: NG0002NT@e.ntu.edu.sg

Southeast Asia is one of the most biologically diverse parts of the world. It is also one of the main producers of fish and seafood-related products globally, contributing at least 20% of the total marine capture fisheries production in 2018. Despite playing a crucial role in global food production and supporting the livelihoods of millions of people across Asia, our knowledge of the historical condition of marine capture fisheries from the region remains limited. Moreover, our understanding of the current status of fish stocks may be biased by the “Shifting Baseline Syndrome”. Using colonial reports and anecdotes from the early 1900s, I will reconstruct past catches to describe changes in marine fish stocks around the British Malaya region. Generally, historical catches increased substantially in the 1930s, up to the Second World War; however, this varied considerably between species and geographical regions. Reported changes in fish catches may be attributed to the introduction and adoption of new fishing methods, as well as the increased availability of preservation technologies for local fishermen. My results shed new light on the historical patterns of exploitation of marine fish stocks from this important yet understudied part of the world.

Forgotten elasmobranchs of Terminos Lagoon, Mexico

Ilse Alejandra Martínez-Candelas^{1,2}, Arantxa Zamora-Rendón³, Nadia T. Rubio-Cisneros^{1,4}, Iván Méndez-Loeza⁵

¹ School of Environmental Studies, University of Victoria, ² Mar Sustentable Ciencia y Conservación AC, ³ Ayototl AC, ⁴ Universidad Autónoma de Nuevo Leon, Laboratorio de Biología de la Conservación y Desarrollo Sustentable, ⁵ Independent Researcher

Contact: ilse.a.martinez@gmail.com

Terminos Lagoon, Campeche, is the largest coastal lagoon in southeastern Mexico. Despite elasmobranchs being fished for centuries in the area, current management strategies focus only on sharks with no measures in place to protect rays. Twenty interviews were conducted in four communities of Terminos Lagoon in order to establish the most important elasmobranch species for local people. Using local ecological knowledge, fishers identified and described the distribution, ecology and fisheries of thirteen different shark and ray species recorded in the lagoon, or its proximity. It was determined that only ten elasmobranch species were of commercial or cultural importance; with one of them only recently. According to the IUCN, two of these species are critically endangered, three endangered, and two vulnerable. There were five participatory mapping exercises where fishers described the historical distribution of these species. Fishers were asked to choose their five favorite

species; two rays: *Aetobatus narinari* and *Hypanus americanus*, were preferred by the majority. Fishers agree that elasmobranchs have disappeared in certain areas and have noticed a decrease in catches. These results highlight the urgent need to research local ray populations and to take into account local people's needs when designing management strategies.

Quantifying the historical development of marine recreational fisheries in Moreton Bay, Australia

Carolina Chong-Montenegro^{1,2}, Ruth H. Thurstan², John M. Pandolfi¹

¹ ARC Centre of Excellence for Coral Reef Studies and School of Biological Sciences, The University of Queensland, St Lucia, QLD 4072, Australia, ² Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Penryn, UK.

Contact: c.chongmontenegro@uq.net.au

Recreational fisheries are of global social and ecological significance. Yet historical evaluations of the spatial and temporal expansion of recreational fisheries have been hampered by the lack of time-series catch and effort data. We used newspaper records to reconstruct catch rate trends of recreational fishing activities in Moreton Bay, Queensland, from 1920 to 1984. Using generalized additive mixed models, two catch rate metrics (n = number of fish fisher⁻¹trip⁻¹, k = kg of fish fisher⁻¹trip⁻¹) were constructed as functions of time and distance travelled (km). Significant non-linear relationships were found for n . Declines in n were strongly influenced by time, while increases in distance travelled predicted larger n . k was tightly linked to increases in distance travelled, but did not vary with time. Spatial analysis revealed a shift in areas fished, from inshore reefs (near urban areas) during the 1920s and 1930s (pre-WWI), towards isolated offshore island systems in later decades (>1950s; post-WWII). Catch composition also changed through time. Catches pre-WWI were strongly associated with reef species, while catches post-WWII, were characterized by demersal species. Our study illustrates how fisheries data can be reconstructed from unconventional data sources and provide valuable information about the development of recreational fishing activities.

Maritime History Navigations in the Digital Environmental Humanities: Inventing the Grand Banks: A Deep Chart: ca 1500–1800

Charles B Travis IV, Ludlow, F., Matthews, Loughheed, K., Rankin, K., Allaire, B., Legg, R., Hayes, P., Nicholls, J., Towns, L. & Holm, P.

Trinity College, The University of Dublin

Contact: ctravis@tcd.ie

As a feature of the Fish Revolution (1400–1700), the early modern “invention” of the Grand Banks in literary and cartographical documents facilitated a massive and unprecedented extraction of cod from the waters of the north Atlantic and created the Cod/Sack trade Triangle. This overlapped with the southern Atlantic Slave, Sugar, and Tobacco Triangle to capitalise modern European and North American societies. In 1719, Pierre de Charlevoix claimed that the Grand Banks was “properly a mountain, hid under water,” and noted its cod population “seems to equal that of the grains of sand which cover this bank.” However, two centuries later in 1992, in the face of the collapse of the fishery, and fearing its extinction, a moratorium was placed on five centuries of harvesting Grand Banks cod. The invention and mining of its waters serves as a bellwether for the massive resource extractions of modernity that drive the current leviathan and “wicked problem” of global warming. The digital environmental humanities narrative of this study is parsed together from 83 pieces of Grand Banks charting from 1504 to 1833, which are juxtaposed through Humanities GIS applications with English and French cod-catch records kept between 1675 and 1831, letters regarding Cabot's 1497 voyage, Shakespeare's *The Tempest* (1611) and scientific essays by De Brahm (1772) and Franklin (1786).

Preliminary estimation of reference points for commercially important shark species from Mexican waters included in the CITES Appendices

Esteban Bada Sánchez¹, Luis Daniel Carrillo Colín² and Javier Tovar Ávila¹

¹ Instituto Nacional de Pesca y Acuicultura, México, ² Universidad Nacional Autónoma de México, México

Contact: estebanba@hotmail.com

Mexico is one of the primary producers of sharks globally. Shark fishing in Mexico is undertaken by artisanal, semi-industrial and industrial fleets. This fishery is essential in Mexico because of the volume of catch, economic value, and social and cultural importance. The concern about the populations' status of some species of economic importance has driven to their inclusion in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), requiring the issuance of a non-detriment finding (NDF) report to export any of their products, thus being necessary reliable information about the abundance of the species. However, there is no historical record of the capture of sharks by species in Mexico. The catches are only recorded in two broad categories: large and small sharks, making it difficult to assess the populations through traditional methods. The National Institute of Fisheries and Aquaculture (INAPESCA) carried out an exercise of a historical reconstruction of species-specific landings and a poor-data assessment method. As a result, thresholds were obtained that can serve to determine the status of shark populations, as reference points for management measures to ensure its sustainability as well as the development of NDFs.

Otolith biochronology for the long-term reconstruction of growth and stock dynamics of fish

Szymon Smoliński, Julita Gutkowska

Department of Fisheries Resources, National Marine Fisheries Research Institute, Poland

Contact: ssmolinski@mir.gdynia.pl

Biological time series covering long periods are essential to evaluate previous responses of organisms to the alterations in the environment and predict future consequences of the ongoing changes. In this project, we reconstructed the variation in the growth of European sprat (*Sprattus sprattus*) in the Baltic Sea over the last multiple decades based on the measurements of annual increments in archived otoliths, which were used as an approximation of fish body growth. We assessed the relationships between fish growth and environmental factors, considering ongoing climate change and changes in the size of sprat stock. We strived to estimate the stock biomass prior to the period of available historical data (before 1974) based on the obtained information on growth variation in the past. This estimation was based on the strong relationships between sprat growth and sprat biomass. For this reconstruction, models were calibrated using data from the more recent past when official information on the stock biomass is available. This study provides new and unique multidecadal data, giving insights into environmental factors affecting the growth of Baltic sprat. This research indicates the potential of the otolith-based biochronologies for the provisioning of independent indices of the historical fish stock size.

Oceania 1947-2021: mechanisms for future architectures in an Anthropocene Ocean

Genevieve Quirk

Australian National Centre for Ocean Resources and Security, University of Wollongong, Australia

Contact: genevieve.quirk@gmail.com

Situated at the vanguard of adverse impacts from ocean change Oceania provides compelling insights into future architectures for an Anthropocene Ocean. As ocean change accelerates, conflict between governance institutions is expected to intensify. The intention, under the United Nations Convention on the Law of the Sea to govern in an integrated manner grows ever more prescient. Oceania ranks among the most integrated regional ocean governance architectures. In Oceania, a complex of regional-scale institutions evolved to meet the capacity demands of Small Island Developing States (SIDS) in governing their vast ocean continent. This research examines the evolution, from 1947-2021, of this governance architecture and the consequence for future ocean governance. The research delivers insights on the path dependent forces and cooperative institutional mechanisms that

produced Oceania's integrated and effective architecture. The research focuses on these historical governance mechanisms as they represent useful and transferable qualities for governing an Anthropocene Ocean. The purpose is to provide insights on strategic interventions of value for the resilience and restoration of an Anthropocene Ocean.

Overcoming objections: harnessing the full potential of historical research for marine policy development

Alison MacDiarmid¹, Gesche Krause², Poul Holm³, Ruth H. Thurstan⁴, Ben Fitzhugh⁵, Cristina Brito⁶

¹ NIWA, Aotearoa New Zealand; ² Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Germany; ³ Trinity College, Dublin, Ireland; ⁴ University of Exeter, Cornwall, UK; ⁵ University of Washington, Seattle, USA; ⁶ Universidade Nova de Lisboa, Lisbon, Portugal

Contact: alison.macdiarmid@niwa.co.nz

Best practice for measuring current environmental state requires or implies knowledge of prior states in order to assess trajectories of change. Time series are important in determining a change in environmental state, particularly when widespread environmental alteration makes spatial comparisons over the whole span or gradient of change from pristine to highly impacted localities, impossible. Historical information could be used to augment modern time series, but in our experience, is often unappreciated by those for whom it could provide an important ecosystem context. We identify objections to the use of historical data, the circumstances where these have been voiced, and explore their validity, particularly from the point of view of human mind maps, our mental models of human-nature relations that strongly influence our usually subconscious decision about the validity of an argument. We conclude that marine researchers, marine policy makers and managers need to adopt a historically-informed socio-ecological systems framework to fully understand the patterns, intensities, and trajectories of human activities affecting the ocean, determine their impacts on natural ocean systems and mitigate their impacts.

Day 3: Friday 24 June

KEYNOTE: Advancing marine historical ecology in the southwestern Atlantic Ocean

Andre Carlo Colonese¹, Thiago Fossile¹, Krista Michelle McGrath¹, Alice Toso¹, Dannieli Firme Herbst Gerhardinger¹, Luiz Geraldo Silva², Jessica Ferreira³, Dione da Rocha Bandeira³, Tatiana Andaluza³, Marta Cremer³, Paulo César Fonseca Giannini⁴, Rafael Guedes Milheira⁵, Simon-Pierre Gilson⁶, Bruna Ceretta⁷, Mariana G. Bender⁷

¹ Department of Prehistory & Institute of Environmental Science and Technology (ICTA), Universitat Autònoma de Barcelona, 08193, Bellaterra, Spain, ² Department of History, Universidade Federal do Paraná (UFPR), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil, ³ Programa em Patrimônio Cultural e Sociedade, Universidade da Região de Joinville, Joinville, Brazil, ⁴ Instituto de Geociências, Universidade de São Paulo, 05508-080, São Paulo, Brazil, ⁵ Universidade Federal de Pelotas. Departamento de Antropologia e Arqueologia, 96010-160, Pelotas, Brazil, ⁶ Instituto de Ciências Humanas e da Informação, Universidade Federal do Rio Grande, Rio Grande, Brazil, ⁷ Laboratório de Macroecologia e Conservação Marinha, Universidade Federal de Santa Maria, Santa Maria, Rio Grande do Sul, Brazil.

Contact: andrecarlo.colonese@uab.cat

Anthropogenic impacts on tropical and subtropical coastal environments are increasing at an alarming rate compromising ecosystem functions, structures and services. Understanding the scale of marine population decline and diversity loss in these regions requires a long-term perspective that incorporates information from a range of sources, including archaeological, environmental and historical records. Here we will bring together zooarchaeological and biomolecular (palaeoproteomic and stable isotopes) analyses of archaeological records, along with the analysis of historical documents and modern fish communities, to reconstruct fishing strategies, catch volumes and compositions, and the contribution of marine resources to the diets of pre-industrial coastal communities in southern Brazil. The results reveal how collaborative research efforts between archaeologists, historians, geologists and marine ecologists can productively advance our understanding of past coastal ecosystems in the southwestern Atlantic Ocean and contribute to conservation debates. The work is part of TRADITION, an ERC-Consolidator Grant funded research project (European Commission) that is currently assessing the long-term development of small-scale fisheries in Brazil.

Pinnipeds at Alluitsoq: A Zooarchaeological Investigation

Wendi K. Coleman (presented by [Thomas H McGovern](#))

The Graduate Center, CUNY – United States of America

The collaborative Alluitsoq project attempts to investigate colonial interactions in Southern Greenland between the Kalaallit, Moravian missionaries, and Danish traders and colonists in the 18th century at the former Lichtenau Moravian mission. In this paper, a preliminary zooarchaeological analysis of the faunal material from the Alluitsoq 2019 excavation season considers how increased interactions with imperial networks influenced human-environment dynamics in Southern Greenland. The introduction of domesticated animals and the commodification of animals as items of trade has the potential to impact the relationships between people and their environment. The well-preserved archaeofauna at Alluitsoq notably reveals the persistent use of primarily wild animal resources at the site, predominantly pinnipeds. The limited presence of domesticated animal species at the site may reveal the maintenance of previous human-environment relationships. In addition, the influence of colonial interactions may be present in the tool marks on several bone elements potentially revealing the introduction of new tools or methods utilized in the butchery of pinnipeds. As the zooarchaeological analysis continues, it will continue to employ multiple variables including species diversity, elemental frequency, and butchery patterns to examine whether the influences of imperial networks transformed human-environment and human-animal relationships at the site.

Interdisciplinary Science to Study Coastal Exploitation on touristic Islands in the Mexican Caribbean

Nadia T. Rubio-Cisneros^{1,2*}, Ilse Martínez, Candelas^{2,3}, Izaizel L. Cruz-Gómez^{2,4}, Oscar Frausto-Martínez⁵, Francisco Rodríguez-Castillo⁵, Juan Carlos Pérez Jimenez⁶, Jeffrey Glover⁷, Igor I. Rubio-Cisneros¹, Rodrigo A. Núñez-Inzunza^{2,8}, Félix A. Vázquez-Pech^{2,9}, Andrés Romero-López^{2,9}, Teresa Martín^{2,10}, Ángela Domínguez Eligio^{2,5}, José Ignacio González-Rojas²

¹ *Mar Sustentable Ciencia y Conservación, A.C.*, ² *Universidad Autónoma de Nuevo León, Laboratorio de Biología de la Conservación y Desarrollo Sustentable*, ³ *University of Victoria*, ⁴ *Universidad Nacional Autónoma de México, Facultad de Ciencias*, ⁵ *Universidad Autónoma de Quintana Roo, Campus Cozumel, Laboratorio de*, ⁶ *Observación e Investigación Espacial*, ⁷ *Colegio de la Frontera Sur, Campeche*, ⁸ *Department of Anthropology, Georgia State University*, ⁹ *Centro de Investigación y de Estudios Avanzados. Unidad Mérida*, ¹⁰ *Universidad Autónoma de Yucatán, Facultad de Medicina Veterinaria y Zootecnia*, ¹¹ *Corales Vivos Cozumel*.

Contact: nadia@marsustentable.org

Our initiative focuses on the history of fishing from Pre-Columbian times to the present to determine how past fishing activities have contributed to subsequent changes and declines in coastal resources of islands in the Mexican Caribbean (IMC) (Holbox, Isla Mujeres, and Cozumel). Our interdisciplinary methods integrate ecological, historical, and archaeological data on coastal exploitation, together with fishers' traditional knowledge collected through surveys with a spatial component. We present results from IMC, which describe increasing fishing effort through the mid 20th century, overfishing higher trophic level fish (e.g., sharks and sawfishes), and growing illegal fishing. Overall, fishers recall abundant marine biodiversity existed nearshore of IMC. Archaeological information for the Holbox region demonstrates

diverse shark remains. Studying IMC coastal exploitation with a historical ecology perspective will provide a unique opportunity to examine the long-term availability, biodiversity, and exploitation of coastal resources in the Caribbean, e.g., top predators. The increasing fishing effort and tourism development in IMC and other islands of Latin America make regional data on coastal exploitation timely for developing management guidelines focused on the welfare of coastal communities and the conservation of their natural capital.

Noise into Signal - Identification Challenges and the Medieval Sea Fishing Revolution

Rachel Blevis¹, Enrico Crema¹, James H. Barrett²

¹University of Cambridge, United Kingdom, ²Norwegian University of Science and Technology, Norway

Contact: rkb34@cam.ac.uk

The Atlantic cod (*Gadus morhua*) has been a prominent European trade good from as early as the start of the 11th century CE. The ensuing popularity and energetic exploitation of this species has led to numerous overfishing events and has left modern populations vulnerable to extinctions. The archaeological record continues to assist in the reconstructions of ecological characteristics of such marine populations in the past. These reconstructions are pertinent to evaluations of modern fish stocks and of past overfishing and exploitation patterns. Correspondingly, my research utilizes fishbone assemblages, and cod remains in particular, from the 8th-9th century CE site of Lydinge, Kent, to assess the characteristics of fish populations and fishing practices prior to the intensified exploitation of marine resources in England. The key methods used to assess the shift to intensified marine fishing include the zooarchaeological analysis of the Lydinge assemblage and the development of morphometric parameters and linear regression models that utilize vertebrae measurements. The developed regression models simplify and refine size estimations of past *Gadus morhua* specimens. The application of the models to the Lydinge cod remains and reconstruction of the sizes of previously unexploited 'baseline' populations holds importance for understanding the potential of protected marine habitats.

4-OCEANS: a global, collaborative project

Poul Holm¹, James Barrow², Cristina Brito³, Francis Ludlow¹

¹Trinity Centre for Environmental Humanities, Trinity College Dublin, Ireland, ²Department of Archaeology and Cultural History, NTNU Vitenskapsmuseet, Norwegian University of Science and Technology, Trondheim, Norway, ³ Centre for the Humanities, NOVA FCSH, Lisbon, Portugal

Contact: holmp@tcd.ie

The presentation will introduce the overall research questions and the research plan of the 4-OCEANS project 2021-2027. How did marine life affect and alter societies of the past? This is one of the key questions the EU-funded 4-OCEANS project will seek to answer by investigating the importance of marine life for human societies during the last two millennia, from 100 BCE to 1860 CE. Bringing together expertise from marine environmental history, climate history, natural history, geography, historical ecology, genomics and zooarchaeology, the project will conduct the first-ever global assessment of the role of marine life in societal development and will consider how selected socio-economic, cultural and environmental forces limited as well as enabled marine exploitation.

Multi-proxy Approaches to the Historical Ecology of Marine Resource Exploitation c.100 BCE to 1860 CE

James H. Barrett¹, Bastiaan Star², Danielle Buss¹, Mohsen Falahati Anbaran¹, Thomas Larsen³, Marie-Josée Nadeau⁴ and Paul Szpak⁵

¹ Department of Archaeology and Cultural History, NTNU Vitenskapsmuseet, Norwegian University of Science and Technology, Trondheim, Norway, ² Centre for Ecological and Evolutionary Synthesis, Department of Biosciences, University of Oslo, Oslo, Norway, ³ Max Planck Institute for the Science of Human History, Jena, Germany, ⁴ The National Laboratory for Age Determination, NTNU Vitenskapsmuseet, Norwegian University of Science and Technology, Trondheim, Norway, ⁵ Department of Anthropology, Trent University, Peterborough, Ontario, Canada

Contact: james.barrett@ntnu.no

This paper sets out the methodology and research objectives of archaeological components of the European Research Council 4-OCEANS project, a global study of the causes and consequences of marine resource exploitation for human societies and the oceans. Here, we (i) outline new research on the historical ecology of ten marine taxa, chosen for their social, economic and ecological significance, and/or because they are sensitive indicators of human disturbance; (ii) outline how combining new ancient DNA, stable isotope, radiocarbon and osteometric data will help us achieve our research goals, and (iii) address the complexities and opportunities of meta-analysis at scales ranging from the national to the global. Additionally, we present two of the ten marine taxa as case studies: the Atlantic Cod and the Atlantic walrus. Both species are currently impacted by human harvesting and climate change. Although they experienced very different exploitation pressures and vulnerabilities over the last 2000 years, they offer converging lessons regarding processes of serial depletion and ecological globalization.

English excitement by the New World: Native American connections with the marine world and their perceptions of marine life in the North Atlantic, ca. 1550-1640

Kunyan Zheng, Poul Holm

Trinity College Dublin, Republic of Ireland

Contact: zhengk@tcd.ie

Drawing on written and material records, this paper aims to investigate the possible connections between indigenous knowledge of marine fish and English perceptions of marine fish in the North Atlantic between 1550 and 1640. This paper will begin with the differences in climate and ecology between both sides of the North Atlantic. Concentrating on three typical regions along the east shore, this paper will examine the indigenous knowledge of marine fish, which was mainly accumulated through their daily connections with marine fish, including their fishing methods, terminology for marine fish, identification of various fish species, and use of marine fish. Further, this paper will reveal the English description and portrayal of these sea lives, their observation of the indigenous knowledge of marine fish, and the interactions of knowledge of marine fish between the indigenous and the English. Finally, this chapter will reflect on how the English coped with unfamiliar and hostile marine environments and extracted marine wealth with the help of the indigenous, and to reevaluate the significance of marine fish to study to what degree the knowledge of marine fish contributed to the growth of English power.

Many tanks 4 many fish: Mapping the Roman network of cetariae on the Western Roman Empire

Joana Baço, Catarina Garcia, Cristina Brito

CHAM - Centre for the Humanities, NOVA FCSH, Lisbon, Portugal

Contact: joanabaco@fcsb.unl.pt

Our work focuses on the Roman Empire and on their local and regional exploitation and use of marine resources. Historically, one of the most important marine products produced and traded by the Romans was garum, a fish sauce made from a mixture of chopped fish parts, blood, viscera, crustaceans, and molluscs fermented in brine. Most used pelagic species, including mackerel, sardines, tuna, and anchovies, were captured in the vicinity of the coastal complexes. Here, we aim to identify the relevant garum production centres along the Atlantic coast of the Iberian Peninsula (1st to 4th centuries AD). We will analyse published and grey literature about extraction, production, and trade of garum and similar products used in the Western Roman Empire. Through a comprehensive analysis of sources and literature and archaeological review, we compiled information to identify and compare, not just factories, but also species used, and, if possible, the quantities of exported products. Each site will be mapped with different levels of information to produce a visualization tool to interpret garum production and consumption networks and the relationship between coastal and urban centres in the Roman Empire.

Explosive Eruptions as Tests of Marine Ecosystem and Food Security Linkages, 1600-1850 CE

Francis Ludlow¹, John (Al) Matthews¹, Francesco S. R. Pausata², Kevin Healy³, Andrew Jackson¹, Eva Jobbová¹, John Nicholls¹, Patrick Hayes¹, Josh Ivinson¹, Bernard Allaire¹, Charles Travis¹, Poul Holm¹

¹ *Trinity Centre for Environmental Humanities, Trinity College Dublin, Ireland*, ² *Department of Terrestrial and Atmospheric Sciences, University of Quebec in Montreal*, ³ *Macroecology, Macroevolution and Comparative Biology, The National University of Ireland, Galway*

Contact: ludlowf@tcd.ie

Explosive volcanism can trigger severe short-term climatic changes that impact marine environments. Increasingly complete and chronologically secure time-series of historical eruptions derived from polar ice-cores are now available. These allows us to take the dates of climatically significant eruptions over past centuries as tests of (1) marine ecosystem responses to sudden environmental shocks and (2) the responses of fishers and the communities and markets that they supplied to associated changes in marine species abundance. We thus employ detailed contemporary documentation to show a notably increased catch of North Sea herring (1600-1860 CE) and Grand Banks cod (1675-1827 CE) in the decade following historical eruptions. We then use the Norwegian Earth System Model to simulate the impact of volcanism on sea-surface temperatures (SSTs), observing a decadal-scale reduction in North Sea temperatures and an increase in Northwest Atlantic temperatures. Zooplankton populations (a key food source for both fish species) are expected to increase under lower SSTs in the North Sea and higher SSTs in the Grand Banks, respectively, suggesting that the observed increases in catch are driven at least partly by increased abundance. Population modelling also predicts a herring and cod population boom in the first decade following a simulated positive disturbance (e.g., increased zooplankton availability) that encourages increased survivorship. Lastly, we observe an increase in historical herring prices in the first two post-eruption years. Here we hypothesize that herring acted as a food substitute for terrestrial agriculture shortfalls in the aftermath of volcanic climatic disturbances. These initial results suggest the important role of marine ecosystems in historical food security, though major questions remain over how widely accessible marine foods were during subsistence crises. Our results can also help improve fish population projections for the North Atlantic after the next big eruption. This work is supported by the ERC NorFish (ID 669461) and 4-OCEANS (ID 951649) projects.

Reviewing practices and extractions of manatees and turtles in central and south America

Cristina Brito, Catarina Garcia, Jaime Silva, Nina Vieira

CHAM – Centre for the Humanities, FCSH, Universidade NOVA de Lisboa, Portugal

Contact: cbrito@fcs.unl.pt

The study of aquatic living resources' extractions for food and by-products demands a critical analysis of available sources, most of the time only indicative of contexts and practices. Our research is based on cross-analysis of landscape descriptions, travel literature, itineraries accounts and official documentation, to understand, among other, the past of sea turtles and manatees' populations and their relationship with humans. We have collected Portuguese, Spanish English and Dutch historical written sources, broadly from 1400 to 1800's, focusing on European expansions and colonization in extra-European Atlantic territories (Sea Citation database). Through an exhaustive source analysis and literature review, we have identified data to quantify past captures of manatees and sea turtles in American water bodies. Besides numbers, historical context is fundamental. We will not only characterize and quantify extractions, but also try to uncover the practices employed and to provide a better understanding on how these animals were caught, were kept in captivity, and consumed. We will address different local exploitation techniques, ranging from ropes and hand harpoons, to holes, entrapments, and natural or human-made enclosures. When possible, we will discuss abundance, availability, and seasonality of these resources.

Conspicuous Marine Consumption: concepts and avenues for interdisciplinary historical research

Bo Poulsen

Department of Politics and Society, Aalborg University, DK-9220 Aalborg, Denmark

Contact: bpoulsen@dps.aau.dk

The paper proposes that in Northern and Central Europe well-to-do urban dwellers have sought fresh fish since the Middle Ages, and from at least the 15th century onwards fresh fish became an object of international shipping. While initially food for the few, later developments such as speedy steam propelled transportation and the use of ice for storage marked the onset of largescale harvesting of marine resources, sometimes depleting the sources of the exotic. These exploitation patterns thus helps to explain much contemporary fashion for fresh marine food products. Marine environmental history has evolved greatly over the past couple of decades, and our knowledge of past exploitation of many of the main fish species fished for mass consumption has grown tremendously. Nonetheless, much modern, and early modern consumption of marine products are marked by desires to consume products that are exotic and often expensive. The traits and development of this consumption however is a lot less well understood. This paper will discuss the possible dynamics behind the development of conspicuous marine consumption in the form of fresh fish vis-à-vis changes in demand, infrastructure, technology and fashion.

Seafood Consumption in West Europe, 1520-2019

Poul Holm, Patrick Hayes, John Nicholls

Trinity College Dublin, Ireland

Contact: holmp@tcd.ie

Using a combination model for diverse data series, we present estimates of seafood consumption in twelve north and west European countries. We identify three main stages of the development of the seafood market. Consumption removed about 800,000 t every year during the seventeenth and eighteenth centuries, doubling by 1850, and again by 1900. Through the early modern period, average European consumption was 10-14 kg per capita, with extreme variations between nations around 1600 and some convergence in the last two centuries. In the second half of the nineteenth century consumption accelerated to double overall demand. In the twentieth century, wildfish catches continued to grow but at a slower rate, and eventually decreasing in recent decades as European home resources were depleted. After 1980, per capita intake continued to grow based on global imports and mariculture. At all stages, rural consumption was considerably lower than urban, by half or less. We point to factors of reduced costs, improved palatability, and increased convenience as the main drivers of demand.

Nanše, the goddess that lost the Sea: A vision of Lower Mesopotamia connection with the aquatic element (3rd millennium BC)

Jaime Silva, Isabel Gomes de Almeida, Cristina Brito

CHAM, FCSH, Universidade NOVA de Lisboa, Portugal

Contact: jaimemrsilva@gmail.com

The ancient civilization that flourished in the territory of modern-day Iraq and Syria was perceived as structured by its fluvial courses, as it was conveyed in its old Greek designation, “the land between the rivers”. Yet, for ancient Mesopotamians the territorial perception was much wider, also encompassing the mountains, the deserts, and, of course, the sea. In fact, literary references dated to the 3rd millennium BC, state how the Mediterranean Sea and the Arabian-Persian Gulf (“Upper and Lower seas”, respectively) were understood as both physic and mental limits. Consequently, very early in time we can identify the development of religious discourses focused on natural aspects. Given that for Mesopotamians, diachronically, these aspects were controlled by deities, the goddess Nanše was conceived as the deity responsible for the Arabian-Persian Gulf. However, a closer look to the 3rd millennium BC data allows to identify how the natural changes occurred throughout time, which, consequently, impacted the relation of Mesopotamians with the sea, were transposed to the mythical sphere, changing Nanše’s functions. Through an intertwined approach of Environmental History and History of Religion, we intend to explore these differences, focusing on the importance of the aquatic element for the Mesopotamian metaphysical conceptions.

Cod Heads, Salmon Tails: Colonial-Period Sugpiaq/Alutiiq Foodways Near Old Harbor, AK, USA

Hollis K. Miller

University of Washington, Seattle, WA, USA

Contact: hollism@uw.edu

The Old Harbor Archaeological History Project is a community-based participatory research program that explores the resilience of the Old Harbor Sugpiaq/Alutiiq community through the period of Russian colonialism in Alaska (1760s-1867). Old Harbor is a maritime-oriented community with relations to the waters of the Gulf of Alaska (*Imarpak*) that extend back millennia. Russian colonialism brought many changes to social and gendered dynamics because their economic success relied on the long-term mass conscription of skilled Native Alaskan hunters to capture fur-bearing sea mammals. This meant that many Sugpiaq villages and fish camps were transformed seasonally or over longer intervals into predominantly women's spaces, where women worked both to support their families and meet Russian demands for local labor. In this paper, I discuss Sugpiaq/Alutiiq relationships to ocean foods in the context of Russian colonialism. The data is drawn from archaeological excavation of a midden at the Ing'yuyq site (KOD-114), which was occupied by Sugpiaq/Alutiiq ancestors before and during the Russian colonial period. The faunal remains in the Ing'yuyq midden represent the bounty of marine foods that Sugpiaq/Alutiiq ancestors harvested over generations. Using measures of relative abundance, I trace how Sugpiaq/Alutiiq utilization of marine resources changed as the ancestors managed Russian impositions.

Day 4: Saturday 25 June

KEYNOTE: The relevance of historical perspectives to species recovery: A Northwest Atlantic case study

Loren McClenachan, Katie Cramer

University of Victoria, Victoria BC, Canada

Contact: loren.mcclenachan@gmail.com

Shifting baselines have resulted in a loss of memory about formerly productive fisheries, abundant marine animals, and widespread intact habitat. This memory loss is relevant to modern recovery efforts, because recovery of depleted species requires a collective memory of more abundant past populations, as well as buy-in from key stakeholder groups about recovery goals. This talk will highlight the relevance of historical perspectives to species recovery, drawing from recent work on the links between perceptions of baselines and visions for the future in the Northwest Atlantic. Here, conservation and recovery efforts are underway for both cod, whose populations crashed in the 1990s, and endangered right whales, whose populations failed to recover from 18th century whaling. This talk will highlight both the value and limitations of local knowledge to recovery planning, and the need for environmental history to tell a more complete story of long-term change.

Long-term change in an Inshore Fish Assemblage of the Western North Sea

Georgina L. Hunt¹, John K. Pinnegar², Georg H. Engelhard², Ben D. Wigham³, Nicholas V. C. Polunin³

¹School of Biological Sciences, University of Aberdeen, Aberdeen, UK, ²Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield Road, Lowestoft, UK, ³School of Natural and Environmental Sciences, Newcastle University, Newcastle Upon Tyne, UK

Contact: georgina.hunt@abdn.ac.uk

Commercial fishing has taken place around the British coast for centuries, and many fish species have undergone extensive changes over the last century as fishing activities have intensified. However, knowledge of which species have changed in abundance and body size distributions in inshore waters, and the underlying drivers of these changes, is limited due to the lack of long-term monitoring data. Here we report a study of long-term change in a marine fish assemblage from inshore waters of the western North Sea. We utilised historical catch data collated from scientific trawl surveys (1899 – 1913) and resurveyed the same sites a 120 years later (2018 – 2019). Our results revealed striking declines in the overall fish assemblage between historical and contemporary time periods, pointing to considerable modifications of the benthic ecosystem during the 20th century. Formerly abundant species such as the grey gurnard *Eutrigla gurnardus* were either completely either completely absent or rare in the

2018-2019 surveys. Other demersal fish species also declined in abundance over the 20th century; the inshore fish assemblage is now substantially less diverse and dominated by only two species, plaice *Pleuronectes platessa* and dab *Limanda limanda*. Significant differences in the abundance size-spectra were detected between time periods, declining more steeply in contemporary trawls. This study provides further evidence of systematic declines of demersal fish species from previously understudied inshore areas, and a useful benchmark for improving ecosystem status and future assessment of inshore fish stocks.

Changing fish and fisheries: A Welsh perspective

Alec B.M. Moore

School of Ocean Sciences, Bangor University, UK

Contact: a.moore@bangor.ac.uk

Marine historical ecology studies have addressed the seas of northwest Europe several times, yet the waters of Wales (UK, eastern Irish Sea) remain overlooked. Drawing on documentary sources dating back to the 1700s and earlier, this presentation will outline long-term changes to marine fish and fisheries of north Wales, and the implications of these findings for policy and management.

Exploitation history of Atlantic bluefin tuna in the eastern Atlantic and Mediterranean

Adam J. Andrews^{1,2}, Antonio Di Natale³, Darío Bernal-Casasola⁴, Veronica Aniceti⁵, Vedat Onar⁶, Tarek Oueslati⁷, Tatiana Theodropoulou⁸, Arturo Morales-Muñiz⁹, Elisabetta Cilli², Fausto Tinti¹

¹*Department of Biological, Geological and Environmental Sciences, University of Bologna, Campus of Ravenna, Ravenna, Italy,* ²*Department of Cultural Heritage, University of Bologna, Campus of Ravenna, Ravenna, Italy,* ³*Aquastudio Research Institute, Messina, Italy,* ⁴*Department of History, Geography and Philosophy, Faculty of Philosophy and Letters, University of Cádiz, Cádiz, Spain,* ⁵*University of Rome Tor Vergata, Italy,* ⁶*Istanbul University-Cerrahpaşa, Osteoarchaeology Practice and Research Centre & Faculty of Veterinary Medicine, Istanbul, Turkey,* ⁷*CNRS-Université de Lille, Histoire Archéologie Littérature des Mondes Anciens, Lille, France,* ⁸*University of Côte d'Azur, UMR7264 CEPAM CNRS, Team GReNES, Nice, France,* ⁹*Department of Biology, Autonomous University of Madrid, Madrid, Spain*

Contact: adam@palaeome.org

Overexploitation has directly, negatively affected marine fish populations in the past half-century, modifying not only their abundance but their behaviour and life history traits. The recovery and resilience of such populations is dependent upon their exploitation history,

which often extends back millennia. Hence, information on when exploitation intensified and how populations were composed in historical periods, has the potential to provide context on the baselines currently used in fisheries management and conservation. Here we investigate the exploitation history of Atlantic bluefin tuna (*Thunnus thynnus*; BFT) in the eastern Atlantic and Mediterranean by collating records of their zooarchaeological remains and critically reviewing these alongside the literature. Our review of literature provides clear evidence of BFT overexploitation during the mid-20th century CE. Furthermore, a strong case could be made that the intensification of BFT exploitation extends back further to at least the 19th century CE, if not the 13th-16th century CE, in the eastern Atlantic and Mediterranean. However, a host of archaeological evidence would suggest that BFT exploitation may have been intensive since antiquity. Altogether this indicates that by the currently used management baselines of the 1970s, population abundance and complexity was already likely to have declined from historical levels.

Shifting Identities and Maritime Trade in First Millennium Northern Japan: A case study from the Hamanaka 2 site on Rebun Island, Northern Hokkaido

Erin Gamble

University of Washington/United States

The formation of the Okhotsk culture, a subarctic maritime-adapted set of communities found on the coasts of the southern Sea of Okhotsk from ca. 400-1000 C.E., remains largely an enigma. This paper examines the role of emergent maritime trade routes driven by the Tang Dynasty's trade policies reinvigorating silk road trade routes. I argue that preexisting exchange networks preexisting may have provided the conduit by which new social and economic patterns were negotiated in the transition from Epi-Jomon to Okhotsk in northern Hokkaido and Rebun. My studies evaluate a model of cultural transformation framed by the concepts of practice, resilience, and risk-mitigation. I use geoarchaeological methods to analyze the following questions: How did the opening of long-distance trade routes between Hokkaido and the market-driven political economies of East Asia alter trade interactions in northern Hokkaido and adjacent regions, and how did they in turn influence social identities and forge new kinds of communities in the first millennium C.E.? In doing so, I hope to how expressing identity relates to resilience and how, through entanglements with new objects and people, identities can change.

Managing Risks for Coastal Sailing in Japan (1670-1870)

Jakobina Arch

Whitman College, USA

Contact: archjk@whitman.edu

Until recently, histories of Japan have mostly ignored the oceanic spaces of the archipelago. The Tokugawa shogunate (1603-1868) did restrict Japanese overseas travel, but this was also a period dominated by an explosion of domestic coastal shipping. The nearshore waters of Japan shaped the daily lives not just of the sailors on the thousands of ships in those waters, but also on everyone else who relied on their cargoes, from the rice foundational to the economic system to the merchant goods that supported daily life and luxuries. After the 1670s, once the shogunate had codified coastal routes for shipping tax rice, Japan's nearshore waters became increasingly important. Shipping bulk cargoes by sea was generally cheaper and easier than hauling them over Japan's mountainous interior, but even popular woodcut artists focusing on travel tend to show ships only in the background of land-based travel. My case study of risk mitigation practices helps expand our understanding of transport and travel into coastal waters, by focusing on adaptations to maritime hazards at different levels, from shogunal regulations protecting tax rice to the practices of coastal villagers rescuing ships and sailors in danger.

Shipworms and the Atlantic: How Early Modern Peoples Adapted to Marine Woodborers

Derek Lee Nelson

EvCC, Everett, Washington, United States

Contact: dekesn@gmail.com

During the late seventeenth and early eighteenth centuries, complaints started emanating out from British North America. They weren't the usual complaints about "taxes" and "tyranny" that historians have long pondered. But they were important. Colonial peoples from Maryland to Barbados wrestled with the same problem: the "worm season". This was a perilous time. Ships arriving too early or departing too late in the year were at risk of being devoured by the infamous shipworm, which ate wooden vessels from the inside out. Throughout the early modern era, shipworms were a fixture on both sides of the Atlantic. Everything from war to trade adhered to their habits. But somehow these marine organisms, which made their way into the writings of everyone from Christopher Columbus to George Washington, have evaded detection by historians, particularly Atlantic scholars, who have largely treated the ocean as an opaque void instead of a dynamic feature of nature. My research tries to help reinsert the Atlantic Ocean back into this scholarship by highlighting the important ways that marine wood-boring organisms like shipworms intersected with everything from trade, coastal building, and war during the heyday of the Atlantic World.