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-abstract volume-

Paleoproductivity records in the Subarctic North Pacific Ocean: Baseline marine ecological data for the Holocene

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The coastal regions of the Subarctic North Pacific Ocean (SNPO) experience some of the highest levels of primary productivity in the global ocean, including the >1,100 islands and fjords of the Alexander Archipelago in Southeast Alaska along the Gulf of Alaska (GoAK) margin. However, these areas are susceptible to impacts from climate-related ecological perturbations, such as “The Blob” marine heat wave that struck the GoAK region in CE 2015-2017. The unprecedented impacts from this event, such as the crash of modern Pacific cod stocks and the occurrence of the largest toxic diatom bloom ever observed, were not anticipated. Geologic records offer an opportunity to examine past time intervals beyond the modern instrumental record for analogues of future change to better predict and understand potential trends and ecological impacts.

This presentation will explore a synthesis of SNPO Holocene biogenic silica (opal) data sets, as opal is considered a robust proxy for diatom-based phytoplankton productivity. The SNPO opal compilation details the last 10,000 years, and was generated using a combination of new laboratory measurements and literature review from the GoAK (n = 4 records), Bering Sea (BS; n = 5 records), Sea of Okhotsk (n = 10 records) and the Northwest Pacific (n = 5 records) margins of the SNPO. These data suggest contemporaneous shifts in all these areas towards higher diatom productivity during the late-middle Holocene, particularly after ~4000 cal yrs BP. A second regional increase is also seen in both the GoAK and BS regions at ~1000 cal yrs BP. A unique discontinuous varve record from Deep Inlet (an anoxic fjord in Southeast Alaska) provides further annually-resolved productivity data during these late Holocene transitions.

Opal-based phytoplankton data represents an important link between physical/ environmental forcing and higher trophic level dynamics, and this analysis will yield a better understanding of how these elements have interacted in the past, which will in turn provide new insights for the future of the SNPO ecosystem under projected future climate change.

Opportunities in Southeast Alaska for Understanding the Post-Glacial Landscape

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From the early 1990's until now, the glacial history paradigm for Southeast Alaska has greatly changed. It began as a wall of ice covering the landscape to the continental margin until 10 ka to our current understanding that deglaciation began at 16.9 ka and fjords ice free by 13.9 ka. This paradigm was first challenged by the ages of bones recovered from cave passages. Palynological investigations suggested a dynamic changing environment from herb dominated tundra to the rainforests of today. Studies of the shell bearing marine deposits yielded minimum deglaciation ages and defined isostatic uplift across the region. Studies of these same shell deposits defined the timing of the collapse of a forebulge along the western margin of Southeast Alaska. The search for glacial refugia has not defined any area above the current tides. Refugia likely existed on the coastal plain exposed by lower sea-levels and forebulge development. It is possible that Kruzof Island was not overridden as is evidenced by unglaciated, pahoehoe lava flows. A few marine cores have given us glimpses of the post-glacial environments of the coastal plain. Recent interest in the late Pleistocene and Holocene tephras from cores and samples has highlighted shortcomings in our understanding of the volcanic history of the region. The eruptive history of the Mount Edgecumbe Volcanic Field is somewhat known. Little is known about the post-glacial eruptive history of the Addington, Craig, and Ketchikan volcanic fields. A minimum of nine post-glacial vents suggests an episode of increased deglacial volcanic activity. These eruptions would have coincided with rapid isostatic crustal adjustments that resulted from glaciation and deglaciation, eustatic sea level change, and forebulge collapse. Many of these vents are now beneath the waves. Precise dating of these eruptions has only begun.

Genomic evolution across fragmented landscapes

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Molecular genetics has revolutionized our understanding of biological diversity and evolution in Southeast Alaska, painting a picture of fragmented distributions, elevated endemicity, and complex evolutionary histories. Historically, molecular investigations relied on microsatellites or single or multi-locus Sanger sequence datasets to delimit relationships among species and populations, but newer high-throughput sequencing technologies have significantly expanded our ability to access more detailed and nuanced evolutionary information from species and island populations. In addition to parsing relationships with high confidence, genomic data can be leveraged to identify patterns of gene flow, colonization, and demographic variation, detect evidence of selection and adaptation, and model host-pathogen dynamics, among other variables. Collectively, these data help piece together a more complete picture of regional biotic history. Although genomic investigations in Southeast are in their infancy, clear themes are emerging. Drawing from examples in Mustelidae (*Mustela*, *Martes*) and associated parasites, I will show that histories of isolation and contact are complex: some taxa exhibit elevated divergence (paleoendemics), while others colonized more recently (neoendemics) and have since diverged in response to insularization. Geographic histories are generally shared between island clusters and temporally coincident with major climatic events. Expanded taxonomic and geographic sampling from across the archipelago will be critical to resolving outstanding questions about refugial origins, invasion histories, and rates of adaptation. Results of genomic inference must be effectively translated to regional managers so that conservation policy and practices can be updated and adapted.

Biological Perspectives on the Coastal Refugium Hypothesis: Where Have We Been, Where Should We Head?

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Southeast Alaska was repeatedly covered by ice followed by shifts in climate that radically changed local environments as the North Pacific Coast acquired the lush biomes that we find today. What biological evidence or clues can we use to understand how dynamic climate change repeatedly structured (or restructured) this distinctive coastal biome? What factors contributed to organismal diversification and endemism? Our research over the past three decades started with old-fashioned specimen-based fieldwork on mammals (and their associated parasites) conducted at numerous sites across the Alexander Archipelago and mainland of Southeast Alaska. Productive collaborative efforts with natural resource and wildlife management agencies provided additional valuable materials and perspectives. We aimed to 1) physically document the species in the region; 2) clarify their individual distributions; 3) use community composition to identify hypothetical biogeographic subregions, potential corridors of connectivity, and areas of elevated endemism across this complex landscape, and 4) use DNA-based studies to test these hypotheses in an attempt to help unravel the dynamic history of this region. To date, we have focused primarily on colonization or long-term persistence of individual species. Using preliminary molecular perspectives gained from a few genes, we have shown that some mammals and associated parasites are recent arrivals, showing little genetic differentiation. In other cases, taxa are distinctive or endemic to Southeast Alaska (or along the broader North Pacific Coast). Using larger genomic and geographic sampling, we are now testing and extending the preliminary work to further resolve their complex biogeographic histories (e.g., neoendemism vs. paleoendemism).

Cordilleran Ice Sheet Stability During the Last Deglaciation

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The Cordilleran Ice Sheet in western North America was of comparable size and topographic setting to the modern Greenland Ice Sheet and exhibited similar dynamics. Ice streams channelled rapid flow and the western ice margin terminated in both marine and terrestrial environments. Reconstructing Cordilleran Ice Sheet retreat can therefore provide a helpful analogue for how the Greenland Ice Sheet may respond to changing climate and underlying topography in the future. Moreover, deglaciation in this region controlled routes available for early human migration into the Americas. Here, we present cosmogenic 10Be nuclide exposure ages from glacial erratics and bedrock on the west coast of British Columbia (53.4°N, 129.8°W) that add to existing chronologies along ~600 km of coastal North America. Collectively, these data show deglaciation back to the present coastline by ca. 18–16 ka. Retreat then slowed and ice seemingly stabilised close to the present coastline for several thousand years until ca. 14–13 ka. Ice may still have been lost during this period of relative stability, but through vertical thinning rather than lateral retreat. We attribute initial retreat to destabilisation and grounding line retreat resulting from rising sea level and/or ocean warming in the northern Pacific. Subsequent stability at the present coast was likely due to the transition from marine to terrestrial margins despite increasing temperatures that may have driven ice sheet thinning. Hence, we show the importance of understanding both climatic and non-climatic drivers of ice sheet change through time. We also show that hundreds of kilometres of coastline were free of ice prior to an important period of early human migration into the Americas.

Ancient bears provide insights into Pleistocene ice age refugia in southeast Alaska

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Areas of the Alexander Archipelago, along the southeast Alaska coast, have been hypothesized to have been ice-free during the Last Glacial Maximum (LGM). However, there is no direct evidence of such ice age refugia, and cosmogenic exposure dating indicates that areas above sea level today were covered in ice during the LGM. Nonetheless, due to sea-level changes, refugia could have existed in areas that are now submerged. Numerous subfossils spanning the last 50,000 years have been recovered from caves in southeast Alaska, including of American black (Ursus americanus) and brown (U. arctos) bears that today are found in the Alexander Archipelago but are genetically distinct from other bear populations. Hence, these bear species offer an ideal system to investigate long-term occupation and refugial survival in southeast Alaska. We present genetic analyses based on complete mitochondrial genomes from ancient bear remains. Southeast Alaskan black bears form two distinct lineages, one preglacial and a postglacial, the split time of which is >100,000 years ago. All postglacial brown bears are closely related to modern bears in the archipelago, while a single preglacial brown bear is distantly related to postglacial bears in the archipelago. A hiatus in the bear subfossil record around the LGM and the deep split of their pre- and post-glacial lineages suggest that southeast Alaskan bears did not survive in LGM refugia. Our results are consistent with an absence of refugia along the southeast Alaska coast but support a short-lived LGM peak and that vegetation quickly expanded after deglaciation, allowing bears to recolonize the area.

Multiproxy Investigation of the Northern Cordilleran Ice Sheet during Siku Events using Gulf of Alaska Sediments

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Gulf of Alaska slope Site U1419 (687 m) from IODP EXP 341 documents recurrent episodes of Northern Cordilleran Ice Sheet (NCIS) retreat during the last ice age, termed Siku Events (Walczak et al., 2020), documented by an enhanced ice rafted debris (IRD) flux marked by attendant changes in ocean circulation and structure. Here we further explore NCIS dynamic over this time interval from two sites with developing high-resolution radiocarbon chronologies, but from a different observational perspective. These sites from the proximal and distal Surveyor Fan, Site U1418 (3,678 m) and Site U1417 (4,178 m), respectively indicate elevated sediment flux through the fan's channel-levee system during Siku Events when radiocarbon constraints are strong. Site surveys indicate that each site is fed by different sediment transport pathways and are linked to different part of the NCIS. Comparisons of physical, magnetics, and computed tomographic (CT) properties on detailed radiocarbon and paleomagnetic chronologies illustrate remarkable coherence in lithologic variability through (before, during and after) Siku 1 (18–17 ka) that is not observed before, during and after Siku 2 (27–25 ka). The ratio k_{ARM}/k, a proxy for magnetic grainsize and potentially a source indicator, displays a shift from incoherent (Siku 2) to coherent variability (Siku 1). These variations in coherence of physical and magnetic properties and potential source variations are hypothesized to reflect a transition from the independence of the Malaspina and Bering glacial systems to one that becomes locked and behaves coherently with development of glacial maximum NCIS conditions.

Holocene Records of the Aleutian Low Pressure System

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How the wintertime Aleutian Low pressure system (AL) will respond to climate forcing is germane to the water resources, glaciers, and fisheries in the North Pacific region. Recent work suggests the AL has strengthened over the last few centuries, will continue to strengthen with global warming, and that the AL's decadal regimes can undergo sudden changes in duration. I will contextualize these recent patterns in AL variability by reviewing Holocene paleo-records that describe North Pacific decadal variability. This will include trying to reconcile information gained from high-resolution reconstructions based on tree rings and lower resolution sedimentary records. The talk will close by discussing some outstanding questions in this expanding front of research.

Mafic tephra deposition 70-km downwind increased early Holocene aquatic productivity, Wells Gray Volcanic Field, British Columbia

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It is well known that tephra inputs to lakes can fertilize diatom productivity via silica and phosphorus loading. I identified an early Holocene mafic tephra from a sediment core from Eleanor Lake in eastern British Columbia and attribute it to a volcanic source (Wells Gray Volcanic Field) > 45 km upwind. A second lake, Zellers Lake, located centrally among three Holocene volcanic centers contains several mafic tephras between 8.5 to 10.2 ka The tephra deposited at Eleanor Lake (1.65 kg/m2) dates exactly (8.5 ka) to a rapid rise in planktonic diatom content, especially Stephanodiscus minutulus. This species is well known to be most sensitive to phosphorus limitation. Earlier peaks of S. minutulus at Eleanor Lake between 10.2 and 9 ka temporally correlate with Wells Gray tephras recorded at Zellers Lake, though no tephra was detected at Eleanor Lake by magnetic susceptibility or visible tephra > 125 um. The possibility of aerosol transport of phosphorus or other aerosolized nutrients is being investigated. Eleanor Lake diatoms did not respond to the silicic Mazama or Bridge River tephras. Previous work at Eleanor Lake, prior to detecting the 8.5 ka tephra, attributed the early Holocene diatom variability primarily to abrupt climate changes. Ongoing work on the tephra mineralogy may help clarify links to specific volcanic centers and the nutrients responsible for the 8.5 ka and earlier events.

Return to Activity: Rapid inflation and seismic unrest at Mt. Edgecumbe (Lˈúx Shaa) Volcano, Alaska

Ronni Grapenthin, Cheng, Angarita, Tan, Meyer, Fee, Coombs, Cameron

In April 2022 a cluster of earthquakes was detected by the Alaska Earthquake Center (AEC) near Mt. Edgecumbe (Lˈúx Shaa) in Southeast Alaska, the first unrest observed at the volcano in historic time. Oral Tlingit history describes low-level eruptions about 800 years ago, and thin, rhyolitic tephra deposits on Kruzof Island have been attributed to 2-3 explosive eruptions between 6-4 ka. Past earthquakes occurring in the vicinity of Mt. Edgecumbe had previously been assumed to be tectonic in nature, since the volcano is near the Queen Charlotte-Fairweather transform fault that separates the Pacific and North American plates. However, more in-depth analysis of data from the regional seismic network reveals a cluster of locatable earthquakes under Kruzof Island going back to January 2020 which we interpret to also be associated with the volcano. Seismicity recorded by the nearest seismograph about 25 km away in Sitka was reanalyzed by REDPy shows increased seismic activity since July 2019. To understand the nature of the seismic activity, we analyze synthetic aperture radar data from 2014-2022 in the area around Mt. Edgecumbe and find rapid inflation of up to 8.7 cm/yr beginning in August 2018. Bayesian modeling suggests that a gently westward dipping sill opened 0.65 m between 7.6 km to 5.3 km depth, centered about 2-3 km east of Mt. Edgecumbe. By November 2021, the cumulative deformation reached up to 27 cm. We hypothesize that mafic magma has been ascending through ductile material, accumulating below a silicic seal or in a silicic reservoir, and triggering seismicity in the overburden. Our rapid analysis and modeling of the unrest was enabled through cloud-native open data and workflows, allowing discovery and analysis of this rapid inflation within days after going unnoticed for >3 years.

Reconstructing late Quaternary volcanic activity and surface exposure at the Mount Edgecumbe Volcanic Field, Alaska

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The Mount Edgecumbe Volcanic Field (MEVF) lies along the Pacific coastal route for human migration into the Americas. Unraveling the eruptive history of the MEVF can thus play a role in assessing the extent and timing of unglaciated terrain available for human occupation during the late Pleistocene. Here, we will discuss the physical characteristics, surface exposure history, and emplacement chronology of four lava flows that are exposed on the eastern shores of the MEVF. To determine the total duration of flow exposure and assess if portions of the region were ice-free and emergent during the latest Pleistocene, we collected six samples for cosmogenic ^{36}Cl surface exposure dating. We also collected four samples for Ar-Ar dating to establish flow emplacement ages. Thus far we have obtained two ^{36}Cl ages from a subaerially emplaced basalt flow. Exposure ages for these samples, which lie below the regional marine limit, are 7.0 ± 0.6 and 7.1 ± 0.6 ka. In our favored scenario, this unit was emplaced after deglaciation at ~15 ka and then buried by pyroclastic deposits at ~13.2 ka. Wave action during postglacial sea-level regression eroded the overlying deposits, exposing the flow at ~7 ka. An additional ^{36}Cl age on a sample in the same unit, but above the marine limit should reveal if this scenario is valid. ^{36}Cl and Ar-Ar ages from the other three units will allow us to further constrain the history of volcanism and surface exposure at the MEVF, and to better reconstruct the dynamic late Quaternary environment of coastal Southeast Alaska.

Paleoceanographic constraints on viable windows for human migration along the Alaskan coast during the terminal Pleistocene

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Genetic evidence suggests that the primary founding populations of the Americas arose from Beringia during the Last Glacial Maximum (LGM), but the timing, pathways, and modes of their subsequent southward transit remain speculative. We utilize model simulations and multi-proxy paleoceanographic data to shed light on the ocean and climate conditions that would have prevailed in the Gulf of Alaska from the late glacial period to early Holocene to assess viable time periods in which humans could have traversed the Cordilleran coastal corridor. Our synthesis provides new insights and constraints on the debates about the first human migrations along the Pacific Northwest coastal route. We find that the cyclonic currents along the Alaskan margin would have been strengthened during the LGM and times of enhanced meltwater input, making a southward transit by boat difficult during glacial periods and times of freshwater input. We infer that the Cordilleran ice-surge episodes ("Siku events") would have been the most challenging periods for a coastal transit due to regional cooling, abundant icebergs, and strong coastal currents, possibly creating episodic (1-2 kyr) barriers to southward transit. Given the prevalence of seasonal sea ice throughout the LGM and early deglacial period, we suggest that stable winter sea ice may have acted as a platform that facilitated early coastal migrations into the Americas. Viable time periods for this scenario would likely have occurred intermittently between the Siku events when intermediate sea-ice conditions prevailed and ice-free coastal refugia were available along the Alaskan margin. We identify 24.5-22 ka and 16.4-14.8 ka as the most likely time periods to accommodate early coastal migration along the Alaskan coast.

Preliminary results from a sediment core from Parrot Lake, Dall Island, Southeast Alaska

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The existence of coastal refugia during the local Last Glacial Maximum (LGM) along the modern coast of southeast Alaska (SE AK) appears unlikely. Based on recent cosmogenic exposure dating, the Cordilleran Ice Sheet (CIS) retreated behind the modern coast of the northern and southern Alexander Archipelago 15.1±0.9 and 16.3±0.8 ka, respectfully. However, parts of the continental shelf along SE AK may have been subaerially exposed during the LGM due to lowered sea level and a forebulge from the CIS. As these areas of hypothesized refugia now lay below sea level, we rely on terrestrial records to preserve evidence of their existence. *Pinus contorta* pollen is present in the post-glacial section of sediment cores taken from SE AK, leading to one hypothesis that *P. contorta* survived in local refugia and were able to quickly populate the post-glacial landscape. Pine pollen, however, can be wind-transported hundreds of kilometers, and its presence may instead reflect long-distance dispersal from the Pacific Northwest. In contrast, the presence of ancient sedimentary DNA (sedaDNA) in a lake sediment record requires that plants were growing within the lake catchment. We collected a 4 m sediment core from Parrot Lake, Dall Island, to test the hypothesis that *P. contorta* survived in refugia and populated the post-glacial landscape in SE AK using sedaDNA. So far, we have measured magnetic susceptibility, elemental abundances, and loss-on-ignition. We have created a radiocarbon-based age-depth model from 8 macrofossils, the oldest of which is 14.7±0.4 cal ka BP. This age agrees well with cosmogenic exposure ages of deglaciation and adds an additional minimum-limiting constraint on the retreat of the CIS. This record will provide insights into the post-glacial plant communities of SE AK, and whether communities existed on refugia during the local LGM.

Exploring 'Time Immemorial' through Archaeology: Next Steps for SEAK

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When identifying data gaps in the late Quaternary history of Southeast Alaska that are relevant to the archaeological record, it is vital to consider contrasting hypotheses about the peopling of Southeast Alaska. As a coastal section of the Beringian gateway into the Americas, the popularity of the broader question of the peopling of the Americas has dominated the interpretation of the archaeology of the archipelago. We might consider approaching the search for evidence of the first peoples of Southeast Alaska at a different scale, grounded not only in our growing understanding of the development of the local post-glacial landscapes, but in consideration of how human populations would have expanded into those new environments. Oral Traditions, paleo-genetics, and the extant archaeological record all indicate that there are more ancient cultural sites hidden in the rainforest; it is worth investigating data gaps for multiple possible routes for human expansion into the region if we are to find, learn from, and protect these places.

The Bølling-Allerød to Early Holocene record from Sitka Sound Alaska, USA: Transition from proglacial lake to open ocean

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The deglacial history of the Northeast Pacific Ocean margin is complex, reflecting abrupt environmental changes that include sea level rise, enhanced volcanic activity, and the retreat of the Cordilleran Ice Sheet. Sediment core EW0408-40JC (56.99° N, 135.48° W, 216 m water depth, 1161 cm core length) was recovered from Sitka Sound on the southeastern Alaska continental margin to help understand this complex set of changes and provide a new record of changing regional aquatic ecosystems. The age model for this core is based on six radiocarbon dates (error ~+/- 60 years) and the age of the Mount Edgecumbe dacite tephra, and spans the interval 14,400-11,500 cal yr B.P., with a median sedimentation rate of >0.6 cm/yr. This age model, when paired with ultra-high-resolution 3D computerized tomography scans, documents a clear transition from a proglacial(?) lake to the marine conditions in Sitka Sound today.

Between ~14,400 and 12,900 years, the diatom assemblage is dominated (up to 80% of the assemblage) by Aulacoseira spp. and Stephanodiscus spp., indicating a freshwater lake. At the beginning of the YD there is an abrupt increase in freshwater diatoms followed by a gradual decrease to less than 20% and the end of the YD; brackish and marine species make their appearance at this time. During this interval, biogenic silica concentrations decrease from more than 25 to around 10 wt.%. Although present from about 12,700 cal yr B.P., sea ice diatoms never comprise more than 9% of the assemblage, and generally account for only a few percent of the assemblage. The Holocene section above the unconformity contains a diatom assemblage composed of brackish-marine and marine taxa which reflects modern oceanographic conditions.

These data constrain the timing of the collapse of the northern edge of the forebulge west of Baranof Island as the basin sill enclosing a proglacial lake was breached and the basin was flooded by saline water. Baichtal et al. (2021, Geosphere. https://doi.org/10.1130.GES02359.1.) have suggested a median age of 12,000 +/- 200 cal yr B.P. as a minimum-limiting age of inundation based on a radiocarbon-dated bivalve. A high-resolution opal and microfossil record indicates that the sill was breached more than 500 years earlier, shortly after the beginning of the Younger Dryas (YD). Fluctuations in the diatom assemblages indicate that the transition from freshwater lake to marine conditions may have taken more than 500 years.

Dark birds stay home in the cold and wet: Variation at genes associated with melanization and migratory propensity in four North Pacific migratory bird species

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Gloger's Rule, one of most well-known ecogeographical principles, states that individuals in wet humid regions tend to be more heavily pigmented than their conspecifics in more arid environments. Such is the case with avian subspecies endemic to the forests of the North Pacific Coast (NPC), which are as a general rule darker- (or more deeply-) plumaged and more sedentary than their conspecifics in other parts of their range. Clear examples of this pattern include the Queen Charlotte goshawk and Prince of Wales spruce grouse, and is also evident for non-old forest obligate subspecies such as the Vancouver Canada goose and Peale's peregrine falcon. Melanin polymorphisms—classically due to polymorphisms in the melanocortin-1 receptor (MC1R) gene—have been implicated in the expression of many phenotypic traits, including variation in dispersal and migratory tendencies, which have been shown to be correlated with length polymorphisms of the adcyap1 gene. Pleiotropy and the evolution of adaptive gene complexes are often invoked as the mechanism behind such associations between different signaling cascades. Here we summarize ongoing research that examines neutral genetic data in relation to possible mechanisms influencing the degree of isolation and lineage differentiation within the context of refugial persistence and population expansion, and functional genetic data thought to influence complex polygenic characters used to diagnose current subspecies, including migratory behavior (adcyap1) and plumage coloration (MC1R). We ask the following questions comparing patterns between NPC resident subspecies and migratory conspecifics from other regions: (1) does allele size at the adcyap1 gene correspond with movement propensity? (2) are there functional amino acid changes at MC1R corresponding to darker plumage? (3) is there concordance between lineage differentiation based on neutral and functional loci? and (4) what are the inferences about the historical ecology of NPC and evolutionary trajectories of extant lineages species?

Cosmogenic exposure ages indicate no MIS 2 refugee on southern Baranof Island, USA

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The late-Pleistocene history of the coastal Cordilleran Ice Sheet remains relatively unstudied compared to chronologies of the Laurentide Ice Sheet. Yet accurate reconstructions of Cordilleran Ice Sheet extent and the timing of ice retreat along the Pacific Coast are essential for paleoclimate modeling, assessing meltwater contribution to the North Pacific, and determining the availability of ice-free land along the coastal Cordilleran Ice Sheet margin for human migration from Beringia into the rest of the Americas. To improve the chronology of Cordilleran Ice Sheet history in the Alexander Archipelago, Alaska, we applied 10Be and 36Cl dating to boulders and glacially sculpted bedrock in areas previously hypothesized to have remained ice-free throughout the local Last Glacial Maximum (LLGM; 20–17 ka). Results indicate that these sites, and more generally the coastal northern Alexander Archipelago, became ice-free by 15.1 ± 0.9 ka (n = 12 boulders; 1 SD). We also provide further age constraints on deglaciation along the southern Alexander Archipelago and combine our new ages with data from two previous studies. We determine that ice retreated from the outer coast of the southern Alexander Archipelago at 16.3 ± 0.8 ka (n = 14 boulders; 1 SD). These results collectively indicate that areas above modern sea level that were previously mapped as glacial refugia were covered by ice during the LLGM until between ~ 16.3 and 15.1 ka. As no evidence was found for ice-free land during the LLGM, our results suggest that previous ice-sheet reconstructions underestimate the regional maximum Cordilleran Ice Sheet extent, and that all ice likely terminated on the continental shelf. Future work should investigate whether presently submerged areas of the continental shelf were ice-free.

Southeast Alaska caves: A paleo-perspective

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With over 600 caves discovered in southeast Alaska, and more being found every year, much can be learned from this unique northerly setting of caves. In particular, speleothems (secondary calcite deposits) found within these caves are important archives that can be used to piece together the climate history of the region. This is due to precise U/Th dating, high-resolution climate signals, and multiple climate proxies. Further, because caves act as shelters against previous glaciations, speleothem climate records are able to extend to previously unattainable time periods for this region. Yet, southeast Alaska speleothem studies remains in its infancy. Here, I will discuss what is currently known from speleothem paleoclimate research in southeast Alaska, and then discuss the gaps in knowledge related to this field and how to address it.

Previously undocumented early-Holocene activity of Mount Edgecumbe, Sitka region

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The Mount Edgecumbe Volcanic Field (MEVF) is located on Kruzof island, 16 km west of the town of Sitka, Alaska. Local mapping and documentation of tephras related to the MEVF in marine cores show a burst of activity in the late Pleistocene, likely related to deglaciation of the region. However, there is little understanding of eruptive activity after this time, with only two potential tephras dating to the Holocene tentatively identified in peat deposits on Kruzof. Recent seismic activity and deformation at this complex show a pressing need to understand Mount Edgecumbe's Holocene eruptive history. On Biorka Island to its south, a previously undescribed tephra sequence was mapped that contains 5-7 individual depositional units. Radiocarbon dates from below the sequence (9820-10180 cal yr BP) and mid-sequence (8200-8380 cal yr BP) show that these tephras were deposited during the early Holocene. Glass geochemistry was successfully obtained from seven of eight samples, with results geochemically consistent with MEVF tephras found in marine cores across Sitka Sound. This sequence reveals previously undocumented Holocene activity of the MEVF. These findings could adjust plume directions inferred from previous work and alter hazard assessments of the volcano.