



# **Proceedings and Abstracts for the Hakai Research Exchange 2014**

*October 24th, 2014*

*Mary Winspear Centre, Sidney, BC*

*09:15-18:30*

*Hosted by UVic Faculty of Social Sciences and Faculty of Law*

*Livestreaming: <http://www.livestream.com/hakairesearchexchange2014>*

*Hashtag: #HakaiResearch*

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## Agenda

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### **Opening Remarks**

**09:15 – 10:00**

*WSÁNEĆ (Saanich) First Nation – Welcome from a local Elder*

*Event Emcee: Ian Walker, UVic Geography*

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Eric Peterson, President, Hakai Institute

Catherine Krull and Jeremy Webber, Deans, UVic Faculties of Social Sciences and Law

Nancy Turner, Hakai Professor, UVic Environmental Studies

Harvey Humchitt, Research Liaison, Heiltsuk Integrated Resource Management  
Department

Jennifer Walkus, Research Liaison, Wuikinuxv Resource Stewardship Department

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## Oral Presentations

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### **Session 1: Landscape History and Coastal Sand Ecosystems**

**10:00 – 10:30**

*Theme Leader: Ian Walker, UVic*

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#### **Landscape History of Calvert Island**

Ian Walker and Olav Lian

#### **Toward a Luminescence Chronology for Coastal Dune and Beach Deposits on Calvert Island, British Columbia Central Coast, Canada**

Christina Neudorf, Olav Lian, Ian Walker, Dan Shugar, Jordan Eamer, and Libby Griffin

#### **Post-Glacial Sea Levels in Pacific North America – Hinge Zones and Human Occupation**

Dan Shugar, Duncan McLaren, Ian Walker, Olav Lian, Christina Neudorf, and Daryl Fedje

#### **A Significant Late Pleistocene Glacial Re-Advance during Retreat of the Cordilleran Ice Sheet on the Central Coast of British Columbia**

Jordan Eamer, Dan Shugar, Ian Walker, Olav Lian, Christina Neudorf, and Alice Telka

#### **Overview of Coastal Sand Ecosystem Program**

Derek Heathfield and Ian Walker

#### **Where Does the Sand Come From?**

Brian Menounos

#### **Soil Evolution and Diversity on Sandy Substrates, Calvert Island, BC**

Paul Sanborn

**Assessing the Role of Large Woody Debris on Beach-Dune Morphodynamics and Shoreline Change Using Aerial Photography, Photogrammetry, and Terrestrial LiDAR.**

Michael Grilliot and Ian Walker

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**Session 2: Human Habitation and Ancient Knowledge: The Calvert Island Region**

**10:35 – 11:05**

*Theme Leader: Duncan McLaren, UVic Anthropology*

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**Cultural Processes and Occupation Site Continuity in the Hakai Passage Region**

Duncan McLaren

**Origin Story**

Gitla Elroy White

**Animals, People and Plants: Supporting Traditional Cultural Values and Relationships in Contemporary Management**

Jonaki Bhattacharyya

**Deep Time on the Central Coast: First Nations History and Environmental Change**

Farid Rahemtulla

**“In the Shadow of *Mnsgmxdhi*”: from Mountain Top to Ocean Floor: A Cultural and Ecological History of North Hunter Island**

Jennifer Carpenter, Dana Lepofsky, Nancy Turner, Julia Jackley, Jonaki Bhattacharyya, Elroy White, Fiona Chambers, Darcy Mathews, Desirée Lawson, Josh Vickers, Andrea née Walkus Vickers, and Danny Windsor

**The Convergence of Archaeology and Ecology at Hakai: Insights from a Short-Course Hosted in May 2014**

Iain McKechnie and Margot Hessing-Lewis

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**Session 3: Human Habitation and Ancient Knowledge: The Discovery Islands Region**

**11:10 – 11:40**

*Theme Leader: Daryl Fedje, UVic Anthropology*

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**Discovery Islands Archaeology: Introduction and Paleoecology**

Daryl Fedje

**Discovery Islands Archaeology: 2014 Archaeological Research**

Quentin Mackie and Daryl Fedje

**The Social and Ecological Contexts of Ancient Mariculture around Bella Bella and Quadra Island**

Dana Lepofsky, Nicole Smith, Ginevra Toniello, Quentin Mackie, Daryl Fedje, Louis Wilson, and Elroy White

**Toward a Chronology for Clam Garden Construction on Quadra Island, British Columbia, Canada**

Christina Neudorf, Nicole Smith, Dana Lepofsky, and Olav Lian

**Sand, Silt and Archaeology in the Discovery Islands**

Alex Lausanne

**Lithic Landscapes of the Discovery Islands**

Cal Abbott

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**Session 4: Research for Communities and Society**

**11:45 – 12:15**

*Theme Leader: Deborah Curran, UVic*

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**A Community-Engaged Approach to Long-Term Monitoring of Coastal Bears**

Megan Adams, Kyle Artelle, Heather Bryan, Jennifer Carpenter, Chris Darimont, Krista Duncan, Jess Housty, William Housty, Howard Humchitt, Jason Moody, Megan Moody, Doug Neasloss, Scott Rogers, Christina Service, and Jennifer Walkus

**QQS Community Salmon Program: Building Capacity for Salmon Research and Monitoring on the Central Coast of BC**

Will Atlas

**An Agenda for Law Reform: The Need to Publicly Disclose Diseases on BC Fish Farm**

Sam Harrison

**Engaging Science to Address Policy and Management Issues Relevant to Central Coast Nations**

Alejandro Frid

**Science, Litigation and the Public Interest**

Anthony Ho and Erin Placatka

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**LUNCH and POSTER SESSION: 12:20 – 13:20**

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**BC PARKS AWARD CEREMONY: 13:25 – 13:35**

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**Session 5: The Kwakshua Watershed Project and Community Ecology of Calvert  
Island: Part 1  
13:40 – 14:10**

*Theme Leaders: Ian Giesbrecht, Hakai Institute and Ken Lertzman, SFU*

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**Kwakshua Watershed Project Introduction**

Ken Lertzman and Ian Giesbrecht

**Soils Across a Landscape Gradient**

Paul Sanborn

**Microbial Communities across the Kwakshua Watershed Landscape and Seascapes**

Colleen Kellogg, Ian Geisbrecht, Thierry Heger, Brian Hunt, Allison Oliver, Melanie Scofield, Suzanne Tank, Bill Mohn, and Steven Hallam

**Terrestrial Ecosystem Responses to Past and Present Environmental Change**

Andrew Trant and Brian Starzomski

**A Burning Question: Reconstructing Fire Disturbances on the Outer Coast**

Kira Hoffman and Brian Starzomski

**Landscape Ecology and Mapping**

Ian Giesbrecht

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**Session 6: The Kwakshua Watershed Project and Community Ecology of Calvert  
Island: Part 2  
14:15 – 14:40**

*Theme Leaders: Ian Giesbrecht, Hakai Institute and Ken Lertzman, SFU*

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**The Kwakshua Watershed Program: Water, Weather and Dissolved Organic Carbon (DOC) Fluxes**

William Floyd, Maartje Korver, Colby Owen, James McPhail, Suzanne Tank, Ian Giesbrecht, Allison Oliver, Ray Brunsting, and Ilja van Meerveld

**Freshwater Export of DOM and Nutrients from Kwakshua Watersheds to Near Shore Marine Ecosystems: Improving Understanding of Watershed Processes and Terrestrial-Marine Linkages**

Allison Oliver, Suzanne Tank, Brian Hunt, Ian Giesbrecht, Colleen Kellogg, Skye McEwan, and Ken Lertzman

**Marine and Freshwater Microbial Ecology**

Colleen Kellogg

**Kwakshua Channel Oceanography and Food Webs – Towards an Integrated Understanding of Land-Sea Connections**

Brian Hunt, Bryn Fedje, Ian Giesbrecht, Colleen Kellogg, Skye McEwan, Lawren McNab, Bill Mohn, Allison Oliver, Nelson Roberts, Suzanne Tank, Adam Turner, and Kang Wang

**Kwakshua Watershed Project Summary**

Ken Lertzman

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**COFFEE BREAK: 14:45 – 15:00**

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**Session 7: Outer Shores 1: The Otter Landscape**

**15:05 – 15:35**

*Theme Leaders: Erin Rechsteiner and Margot Hessing-Lewis, Hakai Institute*

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**Changes in Sea Otter Foraging Behavior and Habitat-Use on the Central Coast of British Columbia**

Erin Rechsteiner, Angeleen Olson, Linda Nichol, Jane Watson, Keith Holmes, Luba Reshitnyk, Margot Hessing-Lewis, Leah Honka, and Anne Salomon

**Hakai SEAggrass Research**

Margot Hessing-Lewis, Erin Rechsteiner, Angeleen Olson, Megan Vaughan, Mary O'Connor, Francis Juanes, and Brent Hughes

**Habitat Mapping: Place-Based Research**

Luba Y. Reshitnyk and Keith R. Holmes

**Tipping Points in North Pacific Kelp Forest Ecosystems**

Anne K. Salomon, Kyle Demes, Jenn Burt, Leah Honka, Kira Krumhansl, Lynn Lee, Linda Nichol, Angeleen Olson, Josh Silberg, Christine Stevenson, Jane Watson, Gitla Elroy White, and Kii' iljuus Barb Wilson

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**Session 8: Outer Shores 2 - A Marine Mix**

**15:40 – 16:10**

*Theme Leader: Katy Hind, UBC*

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**Integrative Taxonomic Approaches to Understanding Marine Diversity at Hakai Institute**

Katy Hind and Patrick Martone

**Seaweed Studies at Hakai: An Update**

Sandra Lindstrom, Katy Hind, and Patrick Martone

**Introducing Microbes to Macrophytes**

Laura Wegener Parfrey

## **Island Biogeography and Ecosystem Subsidies on the BC central coast**

John Reynolds, Brian Starzomski, Chris Darimont, Trisalyn Nelson, and Luba Reshitnyk

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### **Session 9: Marine Food Webs**

**16:15 – 16:45**

*Theme Leaders: Brian Hunt, UBC and Margot Hessing-Lewis, Hakai Institute*

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#### **Hakai Institute Ocean Monitoring: Calvert Island Node**

Brian Hunt, Bryn Fedje, Ian Giesbrecht, Wayne Jacob, Colleen Kellogg, Skye McEwan, Lawren McNab, Bill Mohn, Allison Oliver, Nelson Roberts, Suzanne Tank, Adam Turner, and Kang Wang

#### **Initiating a Sampling Program of Nearshore Fish Communities around Calvert Island**

Trevor Haynes, Margot Hessing-Lewis, Midoli Bresch, Brian Hunt, Carolyn Knapper, Ben Millard-Martin, and Evgeny Pakhomov

#### **Pacific Herring Research at Hakai Institute**

Margot Hessing-Lewis, Brian Hunt; *Dive team* – Joel Harding, Brittany Keeling; *Feeding biology*: Reg Moody, Evgeny Pakhomov, Nikita Sergeenko; *Genetics*: Lorenz Hauser, Eleni Petrou, Mike Reid; *Herring Midden records*: Iain McKechnie; *Microchemistry*: Tony Pitcher, Wade Smith; *Modelling*: Dan Okomoto, Colette Wabnitz; *Oceanography*: Bryn Fedje, Lawren McNab, Skye McEwan, Nelson Roberts, Adam Turner; Anne Salomon; Dana Lepofsky, and Suzanne Vonderporten

#### **Stable Isotope Analysis of Rivers Inlet Sockeye Salmon (*Oncorhynchus nerka*): Investigating the Contribution of Environmental Conditions in the High Seas to British Columbia Population Declines**

Yago Doson Coll, Brian Hunt, and Evgeny Pakhomov

#### **Quadra Ocean Monitoring and the Salmon Early Marine Survival Program**

Brian Hunt, Cheryl Chow, Brendan Connors, Megan Foss, Wayne Jacob, Colleen Kellogg, Martin Krkosek, Kate Lansley, Evgeny Pakhomov, Luke Rogers, Curtis Suttle, Marc Trudel, and Kevin Weng

#### **Pelagic Forage Fish and Salmon Marine Survival: Smolt Growth**

Evgeny Pakhomov (see abstracts for Sergeenko et al., Stocks et al., and Egorova et al.)

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### **Conference closing remarks**

**16:45 – 16:50**

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**POSTER and INTERACTION SESSION (with cash bar and food): 16:50 - 18:30**

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## **Poster Presentations**

12:20 – 13:20 & 16:50 – 18:30

### **LANDSCAPE HISTORY**

#### **Paleoecology at Hakai: Current and Proposed Studies**

Jennifer Eamer

#### **A Significant Late Pleistocene Glacial Re-Advance during Retreat of the Cordilleran Ice Sheet on the Central Coast of British Columbia**

Jordan Eamer, Dan Shugar, Ian Walker, Olav Lian, Christina Neudorf, and Alice Telka

#### **The 1964 Alaska Tsunami Preserved within Intertidal Wetland Sediments of Rivers Inlet**

Jonathan Hughes

#### **Postglacial Landscape Evolution of Savary Island, British Columbia**

Libby Griffin, Olav Lian, John Clague, Brent Ward, and Jordan Bryce

#### **An Example of the Importance of using Multiple Dating Methods, Calvert Island, British Columbia**

Libby Griffin, Christina Neudorf, Olav Lian, Ian Walker, Dan Shugar, and Jordan Eamer

#### **Assessing the Role of Large Woody Debris on Beach-Dune Morphodynamics and Shoreline Change Using Aerial Photography, Photogrammetry, and Terrestrial LiDAR.**

Michael Grilliot and Ian Walker

#### **Refining Luminescence Dating Procedures for Feldspar on Calvert Island, British Columbia Central Coast, Canada**

Christina Neudorf, Olav Lian, Ian Walker, Dan Shugar, Jordan Eamer, and Libby Griffin

#### **Post-Glacial Sea Levels in Pacific North America – Hinge Zones and Human Occupation**

Dan Shugar, Duncan McLaren, Ian Walker, Olav Lian, Christina Neudorf, and Daryl Fedje

### **HUMAN HABITATION AND ANCIENT KNOWLEDGE**

#### **Mountain Top to Ocean Floor: The Eco-cultural History of *Hauyat***

Julia Jackley, Dana Lepofsky, Nancy Turner, and Jennifer Carpenter

#### **EjTa-15: Archaeological Excavations on the North Shore of Pruth Bay**

Jess Barton and Duncan McLaren

**“In the Shadow of *Mnsgmxdhi*”: from Mountain Top to Ocean Floor: A Cultural and Ecological History of North Hunter Island**

Jennifer Carpenter, Dana Lepofsky, Nancy Turner, Julia Jackley, Jonaki Bhattacharyya, Elroy White, Fiona Chambers, Darcy Mathews, Desirée Lawson, Josh Vickers, Andrea née Walkus Vickers, and Danny Windsor

**“Everything Revolves around the Herring”: Continuity and Transformation of the Heiltsuk Herring Fishery through Time**

Alisha Gauvreau

**Lithic Artifacts from Early Period Archaeological Sites, Hakai Ancient Landscapes Archaeology Project**

Cecilia Porter and Jenny Cohen

**Local Observations of Climate Change**

Valentina Savo, Dana Lepofsky, Jordan Benner, and Ken Lertzman

**Rock Art: Paintings and Carvings in Owikeno Lake and Roscoe Inlet**

Aurora Skala

**Emerging Stories from the Discovery Islands Landscape Archaeology Project**

Nicole Smith, Daryl Fedje, Quentin Mackie, Cal Abbott, Jenny Cohen, Alex Lausanne, Alexander Mackie, Duncan McLaren, Joanne McSporran, Christine Roberts, and Louis Wilson

**Reconstructing Human-Environment Interactions on the Northwest Coast through the Ancient DNA Analysis of Faunal Remains**

Dongya Yang

**RESEARCH FOR COMMUNITIES AND SOCIETY**

**A Community-Engaged Approach to Long-Term Monitoring of Coastal Bears**

Megan Adams, Kyle Artelle, Heather Bryan, Jennifer Carpenter, Chris Darimont, Krista Duncan, Jess Housty, William Housty, Howard Humchitt, Jason Moody, Megan Moody, Doug Neasloss, Scott Rogers, Christina Service, and Jennifer Walkus

**The Environmental Law Centre (ELC) at Work**

Holly Pattison and Calvin Sandborn

**KWAKSHUA WATERSHED PROJECT AND COMMUNITY ECOLOGY OF CALVERT ISLAND**

**How have Past Sites of Habitation Influenced Present-Day Ecology on the Central Coast of British Columbia?**

Julia Fisher and Brian Starzomski

**Patterns of Protist Diversity across Different Ecosystems at Hakai**

Thierry Heger, Ian Giesbrecht, Colleen Kellogg, Kira Hoffman, Ken Lertzman, Bill Mohn, and Patrick Keeling

**A Burning Question: Reconstructing Fire Disturbances on the Outer Coast**

Kira Hoffman and Brian Starzomski

**Developing a Novel Detection Method for Freshwater Fish using Environmental DNA**

Jeff MacAdams, Morgan Hocking, and Brian Starzomski

**Freshwater Export of DOM and Nutrients from Kwakshua Watersheds to Near Shore Marine Ecosystems: Improving Understanding of Watershed Processes and Terrestrial-Marine Linkages**

Allison Oliver, Suzanne Tank, Brian Hunt, Ian Giesbrecht, Colleen Kellogg, Skye McEwan, and Ken Lertzman

**Losing the Bog to the Trees: Testing the Role of Long Term Change in Ecosystem Recovery from Disturbance**

Nancy Shackelford, Rachel Standish, Kira Hoffman, and Brian Starzomski

**Terrestrial Ecosystem Responses to Past and Present Environmental Change**

Andrew Trant and Brian Starzomski

**OUTER SHORES**

**Pattern, Process, and Preferences: Implications for Kelp Forest Recovery on High Latitude Temperate Reefs**

Jenn Burt and Anne Salomon

**Biomass, Productivity, and Resilience of *Macrocystis integrifolia* to Canopy Disturbance in High Latitude Kelp Forests**

Kira Krumhansl and Anne Salomon

**From Seagrass to Kelp Forests: Effects of Habitat Connectivity on Temperate Nearshore Fish Recruitment and Growth**

Angeleen Olson, Francis Juanes, Margot Hessing-Lewis, and Anne Salomon

**Habitat Mapping: Place-Based Research**

Luba Reshitnyk and Keith Holmes

**Indirect Effects of Sea Otter Recovery on Temperate Reef Fish**

Josh Silberg and Anne Salomon

**When Size Matters: Accounting for Size-Specific Predation and Grazing Rates Improves our Ability to Predict Trophic Cascades**

Christine Stevenson, Kyle Demes, and Anne Salomon

**MARINE WEB DYNAMICS**

**Quadra Ocean Monitoring and the Salmon Early Marine Survival Program**

Brian Hunt, Cheryl Chow, Brendan Connors, Megan Foss, Wayne Jacob, Colleen Kellogg, Martin Krkosek, Kate Lansley, Evgeny Pakhomov, Luke Rogers, Curtis Suttle, Marc Trudel, and Kevin Weng

**Hakai Institute Ocean Monitoring: Calvert Island Node**

Brian Hunt, Bryn Fedje, Ian Giesbrecht, Wayne Jacob, Colleen Kellogg, Skye McEwan, Lawren McNab, Bill Mohn, Allison Oliver, Nelson Roberts, Suzanne Tank, Adam Turner, and Kang Wang

**INDEPENDENTLY SUBMITTED**

**Working Together to Achieve Healthy and Sustainable Salmon Populations in Rivers Inlet**

Karl English, Rick Hansen, Sid Keay, Ted Walkus, Tony Allard, Brian Riddell, John McCulloch, Sandie MacLaurin, Dave Rolston, Erik English, Peter Johnson, Chris McConechy, and Billie Johnson

**Hakai Magazine, Exploring Science and Society in Coastal Ecosystems**

Jude Isabella, Dave Garrison, Mark Garrison, and Gord More

**Preliminary Metadata in Support of Calvert Island Beach Microbiomes**

Vera Tai\*, Noriko Okamoto\*, Patrick Keeling (\*equal contribution)

## Abstract List

Abstracts ordered alphabetically by last name of primary author

### Lithic Landscapes of the Discovery Islands

Cal Abbott – Department of Anthropology, University of Victoria

Session - Human Habitation and Ancient Knowledge: Discovery Islands

#### Oral Presentation Abstract

Archaeological investigations of the Discovery Islands Ancient Landscapes Project have produced promising preliminary data that hint to the region's rich human history. The 2014 field season involved prospective testing at 14 archaeological sites on Quadra Island. Subsurface tests and surface collections yielded numerous stone tools sampled for analysis. Visual and geochemical analyses of tool typologies and raw materials offer insights into site functionality and engagements with the landscape on a regional scale. By comparing and contrasting the temporal and spatial distributions of stone tool typologies and the selection of raw materials, an outline of the culture history of the study area as inferred through lithic technologies is achievable. These inferences can be refined through the construction of a spatial interaction model of the flow of materials, technologies, practices and people at multiple scales. In this presentation I discuss the interpretive potential of obsidian artifacts collected in 2014. Due to the limited availability of obsidian sources and their unique geochemical signatures, obsidian artifacts provide a means of empirically investigating the movement of raw materials across the landscape as well as trade networks and social interactions amongst ancient people on a broad regional scale.

### A Community-Engaged Approach to Long-Term Monitoring of Coastal Bears

Megan Adams<sup>a,b,c</sup>, Kyle Artelle<sup>a,b,c,j</sup>, Heather Bryan<sup>a,b,c</sup>, Jennifer Carpenter<sup>d</sup>, Chris Darimont<sup>a,b,c</sup>, Jess Housty<sup>e</sup>, William Housty<sup>e</sup>, Jason Moody<sup>f</sup>, Megan Moody<sup>f</sup>, Doug Neasloss<sup>g,h</sup>, Scott Rogers<sup>b</sup>, Christina Service<sup>a,b,c,h</sup>, and Jennifer Walkus<sup>i</sup>

<sup>a</sup> Applied Conservation Science Laboratory University of Victoria

<sup>b</sup> Hakai Institute

<sup>c</sup> Raincoast Conservation Foundation

<sup>d</sup> Heiltsuk Integrated Resource Management Department

<sup>e</sup> Qqs Projects Society

<sup>f</sup> Nuxalk Stewardship Office

<sup>g</sup> Spirit Bear Research Foundation

<sup>h</sup> Kitasoo/Xai'xais Integrated Resource Authority

<sup>i</sup> Wuikinuxv Stewardship Department

<sup>j</sup> Earth to Oceans Group, Simon Fraser University

Session - Research for Community and Societies

#### Oral and Poster Presentation Abstract

Bears are ecologically, culturally, and economically important to the ecosystems and people of coastal BC. Accordingly, they comprise conservation and management priorities for the Kitasoo/Xai'xais, Nuxalk, Heiltsuk, and Wuikinuxv First Nations. The relationships among bears, salmon, and people also provide opportunity for scholars to conduct conceptually interesting research. Our program consists of collaborative studies among the Nations and partnering research organizations, where community leaders and scientists work together

towards shared research priorities, questions, and outcomes. Emerging under the direction of the Central Coast Bear Working Group, we now monitor grizzly, black, and Spirit bears over ~ 20,000 km<sup>2</sup>. Most research involves investigating bear population trends in relation to food availability (particularly salmon) and other landscape characteristics. Specific research goals differ among territories but all work integrates non-invasive snagging of bear hair with local knowledge as well as innovative laboratory, spatial, and analytical approaches to gain insight into bear population ecology and health. Initial insights from this research program have been diverse: 1) salmon consumption by bears varies markedly over space, 2) bear populations are declining in the Kvai watershed, possibly in relation to declining salmon numbers, 3) salmon declines may influence bear health as shown through a linked relationship between salmon abundance and stress hormones in bear hair, and 4) coastal grizzly bears have recently expanded their range to include some coastal islands. Additionally, the trophy hunt of grizzly bears is an important concern and a research priority across Nations. Research by our group identified considerable shortcomings in the rigour of current provincial hunt management. Our community-engaged approach provides opportunities for all participants to learn from one another, cultivates relationships among collaborators, and generates long-term data about coastal carnivores that addresses not only scholarly questions but also specific conservation and management priorities identified by each community.

### **QQS Community Salmon Program: Building Capacity for Salmon Research and Monitoring on the Central Coast of BC**

Will Atlas - Hakai Scholar and PhD Student, QQS Projects Society Salmon Program Coordinator  
Session – Research for Communities and Society

#### Oral Presentation Abstract

First Nations across British Columbia are increasingly taking an active role in monitoring and stewardship of the natural resources within their territory. With this growing responsibility, there is a strong need to develop capacity and programs that support management of food, social and ceremonial fisheries. In the Heiltsuk First Nation community of Bella Bella, QQS Projects Society has been working in partnership with the Hakai Institute and SFU to develop research and monitoring programs for key populations of salmon in several ecologically and culturally significant watersheds. Through projects such as the Koeye River fish weir and smolt trap, and annual monitoring of abundance and life histories we are creating a foundation of information to support resilient fisheries and adaptive management in the 21<sup>st</sup> century. In addition to providing monitoring data, these projects and partnerships are also providing exciting opportunities for research into how life-history variation across watersheds supports more stable, diverse fisheries and ecosystem function. We are also working to expand monitoring programs in the Koeye and Namu Rivers to address how our changing climate may affect survival and migration behavior in thermally sensitive populations of sockeye salmon across the region.

### **EjTa-15: Archaeological Excavations on the North Shore of Pruth Bay**

Jess Barton and Duncan McLaren

Hakai Institute and University of Victoria, Department of Anthropology

#### Poster Presentation Abstract

Archaeological work undertaken at site EjTa15 in Pruth Bay, Calvert Island, has uncovered deposits, artifacts, and features dating to the early Holocene (10,000-8,000 years ago). For the

most part these early period deposits are shell-free. Overlying strata are also archaeological, they date later than 3,500 calendar year ago, and include a thin shell midden deposit. Lithics are common in most strata. The elevation of the earliest deposit is at the upper intertidal zone. During the 2014 field season, 11 excavation units were opened up to sample these deposits. Out of the 11 units, two were located in the mid-intertidal zone, eight were located at the vegetation/high tide line, and one was situated 17 metres inland from the shoreline. Included amongst the archaeological features uncovered at this site to date is an expansive cobble rich feature. We are conducting analysis to address three main hypotheses pertaining to this feature: Is it a hearth? Is it a living surface stabilized by cobble fill? Is it a naturally occurring feature (marine deposited sediment)? Analysis of the material collected from the feature is drawn upon in order to address these hypotheses. Overall, the archaeological deposits at EjTa15 demonstrate multiple occupations and intensive land use in the Pruth Bay region over thousands of years.

### **Animals, People and Plants: Supporting Traditional Cultural Values and Relationships in Contemporary Management**

Jonaki Bhattacharyya – Hakai Post-Doctoral Fellow, University of Victoria

Session - Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region

#### Oral Presentation Abstract

This exploratory research engages Indigenous knowledge and social science methods to identify and understand relationships among people, animals and plants in parts of the Central Coast, particularly estuarine environments. The study is currently focused in Heiltsuk Territory, particularly Hauyat (north Hunter Island), and Clatsja (near Roscoe Inlet). With guidance and collaboration from Heiltsuk Advisors, researchers' approach to this project is based in Indigenous research methodologies and participatory ethnographic methods, including interviews. Qualitative analysis based in grounded theory will involve coding for emergent themes and meanings. The purpose of the research is to:

- identify and characterize key relationships between people, animals and plants in estuarine environments,
- understand and articulate the local knowledge and cultural values pertaining to those relationships; and
- explore how those traditional relationships, knowledge and values can inform and influence resource management, land use planning and community development and resilience.

Local understandings and memories of animal-human relationships are a rich and deeply embedded part of Heiltsuk connection to land and place through time. Specific relationships among animals, people and places in stories, dances, songs, and memories provide strong guidance and codification of traditional law relevant to contemporary social protocol, governance, and resource management.

## **Pattern, Process, and Preferences: Implications for Kelp Forest Recovery on High Latitude Temperate Reefs**

Jenn Burt<sup>a,c</sup> and Anne Salomon<sup>b,c</sup>

<sup>a</sup> Ph.D. Student, School of Resource and Environmental Management, Simon Fraser University

<sup>b</sup> School of Resource and Environmental Management, Simon Fraser University

<sup>c</sup> Hakai Institute

Session – Outer Shores 1: The Otter Landscape

### Poster Presentation Abstract

Kelp forests are known to shift rapidly in response to environmental and biological perturbations. What is less well known, are the mechanisms influencing large-scale phase shifts; the thresholds at which these transitions occur; the spatial extent to which canopy kelp cover and composition shifts over time; and whether the values and preferences of coastal communities also shift in response to these ecological transitions. We have begun to examine these questions on the Central Coast of British Columbia where sea otters have recently recovered and are rapidly expanding their range. This summer we conducted subtidal grazing experiments at eight rocky reef sites to quantify how the abundance, size and behaviour of red urchins (*Mesocentrotus franciscanus*), as well as drift abundance, wave exposure, and the presence of other algal species influence the rate of kelp loss. Preliminary results show that grazing rates were highly variable among sites, and also among patches within sites, and that total grazing rates varied as a function of ambient urchin density such that kelp loss initially increased at low ambient sea urchin abundance, but then saturated at high urchin densities. This summer we also conducted a pilot study to explore the values and trade-offs associated with kelp system components and how they might differ between coastal First Nation communities in relation to their exposure to sea otter reintroduction. These data, along with our annual kelp forest monitoring and information from spatial data sources, together will help elucidate the patterns and processes associated with kelp forest recovery on the Central Coast across multiple, interconnected scales.

## **“In the Shadow of *Mnsgmxdhi*”: from Mountain Top to Ocean Floor: A Cultural and Ecological History of North Hunter Island**

Research Team: Jennifer Carpenter<sup>a</sup>, Dana Lepofsky<sup>b</sup>, Nancy Turner<sup>c</sup>, Julia Jackley<sup>b</sup>, Jonaki Bhattacharyya<sup>c</sup>, Elroy White<sup>a</sup>, Fiona Chambers<sup>c</sup>, Darcy Mathews<sup>c</sup>, Desirée Lawson<sup>a</sup>, Josh Vickers<sup>a</sup>, Andrea née Walkus Vickers<sup>a</sup>, Danny Windsor<sup>a</sup> and other research assistants, supported in part by Tula Foundation through Nancy Turner’s Hakai Chair support

<sup>a</sup> Heiltsuk Nation

<sup>b</sup> Simon Fraser University

<sup>c</sup> University of Victoria

Session – Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region

### Poster and Oral Presentation Abstract

This ongoing research, an undertaking of the Heiltsuk Nation, led by Jennifer Carpenter, Culture & Heritage Manager of HIRMD, in partnership with Dana Lepofsky, Nancy Turner and their colleagues and students, is aimed to create a better understanding of the complex history of this culturally and ecologically rich region within Heiltsuk territory. We are drawing on Indigenous knowledge and oral history, combined with archaeological and ecological surveys and experimental management to reconstruct the unique geological, ecological, and eco-cultural



history of Hunter Island, and to inform a vision for its future. In January 2014, at SFU, we hosted a meeting of Heiltsuk people living in the Lower Mainland to hear about their recollections of the region, especially during the “smokehouse” days when people stayed there for long periods of time to harvest salmon and other resources. A range of survey and mapping work, interviewing of knowledge holders, and experimental research is being undertaken: settlement areas and camps are being identified and mapped, cultural management features, including clam gardens, salmon traps, root gardens (Julia Jackley, Jonaki Bhattacharyya, Elroy White and team), crabapple stands, berry patches and vegetation of middens and habitation sites (Fiona Chambers), culturally modified trees (Darcy Mathews), and burned sites, as well as more recent garden, orchard and hunting sites, and their temporal and geographic juxtapositions, are being documented through field work and interviews to learn how the Heiltsuk have integrated their food production and other activities in past, enabling them to live sustainably in this environment. It is hoped that the knowledge gained from this research will be used to revitalize people’s management practices, both at Hunter Island and elsewhere in Heiltsuk territory, where similar practices would have occurred.

### **The ‘Lost’ Berry Gardens: Heiltsuk Berry Cultivation on British Columbia’s Northwest Coast**

Fiona Hamersley Chambers - Environmental Studies, University of Victoria

Session - Human Habitation and Ancient Knowledge: the Calvert and Hunter Islands Region

#### Project Abstract

‘Berry gardens’ have been described by Elders of the central British Columbia (BC) coast as habitats enhanced by humans for the production of wild berries, a major food source. Despite the major role historically played by berry resources in diets, landscape management, economy, culture and ceremony of Northwest Coast First Peoples, these species remain relatively unstudied and under-reported in the literature and scientific research. The purpose of my doctoral research is to better understand and characterize First Nations’ berry cultivation on the Northwest Coast. This study will first identify and define the key features/attributes of a historic berry garden, such as that described by the late Cyril Carpenter from his grandmother Bessie Brown in Roscoe Inlet. Second, this research will apply, in experimental plots, some major traditional berry management techniques, such as pruning and fertilizing. A key practical goal is ethnoecological restoration - to engage the Heiltsuk and other First Nations communities, through working with youth and Elders, with traditional berry production and to apply this knowledge and experience to broader issues of human and environmental well-being.

## **Stable Isotope Analysis of Rivers Inlet Sockeye Salmon (*Oncorhynchus nerka*): Investigating the Contribution of Environmental Conditions in the High Seas to British Columbia Population Declines**

Yago Doson Coll<sup>a</sup>, Brian Hunt<sup>a,b</sup>, Evgeny Pakhomov<sup>a,b</sup>

<sup>a</sup> University of British Columbia

<sup>b</sup> Hakai Institute

Session - Marine Food Web Dynamics

### Oral Presentation Abstract

Sockeye salmon (*Oncorhynchus nerka*) populations in BC have undergone various degrees of decline coinciding with a shift to a warmer phase of the Pacific Decadal Oscillation (PDO) affecting the physical and biological characteristics of the North East Pacific Ocean. Changes in ocean productivity driven by climate may cause shifts in the abundance of potential prey for salmon, impacting long-term salmon production patterns. We investigated the coupling of ocean conditions and population fluctuations using Rivers Inlet as a case study, a system that suffered probably the most catastrophic sockeye stock collapse in BC history. Stable isotope analysis was used to access information on ocean conditions stored in the carbon and nitrogen isotope ratios of archived sockeye scales for the period 1915-2013. The high level of covariance between carbon and nitrogen stable isotope time-series indicates that sockeye might have experienced substantial changes in their foraging location combined with shifts in trophic level during this period of climate variability. However, Rivers Inlet sockeye population dynamics did not appear to be impacted by open ocean conditions supporting the hypothesis that Rivers Inlet sockeye experience the highest mortality rates during the early marine stage of their life cycle. This was in contrast to Fraser River sockeye where open ocean conditions and sockeye salmon returns were strongly correlated. The methodology developed in this study is being used for ongoing monitoring of marine conditions experienced by Rivers Inlet sockeye using fish collected from the Wuikinuxv Nation's food fishery.

## **Paleoecology at Hakai: Current and Proposed Studies**

Jennifer Eamer – Hakai Institute

Session – Landscape History

### Poster Presentation Abstract

Paleoecological studies have many applications in various ongoing projects at the Hakai Institute with far reaching implications for many researchers. Vegetation history reconstructions using pollen analysis, stomata identification, and macrofossil analysis are currently being conducted at various lakes, ponds, and bogs on Calvert Island, Triquet Island, and Namu to pair with archeological data in these areas. The 2014 bog core from Triquet Island contains ~15,000 calendar years of sediment with a very detailed record from the late glacial period (highest accumulation rate at 1 cm/year). Because of this high resolution record, this core will also be used to examine late glacial bog development and hydrarch succession. Approximately 14,000 calendar years of sediment was collected in 2014 from Namu Lake, revealing a complicated sedimentological history. A bog core from Hecate Island is being used to compliment a study on fire history in the area by conducting charcoal analysis on the ~14,000 calendar years of sediment collected. A proposed project to further explore bog development would examine multiple cores along a gradient in the Tsunami Hill and western Calvert Island areas. Fossil

pollen, plant macrofossil, and testate amoebae analyses of peat cores in combination with carbon and peat humification analyses will be used to reconstruct the long-term development and dynamics of three peat bogs. This will allow us to determine the climatic and hydrological conditions that led to their formation and to differentiate the developmental stages that led to the current vegetation composition.

### **A Significant Late Pleistocene Glacial Re-advance during Retreat of the Cordilleran Ice Sheet on the Central Coast of British Columbia**

Jordan Eamer<sup>a</sup>, Dan Shugar<sup>a</sup>, Ian Walker<sup>a</sup>, Olav Lian<sup>b</sup>, Christina Neudorf<sup>b</sup>, Alice Telka<sup>c</sup>

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Session – Landscape History

#### Poster and Oral Presentation Abstract

Descriptions of the dynamics of Cordilleran Ice Sheet (CIS) retreat after the Last Glacial Maximum (LGM) have often included short-lived re-advances occurring during the Older and Younger Dryas stadial periods and into the Holocene. Proposed causes of these re-advances have included changing bed conditions (i.e. the interaction between the base of the ice and the substrate) and climatological factors, although identification of these events has been limited to southwest and central British Columbia as well as northwest Washington State. We present evidence of a post-LGM re-advance of Cordilleran ice on Calvert Island on the central coast of British Columbia between Northern Vancouver Island and Haida Gwaii. Evidence is provided by sedimentological and palaeoecological information contained in an exposed glacial advance sequence combined with LiDAR-derived geomorphic mapping of glacial features in the region. Radiocarbon ages from the sequence suggest ice advanced to—and retreated from—the western edges of the island between 15086 and 13809 cal. yr BP, respectively. These data fill an important spatial and temporal gap in knowledge of fluctuations of the retreating ice sheet margin, and have implications for climate and sea-level reconstructions, past human migration patterns, and the paleoecology of an understudied area of the Pacific Northwest.

### **Residence Time and Spatial Habitat Utilization of the Sockeye Salmon (*Oncorhynchus nerka*) Smolt in Rivers Inlet, British Columbia**

Yulia Egorova<sup>a</sup>, Evgeny Pakhomov<sup>a,b</sup>, Brian Hunt<sup>a,b</sup>

<sup>a</sup> University of British Columbia

<sup>b</sup> Hakai Institute

Session - Marine Food Web Dynamics

#### Project Abstract

A decrease in the early marine survival (EMS) of sockeye salmon is considered to be a critical factor in population declines in the Pacific north-west over the past two decades. Residence time in productive and sheltered marine waters is potentially a key contributor to EMS. Rapid growth is expected to enhance predation avoidance, improve migration speed, and providing resources to survive the first winter at sea. The purpose of this study is to investigate the variability of juvenile sockeye residence time in River Inlet during their outmigration phase. Residence time

will be measured as the number of daily rings from the point of marine entry. The latter will be determined by analysis of otolith elemental composition using *in situ* laser ablation inductively coupled with a plasma mass spectrometer (Stocks et al. 2014). Using samples collected during the Rivers Inlet Ecosystem Study (2008-2011) and new samples to be collected by the Hakai Institute salmon early marine survival program, we will determine inter-annual variability in the duration of the seaward migration and investigate the spatial and seasonal patterns of sockeye smolt migration rates. Lastly, we aim to identify the environmental drivers of smolt residence time in Rivers Inlet. The proposed research will advance our understanding of the migration behavior of Rivers Inlet sockeye smolts during their early marine phase, and the contribution of residence time to smolt growth, condition, and ultimately their early marine survival.

### **Working Together to Achieve Healthy and Sustainable Salmon Populations in Rivers Inlet**

Karl English<sup>a</sup>, Rick Hansen<sup>b</sup>, Sid Keay<sup>c</sup>, Ted Walkus<sup>d</sup>, Tony Allard<sup>e</sup>, Brian Riddell<sup>f</sup>, John McCulloch<sup>g</sup>, Sandie MacLaurin<sup>h</sup>, Dave Rolston<sup>i</sup>, Erik English<sup>a</sup>, Peter Johnson<sup>a</sup>, Chris McConechy<sup>i</sup> and Billie Johnson<sup>i</sup>

<sup>a</sup> LGL Limited

<sup>b</sup> Rick Hansen Foundation

<sup>c</sup> Ocean Trailer and Duncanby Lodge

<sup>d</sup> Wuikinuxv First Nation

<sup>e</sup> Good Hope Cannery Lodge

<sup>f</sup> Pacific Salmon Foundation

<sup>g</sup> Langara Lodge

<sup>h</sup> Department of Fisheries and Oceans

<sup>i</sup> Wuikinuxv Fisheries

Session – Independent

#### Poster Presentation Abstract

In 2011, the Wuikinuxv (Owikeeno) First Nation, local lodge owners, Fisheries and Oceans Canada, Rick Hansen Foundation, Pacific Salmon Foundation and independent scientists confirmed their commitment to work together to achieve healthy and sustainable salmon populations in Rivers Inlet. The group agreed that the initial focus should be Wannock Chinook. A Steering Committee was established to guide the development of an immediate action plan for Wannock Chinook and long-term plans for other Rivers Inlet stocks and salmon species. The initial objectives and priority actions for Wannock Chinook were set to ensure that the available resources were applied to fill the key information gaps for Wannock Chinook and build a sustainable monitoring system. From 2012-13, we made significant progress towards achieving the initial set of objectives defined in 2011. In 2014, the monitoring and enhancement systems initially developed for Wannock Chinook were expanded to provide the information needed to direct fisheries management and enhancement activities for other Rivers Inlet salmon stocks and species. Thus, we have broadened our goals for the next five years to include:

1. Design and implement improved escapement monitoring systems for chinook, sockeye and other salmon species that return to the Wannock/Owikeeno watershed;
2. To rebuild depleted salmon stocks through a combination of improved monitoring, fisheries management actions and targeted enhancement efforts;
3. Secure funding for monitoring and enhancement efforts in Rivers Inlet and ensure these efforts are consistent with escapement goals and stock recovery plans; and

4. Provide information that could be used to make better in-season fisheries management decisions and guide the development of plans for future fisheries in Rivers Inlet.

These goals will be achieved by combining local knowledge, modern technology and successful leadership models from other efforts supported by the Rick Hansen and Pacific Salmon Foundations.

### **Discovery Islands Archaeology: Introduction and Paleoecology**

Daryl Fedje<sup>a,b</sup>

<sup>a</sup> Department of Anthropology – University of Victoria, Victoria, BC, Canada

<sup>b</sup> Tula Foundation, Heriot Bay BC

Session - Human Habitation and Ancient Knowledge: Discovery Islands

#### Oral Presentation Abstract

The studies of human habitation and ancient knowledge in the Discovery Islands encompass several aspects of the human and natural history of this area. In this presentation I provide a general introduction to the papers and poster (Fedje, Mackie, Lepofsky, Neudorf, Lausanne, Abbott, Smith) and then move on to briefly describe preliminary results of paleoecological research conducted in support of the research. The sea level history for the Quadra – Discovery Islands area has been refined as consequence of paleoecological and archaeological investigation. Previous research by Tom James and others (2009) showed that relative sea level (rsl) fell from ca. 170 m to 25 m above modern between 14,000 and 13,000 years ago and was near modern by 2,000 years ago. In order fill in data gaps and obtain greater detail in support of Discovery Islands archaeological prospection and interpretation additional data constraining seal level history was collected. This included isolation basin cores collected at elevations from ca. - 1 m to +17 m as well as constraining points from a number of stratigraphic sections and archaeological sites. Together, these data indicate that rsl fell rapidly between 14,000 and 12,000 years ago and more slowly after that time. No evidence was found for rsl falling below modern. The sea level history of this area will be further detailed by the results of archaeological and paleoecological investigations as the investigations progress.

### **How have Past Sites of Habitation influenced Present-Day Ecology on the Central Coast of British Columbia?**

Julia Fisher and Brian Starzomski

Starzomski Lab, School of Environmental Studies, University of Victoria

Session - Cross-listed with 1) Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region and 2) Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1.

#### Poster Presentation Abstract

The combination of time and complex human-environment interactions within the Hakai Luxvbalis Conservancy has resulted in a highly modified region. To gain an understanding of the land-use legacies we conducted an observational study on past sites of Heiltsuk and Wuikinuxv habitation with extensive shell middens. Ten archaeological sites and ten controls were selected for vegetation surveys to gain insight into plant diversity and abundance. At these sites, species with known cultural associations, including culturally modified trees, as well as species that are uncommon in this region were also documented. Soil samples and foliar samples from four plant species were collected at sites with and without middens to compare the fate of midden-derived

nutrients. Overall, the data collected from this study will improve our understanding of the factors shaping  $\alpha$  and  $\beta$  diversity on the Central Coast and provide a detailed inventory of these ancient sites of habitation.

### **The Kwakshua Watershed Program: Water, Weather and Dissolved Organic Carbon (DOC) Fluxes**

William Floyd<sup>a</sup>, Maartje Korver<sup>b</sup>, Colby Owen<sup>c</sup>, James McPhail<sup>c</sup>, Suzanne Tank<sup>d</sup>, Ian Giesbrecht<sup>e</sup>, Allison Oliver<sup>d</sup>, Ray Brunsting<sup>e</sup> and Ilja van Meerveld<sup>f</sup>

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<sup>f</sup> University of Zurich

Session - Kwakshua Watershed Project and Community Ecology of Calvert Island

#### Oral Presentation Abstract

The 2013-2014 field season saw the expansion of the real-time weather and surface water observation network for the Kwakshua Watershed Project to seven discharge gauging stations (watersheds 1015, 819, 844, 693, 703, 708 and 626), six low and four middle elevation weather stations measuring rain, temperature and relative humidity and one high elevation weather station on Mount Buxton. The primary objective of the network is to describe weather inputs and stream discharge among the seven focal watersheds, for both short and medium term research questions. The network will also provide long term climate and hydrological monitoring on the central coast for many operational and research needs as time progresses. Weather and water related data are available near real-time from [www.data.hakai.org](http://www.data.hakai.org) using an extensive telemetry network. A prototype automatic discharge system (auto-salt) was installed in watershed 708 to remotely measure stream discharge at pre-determined stream depths to enable rapid rating curve development. Rating curves are under development in all seven watersheds, with many low to moderate flows captured through the summer of 2014. To date, seven moderate to high flow discharge measurements have been collected using auto-salt at watershed 708. To better understand event based DOC dynamics, several rain events were sampled manually and with an innovative remote rack sample method. We will present DOC fluxes from the seven focal watersheds using preliminary discharge calculations and DOC concentrations from the synoptic sampling program.

### **Fine Scale Inventory of Ecosystem Structure with a Terrestrial LiDAR**

Richard Fournier<sup>a</sup>, Danny Blanchette<sup>a</sup>, and Gordon Frazer<sup>b</sup>

<sup>a</sup> University of Sherbrooke

<sup>b</sup> Frazer Consulting Inc.

Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1.

#### Project Abstract

Terrestrial LiDAR (T-LiDAR) uses a laser beam to scan objects within its field of view and enables millions of precise distance measurements (millimeter accuracy) to be taken in a few minutes. A scan captures a high-resolution point cloud with 3-D representation of the objects of interest. T-LiDAR (Riegl VZ-1000) was used to scan test sites representative of several

terrestrial ecosystems present on Calvert Island. This study was essentially exploratory in nature, and was used to identify a set of best practises for T-LIDAR measurements of vegetation and terrain structure in field plots (20 m × 20 m) and along transects (e.g. 40 m × 125 m). Procedures were developed to handle the large data volume and to ensure the precise georeferencing and spatial merging of multiple scans. Finally, an analysis of the T-LiDAR point cloud produced several descriptive metrics and spatial representations of fine-scale ecosystem structure at these sites. The spatial outputs from an analysis of the T-LiDAR point cloud are exceptional tools to characterize ecosystem structure, far beyond what is currently available from a forest or an ecological field survey. Seven sites were scanned including three transects. The results were provided in a standardized form for each test site where the following results were produced: (1) a visual representation of the 3-D point cloud, (2) a detailed Digital Elevation Model (DEM), (3) a Canopy Height Model (CHM), and (4) estimation of a series of spatial metrics. The spatial metrics are useful to characterize specific aspects of the ecosystem structure. With the available DEM and CHM, more metrics can be tested for suitability to any study. Statistics can be compared from one site to another and their link to ecophysiological processes can be assessed. The effort needed to collect and process T-LiDAR data is substantial; however, the amount of available spatially explicit information on ecosystem structure is also currently unparalleled. Further work is required to assess how T-LiDAR data can be effectively integrated within a systematic ecological monitoring program.

### **Topographical Controls on Vegetation Pattern and Site Productivity in Hypermaritime Forests of Coastal BC**

Gordon Frazer<sup>a</sup>, Ian Giesbrecht<sup>b</sup>, and Ken Lertzman<sup>c</sup>

<sup>a</sup> GWF LiDAR Analytics

<sup>b</sup> Hakai Beach Institute

<sup>c</sup> Simon Fraser University

Session - Kwakshua Watershed Project and Community Ecology of Calvert Island

#### Project Abstract

Topography influences the distribution of key plant resources (temperature, light, moisture, and nutrients) and other environmental factors that affect local to landscape level patterns of vegetation composition, structure, and productivity. Vegetation pattern and dynamics, in turn, exert considerable spatiotemporal control over watershed hydrology and biogeochemistry and other vital ecosystem processes and functions. In this study, we use spatially continuous measurements of vegetation height and terrain indices extracted at several spatial scales (5 to 20 m) from airborne LiDAR data to explore the statistical relationships between vegetation pattern and topography on Calvert Island. We chose quadratic mean canopy height (LHQM) as the model response variable, because LHQM has demonstrated to be a consistently strong correlate of stand height, diameter, volume, and total aboveground biomass in other forest ecosystems. Our strategy for model building and inference is necessarily stepped, and will shift from an initial exploratory phase using non-parametric modelling techniques to more complex parametric models that will support hypothesis testing and inference. Preliminary findings, based on Regression Tree and Random Forest models fit to a very large probability sample ( $n > 30,000$ ), indicate that flatter, more subdued and less well-drained topography (catchment slopes  $< 17$  degrees) and extreme landscape positions (top or bottom of slope) support a lower LHQM. The highest LHQM values occur on catchment slopes greater than 29 degrees and at mid-slope

positions. These preliminary findings are consistent with the thought that site water balance is the principal factor limiting forest growth and productivity in hypermaritime ecosystems. A spatial analysis of the model prediction errors revealed that the magnitude and sign of the error term is strongly spatially autocorrelated, suggesting that other abiotic and biotic factors, such as soils, parent material, geology, species composition, and disturbance history, may also interact with local topography to control vegetation pattern and dynamics on Calvert Island.

## **Engaging Science to Address Policy and Management Issues Relevant to Central Coast Nations**

Alejandro Frid - Central Coast Indigenous Alliance

Session – Research for Communities and Society

### Oral Presentation Abstract

In 2005 the four Central Coast Nations—Kitasoo/Xai'Xais, Heiltsuk, Nuxalk and Wuikinuxv—formed the Central Coast Indigenous Resource Alliance (CCIRA), a non-profit society that provides technical support and coordination to member Nations. Since then, the Nations have worked collaboratively on fishery issues and have developed a marine use plan (MUP) for the entire Central Coast. The MUP, which arose from the synergy of traditional knowledge and modern science, aims to manage human activities in ways that promote the recovery and conservation of multiple species while ensuring First Nations access to marine resources. It is the backbone for the MaPP initiative (mappocean.org), an ongoing partnership between the Province of BC and First Nations which is zoning allowable uses, designing a candidate network of marine protected areas (MPA) and selecting indicator species for ecosystem health. Implementation of MPAs and related management actions, however, will require further collaboration with the federal government. Crucial to that implementation, First Nations require scientific data to complement their traditional knowledge and support their negotiations with the federal government. Towards that end, CCIRA is coordinating scientific research on Dungeness crab, rockfish, and lingcod, and developing proposals that address spatial variation in salmon population productivity and shifting oceanographic conditions in the context of climate change, ocean acidification, and other stressors. To address these sorts of management issues and increase scientific capacity within their communities, Central Coast Nations wish to keep building collaborations with academic scientists.

## **“Everything Revolves around the Herring”: Continuity and Transformation of the Heiltsuk Herring Fishery through Time**

Alisha Gauvreau - MRM Candidate, Department of Resource and Environmental Management, Simon Fraser University

Session - Human Habitation and Ancient Knowledge: Calvert and Hunter Island Areas.

### Poster Presentation Abstract

Pacific herring (*Clupea pallasii*), a cultural keystone species, are a critical part of the social-ecological systems on the central coast of British Columbia. For millennia, the Heiltsuk First Nation has depended on this forage fish for food, social, ceremonial, and economic purposes. My research, nested within the coast-wide “Herring School” initiative, documents and analyzes the components of the Heiltsuk First Nation traditional management system for Pacific herring, and how they have changed over time. Through a series of 25 formal and informal interviews with



key community informants, and participation in DFO-Gladstone reconciliation meetings and Integrated Herring Harvesting Planning Committee meetings I've identified: (1) How traditional social institutions, local ecological knowledge, and aspects of Heiltsuk worldview informed herring management strategies in the past, (2) and how changes in state-led herring management in BC have impacted the role of local knowledge/strategies today.

### **Sampling and Sensor Infrastructure for Investigating Landscape and Climate Controls on Terrestrial Ecosystem Patterns and Processes**

Ian Giesbrecht<sup>a</sup>, Kira Hoffman<sup>b</sup>, Allen Banner<sup>c</sup>, Ray Brunsting<sup>a</sup>, William Mohn<sup>d</sup>, Paul Sanborn<sup>e</sup>, Colleen Kellogg<sup>d</sup>, Thierry Heger<sup>d</sup>, Andrew Trant<sup>b</sup>, Allison Oliver<sup>f</sup>, and Ken Lertzman<sup>g</sup>.

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Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1.

#### Oral Presentation Abstract

Terrain and climate exert strong controls on the production and processing of the terrestrial organic matter that is available for export to the coastal waters. In support of the Kwakshua Watershed Project, the Hakai Institute is establishing a network of plots and sensors to examine spatial patterns and temporal dynamics of key ecosystem properties and processes in a complex coastal-landscape mosaic. We have established 27 plots and four sensor nodes in contrasting terrestrial ecosystem types, from deep soil peatlands through relatively productive forests. We used combinations of LiDAR terrain metrics, ecosystem maps, and field reconnaissance to stratify the landscape and select plot locations. Vegetation biomass, structure and composition vary dramatically across a drainage gradient, from bryophyte and sedge dominated wetlands to forests of moderate productivity on better-drained soils. Soils vary from thin veneers over bedrock to peat accumulations of >2m. In three contrasting sites, we are using sensors to remotely monitor soil conditions in relation to seasonal and storm-driven weather patterns. Remotely monitored variables include water table depth, soil water content, soil temperature and soil redox potential. Mean water table depth varies spatially across and within ecosystem types. The soil environment is dynamic, tightly tied to storms and seasons. Several emergent studies are built upon the foundational plot network, involving soil microbial ecology, dendroecology, terrestrial laser scanning and biogeochemistry.

### **Postglacial Landscape Evolution of Savary Island, British Columbia**

Libby Griffin<sup>a,b</sup>, Olav Lian<sup>a,b</sup>, John Clague<sup>b</sup>, Brent Ward<sup>b</sup>, Jordan Bryce<sup>a</sup>

<sup>a</sup> Luminescence Dating Laboratory, Department of Geography, University of Fraser Valley

<sup>b</sup> Department of Earth Sciences, Simon Fraser University

Session – Landscape History

#### Poster Presentation Abstract

Savary Island, the most southern of the Discovery Islands, is unique in the region in that it is capped with a thick sequence of aeolian sand that rest unconformably on sediments deposited during the last glaciation. Where undisturbed by human activity the aeolian sediments form large stabilized parabolic dunes that trend to the northwest. A reconnaissance investigation of the aeolian sequence has revealed the presence of several buried soils (palaeosols), the oldest discovered so far dating to nearly 10,000 calendar years. These sediments therefore represent a record of relative landscape stability (soil formation) and instability (aggrading sand) spanning nearly all of the Holocene. This research will use remote sensing (LiDAR), radiocarbon and optical dating, and paleopedology, to gain an understanding of the character and timing of Holocene geomorphic change on Savary Island. Primary forcing mechanisms will be inferred by comparing the Savary Island record to what is already known about long-term regional shifts in postglacial climate, ecology, and sea level.

### **An example of the Importance of Using Multiple Dating Methods, Calvert Island, British Columbia**

Libby Griffin<sup>a</sup>, Christina Neudorf<sup>a</sup>, Olav B. Lian<sup>a,b</sup>, Ian Walker<sup>b</sup>, Dan Shugar<sup>b</sup> and Jordan Eamer<sup>b</sup>

<sup>a</sup> Luminescence Dating Laboratory, Department of Geography, University of Fraser Valley

<sup>b</sup> Department of Geography, University of Victoria

Session – Landscape History

#### Poster Presentation Abstract

Radiocarbon dating has been used extensively on Calvert Island to reconstruct palaeoenvironments, sea level change, and to date archaeological finds. However, the use of additional dating methods, particularly optical dating, can provide a check on radiocarbon dating results, or add additional information, as the two methods often date different events. In this study, the importance of using multiple dating methods will be demonstrated using ancient beach deposits found on the northwestern coast of Calvert Island (North Beach) exposed by storm erosion in 2013. The ancient beach deposit contains a peat bed rich in detrital material (macrofossils) that has been radiocarbon dated. An optical age obtained from sediment directly underlying the peat bed is used to date directly the beach surface on which the peat formed. We will show that the application of both dating methods, together and alone, can lead to different interpretations of past depositional events.

## **Assessing the Role of Large Woody Debris on Beach-Dune Morphodynamics and Shoreline Change Using Aerial Photography, Photogrammetry, and Terrestrial LiDAR.**

Michael Grilliot and Ian Walker - Coastal Erosion & Dune Dynamics Laboratory, Department of Geography, University of Victoria

Session – Landscape History

### Poster and Oral Presentation Abstract

Large woody debris (LWD) plays important roles in the ecology and geomorphology of sandy beach morphodynamics and is common on almost all beaches throughout the Pacific Northwest. In British Columbia, LWD on beaches is comprised mainly of historical escape logs. With improvements in log transportation methods and a general decline in coastal logging, the total amount of LWD from anthropogenic sources in coastal systems is decreasing. Despite this decrease LWD still has a measurable effect on beach morphodynamics. This work examines historical changes and seasonal variability in LWD coverage and its effects on beach morphodynamics using historical aerial photography, time-lapse cameras, and high-resolution terrestrial LiDAR. Continued use of LiDAR and the potential for stereophotogrammetry will help determine the role of LWD in beach-dune sediment budgets and shoreline stabilization trends. This research will help achieve key research questions of the Landscape History and Coastal Sandy Ecosystem projects by addressing how sandy ecosystems seasonally evolve in response to meteorological and geological conditions and the role of tidal debris on beach morphology. The research will be linked to a broader understanding of sandy beach morphodynamic trends in British Columbia.

## **An Agenda for Law Reform: The Need to Publicly Disclose Diseases on BC Fish Farm**

Sam Harrison – The Environmental Law Centre, University of Victoria

Session – Research for Communities and Society

### Oral Presentation Abstract

Diseases originating on fish farms have the potential to spread to wild salmon and cause catastrophic damage to coastal ecosystems. In partnership with the Wuikinuxv First Nation, the Environmental Law Clinic investigated the Canadian Food Inspection Agency's (CFIA) policy of withholding information about aquatic diseases on BC's fish farms. We produced a law reform document that provided an overview of Canada's aquatic animal regulatory framework, its unmet transparency goals, and a comparison with access to information regimes of other farmed salmon-producing nations. Three major aspects of fish-disease information publication affect its utility: timely release, specific location of outbreak, and accessibility of the information. Canada meets international protocols regarding speed of information dissemination but fails to attach specific locations or present the information in an intuitive manner, thereby failing on two of the three criteria. Most egregiously, the fact that disease records are published on a provincial scale rather than site-by-site makes them virtually useless to the public and investigating scientists. By contrast, the European Union leads the world with unambiguous legislation requiring all of its countries to create and maintain a database listing the disease status of each individual fish farm. With the aforementioned shortcomings, CFIA's publication regime is so inadequate that the facts presented in this report could be marshalled for an argument that Canada is failing to meet its constitutional duty to consult with aboriginal communities. In light of the recent T'silhqot'in decision, this shortcoming could provide the traction needed to push CFIA to implement some true transparency.

## **Initiating a Sampling Program of Nearshore Fish Communities around Calvert Island**

Trevor Haynes<sup>a</sup>, Margot Hessing-Lewis<sup>b</sup>, Midoli Bresch<sup>b</sup>, Brian Hunt<sup>b,c</sup>, Carolyn Knapper<sup>b</sup>, Ben Millard-Martin<sup>b</sup> and Evgeny Pakhomov<sup>b,c</sup>

<sup>a</sup> University of Alaska, Fairbanks

<sup>b</sup> Hakai Institute

<sup>c</sup> University of British Columbia

Session - Marine Food Web Dynamics

### Oral Presentation Abstract

Nearshore coastal regions, including intertidal and shallow subtidal areas, provide key habitat to a diverse array of fish species. These include both nearshore specialists and the juvenile stages of certain pelagic species, some of which are key forage in marine food webs and also commercially important. Nearshore regions are particularly sensitive to anthropogenic impacts, necessitating a strong understanding of life history / community dynamics, including seasonal and spatial patterns in species distribution, abundance and richness, and trophic dynamics. In the summer of 2014, Hakai Institute initiated a beach seine sampling program to capture the nearshore community level occupancy dynamics of fish and their food web dynamics. We sampled 42 sites, including 9 “core” sites that were sampled multiple times through the season. Sites varied in benthic substrate type (mud, sand and gravel), aquatic vegetation (e.g., kelp forests, seagrass beds) and exposures to wind and waves (sheltered to completely exposed). We caught over 65,000 fish, representing 62 species (mean naïve richness  $\pm$  SD =  $14 \pm 5$  species per site). These included the key forage species Pacific sand lance and herring, and commercially important species including salmonids, lingcod, and rockfish. These data will provide the foundation for analysis of species distributions and habitat use, community dynamics and species richness at multiple spatial and temporal scales. A combination of stomach content and stable isotope analysis will be used to identify species trophic niche, between species niche overlap, and investigate the role of feeding biology in habitat selection.

## **Overview of Coastal Sand Ecosystem Program**

Derek Heathfield and Ian Walker – Department of Geography, University of Victoria

Session – Landscape History

### Oral Presentation Abstract

The Coastal Sand Ecosystem (CSE) program at HBI began in summer 2014, with the intent to have associated projects up and running by spring of 2015. The general structure of the CSE involves a team of researchers working on various sub-projects that explore biogeophysical processes within, connections between, and ecological and/or geomorphic responses of sub-tidal (nearshore), inter-tidal (foreshore), and supra-tidal (backshore) components of coastal sand ecosystems. Research conducted under the CSE framework will follow Long Term Ecological Research (LTER) protocols, with opportunities for short-term experimentation, as well as long-term monitoring of key environmental attributes. The principal objective of the CSE is to develop a strong interdisciplinary collaboration amongst ecologists, soil scientists, biogeochemists, microbiologists, marine biologists, oceanographers, and geomorphologists. At present, two sub-projects are ready to initiate or continue research in the spring of 2015: 1) Geomorphology of embayed CSE, which will investigate how nearshore processes and beach-dune interaction vary between the various pocket beaches on NW Calvert Island; and 2) Soils &

pedogenic processes in CSE, which will investigate how long-term pathways of soil evolution in sandy landscapes drive ecosystem development, particularly primary production and nutrient cycling. Proposed projects include investigations of the origins and delivery of sand to CSE; intertidal interstitial meiofauna in CSE; and macrofaunal & vegetation communities in CSE. All current and proposed projects have varying degrees of interlocking objectives and potential for interdisciplinary synergies. We welcome your feedback and are looking for collaborators.

### **Patterns of Protist Diversity across Different Ecosystems at Hakai**

Thierry Heger<sup>a</sup>, Ian Giesbrecht<sup>b</sup>, Colleen Kellogg<sup>a</sup>, Kira Hoffman<sup>c</sup>, Ken Lertzman<sup>b,d</sup>, Bill Mohn<sup>a</sup> and Patrick Keeling<sup>a</sup>

<sup>a</sup> University of British Columbia

<sup>b</sup> Hakai Institute

<sup>c</sup> University of Victoria

<sup>d</sup> Simon Fraser University

Session - Kwakshua Watershed Project Community Ecology of Calvert Island

#### Poster Presentation Abstract

Protists are present in all ecosystems and play fundamental roles in food-web processes and nutrient cycling. Yet, protists (unicellular eukaryotes) remain the least explored eukaryotic component of the biosphere and are especially poorly characterized in terrestrial ecosystems. In this study, we aim to explore the diversity of protists across a variety of terrestrial and aquatic ecosystems at Hakai and determine which factors structure their communities. In collaboration with colleagues of the Bog Forest Ecosystem Program, soil samples have been collected from three different depths in blanket bogs, bog woodlands, bog forests and zonal forests. In addition, aquatic samples have been collected from streams and coastal marine environments at different depths. Our preliminary results, based on high-throughput sequencing data, revealed an impressive diversity of protists from soil surface (moss and litter) samples where more than 1000 distinct heterotrophic and phototrophic protist taxa were retrieved per sample. The diversity of protist in soils decreased considerably with soil depth (i.e. in organic and mineral horizons). In aquatic habitats, protists are also quite diverse, but less than on soil surface. Further analyses are underway to quantify protist community composition changes among ecosystems and determine how abiotic parameters influence protist communities. Also, this data-set, combined with the important amount of data generated by the other members of the Kwakshua Watersheds Project might contribute to better understand how DOC and other terrestrial exports affect coastal water food webs.

## **Pacific Herring Research at Hakai Institute**

Margot Hessing-Lewis<sup>a</sup>, Brian Hunt<sup>a,c</sup>; *Dive team* – Joel Harding<sup>a,b</sup>, Brittany Keeling<sup>a</sup>; *Feeding biology*: Reg Moody<sup>e,f</sup>, Evgeny Pakhomov<sup>c</sup>, Nikita Sergeenko<sup>c</sup>; *Genetics*: Lorenz Hauser<sup>d</sup>, Eleni Petrou<sup>d</sup>, Mike Reid<sup>e</sup>; *Herring Midden records*: Ian McKechnie<sup>a,b,c</sup>; *Microchemistry*: Tony Pitcher<sup>c</sup>, Wade Smith<sup>a,c</sup>; *Modelling*: Dan Okomoto<sup>b</sup>, Colette Wabnitz<sup>c</sup>; *Oceanography*: Bryn Fedje<sup>a</sup>, Lawren McNab<sup>a</sup>, Skye McEwan<sup>a</sup>, Nelson Roberts<sup>a</sup>, Adam Turner<sup>a</sup>; Anne Salomon<sup>b</sup>; Dana Lepofsky<sup>b</sup>, Suzanne Vonderporten<sup>b</sup>.

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<sup>e</sup> Heiltsuk Integrated Resource Management Department

<sup>f</sup> Gladstone Reconciliation Society

Session - Marine Food Web Dynamics

### Oral Presentation Abstract

Pacific herring act as intermediaries between plankton and other secondary producers, and shunt energy to top predators such as marine mammals, seabirds and a wide range of commercially important fish species. As such, population fluctuations can result in dramatic consequences to the broader ecosystem, including coastal peoples. Despite their importance, there remain substantial gaps in our understanding of herring life history parameters, population cycles and distribution, and their response to environmental and anthropogenic forcing. The Hakai Institute's long term monitoring of herring focuses on their spawning events, with additional year-round sampling. Routinely monitored water column characteristics are used to determine the key triggers for spawning events and larval development. Dive surveys at spawn sites investigate the role of habitat limitation and herring roe as subsidies. Herring abundance and distribution are monitored at four important life stages: egg (roe), larvae, juveniles and adults. Roe are quantified using dive surveys, and plankton sampling captures herring larvae. Juveniles are currently collected using beach seines, and adults will be quantified using seine surveys. To understand the spatial structure and connectivity of populations, we are also using genetic and microchemical approaches. Post-spawning events, we aim to assess the spatiotemporal distribution of adult and juvenile fish using acoustics. At this large spatial scale, we are looking at correlations with humpback whales, and their feeding behavior. All of the herring research components will contribute to detailed ecosystem models for this region, and inform future modeling of herring-centric coupled social-ecological systems.

## **Hakai SEAggrass Research**

Margot Hessing-Lewis<sup>a,b</sup>, Erin Rechsteiner<sup>a</sup>, Angeleen Olson<sup>a,b</sup>, Megan Vaughan<sup>c</sup>, Mary O'Connor<sup>c</sup>, Francis Juanes<sup>d</sup> and Brent Hughes<sup>f</sup>

<sup>a</sup> Hakai Institute

<sup>b</sup> Simon Fraser University

<sup>c</sup> University of British Columbia

<sup>d</sup> University of Victoria

<sup>e</sup> University California Santa Cruz

Session - Outer Shores 1 - The Otter Landscape

### Oral Presentation Abstract

Despite our general understanding of the critical role of seagrass habitats to coastal ecosystems, we know little about their distribution, dynamics and function in coastal British Columbia, especially north of Vancouver Island, a region currently subject to coastal development, the recovery of top predators and the myriad effects of climate change. Hakai's SEAggrass (Seagrass Ecosystem Assessment) monitoring program is a part of Hakai's long term ecological research (LTER) approach to understanding seagrass ecosystems by documenting their spatial extent, seasonal dynamics, and interannual change. The SEAggrass program focuses on determining the role of seagrass as habitat for a diversity of fish, invertebrate and epiphyte species, as well as its structural role as a submerged aquatic plant, and important player in nutrient cycling. Focal research projects are currently investigating the context specificity of otter-induced trophic cascades in seagrass systems, and the connectivity and spatial variability of seagrass ecosystems in this region. Together, monitoring and research projects aim to decipher the variability and drivers of change in this important marine habitat.

## **Integrative Taxonomic Approaches to Understanding Marine Diversity at Hakai Institute**

Katy Hind and Patrick Martone - Department of Botany and Biodiversity Research Centre, University of British Columbia and the Hakai Network for Coastal People, Ecosystems and Management

Session – Outer Shores 2 – A Marine Mix

### Oral Presentation Abstract

An accurate assessment of species diversity is an essential precursor to studies in ecology and evolution, yet only 10-20% of species on the planet have been described. My research aims to characterize not only current taxonomy, but also to better understand the processes giving rise to diversity. My research focuses on the Corallinales (coralline red algae), which provide an excellent study system as they are ecologically important but have received little taxonomic attention due to difficulties in effective species discrimination. Further, the susceptibility of their calcified thalli to ocean acidification has made them an important lineage for studying the effects of climate change on marine biota. To date, I have documented 40 species of coralline algae, 18 which are new to science, at the Hakai Institute (HBI). During the summer of 2014 a subtidal survey of crustose coralline algae was conducted. Samples are currently being sequenced in the lab and I predict that many more new species will be discovered. In addition to documenting species, I have started a new project at HBI examining the community structure of coralline algae between urchin 'barrens' and kelp forests. Very little is known about the biological diversity of coralline algae and their relative abundance within urchin 'barrens' and kelp forests, particularly for the central coast of British Columbia. I will be studying the relationship between

kelp density and coralline algal assemblages across a gradient of otter occupation. This study will incorporate the use of molecular tools to accurately identify coralline algal species.

### **Science, Litigation and the Public Interest**

Anthony Ho and Erin Placatka - Environmental Law Centre, University of Victoria

Session Research for Community and Society

#### Oral Presentation Abstract

The Environmental Law Centre (ELC) at the University of Victoria continues to provide *pro bono* legal representation to public interest clients on important natural resource and environmental issues before superior courts and administrative tribunals. The ELC is acting for BC Nature, one of a group of litigants challenging the federal government's approval of the Northern Gateway Pipelines Project at the Federal Court of Appeal. Additionally, the ELC is acting for BC Nature and Nature Canada in the regulatory review process for the Trans Mountain Expansion Project currently before the National Energy Board. In the province's north, the ELC is providing legal representation before the Environmental Appeal Board for two appellants who are trying to protect the Kitimat-Terrace airshed from a government decision to allow a significant increase in industrial air pollutant emissions. Each of these cases teaches us the value of an adversarial legal process in upholding scientific integrity in the regulatory setting. Public interest litigants hold project proponents and governments accountable by not letting them get away with questionable science. Our experience also teaches us the importance of having clear and fair procedural rules in the regulatory setting that enable transparent and scientific environmental assessments. Lastly, the ELC benefits from the work of students who are passionate about science, litigation, and the environment, while the students benefit from obtaining a hands-on clinical experience.

### **A Burning Question: Reconstructing Fire Disturbances on the Outer Coast**

Kira Hoffman and Brian Starzomski - University of Victoria, School of Environmental Studies

Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1.

#### Poster and Oral Presentation Abstract

It is not immediately intuitive to think about fires in coastal temperate rainforests, and evidence to reconstruct fires is often lacking. As such, fire disturbances on the Central Coast have remained largely unexamined. Fire-scarred trees are considered very rare in wet coastal environments, because the age of the trees often does not exceed the age of the most recent fire event, estimated to occur at ~6000-year return intervals. My research examines the role of both natural and cultural fires, attempting to reconstruct how and why fires burned. I am employing multiple lines of evidence including fire-scarred trees, post-fire tree establishment, charcoal buried in soil horizons and fires associated with historical settlement areas. The majority of my research is focused on a 287-hectare fire on Hecate Island. Preliminary results from a 700-year tree ring chronology developed from the site reveal four distinct fire events dated to 1346, 1525, 1764 and 1893. The 287-hectare fire occurred in 1893 and was the largest of these fires. The short interval between fire events suggests purposeful and repeated low-intensity ground fires, which may be associated with controlled landscape burning. I propose that fires are more widespread and complex than previously thought, and that the inclusion of cultural fires enhances our understanding of coastal fire ecology and the legacies associated with traditional plant management.



## **The 1964 Alaska Tsunami Preserved within Intertidal Wetland Sediments of Rivers Inlet**

Jonathan Hughes - University of the Fraser Valley

Session - Landscape History

### Poster Presentation Abstract

Sediment stratigraphy beneath intertidal wetlands in Kilbella Bay and the Wannock River estuary located at the head of Rivers Inlet likely record the 1964 Alaska tsunami. Sediment samples collected from river cut banks, soil pits, and gouge augers are used to map sediment stratigraphy, develop sediment age-depth models; characterize changes in sediment supply over time; and estimate past marsh productivity. Radioisotope data obtained from sediment samples collected at each wetland yield distinctly different age-depth models. The rate of recent sediment accumulation ranges from 0.02-0.04 g/cm<sup>2</sup>/yr at Wannock and 0.05-0.14 g/cm<sup>2</sup>/yr at Kilbella. Unlike the Wannock, Kilbella includes sand layers that were likely deposited in the 1960's. These sandy layers include low organic carbon (0.8%) and high bulk density (1.2 g/cm<sup>3</sup>). Wannock shows anomalous measures of Al, Ca, K, and N immediately above the 1963 cesium peak. The sandy layers at Kilbella and oral accounts of damage from the 1964 tsunami around the Wuikinuxv Village provide compelling evidence that these sites have the capability to record distant-source tsunamis. This research will be best complimented by similar work in the Koeye River estuary.

## **Quadra Ocean Monitoring and the Salmon Early Marine Survival Program**

Brian Hunt<sup>a,b</sup>, Cheryl Chow<sup>a</sup>, Brendan Connors<sup>d,f</sup>, Megan Foss<sup>a</sup>, Wayne Jacob<sup>a</sup>, Colleen Kellogg<sup>b</sup>, Martin Krkosek<sup>c,f</sup>, Kate Lansley<sup>a</sup>, Evgeny Pakhomov<sup>a,b</sup>, Luke Rogers<sup>c</sup>, Curtis Suttle<sup>b</sup>, Marc Trudel<sup>e</sup> and Kevin Weng<sup>b</sup>,

<sup>a</sup> Hakai Beach Institute

<sup>b</sup> University of British Columbia

<sup>c</sup> University of Toronto

<sup>d</sup> Department of Fisheries and Oceans

<sup>e</sup> Pacific Salmon Foundation

<sup>f</sup> Salmon Coast Researchers

Session - Marine Food Web Dynamics

### Poster and Oral Presentation Abstract

The food web ecology along juvenile salmon migration routes is critical to their growth and condition, and ability to cope with predation, pathogens and food-limitation in their first year at sea. Survival during this early marine phase of the life cycle is considered to be a key factor determining the return success of spawners. In their first 4-6 weeks of northward migration Fraser River sockeye traverse the seasonally stratified estuarine Strait of Georgia, the turbulent and un-stratified Discovery Islands and Johnstone Strait region, weakly stratified Queen Charlotte Strait, and seasonally stratified oceanic Queen Charlotte Sound. The availability of juvenile salmon prey (zooplankton) quantity and quality across these regions has not been examined in detail, but has been hypothesized to be a bottleneck in their survival success (McKinnel et al, 2014). The Hakai Institute Salmon Early Marine Survival Program is developing as a multi-disciplinary collaborative program that will undertake detailed measurement of the physical and bio-chemical process that determine zooplankton quantity and quality; the spatial and temporal dynamics of juvenile salmon feeding biology; the role of

competitive interactions in foraging success; and the interaction between juvenile growth, condition and pathogen load. To be launched in 2015, this program will link the Hakai Institute's Calvert and Quadra ocean monitoring nodes, develop a dedicated Hakai Institute juvenile salmon sampling program, and forge new collaborations with essential research partners in the Department of Fisheries and Oceans, Pacific Salmon Foundation, and Salmon Coast.

### **Kwakshua Channel Oceanography and Food Webs – Towards an Integrated Understanding of Land-Sea Connections**

Brian Hunt<sup>a,b</sup>, Bryn Fedje<sup>a</sup>, Ian Giesbrecht<sup>a</sup>, Colleen Kellogg<sup>b</sup>, Skye McEwan<sup>a</sup>, Lawren McNab<sup>a</sup>, Bill Floyd<sup>d</sup>, Allison Oliver<sup>c</sup>, Nelson Roberts<sup>a</sup>, Suzanne Tank<sup>c</sup>, Adam Turner<sup>a</sup> and Kang Wang<sup>a,b</sup>

<sup>a</sup> Hakai Institute

<sup>b</sup> University of British Columbia

<sup>c</sup> University of Alberta

<sup>d</sup> Ministry of Forests, Lands and Natural Resource Operations and Vancouver Island University  
Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 2.

#### Oral Presentation Abstract

The Hakai Institute's Calvert Island oceanographic monitoring node provides baseline data on the local marine environment, while acting as a sentinel of long term change driven by large scale climate forcing. In addition to its monitoring function, Hakai oceanography aims to interface with other projects to answer directed research questions. Under the framework of the Kwakshua Watershed Project, oceanographic research is seeking to understand land-sea linkages in Kwakshua Channel, and specifically the role of freshwater run-off, and its dissolved and particulate load, in shaping the marine ecosystem. High freshwater dissolved organic carbon (DOC) concentrations stands out as a key terrestrial input to Kwakshua Channel. The DOC bearing freshwater enters the channel during rain events as low density plumes that ride over the top of the saline, high density marine waters. Measurement of high turbidity, indicative of particulates, at the freshwater marine boundary layer indicates that at least part of the DOC comes out of suspension in this region of the water column (salinity ~ 27.5), possibly due to a combination of high colloid concentrations and low turbulence aggregation. Flocculation therefore represents a potential mechanism for making DOC accessible to the marine food web, in addition to microbial pathways. A combination of experimental and field studies applying natural stable isotope tracers will be used to investigate and quantify the food web pathways of DOC and nitrogenous nutrients. Particular attention will be focused on the relative terrestrial and marine contributions to water column and food web carbon and nitrogen pools in Kwakshua Channel.

### **Hakai Institute Ocean Monitoring: Calvert Island Node**

Brian Hunt<sup>a,b</sup>, Bryn Fedje<sup>a</sup>, Ian Giesbrecht<sup>a</sup>, Wayne Jacob<sup>a</sup>, Colleen Kellogg<sup>b</sup>, Skye McEwan<sup>a</sup>, Lawren McNab<sup>a</sup>, Bill Floyd<sup>d</sup>, Allison Oliver<sup>c</sup>, Evgeny Pakhomov<sup>b</sup>, Nelson Roberts<sup>a</sup>, Suzanne Tank<sup>c</sup>, Adam Turner<sup>a</sup> and Kang Wang<sup>a,b</sup>

<sup>a</sup> Hakai Institute

<sup>b</sup> University of British Columbia

<sup>c</sup> University of Alberta

<sup>d</sup> Ministry of Forests, Lands and Natural Resource Operations and Vancouver Island University

Session - Marine Food Web Dynamics

#### Poster and Oral Presentation Abstract

The Hakai Institute's Calvert Island oceanographic monitoring node spans the open ocean Queen Charlotte Sound, coastward across the inside passage, to the head of mainland Rivers Inlet. Kwakshua Channel, bisecting Calvert and Hecate islands, is the centre piece of the monitoring region. Ease of access and sheltered waters make it an ideal location for high resolution long term sampling in an otherwise challenging coastal environment. Daily Conductivity-Temperature-Depth (CTD) profiles at Pruth Station, approximately mid channel, are augmented by ~ 10 day resolution detailed bio-oceanographic sampling at 19 stations covering nearshore and mid-channel locations. Sampling at these stations comprises combinations of CTD, secchi disc, nutrients, dissolved organic carbon, microbial communities, phytoplankton biomass, zooplankton biomass and composition, and water column stable isotope chemistry. Subsets of these data are collected at a similar frequency from offshore and inner coast stations. In addition to its monitoring function, Calvert oceanography is investigating marine linkages with terrestrial ecosystems (Kwakshua Watershed Project), the size structured dynamics of plankton food webs, and the temporal and spatial availability of zooplankton prey for forage fish. As its core function Calvert ocean monitoring aims to provide baseline data on the local marine environment, and to act as a sentinel of change. Our first three years of data depict a strongly seasonal environment, characterised by an ~ April spring phytoplankton bloom, as light and temperature increase, a prolonged summer phytoplankton growth season, before a late October return to low winter production levels. In addition to terrestrial watershed inputs, June-July deep water upwelling is evident which serves to replenish nutrients on an annual basis.

### **Hakai Magazine, Exploring Science and Society in Coastal Ecosystems**

Jude Isabella, Dave Garrison, Mark Garrison, Gord More - Hakai Magazine

Session - Independent

#### Poster Presentation Abstract

Hakai Magazine will be an editorially independent web-based publication that explores the ties between oceans, coasts, and human societies. About 40 percent of the world's population lives within 100 kilometres of the coast and coastal communities around the world face pressures of habitat conversion, land cover change, pollution, and invasive species. Resisting these pressures can further coastal conservation, and resistance starts with scientifically accurate and accessible information. We want people in coastal communities around the world to think about their relationship with the ocean and coastal ecosystems — from multiple perspectives, multiple disciplines — on a daily basis. We're Planet Ocean, not Planet Earth. To reach readers we will publish a range of work on a daily/weekly basis: written essays and photo essays, illustrative features, thoughtful list-type features, data driven infographics, and video. Our aim, overall, is to

create an engaging publication that reaches multiple audiences — a magazine that is a must-read for coastal community leaders and for readers who enjoy a great non-fiction narrative, no matter the subject matter.

### **Mountain Top to Ocean Floor: The Eco-cultural History of *Hauyat***

Julia Jackley<sup>a</sup>, Dana Lepofsky<sup>a</sup>, Nancy J. Turner<sup>b</sup> and Jennifer Carpenter<sup>c</sup>

<sup>a</sup> Hakai Network for Coastal People, Ecosystems and Management, Simon Fraser University

<sup>b</sup> Environmental Studies, University of Victoria

<sup>c</sup> Heiltsuk Integrated Resource Management Department

Session - Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region  
Poster Presentation Abstract

The Mountain Top to Ocean Floor Project is a collaborative undertaking by the Heiltsuk First Nation, Simon Fraser University, and University of Victoria, that seeks to document and explore the unique cultural and ecological history of *Hauyat*, a landscape in Heiltsuk traditional territory on the Central Coast of British Columbia. Over the millennia *Hauyat* has been transformed by a complex web of relationships between people, plants, animals and ecosystems. The rich and deep history of this place is known through Heiltsuk oral history and is also reflected in the number and diversity of archaeological sites and eco-cultural features. Ranging from the lower intertidal to the subalpine, the landscape has been modified to include clam gardens, fish traps, root gardens, berry patches, orchards, settlements, rock art, and defensive sites. These features are suggestive of long-term resource management systems that likely worked together to provide food, materials, and medicines for past communities.

### **Microbial Communities across the Kwakshua Watershed Landscape and Seascape**

Colleen Kellogg<sup>1</sup>, Ian Giesbrecht<sup>2</sup>, Thierry Heger<sup>1</sup>, Brian Hunt<sup>1,2</sup>, Allison Oliver<sup>3</sup>, Melanie Scofield<sup>1</sup>, Suzanne Tank<sup>3</sup>, Bill Mohn<sup>1</sup> and Steven Hallam<sup>1</sup>

<sup>1</sup>University of British Columbia

<sup>2</sup>Hakai Institute

<sup>3</sup>University of Alberta

Session: Kwakshua Watershed Project and Community Ecology of Calvert Island

Oral Presentation Abstract

Microbial communities play a crucial role in mediating global biogeochemical cycles. Their importance is especially acute in productive coastal ecosystems, such as coastal temperate rainforests, where large amounts of organic matter (OM) can be exported from land to sea. Much of this OM requires microbial transformation before assimilation into upper trophic levels in the marine food web. Still, surprisingly little is known about the structure and function of the microbial communities driving terrestrial OM transformation in coastal forest ecosystems. Here we investigate the soil, freshwater and marine microbial (Bacterial, Archaeal, Fungal and Eukaryotic) communities of Calvert and Hecate Islands and their surrounding waters to establish a baseline understanding of microbial distributions and ecosystem function along the central coast of British Columbia. These islands are characterized by a mosaic of terrestrial ecosystem units, ranging from productive zonal forests to deep ombrotrophic blanket bogs. Preliminary analysis of samples collected in September 2013 suggest that soil microbial communities vary more by ecosystem unit than by watershed on these islands, with bog communities being distinct from the forest and woodland communities. Forthcoming analyses of shotgun metagenomic data

will allow us to assess whether microbial function also varies by ecosystem unit. Moving seaward, we observe significant differences in marine microbial community composition from samples collected in July, September and November 2013, with communities differing temporally and also stratifying by depth. Continued sampling during 2014 will reveal environmental conditions influencing marine and freshwater community composition and function in this dynamic ecosystem. The observed spatial and temporal variability in the composition of Kwakshua watershed microbial communities highlights their ability to respond to the dynamic OM inputs characteristic of this ecosystem, ultimately affecting the fate of carbon in this productive coastal environment.

### **Biomass, Productivity, and Resilience of *Macrocystis integrifolia* to Canopy Disturbance in High Latitude Kelp Forests**

Kira Krumhansl<sup>a,b</sup> and Anne Salomon<sup>a,b</sup>

<sup>a</sup> Simon Fraser University, Burnaby, British Columbia, Canada

<sup>b</sup> Hakai Institute

Session - Outer Shores 1: The Otter Landscape

#### Poster Presentation Abstract

Based on previous field research at Hakai, mounting evidence suggests that the return of sea otters along the central coast of British Columbia is leading to the recovery of mature kelp forest ecosystems dominated by the giant kelp *Macrocystis integrifolia*. This massive and highly productive kelp species is an important ecosystem engineer and source of atmospheric carbon storage in coastal areas. This research project aims to document seasonal changes in the productivity, biomass, and density of *M. integrifolia* along the central coast, and investigate the recovery of this species following disturbances that cause canopy biomass loss. There is currently a pressing need to understand how the environmental context (e.g temperature regime) can amplify or dissipate the effects of local disturbances, so we explicitly investigate the role of temperature and wave action in driving population dynamics and kelp recovery. We set up five sites on a north-south gradient from Calvert Island to Campbell Island, and are monitoring basic kelp population parameters (density, biomass, productivity, mortality, and recruitment) on a bi-monthly basis. This field based information can be coupled with satellite data to inform estimates of historical and present shifts in kelp productivity on a regional scale following the recovery of sea otters. In summer 2014, we measured recovery of *M. integrifolia* at each site following an experimental canopy removal. We found significant differences in growth ( $m\ d^{-1}$ ) and recovered canopy biomass (kg) among sites such that sites with higher average water temperatures had significantly slower regrowth. These results suggest that oceanographic context mediates the resilience of these kelp forests to canopy disturbances.

### **Sand, Silt and Archaeology in the Discovery Islands**

Alex Lausanne - Department of Geography, University of Victoria

Session - Human Habitation and Ancient Knowledge: Discovery Islands

#### Oral Presentation Abstract

Natural processes influence the formation of the archaeological record in two main ways: 1) by influencing primary deposition of cultural artifacts by creating ideal landscape conditions for human habitation; 2) by relocating artifacts through dynamic geomorphic processes, causing secondary deposition. Gaining a deeper understanding of the Holocene paleolandscapes of

Quadra Island will aid in both archaeological site discovery and interpretation. Bare-earth and DEM models, from lidar data, will help to identify key landforms commonly associated with archaeological sites, such as tombolos, raised beaches, terraces. Due to past sea level regression, sites at various elevations above modern sea level (i.e. 5m, 12m and 25m) represent dramatically different time periods. Sedimentology at archaeological sites of various elevations will be compared to get at both site-specific and landscape-scale geomorphology. Many archaeological sites, thus far, have a thick sand layer and a red silt layer. The origins and time period of the sand layers are currently unknown. It is unclear whether the sand deposits represent relatively recent transport processes, such as aeolian, colluvial or fluvial, or much older. Dating and sourcing natural sediment layers will allow archaeologists to situate cultural horizons within the natural stratigraphy, using relative and absolute dating methods. This will ultimately help inform where to look for archaeological sites on the modern landscape.

### **The Social and Ecological Contexts of Ancient Mariculture around Bella Bella and Quadra Island**

Dana Lepofsky<sup>a</sup>, Nicole Smith<sup>b</sup>, Ginevra Toniello<sup>a</sup>, Quentin Mackie<sup>c</sup>, Daryl Fedje<sup>c,d</sup>, Louis Wilson<sup>e</sup> and Elroy White<sup>f</sup>

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<sup>b</sup> Independent Archaeologist – Vancouver, BC

<sup>c</sup> Department of Anthropology – University of Victoria

<sup>d</sup> Tula Foundation

<sup>e</sup> Cape Mudge

<sup>f</sup> Bella Bella

Session - Human Habitation and Ancient Knowledge: Discovery Islands

#### Oral Presentation Abstract

Our research is focused on the social and ecological context of ancient resource management, particularly mariculture, around Bella Bella and northern Quadra Island. In Bella Bella, we conducted interviews with Heiltsuk knowledge holders on traditional clam management and use. In both areas, our archaeological work dovetails with our ecological experiments that measure how much more productive clam gardens today are than non-walled beaches. Archaeologically, on Quadra Island we are documenting the location and age of clam gardens, determining their relationship to late Holocene settlements, and excavating middens to measure the growth and relative abundance of clams pre- and post clam garden construction. We are also excavating clam gardens themselves to date the construction of the rock walls and are examining sediments to determine how much more food (clams) was produced by building clam beds. Our preliminary results suggest that clam gardens were built at specific tidal heights (zero tides) and thus their locations are tied to sea level changes. Gardens stranded in the upper beach are older than those at current zero tides. Our surveys indicate that many of clam gardens in Quadra and Bella Bella were built over bedrock – thus creating productive beaches where no beach existed prior. Our work on clam gardens informs and is informed by the work of others in the Discovery Islands research team, in particular the development of sea level curves, fine-tuning marine reservoir calibrations, using optical stimulated luminescence for dating clam gardens, and the dating of settlements.

### **Seaweed Studies at Hakai: An Update**

Sandra Lindstrom, Katy Hind and Patrick Martone - Department of Botany, University of British Columbia

Session - Outer Shores 2: A Marine Mix

#### Oral Presentation Abstract

The Central Coast is one of the least studied areas of British Columbia due to its relative inaccessibility. The creation of the Hakai Institute near the north end of Calvert Island has allowed us to add to our knowledge of the species of marine benthic macrophytes occurring in this area. To date, we have collected specimens of at least three seagrasses, 206 fleshy algae, 26 articulated corallines and more than 14 coralline crusts. While most of the species occurring in this area are more broadly distributed both to the north and the south, a notable number of species appear to reach their distribution limits in this area. New northern limits are recorded for *Dilsea pygmaea*, *Gracilariopsis andersonii*, *Gracilariophila oryzoides*, *Grateloupia californica*, *Hincksia granulosa*, *Lomentaria hakodatensis*, *Mastocarpus agardhii*, *M. pachenicus*, *Mazzaella californica*, *Ozophora lanceolata*, *Porphyra mumfordii*, and *Pyropia* sp. nov. Many of these new northern records are for species occurring in association with sand, a habitat not always sampled by algal taxonomists. New southern limits are recorded for *Acrosiphonia sonderi*, *Ulva* sp. nov., *Palmaria hecatensis*, and *Tokidadendron bullatum*. In addition to recording species occurrences, we are also monitoring species abundances at three intertidal reference sites. Both of these approaches (qualitative and quantitative) will enhance our understanding of intertidal species, the communities they comprise, and the factors responsible for changes in them.

### **Developing a Novel Detection Method for Freshwater Fish using Environmental DNA**

Jeff MacAdams, Morgan Hocking and Brian Starzomski - University of Victoria, School of Environmental Studies

Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1.

#### Poster Presentation Abstract

Monitoring of freshwater fisheries has traditionally been carried out through labour-intensive field methods, often subject to limitations of cost, access, and error in both identification and estimation. Newly emerging environmental DNA (eDNA) methods use organisms' DNA shed to the environment for detection and abundance estimation. For juvenile stream fish, they need no longer even be seen, let alone trapped and handled, to determine their presence. We collect this eDNA by filtering small volumes of water from several Kwakshua streams. PCR amplification of target DNA fragments collected directly from stream water yields positive detections for Coho salmon and several other fish species at broader taxonomic levels. Quantification of eDNA recovered from water samples correlates with our abundance and density estimates based on traditional monitoring methods in Kwakshua streams. Our experimental validation of eDNA techniques suggest that at low fish density, like that found in juvenile salmon rearing streams, quantity of eDNA is directly proportional to biomass/abundance of target species. eDNA has the potential to replace more time-consuming and less reliable field detection methods in fisheries monitoring. Efficiencies of scaling up sampling and processing will make possible the expansion of monitoring capacity for the immensely valuable Pacific Salmon stocks.

## **Discovery Islands Archaeology: 2014 Archaeological Research**

Quentin Mackie<sup>a</sup> and Daryl Fedje<sup>a,b</sup>

<sup>a</sup>Department of Anthropology, University of Victoria

<sup>b</sup>Tula Foundation, Heriot Bay BC

Session - Human Habitation and Ancient Knowledge: Discovery Islands

### Oral Presentation Abstract

Archaeological fieldwork on Quadra began in June 2014 in conjunction with Dana Lepofsky's group, and continued in July and August with a team of 12 based at the Hyacinthe Bay facilities. Thirty-three sites have been visited, with 14 seeing test excavations. These consisted mostly of 50 x 50 cm evaluative tests in sites at various elevations and geological settings, ranging from 5 to 160 m above modern sea level and including stranded marine features, rockshelters, lakeshores, and the nearshore and intertidal zone. Numerous artifacts have been recovered, including diagnostic discoidal core technology, microblade technology, and a suite of sites containing obsidian (volcanic glass). Including the clam garden work, 77 radiocarbon dates on archaeological features or deposits have been obtained. In this first year of archaeological work, not all dates conformed to expectations based on the sea level history. Some are unexpectedly young and some tests had reversals, with older dates above more recent ones. In order to better understand site formation processes in this dry, sandy and silty deposits a 1 x 1 m unit was opened in October near Crescent Inlet. This test on a 12 metre terrace will give us guidance on how to best excavate on Quadra Island. It also returned a large sample of microblade technology and may date to a period around 7,000 years ago.

## **Five Hundred Years of Residency, Resilience, and Forest Management Practices at Calvert Island**

Darcy Mathews - Hakai Post-Doctoral Fellow, School of Environmental Studies, University of Victoria

Session - Human Habitation and Ancient Knowledge: The Calvert and Hunter Island Region

### Project Abstract

Focusing on the area centred around Calvert Island, I consider the long-term dynamics of dwelling within this place, and the deep history of past forest utilization and management practices as a site of cultural resiliency over the last half of the millennium. Culturally modified trees are a living legacy of forest use, and encompass a wide range of practices, including collecting western redcedar bark, felling trees for houseposts and canoes, and collecting house planks from standing trees. These modifications may also provide a precise tree-ring chronological record. This fine-grained temporal resolution, combined with the form of tree modification and where those modifications happened on the landscape, are the material and spatial record of forest utilization practices. Paired with radiometric dates collected from the top strata of village sites in the area, and triangulating with community traditional use knowledge, these data allow us to consider the historical relationships between forest management practices and residency around Calvert Island.



## **The Convergence of Archaeology and Ecology at Hakai: Insights from a Short-Course Hosted in May 2014**

Iain McKechnie<sup>a,b</sup> and Margot Hessing-Lewis<sup>b</sup>

<sup>a</sup> SSHRC Postdoctoral Fellow and Courtesy Research Associate, Anthropology, University of Oregon

<sup>b</sup> Hakai Institute and Hakai Network for Coastal People, Ecosystems and Management, Simon Fraser University

Session - Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region

### Oral Presentation Abstract

This past summer, Hakai scholars Margot Hessing-Lewis and Iain McKechnie co-instructed a 2-week course focused on the intersections between Archaeology and Ecology. The goal of the course was to bring together students and experts from both disciplines to productively converse and converge our different perspectives and methodologies. In doing so, our aim was to improve, reconcile, and find new collaborative approaches to understand the social and ecological landscape of BC's Central Coast, and beyond. Twelve students from diverse fields and backgrounds took part in the course's daily lectures and field trips. During their busy 2-week stay at HBI, they heard from and took part in discussion with 22 guest lecturers, including academics, Indigenous knowledge holders and Hakai affiliated researchers. This presentation reviews and reflects on the course activities and includes photos and a discussion of the synergies that have emerged from the experience.

## **Cultural Processes and Occupation Site Continuity in the Hakai Passage Region**

Duncan McLaren – Hakai Institute and University of Victoria, Department of Anthropology

### Oral Presentation Abstract

Ongoing archaeological work on the central Pacific coast of Canada has revealed thirteen archaeological sites that have records of occupation that exceed 5,000 years. Five of these sites have strata that indicate over 10,000 years of repeated occupation. As a part of the Hakai Ancient Landscapes Archaeology Project, work is being conducted to better understand and document the chronology of sites in the region using different methods of sediment sampling combined with radiocarbon dating. To date our research has focused on the stability of sea level as being a primary agent allowing for the accumulation of archaeological deposits over the long term. However, cultural factors are also important in the repeated use of a given area. Significantly, I argue that the entrenched and codified system of village affiliation to an origin story is a prime driver of cultural continuity in occupation and land use. Traditionally, each village had its own origin story, whereby the people of that place could trace ancestry from an original inhabitant of the landscape who came to earth in or near the village site. Various prerogatives, rights, and privileges of this local group were pre-empted or formed by these original ancestors and, in turn, bestowed on their descendents. As such, the origin story and prerogatives associated with it are considered to be extremely valuable property, to be protected through bloodshed if necessary. Stemming from this common origin story, a local group was politically autonomous with its own nobility, land titles, crests, names, and ceremonial prerogatives. Of particular significance, village sites and primary resource use areas were owned property. This property was inalienable from the descendents of the local group, thus, ensuring the inheritance of title from one generation to the next. These cultural mechanisms should be

reflected in the archaeological record as long-term places of occupation and land-use, not unlike sites encountered and investigated by the Hakai Ancient Landscapes Archaeology Project.

### **Where Does the Sand Come From?**

Brian Menounos - Natural Resources and Environmental Studies Institute and Geography Program, University of Northern British Columbia

Session – Landscape History

#### Oral Presentation Abstract

Sand is an important substrate of the near-shore marine ecosystem in coastal British Columbia, but exactly where does it come from? Sources for the sand include reworking of glacially-derived sediments from the last glaciation or erosion of contemporary bedrock in coastal settings. We propose to examine the provenance and production rate of Calvert Island sand. Geochemical and trace isotope geochemistry will allow us to fingerprint beach and shallow-marine sand; we will compare these data to geochemistry of representative samples collected from bedrock, glacial deposits both on Calvert Island and in regions to the east of Calvert, the source for the Cordilleran Ice Sheet. Terrestrial cosmogenic dating ( $^{10}\text{Be}$  and  $^{14}\text{C}$ ) for bedrock and regolith exposed on Calvert Island will allow us to estimate bedrock erosion rates for the last 14,000 years. The results of our study will help address the fundamental objectives proposed for the sandy ecosystems study; our investigation will also complement ongoing research of the bog forest. More broadly, our study will better quantify natural rates of sediment supply to sandy ecosystems of British Columbia.

### **Toward a Luminescence Chronology for Coastal Dune and Beach Deposits on Calvert Island, British Columbia Central Coast, Canada**

Christina Neudorf<sup>a</sup>, Olav Lian<sup>a</sup>, Ian Walker<sup>b</sup>, Dan Shugar<sup>b</sup>, Jordan Eamer<sup>b</sup> and Libby Griffin<sup>a</sup>

<sup>a</sup> Department of Geography – University of the Fraser Valley, Abbotsford, BC, Canada

<sup>b</sup> Department of Geography – University of Victoria, Victoria, BC, Canada

Session – Landscape History

#### Oral Presentation Abstract

The Quaternary history of the central coast of British Columbia (BC), Canada is poorly understood, but recent research in the area suggests that it has a unique glacial history, postglacial sea levels remained remarkably stable, and archaeological evidence exists for human occupation for at least the last 10,000 years. During this time, and particularly over the last ~1000 years, foredune and beach deposits experienced episodic disturbance due to phases of aeolian activity, coastal erosion and possible tsunami inundation. Though radiocarbon ages have provided a crude temporal framework for these events, a more robust chronology can be achieved by combining them with luminescence ages. New optical age information for samples collected from Calvert Island will be reported in this presentation and procedures used to fine-tune and test our laboratory procedures to the character of feldspar in the region are discussed in an accompanying poster to these proceedings (Neudorf et al. 2014). Refined age estimates show consistency with independent radiocarbon dating control and suggest that the large prograding beach ridge/foredune complex on the NW part of the island has prograded west at a rate of 0.65–0.74 m/a.

## **Refining Luminescence Dating Procedures for Feldspar on Calvert Island, British Columbia Central Coast, Canada**

Christina Neudorf<sup>a</sup>, Olav Lian<sup>a</sup>, Ian Walker<sup>b</sup>, Dan Shugar<sup>b</sup>, Jordan Eamer<sup>b</sup> and Libby Griffin<sup>a</sup>

<sup>a</sup> Department of Geography – University of the Fraser Valley, Abbotsford, BC, Canada

<sup>b</sup> Department of Geography – University of Victoria, Victoria, BC, Canada

Session – Landscape History

### Poster Presentation Abstract

This study presents new optical age information from K-feldspar from coastal dune and beach sands on Calvert Island for the purpose of developing suitable luminescence dating protocols that will allow for a more rigorous chronology for landscape evolution and human occupation on BC's central coast. Luminescence signals from quartz are dim and lack the so-called "fast component" that is required for optical dating. Thus, we have refined a single-aliquot regenerative-dose (SAR) protocol for K-feldspar specific to Calvert Island through a series of dose recovery and preheat plateau tests. Because K-feldspar is known to suffer from "anomalous fading" (i.e., the signal fades over geological time periods), this effect must be measured and corrected for. Measured fading rates from Calvert Island vary from sample to sample implying that, in this region, it is not sufficient to rely on two or three representative fading rates as has sometimes been done in studies elsewhere. Bleaching experiments show that some samples may yield age overestimates if they were exposed to the UV portion of sunlight prior to burial, and this is attributed to a phenomenon called phototransfer. A new correction for phototransfer is introduced and applied. Refined age estimates show consistency with independent radiocarbon dating control.

## **Toward a Chronology for Clam Garden Construction on Quadra Island, British Columbia, Canada**

Christina Neudorf<sup>a</sup>, Nicole Smith<sup>b</sup>, Dana Lepofsky<sup>c</sup> and Olav Lian<sup>a</sup>

<sup>a</sup> Department of Geography – University of the Fraser Valley, Abbotsford, BC, Canada

<sup>b</sup> Independent Archaeologist – Vancouver, BC

<sup>c</sup> Department of Archaeology – Simon Fraser University, BC, Canada

Session - Human Habitation and Ancient Knowledge: Discovery Islands

### Oral Presentation Abstract

This study explores the feasibility of constraining the time of clam garden construction on Quadra Island using luminescence dating. Clam gardens were constructed by First Nations communities by building rock walls in the intertidal zone parallel to steep rocky beaches. Sediments that accumulated behind these walls increased the surface area of clam habitat. Luminescence dating exploits the luminescence signals of quartz or feldspar grains to determine the last time they were exposed to sunlight (i.e., their burial age). In the summer of 2014, sediment samples were collected from below three clam garden walls in Small Inlet. Vertically-oriented ~1 m core samples were also obtained from the sediment infill behind the walls in order to see if fluctuations in sedimentation rates are recorded in down-core trends in signal brightness. Luminescence signals from one vertically-oriented core obtained from one of the highest clam garden terraces in Small Inlet (Site KB14-05) show an abrupt increase in intensity ~1.2 m below the surface. This suggests that ancient sediments behind the clam garden wall have been recently overlain by young deposits; perhaps an indication of either the beginning, or a pause, in wall construction. Further measurements will be made to estimate the burial age of sediments in the

lower part of this core. A weighted mean (Central Age Model) age estimate of  $1525 \pm 144$  years was obtained from twenty-two aliquots of one sample collected from sediments underlying the clam garden wall at Site KB14-05.

### **Freshwater Export of DOM and Nutrients from Kwakshua Watersheds to Near Shore Marine Ecosystems: Improving Understanding of Watershed Processes and Terrestrial-Marine Linkages**

Allison Oliver<sup>a</sup>, Suzanne Tank<sup>a</sup>, Brian Hunt<sup>b,c</sup>, Ian Giesbrecht<sup>b</sup>, Colleen Kellogg<sup>c</sup>, Skye McEwan<sup>b</sup> and Ken Lertzman<sup>d</sup>

<sup>a</sup> University of Alberta

<sup>b</sup> Hakai Institute

<sup>c</sup> University of British Columbia

<sup>d</sup> Simon Fraser University

Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 2

#### Poster and Oral Presentation Abstract

Little is known about the factors influencing the quantity and quality of dissolved organic matter (DOM) exported from coastal temperate rainforests or the role of this DOM in near-shore marine ecosystems. Here we examine the aquatic biogeochemistry of freshwater being delivered to Kwakshua Channel and the potential role of terrestrially-derived DOM and nutrients in near shore marine ecosystems. In 2013, the Kwakshua Watershed Project began year-round routine collection and analysis of freshwater grab samples from the outlets of seven watersheds draining into Kwakshua Channel as well as near-shore marine stations adjacent to freshwater outflows. Samples were analyzed for a variety of parameters including concentration and composition of DOM, nutrients, ions, and stable isotopes. Dissolved organic carbon (DOC) varied across watersheds (mean= 11.45 mg L<sup>-1</sup>, sd± 4.22) and fluctuated synchronously with seasons and storm events. In general, higher DOC was associated with lower specific UV absorbance (SUVA<sub>254</sub>; mean= 4.59 L mg<sup>-1</sup> M<sup>-1</sup>, sd± 0.55). The relationship between DOC and SUVA<sub>254</sub> differed between watersheds, suggesting exports in DOM are regulated by watershed attributes (e.g. landscape classification, flow paths) and precipitation. At near shore marine sites, coupled CTD (Conductivity Temperature Depth) and optical measures (e.g. spectral slopes, EEMs), provide evidence of freshwater DOM within the system, particularly following rain events. Ongoing work includes expansion of monitoring via in-situ instrumentation, event sampling, and novel experimental work in an effort to better constrain carbon budgets and improve understanding of how DOM influences microbial phytoplankton community dynamics.

## **From Seagrass to Kelp Forests: Effects of Habitat Connectivity on Temperate Nearshore Fish Recruitment and Growth**

Angeleen Olson<sup>a,b</sup>, Francis Juanes<sup>a</sup>, Margot Hessing-Lewis<sup>b,c</sup> and Anne Salomon<sup>b,c</sup>

<sup>a</sup> University of Victoria

<sup>b</sup> Hakai Institute

<sup>c</sup> Simon Fraser University

Session – Outer Shore 1: The Otter Landscape

### Poster Presentation Abstract

The use of diverse habitats by different life history stages (ie. juvenile to adult) is critical to maintaining the productivity of fish populations. Specifically, increased structural complexity of marine vegetation can augment fish biomass and enhance population rates of increase by increasing substrate for recruitment, shelter from predators, and food sources. On the west coast of North America, marine macrophyte communities are often dominated by seagrass in protected, soft-sediment embayments and by kelp in wave-exposed, rocky reef systems. Although nursery effects of seagrass beds have been well documented for coral reefs, their connection to kelp forests in temperate ecosystems remain poorly understood. We aim to determine if fish recruitment and growth are mediated by the connectivity between seagrass (*Zostera marina*) and kelp (*Macrocystis pyrifera*) nursery habitats. Next summer, we will examine habitat-mediated effects using snorkel surveys at varying degrees of connectivity between seagrass, kelp, and seagrass-kelp mixed sites, and by using  $\Delta^{13}\text{C}$  stable isotopes of fish as tracers of primary production. Habitat-mediated effects are of particular importance on the Central Coast, BC as significant top-down and bottom-up stressors are occurring simultaneously in the nearshore marine environment. As the factors influencing seagrass and kelp are multifaceted, this study will enhance our knowledge of the nursery roles of these habitats on important reef fish communities that will inform the management of BC's coast in the future.

## **Introducing Microbes to Macrophytes**

Laura Wegener Parfrey – University of British Columbia

Session – Outer Shores: A Marine Mix

### Oral Presentation Abstract

Macrophytes such as kelp (*Macrocystis/ Nereocystis*) and eelgrass (*Zostera*) are foundational species in coastal waters along the west coast of North America and important contributors to primary production. These macrophytes also provide important habitat for fish and diverse communities of marine animals. Microbes link macrophyte production to higher trophic levels by feeding on algal exudates and in turn making up the base of the heterotrophic food chain of protists, small invertebrates and fish. Microbes represent a substantial fraction of primary production in eelgrass beds, and are essential for breaking down dead eelgrass and recycling the carbon and nitrogen within the system. Thus, understanding the microbial dynamics is critical to documenting the overall flux of carbon through both kelp and eelgrass systems. Judging by the myriad roles host-associated microbes play in other ecosystems and previous studies, we predict that the impact of macrophyte-associated microbes extends far beyond trophic linkages. For example, microbes influence the morphology of *Ulva*, and likely manufacture the chemicals produced by coralline red algae that act as settling cues for a wide range of species in the rocky intertidal. However, the microbial communities associated with macrophytes are poorly characterized, and their responses to major environmental changes such as ocean acidification

are essentially unknown. This study will establish baseline knowledge about the variation of macroalga-associated communities across host phylogeny as well as spatial and temporal (seasonal) scales. Baseline data on the microbial communities associated *Zostera* are currently being generated externally by the seagrass microbiome project. This initial understanding of the microbial diversity associated with macrophytes will inform manipulative experiments testing the factors that determine microbial community assembly and succession and the response of macrophyte communities to ocean acidification.

### **The ELC at Work**

Holly Pattison and Calvin Sandborn - Environmental Law Centre, University of Victoria

Session - Research for Communities and Society

#### Poster Presentation Abstract

The Environmental Law Centre works with community organizations and First Nations across B.C. to protect and improve the environment and access to justice. The news stories contained in this poster represent the range of work undertaken over the past year and demonstrate the far-reaching impact that access to law can make.

### **Lithic Artifacts from Early Period Archaeological Sites, Hakai Ancient Landscapes Archaeology Project**

M. Cecilia Porter<sup>a,c</sup> and Jenny Cohen<sup>b,c</sup>

<sup>a</sup> University of Calgary

<sup>b</sup> University of Victoria

<sup>c</sup> Hakai Institute

Session - Human Habitation and Ancient Knowledge - Calvert and Hunter Island Region

#### Poster Presentation Abstract

For the past four field seasons the Hakai Ancient Landscapes Archaeology Project has been conducting archaeological investigations on the Central Coast of BC, with focus on early period (13,000-5,000 Cal BP) sites. Analysis of collected lithic artifacts (stone tools) is a major component of the overall project. We present the results from the analysis, highlighting the lithic technologies from early period sites. Emphasis is on the 2014 field season, although significant finds from all years of the project are also highlighted. Previously, Namu had stood alone as the only investigated archaeological site on the Central Coast with a 10,000-year-old time depth. The extent to which the early period lithic assemblage at Namu represents lithic traditions throughout the Central Coast was unknown. Through survey and excavation of several early period sites, the findings increase the recorded geographic extent of these early technologies. Our research demonstrates that lithic data from all years of the project is consistent with and expands the previously established lithic typologies from Namu.

### **Deep Time on the Central Coast: First Nations History and Environmental Change**

Farid Rahemtulla - Dept. of Anthropology, University of Northern British Columbia

Session, Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region

#### Oral Presentation Abstract

The Hakai/central coast area has a deep Aboriginal history that is intertwined with major environmental changes over the last 10,000 years. With a focus on intensive excavations at one

very deep and extensive midden, we are exploring the relationship between changing resource availability on the one hand, and First Nations responses to those ecological changes over the course of the Holocene epoch. For the last four years we have continued excavations at midden site EJTa-4 in Meay Inlet, which is showing remarkable continuity in aboriginal use starting at least 7,000 years ago (and likely earlier), and ending roughly 300 years ago. A major research goal is to trace the long-term development of seasonal (winter) sedentary settlement, evidence for which has proven elusive along most of the Pacific Northwest due to the lack of long-occupation sites such as the ones in this region. This includes an exploration of the antiquity of rock wall clam beds (clam gardens) in this area. These deep middens also contain an incredible amount and variety of evidence that not only reflect human procurement of subsistence and of raw material (including long distance trade) resources, they are also repositories of data that can reveal much about changes in the natural biome through time.

### **Changes in Sea Otter Foraging Behavior and Habitat-Use on the Central Coast of British Columbia**

Erin Rechsteiner<sup>a</sup>, Angeleen Olson<sup>a,b</sup>, Linda Nichol<sup>c</sup>, Jane Watson<sup>d</sup>, Keith Holmes<sup>a,c</sup>, Luba Reshitnyk<sup>a,c</sup>, Margot Hessing-Lewis<sup>a</sup>, Leah Honka<sup>b</sup> and Anne Salomon<sup>a,b</sup>

<sup>a</sup> Hakai Institute

<sup>b</sup> CMEC Lab, Simon Fraser University

<sup>c</sup> Pacific Biological Station, Fisheries and Oceans Canada

<sup>d</sup> Vancouver Island University

<sup>e</sup> SPAR Lab, University of Victoria

Session - Outer Shores 1: The Otter Landscape

#### Oral Presentation Abstract

Sea otters exert top-down effects on invertebrate communities that trigger changes in prey availability, which in turn influence sea otter diet and habitat. We are documenting habitat use and foraging behavior of sea otters on the Central Coast of BC using two methods: 1) foraging observations of male sea otters expanding into an area unoccupied by sea otters since the 19<sup>th</sup> century, and 2) foraging observations of sea otters at sites they have occupied from ~25 to <1 year. At new sites, male otters foraged over rocky habitats where their diet consisted of large red sea urchins. Within 5 months, the size of urchins taken by sea otters declined, diet diversified, and otters began to forage in seagrass ecosystems. Within 10 months the size of all prey species taken by otters declined and sea otters were rare; remaining otters foraged over sandy habitats. This suggests that once male sea otters have depleted easily exploited, large prey items they move on to new areas. Using a space-for-time substitution, we found that as occupation time and otter densities increased, diet diversity peaked (~ 3 yrs), followed by declines in diversity and prey size. Changes in diet were associated with changes in habitat use, with small snails and mussels prevalent in the diet in rocky areas, and small clams and kelp crabs dominating in soft sediments. Spatial habitat complexity on the Central Coast contributes to variation in sea otter diet, movements, and range expansion, and future work includes assessing the magnitude of these effects across ecosystems.

## **Habitat Mapping: Place-Based Research**

Luba Reshitnyk<sup>a,b</sup> and Keith Holmes<sup>a,b</sup>

<sup>a</sup> Hakai Beach Institute

<sup>b</sup> Spatial Patterns and Analysis Research Lab, University of Victoria

Session – Outer Shores 1: The Otter Landscape

### Poster and Oral Presentation Abstract

The Spatial Pattern Analysis and Research (SPAR) Laboratory at the University of Victoria uses maps to bridge the gap between the multiple disciplines and research projects at the Hakai Institute (HBI). We provide a number of GIS and remote sensing tools in the field and in the lab to assist various research teams in gaining a better spatial understanding of the complex environment of the Central Coast of British Columbia. One project we chose to feature this year is our work with habitat mapping in the marine environment. Habitat maps derived using remote sensing technologies are increasingly being used to assess the status of coastal marine habitats and are crucial to the conservation and monitoring of coastal habitats. Remote sensing technologies offer effective and efficient methods for mapping large remote tracts of coastal habitat compared to traditional field techniques. This year we collected two remote sensing datasets - very high resolution multispectral satellite imagery from the WorldView-2 sensor (8 band, 2 m) and aerial photographs (0.15 m) for the purpose of mapping nearshore marine habitats including canopy-forming kelps (*Macrocystis* sp. and *Nereocystis* sp.) and eelgrass beds (*Zostera marina*) with towed underwater video for ground-truth data. Situated on the central coast of British Columbia, the Hakai Institute (HBI) seeks to conduct place-based research of long term ecological processes. We are exploring the methods, benefits and limitations of satellite imagery and aerial photography with regards to marine habitat mapping in temperate nearshore environments.

## **Island Biogeography & Ecosystem Subsidies on the BC central coast**

John Reynolds<sup>a</sup>, Brian Starzomski<sup>b</sup>, Chris Darimont<sup>b</sup>, Trisalyn Nelson<sup>b</sup> and Luba Reshitnyk<sup>b,c</sup>

<sup>a</sup> Simon Fraser University

<sup>b</sup> University of Victoria

<sup>c</sup> Hakai Institute

Session - Out Shores 2: A Marine Mix

### Oral Presentation Abstract

This new project aims to blend the theory of island biogeography with theories about the role of ecosystem subsidies in ecology. Specifically, we wish to understand how nutrients from seaweed and marine animals on islands affect the ecology of plants, breeding birds, mammals, and insects. This spring, our team will begin a five-year project on 100 islands near Calvert Island. We will use a variety of census techniques, supported by use of stable isotopes, to connect marine-derived nutrients to diversity, density, and species-area relationships of each of these species groups. There will be synergy with numerous other Hakai projects in the region. We are currently considering applications from interested graduate students, postdocs, and field assistants.



## **Tipping Points in North Pacific Kelp Forest Ecosystems**

Anne Salomon<sup>a,b</sup>, Kyle Demes<sup>a,b</sup>, Jenn Burt<sup>a,b</sup>, Leah Honka<sup>a,b</sup>, Kira Krumhansl<sup>a,b</sup>, Lynn Lee<sup>a,b</sup>, Linda Nichol<sup>c</sup>, Angeleen Olson<sup>a,b</sup>, Josh Silberg<sup>a,b</sup>, Christine Stevenson<sup>a,b</sup>, Jane Watson<sup>d</sup>, Gitla Elroy White<sup>e,b</sup> and Kii' iljuus Barb Wilson<sup>a,f</sup>

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Session - Outer Shores 1 - The Otter Landscape

### Oral Presentation Abstract

Emerging evidence suggests that ecosystems can exhibit system boundaries, known as tipping points, beyond which they can rapidly re-organize and flip into alternative states. Explicit consideration of these thresholds can illuminate our scientific understanding and management of ecosystems. In the northeastern Pacific, sea otters are known architects of coastal marine ecosystems because they trigger tipping points, however, when, where and to what extent these dramatic changes occur remain unknown. Based on a space-for-time substitution, our research has shown that a one year increase in occupation time corresponds to a 90% decline in sea otter attack rates on sea urchins. Furthermore, densities of this key grazer decline non-linearly as sea otter occupation time increases to a distinct threshold at 3 (+/- 0.6) years, after which densities hover around 1.3 individuals m<sup>-2</sup>. This has cascading effects on the abundance and spatial distribution of kelps which become dramatically less patchy after 3.1 years of occupation and more dense when urchins are reduced below 5.4 urchins per m<sup>2</sup>. While sea otters indirectly increase nearshore primary productivity, recent kelp growth rate estimates suggest that kelp recovery is extremely sensitive to ocean temperature. Lastly, with each year of otter occupation, exposed abalone density decreased by a factor of 1.5, and, contrary to our predictions, we did not detect an increase in kelp associated fish. In sum, we quantified various kelp forest tipping points that can elicit profound socioeconomic and cultural trade-offs.

## **Soil Evolution and Diversity on Sandy Substrates, Calvert Island, BC**

Paul Sanborn - Ecosystem Science and Management Program, University of Northern British Columbia

Session – Cross-listed with 1) Landscape History and 2) Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1

### Oral Presentation Abstract

Sandy-textured deposits of marine, glaciofluvial or aeolian origin, ranging in age from modern to early Holocene, provide a chronosequence for studying long-term soil evolution on northern Calvert Island. Soil diversity was examined within a compact (~ 0.5 hectare) area on and adjacent to the oldest identified aeolian landform, a stabilized dune (~ 8600 BP) near Second Beach. Salient features of soil evolution, and some implications for ecosystem and watershed functioning, include: (1) ubiquitous soil cementation by iron (Fe) oxides and humus, ranging from incipient to indurated, can restrict the depth of root penetration to ~ 30 cm or less, potentially reducing forest productivity, while limiting infiltration and promoting rapid runoff response to rainfall; (2) across the range of horizon types examined, average total phosphorus (P)

concentrations are < 400 ppm in both upland organic and peat materials, and ~ 150 ppm in mineral horizons, mirroring low P concentrations in local bedrock, and suggesting potential for widespread P limitation in these ecosystems; (3) lowland sites with high but rapidly fluctuating water tables exhibit pronounced lateral variability in patterns of soil organic matter and Fe oxide accumulation on scales of < 5 m, contributing to the potential diversity of environments for microbial life. Further study of the Calvert Island soil chronosequence would clarify the time scales for cementation genesis and P transformations.

### **Local Observations of Climate Change**

Valentina Savo<sup>a</sup>, Dana Lepofsky<sup>a,b</sup>, J. Benner<sup>a,c</sup>, and Ken Lertzman<sup>a,c</sup>

<sup>a</sup> Hakai Network for Coastal People, Ecosystems and Management

<sup>b</sup> Department of Archaeology, Simon Fraser University

<sup>c</sup> School of Resource and Environmental Management, Simon Fraser University

Session - Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region

#### Poster Presentation Abstract

Climate change is a global problem with complex effects at the local level. Coastal regions and peoples are especially vulnerable to climate-induced environmental changes. We collated data on observations of climate change at the global level (from more than 1000 sources) and the local level in BC's Central Coast (through 20 semi-structured interviews with members of Heiltsuk and Wuikinuxv communities). Subsistence oriented communities are observing multiple changes in climate. Increases in temperature and changes in seasonality and rainfall are the most cited changes at the global level. More specific threats to coastal areas include sea level rise, coastal erosion, salt water intrusion, floods, extreme weather events, decrease of fish catch, loss of properties and cultural sites. These changes are happening in many coastal localities worldwide including the Central Coast where changes in the environment are seen not only as consequences of climate change but also of other economic and socio-ecological factors (e.g., over-exploitation by non-indigenous fishers). One of the main results of our research is that climate change is having more disruptive effects at a local level than is highlighted by global models and that local observations can make important contributions to understanding the pervasiveness of climate change on ecosystems and societies.

### **Feeding Interactions of Pelagic Fish Communities**

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Session - Marine Food Web Dynamics

#### Project Abstract

Fluctuations of low-trophic level forage fish, including Pacific herring and salmon juveniles, can have substantial repercussions for the entire coastal ecosystem, as well as subsistence and commercial fisheries. One of the factors influencing the productivity of forage fish is the availability of their zooplankton prey. Zooplankton abundance is determined by a combination of bottom up (e.g., phytoplankton growth) and top down processes (predation). The growth of fish juveniles may be strongly affected by inter species competition for available prey resources. Although competition can ultimately determine the abundance and distribution of forage fish, with both ecological (food web continuity) and commercial fisheries implications, this aspect of

forage fish dynamics has seldom been studied in detail. Our ongoing research is investigating the dietary preferences of forage fish collected in Rivers Inlet and regional Central Coast (BC) waters. A data base has been established that spans 2005 to present, comprising fish ranging in size from 20mm to 300mm collected by trawl (DFO) and purse seine sampling (Rivers Inlet Ecosystem Study, Hakai Institute, HIRMD). The most abundant species include Pacific herring, capelin, stickleback, pink, chum, chinook, sockeye and coho. Detailed dietary analyses and stable isotope data collections are nearing completion. Subsequent statistical analyses will pay particular attention to inter-annual diet variability and inter species competition. This study aims to improve understanding of forage fish trophic dynamics and the quality of the forage fish component of the Central Coast food web modelling program, with the view to enhanced model application in ecosystem-based fisheries management.

### **Losing the Bog to the Trees: Testing the Role of Longterm Change in Ecosystem Recovery from Disturbance**

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Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part1.

#### Poster Presentation Abstract

Ecosystems are experiencing slow, abiotic changes due to anthropogenic factors such as climate shifts and nutrient deposition. As abiotic conditions change over the long term (30-100 years), an ecosystem may eventually shift into an alternative state. In the short term (2-3 years), however, the impact of these changes are relatively unknown. Although some models predict that the ability of an ecosystem to recover from short term disturbance will slow as the ecosystem undergoes long term changes, the full extent of effects have yet to be substantiated. We are testing this theory in the bogs of Calvert Island. Bog and forest communities are known alternative ecosystem states, with bog states maintained by saturated soil conditions that switch to forest states once drained. To investigate the effects of slow changes towards a forested state, we dropped the water table in bog microcosms. Though we expect the immediate effects on the vegetation communities will be low, impacts on the community's short term ability to respond to further disturbance may be significant. We chose to use trampling as our primary short term disturbance. Both drained and intact bogs were trampled equally and the impact measured. We expect that those bogs undergoing long term drainage will show slower recovery rates from the disturbance due to the continuously shifting abiotic conditions. We are monitoring vegetation, microarthropod communities, and ecosystem functioning such as decomposition rates and nutrient cycling to assess resistance and recovery of the bog to trampling over the next three years.

## **Post-Glacial Sea Levels in Pacific North America – Hinge Zones and Human Occupation**

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Session – Human History

### Poster and Oral Presentation Abstract

Post-glacial relative sea level (RSL) histories vary with distance from ice loading and associated factors such as time-transgressive ice retreat, diverse tectonic settings, and differential crustal responses. At the last glacial maximum (LGM), the Cordilleran Ice Sheet depressed the crust over which it formed and created a raised forebulge along peripheral areas offshore. We synthesize the state of knowledge regarding post-glacial sea-level changes on the Pacific coast based on ~2,200 previously published radiocarbon dates from northern California to Cook Inlet, Alaska. We then describe a 1000-km long hinge zone, separating the isostatically depressed inner coast from the forebulged outer coast, and discuss the implications for human occupation, based on 100 new dates from the Hakai region on the central BC coast. The post-glacial RSL history for several locations on the northwest coast of North America can be described as relatively stable, where isostatic effects kept equal pace with eustatic sea level rise. These include (from south to north) the Broughton Archipelago and the northern tip of Vancouver Island, the Bella Bella/Calvert Island region on the central BC coast, the Dundas Islands Archipelago near Prince Rupert, and the area east of Prince of Wales and Baranof islands in the Alexander Archipelago in southeast Alaska. These regions form a hinge zone, demarcating the isostatically depressed inner coast, from the forebulged outer coast. The stable shorelines along this hinge zone represented a reasonably hospitable landscape for human occupation and as a result, some of these regions have proven to contain rich archaeological records.

## **Indirect Effects of Sea Otter Recovery on Temperate Reef Fish**

Joshua Silberg and Anne Salomon

Simon Fraser University School of Resource and Environmental Management and Hakai Network for Coastal People, Ecosystems, and Management

Session - Outer Shores 1: The Otter Landscape

### Poster Presentation Abstract

In temperate marine ecosystems, sea otters are well known to consume herbivorous invertebrates, releasing macroalgae from grazing pressure and allowing kelp beds to flourish. The sea otter trophic cascade can also have numerous indirect effects on other species that use kelp forests. For example, various fish species use kelp forests as habitat for juveniles, for shelter from predation, or to feed on other species that inhabit the kelp. Thus, we predicted that there would be increased reef fish biomass at sites with longer sea otter occupation time. We conducted both hook-and-line surveys, diet analysis and underwater visual surveys of reef fish communities at 20 sites along a known spatial gradient in sea otter occupation time on the Central Coast of BC. The most common species caught through fishing were copper rockfish (*Sebastes caurinus*) and kelp greenling (*Hexagrammos decagrammos*), comprising 44% and 22% of the catch, respectively. Contrary to expectations, neither hook-and-line fishing nor

underwater visual surveys showed evidence that sea otter occupation time was the most important factor in determining reef fish biomass within the kelp forests. However, preliminary analysis showed potential effects of sea otter presence on the  $\delta^{15}\text{N}$  signature of kelp greenling. As sea otters expand their range on the Central Coast, it will be critical to understand the implications on the entire kelp ecosystem in order to model sea otter impacts on fisheries and food security.

### **Rock Art: Paintings and Carvings in Owikeno Lake and Roscoe Inlet**

Aurora Skala – Department of Anthropology, University of Victoria

Session – Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region

#### Poster Presentation Abstract

My archaeological research is focused on locating and recording Heiltsuk and Wuikinuxv Nations' rock art. The deep history of peoples on the Central Coast is evident by the stories and material culture which continue to be present today. By listening to these stories and visiting locations where rock art was created I hope to better comprehend the significance of the rock art designs. In the last year I have worked with both Nations to photograph a sample of pictographs (rock paintings) and petroglyphs (pecked rock carvings) from within these two territories. The next stage of my research involves digital manipulation of the photographs back in the lab, using the program D-Stretch. D-Stretch was developed specifically to assist rock art researchers in making visible faint traces of pigment which can no longer be seen with the naked eye. Photographs of pictographs which appear to be portraying a particular motif can sometimes change dramatically when the contrast is digitally adjusted with computer software. New designs can emerge and existing design's interpretation may change once the rest of the painting is made visible. Some examples of this are on the poster I have created. This year I visited River's Inlet, Owikeno Lake, and Roscoe Inlet.

### **Emerging Stories from the Discovery Islands Landscape Archaeology Project**

Nicole Smith<sup>a</sup>, Daryl Fedje<sup>b,c</sup>, Quentin Mackie<sup>b</sup>, Cal Abbott<sup>b</sup>, Jenny Cohen<sup>b</sup>, Alex Lausanne<sup>d</sup>, Alexander Mackie<sup>e</sup>, Duncan McLaren<sup>b,f</sup>, Joanne McSporran<sup>e</sup>, Christine Roberts<sup>g</sup> and Louis Wilson<sup>h</sup>

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Session - Human Habitation and Ancient Knowledge: Discovery Islands

#### Poster Presentation Abstract

This poster highlights some key findings and emerging stories from year one of the Discovery Islands Landscape Archaeology (DILA) project. The DILA project aims to better understand the early archaeological and paleoecological history of the Discovery Islands. Our focus is on the terminal Pleistocene and earliest Holocene time periods from about 15,000 to 6,000 years ago. This poster includes: A summary of archaeological and paleoenvironmental sites visited in 2013-

14; The preliminary sea level curve for the Discovery Islands based on paleoenvironmental coring in ponds, bogs and lagoons; and Emerging stories about obsidian and microblades in the Discovery Islands which may allow us to draw connections to other parts of the coast at various points in time.

### **When Size Matters: Accounting for Size-Specific Predation and Grazing Rates Improves our Ability to Predict Trophic Cascades**

Christine Stevenson<sup>a</sup>, Kyle Demes, and Anne Salomon<sup>a,b</sup>

<sup>a</sup> School of Resource and Environmental Management, Simon Fraser University

<sup>b</sup> Hakai Network for Coastal People, Simon Fraser University

Session - Outer Shores 1: The Otter Landscape

#### Poster Presentation Abstract

Predation can influence the magnitude of herbivory that grazers exert on primary producers by altering both grazer abundance and their per capita consumption rates. However, models based solely on changes in abundance may miss a key component of grazing pressure. We quantified shifts in grazing pressure associated with changes in the abundance and per capita consumption rates of sea urchins triggered by size-selective predation by sea otters (*Enhydra lutris*). Field surveys suggest that sea otters dramatically decreased the abundance and median size of sea urchins. Furthermore, lab experiments revealed that kelp consumption by sea urchins varied nonlinearly as a function of urchin size such that consumption increased to the 0.56 and 0.66 power of biomass for red and green urchins respectively, suggesting that shifts in urchin size structure due to size-selective predation by sea otters alter sea urchin per capita grazing rates. Comparison of two quantitative models estimating total consumptive capacity revealed that a model incorporating shifts in urchin abundance while neglecting urchin size structure overestimated grazing pressure compared to a model that incorporated size ( $p = 0.003$ ). Consequently, incorporating shifts in total consumptive capacity resulting from shifts in urchin size structure better predicted field estimates of kelp abundance compared to equivalent models based only on urchin abundance. We conclude that size-specific grazing parameters can easily increase our ability to describe and predict trophic interactions.

### **A Simple Method to Assess the Marine Environment Residence Duration of Juvenile Sockeye Salmon (*Oncorhynchus nerka*) using Laser Ablation**

Allison Stocks<sup>a</sup>, Evgeny Pakhomov<sup>a,b</sup>, Brian Hunt<sup>a,b</sup>

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Session - Marine Food Web Dynamics

#### Project Abstract

Monitoring habitat utilization and early marine growth of sockeye salmon juveniles in coastal waters is currently hampered by difficulties in estimating residence times, limiting scientific advances in certain aspects of this species' fisheries management and conservation. Combining otolith microchemistry and conventional daily ring counts, we were able to obtain the date of first entry and the marine residence time of sockeye juveniles in Rivers Inlet, a British Columbia fjord, using specimens collected during the Rivers Inlet Ecosystem Study. Natural Barium (Ba) concentrations in freshwater are significantly higher than those in seawater, while the converse is

true of Strontium (Sr). Using in situ laser ablation, inductively coupled with a plasma mass spectrometer (ICPMS), we quantitatively measured Ba and Sr at high spatial resolution across cross sections of individual fish otoliths, to identify the point of marine entry. The daily growth rings after this checkpoint were counted to estimate estuarine / marine residency. Exploratory analysis of a 3-year data set showed that although the marine entry point was consistent between years, the mean residence time of sockeye juveniles in Rivers Inlet varied substantially, from 3 to 7 weeks, between years. The speed of travel through the inlet ranged from 0.7 to 4.2 km per day. This operationally inexpensive method provides an effective means to assess sockeye juvenile residence time in coastal environments.

### **Preliminary Metadata in Support of Calvert Island Beach Microbiomes**

Vera Tai\*, Noriko Okamoto\*, Patrick Keeling (\*equal contribution) - The Department of Botany, University of British Columbia

Session – Independently Submitted

#### Poster Presentation Abstract

Sandy beaches dominate coastlines worldwide. These are dynamic environments composed of shifting sediments and variable mixtures of marine and freshwater due to tidal and seasonal storm cycles. Coastal sand harbours rich microbial communities that contribute to biogeochemical processes and support benthic and interstitial meiofauna or other organisms of the food web. These functions of the microbial community, as well as their diversity, however, are poorly understood. Our goals are to examine the protist and bacterial communities of diverse sandy beaches on Calvert Island to obtain the basic information necessary to understand their diversity, dynamics, and ecological contributions. In June 2014, we conducted our first field collections. Surface sand was sampled from five different pocket beaches along transect lines from the high tide line to shore. Samples were processed to obtain environmental metadata, including nutrients, chlorophyll, and sand characteristics, and to extract DNA for microbial diversity analysis. Variable regions of the 16S and 18S rRNA genes will be sequenced to compare the diversity of bacteria and protists, respectively, along transect lines and between beaches. Here, we present a preliminary look at the environmental metadata from transect lines along West, North, 2nd, 3rd, and 7th beaches.

### **Data-Driven Ecosystem Mapping of Calvert Island with Remote Sensing**

Shanley Thompson<sup>a</sup>, Ian Giesbrecht<sup>b</sup>, Gordon Frazer<sup>b</sup> and Trisalyn Nelson<sup>a</sup>

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Session – Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1.

#### Project Abstract

Standard Terrestrial Ecosystem Mapping (TEM) in British Columbia depends on analysts to interpret aerial photographs to identify ecosystem types, using ground sampling to calibrate and validate the interpretation. Each map polygon identifies one, two, or three ecosystem types (and associated structural categories) that are representative of the polygon as a whole, but the exact location of a mapped ecosystem within a given polygon is not indicated, resulting in some spatial ambiguity. Moreover, TEM uses a pre-defined hierarchical classification scheme referred to as Biogeoclimatic Ecosystem Classification (BEC). In some cases, as on Calvert Island, ecosystems

that are not defined in BEC may be delineated on the ground. The goal of this research was to determine what types of terrestrial ecosystems (especially non-forested wetlands) can be delineated on Calvert Island using other types of remotely sensed imagery and without imposing the BEC framework. To reach this goal, an unsupervised, statistical classification of RapidEye multispectral satellite imagery (5 m spatial resolution) and LiDAR (Light Detection and Ranging) data was undertaken. Multivariate clustering of various remotely sensed topographic and vegetation indices resulted in the delineation of 12 forested and 6 non-forested ecosystems, for a total of 18 across the island. Lakes, ponds, and sand beaches account for additional areas excluded from the clustering. This research has demonstrated the utility of new high resolution datasets for terrestrial ecosystem mapping in a quantitative, repeatable fashion. Further, the resultant map serves as a current baseline of the terrestrial ecosystems across the island, facilitating long-term monitoring.

### **Terrestrial Ecosystem Responses to Past and Present Environmental Change**

Andrew Trant<sup>a</sup> and Brian Starzomski<sup>b</sup>

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<sup>b</sup> McTaggart-Cowan Professor, School of Environmental Studies, University of Victoria

Session - Kwakshua Watershed Project and Community Ecology of Calvert Island: Part 1

Poster and Oral Presentation Abstract

The Central Coast of British Columbia has experienced an array of environmental changes throughout the Holocene and into the present. From long-term climate fluctuations to changes in land-use patterns by First Nations people, the structure of terrestrial ecosystems observed today is strongly influenced by complex and interacting factors. My main research questions are: 1) What are the legacy effects of past land-use and habitation patterns of First Nations people on the growth of western redcedar (*Thuja plicata*)?; 2) How are blanket bog plant communities affected by climate change?; 3) How do stand histories and tree growth change along a soil and productivity gradient from zonal forest to bog woodland? Results from redcedar growing on formerly occupied sites with extensive shell middens show higher radial growth rates and higher levels of calcium in the wood than those trees not growing on midden sites. With calcium deficiency proposed as a cause of redcedar top dieback, the implications of these findings could have ecosystem level consequences. Warming experiments conducted over 2 years with ~1°C of warming has recorded over 70 species and 25,726 individuals measured for changes in diversity and structure. For stand reconstructions and growth parameters along the gradient, we observed differences in tree morphology and regeneration with larger trees and more seedlings found in the more productive sites. Quantifying past and present changes in resource use, climate and stand histories provides us with compelling stories used to better understand the factors controlling and driving ecological processes on the Central Coast.

### **Landscape History of Calvert Island**

Ian Walker<sup>a</sup> and Olav Lian<sup>b</sup>

<sup>a</sup> Department of Geography, University of Victoria

<sup>b</sup> Department of Geography, University of the Fraser Valley

Session – Landscape History

Oral Presentation Abstract

The Landscape History program at the Hakai Institute began in 2011 with an extensive mapping campaign and field reconnaissance to document and interpret the geomorphology and



Quaternary stratigraphy of Calvert Island, and, to a lesser degree, Hecate Island. The principal objectives of our research are to (i) gain knowledge of the late Quaternary history of the BC central coast - a region with a paucity of post-glacial geological and geomorphological research, and (ii) provide foundational datasets to inform concurrent ecological and archaeological research in the region. Aerial laser scanning (LiDAR) and digital photographs were flown to provide high-resolution imagery and datasets of the landscape. From this, a detailed "bare earth" model was produced by extracting ground points from the LiDAR to reveal landforms (glacial moraines, glacially modified bedrock, sand dunes, and shorelines) hidden in dense forest cover or too subtle to be seen with the naked eye. Subsequent field campaigns involved applying sedimentological and pedological (soil) techniques on relict landforms and at coastal bluffs in concert with lake cores in order to establish the late Pleistocene and Holocene history the study area. Select landforms, relict shorelines, and other sediment deposits were dated using radiocarbon and optical dating methods in order to reconstruct and understand the timing of fluctuations in postglacial sea level and other changes in the broader landscape. In this session, members of our research team will give concise summaries of our more specific findings to date.

### **Reconstructing Human-Environment Interactions on the Northwest Coast through the Ancient DNA Analysis of Faunal Remains**

Dongya Yang - Ancient DNA Laboratory, Department of Archaeology, Simon Fraser University  
Session - Human Habitation and Ancient Knowledge: The Calvert and Hunter Islands Region

#### Poster Presentation Abstract

This presentation reviews several ancient DNA projects on faunal remains that have been conducted at the Ancient DNA Laboratory, Simon Fraser University. The faunal remains examined include salmon, herring, whale, and northern fur seal remains from archaeological sites in British Columbia and Alaska. The success rate of the recovery of ancient DNA from these remains has been high, which raises the possibility of reconstructing the population dynamics of species through the analysis of temporal changes in their genetic diversity. Although mitochondrial DNA provides limited information about past population structures, next generation sequencing of more informative nuclear DNA markers is expected to provide more insights into these structures. Human-environment interactions can be reconstructed with greater detail when ancient DNA data is integrated with more traditional archaeological data.

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