

Grays Harbor Conservation District Grays Harbor and Willapa Bay Sedimentation Dynamics and Mitigation Measures Project





ESA has conducted analysis and placement of artificial reefs to promote oyster growth.

Photo Credit: Marilyn Latta



Brandon Carman Aquatic Habitat Restoration Project Manager Grays Harbor Conservation District 330 Pioneer Avenue West Montesano, WA 98563

Subject: Phase II Grays Harbor and Willapa Bay Sedimentation Dynamics and Mitigation Measures

The loss of productive shellfish growing areas in Grays Harbor and Willapa Bay are an urgent concern, and we recognize the importance of understanding the sedimentation dynamics and identifying mitigation measures to prevent further loss and improve growing conditions. Environmental Science Associates (ESA) and our partners, Blue Coast Engineering and David Evans & Associates (DEA) Marine Services Division, offers the needed specialized expertise to support you with this endeavor. The ESA team brings expertise in nearshore mapping, coastal dynamics modeling, and estuarine ecology to greatly advance the understanding of sediment and erosion dynamics in the bays and identify implementable and effective actions to mitigate impacts to the area's vital shellfish industry.

As specified in the Request for Qualifications (RFQ), and described further in our Statement of Qualifications, the ESA team meets the following fundamental requirements:

- **Direct experience in sediment survey design and analysis** DEA has extensive bathymetric survey, sediment sampling, and benthic habitat characterization experience and ESA has experience analyzing shellfish impacts caused by changes in sedimentation and flow.
- Extensive knowledge of estuarine habitat requirements ESA's ecologists have been extensively involved in estuary mitigation/restoration planning considering the habitat requirements of target species.
- Knowledge of Willapa Bay and Grays Harbor geography Key staff on our team have either worked directly in the project area or have direct experience related to the shellfish industry. I have worked in Grays Harbor, the Chehalis Basin, and with shellfish growers in Willapa Bay and Grays Harbor. Blue Coast Engineering has been involved in studies in Willapa Bay and Grays Harbor.
- **Experienced professional engineers licensed in Washington State** The team has several Professional Engineers (PE) registered in the State of Washington.

As Project Manager, I can assure you that we are committed to delivering the analysis and mitigation measures as described in the RFQ. We intend to exceed the expectations of GHCD and the other parties involved. I regularly manage multi-disciplinary teams working on innovative solutions to complex environmental issues. My greatest strength as Project Manager, and my commitment to you, is in maintaining regular communication so you are fully updated on project status and decision points we come to as the project progresses. My estuarine ecology background and past personal interactions with the shellfish growers in Willapa Bay and Grays Harbor, make me ideally suited to lead the team's efforts to apply the outputs of complex hydrodynamic models to develop solutions for the Grays Harbor Conservation District, the shellfish industry, and other stakeholders.

Thank you for your consideration of our qualifications. Please contact me if you have any questions about the materials provided. My cell phone number is (206) 601-1405 and my email is pschlenger@esassoc.com.

Sincerely,

ESA Sellen

Paul Schlenger Project Manager



Section 1 Qualifications & Relevant Experience

Founded in 1969, Environmental Science Associates (ESA) is a 100% employee-owned corporation with 525 nationwide, including 90 staff in the Pacific Northwest. ESA is a nationally-recognized leader in coastal dynamics modeling, analysis, planning, and restoration. Our coastal team - comprised of coastal and estuarine engineers, biologists, and geomorphologists – helps our clients solve complex coastal issues at both the regional and site-specific levels. Particularly relevant to this scope of work, ESA is an environmental services firm with the coastal engineering and estuarine ecology expertise to deliver the highest level technical analysis of the sedimentation dynamics in both bays and estuaries apply that new information to the development of best practices and mitigation measures to improve growing conditions for shellfish.

ESA staff apply state-of-the-art hydrodynamic, sediment transport, and wave modeling – such as Coastal Modeling System (CMS)-Flow, CMS-Wave, Particle Tracking Model (PTM) – to evaluate sediment dynamics in estuarine and coastal environments. Our modeling staff have experience using more than 30 numerical modeling platforms and have a strong understanding of each model's capabilities, data input needs, model outputs, and necessary QA/QC procedures.

This experience provides us with the ability to advise clients on the most appropriate model(s) to apply to achieve specific goals and objectives for a given project. Paul Schlenger, our proposed Project Manager, has worked on ecological assessments, decision frameworks, and prioritizations to inform decision-making on natural resource issues in bays and estuaries of Washington. Most recently, Paul led a project in Hood Canal evaluating how the habitat requirements of shellfish were impacted by changes in sedimentation and flow routes associated with salmon habitat restoration projects.

Our team will provide the specialized expertise needed to advance the understanding of sedimentation dynamics in Grays Harbor and Willapa Bay and apply that information in the development of best practices and mitigation measures to improve growing conditions for shellfish. The ESA team includes Blue Coast Engineering and David Evans and Associates (DEA) Marine Services Division.

Blue Coast Engineering is a certified woman-owned business specializing in coastal engineering and geomorphology, estuary restoration design, and soft shoreline stabilization. As sole proprietor, Jessica Côté has 20 years of experience as a civil engineer leading feasibility studies, assessments, design, construction, and management of projects featuring estuary restoration, dredge design, and beneficial use of dredge material. Blue Coast routinely conducts coastal processes and hydraulic analysis, morphologic change analysis, and suspended and bedload sediment transport to develop design criteria for coastal projects. Jessica has extensive experience working in the large estuaries along the Southwest Washington Coast and has been involved in studies in Willapa Bay and Grays Harbor for the past 15 years. She was part of the PIE project team who conducted the 2003 investigation of sediment dynamics of Whitcomb Flats. More recently, she led a study of sediment transport patterns around commercial shellfish operations in Willapa Bay.

DEA is an employee-owned, multidisciplinary consulting firm founded in 1976 and headquartered in Portland, Oregon. DEA's Marine Services Division in Vancouver, Washington, was established in 1989 and is dedicated to coastal and marine data collection, analysis, and processing. DEA's Marine Services Division staff includes 17 hydrographers, six of whom are certified by the National Society of Professional Surveyors (NSPS) and The Hydrographic Society of America (THSOA); and three marine geophysicists with advanced degrees. DEA has WA licensed Professional Land Surveyors, one of which is also a Certified Hydrographer. DEA's staff have completed shallow multibeam, side scan, sub-bottom and magnetometer surveys under public and private sector contracts. DEA has invested in state-of-the-art hydrographic and geophysical survey instrumentation and owns an extensive inventory in its Vancouver office. DEA acquires high-resolution, high-precision acoustic bathymetric and imagery data along with surface sediment samples to characterize the seafloor. DEA has also produced shellfish distribution and benthic habitat characterization maps by integrating and analyzing acoustic data along with sediment samples and benthic photos or videos for seafloor characterization. The resulting maps show the type and spatial distribution of sediment types within each area and areas of erosion and deposition.

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EDUCATION M.S., Fisheries, Univ. of Washington B.A., Environmental Sciences, Univ. of Virginia

CERTIFICATIONS Certified Fisheries Professional, #3470

TRAINING

Theory and Application of IFIM and PHABSIM Modeling, Utah State Univ.



EDUCATION

Ph.D., and M.S., Civil and Environmental Engineering, Stanford Univ. B.S., Civil and Environmental Engineering, Princeton Univ.

REGISTRATION

Civil Engineer, CA #C72551



EDUCATION M.S., Ocean Engineering, Oregon State Univ. B.S., Mechanical Engineering, Tufts Univ.

REGISTRATION Professional Engineer, Civil, WA #46704

Paul Schlenger PROJECT MANAGER

Paul has 22 years of experience in aquatic ecology, fish population modeling, and mitigation/restoration planning and design. He has managed projects ranging from small scale to multimillion dollar efforts. He has maintained budgets, staffing, and assignments; reported on budget and schedule; ensured timely work products; reviewed deliverables; and communicated and documented project changes. Paul's technical work has included development of science-based functional habitat assessments to facilitate the interpretation of habitat quality for target species and resources. Paul's relevant experience includes serving as lead ecologist on a project team mapping sediment supply and depositional areas in Kitsap County and identifying priority opportunities for restoration and conservation. Paul has also trained over 30 shellfish growers in Willapa Bay and Grays Harbor to identify forage fish eggs as part of their compliance requirements for the USACE Nationwide Permits. In Grays Harbor. Paul has also conducted fish exclusion operations at WSDOT's bridge pontoon casting basin in Aberdeen and aquatic invasive species sampling of pontoons stored near Westport.

Matt Brennan, PhD, PE

LEAD STRATEGIST FOR MODELING APPROACH

Matt is a water resources engineer with 20 years of experience specializing in estuarine management and restoration. He has evaluated management and restoration scenarios from hydrologic and geomorphic perspectives to support ecosystem sustainability. Matt has developed and applied a wide range of hydrodynamic and transport process numeric models. For example, Matt is managing ESA's ongoing assessment of Kilisut Harbor's channel stability by directing 2D hydrodynamic modeling, conducting 2D wave modeling, and interpreting these results in relation to geomorphic reference sites. In Deer Harbor on San Juan Island, ESA's study evaluated the size of a new bridge opening that would achieve habitat objectives within a range of reasonable cost and engineering constraints and with minimal impacts to adjacent landowners. Matt provided technical analysis, including hydraulic and geomorphic tools to inform stakeholders of overall bridge design alternatives and the effects of the bridge on sediment and hydrology in the study area.

Jessica Côté, PE

SENIOR ADVISOR ON MODELING APPROACH

Jessica is a Principal Coastal Engineer of Blue Coast Engineering, Inc. She has 20 years of experience integrating physical and biological sciences with engineering to solve complex problems in estuarine, coastal, and ocean environments. She focuses on process-based studies to quantify and characterize geomorphology, sediment transport, sediment pathways, and the interaction of structures with coastal processes. She has been working along the Southwest Washington Coast and estuaries including the mouth of the Columbia River, Willapa Bay, and Grays Harbor for the last 14 years. Jessica has conducted multiple studies to evaluate the changes to circulation patterns and sediment transport from shellfish aquaculture farms in Humboldt Bay, Willapa Bay, and throughout Puget Sound. Her studies on shellfish aquaculture have involved collection of new data, analysis of existing data and direction of numerical modeling of coastal processes and their interaction with culture structures which might alter sediment transport within aquaculture farms and the surrounding environment.

Hannah Snow, PE

DEPUTY PROJECT MANAGER AND MODELER

Hannah brings four years of engineering experience in coastal, fluvial, and estuarine environments. Her project portfolio includes tidal wetland, beach, and river restoration projects, sea-level rise and flooding vulnerability studies, and shoreline protection design. She has engineered design plans, prepared technical reports, and modeled aquatic environments, including wind-wave, tidal circulation, sediment transport, and water balance modeling. At Naval Base Kitsap Bangor, Hannah conducted wind-wave modeling for 1,000 different wind-wave conditions to understand the wave climate near the project site. She used the wave modeling results to run a sediment transport model analyzing changes in sediment transport and shoreline evolution under each project alternative. To help Seattle Parks and Recreation study the feasibility of replacing or removing a failing seawall on Puget Sound at Lowman Beach Park, Hannah created a SWAN wind-wave model to analyze typical and extreme storm conditions anticipated to impact the beach.

Pablo Quiroga

LEAD MODELER

Pablo has more than 15 years of experience on complex oceanographic and coastal engineering projects. He has integrated his knowledge of complex coastal environments, understanding of coastal dynamics, and use of advanced numerical models into his work. Pablo has worked on a variety of projects and coastal systems that include beach nourishment, soft shoreline protection, erosion control, flooding reduction, sediment management, oyster reef design and construction, design and implementation of large-scale hydraulic physical models, wave modeling, and longshore transport studies. At Giant Marsh in Richmond, California, Pablo performed an advanced wave modeling analysis to evaluate reef performance and improve oyster reef design; he provided feedback on the preliminary engineering design and helped develop the post-construction monitoring plan. At Lowman Beach Park in Seattle, Pablo conducted wave modeling studies to predict littoral sediment transport and coastal flooding.

Kevin Coulton, PE

SENIOR ENGINEERING QA/QC

Kevin is a water resources engineer with over 30 years of experience in hydraulic engineering and hydrology. Kevin has conducted projects at a range of spatial scales, including GIS analyses of the entire United States to assess national flood risk for FEMA. Kevin provided input and guidance to the U.S. Navy for future dredging efforts by developing a MIKE 3D hydrodynamic and sediment transport model of the Kings Bay estuary in Georgia to analyze sedimentation transport and deposition trends. The study included a literature review, extensive field data collection and multidimensional modeling of flow and sediment transport within a 241 square mile complex estuary.

Jonathan Dasler, PE, PLS, CH

SURVEY DATA ACQUISITION AND MANAGEMENT

Jon brings more than 34 years of experience in hydrographic surveying. He has directed and managed large nautical charting surveys for NOAA, IDIQ hydrographic survey contracts for USACE, and on-call hydrographic survey contracts for port authorities. He served for seven years on NOAA's Hydrographic Services Review Panel; attends conferences and symposiums to keep abreast of changing technology; and has presented papers and training sessions to advance the profession of hydrography.

EDUCATION

M.S., Civil and Environmental Engineering – Environmental Fluid Mechanics, Stanford Univ. B.S., Civil and Environmental Engineering, Minor in Oceanography, Univ. of Washington

REGISTRATION

Professional Engineer, WA #57394

EDUCATION

M.Sc. Ocean and Resources Engineering, Univ. of Hawaii at Manoa BS.c. Oceanography, Universidad Autónoma de Baja California, Mexico

REGISTRATION

Engineer-in-Training

EDUCATION

M.S., Civil/Hydraulic Engineering, Washington State Univ. B.S., Civil Engineering, and B.S., Landscape Architecture, Penn State Univ.

REGISTRATION/CERTIFICATION

Professional Engineer, WA #25691 Certified Floodplain Manager

EDUCATION

B.S., Civil Engineering, Cum Laude, Univ. of Portland

REGISTRATION/CERTIFICATION

Professional Civil Engineer, OR, MS Professional Land Surveyor, OR, CA, MS NSPS/THSOA, Certified Inshore Hydrographer (107)

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Teaming History

The ESA Team has worked together successfully and seamlessly on projects throughout the Pacific Northwest. ESA staff and Blue Coast have worked together over the last three years on estuary assessment and restoration projects across Washington State. One example is a study of tidal channel geometry and tidal flow conditions in embayments throughout Puget Sound. ESA staff and Blue Coast staff collaborated on field data collection, data interpretation, and stakeholder outreach.

ESA and Blue Coast are currently teamed on a tidal restoration project at Point No Point in Hansville, Washington. Blue Coast is managing the coastal assessment for reconstructing an historical tidal marsh, including sediment transport and deposition patterns. ESA is providing ecological expertise to the assessment and is leading the field data collection for the site topographic and benthic mapping to be used in 2D hydrographic modeling that well be conducted in a later phase of work.

ESA and DEA have also teamed together. ESA is currently teamed with DEA on the Tualatin Basin Dam Safety and Water Supply Joint Project (TJP). For that effort, Clean Water Services (CWS) and the Bureau of Reclamation (Reclamation) are working to address the seismically at-risk Scoggins Dam and develop additional future water supplies. ESA and DEA are assisting CWS with activities in preparation for and during Environmental Impact Statement (EIS) development and permitting of the TJP. All activities are intended to facilitate the NEPA process, of which Reclamation is the lead federal agency. ESA and DEA are developing Resource Area Reports for use during writing of the EIS; conducting pre-EIS and pre-permit activities (including local, state and federal agency coordination; field surveys; stream functional assessments; and development of mitigation strategies); and supporting the NEPA and permit application processes. ESA is the NEPA lead and DEA is the permitting lead for the consultant team.

Blue Coast staff have worked extensively with groups from DEA (formerly known as Triad Associates) to conduct marine surveys in Puget Sound. Blue Coast and DEA are currently working collaboratively on a project for Puget Sound Energy in Colvos Passage, Puget Sound. DEA is conducting the bathymetric and topographic surveys which are being used by Blue Coast to design beach nourishment for an eroding shoreline.

Project Manager's Qualifications

Our proposed Project Manager, Paul Schlenger, brings 21 years of experience in ecological assessment, estuarine ecology, and project management. He has served as project manager on projects ranging in size up to multi-million dollar efforts with numerous subconsultants. Paul's extensive project management experience includes managing multi-disciplinary teams providing ecological assessment to inform regional planning of restoration projects. An example is the Puget Sound Nearshore General Investigation for the USACE. Paul managed a team with 12 active subconsultants working on 8 active task orders assessing the current and historic conditions of Puget Sound, as well as developing and prioritizing restoration projects to address habitat changes in the estuary. Much like the Grays Harbor and Willapa Bay project, the Puget Sound Nearshore General Investigation project entailed Paul managing mapping work, spatial modeling analysis, and reports focused on ecological implications.

Paul is committed to project management excellence and has completed professional Project Management training through Bob Rosain & Associates as well as an intensive program conducted at ESA. Paul is a firm believer in establishing and maintaining regularly scheduled communication with the client and project team on scope, schedule, and project-specific topics. He emphasizes advance planning and pro-active communication, particularly regarding issues or schedule bottlenecks. Paul is an excellent communicator and technical expert. His perspective as an estuarine ecologist brings an added dimension to his management of modeling and engineering teams because he is highly effective in ensuring the target species and biological end parts are considered as they relate to mapping and modeling decisions.

Paul is especially well suited for serving as the project manager because while the main tasks are modelingfocused, the overall purpose of the assessment is to improve habitats for shellfish. Paul is a well-respected estuarine ecologist who is ideally suited to manage the team and interpret the findings as they relate to the habitat needs for commercial shellfish operations. Paul will be highly effective in stakeholder meetings in communicating the biological implications of the complex modeling results and clearly articulating the identified best practices and projects to address oyster and shellfish operations.

Paul will also be supported by Hannah Snow, who will serve as a deputy project manager. Hannah is a coastal engineer who will be integrally involved in the team's modeling analysis. Hannah has worked extensively on coastal environments and large estuaries in California and Washington.



Section 2 Description of Project Experience

As demonstrated by our project examples below, we excel at tackling difficult problems by first identifying the key relationships between physical processes and then applying complex, yet sharply-honed technical analysis to quantify those relationships and identify solutions.



Kilisut Restoration Modeling Review

The North Olympic Salmon Coalition (NOSC) is restoring tidal connectivity to Kilisut Harbor by re-creating the natural inlet from Oak Bay; the restored inlet will allow salmonids and other aquatic species to access habitat and improve water quality in Kilisut Harbor. **ESA** developed and led an assessment of the inlet's hydraulic and geomorphic performance that predicted and interpreted key physical processes affecting the inlet: wind-waves, tides, and littoral sediment transport. ESA developed and applied wind-wave modeling to predict wind-wave generation, propagation, and refraction that produces nearshore waves. The wave modeling was used to predict littoral sediment transport and verify these predictions against local reference site data. ESA also developed and applied a wave runup and sediment transport model to evaluate wave overtopping during storm surge and high wave conditions. ESA integrated and interpreted all data and modeling to assess inlet geomorphology from multiple perspectives and concluded that the open inlet will persist for multiple decades.

With ESA's key finding that the restored inlet will persist, NOSC and its collaborator, Washington Department of Transportation (WSDOT), deemed a longer replacement bridge spanning the inlet was feasible. To support bridge design, ESA provided coastal hydraulic design criteria for future conditions that consider sea level rise and waves. ESA is continuing to guide inlet restoration design and downdrift sediment augmentation. ESA recommended channel dimensions and alignment that provide hydraulic connectivity while reducing impacts to the existing marsh. ESA also proposed and designed a downdrift sediment augmentation to lessen the potential for scour as the littoral sediment adjusts to the restored inlet.

REFERENCE:

Kevin Long North Olympic Salmon Coalition (360) 379-8051 projectmanager@nosc.org

PROJECT RELEVANCE:

- Sediment Transport and Wind-Wave Modeling
- Inlet Stability Analysis
- Tidal Processes Analysis

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REFERENCE: Audrey Lamb, Taylor Shellfish (360) 426-6178 audreyl@taylorshellfish.com

PROJECT RELEVANCE:

- · Sedimentation and Shellfish Study
- Data Collection and Assessment
- Stakeholder and Community Dialogue

REFERENCE:

John Gerhard, Woolpert Program Director (303) 925-1400 john.gerhard@woolpert.com

PROJECT RELEVANCE:

- Coastal Bathymetry Data Collection
 and Processing
- Benthic Habitat Mapping

Willapa Bay Oyster Farm Flip Bag Studies on Currents and Sediment Transport

Jessica Côté of **Blue Coast Engineering** designed and conducted a study to investigate the potential for oyster longline aquaculture structures to alter tidal currents in Willapa Bay. Tidal currents are one of the primary mechanisms for driving sediment transport and determining the distribution of food resources in estuaries. It has been suggested that oyster flip bags might alter tidal current circulation patterns and disrupt the natural erosion and deposition of sediments as well as the availability of food resources in the water column. A boat-based Acoustic Doppler Current Profiler (ADCP) survey was conducted in Willapa Bay to measure current speed and direction up-current, down-current, and within oyster longline plots; These data were analyzed to determine the effect that flip bags may have on current speed and direction. In addition, a literature review was conducted for previous studies describing circulation patterns and sediment transport pathways in Willapa Bay. Information from previous studies was used to provide context and interpretation of the analysis of the ADCP current measurements. Jessica presented the results of the study to stakeholders at a community meeting and helped Taylor Shellfish identify future measurements and studies which could be conducted to better understand the effects of aquaculture on sediment transport in Willapa Bay.

Great Lakes Benthic Habitat Mapping: South Manitou Island (NOAA Office of Coastal Management)

DEA produced benthic habitat maps for South Manitou Island in Lake Michigan for the National Oceanic and Atmospheric Administration's (NOAA) Office for Coastal Management (OCM). This effort was a joint project involving NOAA OCM and the National Park Service (NPS) and a pilot project for the Coastal and Marine Ecological Classification Standard (CMECS) in the Great Lakes region. These benthic habitat maps were produced using a combination of digital aerial ortho-imagery (fixed wing aircraft), LiDAR bathymetry, multibeam echosounder data, acoustic imagery from side scan sonar and available ground reference data using object-based image analysis (OBIA) techniques. Accuracy assessments were performed to quantify the overall and internal thematic accuracy of the final benthic habitat map products.



Naval Base Kitsap-Bangor Littoral Sediment Transport Modeling

A proposed pier at Naval Base Kitsap-Bangor that would provide moorage for two 250-foot blocking vessels that are part of the Transit Protection Program (TPP). **ESA** developed a conceptual understanding of littoral sediment transport by observing field conditions, reviewing existing studies, and synthesizing geomorphic information from publicly available sources. Modeling simulations were performed for existing conditions and proposed TPP pier alternatives to determine how changes in sediment transport under the alternatives could impact nearby sensitive shellfish beds. Modeling and analysis captured the effects of the pier alternatives on tidal currents, wind-waves, sediment transport, and shoreline response. Hydrodynamic modeling simulations were performed for the existing conditions and proposed alternatives using Delft3D for tidal currents, SWAN for wind-waves, and UNIBEST for littoral sediment transport and shoreline change.



PROJECT RELEVANCE:

- Wave Modeling
- Tidal Hydrodynamic Modeling
- Sediment Transport Modeling
- Shellfish Impact Analysis

Deer Harbor Estuary Sediment Modeling

Within Deer Harbor, a bridge slated for replacement limits tidal exchange, fish access, and the downstream flux of sediment. **ESA** developed and applied hydrodynamic and sediment transport modeling to evaluate the impact of different bridge openings on tidal exchange, flow velocity, and geomorphic change. The model was developed with new bathymetric surveying, calibrated with water level observations, and informed by bed sediment sampling. Predictions of tidal exchange and flow velocity were used to estimate habitat and fish access improvements. ESA also assessed the rate and spatial extent of sediment scour and deposition, which are possible impacts to habitat and existing infrastructure. The hydraulic assessment considered future sea level rise in the project planning. Supported by ESA's hydraulic and geomorphic analysis, the alternative selected for the replacement bridge is an 80-foot span, nearly doubling the width of the existing opening to the lagoon. In addition, the new bridge will enable removal of the armored sill, further improving tidal exchange.



PROJECT RELEVANCE:

- Tidal Hydrodynamic Modeling
- Sediment Transport Modeling
- Geomorphic Assessment

Giant Marsh Artificial Reef and Living Shoreline Design

To advance the science and practice of living shorelines techniques in San Francisco Bay, **ESA** led engineering design and provided physical processes analysis for this multi-disciplinary pilot scale project in Giant Marsh that will benefit habitats ranging from the sub-tidal to the estuarine-upland transition zone. ESA directed work that included aerial drone surveying, advanced wave modeling and analysis, environmental permitting, and preliminary engineering design of oyster reef treatments. Unique design elements developed by the project team included oyster reefs composed of concrete and shell units, new low marsh planting techniques, and high marsh transition/ refuge planting techniques. ESA is providing post-construction monitoring to measure physical responses to the various design elements and to improve future living shoreline practices.



PROJECT RELEVANCE:

- Wave Modeling
- Oyster Reef Analysis and Design
- Field Monitoring



Section 3 Methodology & Background

Using our skills and experience described in the prior sections, the ESA team will execute the tasks outlined in the RFQ as written. In this section we describe our approach to completing the tasks and delivering highest quality analysis to advance the understanding of sedimentation dynamics in the bays and develop a prioritized list of best practices and mitigation measures. Our experience in estuarine mapping, modeling, and shellfish habitat management will help provide a streamlined, well-informed project that considers the needs of the client group to maximize the usefulness of the effort. The sections below outline our proposed approach; we look forward to collaborating with GHCD and the counties to develop a scope of work to best meet the objectives of Phase II.

Develop Project Plan & Conceptual Model

To provide clear direction for each project task, the ESA team proposes to develop a concise project plan that addresses the project goals specified in the RFQ and articulates a conceptual model of sediment dynamics in the bays, state the analysis questions that Phase II will address, and inform the modeling work plan described later. This document will allow the ESA team to take an organized approach to identifying the most effective and efficient data collection and analysis approaches.

The conceptual model will identify the linkages between desired habitat outcomes, anthropogenic and environmental factors, and management measures to avoid, minimize, or mitigate impacts on the shellfish beds and related habitats in the twin bays. The data reviewed for Task 1, and stakeholder input (under Task 9) such as local shellfish growers and USFWS staff from the Willapa National Wildlife Refuge, will inform conceptual model development. The draft conceptual model developed at the project outset will be refined over the course of the project and included in the project reporting (Task 8).

Developing and stating the analysis questions at the outset is fundamental to identifying the appropriate models and data sets needed to conduct the analysis. ESA is prepared to conduct the modeling tasks as described in the RFQ. If the GHCD is interested in considering other approaches, we see the potential for other models to better inform the analysis questions and streamline the analysis process while still adhering to the project budget. The analysis key questions will drive the recommendation on whether there are better-suited modeling frameworks for the project.

At the outset of the project, the ESA team will work with GHCD to establish key project questions and needs that will be investigated with the mapping and numerical modeling. The ESA team will translate these key questions into data collection objectives and modeling scenarios. Key questions may cover topics such as:

- What environmental factors and/or anthropogenic actions have contributed to the observed changes in sedimentation patterns in Grays Harbor and Willapa Bay?
- What is the effect of environmental factors, such as a riverine flood or burrowing shrimp, on sediment, eelgrass, and shellfish beds? What is the effect of anthropogenic actions, such as a dredging cycle?
- What is the sediment budget for Grays Harbor and Willapa Bay and what are the geomorphic processes that distribute and re-distribute sediment within these water bodies?
- Are there areas within the bays that are more resilient to changes in sediment circulation?
- By what mechanism are proposed mitigation alternatives likely to ameliorate sediment impacts at the shellfish bed? What are the other consequences and costs of mitigation measures?

These questions can be refined or modified based on input from GHCD and other project stakeholders.

Data Preparation

After reviewing, processing, and integrating existing data (Task 1), we will identify how to use the data and where additional data collection is warranted. We will identify data gaps and establish data collection procedures for new field surveying. Team member DEA has access and contacts within NOAA and USACE to facilitate acquisition and merging of historical bathymetry and coastal LiDAR data sets. This will support time series comparisons of temporal data sets to assess erosion and deposition within specific areas of interest. This tactic will allow us to strategically target a subset of important areas, thus maximizing the efficiency of data collection. Possible targeted field data collection efforts could include bathymetry and calibrated backscatter data for seafloor habitat delineation in critical regions. The substrate identification, which can include shellfish and vegetation presence/absence based on sonar backscatter, would be ground-truthed with benthic grab samples assessed by ESA biologists. Data to enhance model calibration could also be collected, such as tidal velocities, suspended sediment sampling, and sedimentation rate monitoring. Information that will be directly input into the modeling will be processed appropriately prior to use. We will also review previous modeling studies and published literature on sediment transport patterns in the harbors, particularly focusing on sediment contribution from the Chehalis and other rivers.

We anticipate initial data collection occurring in parallel with model development. We have reviewed the budget for the grant supporting this study, are very familiar with the level of effort needed for numerical modeling, and believe that the available funds are adequate for new data collection within this study.

Model Approach & Application

In Task 2 ESA will develop a modeling work plan that matches the technical modeling to the conceptual model. We will consider if translating the existing CMS models to another modeling system would better meet project needs while also conforming to the budget and schedule. ESA will compare the strengths and weaknesses of other industry-standard models, such as the Delft3D, and MIKE21 software suites, which have advantages such as broader user communities and being open source. The conceptual model will also provide information about this project's specific modeling needs that may influence the selection. The modeling work plan will specify how model scenarios and output will be used to inform mapping, alternatives evaluation, and improved understanding via the conceptual model.

Numerical modeling (Tasks 4 - 7) of physical processes in the bays will consist of coupled tidal hydraulic, wave, and sediment/particle transport models, using the software chosen during model work plan development. Our engineers will select model scenarios (time periods, wind speeds and directions, river flows, starting sediment concentrations, structural elements, etc.) that span a range of conditions and are targeted to answer the key questions previously identified. Models will first be updated with current bathymetry (Task 3), verified for existing conditions, and the results interpreted in relation to the model and observations from Task 1. Depending on the key questions identified, possible scenarios to be assessed in modeling could include:

MODEL TIMEFRAME	BED CONDITIONS
Spanning an anthropogenic event, such as dredging	Current conditions (existing bathymetry)
Spanning an environmental event, such as a large storm or flood	Historical conditions (no harbor jetties, historical bathymetry) Future mitigation options (modify model for each alternative)

Mapping & Mitigation Action Prioritization

Following the bed surveys and numerical modeling, we will develop a series of maps characterizing areas potentially affected by dredging and other sediment transport events. Modeling outputs will be analyzed to determine where shellfish growing habitat criteria is met, overlaid with existing mapped shellfish beds. Maps can be produced for each of the key modeling scenarios to determine change in suitable areas after significant environmental or anthropogenic events. Similarly, mapping suitability under the different mitigation alternatives can illustrate the effectiveness of each alternative to protect growing beds during an environmental or anthropogenic event. Maps may also identify new areas of opportunity for shellfish bed growth, with or without mitigation measures.

Using the new information on sedimentation and erosion dynamics, the ESA team will identify potential best practices and mitigation actions to improve growing conditions for shellfish. We will work with GHCD and stakeholders to create a framework for prioritizing habitat areas and mitigation actions. Considerations of the framework may include threat exposure to dredging, acreages of potential bed recovery or protection, and cost-effectiveness and ability to obtain permits for each potential mitigation action. Using the framework, the project team can produce a summarized list of areas and actions ranked by priority for both bays.

Modeling Report with Mitigation Actions

Based on the technical Tasks 1-7, the ESA team will prepare a report documenting the modeling process, results, and effectiveness of mitigation alternatives. The presentation of mitigation actions will establish schedules and decision rubrics for mitigation actions, and provide best management practices for implementing mitigation measures. This forward-looking plan will guide stakeholders as the project moves forward into Phase III's implementation of mitigation actions to improve shellfish growing conditions. ESA's team of interdisciplinary biologists, engineers, and planners have developed similar plans for other estuary restoration efforts.



Section 4 Schedule

The continued loss of productive shellfish growing areas in Grays Harbor and Willapa Bay are an urgent local and statewide economic concern. ESA acknowledges the need to identify and implement effective mitigation strategies prior to further loss of growing grounds. The draft schedule proposed herein considers this urgency. ESA understands that the anticipated project end date for this effort is December 30th, 2019.

After executing the contract, our team would schedule a kickoff meeting with the client and relevant stakeholders to develop and/or review key analysis questions and the project plan. Establishing key modeling questions at the onset of the project is critical to ensuring a focused project with valuable results. Our team will then work to develop a conceptual model for sediment transport and shellfish response in the twin bays, integrating our team's coastal geomorphology expertise with local observation and previous studies. Data collection and preparation will take several weeks, including the development of survey protocols and field deployment for the targeted data collection efforts proposed in the prior section.

We anticipate initial data collection occurring in parallel with model development, considering the compressed timeline for this effort. Many elements of the model set-up can be conducted while data collection is still ongoing. The separate numerical models to assess tidal circulation and waves can be updated or developed in tandem and then coupled to expedite modeling time. Particle tracking and sediment transport models would likely need to be run following the execution of the wave and tide models. Preliminary model results may suggest further field investigations would be useful in limited/targeted areas to determine the health of particular shellfish beds, or, to take samples from possible new growing regions identified in the modeling. A second window of time prior to mapping and prioritization is reserved for these efforts.

Mapping of areas suitable for shellfish can be conducted following the numerical modeling efforts. The ESA team will then develop a prioritization framework with stakeholders to create a ranked list of actions and mitigation measures, based on the results of the modeling and mapping. A report communicating the results of the joint modeling, mapping, prioritization, and mitigation assessment effort will be produced prior to the end of the year.

Throughout the project timeline, our team will emphasize regular communication with GHCD and stakeholders, including site visits, regularly scheduled in-person and virtual meetings, and check-in emails. A detailed communication schedule and chain will be established at the onset of the project.





Appendix Key Personnel Resumes



Paul Schlenger, PE

Project Management

Paul is an estuarine ecologist with 22 years of experience in aquatic ecology, ecological assessment, and habitat mitigation/restoration planning and design. Paul's work focuses on characterizing fish and other aquatic resource distributions in relation to habitat conditions such as water flow/tidal inundation, substrate conditions, and manmade modifications. Paul works closely with modelers and engineers on the characterization of existing conditions and development of effective restoration project designs. Paul has managed projects ranging from small scale to multimillion dollar efforts. Paul has worked in freshwater and estuarine areas of the southwest Washington.

Relevant Experience

Hood Canal Assessment of Effects to Shellfish Resources from Salmon Habitat Restoration Actions, Hood Canal, WA. *Project Manager.* The potential for interactions between salmon habitat restoration and shellfish resources has emerged as a key issue in restoration projects in Hood Canal estuaries. Salmon restoration projects tend to be getting larger and focusing on locations and process-based activities that result in increasing overlap with other user groups of river deltas and nearshore habitats. To provide information on the state of the knowledge of interactions, Paul led the assessment of how shellfish resources may be affected by restoration actions to improve salmon habitat. The most impactful changes to shellfish were commonly sedimentation and flow patterns. Knowledge of shellfish ecology and life histories were key considerations in assessing the potential for impacts and developing best management practices.

Chehalis River Fisheries Impact Study, Chehalis, WA. *Project Manager and Lead Fisheries Biologist.* Paul applied salmon ecology expertise in an assessment of the potential effects to salmonids by a proposed upper-watershed dam intended to alleviate flooding problems in the Chehalis River basin. The assessment included hydrologic, water quality, and instream flow studies, as well as the SHIRAZ fish-population simulation model. Paul led the development of the SHIRAZ models for coho, spring Chinook, and steelhead; and ensured effective communication with the stakeholders and community members throughout efforts to compile, collect, and analyze the data. In a second phase of the work, Paul led additional fish population modeling to inform the development of an Aquatic Species Enhancement Plan for the watershed and feasibility analysis of specific dam alternatives.

Willapa Bay and Grays Harbor Pacific Herring Egg Identification Training, Various Locations, WA. *Project Manager*. Paul developed and conducted training on forage fish and egg identification for shellfish growers in Willapa Bay and Grays Harbor, Washington. The session was attended by more than 30 shellfish growers. Topics also included the location of Willapa Bay and Grays Harbor spawning areas and recommended actions when eggs are found.



EDUCATION M.S., Fisheries, University of Washington

B.A., Environmental Sciences, University of Virginia

22 YEARS OF EXPERIENCE

CERTIFICATIONS

Certified Fisheries Professional, #3470 American Fisheries Society

TRAINING

Theory and Application of IFIM and PHABSIM Modeling, Utah State University

AFFILIATIONS

American Fisheries Society

Pacific Estuarine Research Society

Paul Schlenger

RESUME CONTINUED

Grays Harbor Estuary Fish Handling and Aquatic Invasive Species Survey, Aberdeen, WA. *Fisheries Biologist.* As part of the WSDOT construction of the SR520 bridge over Lake Washington, Paul provided fish biology and fish handling expertise during fish exclusion operations at the pontoon casting basin at the Aberdeen Log Yard site. In this role, he supported WSDOT's oversight of the construction contractor's fish removal operations. His abilities

in using different gear and proper handling of fish, supported efforts to return fish safely to the Grays Harbor estuary. Paul also prepared a decision-support framework for characterizing the potential colonization of aquatic invasive species on the pontoons and transporting them through Puget Sound to Lake Washington.

Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), Puget Sound, WA. *Deputy Project Manager and Estuarine Ecologist.* Paul managed a diverse range of on-call technical services to the U.S. Army Corps of Engineers while serving as the primary point of contact and technical lead on a series of task orders. He led the consultant team's effort to implement a soundwide analysis of changes in shoreline and watershed conditions between current and historic (late 1800s) habitat conditions. Paul was also the lead author of PSNERP's Strategic Needs Assessment Report, which developed and implemented an analysis of ecological process degradation along the shorelines and deltas of the Puget Sound planning area. During this assessment, Paul managed the meetings of a 10-person team of representatives from federal, state, local, tribal, and nonprofit organizations. He led the consultant team's work on the development of a restoration benefit metric that was applied to evaluate the relationship between project costs and benefits.

Kitsap County Marine Shoreline Sediment Supply Mapping and Prioritization, Kitsap County, WA. *Lead Ecologist.* Paul was part of a multi-disciplinary consulting team working for Kitsap County to map sediment supplies along the marine shoreline and identify priority opportunities for restoration and conservation. He contributed to the team's development of a scoring framework to characterize the relative magnitude of sediment inputs from mapped sediment sources. The framework was an effective way to interpret the "potential" sediment inputs along a shoreline, and the "existing" sediment inputs based on the extent to which shoreline armoring has disconnected sediment supplies.

Point No Point Restoration Connection Feasibility Study, Hansville, WA. *Lead Ecologist.* Paul is working with Jessica Côté of Blue Coast Engineering on the early feasibility study focusing on the potential to restore the tidal marsh at Point No Point wetland. Work involves conducting a preliminary coastal processes assessment of the site to inform the feasibility of potential locations for tidal channel reconnection and the potential for maintaining the opening over time.

Marine and Estuarine Habitat Restoration Prioritization in Water Resource Inventory Area 1, Whatcom County, WA. *Fisheries Biologist*. Paul provided marine and estuarine ecology expertise to the consultant team evaluating habitat function in the WRIA 1 marine nearshore and identifying/prioritizing habitat restoration and protection opportunities in the marine nearshore and Nooksack River estuary.



Matt Brennen, PhD, PE

Lead Strategist for Modeling Approach

Matt is a water resources engineer with 20 years specializing in estuarine management and restoration. His strengths include evaluating management and restoration scenarios from hydrologic and geomorphic perspectives to support ecosystem sustainability. To implement these perspectives, Matt has developed and applied a wide range of hydrodynamic and transport process numeric models. In conjunction with these technical skills, his project management experience includes active client communication, teaming with biologists, integrating input from expert advisors, overseeing technical tasks and managing subcontractors

Relevant Experience

Kilisut Restoration Modeling Review, Longview, WA. *Project Manager.* ESA reviewed 2D hydrodynamic modeling and geomorphic assessments of the Kilisut Harbor Restoration Project in Puget Sound. The project proposes restoration of a tidal inlet underneath a bridge slated for replacement. Matt developed and directed ESA's assessment of the inlet and channel's resilience to closure. This assessment included interpreting 2D hydrodynamic modeling, conducting 2D wave modeling, and analyzing these results according to geomorphic inlet stability analysis. In addition, Matt led ESA's design recommendations for the inlet and adjacent shoreline, as well as a construction cost estimate review.

Deer Harbor Estuary Sediment Modeling, San Juan Island, WA. *Project Manager.* Within Deer Harbor, a bridge restricting tidal exchange to a tidal lagoon and marsh is slated for replacement. ESA's study evaluated the size of a new bridge opening that achieves the habitat objectives within a range of reasonable cost and engineering constraints and with minimal impacts to adjacent landowners. ESA developed and applied hydrodynamic and sediment transport modeling to evaluate the impact of different bridge openings on tidal exchange, flow velocity, and geomorphic change. The goal of the study is to determine the best bridge configuration for the site to minimize impairments to sediment and hydrologic processes within the study area. Matthew is providing technical analysis, including hydraulic and geomorphic tools to inform stakeholders of overall bridge design alternatives and the effects of the bridge on sediment and hydrology in the study area.

Liberty Island Hydrodynamic, Wind-wave, and Sediment Transport Modeling, Sacramento-San Joaquin Delta, CA. Project Manager and Modeling Task Leader. As part of an interdisciplinary project team, Matt developed hydrodynamic, wind-wave, and sediment transport models for Liberty Island, a former diked area restored to flow, and surrounding Cache Slough area. The models are used to analyze the relative role of different forcing mechanisms (wind-waves, channel-mudflat connectivity, and the Yolo Bypass) to creating the elevated suspended sediment conditions in the region and the trends in geomorphic change. Linkages to ecosystem data (vegetation, plankton, and fish), assist in improving understanding of habitat evolution and species use.



EDUCATION Ph.D., and M.S., Civil and Environmental Engineering, Stanford University, Stanford, CA

B.S., Civil and Environmental Engineering, Princeton University

20 YEARS EXPERIENCE

CERTIFICATIONS/REGISTRATION

Professional Civil Engineer, CA. #C72551

Matt Brennen, PhD, PE,

RESUME CONTINUED

SCHISM Model Development, Sacramento-San Joaquin Delta, CA. *Project Manager.* Matt is overseeing improvements to the Bay-Delta Office's SCHISM modeling system. This model system simulates three-dimensional water flow and water quality in the San Francisco Bay-Delta estuary. This project adds capabilities to predict the effect of submerged aquatic vegetation (SAV) on flow, waves, sediment transport, and water quality. With these capabilities, the modeling system can then be used to assess the potential effects on SAV removal at site such as Franks Tract and in the Cache Slough Complex. Parameters of interest include salinity, dissolved organic carbon, dissolved oxygen, light, sediment, turbidity, and nutrients.

South Bay Salt Pond Restoration Project, San Francisco Bay, CA.

Hydrodynamic Modeler. The project consists of restoring 15,000 acres of former salt ponds to tidal action, enhancing wetland habitat and providing flood protection. DELFT3D hydrodynamic modeling for NEPA/CEQA assessed the long-term impacts on water levels, salinity, tidal prism and habitat. Further particle transport modeling optimized specific project features to meet the multiple criteria of sediment management, water quality and ecological habitat.

Deschutes Estuary Independent Technical Review, Olympia, WA. *Geomorphologist.* Matt reviewed U.S. Geological Survey hydrodynamic and sediment transport modeling used to predict the potential geomorphic response of proposed Deschutes Estuary restoration.

Russian River Estuary-Lagoon Adaptive Management Plan, Jenner, CA.

Project Manager. For nearly a decade, Matt has managed the ESA team that developed and revises an adaptive management plan to improved aquatic habitats in the Russian River Estuary. When the Estuary closes for longer portions of the summer, a freshwater lagoon is created and favored by juvenile steelhead. Matt was the lead author on the Estuary's management plan, which is based on based on hydraulic engineering analysis and applied coastal geomorphology. Supporting studies developed and implemented by Matt include annual reviews of inlet performance, studying the effects of the jetty, and modeling future response to sea level rise. He also led cost estimating of flood management plan. Matt continues to participate in management decisions and assist with adaptive revisions, as well as presenting findings to the regulatory agencies, the science community, and the public.

Point Reyes Bird Observatory, Spatial Climate Change Scenarios for San Francisco Bay: Tidal Marsh Sustainability Assessment, San Francisco, CA.

Project Manager / Hydrodynamic Modeling. To explore the sustainability of coastal wetlands in response to a combination of sea level rise and sediment availability conditions, ESA partnered with the Point Reyes Bird Observatory to map future projections of tidal marsh habitat in San Francisco Bay. We developed a hybrid modeling approach that couples a physical process treatment of marsh accretion dynamics with spatial variation across an estuary. The model's results improve our understanding of marsh responses to SLR, thereby informing management strategies for these ecosystems. Our model results can be used to assess both system-wide conservation strategies and the vulnerability and restoration potential of individual sites.



Jessica Côté, PE

Senior Advisor on Modeling Approach

Jessica is a Principal Coastal Engineer of Blue Coast Engineering PS, Inc. She has 20 years of experience integrating physical and biological sciences with engineering to solve complex problems in estuarine, coastal, and ocean environments. She focuses on process-based studies to quantify and characterize geomorphology, sediment transport, sediment pathways, and the interaction of structures with coastal processes. She has been working along the Southwest Washington Coast and estuaries including the Mouth of the Columbia River, Willapa Bay, and Grays Harbor for the last 14 years. Jessica has conducted multiple studies to evaluate the changes to circulation patterns and sediment transport from shellfish aquaculture farms in Humboldt Bay, Willapa Bay, and throughout Puget Sound. Her studies on shellfish aquaculture have involved collection of new data, analysis of existing data and direction of numerical modeling of coastal processes and their interaction with culture structures which might alter sediment transport within aquaculture farms and the surrounding environment.

Relevant Experience

Willapa Bay Oyster Farm Flip Bag Studies on Currents and Sediment

Transport, Willapa Bay, WA. *Technical Lead.* Jessica designed and conducted study to investigate the potential for oyster longline aquaculture structures to alter tidal currents in Willapa Bay. Tidal currents are one of the primary mechanisms for driving sediment transport and determining the distribution of food resources in estuaries. It has been suggested that oyster flip bags might alter tidal current circulation patterns and disrupt the natural erosion and deposition of sediments as well as the availability of food resources in the water column. A boat-based Acoustic Doppler Current Profiler (ADCP) survey was conducted in Willapa Bay to measure current speed and direction up-current, down-current, and within oyster longline plots. These data were analyzed to determine the effect that flip bags may have on current speed and direction. Information from literature on other Willapa Bay studies was used to provide context for the analysis of the ADCP current measurements. Jessica presented the information to stakeholders at a community meeting.

Environmental Permitting Assistance for Existing and Expanded Operations for Coast Seafoods Company in Humboldt Bay, Humboldt County,

CA. *Technical Expert.* Jessica is providing permitting assistance for Coast Seafoods' shellfish aquaculture operations in Humboldt Bay. She is preparing sections of a technical report using best available science that evaluates existing circulation patterns and sediment transport and potential impacts from longline operations. The technical report includes the development of best management practices and mitigation measures to avoid and minimize potential impacts. Coast Seafoods' operations include aquaculture of several species of shellfish and numerous culture methodologies (e.g., off-bottom culture, suspended culture, raft culture). Key environmental concerns addressed by Jessica include potential changes to circulation and sedimentation patterns which might impact ecosystem functions.



EDUCATION M.S., Ocean Engineering, Oregon State University

B.S., Mechanical Engineering, Tufts University

20 YEARS OF EXPERIENCE

REGISTRATION/ CERTIFICATION

Professional Engineer, Civil, WA, #46704

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers – Associate

PIANC – Association for Waterborne Transportation Infrastructure

Washington Coastal Hazards and Resiliency Network

Jessica Côté, PE

RESUME CONTINUED

Burley Lagoon Coastal Processes and Sediment Dynamics, Purdy, WA.

Senior Coastal Engineer. Jessica is the technical lead for a data collection program and desktop study of Burley Lagoon, Burley Creek, and Purdy Creek to understand the potential impacts of a change in shellfish aquaculture practices. A conceptual model for sediment dynamics in the lagoon and the tributaries including Purdy Creek was developed based on analysis of existing data (streamflow, precipitation, hydraulics, salinity distribution, wind and waves, and sediments) as well as new data (bathymetry, water levels, tidal currents, and sediments). New data collection included boat based ADCP current measurements, water level measurements and beach profiles. Jessica worked with a multidisciplinary team to complete the review and develop a comprehensive sediment budget (sources and sinks) for the tidally influenced and wave-influenced barrier estuary and tributaries.



Hannah Snow, PE

Deputy Project Manager and Modeler

Hannah is a coastal engineer with a focus on restoration design development in coastal and estuarine environments on the West Coast. Her project portfolio includes tidal wetland, beach, and river restoration projects, sea-level rise and flooding vulnerability studies, and shoreline protection design. Hannah's main responsibilities at ESA include developing engineering design plans, preparing technical reports and graphics, managing complex geospatial datasets, and modeling aquatic environments. Her environmental modeling skillset consists of wind wave, tidal hydrodynamic, sediment transport, shoreline morphology and water balance modeling. Hannah also has experience developing climate change, sea-level rise, and flooding vulnerability assessments for private and public entities. Hannah enjoys collaborating with a diverse team of engineers, scientists, and planners as a technical expert and assistant project manager. Most recently, Hannah served as the deputy project manager and lead numerical modeler for the Naval Base Kitsap TPP Pier Sediment Transport Study where she successfully delivered a complex modeling study under a demanding project timeline.

Relevant Experience

Naval Base Kitsap-Bangor TPS Pier Sediment Transport Study, Bangor, WA. Deputy Project Manager. The U.S. Department of the Navy (Navy) proposes to construct a Transit Protection Program (TPP) pier at Naval Base Kitsap Bangor that would provide moorage for blocking vessels that are part of the TPP. ESA conducted a study evaluating the potential changes in littoral sediment transport resulting from the proposed pier alternatives, and how changes in sediment transport could impact nearby shellfish beds. Conclusions focused on the potential effects of the proposed pier alternatives on littoral sediment transport processes as compared to existing conditions. Hannah conducted wind wave modeling using SWAN and tidal circulation modeling using Delft3D at the project site with and without the pier to understand changes in currents caused by the presence of the pier facilities. She used the wave and tidal modeling results to set up and run a sediment transport model in UNIBEST analyzing the changes in sediment transport and shoreline evolution under the project.

Lowman Beach Park Feasibility Study, Seattle, WA. *Staff Engineer.* ESA is helping Seattle Parks and Recreation study the feasibility of replacing or removing a failing seawall on Puget Sound at Lowman Beach Park in West Seattle. ESA's engineers, landscape architects, archaeologists, and scientists evaluated historical and archaeological resources, reviewed ecological conditions, performed engineering assessment of the existing seawall and adjacent structures, and studied coastal processes (waves, tides, and sediment transport) to inform the development of replacement concepts. ESA developed three draft concepts including replacing the failing structure with a modern seawall, full removal with beach restoration, and partial removal by replacement with a seat wall and beach. Hannah created a SWAN wind-wave model for the project site and modeled a range of typical and extreme storm conditions anticipated to impact the beach.

Giant Marsh Living Shoreline, San Francisco, CA. *Staff Engineer.* To advance the science and practice of living shoreline techniques in San Francisco Bay, ESA led the engineering design and physical processes analysis for this multi-disciplinary pilot scale project that will benefit habitats ranging from the sub-tidal to the estuarine-upland transition zone. ESA directed work that included aerial drone surveying, advanced wave modeling and analysis, environmental permitting, and preliminary



EDUCATION M.S., Civil and Environmental Engineering – Environmental Fluid Mechanics, Stanford University

B.S., Civil and Environmental Engineering, Minor in Oceanography, University of Washington

4 YEARS OF EXPERIENCE

REGISTRATION

Professional Engineer, WA #57394

Hannah Snow, PE

RESUME CONTINUED

engineering design of oyster reef treatments. Unique design elements developed by the project team included oyster reefs composed of concrete and shell units, new low marsh planting techniques, and high marsh transition/refuge planting techniques. Project post-construction monitoring is planned measure physical responses to the various design elements and to improve future living shoreline practices. Hannah developed a SWAN wind wave model for the project site to determine the wave exposure on the project site. The model was used to refine and select the location of habitat elements.

Birch Bay Drive and Pedestrian Facility Improvements, Whatcom County, WA. *Staff Engineer.* The seaside community of Birch Bay has experienced significant beach erosion since the USACE excavated gravel from the Bay in the 1950s and created a sediment deficit. ESA is designing a sustainable 1.6-mile, soft shore protection berm for Whatcom County Public Works to reduce storm/flood damage, improve pedestrian safety, enhance shore access, improve stormwater drainage, and protect water quality while improving natural coastal geologic and ecological processes. Hannah helped to analyze coastal flooding impacts of a proposed shoreline berm.

Shell Mitigation at Telegraph Slough, Skagit County, WA. *Staff Engineer.* ESA is leading the restoration of an out-of-kind mitigation project for impacts related to rail improvements for Shell's operations in Anacortes, Washington. The project concept focuses on restoring approximately 100 acres of diked agricultural area to tidal estuarine conditions. Hannah performed numerical wind wave modeling and tidal hydraulic modeling for extreme storm events and typical conditions in Padilla Bay. The modeling results were used to determine dike breeches and channel sizing inside the site, and to determine the impacts of the project on the nearby marshplain. Hannah also aided in conducting a geomorphic assessment of the site by determining marsh plain evolution under various sea level rise scenarios and erosion potential of design tidal channels.

Terminal 4 Demolition Project, Richmond, CA. Staff Engineer. The derelict Terminal 4 Wharf site is made up of over 2,500 concrete and creosote-contaminated timber piles, plus a wharf building, decking, and other appurtenant structures. The removal project consisted of the preparation of 60% construction documents and environmental documentation. With a strong emphasis on habitat preservation and restoration, a major deliverable for this pilot project was to identify means and methods for the removal of contaminated timber piles. Design efforts were supplemented by an extensive field data collection including real-time wave data. A comprehensive geomorphic assessment of conditions before and after removal was conducted to assess the potential for shoreline re-alignment, long-term slope stability, and impact on protected sub-tidal resources including an extensive eelgrass patch which had developed in the lee of the terminal. Hannah developed and used a wind-wave model and a tidal circulation model to analyze changes to the nearshore wave field and the potential for sediment transport under post-project conditions. She also assisted in the development of the field data collection plan and in the drafting of the 60% design planset.

San Francisco Littoral Cell Coastal Regional Sediment Management Plan, San Francisco, CA. *Staff Engineer.* ESA prepared a Coastal Regional Sediment Management Plan (CRSMP) for a segment of the San Francisco Littoral Cell along the Pacific coast of San Francisco and San Mateo Counties. The purpose of the CRSMP is to help formulate strategies for sediment management policies and guidance that will restore, preserve, and maintain coastal beaches, sustain recreation and tourism, enhance public safety and access, restore habitats, and identify cost-effective solutions for implementation of projects. For this study, Hannah assisted in preparing the final draft of the management plan.



Pablo Quiroga

Lead Modeler

Pablo implements solutions that work within dynamic coastal environments, help reduce flooding and erosion, improve ecological functions, and provide adaptation to climate change. Pablo integrates his expertise and knowledge of complex coastal environments, his extensive experience, and understanding of coastal dynamics, and his use of advanced numerical models into his work. Pablo has experience working on a variety of projects and coastal systems from estuarine environments in San Francisco Bay and Puget Sound to open ocean and coastal areas in Southern California, the South Pacific Islands, and Mexico. Pablo has worked with a variety of coastal systems including mudflats in San Francisco; sandy and gravel beaches in California, Washington, and Mexico; and fringing reef coastlines in the South Pacific Islands.

Pablo's project examples include beach nourishment, soft shoreline protection, erosion control, flooding reduction, sediment management, oyster reefs design and construction, design and implementation of large-scale hydraulic physical models, wave modeling, and longshore transport studies.

Relevant Experience

Living Shorelines at Giant Marsh, Richmond, CA. *Coastal Engineer.* ESA provided engineering analysis and design to test pilot scale restoration techniques to enhance coastal wetlands, intertidal oyster reef, and subtidal aquatic bed habitat at Point Pinole Regional Shoreline park. Pablo performed physical process analysis at the site including advanced wave modeling analysis to evaluate reef performance and improved oyster reef design and provide feedback on the preliminary engineering design and helped develop the post-construction monitoring plan.

Lowman Beach Park Preliminary Design, Seattle, WA. *Coastal Engineer.* ESA is helping Seattle Parks and Recreation study the feasibility of replacing or removing a failing seawall on Puget Sound at Lowman Beach Park in West Seattle. ESA's engineers, landscape architects, archaeologists, and scientists evaluated historical and archaeological resources, investigated geotechnical conditions by digging test pits, reviewed ecological conditions, performed engineering assessment of the existing seawall and adjacent structures, and studied coastal processes (waves, tides, and sediment transport) to inform the development of replacement concepts. Pablo conducted wave modeling studies to predict littoral sediment transport and coastal flooding. Pablo evaluate and provide engineering assessment on the conceptual designs.

Birch Bay Drive and Pedestrian Facility Project, Bellingham, WA. *Coastal Engineer.* ESA provided the design of a sustainable soft shore protection berm that meets the needs of Wolf Bauer and Whatcom County. These needs include reducing storm/flood damage, improving pedestrian safety, enhancing shore access, improving stormwater drainage and protecting water quality while respecting natural coastal geologic and ecological process and the landscape of Birch Bay Drive. Pablo conducted studies of wave action, longshore sediment transport, coastal flooding and evaluation of the designed berm during storm events.



EDUCATION M.S., Ocean and Resources Engineering, University of Hawai'i at Manoa

B.S., Oceanography, Universidad Autónoma de Baja California, Mexico

15 YEARS OF EXPERIENCE

REGISTRATION

Engineer-in-Training

Pablo Quiroga

RESUME CONTINUED

Kilisut Restoration Inlet Morphology, Jefferson County, WA. *Coastal Engineer.* The North Olympic Salmon Coalition (NOSC) is planning to restore tidal connectivity to Kilisut Harbor by re-creating the natural inlet from Oak Bay to southern Kilisut Harbor. The project objectives included creating a self-sustaining and resilient channel that will provide for tidal exchange and fish passage with minimum maintenance. ESA designed a technical study to predict and interpret the key physical processes affecting the inlet: wind waves, tides, and littoral sediment transport. Pablo conducted wave modeling studies to predict littoral sediment transport and verified these predictions against local reference site data. Pablo also applied a wave runup and sediment transport models to evaluate wave overtopping during the combined storm surge and high wave conditions.

Lowman Beach Park Feasibility Study, Seattle, WA. *Coastal Engineer.* ESA is analyzing the feasibility to replace a failing seawall on Puget Sound at Lowman Beach Park in West Seattle, Washington. Pablo analyzed tides, waves and longshore sediment transport at the site and performed numerical modeling of waves to inform the design of alternatives including removal, replacement and beach restoration.

San Diego Bay Native Oyster Restoration, San Diego, CA. *Coastal Engineer.* ESA developed a plan to create biologically rich native Ostrea lurida oyster reef in San Diego Bay as part of a complete marsh system, which restores an ecological niche that was historically present, is ecologically functional and resilient to changing environmental conditions and also protects Bay tidelands and shoreline. Pablo provided conceptual oyster reef designs, perform advanced numerical analysis to evaluate the performance of oyster reef configurations on the marsh and the shore and help to prepare a monitoring plan of the physical process prior and post construction of an oyster reef.

Chula Vista Bayfront Sea Level Rise Analysis, San Diego, CA. *Coastal Engineer.* ESA is performing an analysis of flood and erosion hazards and vulnerabilities for the Chula Vista Bayfront Project (CVBP) under a range of projected sea level rise scenarios. ESA is also assisting the Port District and City of Chula Vista to develop adaptation strategies to reduce future flood risks. Pablo led the coastal studies and sea level rise analysis, managed data collection, implement advanced numerical wave modeling at the site for different scenarios of sea level rise and provide design recommendations.

Heron's Head Shoreline Resiliency Project, Richmond, CA. *Coastal Engineer.* ESA will work with the Port of SF to design a new living shorelines project at Heron's Head Park. The three primary objectives of the Heron's Head Shoreline Resiliency Project are: stabilizing the southern shoreline of the park; responding to sea level rise (currently almost the entire spit portion of the park, excepting only the trail itself, is underwater during king tides); and enhancing biodiversity. Pablo conducted wave modeling studies at the site to inform the design of the shoreline restoration. Pablo assessed the design water level, design wave height which was used to provide rock sizing on the coastal protection structures.



Kevin Coulton, PE, CFM

Senior Engineering QA/QC

Kevin is a water resources engineer with over 30 years of experience in coastal hydrology and hydraulics. He has performed several coastal flood studies in the Pacific Northwest for FEMA and has conducted coastal projects at a range of spatial scales, including: the planning of site-scale tidemarsh restoration projects, the management of numerical modeling in San Francisco Bay to simulate the dispersion of sediment plumes from in-water dredging and assess associated impacts to nearby eel grass beds, and the management of a GIS analysis of coastlines of the entire United States and Territories for FEMA to estimate the percentage of the U.S. population exposed to coastal flood risks. Kevin has assisted FEMA with the development of Pacific Ocean coastal flood insurance study guidance and was the Sheltered Waters Focused Study Team Leader providing direction for developing guidance related to the analysis and mapping of flood hazards in estuaries and bays.

Relevant Experience

Carquinez Strait Hydrodynamic and Sediment Modeling, San Francisco Bay, CA. *Project Manager.* Kevin was responsible for the development and refinement of a Delft3D model and application of the model to assess environmental impacts in support of an EIR for the reclamation of a former smelting facility along Carquinez Strait in San Francisco Bay. The model was used to assess environmental impacts of a preferred design, and involved the application of the model to simulate the dispersion of sediment plumes from in-water dredging and assess associated impacts to nearby eel grass beds.

Tidal Marsh Restoration and Fish Passage, Willapa Bay, WA. *Project Manager.* Kevin managed and performed engineering, geomorphology, and hydrodynamic modeling services for the design of a new bridge under Highway 101 near South Bend, Washington, on the Willapa River. He coordinated hydrodynamic modeling and design of bridge and arch culvert alternatives with WSDOT bridge design staff to achieve project goals and meet new fish passage velocity criteria for estuarine ecosystems.

Hood Canal Estuarine Mitigation Project, Quilcene and Seabeck, WA. *Task Manager.* For the Naval Facilities Engineering Command (NAVFAC), Kevin performed site reconnaissance of two mitigation sites – Big Beef Creek Estuary and the Big Quilcene River Estuary – and provided peer review of sediment transport and hydrodynamic data collection and modeling, civil and structural engineering design, and managed GIS staff performing a historical watershed analysis.

FEMA Coastal Flood Study Guidelines for Atlantic/Gulf Coasts Sheltered Water Areas, FEMA Flood Map Modernization. *Task Manager.* Kevin managed the development of Data Capture Standards (DCS) for coastal analyses and mapping for FEMA Headquarters and he participated in a Technical Working Group to outline supplemental guidance to Mapping Partners for coastal flood hazard analyses in sheltered water areas.

Hydrodynamic Flow Modeling and Sedimentation Study at Naval Submarine Base (NSB), Kings Bay, GA. *Project Manager.* Kevin provided input and guidance to the Navy for future dredging needs to maintain submarine navigation in Kings Bay. He assisted with the development a MIKE 3D hydrodynamic and sediment transport model of the Kings Bay estuary to analyze sedimentation transport and deposition trends.



EDUCATION M.S., Civil/Hydraulic Engineering, Washington State University

B.S., Civil Engineering, Penn State University

B.S., Landscape Architecture, Penn State University

34 YEARS OF EXPERIENCE

REGISTRATION

Professional Engineer, WA #25691

CERTIFICATION

Certified Floodplain Manager

AFFILIATIONS

Association of State Floodplain Managers

Northwest Regional Floodplain Managers

Association American Society of Civil Engineers

Association of State Wetland Managers

Kevin Coulton, PE, CFM

RESUME CONTINUED

Burien Washington Coastal Flood Study. *Project Manager.* Kevin was responsible for managing the processing of LIDAR data to create a terrain database and transects for wave run-up and overtopping analyses for the City of Burien Washington. The delineation of the VE Zone elevations and inland VE Zone limits were based on FEMA's new Pacific Ocean coastal flood study guidelines and specifications.

Tsunami Investigation for Victoria, British Columbia, Canada. *Task Manager.* Kevin was responsible for the development of a digital terrain model (DEM) of the Strait of Juan de Fuca. The DEM provided data for probabilistic tsunami wave modeling, performed by Dr. Kwok Fai Cheung of the University of Hawaii, and encompassed 65 kilometers of shoreline for tsunami wave impact investigations.

Lower Columbia River Estuary Climate Change Study. *Task Manager.* Kevin provided technical support to the U.S. Army Corps of Engineers, Portland District, evaluating potential impacts of climate change on the Lower Columbia River Estuary.

Heceta Shores Coastal Erosion Evaluation, Florence, OR. *Task Manager.* Kevin managed the analysis of an extreme river mouth migration condition on the south Oregon Coast threatening a coastal development. He prepared concept design alternatives to mitigate erosion and developed order-ofmagnitude cost opinions for a preferred alternative.

Impact of Climate Change on the NFIP and Improving Coastal Flood Plain Mapping. *Technical contributor.* For FEMA Headquarters, Kevin assisted with an assessment of the impacts of climate change on the NFIP by reviewing existing research, data, and reports on climate change, and contributed input to the development of stream response functions to link the effects of climate change to Base Flood Elevations and mapping changes to inform risk decision making. Mr. Coulton also contributed to the development of floodplain mapping, management and policy recommendations.

RiskMAP Program, California Coastal Needs Assessment and San Francisco Bay Coastal Analyses. *Engineering Task Lead.* For FEMA Region 9. Kevin was responsible for developing and coordinating GIS and engineering analyses and outreach efforts in support of pre-scoping and scoping activities for coastal flood studies along the California coast and the San Francisco Bay.



Jonathan Dasler, PE, PLS, CH

Survey Data Acquisition and Management

Jonathan is a Senior Vice President and Director of Marine Services at DEA with more than 35 years of experience in hydrographic surveying and 43 years of land and geodetic control surveying. He has served as principal-incharge, project manager and lead hydrographer on large nautical charting surveys for NOAA, IDIQ hydrographic survey contracts for the USACE, and on-call hydrographic survey contracts for port authorities. He is the Chair of the NSPS/THSOA Hydrographer Certification Board; a member of the Board of Trustees for The Hydrographic Society of America; an active member of the American Council of Engineering Companies/USACE Portland District Liaison Committee; served for seven years as a special government employee on NOAA's Hydrographic Services Review Panel; is a member of National Society of Professional Surveyors (NSPS); attends conferences and symposiums to keep abreast of changing technology; and has presented numerous papers and training sessions to advance the profession of hydrography. Jonathan was awarded a Commander's Award for Public Service by the Department of the Army for his management and underwater mapping of the Pyramid Lake Torpedo and Bombing Range Remediation Project. The project located and removed 13 tons of WWII vintage ordnance and won the 2006 Secretary of Defense Environmental Award and the Secretary of the Army Environmental Award.

Relevant Experience

Multibeam Hydrographic and Side Scan Sonar Services, US Territorial Waters. *Principal-In-Charge and Contract Manager.* Jonathan is currently serving on a five-year contract to provide hydrographic services to the National Oceanic and Atmospheric Administration (NOAA). This is DEA's fourth hydrographic services contract with NOAA. Task orders on these contracts have included multiyear surveys offshore of Gulfport, Mississippi; post hurricane Katrina debris mapping in Mobile Bay and the Gulf of Mexico; surveys covering 17 miles of the Willamette River and over 80 miles of the Columbia River; the Pacific Ocean along the Oregon Coast; Chesapeake Bay; and post hurricane Sandy work off the New Jersey Coast. The Columbia River project required full coverage object detection multibeam over the survey area. Jonathan was instrumental in resolving issues with Columbia River Datum and completion of the first NOAA survey using Ellipsoid Reference Surveys using GNSS methods for water level corrections.

Rogue Ocean Dredged Material Disposal Site (ODMDS) Monitoring, Gold

Beach, OR. *Principal-In-Charge.* Jonathan served as Principal-in-Charge in support of the Environmental Protection Agency's (EPA) ODMDS monitoring program, where DEA conducted a high-resolution hydrographic survey and produced a surficial geologic map for the Rogue ODMDS, offshore Gold Beach, Oregon. The survey area included the drop zone for the Rogue ODMDS, approximately 1.75 nautical miles offshore and southwest of the entrance to the Rogue River. After data processing and quality assessments were complete, a high-resolution bathymetric map and an acoustic backscatter image were produced. Bathymetry and backscatter products were evaluated along with bottom samples and video observations from the site. Using advanced image analysis techniques and expert geologic interpretation, a surficial geologic map was produced illustrating the type and spatial distribution of surficial sediment types within the full extent of the Rogue ODMDS.



EDUCATION B.S., Civil Engineering, Cum Laude, University of Portland

35 YEARS OF EXPERIENCE

REGISTRATION/CERTIFICATION

Professional Civil Engineer, OR. # 13673PE

Professional Land Surveyor, OR # 02420PLS

NSPS/THSOA, Certified Inshore

Hydrographer (107),1989

PROFESSIONAL AFFILIATIONS

The Hydrographic Society of America

The Society of American Military Engineers

American Council of Engineering Companies of Oregon (ACECO)

National Society of Professional Surveyors

PANEL MEMBER

NSPS/THSOA Hydrographer Certification Board

Former Hydrographic Services Review Panel, NOAA

ACEC/USACE Liaison Committee

SECURITY CLEARANCE

Transportation Worker Identification Credential (TWIC)

AWARDS

Department of the Army, Commander's Award for Public Service (2005) Jonathan Dasler, PE, PLS, CH

RESUME CONTINUED

Geologic Mapping of the Coos Bay ODMDS, Coos Bay, OR. Principal -In-Charge. Jonathan served as Principal-in-Charge for Oregon International Port of Coos Bay in support of a Section 103 application under the Marine Protection, Research and Sanctuaries Act (MPRSA) and a Section 404 application under the Clean Water Act (CWA) to the United States Army Corps of Engineers (USACE), Portland District (CENWP) for a one-time use Ocean Dredged Material Disposal Site (ODMDS) off Coos Bay, Oregon. The purpose of this survey was to determine the suitability of the proposed location for disposal of dredged material from the proposed channel deepening and widening effort of the Coos Bay Federal Channel. DEA provided a high resolution multibeam bathymetric survey and acoustic Doppler current profiler (ADCP) survey for physical characterization of the proposed site. After data processing and quality assessments were complete, a high-resolution bathymetric map and an acoustic backscatter imager were produced. Bathymetry and backscatter products were evaluated along with sediment samples from the site to delineate seafloor substrate. A surficial geologic map was produced illustrating the type and spatial distribution of surficial sediment types within the proposed disposal site. Additionally, the processed ADCP data was used as model input and validation for sediment transport modeling.