Research Goals

As a broadly trained coastal geologist, I study sediment transport from source to sink, mountains to deep sea, focusing on the interaction between sediment and hydrodynamics in the fluvial-marine transition zone. I proudly apply the same scientific rigor and inquiry to my role as an educator and communicator. Thus, I have two overarching and intertwined goals:

1. study coastal morphodynamics relating to past, present, and future conditions to inform management and preservation efforts, and
2. research and implement teaching strategies that constructively align scientific content and communication skills to best achieve student learning goals and career success.

Morphodynamics in Large Tropical Deltas

Widely varying ratios of marine to freshwater influence within tidal rivers impact sediment-transport pathways and delta morphology. To assess how fluvial and marine hydrodynamics interact to control sediment transport, I related near-bed shear stress to sediment resuspension and deposition along the Mekong Delta over tidal and seasonal timescales. I found that sediment can be trapped within the lower tidal river (McLachlan et al., 2017), a relatively understudied region upstream of where traditional concepts place sites of deposition. With collaboration among many international researchers, we also characterized variable trapping dynamics for mud and sand (Ogston et al., 2017) and quantified the Mekong River's annual sand export (Stephens et al., 2017), which inform how the morphology of large tropical deltas may respond to changing climate and sediment supply.

This research raised questions regarding the impact of flocculation on sediment deposition across the fluvial-to-estuarine reach, which has yet to be studied holistically. To answer these questions, I am analyzing vertical profiles of suspended-sediment concentration and grain-size distribution along with videos from an onboard settling chamber. Preliminary results suggest that suspended particles are more likely to deposit within relatively shallow channels, where aggregation is enhanced and settling distances are shorter. In my future research, I will continue to explore and quantify the combined impacts of channel depth and estuarine stratification on sediment aggregation and deposition. This work will help us to better predict the impact of dam installation along major tropical rivers, which I hypothesize further promotes aggregation, deposition, and channel infilling by decreasing the fluvial discharge and enhancing estuarine intrusion and vertical mixing.

Morphodynamics in Back-Barrier Tidal Channels

While studies of in-situ dynamics can elucidate how coastal regions are developing today, exploration must reach deeper into sedimentary deposits to inform our understanding of past morphologic evolution and accurately predict future changes. I took this approach to evaluate the sequence morphodynamics of mangrove-vegetated back-barrier environments. First, I characterized how channel connectivity impacts sediment transport by measuring and analyzing fluxes through Amazonian tidal channels and mangrove forests in collaboration with an international team (McLachlan et al., in review; Schettini et al., in review). We concluded that channel connectivity controls the amount of sediment stored in channels and that high-connectivity channels act as along-shore conduits for sediment dispersal. Restoration efforts of mangrove forests, which continue to grow in response to sea-level rise and diminished sediment supply, can benefit from our conclusions regarding channel connectivity and sediment transport.

Then, to explore how this back-barrier environment developed since its formation ~2 kya, I mentored and collaborated with two undergraduate researchers. Laboratory analyses of sediment grain size and accumulation rate were coupled with geospatial statistical analysis of channel-network geometries using ArcGIS (McLachlan et al., in review). Results indicate that a high-connectivity channel's narrowest stretch will migrate along the path of net-sediment flux toward regions with more accommodation space until it reaches the flood-tide convergence zone, where the channel may eventually pinch off. These findings inform how sediment transported through vegetated back-barrier environments is ultimately preserved, and how evidence preserved in surface morphology and bed strata can be interpreted.

My research on coastal morphodynamics has thus far been supported by two fellowships from the National Science Foundation: the Graduate Research Fellowship Program and the IGERT Program on Ocean Change. I will continue to fund this research by partnering with local organizations and agencies.

Pedagogy and Science Communication

In addition to my geologic research, I have studied how to best teach students scientific content in tandem with communication skills. Numerous national and global surveys indicate that employers care most about an applicant's communication skills when they hire recent college graduates. However, employers are overwhelmingly unsatisfied with applicant preparedness in communication. To reduce this discrepancy, I designed, implemented, and evaluated a way to effectively incorporate written-communication skills into any university-level science curriculum (McLachlan, in review). Learning goals and teaching strategies were explicitly described to the students and writing lessons were scaffolded and constructively aligned with scientific content. After extensive blind evaluations by STEM professionals and multivariate statistical analysis of the results, the intervention was found to be effective, particularly for students earlier in the academic program, and the explicit teaching style proved to benefit students with lower GPAs. This research illustrates that minor alterations to teaching strategies can significantly improve students' communication skills and career readiness.

I secured funding for this study evaluation via Experiment, an online platform for sharing and funding scientific research, and the research will be published in an Open Access journal with funding from a UW School of Oceanography endowment fund. To expand the scope and impact of this research, I plan to obtain funding from state and national foundations that support STEM education, such as the National Science Foundation's IUSE:GEOPATHS, which supports initiatives that improve student pathways through the geosciences via institutional collaboration.

Future Research

Because my research involves field work, laboratory methods, and numerical analysis, I will be able to develop and mentor a range of student research projects. Possible student projects include 1) characterizing the effects of land use on channel-bank morphology and stability along a tidal river and 2) utilizing satellite imagery and ArcGIS to quantify the impacts of channel-network geometry on wetland restoration success. I look forward to teaching students effective research practices and communication skills in an interdisciplinary and collaborative setting.

My experience as a pedagogical researcher has solidified my goal to better prepare students for their future careers by incorporating communication training into my course curricula. Beyond just career preparation, practicing written communication within a scientific degree program also facilitates better understanding of content because writers consider language and subject matter in parallel. I will further study this effect by evaluating how constructively aligning scientific content with communication training increases student confidence in their ability to understand and communicate scientific text. Innovative teaching strategies are often developed in isolation and rarely published in academic literature. I will continue to innovate, evaluate, and publish teaching strategies to aid other instructors in their own teaching efforts as well as demonstrate the department's commitment to student success.

Publications in Peer-Reviewed Journals

McLachlan, R.L., Ogston, A.S., Asp, N.E., Fricke, A.T., and Nittrouer, C. (in review). Sequence morphodynamics in a back-barrier tidal channel. *Sedimentology*.

McLachlan, R.L. (in review). Constructively Aligning Writing Skills with Scientific Content in University-Level Curricula. *Journal of Research in Science Teaching*.

Schettini, C.A., Asp, N.E., Ogston, A.S., **McLachlan, R.L.**, Fernandes, M., Nittrouer, C.A., Truccolo, E., and Gardunho, D. (in review after minor revisions). Circulation and fine-sediment transport and deposition in the Amazon macrotidal mangrove coast. *Earth Surface Processes and Landforms*.

McLachlan, R.L., Ogston, A.S., Asp, N.E., Fricke, A.T., Nittrouer, C., and Gomes, V.J.C. (in review after minor revisions). Impacts of tidal-channel connectivity on transport asymmetry and sediment exchange with mangrove forests. *Estuarine, Coastal and Shelf Science*.

McLachlan, R.L., Ogston, A.S., and Allison, M.A. (2017). Implications of tidally varying bed stress and intermittent estuarine stratification on fine-sediment dynamics through the Mekong's tidal river to estuarine reach. *Continental Shelf Research*. https://doi.org/10.1016/j.csr.2017.07.014

Ogston, A.S., Allison, M.A., **McLachlan, R.L.**, Nowacki, D.J., and Stephens, J.D. (2017). How tidal processes impact the transfer of sediment from source to sink: Mekong River collaborative studies. *The Oceanographic Society*. https://doi.org/10.5670/oceanog.20 17.311

Stephens, J.D., Allison, M.A., Di Leonardo, D.R., Weathers III, H.D., Ogston, A.S., **McLachlan, R.L.**, Xing, F., and Meselhe, E.A. (2017). Sand dynamics in the Mekong River channel and export to the coastal ocean. *Continental Shelf Research*. https://doi.org/10.1016/j.csr.2017.08.004