FY20 RSM IPR

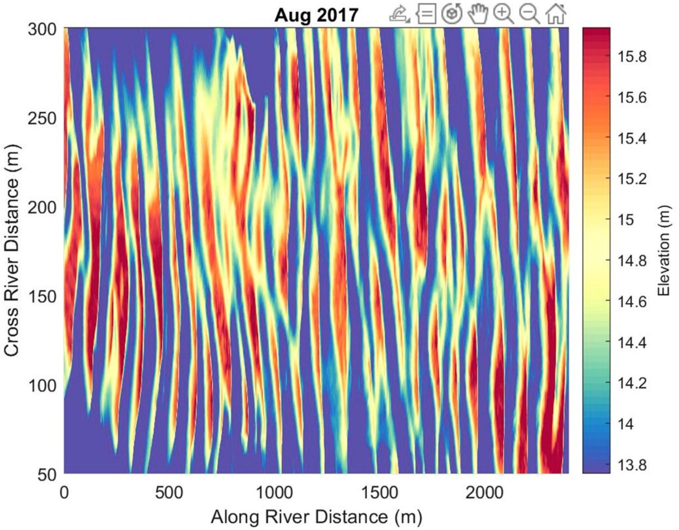
Hydrodynamic Controls on Sand Wave Growth in the Lower Columbia River

POCs: Nick Cohn (ERDC), Hans Moritz/Rachel Stolt (NWP), Andrew Stevens (USGS)

BLUF: Sand waves are a navigation hazard in many river systems which result in large operational management expenses. Improved predictive capabilities of sand wave growth would help to optimize the timing and necessity of dredging actions along federal navigation channels.

Challenge/Objectives

- Develop sand wave amplitude predictors for the Lower Columbia River



Approach

- Develop approaches to automatically characterize spatio-temporal sand wave characteristics in the Lower Columbia River
- Characterize spatial hydrodynamic properties in the region of interest
- Link hydro-morphologic properties to develop sand wave predictors

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District/Other USACE PDT Members

Nick Cohn (ERDC)
Rachel Stolt (NWP)
Rod Moritz (NWP)
Jarod Norton (NWP/NWD)
Andrew Stevens (USGS)
Guy Gelfenbaum (USGS)

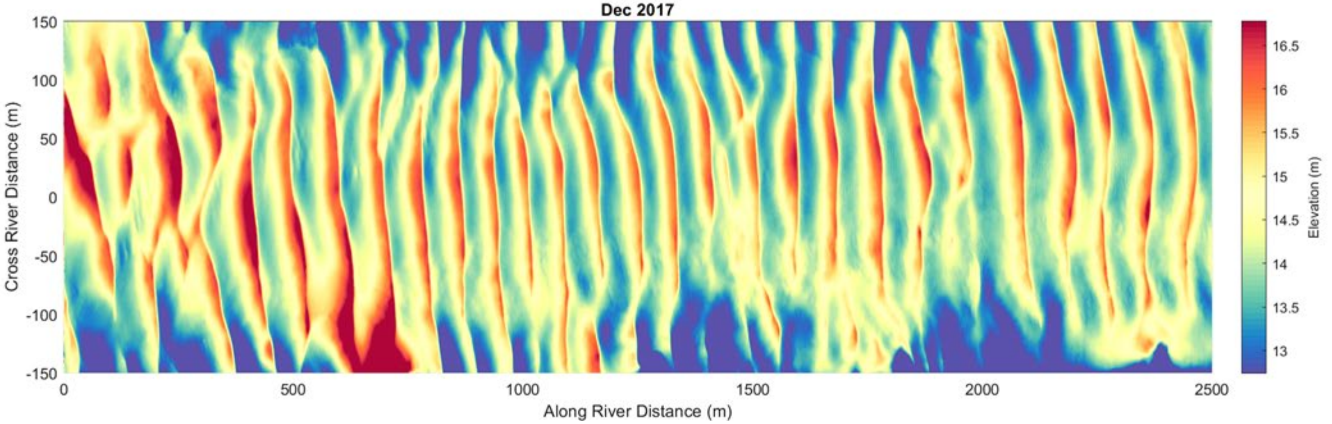
Stakeholders/Partners

Sand waves in the Columbia River impede safe navigation of the federal channel. Key stakeholders in the Lower Columbia River channel maintenance plan include the Ports of Longview, Kalama, Woodland, Vancouver, and Portland.

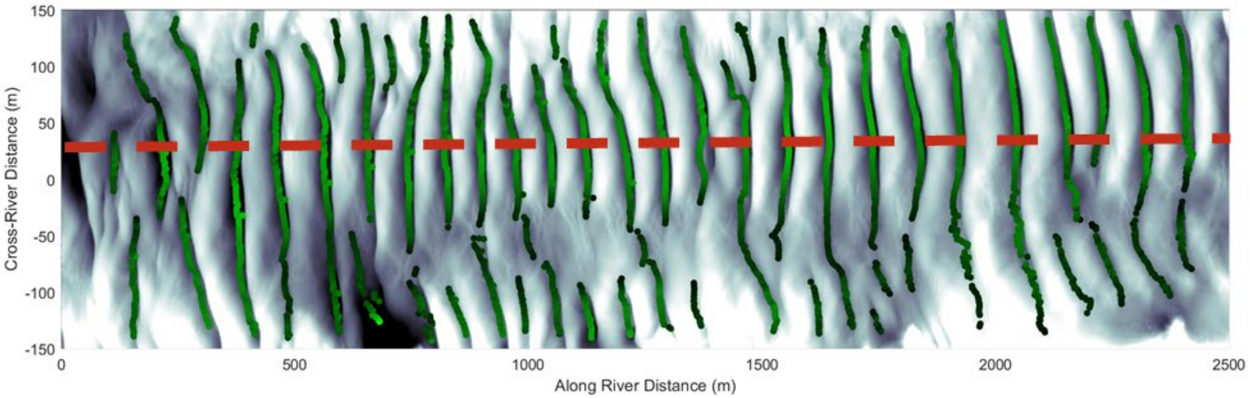
Leveraging/Collaborative Opportunities

-Leverages previous field efforts by NWP and the U.S. Geological Survey (USGS)
-Leverages existing hydrodynamic modeling efforts
-CERB initiative to improve understanding of sediment dynamics relevant for RSM
-Valuable datasets to be curated for testing, validating, and/or extending existing USACE bedload transport tools (e.g., ISSDOT v2, CMS).

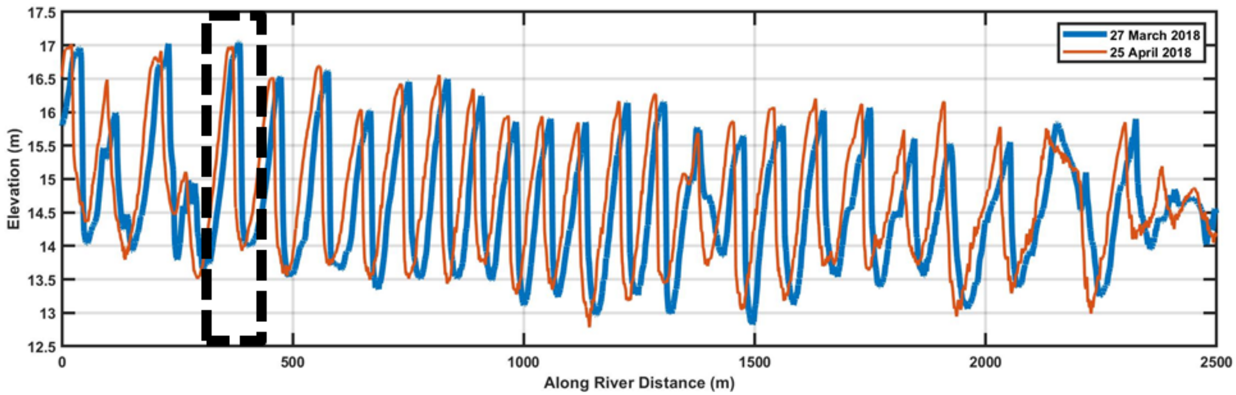
Project Progress and Accomplishments



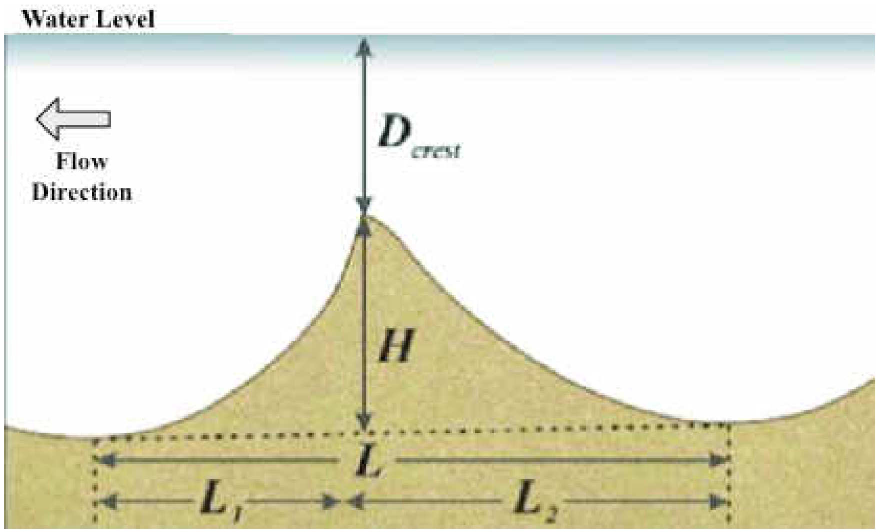
Example sequence multibeam from Willow Bar (Columbia River) rotated into alongriver coordinate system



2D Fourier Analysis + Peakfinding method used to automatically spatially select sand wave crests and troughs



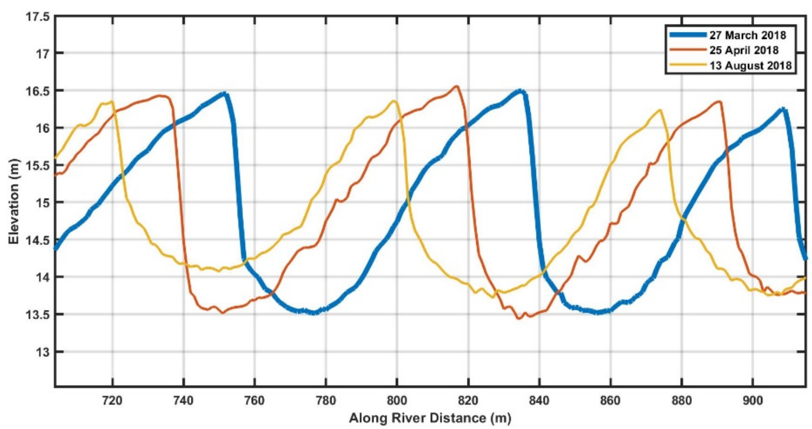
Example alongriver slice of multibeam data to demonstrate data quality and spatio-temporal variability



H = Sandwave Height
L1 = Downriver Wavelength
L2 = Upriver Wavelength
L = Total Sandwave Wavelength = L1 + L2

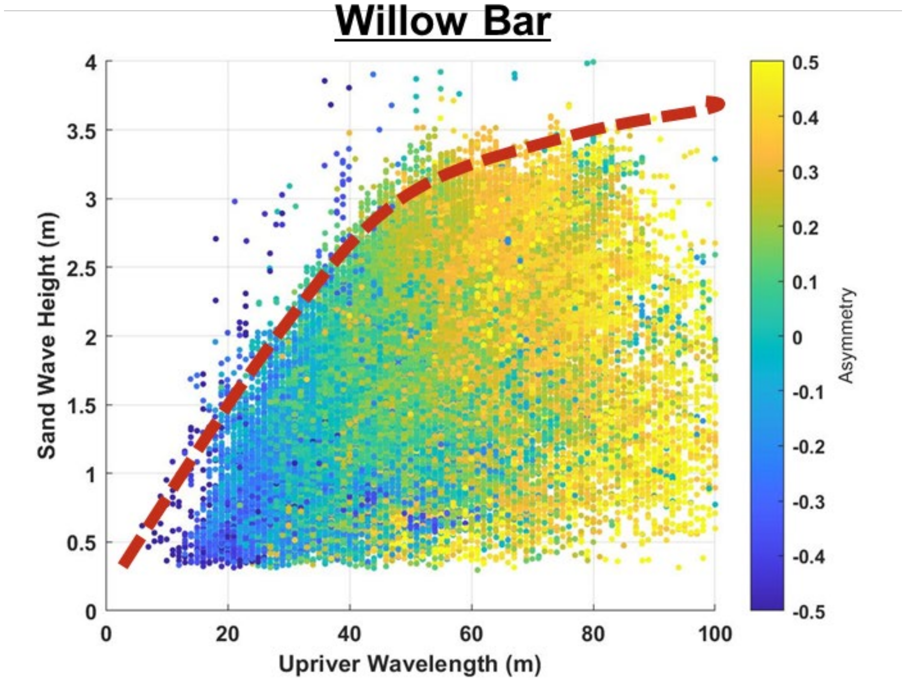
$$Asymmetry = \frac{L1 - L2}{L}$$

$$Steepness = \frac{H}{L}$$



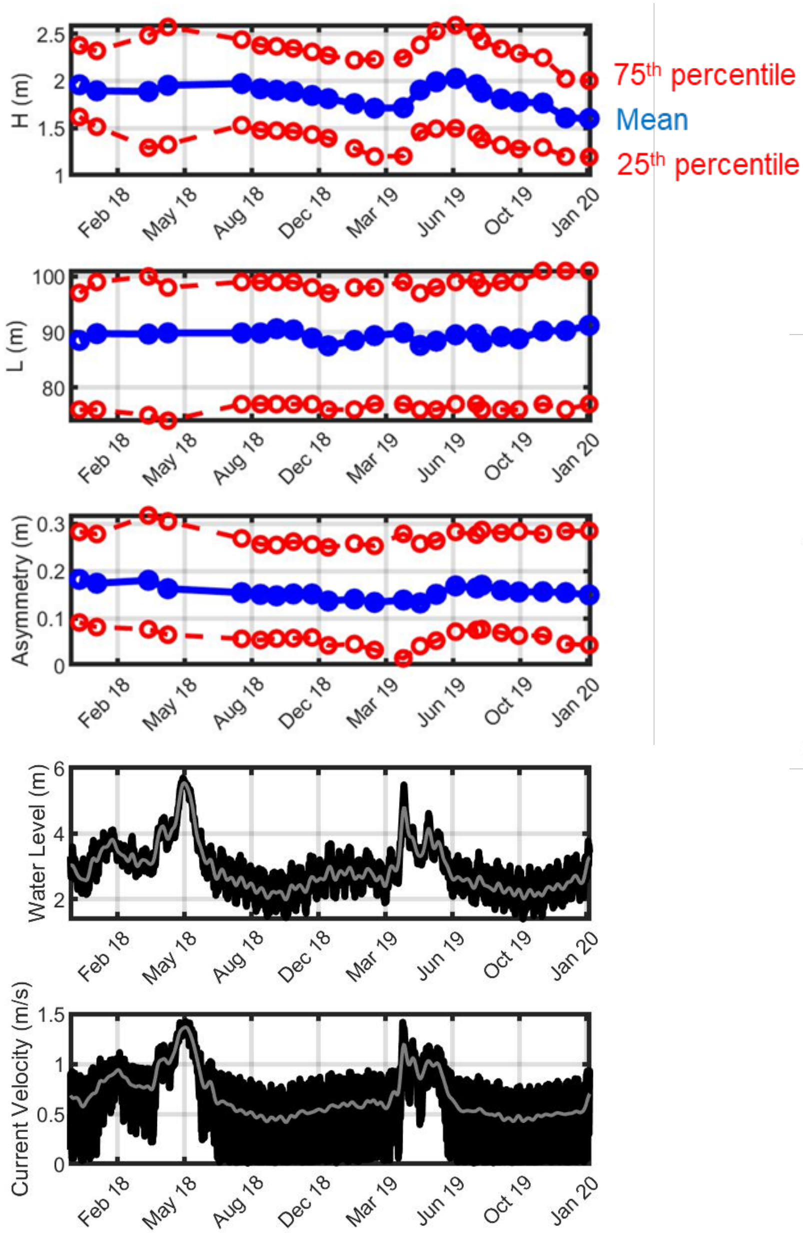
<u>With repeat data can also calculate:</u>
Sandwave migration rates
ΔH
ΔL

Morphological Trends

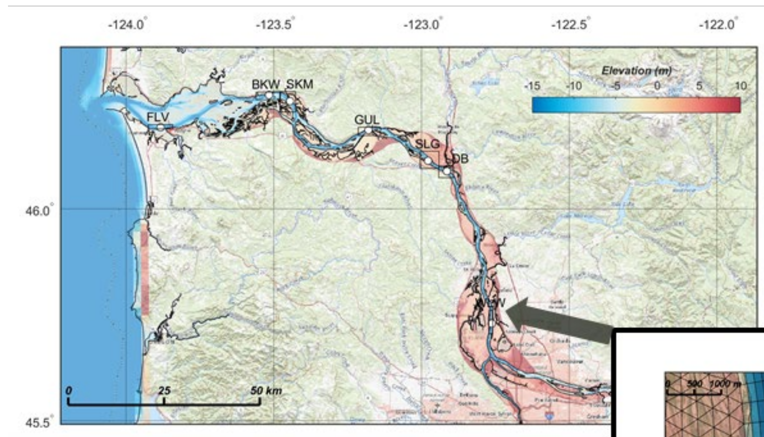


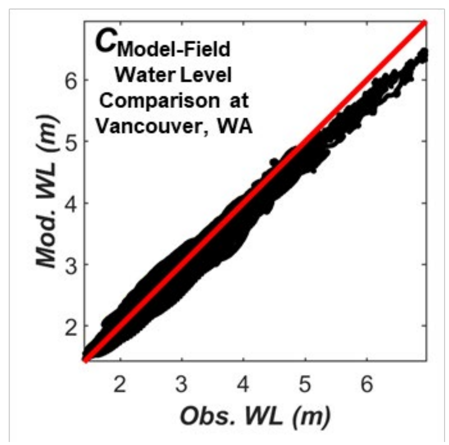
Relevant Findings:

- Large scatter in instantaneous wave height/wavelength relationships
  - Maximum wave heights are f(wavelength)
- "Mean" sandwave feature is generally symmetric in WLW; longer and short wavelengths are more asymmetric
  - Implications for morph-hydro feedbacks, bedload transport predictions, and volume estimates
- Relationships vary in different portions of the Columbia River (not shown)
  - Function of hydrodynamics, river geometry, and grain size

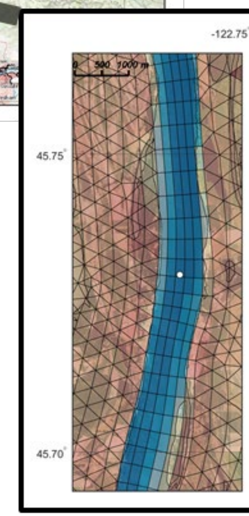


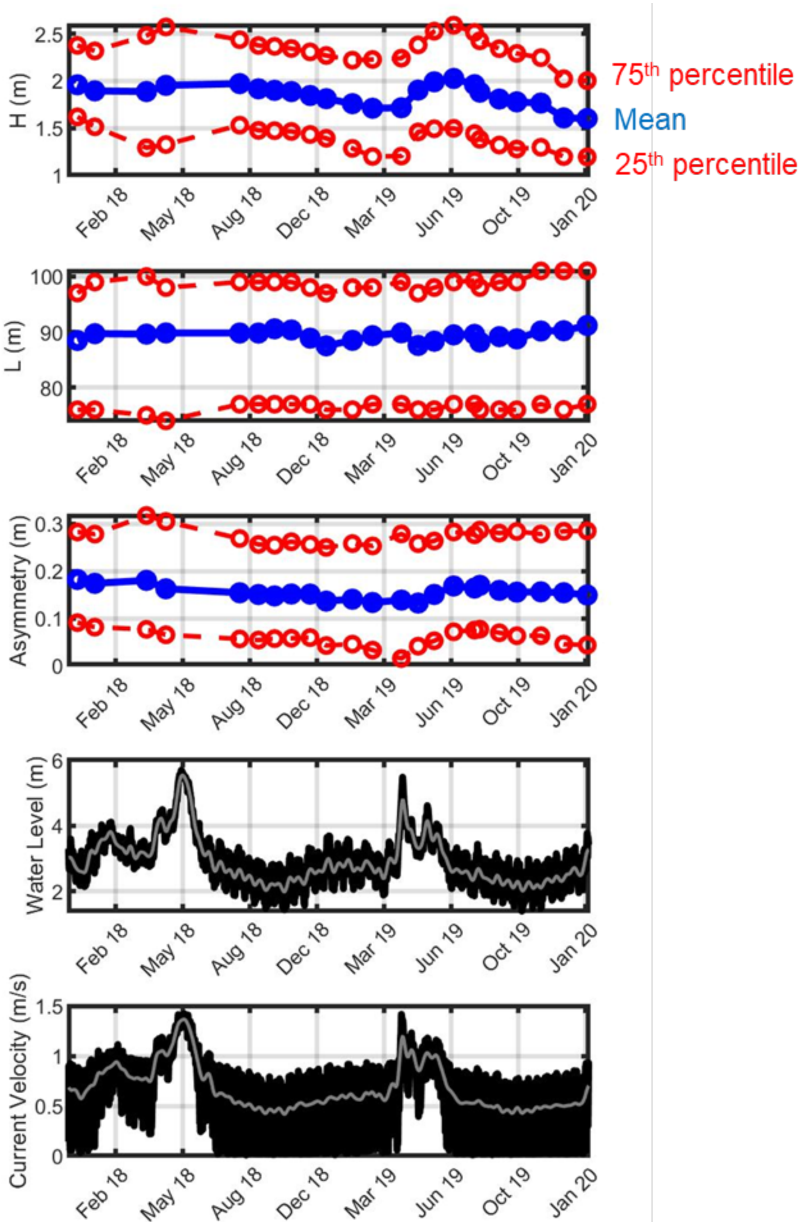
Regional Hydrodynamic Model Set Up





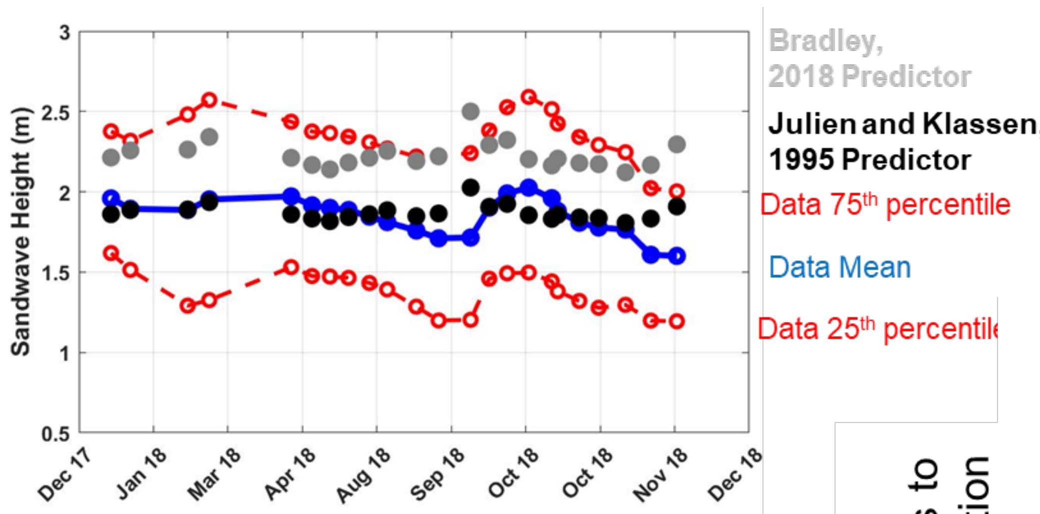
Model Grid at WLW

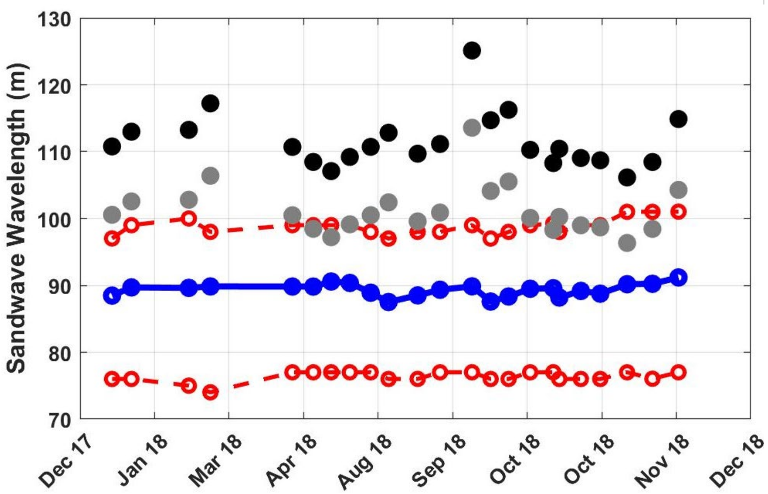




Relevant Findings:

- Observed seasonal changes in sand wave height (mean and extremes)
  - *Timing of sand wave height growth tied to changes in flow conditions*
- Timing of maximum sand wave height lags peak of freshet by 1+ month
  - *O&M Implications: dredging of sand waves likely shouldn't occur until the peak sand wave has formed*
- Relatively limited temporal variability in wavelength and wave asymmetry metrics at inland sites
- Added complication: management actions (e.g., dredging) influence the natural dynamics

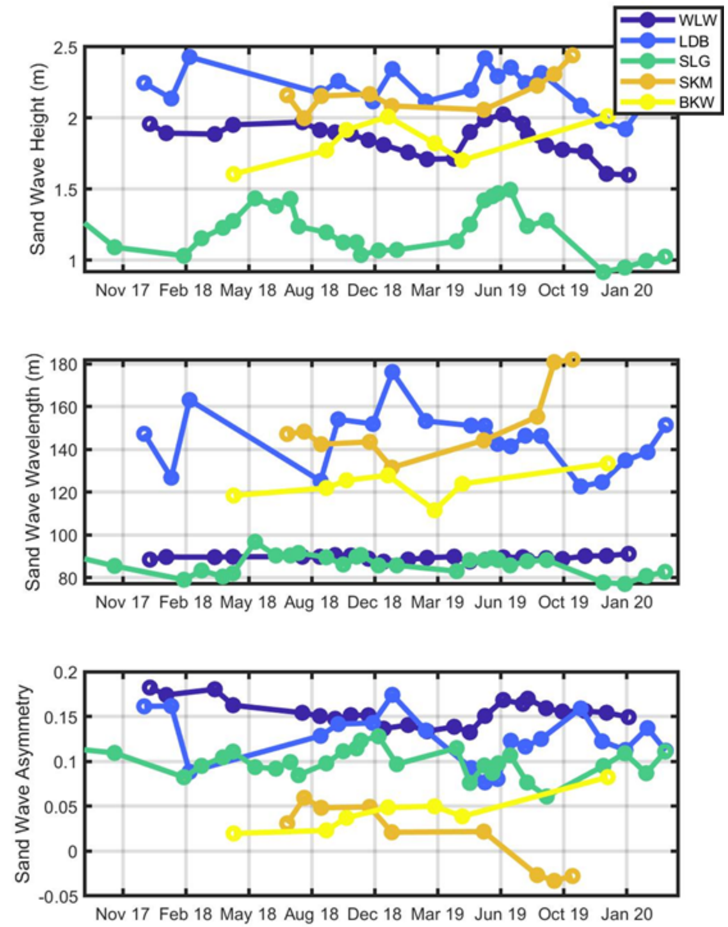




Set up for some simple empirical predictors:

$$H = \frac{h}{c_1} \qquad L = c_2 h$$

Ongoing effort: Using high resolution data from multiple sites to inform drivers of sand wave evolution



What challenges did you face to get your project to implementation and how did you move past them?

- **NOAA stopped hosting full hydrodynamic model output for the LCR**

Data hosting issues required us to run our own hydrodynamic model for the site for the entire study period.

- **Funding timelines complicated project progress**

Funds for external partners not set up until Q4. Expect additional progress next FY

- **Changes to original field data collection**

Available NWP-collected multibeam data at target sites was more frequent than originally anticipated. Adapted project plans to leverage existing high frequency, high resolution datasets.

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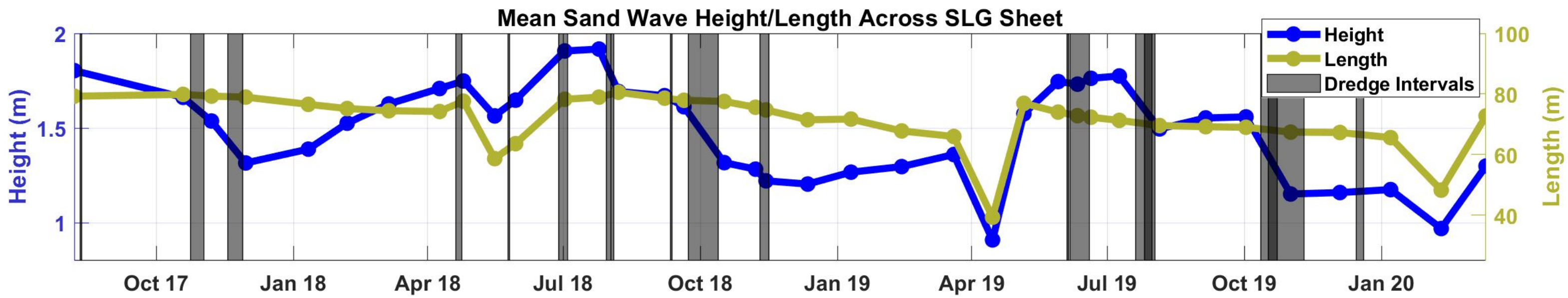
How is this project benefiting the USACE and Nation?

Predictive methods to optimize required dredging locations and timing ahead of time would serve as major benefit to NWP and other Districts

-Currently ~6.5 my/yr removed from the Lower Columbia River



This work is working towards identifying the optimum timing and location of necessary dredging actions

- *Data shows that max sand wave heights occur months after the freshet → immediate management implications*
- *Ongoing work continuing to develop predictors/forecast tools for sand waves and understanding spatial grain size controls on sand wave morphology*
- *NWP multibeam datasets are an underutilized resource for understanding sand wave dynamics at high spatio-temporal resolution. Numerous additional questions/tools that could be pursued with follow on work.*