APPLICATIONS OF THE CORPS SHOALING ANALYSIS TOOL (CSAT) TO EVALUATE DEPTH RESTRICTIONS AT ENTRANCE CHANNELS WITH EXAMPLES FROM SOUTHWEST PASS, PASCAGOULA HARBOR, AND MOUTH OF THE COLUMBIA RIVER

Michael Hartman
Nick Lenssen
Ned Mitchell
Lauren Dunkin

CIRP Technical Discussion
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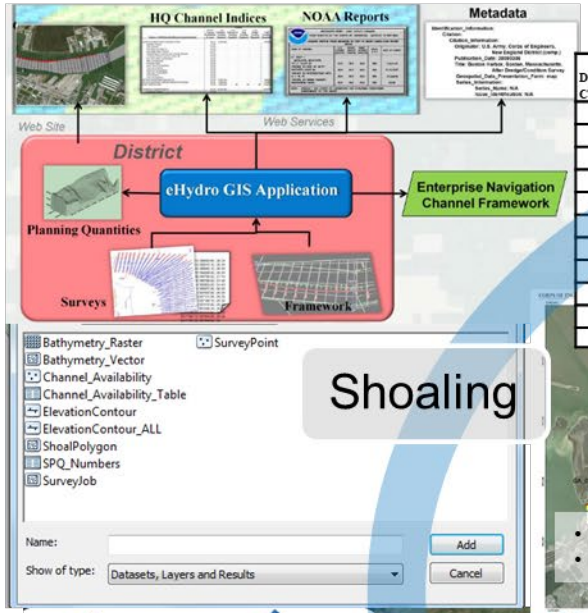
US Army Corps of Engineers®

CHL COASTAL & HYDRAULICS LABORATORY

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

Coastal Navigation Portfolio Management

Advance objective, quantitative, and systems-based approaches to management of the Corps' large coastal navigation portfolio of projects.

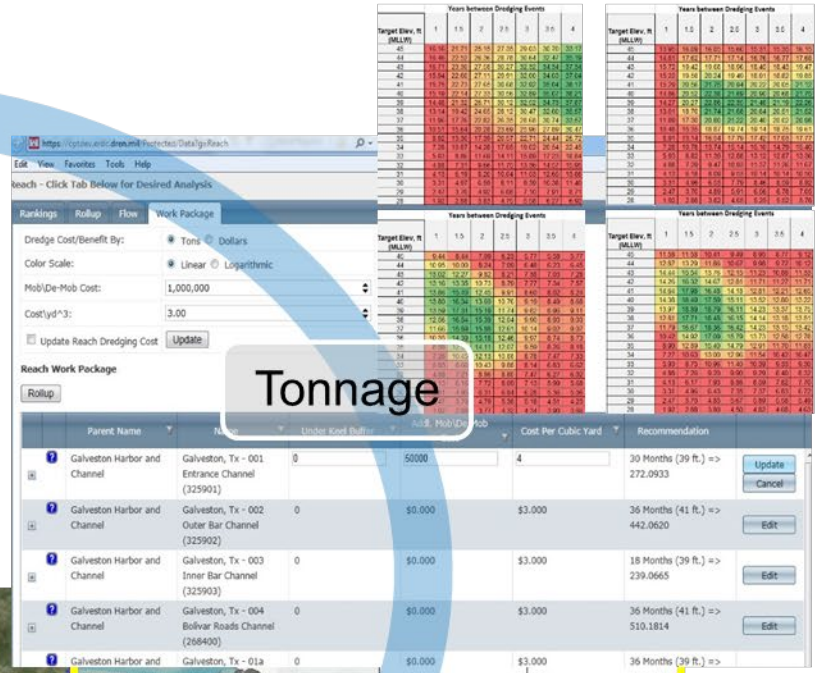


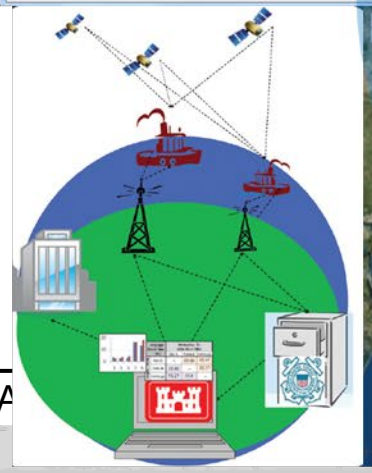
Shoaling

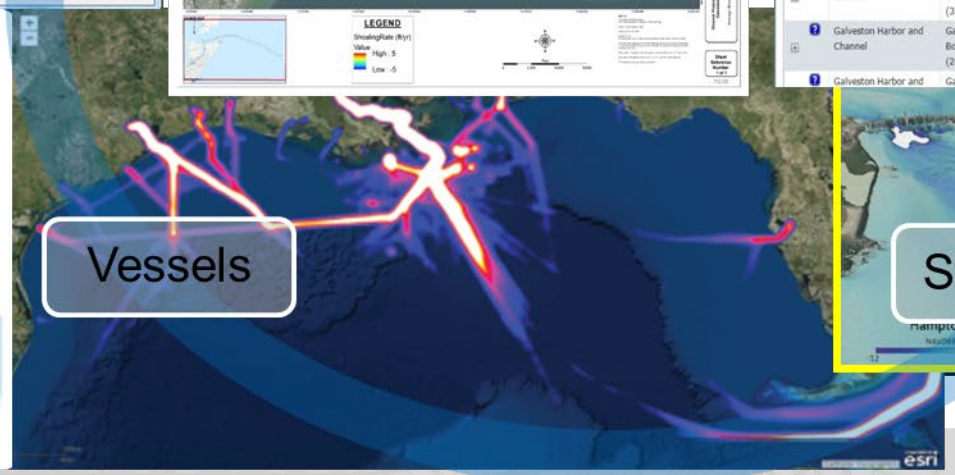
Surveys

Dredge Cut (ft)	Now (CY)	6 months (CY)	12 months (CY)	18 months (CY)	24 months (CY)	30 months (CY)	36 months (CY)
-45	195,320	271,020	373,070	49[illegible]200	624,890	771,020	931,220
-44	125,140	173,140	238,620	33[illegible]710	[illegible]	[illegible]	[illegible]
-43	76,249	109,860	153,260	21[illegible]570	293,080	399,730	522,310
-42	43,628	65,655	95,990	135,350	186,480	258,070	356,920
-41	24,409	37,093	56,313	83,402	119,100	165,270	227,370
-40	14,958	21,022	31,470	48,147	72,041	104,370	146,170
-39	10,060	13,343	18,250	26,832	41,017	61,922	91,020
-38	7,083	9,092	11,945	16,084	23,035	34,823	53,059
-37	5,194	6,480	8,241	10,728	14,312	19,888	29,576
-36	3,865	4,787	5,944	7,496	9,673	12,784	17,358
-35	2,806	3,555	4,412	5,465	6,843	8,751	11,457

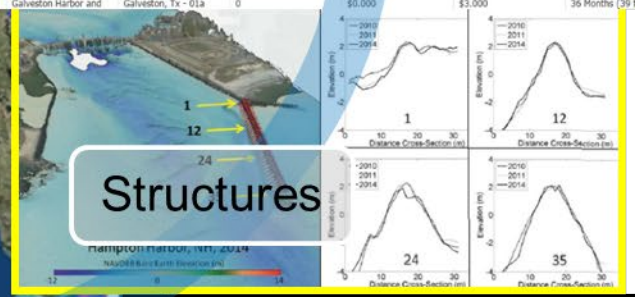
Tonnage







Vessels



Structures

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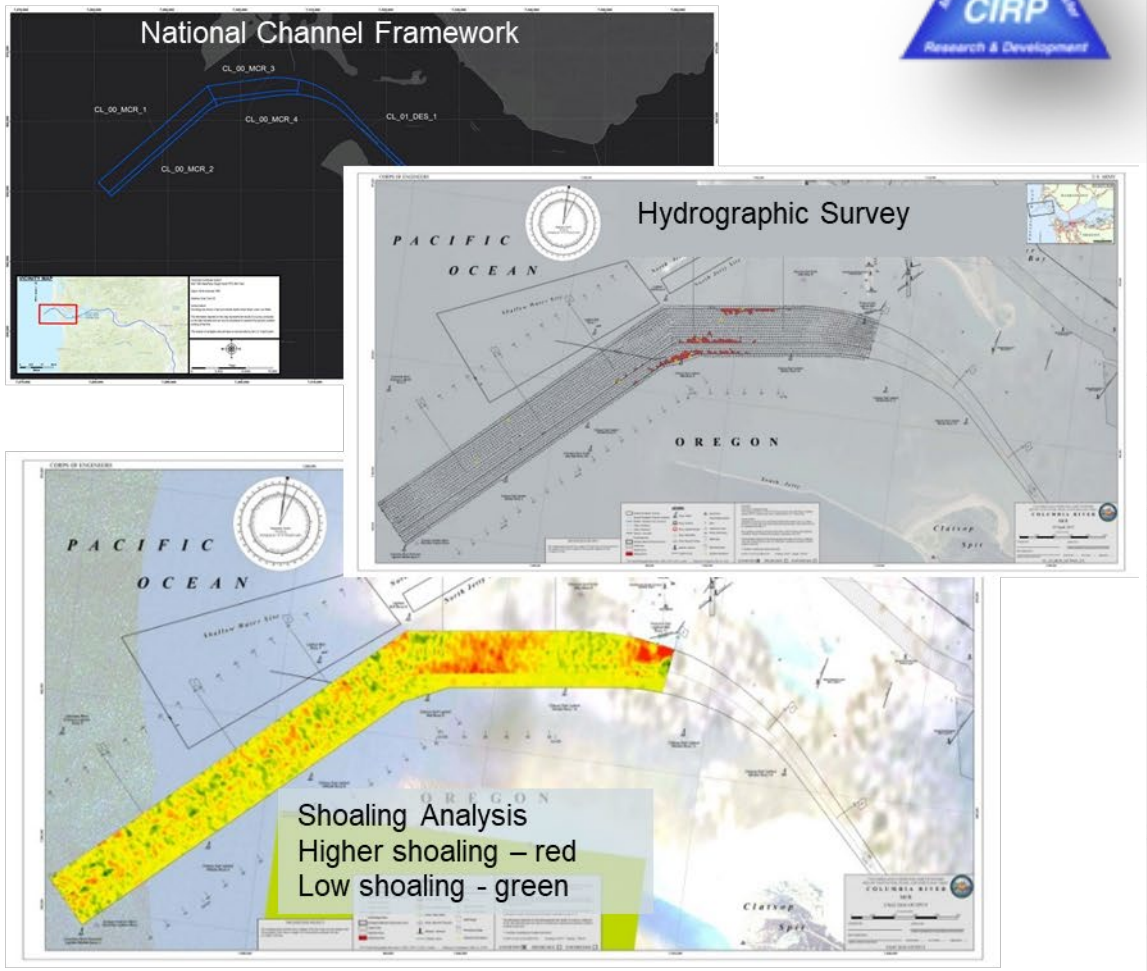
Corps Shoaling Analysis Tool (CSAT)

Description

- CSAT estimates shoaling rates using hydrographic surveys within the boundary of the National Channel Framework.
- CSAT uses the historical shoaling rates to predict future dredging volumes at various channel depth intervals.
- Where are shoaling 'hot spots' within the navigation channel?
- How has shoaling changed as a result of meteorological events (extratropical storm, rainfall or drought periods), dredge schedule change or dredge type change?



National Channel Framework, hydrographic survey map sheet from eHydro, and the shoaling rate prediction for Columbia River, OR.

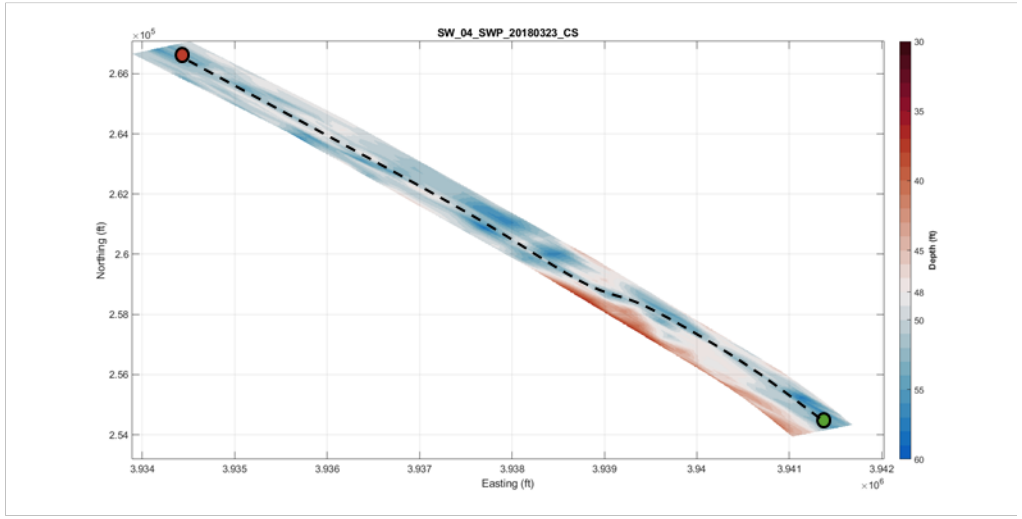
Shoaling Impacts on Channel Availability

Historically evaluated channel availability by controlling depth in each channel quarter.

Controlling Depth is the shallowest depth that might be encountered.

Currently testing Controlling Depth vs Project Depth (reported by Maintained Depth in NCF)

```
if controllingDepth < projectDepth
        channelAvailable = false;
else
        channelAvailable = true;
end
```



This definition means that it is possible for a single survey point to declare the entire channel as unavailable. Does that single point actually impact the vessel traffic though?

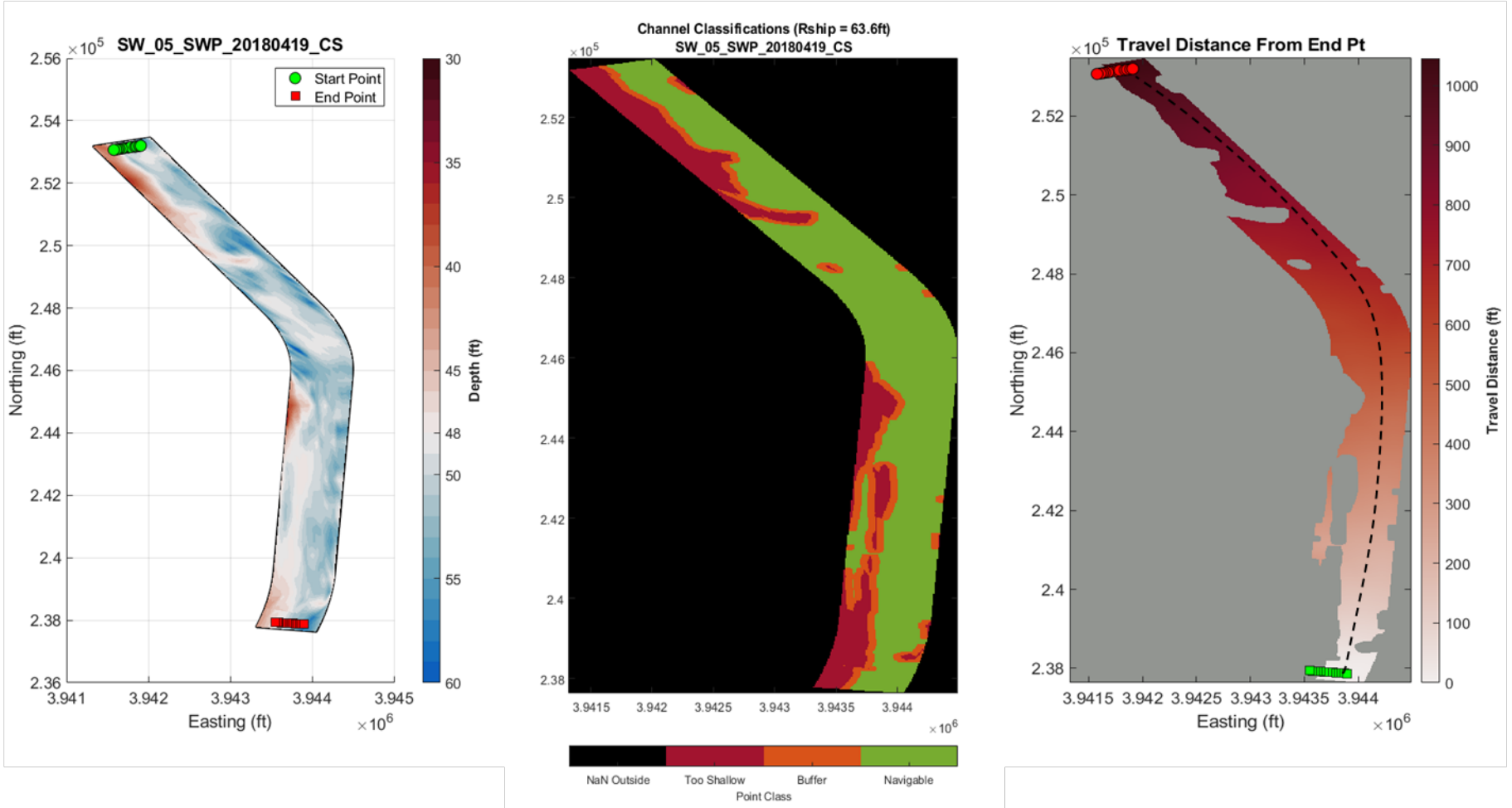
Routing Methodology Overview

1. Pick Start/End Goals
2. Identify areas shallower than target depth (set initial target depth = maintained depth)
3. Buffer around shallow depths
4. Calculate route
   - If routing unsuccessful, set target depth 1 ft shallower and go back to Step 2
   - If successful and target depth >= maintained depth, try 1 ft deeper until no longer passing

The deepest depth permitting successful routing is considered the controlling depth.

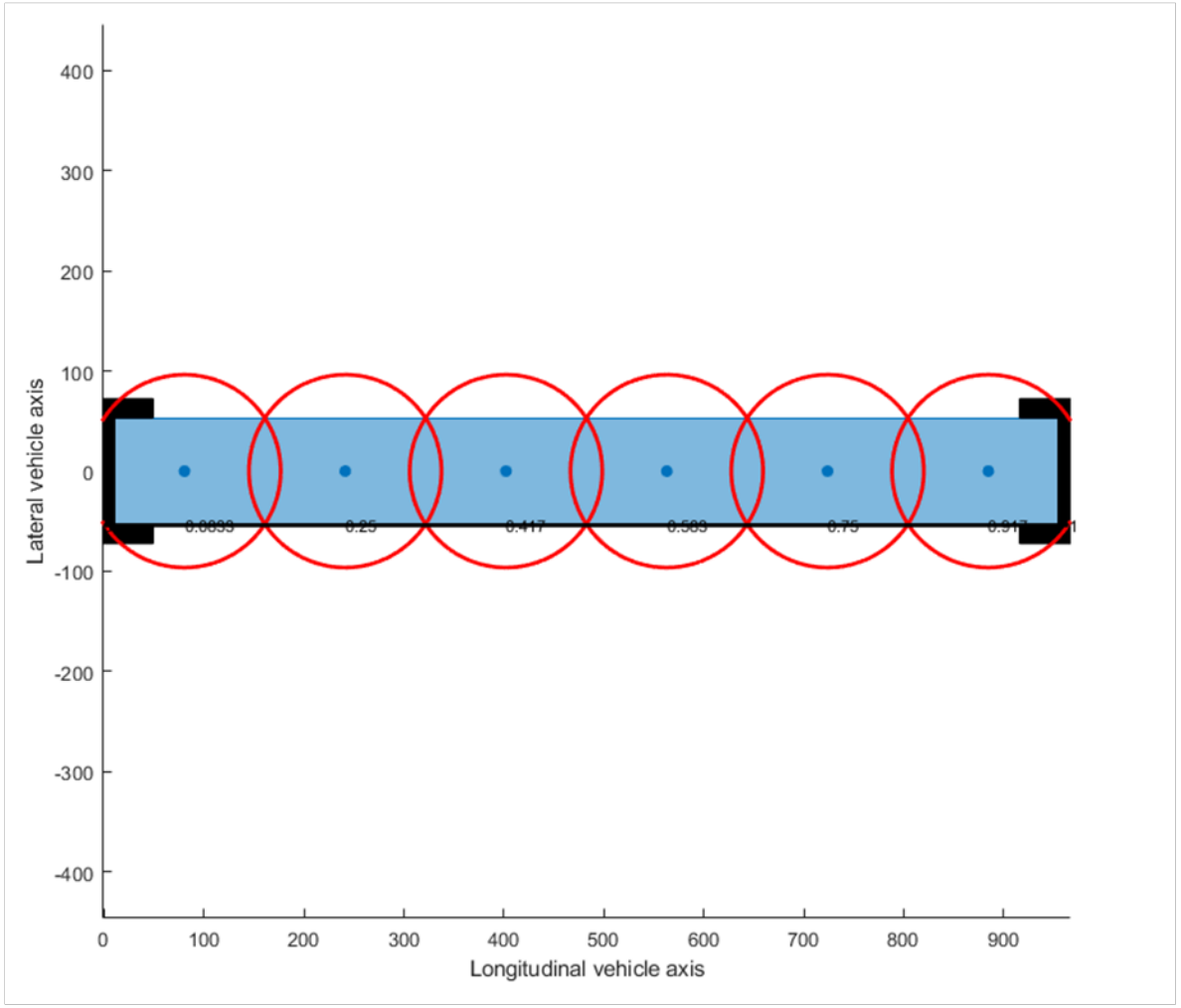
```
if controllingDepth < projectDepth
        channelAvailable = false;
else
        channelAvailable = true;
end
```

Channel Navigability



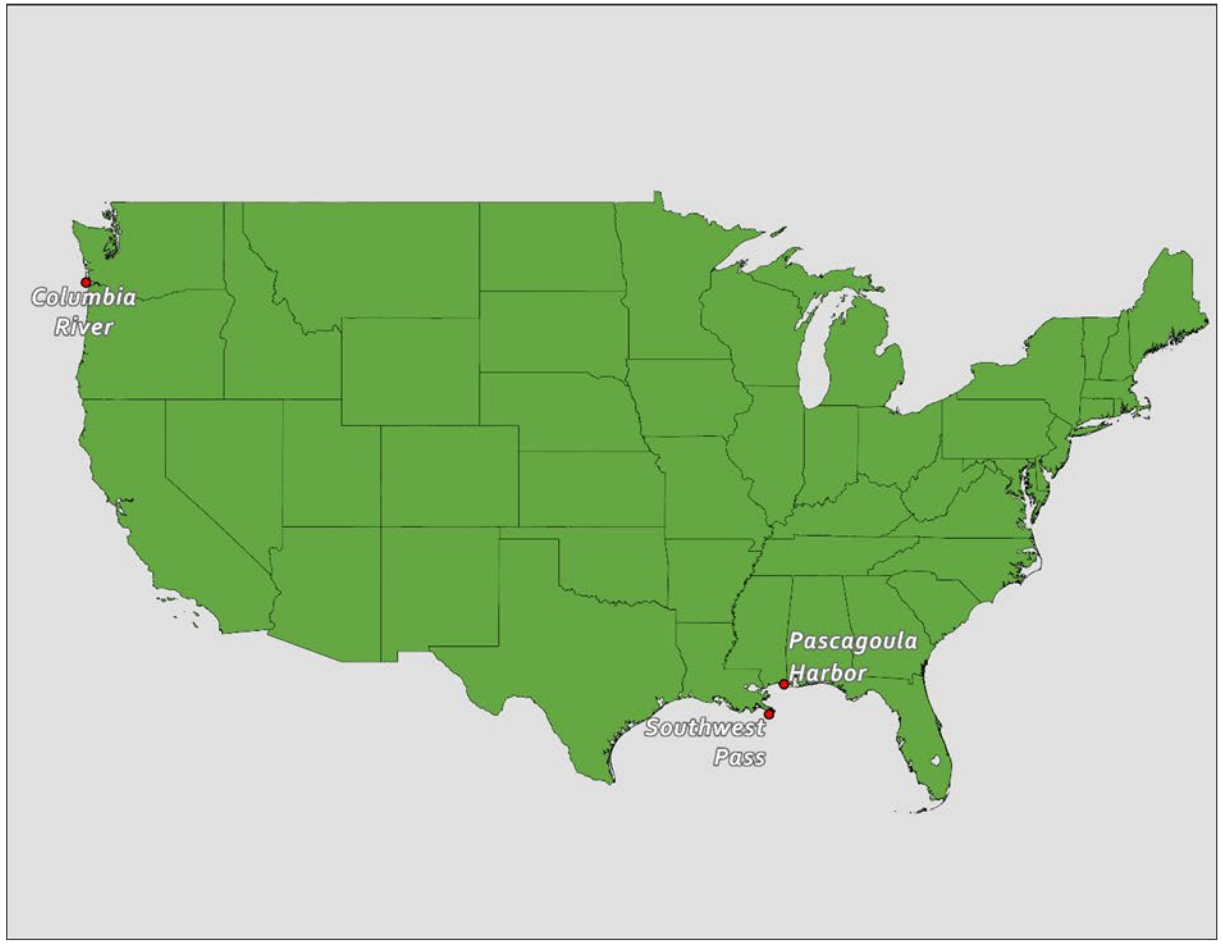
Channel Navigability – Sample Vessel

- Representative Vessel
  - Panamax
    - Length: 965 ft
    - Beam: 106 ft

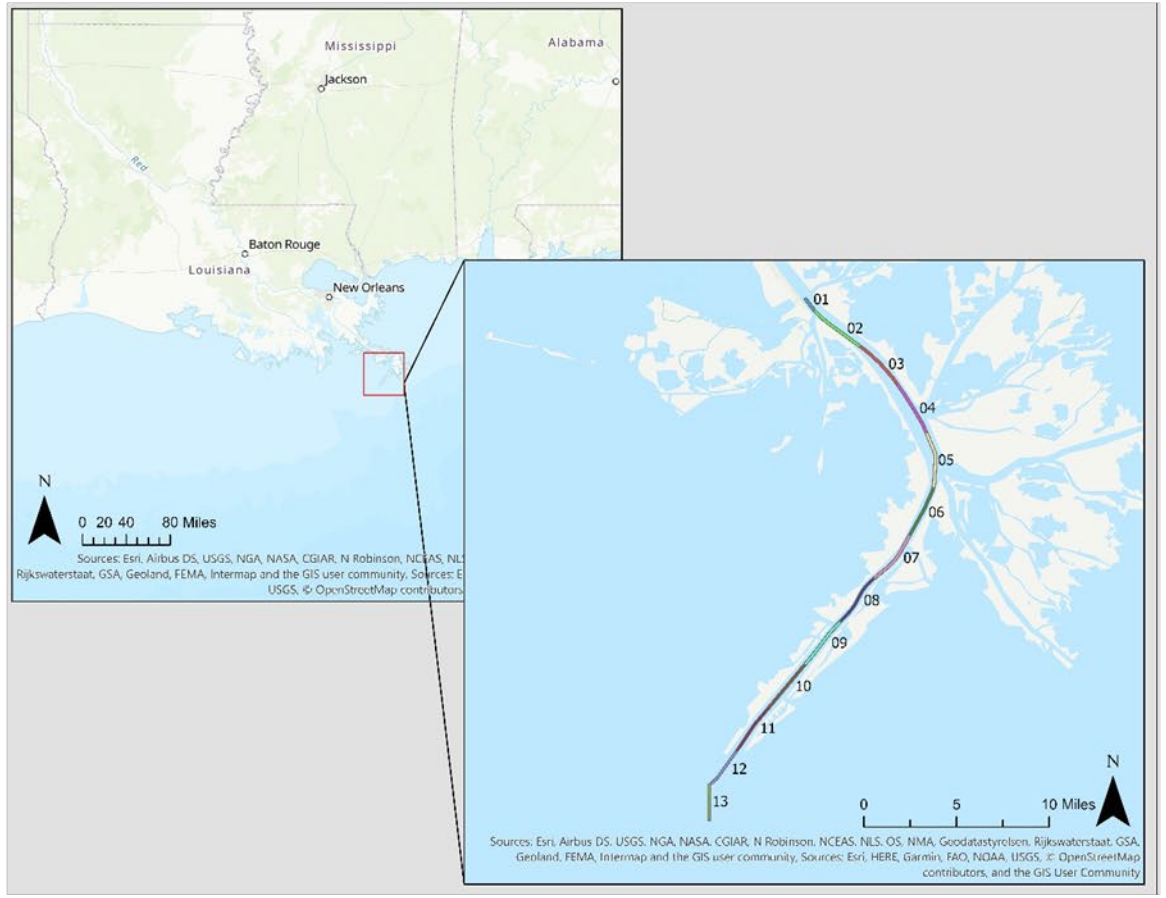


Test Cases

1. Southwest Pass
2. Pascagoula Harbor
3. Columbia River



Southwest Pass (SWP)

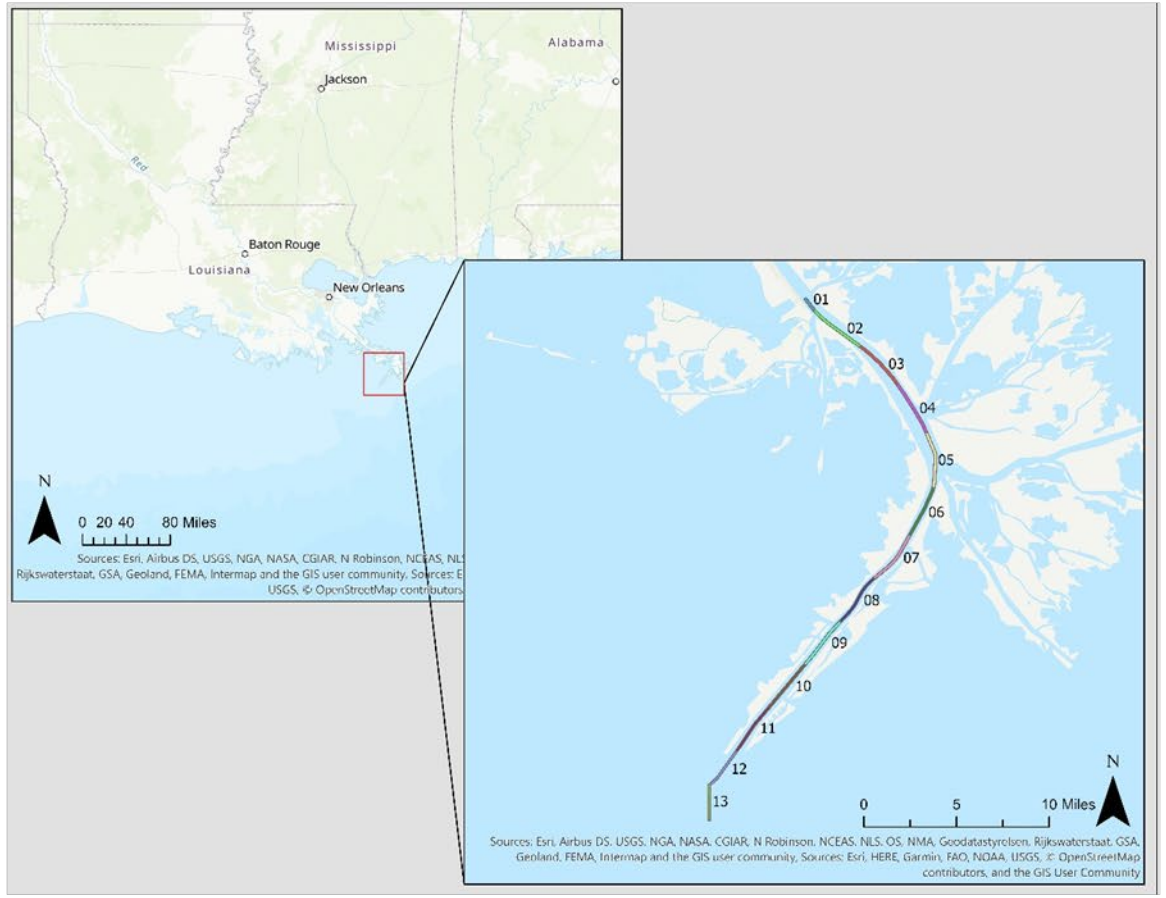


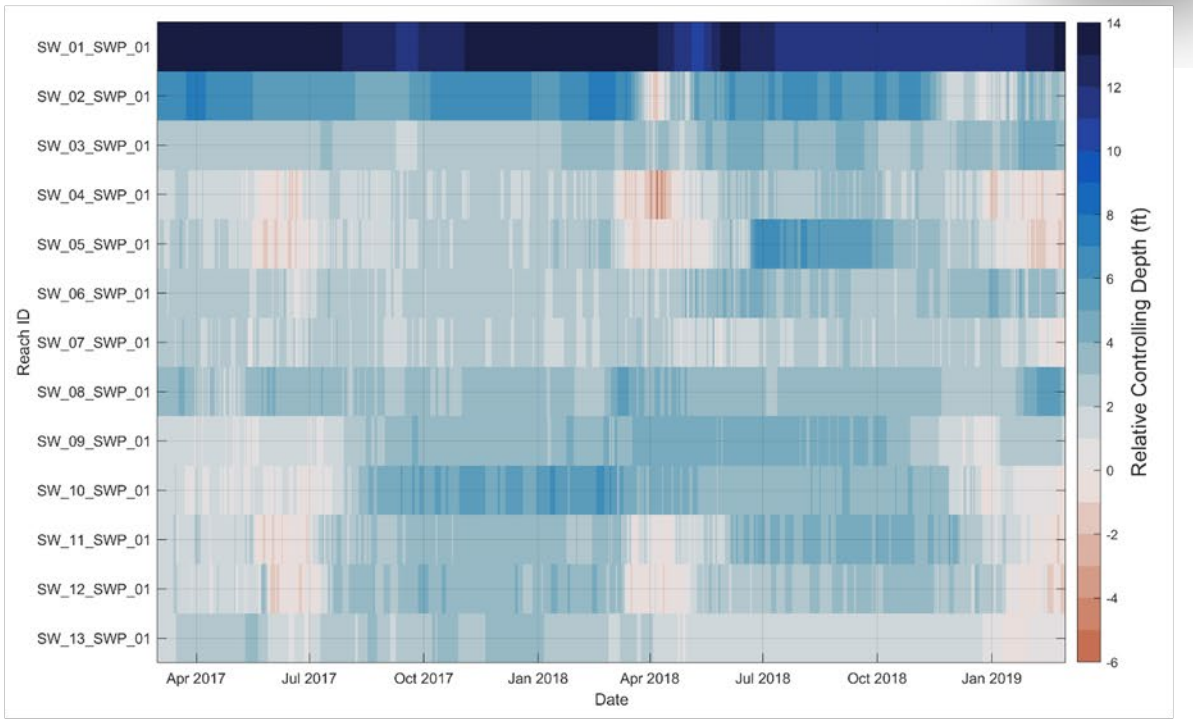
Reach Code	Reach Description	Authorized Depth (ft)	Maintained Depth (ft)	Length (miles)	Width (ft)
CEMVN_SW_01_SWP_01	MILE 13.4 TO 10.5 AHP	48.5	48.5	2.9	750
CEMVN_SW_02_SWP_01	MILE 10.5 TO 7.7 AHP	48.5	48.5	2.8	750
CEMVN_SW_03_SWP_01	MILE 7.7 TO 4.8 AHP	48.5	48.5	2.9	750
CEMVN_SW_04_SWP_01	MILE 4.8 TO 2.0 AHP	48.5	48.5	2.8	750
CEMVN_SW_05_SWP_01	MILE 2.0 AHP TO 1.0 BHP	48.5	48.5	3	750
CEMVN_SW_06_SWP_01	MILE 1.0 TO 3.7 BHP	48.5	48.5	2.7	750
CEMVN_SW_07_SWP_01	MILE 3.7 TO 6.7 BHP	48.5	48.5	3	750
CEMVN_SW_08_SWP_01	MILE 6.7 TO 9.6 BHP	48.5	48.5	2.9	750
CEMVN_SW_09_SWP_01	MILE 9.6 TO 12.4 BHP	48.5	48.5	2.8	750
CEMVN_SW_10_SWP_01	MILE 12.4 TO 15.2 BHP	48.5	48.5	2.8	750
CEMVN_SW_11_SWP_01	MILE 15.2 TO 18.0 BHP	48.5	48.5	2.8	600-750
CEMVN_SW_12_SWP_01	MILE 18.0 TO 21.0 BHP	48.5	48.5	3	600
CEMVN_SW_13_SWP_01	MILE 19.2 TO 22.0 BHP	48.5	48.5	2.8	600

23 Reaches – 37.2 miles

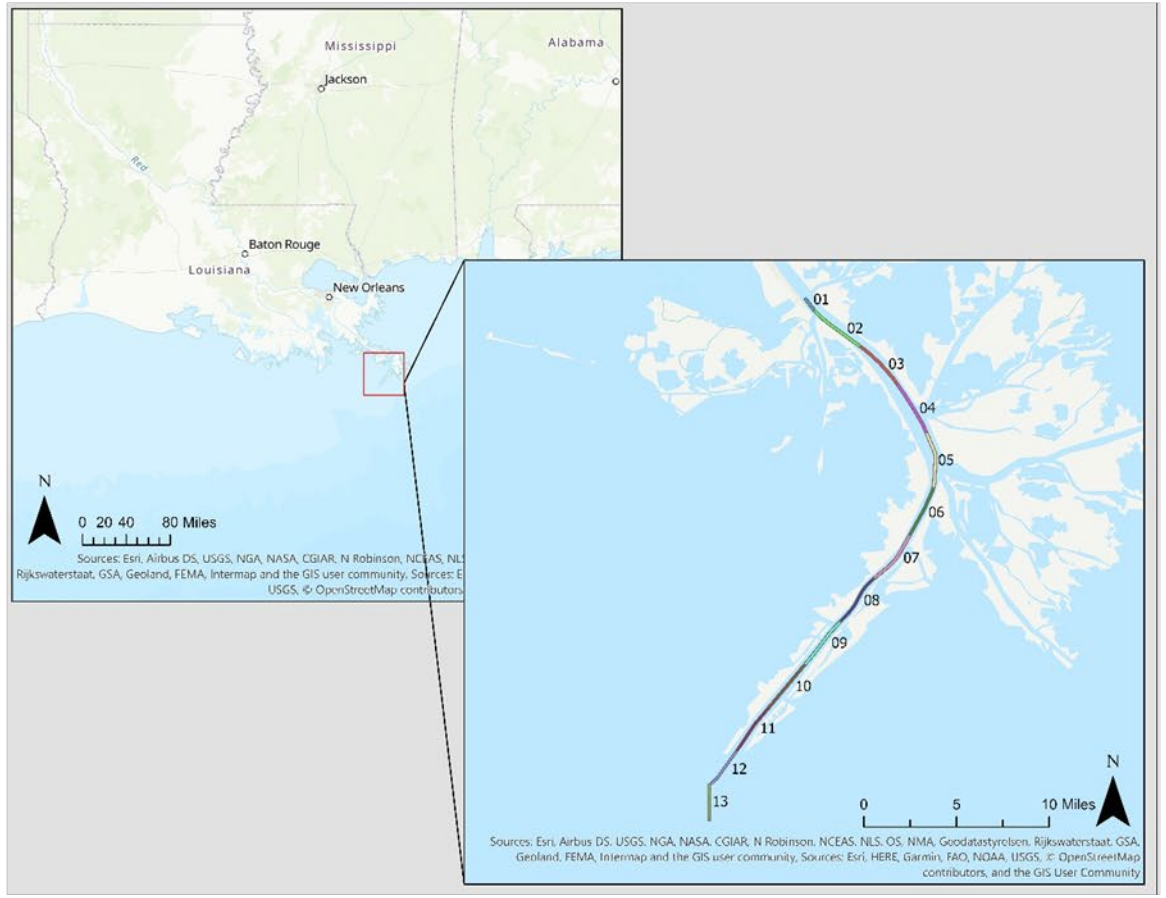
UNCLASSIFIED

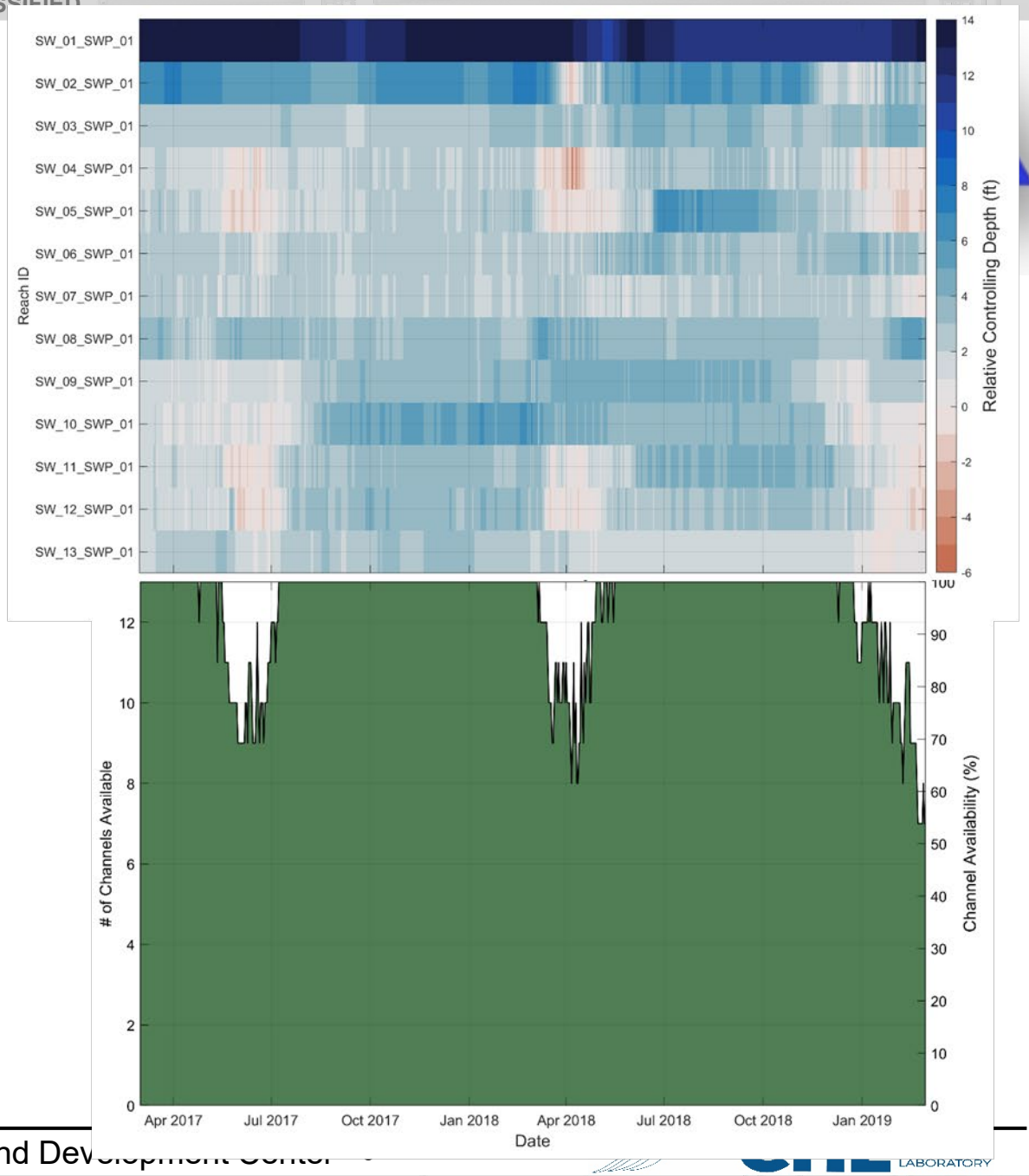
Southwest Pass (SWP)



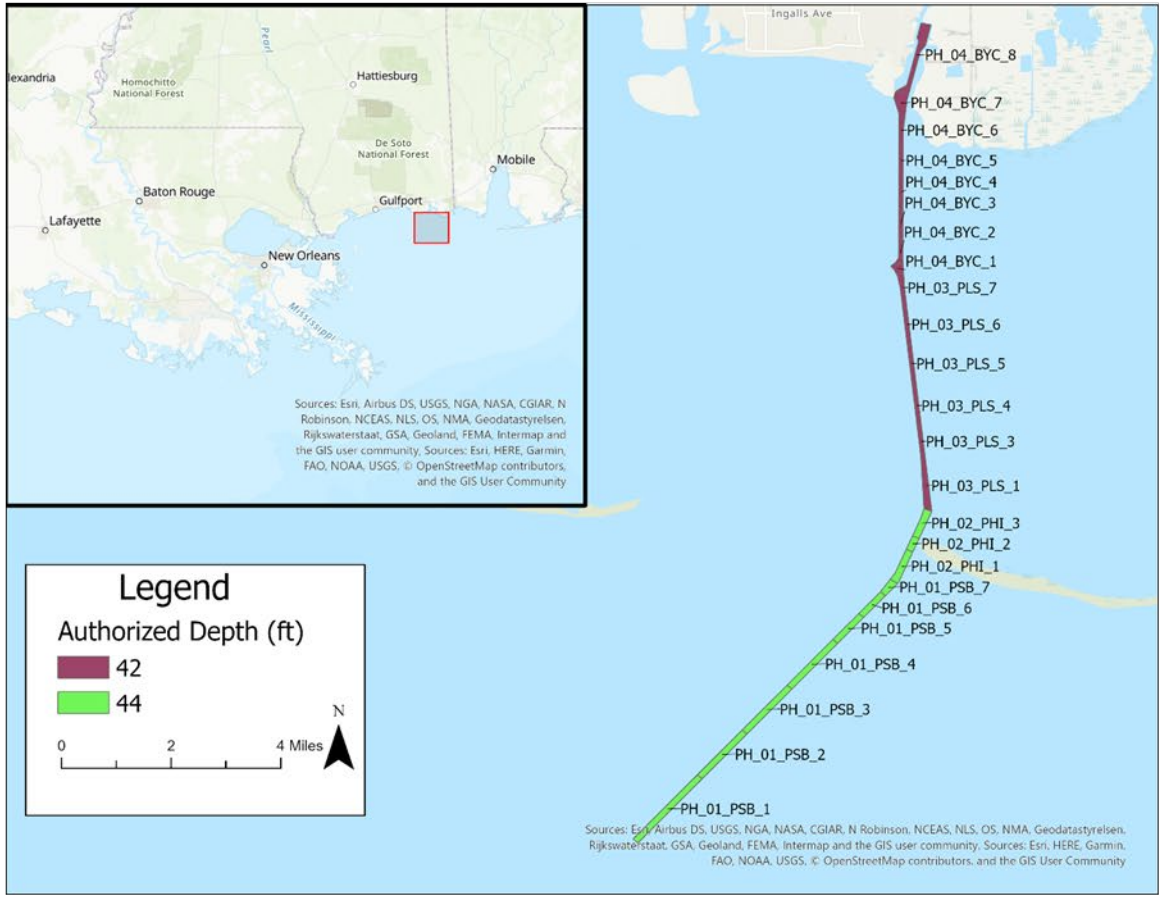


Southwest Pass (SWP)





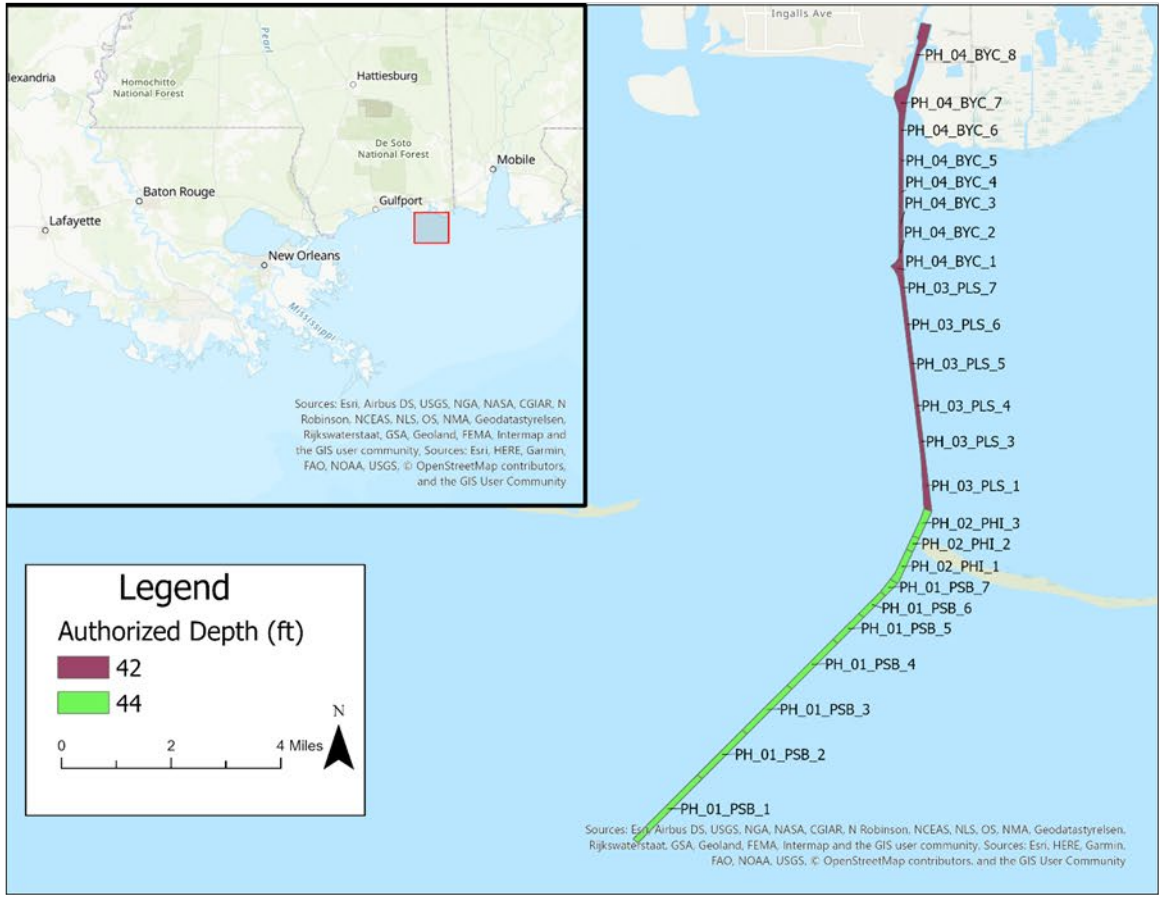
Pascagoula Harbor (July 2015 – July 2019)

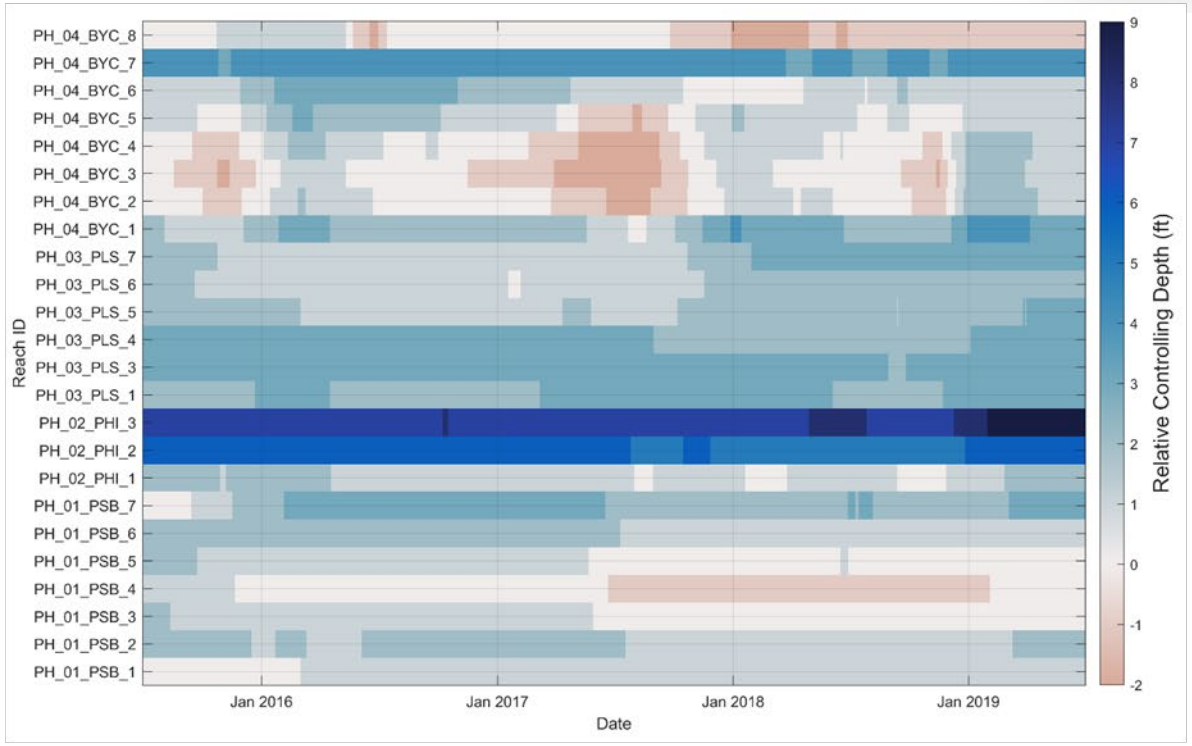


23 Reaches – 15.92 miles

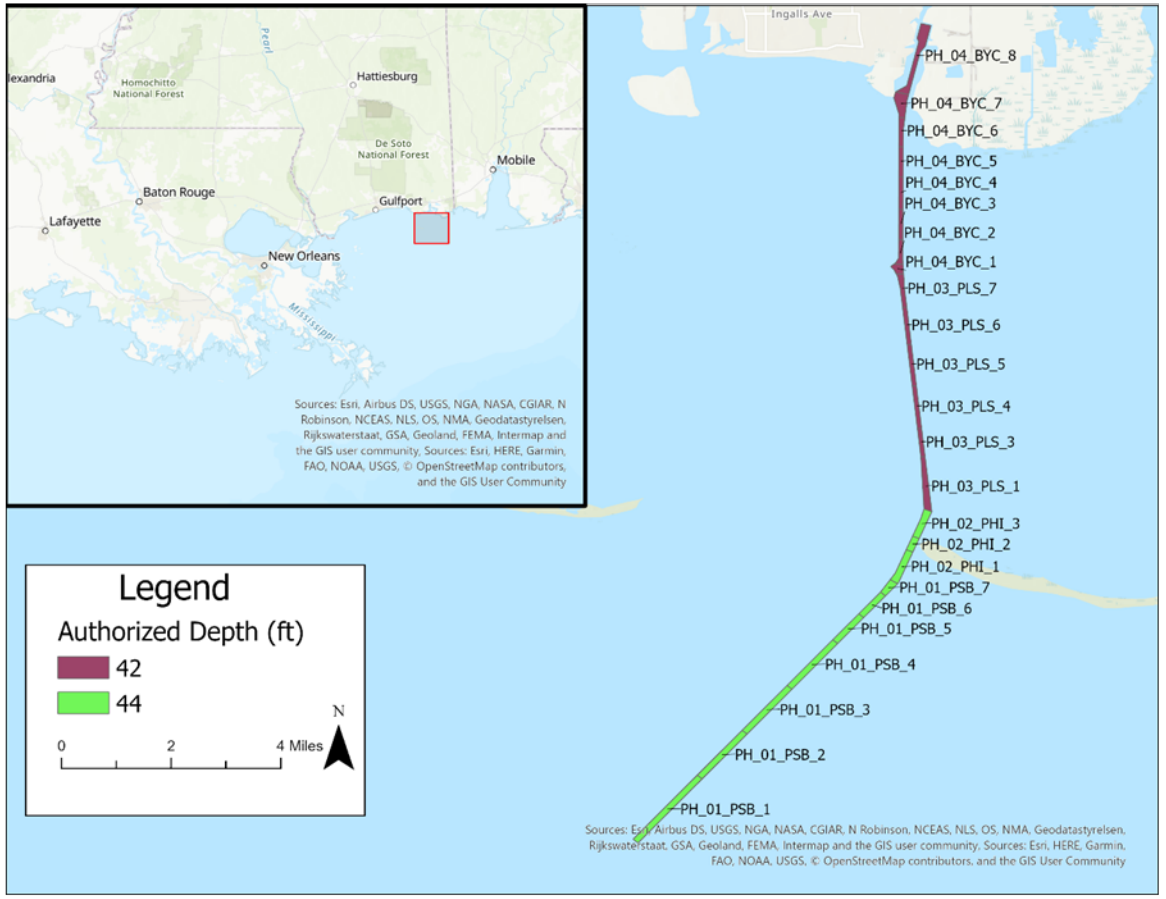
Reach Code	Reach Description	Authorized Depth (ft)	Maintained Depth (ft)	Length (miles)	Width (ft)
CESAM_PH_01_PSB_1	Pascagoula Bar Channel	44	44	1.54	450
CESAM_PH_01_PSB_2	Pascagoula Bar Channel	44	44	1.08	450
CESAM_PH_01_PSB_3	Pascagoula Bar Channel	44	44	1.08	450
CESAM_PH_01_PSB_4	Pascagoula Bar Channel	44	44	1.1	450
CESAM_PH_01_PSB_5	Pascagoula Bar Channel	44	44	0.62	450
CESAM_PH_01_PSB_6	Pascagoula Bar Channel	44	44	0.61	450
CESAM_PH_01_PSB_7	Pascagoula Bar Channel	44	44	0.2	450
CESAM_PH_02_PHI_1	Horn Island Pass	44	44	0.61	600
CESAM_PH_02_PHI_2	Horn Island Pass	44	44	0.26	600
CESAM_PH_02_PHI_3	Horn Island Pass	44	44	0.56	600
CESAM_PH_03_PLS_1	Pascagoula Lower Sound	42	42	0.52	350
CESAM_PH_03_PLS_3	Pascagoula Lower Sound	42	42	0.31	350
CESAM_PH_03_PLS_4	Pascagoula Lower Sound	42	42	0.77	350
CESAM_PH_03_PLS_5	Pascagoula Lower Sound	42	42	0.76	350
CESAM_PH_03_PLS_6	Pascagoula Lower Sound	42	42	0.68	350
CESAM_PH_03_PLS_7	Pascagoula Lower Sound	42	42	0.61	350
CESAM_PH_04_BYC_1	Bayou Casotte	42	42	0.19	350-400
CESAM_PH_04_BYC_2	Bayou Casotte	42	42	0.45	350-400
CESAM_PH_04_BYC_3	Bayou Casotte	42	42	0.55	350-400
CESAM_PH_04_BYC_4	Bayou Casotte	42	42	0.58	350-400
CESAM_PH_04_BYC_5	Bayou Casotte	42	42	0.55	350-400
CESAM_PH_04_BYC_6	Bayou Casotte	42	42	0.53	350-400
CESAM_PH_04_BYC_7	Bayou Casotte	42	42	0.43	350-400
CESAM_PH_04_BYC_8	Bayou Casotte	42	42	1.33	350-400

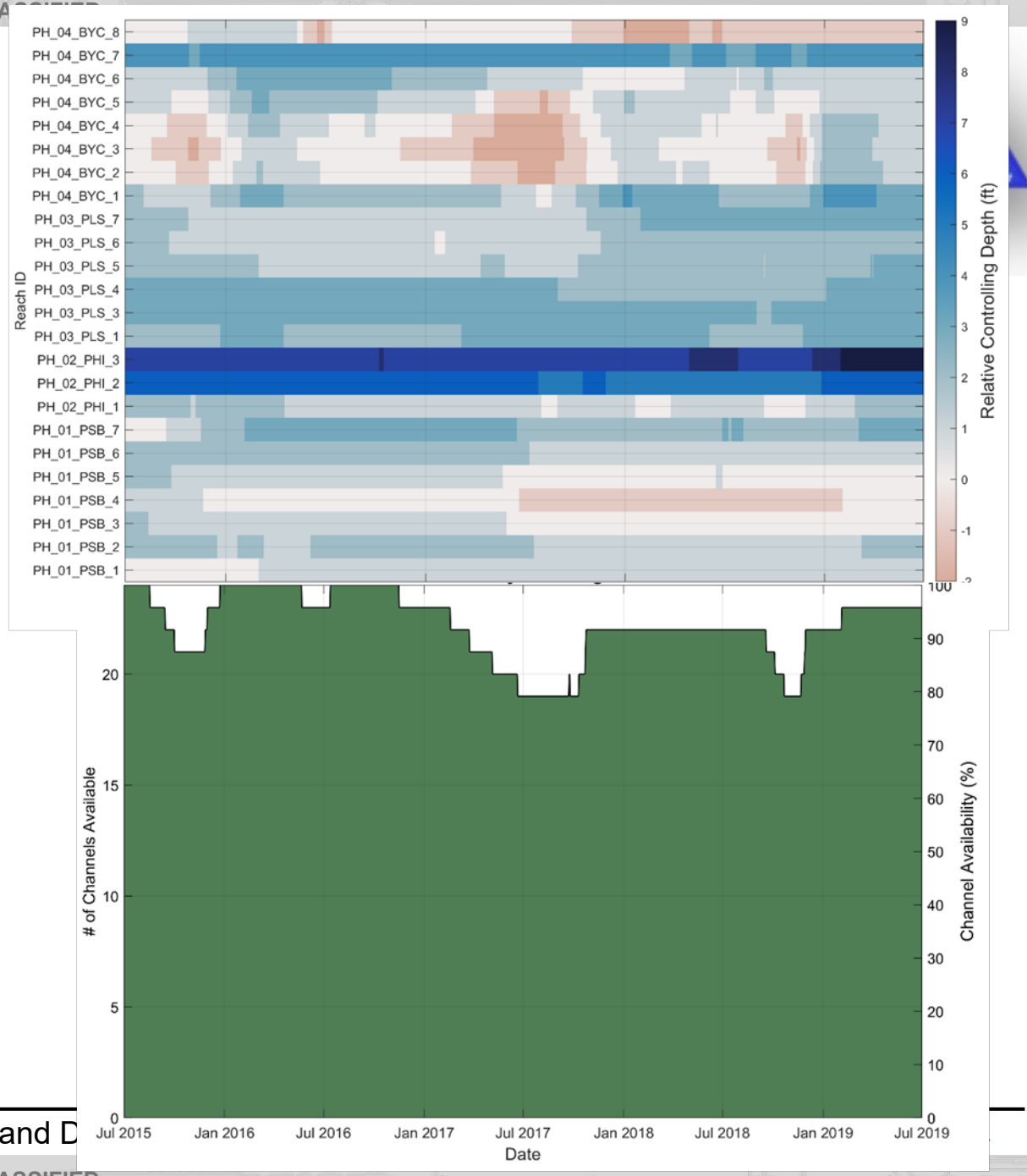
Pascagoula Harbor



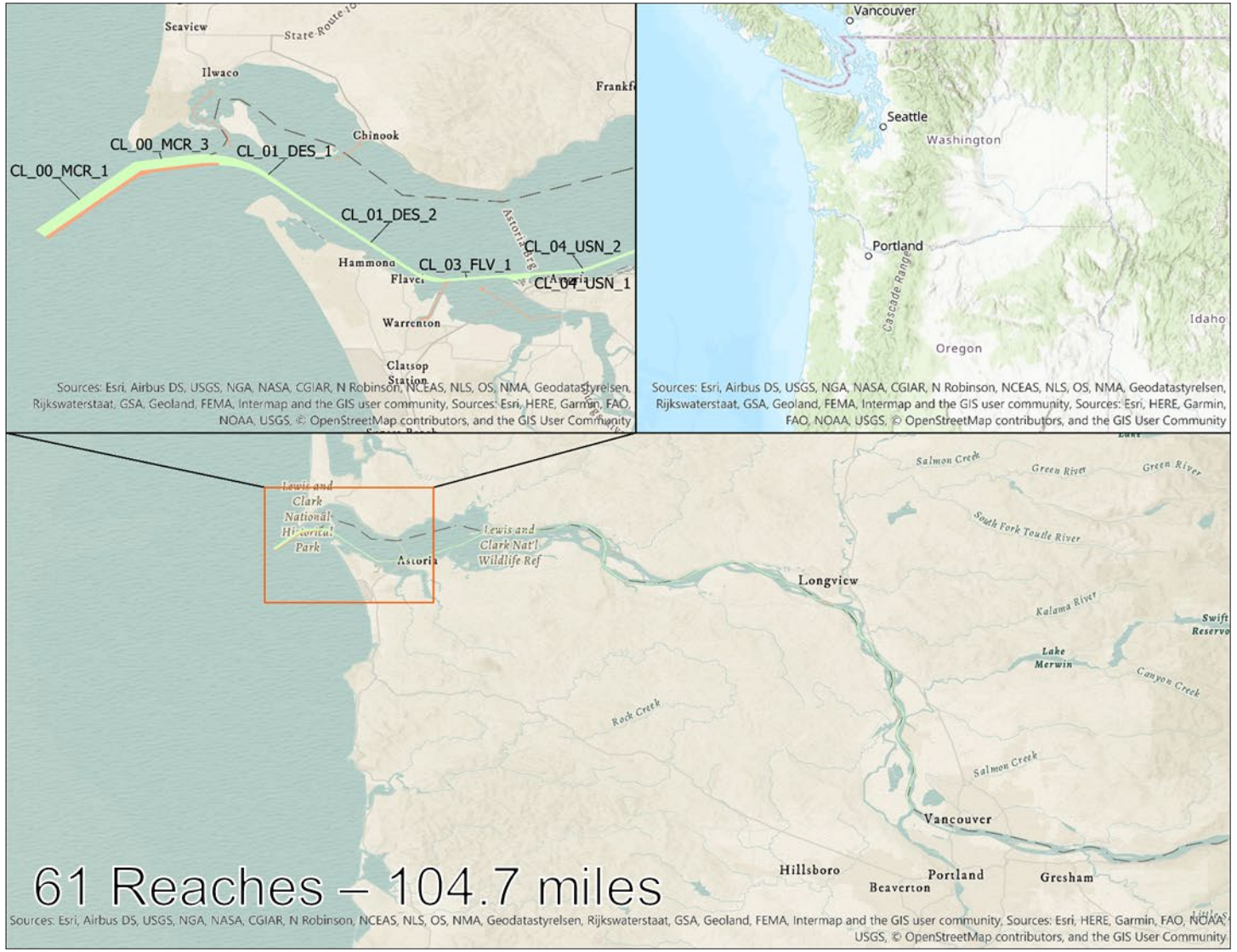


Pascagoula Harbor

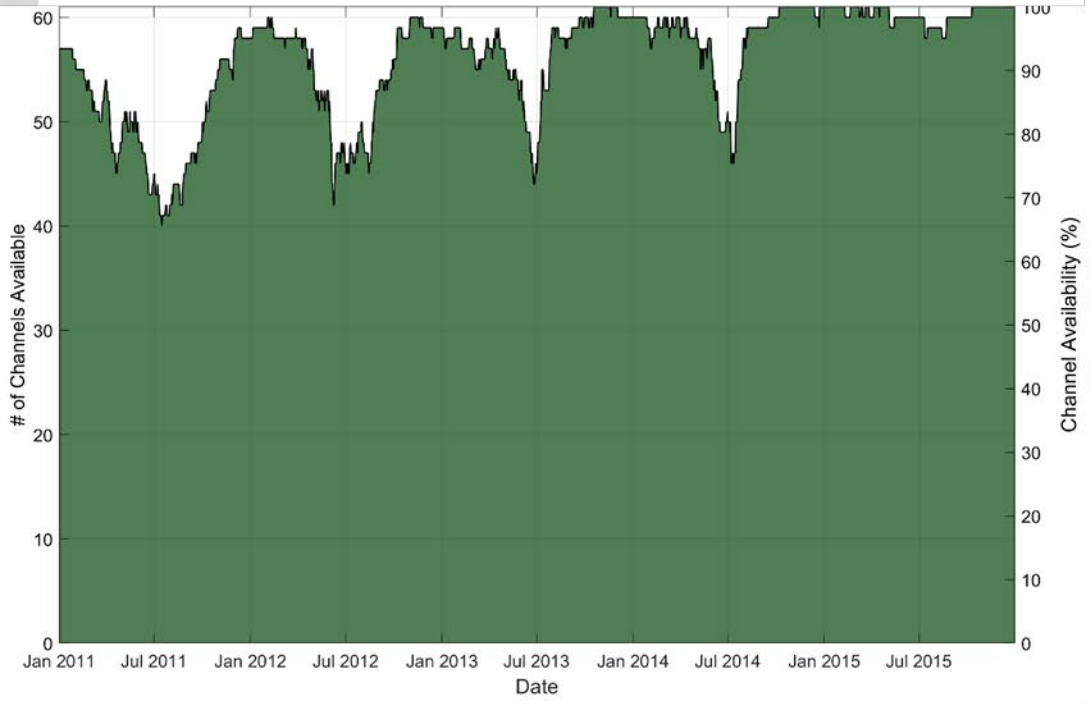


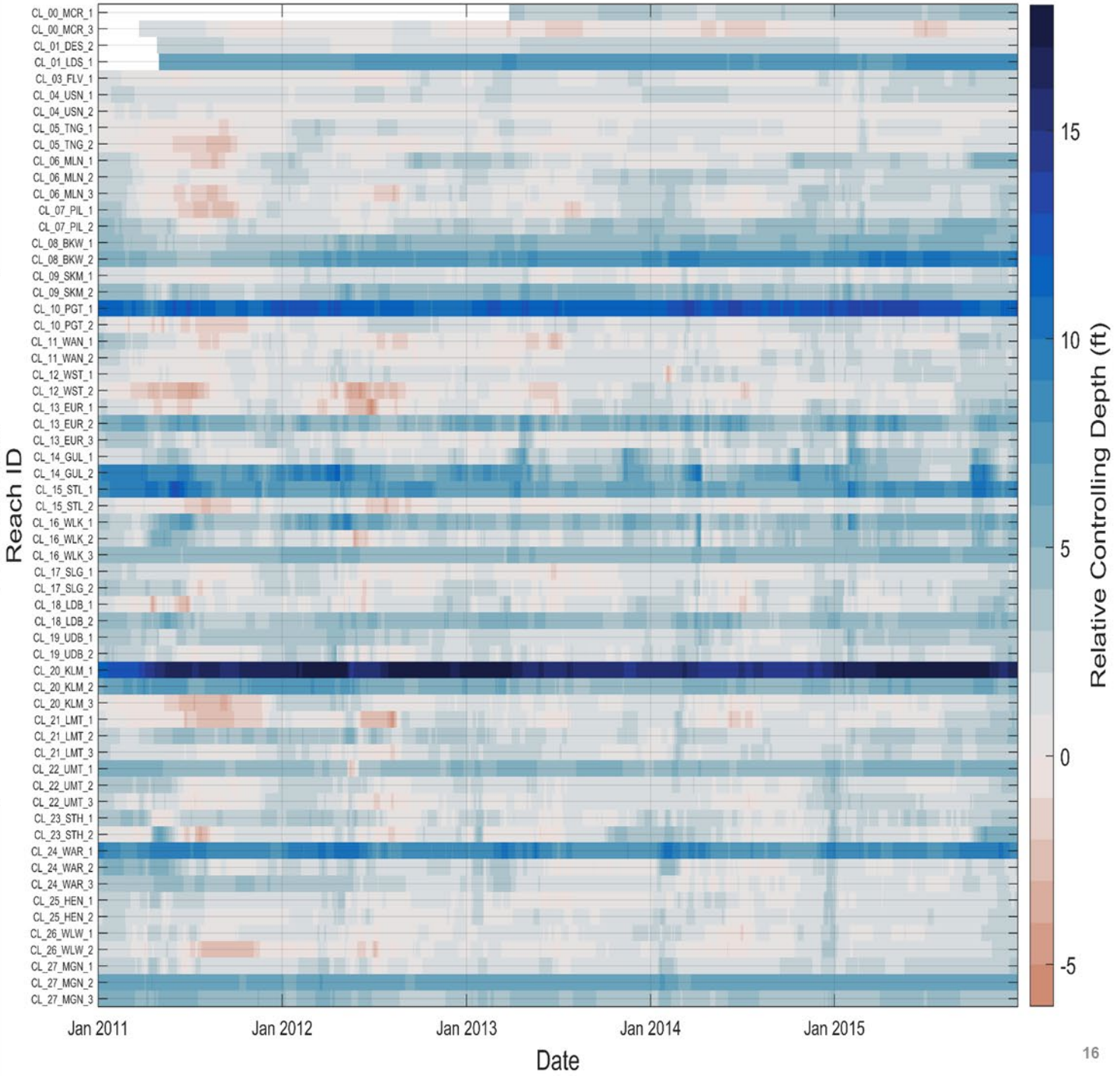


Columbia River (January 2011 – December 2015)



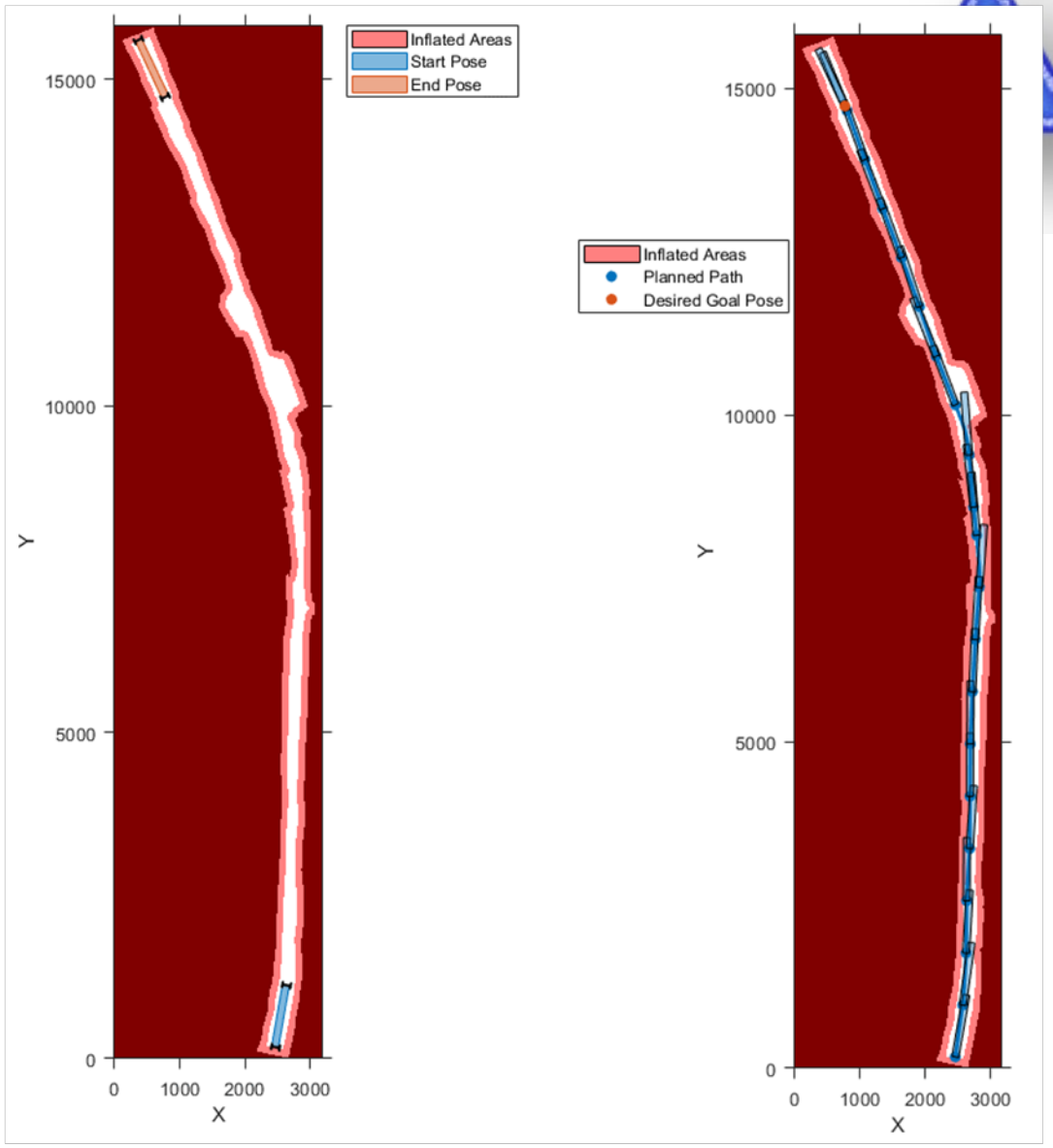
Reach Code	Reach Description	Authorized Depth (ft)	Maintained Depth (ft)	Length (miles)	Width (ft)
CENWP_CL_00_MCR_1	Mouth of Columbia River Entrance Range	55	55	3.3	2000
CENWP_CL_00_MCR_3	Mouth of Columbia River Sand Island Range	55	55	2.2	2000
CENWP_CL_01_DES_1	Desdemona Shoal	43	43	3.6	600-2000
CENWP_CL_01_DES_2	Desdemona Shoal	43	43	3.6	600
CENWP_CL_03_FLV_1	Tansy Point Turn & Range	43	43	3.6	600
CENWP_CL_04_USN_1	Tansy Point Turn & Range	43	43	1.2	600
CENWP_CL_04_USN_2	Astoria Range	43	43	2.7	600
CENWP_CL_05_TNG_1	Tongue Point Channel	43	43	2.2	600
CENWP_CL_05_TNG_2	Harrington Point Range	43	43	1.7	600
CENWP_CL_06_MLN_1	Harrington Point Range	43	43	0.9	600
CENWP_CL_06_MLN_2	Miller Sands Range	43	43	2.2	600
CENWP_CL_06_MLN_3	Pillar Rock Lower Range	43	43	0.7	600
CENWP_CL_07_PIL_1	Pillar Rock Lower Range	43	43	2.3	600
CENWP_CL_07_PIL_2	Pillar Rock Upper Range	43	43	1.3	600
CENWP_CL_08_BKW_1	Pillar Rock Upper Range	43	43	0.6	600
CENWP_CL_08_BKW_2	Welch Island Reach	43	43	3.2	600
CENWP_CL_09_SKM_1	Skamokawa Channel	43	43	3.3	600
CENWP_CL_09_SKM_2	Steamboat Reach	43	43	0.7	600
CENWP_CL_10_PGT_1	Steamboat Reach	43	43	0.7	600
CENWP_CL_10_PGT_2	Puget Island Range & Turn	43	43	3.5	600
CENWP_CL_11_WAN_1	Wauna Range	43	43	2	600
CENWP_CL_11_WAN_2	Driscoll Range	43	43	1.7	600
CENWP_CL_12_WST_1	Westport Turn & Range	43	43	2	600
CENWP_CL_12_WST_2	Westport Channel	43	43	1.7	600
CENWP_CL_13_EUR_1	Westport Channel	43	43	0.7	600
CENWP_CL_13_EUR_2	Eureka Lower Channel	43	43	2.1	600
CENWP_CL_13_EUR_3	Eureka Upper Channel	43	43	0.8	600
CENWP_CL_14_GUL_1	Oak Point Channel	43	43	3	600
CENWP_CL_14_GUL_2	Gull Island Turn & Channel	43	43	1.4	600
CENWP_CL_15_STL_1	Gull Island Channel	43	43	0.8	600

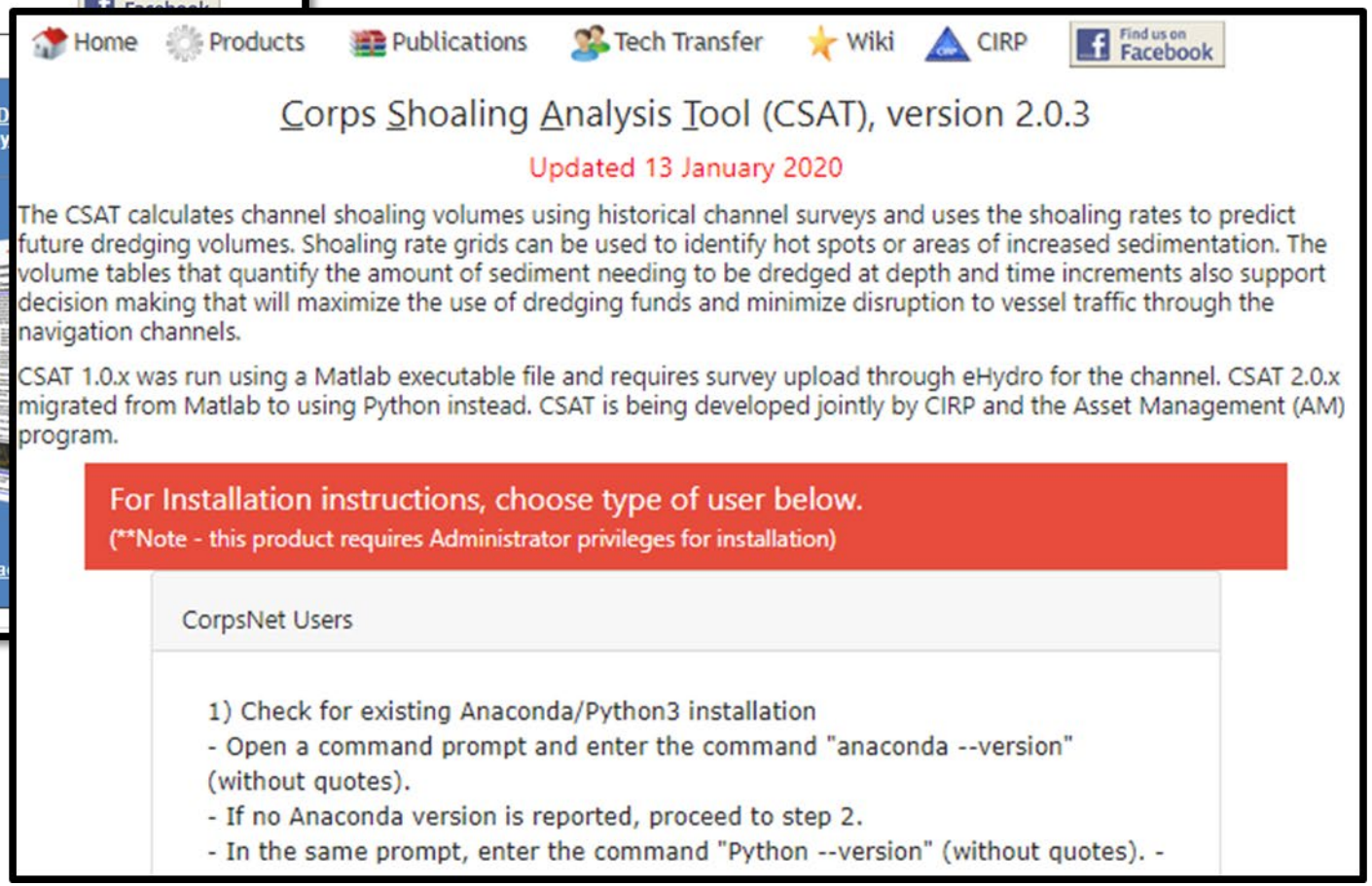

# of Channels Available
Channel Availability (%)
Date
Jan 2011
Jul 2011
Jan 2012
Jul 2012
Jan 2013
Jul 2013
Jan 2014
Jul 2014
Jan 2015
Jul 2015


Reach ID
Date
Relative Controlling Depth (ft)
Jan 2011
Jan 2012
Jan 2013
Jan 2014
Jan 2015

Future Work

- Improve the routing algorithm
  - Improve assumptions
- Investigate sub-regions
- Explore seasonality
- Compare against gages





StoryMap: https://arcg.is/094Lur

Questions?

michael.a.hartman@usace.army.mil