Amendment to 2020 Narrative Operating Plan

Based on the Corps' Appendix 2: On-Site Alternative 2a (Least Environmentally Damaging Practicable Alternative) Project Description

The regulated activity consists of a multi-year phased dredging project associated with a placer gold mining operation within an area known as the Bonanza Channel and is described in the Applicant's report submitted for this project (Yukuskokon Professional Services, LLC. 2020a, 2020b, 2022). As part of the LEDPA review process, the Corps determined that the least environmentally damaging practicable alternative would involve reducing additional impacts associated with the applicant's Case Study proposal and modifying the Reclamation Plan to restore pre-project bathymetry. This Amendment therefore the 2020 Narrative as set forth herein to provide an updated Project Description.

The Bonanza Channel is part of a larger Section 10 waterbody that includes an area known as Safety Sound, which also contains special aquatic sites in the form of vegetated shallows, mudflats, and wetlands comprising an extensive estuarine system in this general vicinity. The project site is also generally adjacent to portions of the Alaska Maritime National Wildlife Refuge (AMNWR). This project would be implemented over a five-year period and involves dredging approximately 4.5 million cubic yards (CY) (estimated bulked volume of 4.82202 million CY) based on 24-hour-per-day operations, processing the materials for gold extraction, concurrently reclaiming the dredged channel, and disposing of the excess processed materials at locations within the immediate area.

During the course of application review, the Corps determined that a civil dawn to civil dusk mining restriction would be imposed to facilitate observation for marine mammals; the applicant intends to seek a modification of this provision based on observation experience, particularly assuming, as expected, no marine mammals are observed during the first mining season. The dawn-to-dusk restriction, by limiting operating hours, will reduce the progress the applicant makes in the mining plan and the total dredged acres in proportion to lost operational hours, meaning that the full five-year mining channel as described in the 2020 Narrative is not likely to be completed. Nevertheless, given the possibility of modifications and other uncertainties, Applicant continued to seek a permit for the full mining channel and the 2020 Narrative plan and footprint except as modified herein to further reduce environmental impacts.

Mining would occur by using a 36-inch-diameter cutterhead attached to a 10-inch diameter suction dredge. Dredged materials would be transferred to a production barge where the materials would be processed for recovery of gold and returned to the channel.

The total area affected by the placement of dredged materials (reclamation and disposal) within waters of the U.S. (WOUS) and Section 10 waters is 159.3 acres (which may be further reduced by operating hours restrictions and other factors). In addition to the dredged areas, which include both a separate access channel (between launch ramp and full-scale mining channel) and the full-scale mining channel, the project includes dredged materials disposal sites (DMDSs) for temporary storage of dredged materials t be used in final reclamation, a launch ramp, man camp, and staging area. DMDS Area C and the DMDS areas to be used in years 2 through 5 of the plan have been adjusted from the 2020 Narrative as described herein. The man camp and staging area would continue to be sited in uplands above the mean high water (MHW) line as set forth in the 2020 Narrative.

The project site is located within ten mining claims secured by the Permittee from the State of Alaska and shown on the enclosed figures as DKSN 29-37, and 39. Twenty-two additional mining claims are held by the Permittee generally to the east of the project site, but no activities within those claims has been included under this permit. From the man camp area, the Permittee would dredge a 10-foot-deep access channel that would extend from the boat ramp to the full-scale mining channel (see attached figures). The full-scale mining channel extends generally east-west across the project site. This channel would be dredged/mined sequentially over a five-year period during the summer mining season between May 1st and November 1st while the work area is free of ice and can be worked by dredging/processing equipment. At the end of the operational season, the Applicant would cease operations and shut down and secure the man camp until the following operational season.

Dredged materials would either be used for concurrent reclamation within the dredged channel or temporarily storied (excess materials) at various locations in the project area. Excess materials dredged from the full-scale mining operations would be placed within shallow water areas approximately adjacent to the dredged areas up to the mean lower low water (MLLW) line. Four DMDSs (approximately 46.7 acres total) would be used (see attached figures and Table A below). The materials stored in the DMDSs would be temporarily stored and used for reclaiming the two access channels at the end of the project. Most of the dredged materials will be used to concurrently backfill the dredge channel to restore the approximate pre-dredging bathymetry except for a temporary access channel extending ten feet below the MHW and along the entire mining channel and the access channel between the mining channel and the man camp/boat ramp. The two access channels would be backfilled to pre-project bathymetry by the end of project operations.

Table A. Estimated Dredge and Fill Volumes and Acreage[1]

Item Description	Acres	Storage Capacity (CY)	Dredged Volume (CY)	Bulked Dredged Volume* (CY)
Access trench	4.2	0	33,200	35,690
Year 1	21.7	957,346	900,000	964,404
Year 2	21.7	957,346	900,000	964,404
Year 3	21.7	957,346	900,000	964,404

[1] This replaces Table 5-7 in the 2020 Narrative.

Year 4	21.7	957,346	900,000	964,404
Year 5	21.7	957,346	900,000	964,404
Dredge Disposal Site A	14.6	13,666		
Dredge Disposal Site B	7.1	7,019		
Dredge Disposal Site C	18.7	23,008		
Dredge Disposal Site Years 2-5	6.3	7,356		
Totals	159.3	4,837,779	4,533,200	4,857,710
*Assuming 1.075 bulking factor				

The modification of the Reclamation Plan to restore original bathymetry enables a significant reduction in DMDS areas disturbed by the project because more materials can be returned to the mining channel,[2] though there remains an ongoing need to use these areas to segregate surface materials.

The access channel between the launch ramp and the full-scale mining area would be maintained at ten feet deep and would be approximately 2,200 feet long and 85 feet wide. The full-scale trapezoidal mining channel would be 31 feet deep with a top width of about 360 to 365 feet and a bottom width of about 200 feet. The total length of this mining channel is approximately 13,000 feet. A ten-foot-deep access channel would be maintained along the entire length of the full-scale mining channel after initial reclamation to allow for access to the full-scale mining channel by dredging equipment.

At the completion of mining operations, the two access channels would be reclaimed to the pre-project bathymetry, meaning that benefits are no longer claimed for modifications to the bathymetry as presently set forth in §§ 4.11 of the 2020 Narrative and in the existing Reclamation Plan.

Equipment proposed for the project includes a single engine dredge vessel (dimensions: 50 feet long x 24 feet wide) with a 36-inch diameter Vosta cutterhead, a 10-inch diameter dredge nozzle, two small tender boats (dimensions: 25 feet long x 12 feet wide) and a processing barge (dimensions: 64 feet long x 40 feet wide). The dredge vessel would be connected to the processing platform by a 300 to 600-foot-long floating pipe.

The total surface area that would be affected by the placement of dredged material is 159.3 acres or less, occurring over a five-year period. Although the impact duration could be limited, because of the period of time expected for special aquatic sites to recover with regard to their respective functions and services (which resource agencies

[2] Site A remains as depicted in Figure 5-20 of the 2020 Narrative. Sites B, C, and Years 2-5 have been modified as indicated in the attached Figures 1-4.

A revised Reclamation Plan will be provided replacing Figure 9-5 of the Plan, which showed additional sites associated with the Case Study Alternative (Sites D-H, Plan Figures A-9 to A-14); those sites will be eliminated along with Site J (Plan Figure A-15). Monitoring and other aspects of the Plan will remain unchanged.

have claimed could be as much as two or more years notwithstanding the applicant's test dredging results) the Corps considers the impact duration permanent. The project would not result in the permanent loss of WOUS or Section 10 waters. Rather the impacts would occur in the form of temporary loss of functions and services from the type conversions between different types of WOUS/special aquatic sites, for example, conversion of vegetated shallows to mudflats from dredge disposal. The impact footprint contains vegetated shallows and mudflats. Wetlands are limited to adjacent areas outside the project footprint.

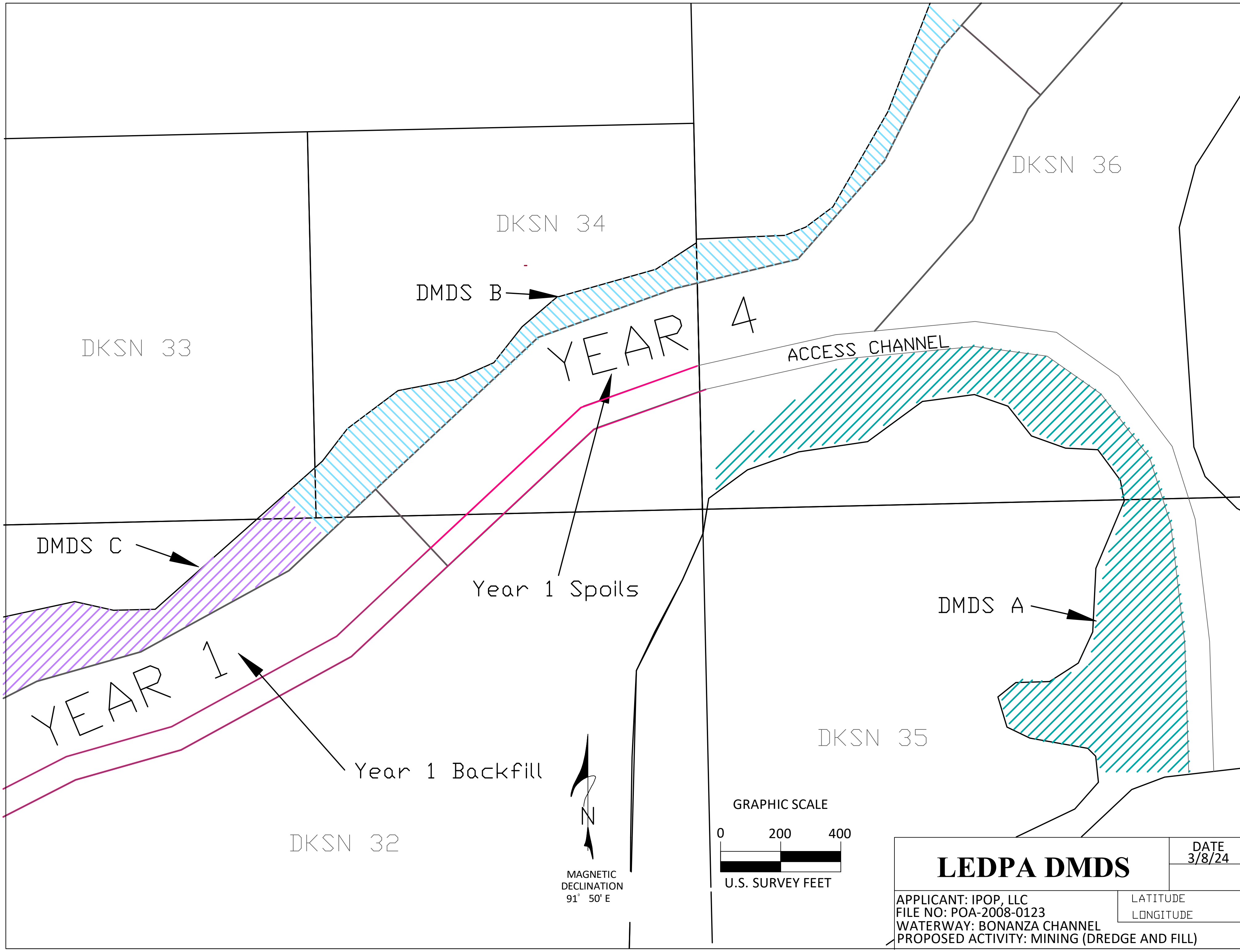
Except as modified by this Amendment, the provisions of the 2020 Narrative will continue to govern project operations.

References:

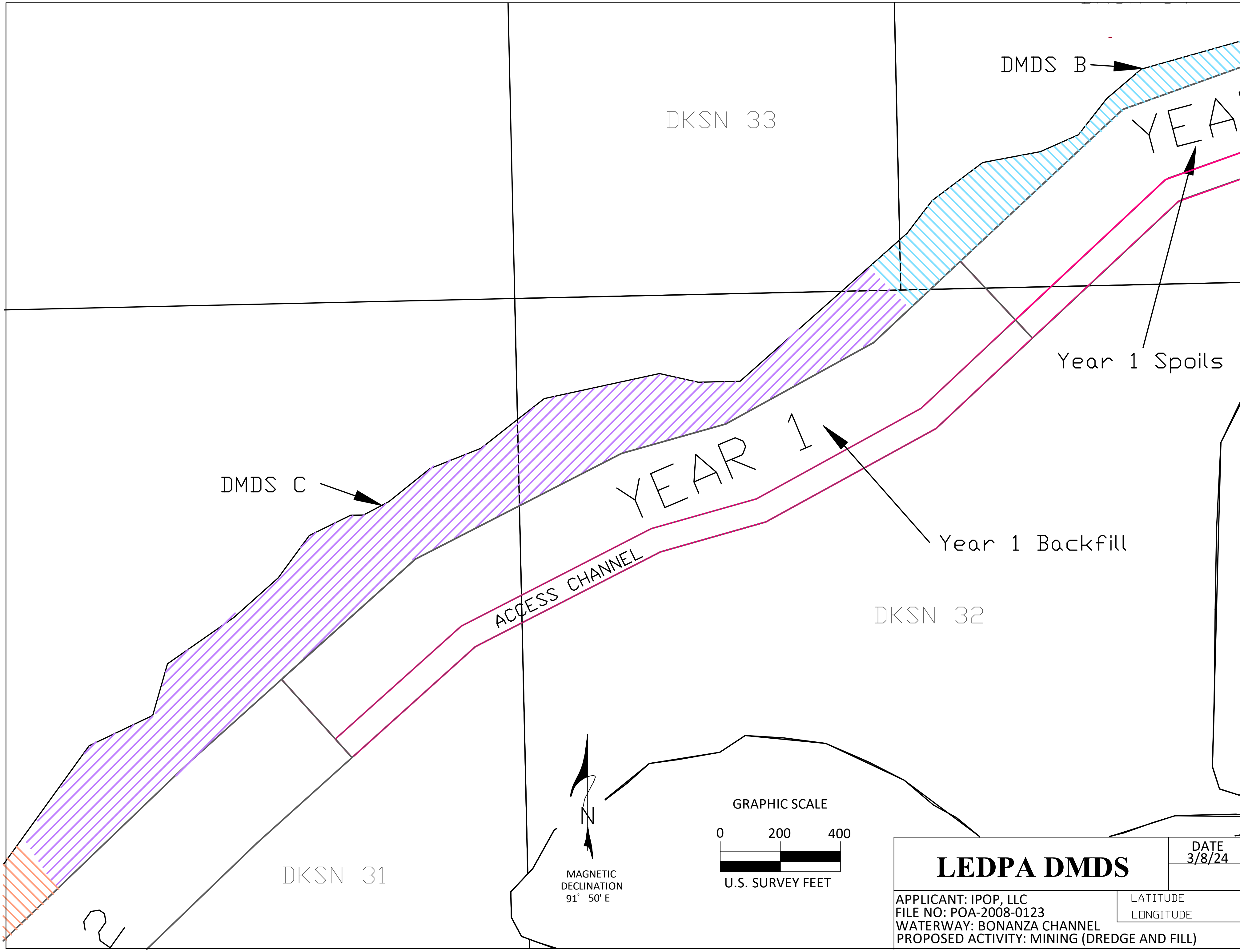
Yukuskokon Professional Services, LLC. 2020a. 2020 Narrative and Plan of Operations for the Bonanza Channel Placer Project, Nome, Alaska, IPOP LLC. Prepared by Yukuskokon Professional Services, LLC. For IPOP, LLC. Wasilla, AK.

Yukuskokon Professional Services, LLC. 2020b. July 3. POA-2018-00123, APMA 2875 – 2020 Individual Permit Application Additional Information Requested. Wasilla, Alaska.

Yukuskokon Professional Services, LLC. 2022. *Bonanza Channel Placer Project near Nome, Alaska, Reclamation Plan Revision 2*. March. Prepared by Yukuskokon Professional Services, LLC. For IPOP, LLC. Wasilla, AK. (to be revised by permittee after permit issuance consistent with the Amended Project Description)



DKSN 34
DKSN 36
DKSN 33
DMDS B
YEAR 4
ACCESS CHANNEL
DMDS C
Year 1 Spoils
DMDS A
YEAR 1
Year 1 Backfill
DKSN 35
N
GRAPHIC SCALE
0
200
400
U.S. SURVEY FEET
MAGNETIC
DECLINATION
91° 50' E
DKSN 32
LEDPA DMDS
DATE
3/8/24
APPLICANT: IPOP, LLC
FILE NO: POA-2008-0123
WATERWAY: BONANZA CHANNEL
PROPOSED ACTIVITY: MINING (DREDGE AND FILL)
LATITUDE
LONGITUDE



LEDPA DMDS

DATE 3/8/24

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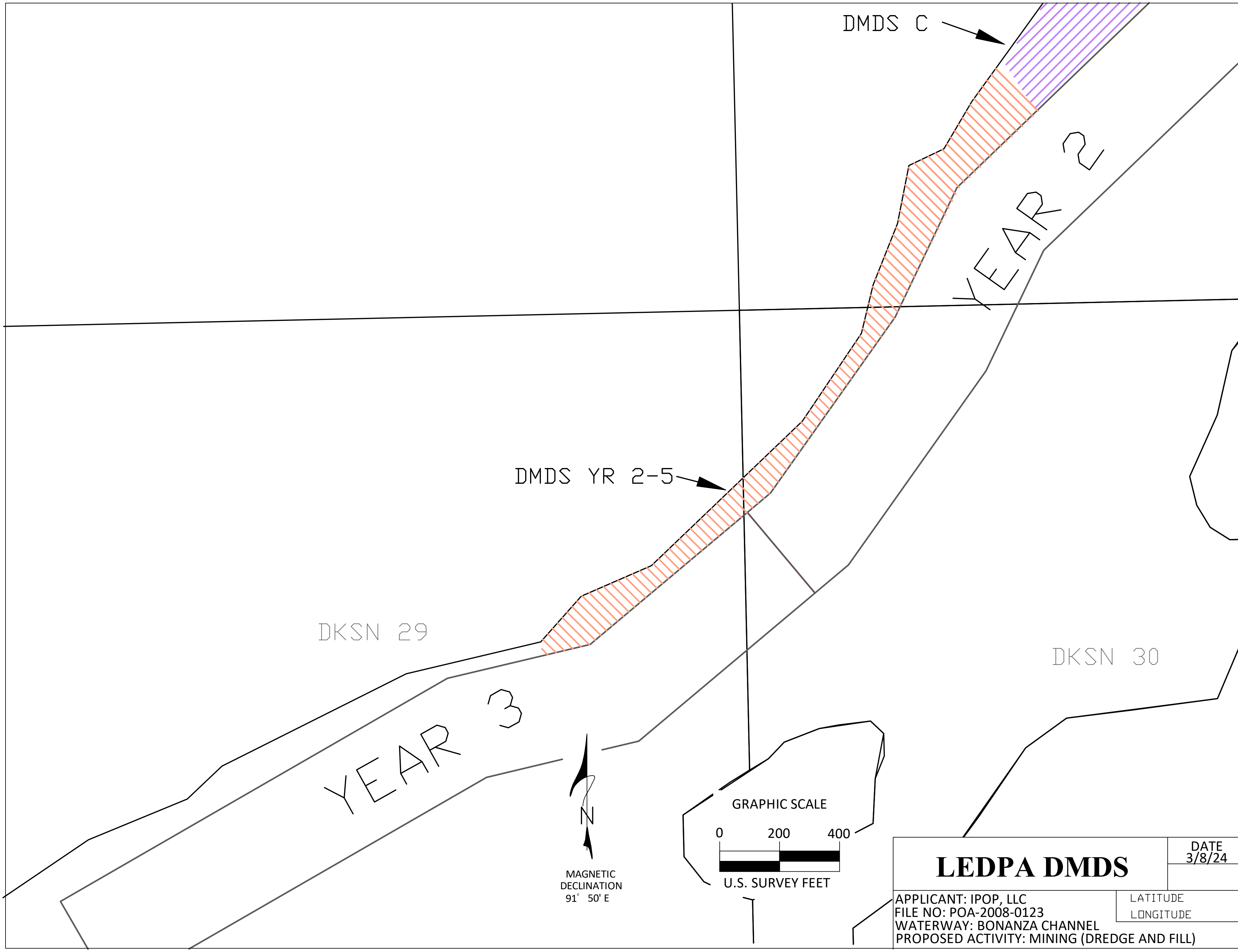
LONGITUDE

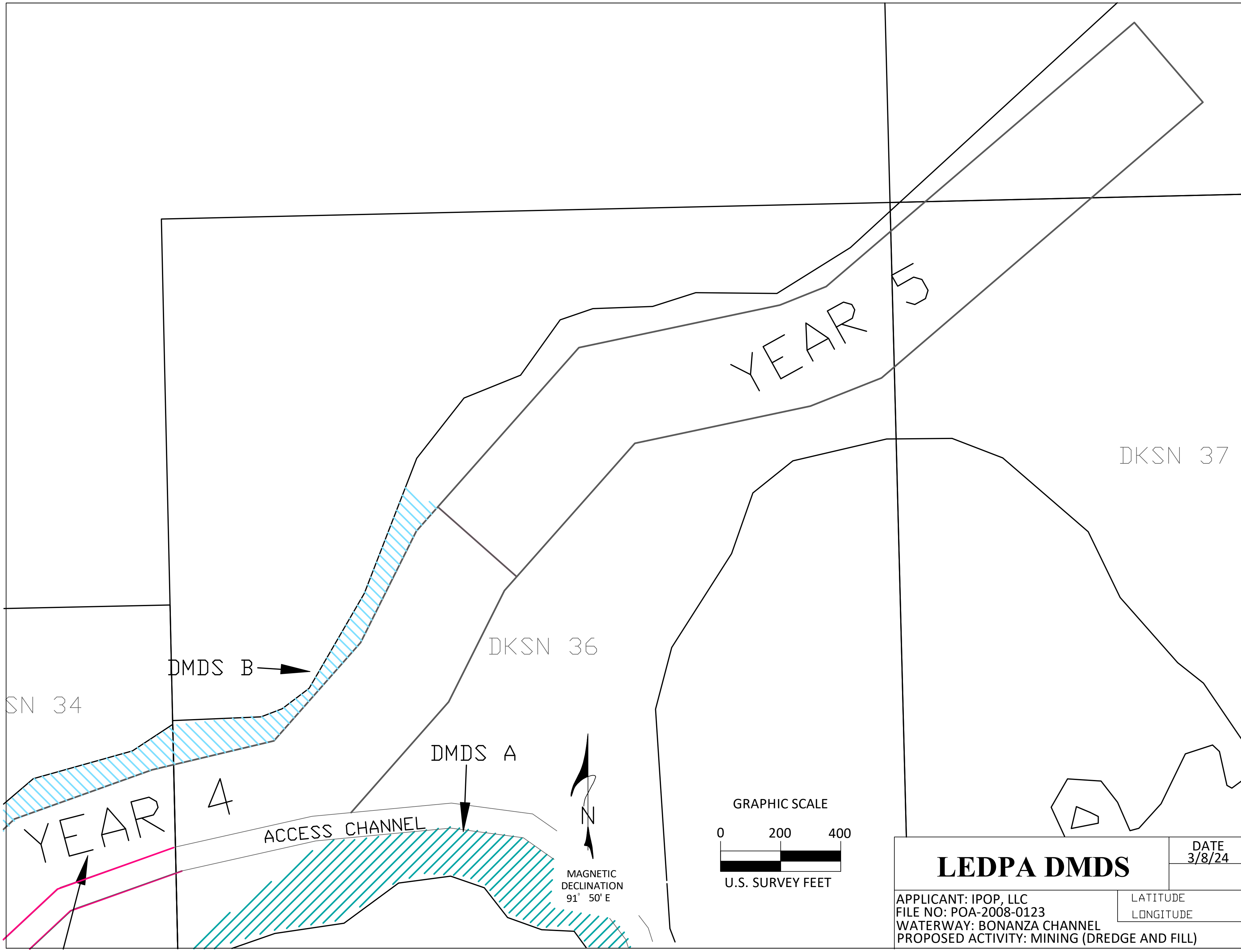


LEDPA DMDS

DATE 3/8/24

LATITUDE
LONGITUDE

APPLICANT: IPOP, LLC
FILE NO: POA-2008-0123
WATERWAY: BONANZA CHANNEL
PROPOSED ACTIVITY: MINING (DREDGE AND FILL)


YEAR 5
DKSN 37
DKSN 36
SN 34
DMDS B
DMDS A
YEAR 4
ACCESS CHANNEL
N
MAGNETIC
DECLINATION
91° 50' E
GRAPHIC SCALE
0
200
400
U.S. SURVEY FEET
LEDPA DMDS
DATE
3/8/24
APPLICANT: IPOP, LLC
FILE NO: POA-2008-0123
WATERWAY: BONANZA CHANNEL
PROPOSED ACTIVITY: MINING (DREDGE AND FILL)
LATITUDE
LONGITUDE

Bonanza Channel Environmental Baseline Studies – Updated Submerged Aquatic Vegetation Sampling

August 2021, David Eilers M.S.

Additional surveying of the submerged aquatic vegetation was conducted by David Eilers on August 3, 2021.

Study Area

The Bonanza Channel between 64.50636^0 N, 164.61610^0 W and 64.52649^0 N, 164.48668^0 W (Claims DKSN 27- DKSN 40) was examined for the characterization of bathymetry and submerged aquatic vegetation community. Locating at the eastern extent of Safety Sound, the Bonanza Channel receives inflow from the Bonanza River and several intermittent streams/flow channels along the northern shores of the channel. The region has access to Norton Sound through two inlets, 4.2 miles southwest in Safety Sound and 4.25 miles northeast near the mouth of the Solomon River. An overview of the study area (green) and claims (yellow) are shown in Figure 1 as well as the proposed Access Channel and 5-Year Mining Channel.

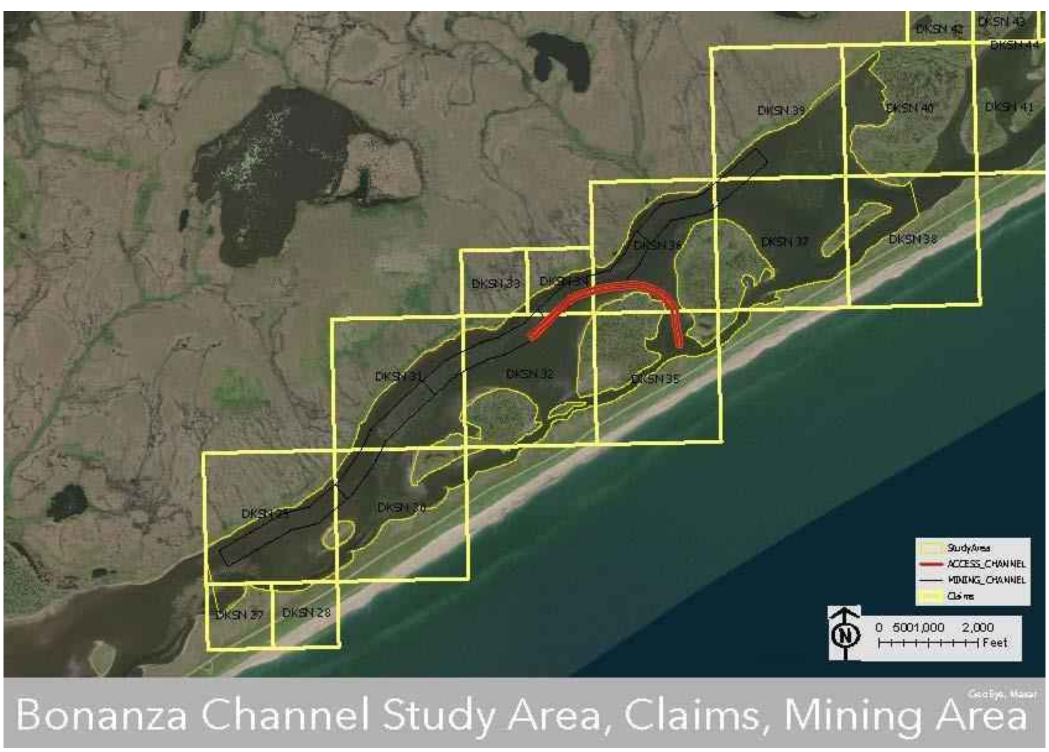


Figure 1 Overview of the Bonanza Channel Study Area east of Safety Sound

Sonar Derived Submerged Aquatic Vegetation Mapping

The Bonanza Channel was mapped using a flat bottom Jonboat with a Lowrance Elite 7 Ti GPS echosounder with a remote Lowrance Point-1 GPS antenna and Totalscan transducer. Using a mounting bracket from a trolling motor, the Totalscan transducer and Point-1 GPS antenna were mounted on opposite ends of a PVC pole. This allows for the highest correlation between the GPS data and the sonar data. Transects were orientated NNW – SSE throughout the study area with approximately 200 ft spacing. The boat and sonar limits for shallow water were approximately 1.75 ft of depth. In waters shallower than this depth the sonar signal becomes difficult to interpret due to backscatter and the physical grounding of the motors lower unit.

The SAV survey was completed on August 3, 2021 specifically targeting fuller tides to allow the highest amount of navigable surface area. Water levels were extremely elevated at the time of the assessment due to a prior weather system. The collected sonar data was processed through SonarTRX software where the depth value was reclassified and erroneous data was removed. The dataset was further analyzed to calculate the height of the submerged vegetation community. A total of 291,578 individual points were collected containing valid GPS, depth and SAV height values. The data was then processed in ESRI ArcMap 10.6 to create a height of vegetation raster of the study area using the Natural Neighbors algorithm. The results of the SAV mapping is shown in Figures 2 through 5 below. The 2021 aquatic vegetation survey showed an increase in the percentage of the surface area of the study area covered by SAV of 9% (73.9% in 7/2020, 82.9% in 8/2021) as well as an increase in the percentage of the volume of the study area occupied by SAV 13.3% (23.8% in 2020, 37.1% in 2021). Comparison of the 2020 and 2021 SAV sampling results are shown below in Table 1.

Table 1 Summary results of 2020 and 2021 SAV assessment in Bonanza Channel

Parameter	2020 Data	2021 Data
Study Area (square feet)	30,574,677	30,574,677
SAV surface area (square feet)	22,601,631	25,353,177
SAV surface area percentage	73.9%	82.9%
SAV volume (cubic feet)	7,271,392	11,353,373
SAV volume percentage	23.8%	37.1%
Mean SAV Height (feet)	0.51	0.56
Maximum SAV Height (feet)	3.6	2.75

Figure 6 details the change in SAV canopy height between the 2020 and 2021 datasets. This figure indicates where the SAV canopy height has increased (Green to Red colors) and where the canopy height has decreased (Blue to Purple colors). The minimum change in height between years to be included was 0.2 feet.

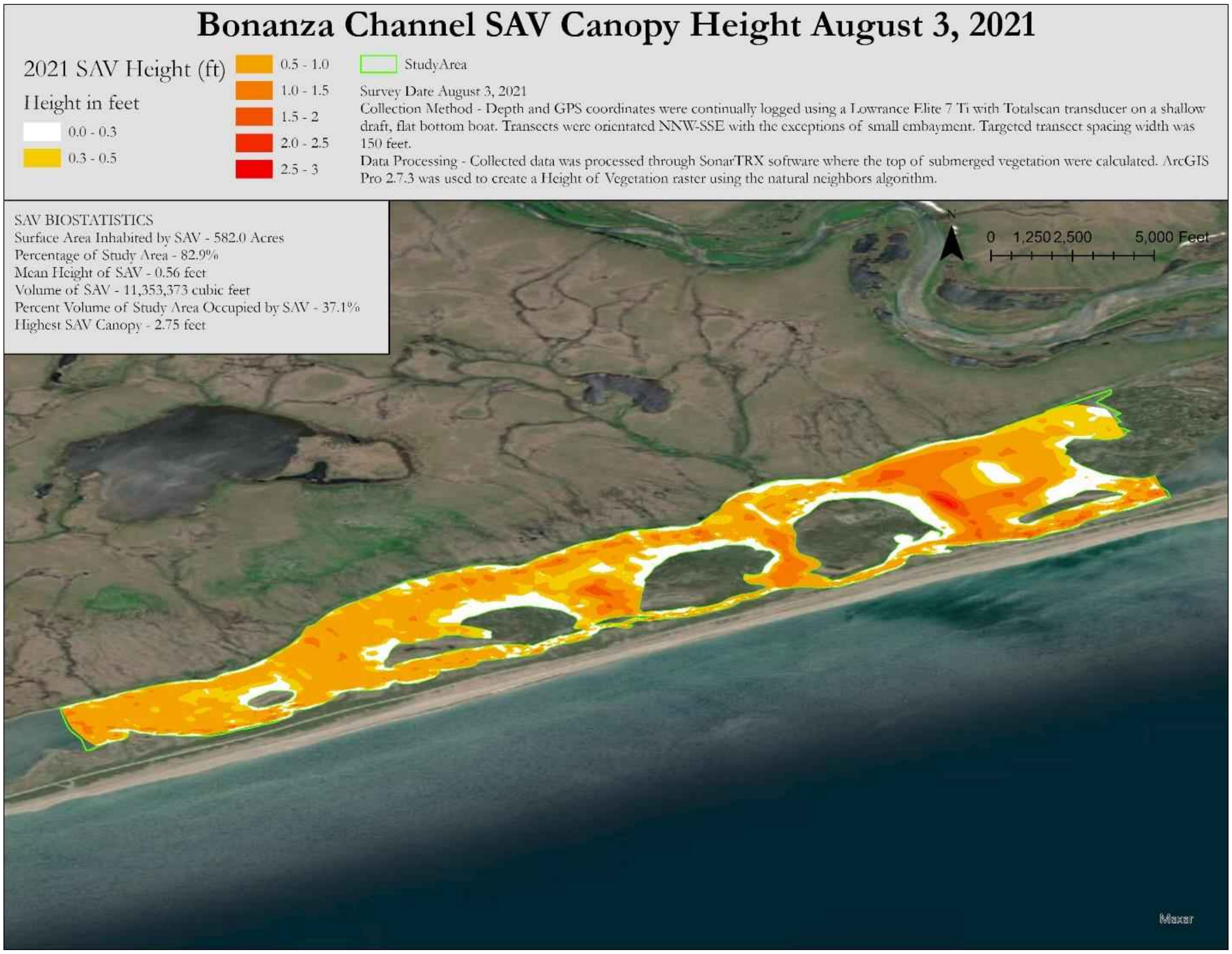


Figure 2 Overview of 2021 Bonanza Channel SAV canopy height data

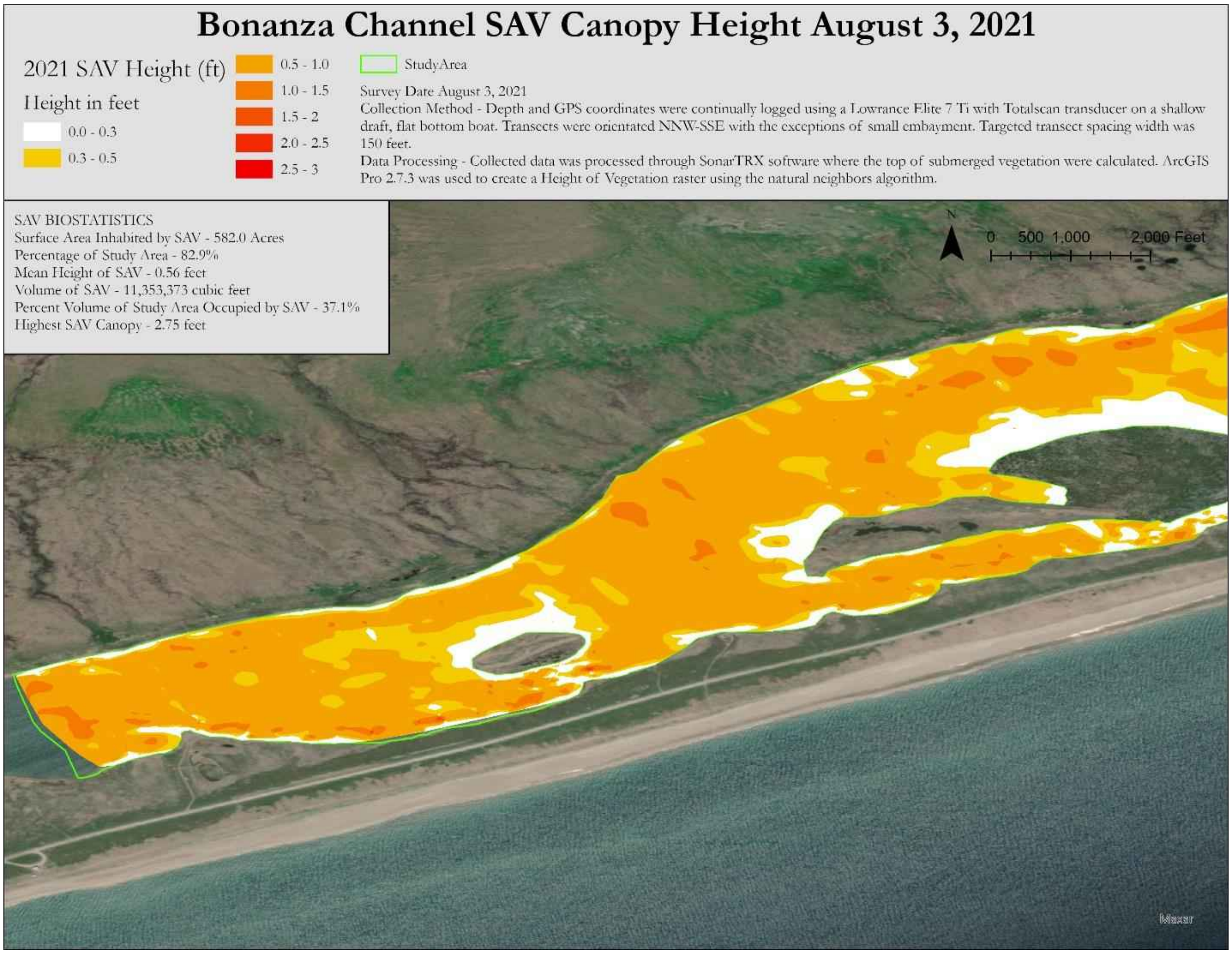


Figure 3 Western extent of 2021 Bonanza Channel SAV canopy height data

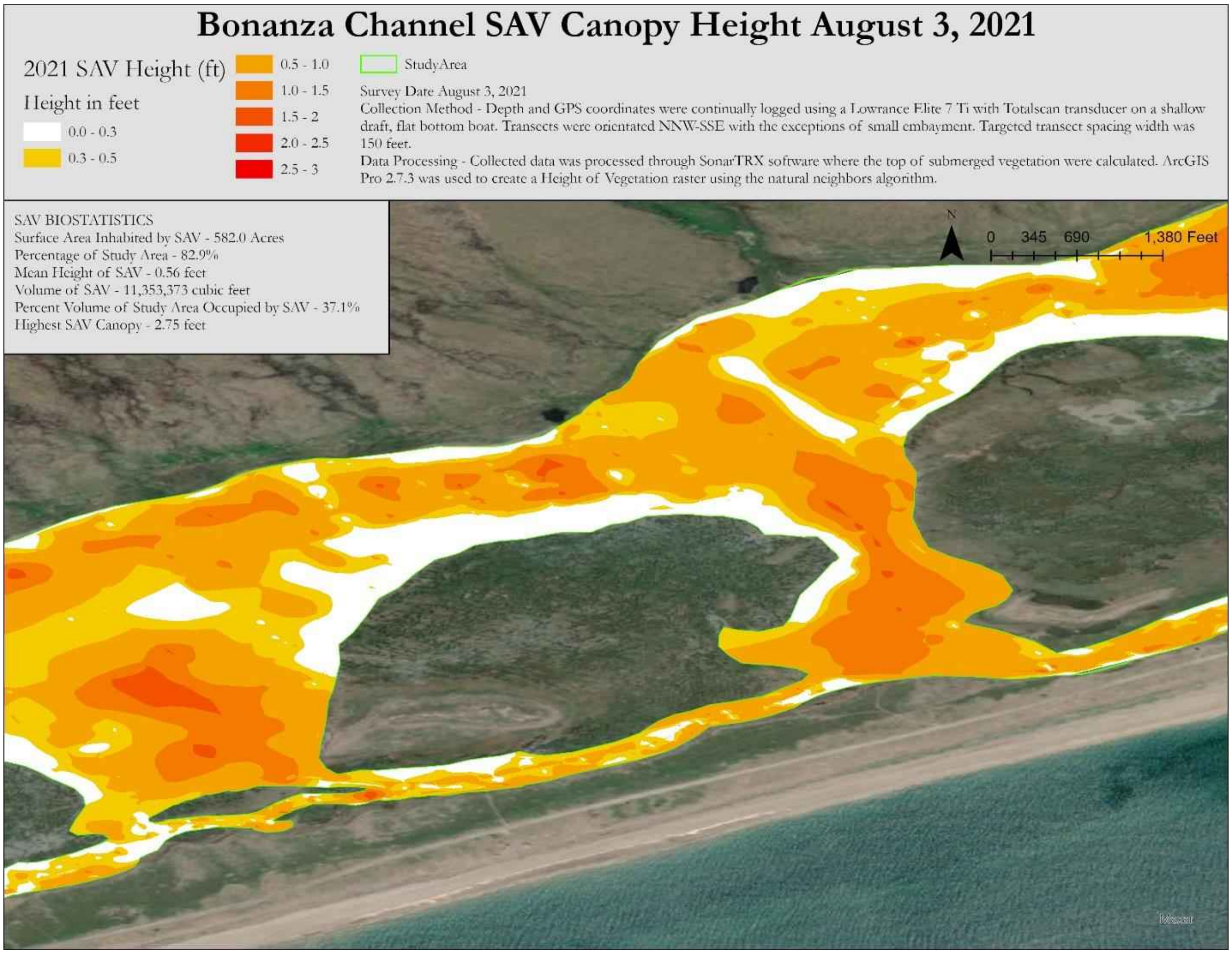


Figure 4 Central portion of 2021 Bonanza Channel SAV canopy height data

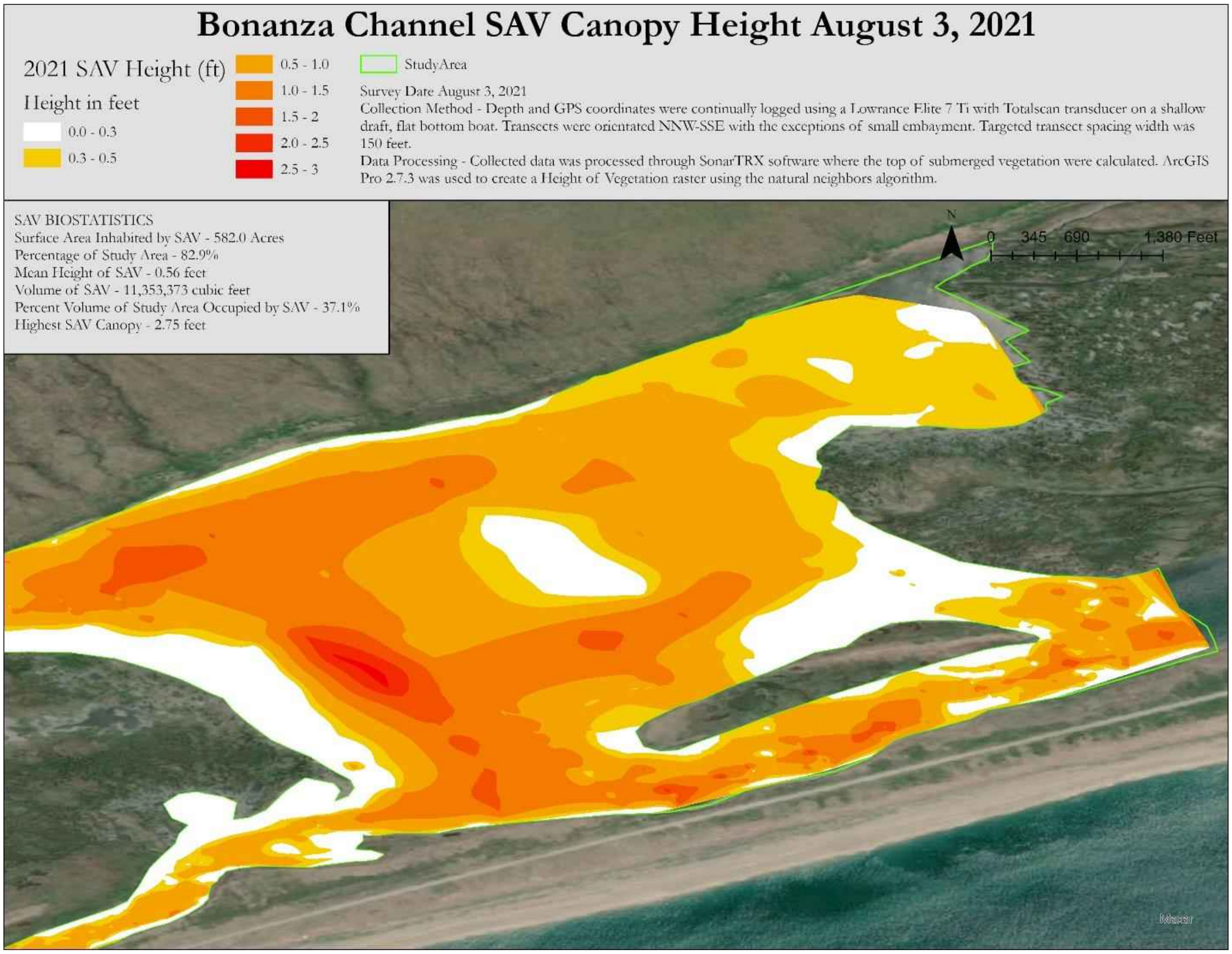


Figure 5 Eastern extent of 2021 Bonanza Channel SAV canopy height data

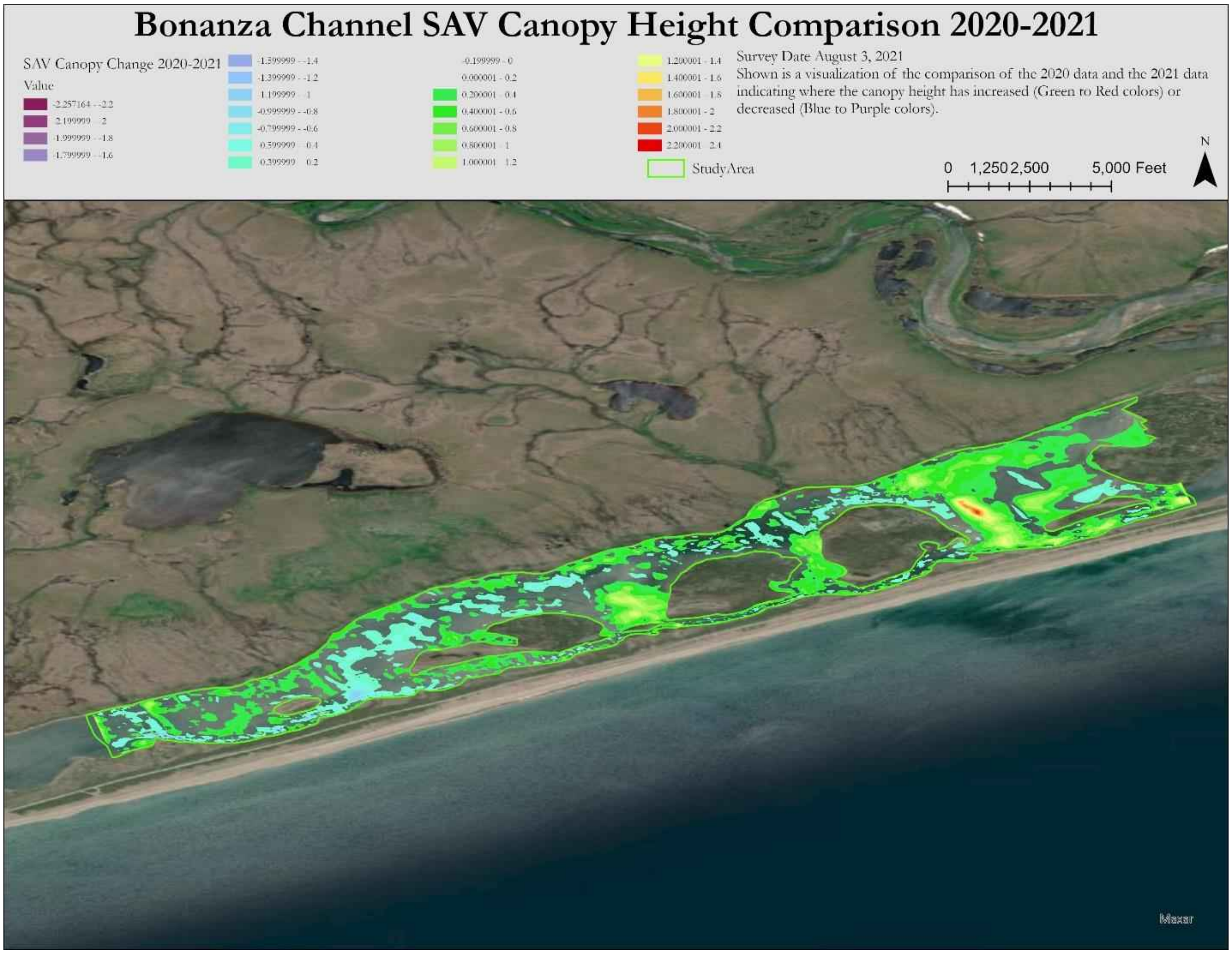


Figure 6 Comparison of Canopy Height between 2021 and 2020 datasets

Species Composition

Data collection using the no impact methods utilized in 2020, which consisted of randomly deployed 0.25m^2 quadrat and underwater camera, was not possible during the timeframe of 2021 sampling due to a drastic reduction in water clarity caused by the preceding weather events a week prior. Due to low image quality of the resulting underwater photographs, alternative manual sampling of submerged aquatic vegetation was conducted without an ADFG Aquatic resource Permit. All future activities will be permitted as appropriate. The alternative sampling device utilized was a vegetation rake (2- standard 14" garden rake heads attached back to back deployed on a rope). The device is randomly thrown within 20 feet of the boat, allowed to contact the bottom, and then retrieved. Species present and dominance in the sample are recorded and a qualitative measure of the density is estimated. Density values were recorded using the same scale as the Modified Braun-Blaquet method. Table 2 shows the values and descriptions of the Modified Braun-Blanquet and the manual rake method.

Table 2 Description and comparison of values used in the Modified Braun-Blanquet method and the Manual SAV Rake method

Value	Modified Braun-Blanquet Description	Manual Rake Method Description
0	No vegetation present	No Vegetation Present on rake
0.1	Solitary Shoot, < 5% Coverage	Solitary Shoot present on rake
0.5	Few shoots (<5), > 5% Coverage	Few Shoots present on rake (<5) moderate coverage of rake
1	Many shoots, < 5% Coverage	Many shoots present on rake, low coverage of rake
2	Many shoots, 5-25% Coverage	Many shoots, some(2-3) teeth of rake have abundant vegetation
3	Many shoots, 25-50% Coverage	Many shoots, 4-8 teeth of rake have abundant vegetation
4	Many shoots, 50-75% Coverage	Many shoots, Majority of rake teeth have abundant vegetation
5	Many shoots, 75-100% Coverage	Many shoots, Nearly all of rake with abundant vegetation/ overflowing

The method is meant to replicate the photograph and Modified Braun-Blanquet quadrat method used in 2020 as close as possible given the visibility restrictions. The samples were taken along 32 transects primarily arranged NNW to SSE with some variations to capture addition data along gradients, channels and areas of interest. Along these transects, samples were taken every 50 meters. The sampling transects and quadrat points will be sampled annually during the mid-end growing season to monitor variations in coverage and species distribution moving forward.

A total of 230 samples were taken along the 32 transects during the August 2021 sampling event shown below in Figure 7 through 10. The 2021 SAV sampling showed *Zannichellia palustris* being dominant in 83 of the 230 compared to 48 for *Ruppia spp*., the next highest species in terms of samples where they were dominant. Table 3 details the summary of the 2021 SAV samples. No new species were observed in the 2021 dataset. The data collected shows variation in the dominant species observed and the distribution of those species. The 2021 data indicates expansion of the abundance of *Zannichellia palustris* and reduction in *Stuckenia pectinatus* and *Ruppia spp.* across the study area*.* The annual growth form and environmental stressors provide one pathway that leads to dynamic variation in the species coverage and dominance while maintaining the same species diversity in the region. *Zostera marina* was documented in additional locations during the 2021 survey with the location identified in 2020 continuing to remain.

Table 3 Summary of species present and dominance in the 230 2021 manual SAV samples and comparison to 2020 sampling efforts

Parameter	Filamentous Algae	No Vegetation	*Ruppia spp.*	*Stuckenia pectinata*	*Zannichellia palustris*	*Zostera marina*
# of samples present 2021	109	34	109	102	158	4
% of total samples present 2021	47.4%	14.8%	47.4%	44.3%	68.7%	1.7%
% of total samples present 2020	4.8%	1.1%	9.0%	98.2%	19.6%	<0.1%
# of samples dominant 2021	26	34	48	38	83	1
% of total samples dominant 2021	11.3%	14.8%	20.9%	16.5%	36.1%	0.4%
% of total samples dominant 2020	0%	1.1%	2.1%	92.5%	4.3%	0%

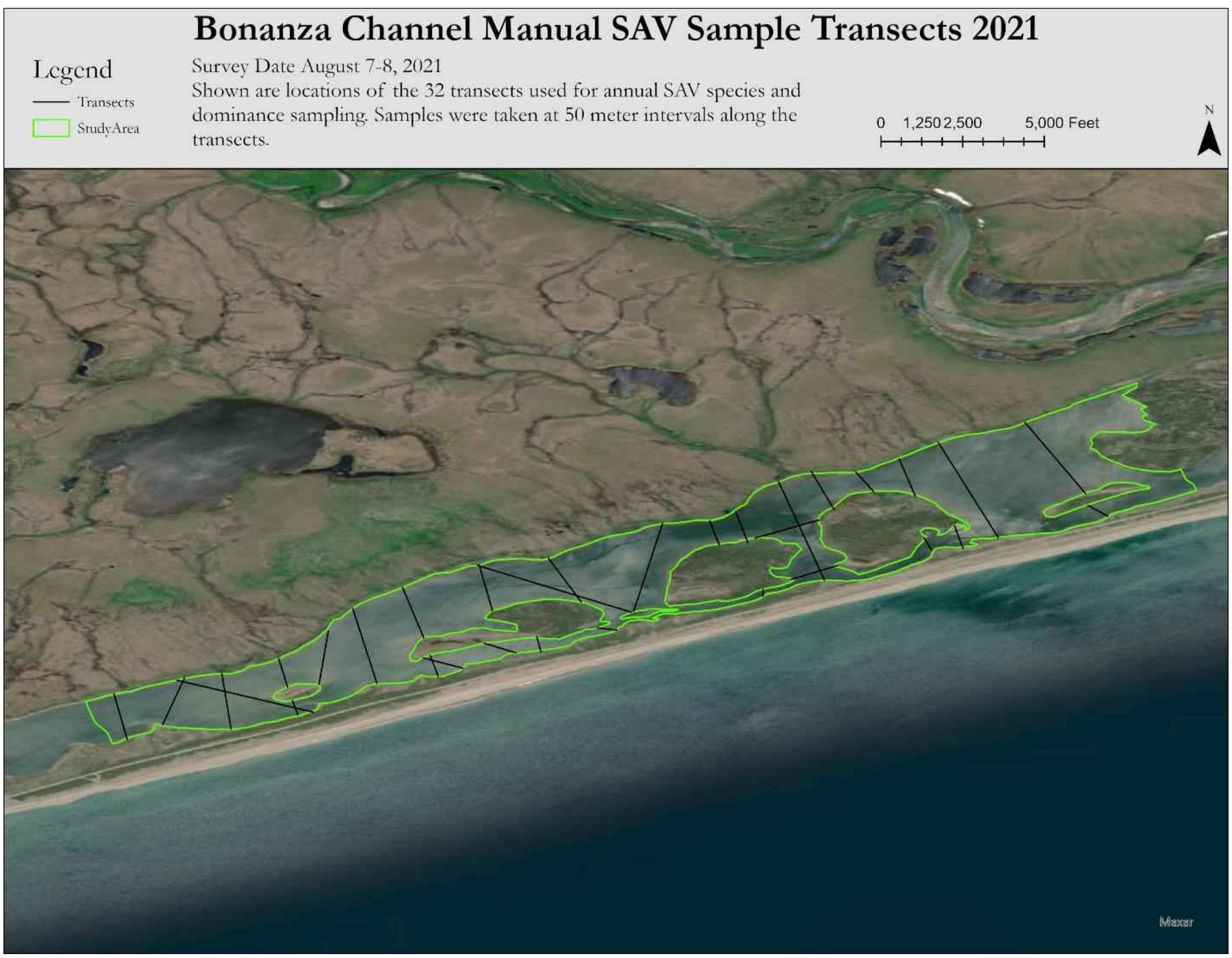


Figure 7 2021 Manual SAV Sampling Transect Locations

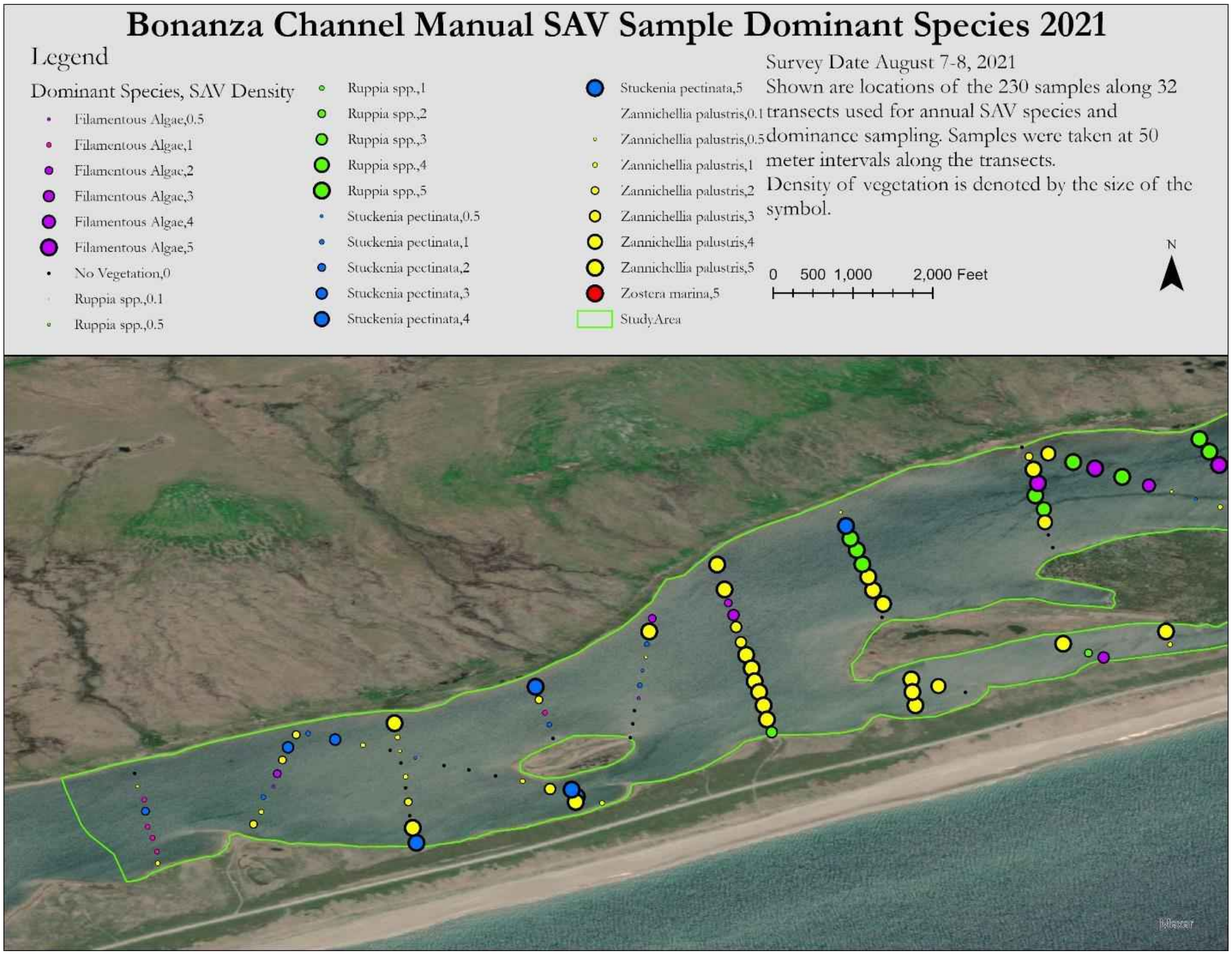


Figure 8 SAV dominant species and density for the western portion of the 2021 data

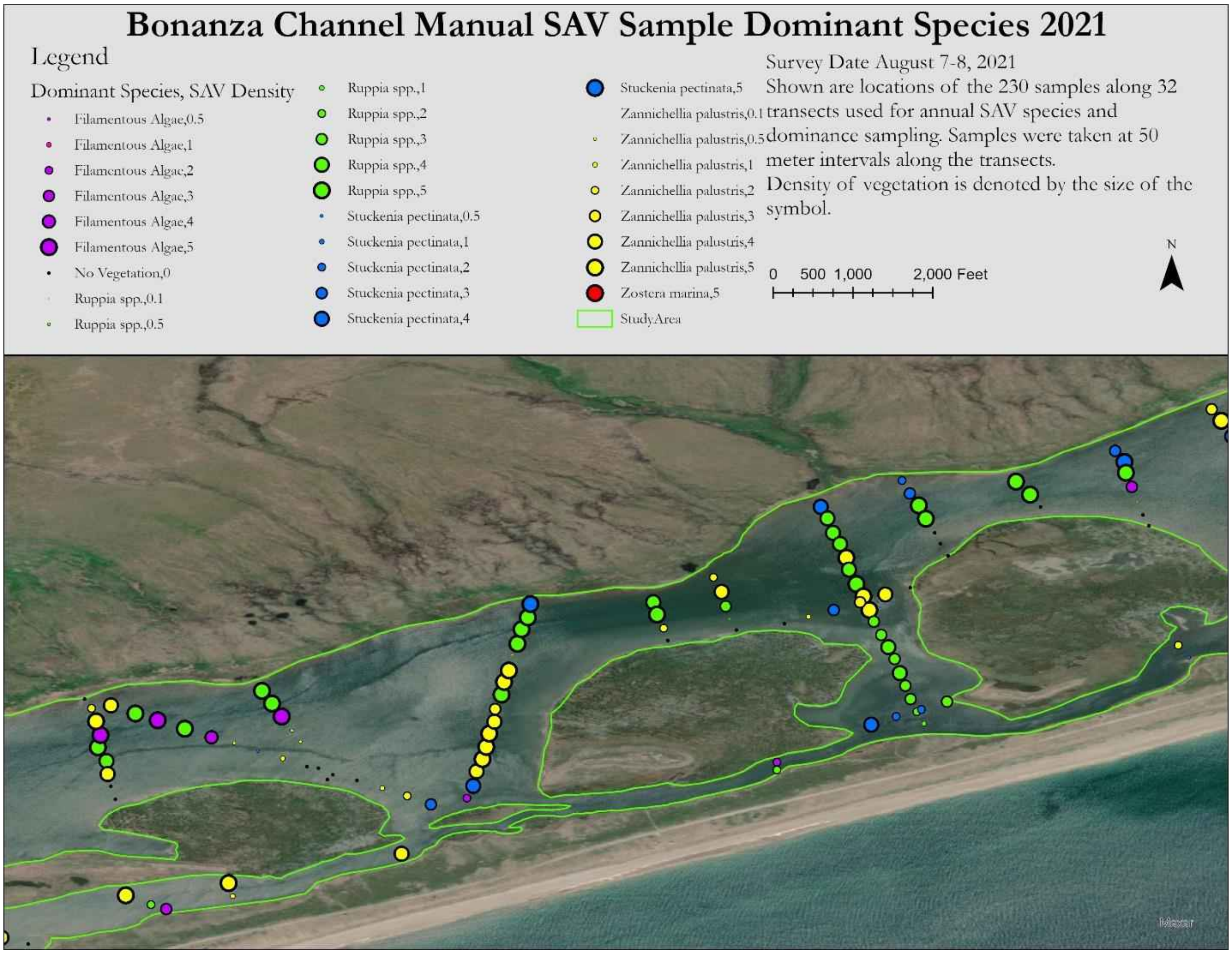


Figure 9 SAV dominant species and density for the central portion of the 2021 data

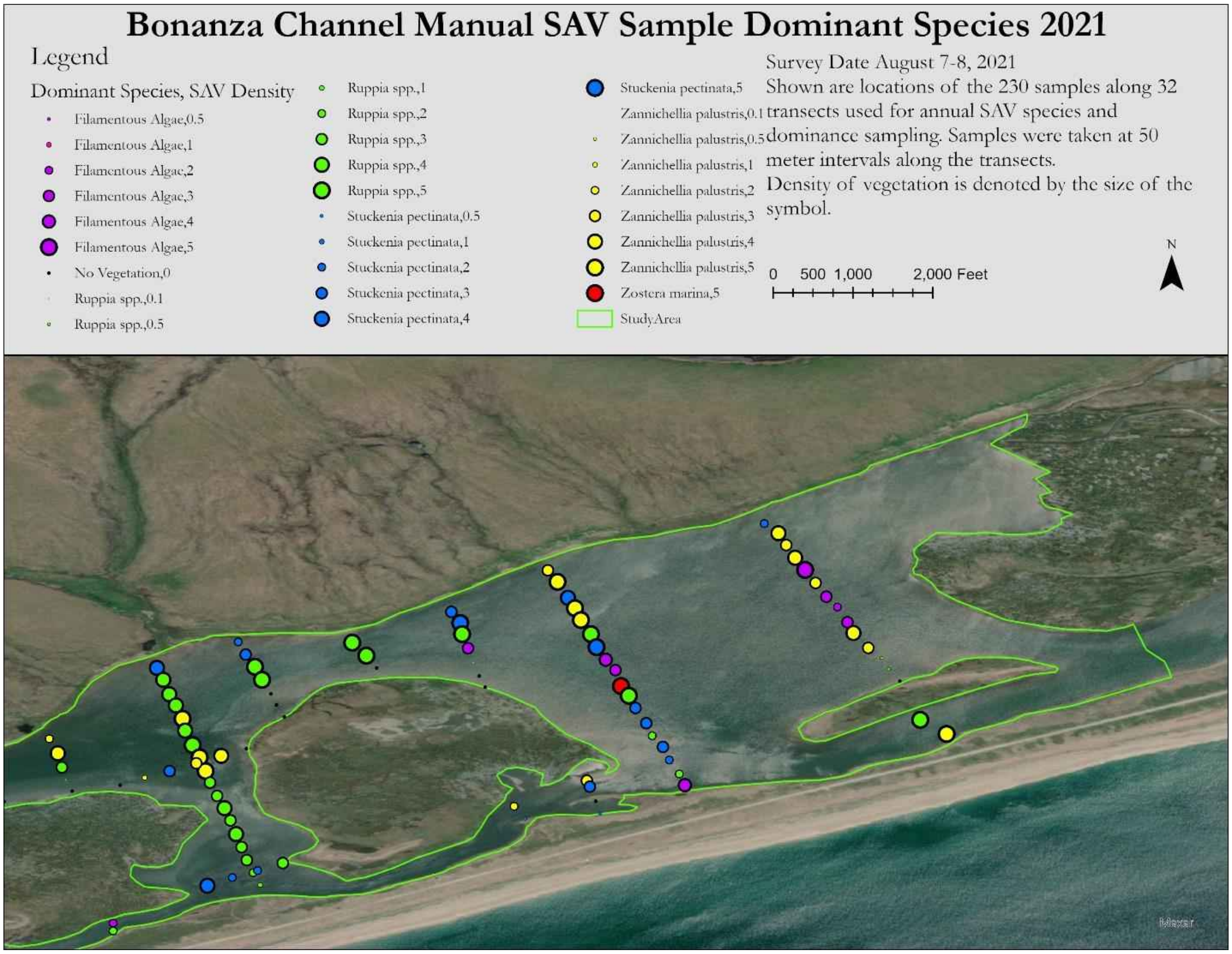


Figure 10 SAV dominant species and density for the eastern portion of the 2021 data

Benthic Invertebrates

To further the results of the 2020 preliminary benthic invertebrate study, the 2021 effort was focused on classifying the benthic invertebrate community of areas with and without SAV present to help document baseline conditions to guide restoration efforts. The sampling method involved the use of a D-frame Dip net with No. 30 mesh (approximately 600 µm) and handle marked in 0.1-m increments to collect macroinvertebrates. A total of 10 sweeps were collected for each habitat site with a sweep being defined as a 0.3 m x 0.5 m area (approximately the width of the D-frame dip net over a 0.5 m area). In the vegetated samples the dip net was situated with the flat edge of the net against the sediment and the SAV was hand agitated with 10 cm of the net to release macroinvertebrates using the above ground biomass of SAV while slowly moving the net along a 0.5m sample swath into the current (if available). In the bare sediment, the flat edge of the net was placed against the sediment and the upper 10 cm of sediment was agitated by hand with a lifting motion within 10 cm of the net to release macroinvertebrates and capture them. Each 0.5m sweep was agitated three times to ensure consistent and complete collection of macroinvertebrates. For each habitat, the 10 collected samples were homogenized and then randomly subsampled using a 5cm x 5cm gridded tray. Each selected grid was further subsampled in a gridded 1cm x 1cm petri dish. The 1cm^2 grids were randomly selected and inspected for macroinvertebrates under a Lecia Dissecting Microscope. All macroinvertebrates observed were removed and placed in a collection vial. The selection of 5cm^2 and 1cm^2 grids continued until approximately 150 organisms were removed. Two subsample aliquots were created for each habitat. Taxonomic identification of collected organisms were enumerated and identified by Wood PLC in Newberry, Fl. The locations of the macroinvertebrate collections are shown in Figure 11 below.

The macroinvertebrate community in the bare sediment samples consisted of 9 species combined which were heavily dominated by Chironomids. The macroinvertebrate samples from the vegetated areas were also dominated by Chironomids but to a lesser extent and contained 13 species combined. The detailed identification results are shown in Table 4. Several descriptive metrics were calculated from the collected data shown in Table 5.

Table 1. Phylogenetic Taxonomic List and Abundances for Alaska SCI Samples. Based on raw data not collapsed data.

Phylum	Subphylum	Class	Subclass	Order	Family	Taxa	Bonanza S1	Bonanza S2	Bonanza V1	Bonanza V2	Taxa Notes	Reference
Annelida		Clitellata	Oligochaeta	Enchytraeida	Enchytraeidae	Enchytraeidae spp.	4	4				
Mollusca		Bivalvia	Autobranchia	Cardiida	Tellinidae	*Macoma* spp.				2		
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda		Senticaudata spp.			2		Suborder	Lowry & Myers, 2017
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridae	*Gammarus setosus*			2			
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Anisogammaridae	*Eogammarus confervicolus*	7	6	12	30		
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Mysida		Mysida spp.			3			
Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Mysida	Mysidae	*Neomysis mercedis*			26	30		
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	Chironomidae spp.		1	1	1		
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	Orthocladiinae spp.			1		Subfamily	
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	Chironomini spp.	1	1		1	Tribe	
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	*Chironomus* spp.	135	142	103	80		
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	*Tanytarsus* spp.	4	2				
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	*Pentaneura* spp.	1					
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	*Rheocricotopus* spp.	2	1	1	3		
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Chironomidae	*Cricotopus* or *Orthocladius*		1	3	1		
Arthropoda	Hexapoda	Insecta	Pterygota	Diptera	Ceratopogonidae	*Culicoides* spp.				1		

Table 4 Identification and enumeration of Bonanza Channel Macroinvertebrate samples

Table 5 Statistics and Diversity Metrics for Bonanza Channel Macroinvertebrate Samples

Parameter	Bonanza S1	Bonanza S2	Bonanza V1	Bonanza V2
Total Number of Taxa - Raw Data	7	8	10	9
Total Number of Individuals	154	158	154	149
Margalef's Richness (d)	1.19	1.38	1.79	1.60
Pielow's Evenness Index (J')	0.29	0.24	0.49	0.57
Shannon's Diversity Index (log_e)	0.57	0.50	1.13	1.25
Shannon's Diversity Index (log_2)	0.82	0.72	1.63	1.80
Shannon's Diversity Index (log_{10})	0.25	0.22	0.49	0.54
Simpson's Diversity Index (1-λ')	0.23	0.19	0.52	0.63

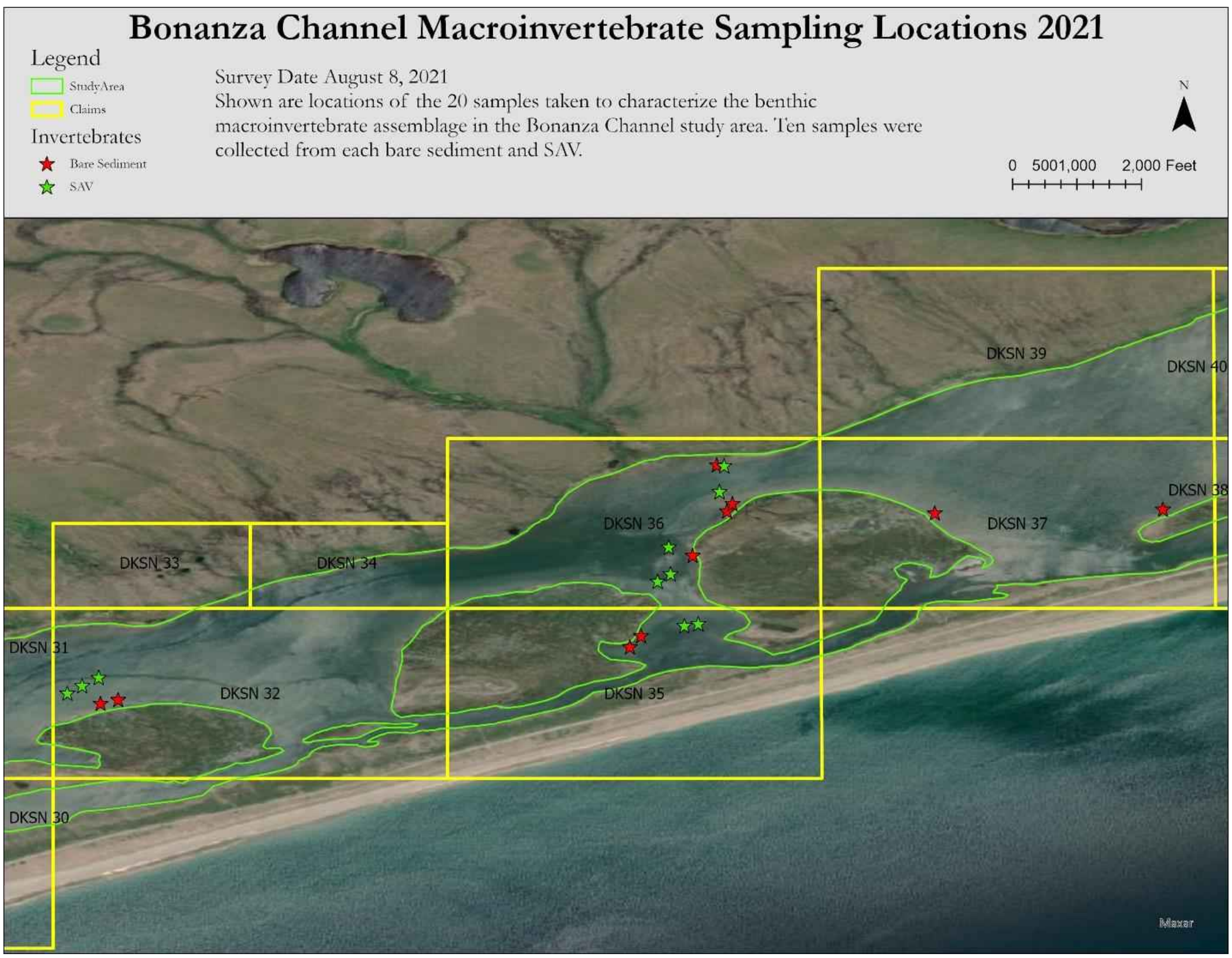


Figure 11 Locations of benthic macroinvertebrate sampling events indicating where samples from SAV and bare sediment habitats were taken

Margalef's Index is a species richness index. Margalef's index was one of the first attempts to compensate for the effects of sample size by dividing the number of species in a sample by the natural log of the number of organisms collected. Margalef's Index values were higher in vegetated samples than in the bare sediment samples, though both sets of values are considered low. Pielou's evenness is an index that measures diversity along with species richness. While species richness is the number of different species in each area, evenness is the count of individuals of each species in an area. A calculated value of Pielou's evenness ranges from 0 (no evenness) to 1 (complete evenness). Pielou's Evenness Index values were lowest in bare sediments indicating few overall taxa and many individuals of limited taxa. Samples for the vegetated area show increased species richness and higher evenness among species found. Similarly there are two factors in Shannon-Weiner diversity index: (1) number of species, i.e. richness; (2) the average or evenness of individual distribution in the species. A large number of species can increase diversity. Similarly, increasing the uniformity of individual distribution among species will also increase diversity. If each individual belongs to a different species, the diversity index is the largest. If each individual belongs to the same species, its diversity index is the smallest. The Shannon-Weiner Species Diversity Index is calculated by taking the number of each species, the proportion each species is of the total number of individuals, and sums the proportion times the natural log (or base 2 or 10) of the proportion for each species. Since this is a negative number, we then take the negative of the negative of this sum. The higher the number, the higher is the species diversity. The same trend is shown in each of these index values with vegetated samples being approximately twice the bare sediment sample values. Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases. The previously shown trend of bare sediment versus vegetated samples is repeated with this index.

Bonanza Channel Bathymetric Mapping and Seagrass Study

David Eilers, M.S.

August 13, 2020

Study Area

The Bonanza Channel between 64.50636^{0} N, 164.61610^{0} W and 64.52649^{0} N, 164.48668^{0} W (Claims DKSN 27- DKSN 40) was examined for the characterization of bathymetry and submerged aquatic vegetation community. Locating at the eastern extent of Safety Sound, the Bonanza Channel receives inflow from the Bonanza River and several intermittent streams/flow channels along the northern shores of the channel. The region has access to Norton Sound through two inlets, 4.2 miles southwest in Safety Sound and 4.25 miles northeast near the mouth of the Solomon River. An overview of the study area (green) and claims (yellow) are shown in Figure 1 as well as the proposed Access Channel and 5-Year Mining Channel.

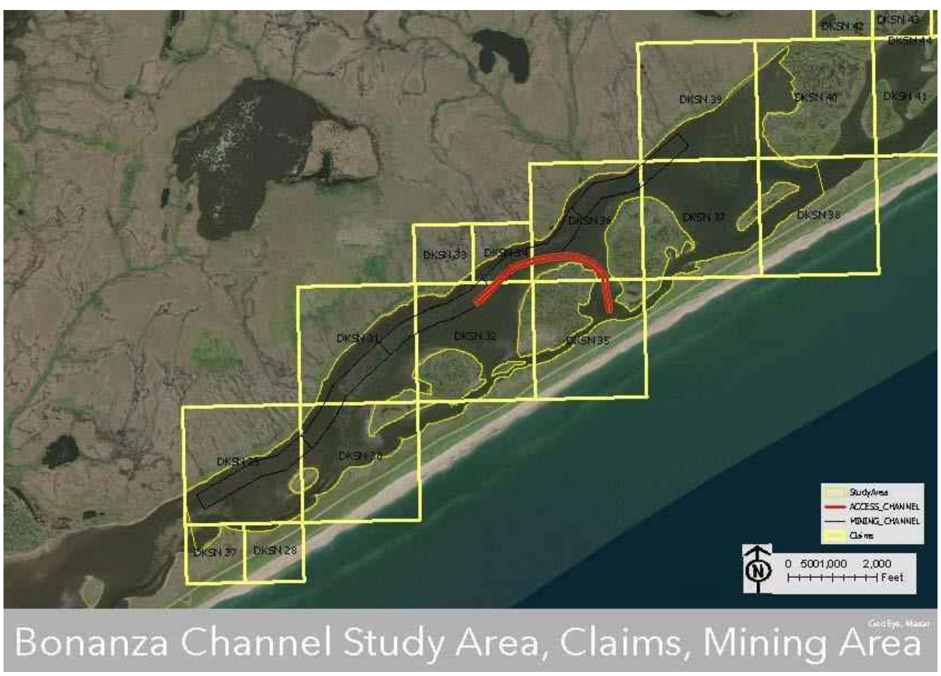


Figure 1 Overview of the Bonanza Channel Study Area east of Safety Sound

Bathymetric Mapping

The Bonanza Channel was mapped using a flat bottom Jonboat with a Lowrance Elite 7 Ti GPS echosounder with a remote Lowrance Point-1 GPS antenna and Totalscan transducer. Using a mounting bracket from a trolling motor, the Totalscan transducer and Point-1 GPS antenna were mounted on opposite ends of a PVC pole. This allows for the highest correlation between the GPS data and the sonar data. Transects were orientated NNW – SSE throughout the study area with approximately 120ft spacing. The boat and sonar limits for shallow water were approximately 1.75 ft of depth. In waters shallower than this depth the sonar signal becomes difficult to interpret due to backscatter and the physical grounding of the motors lower unit.

The Bathymetric survey was completed on July 21- 23, 2020 specifically targeting fuller tides to allow the highest amount of navigable surface area. A relative water level gauge was installed at 64.51806^0N, 164.55536^0W with water level measurements taken at the beginning and end of each survey trip. This allows for the collected data to be normalized to a relative mean water level. The collected sonar data was processed through SonarTRX software where the depth value was reclassified and erroneous data was removed. A total of 380,808 individual points were collected containing valid GPS and depth values. The data was then processed in ESRI ArcMap 10.6 to create a depth raster of the study area using the Natural Neighbors algorithm. The results of the bathymetric mapping is shown in Figures 2, 3, 4 and 5.

The Bonanza Channel study area was shallow with a mean depth value of 2.3 feet at the time of the assessment. The deeper portions of the waterbody exist as a narrow channel in the stream bed that meanders north and south in the study area with the active channel along the southern shore at the western and eastern extents and along the northern shore in the central portion of the study area. At the time of the assessment, the study area covered 698 acres of aquatic habitat containing approximately 515,873,108 gallons of water. The deepest observed depth in the study area was 7.1 feet.

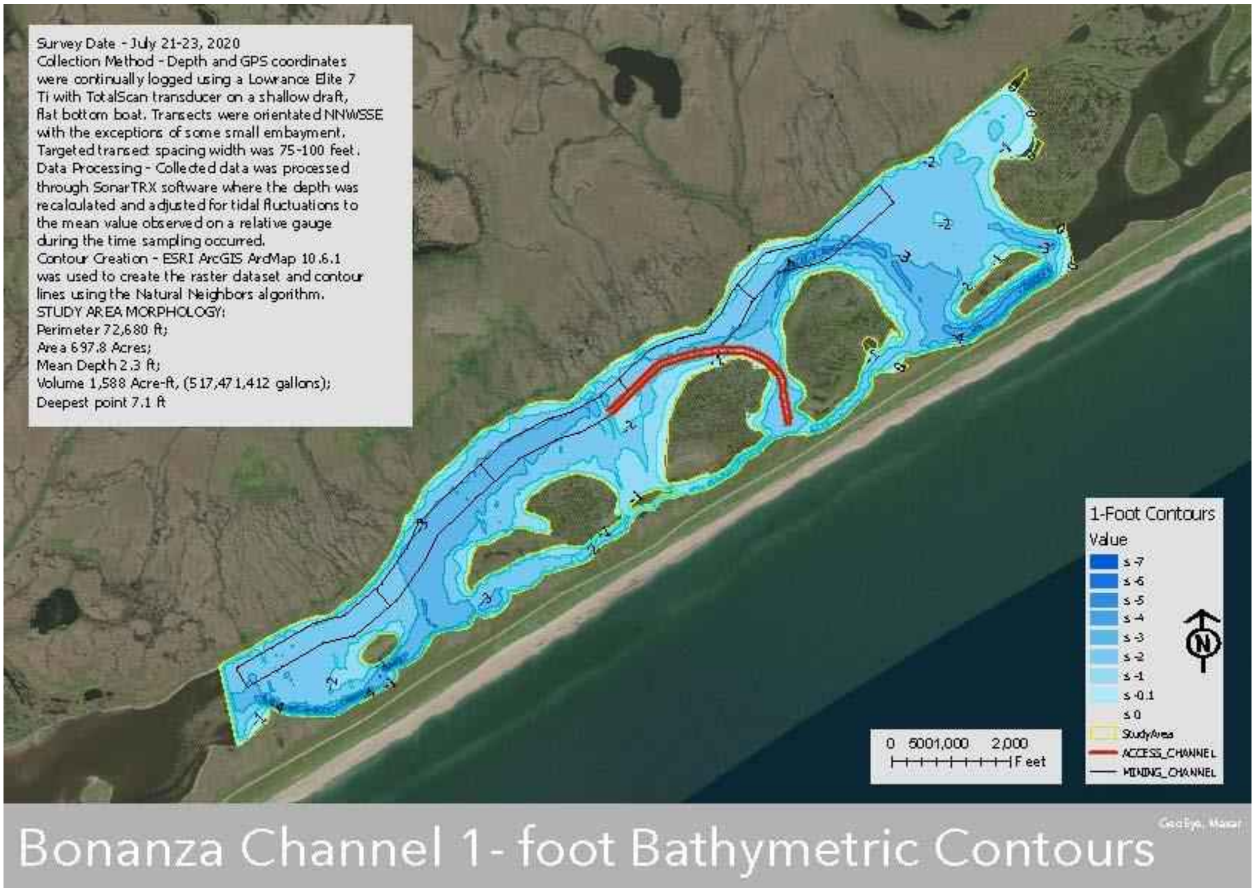


Figure 2 Overview of the 1- foot bathymetric contour map for the Bonanza Channel study area.

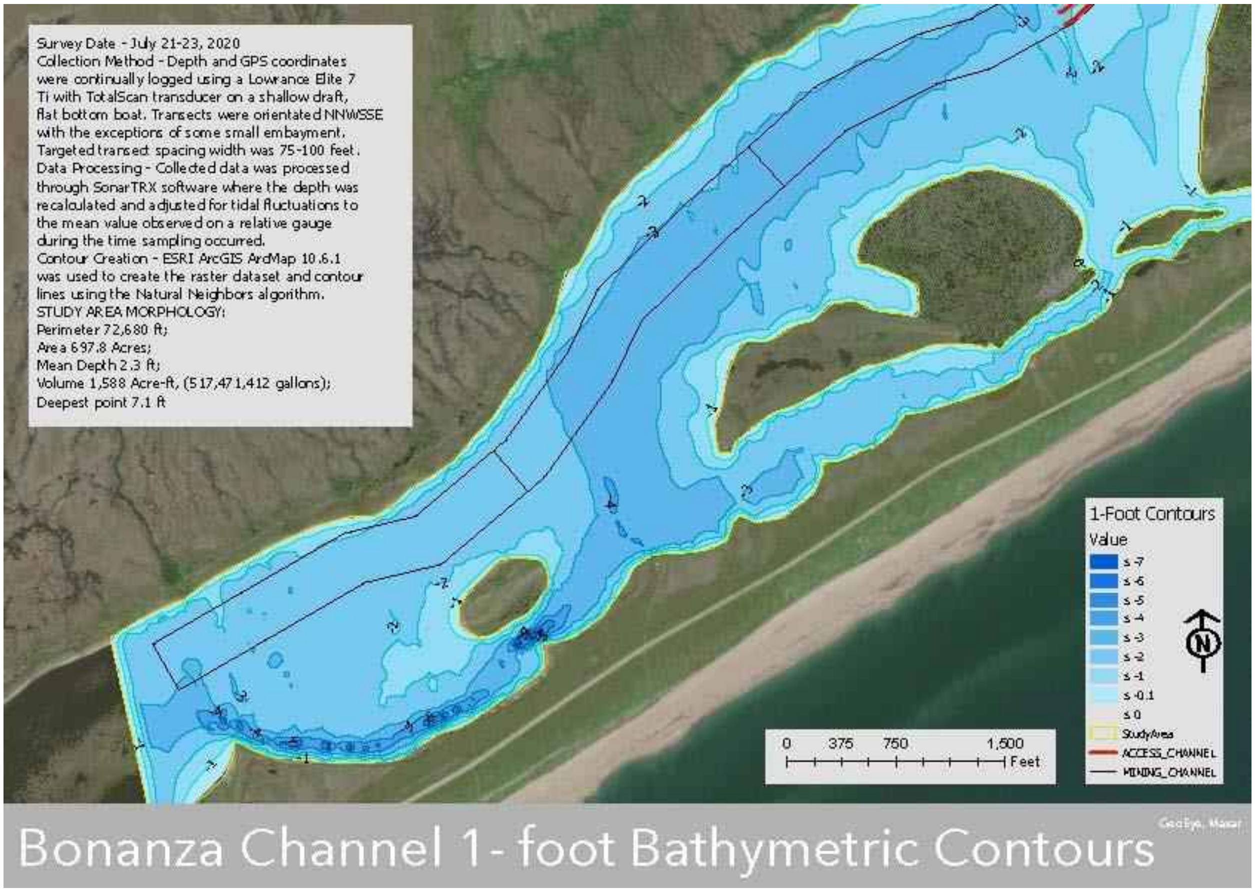


Figure 3 Western extent of the 1-foot bathymetric contour map for the Bonanza Channel study area

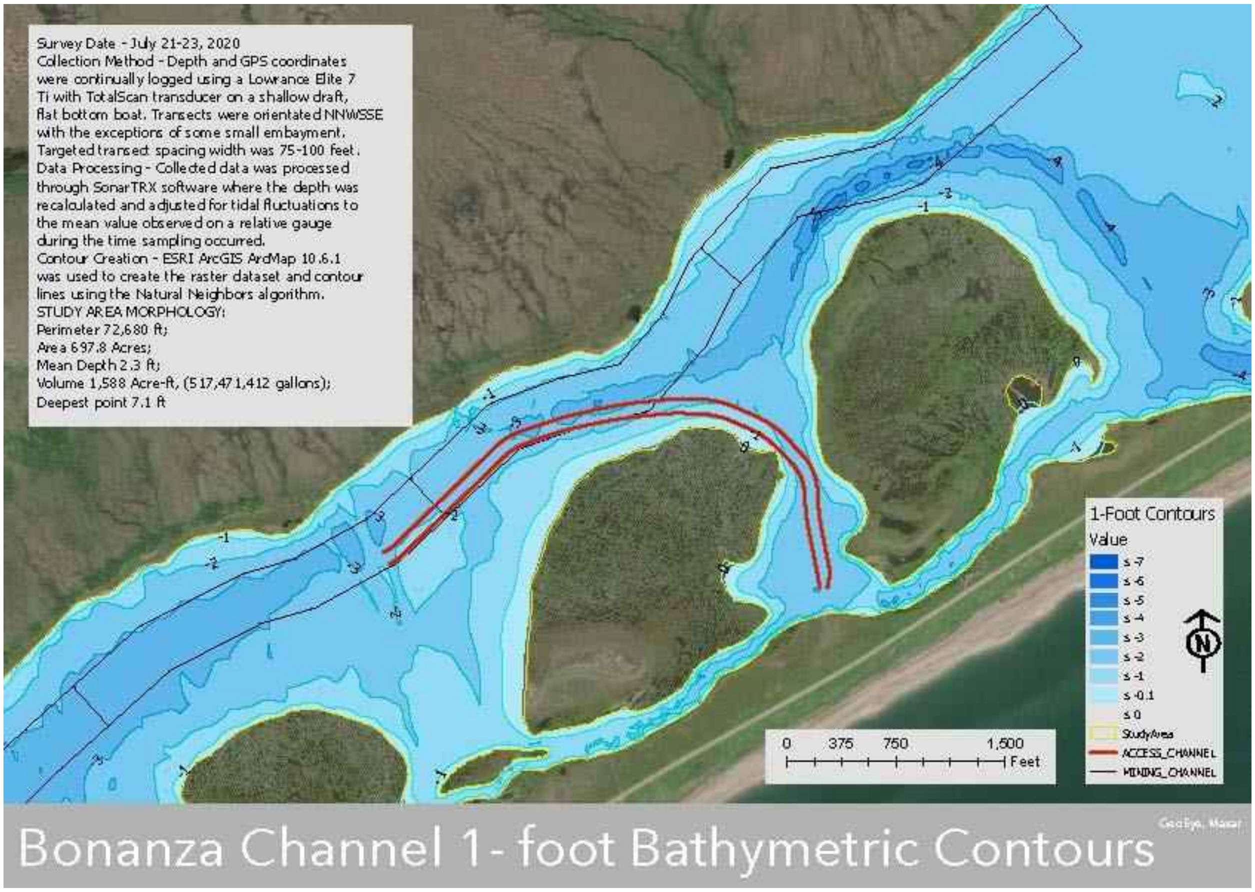


Figure 4 Central extent of the 1-foot bathymetric contours for the Bonanza Channel study area

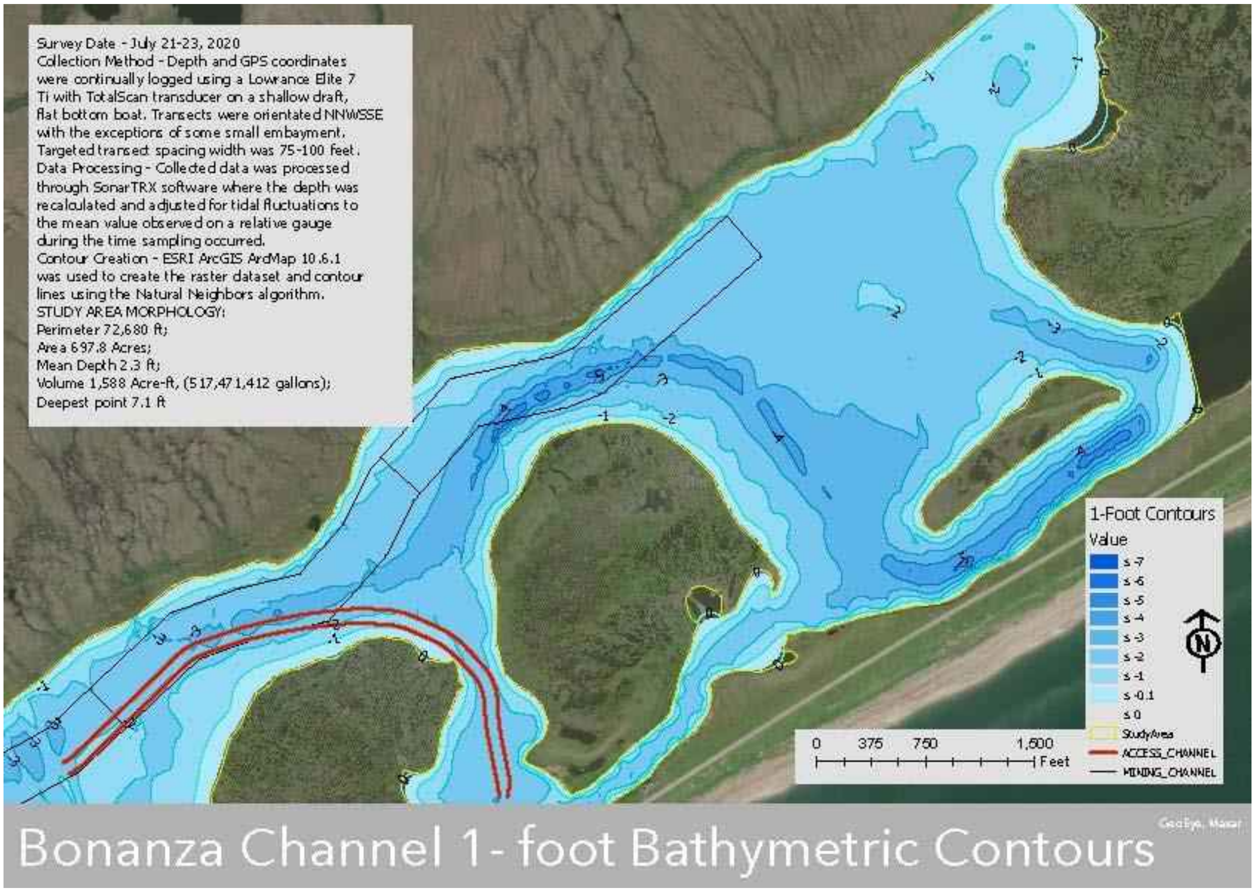


Figure 5 Eastern extent of the 1-foot bathymetric contours for the Bonanza Channel study area

Eelgrass/ Submerged Aquatic Vegetation Survey

Multiple methods were utilized to observe the species composition and distribution of submerged aquatic vegetation in the Bonanza Channel study area. These methods include a mapping of submerged aquatic vegetation derived from collected sonar, visual survey and quadrat sampling

1) Sonar Survey – Additional analysis of the collected sonar charts were performed for the presence and height of submerged aquatic vegetation through SonarTRX software manually digitizing the 'first returns' of the top of vegetation spikes visible in the sonar chart. The height of submerged aquatic vegetation is then calculated at each output point (308,080 points). The lower limit of reliable submerged aquatic vegetation detection is 0.3 feet. The results of the sonar based submerged aquatic vegetation are shown in figures 6, 7, 8 and 9 below. These images indicate the presence/absence of submerged aquatic vegetation as well as an estimate of canopy height. The submerged aquatic vegetation community comprised 74.4% (518.9 acres) of the surface area (518.9 acres) of the Bonanza Channel study area. The average height of submerged aquatic vegetation in the study area based on the collected sonar data was 0.51 feet.

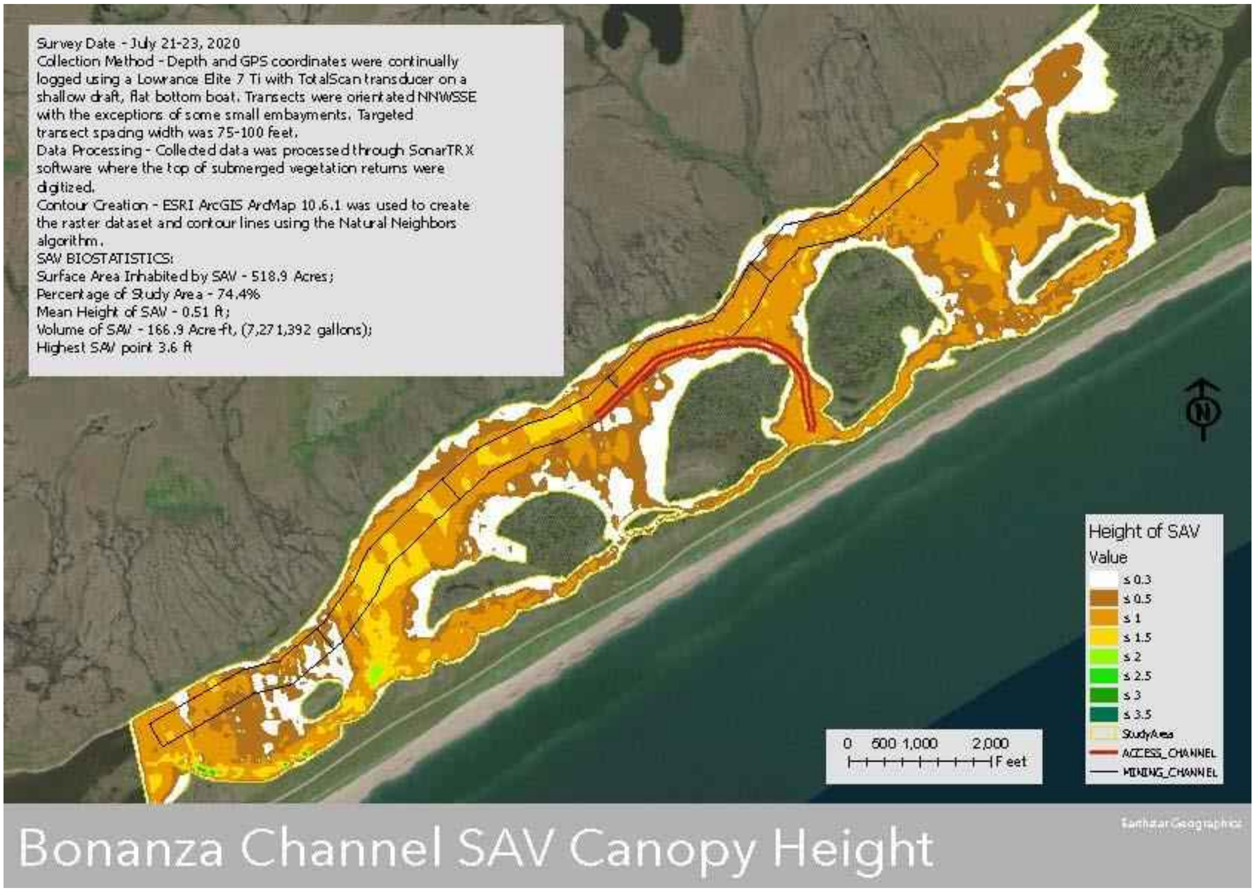


Figure 6 Overview of the sonar based submerged aquatic vegetation survey indicating the canopy height in feet in the Bonanza Channel study area.

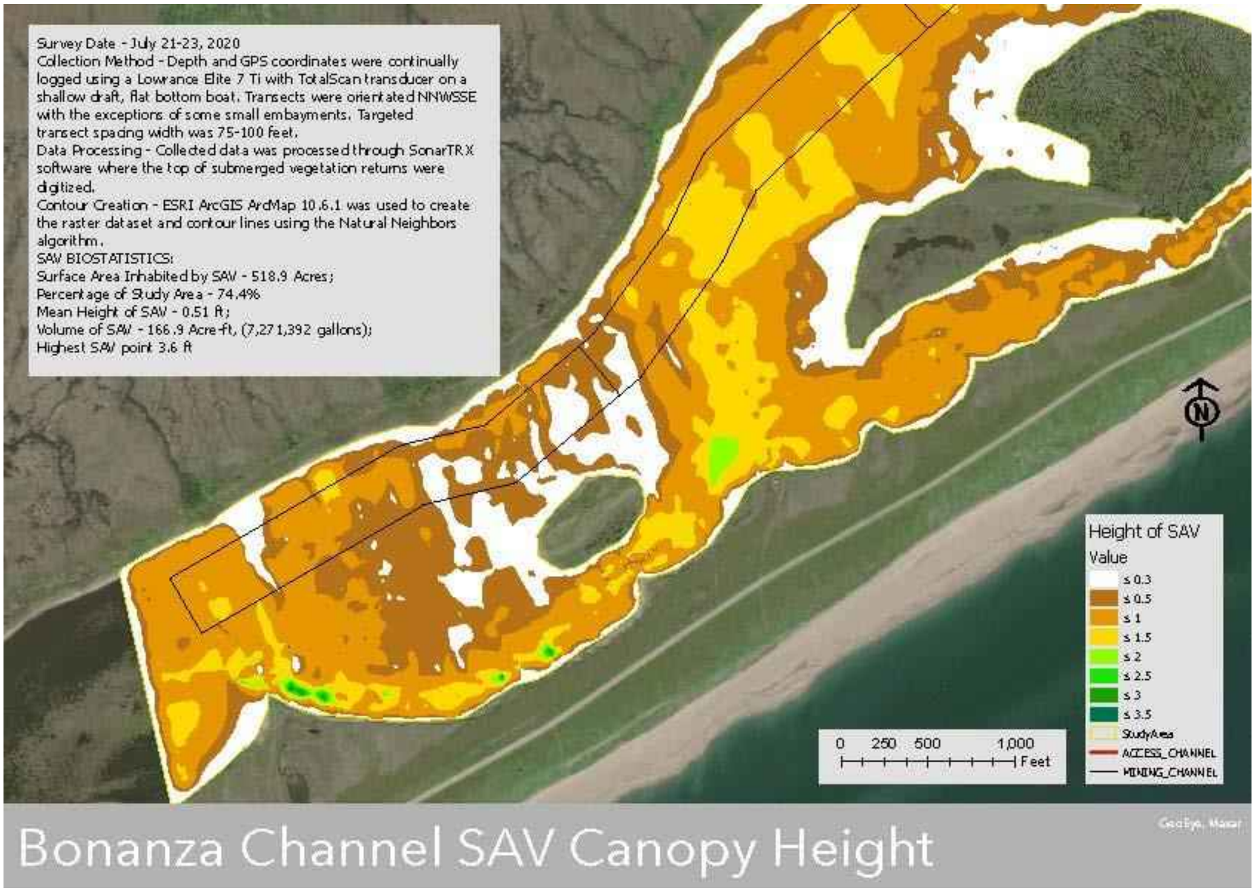


Figure 7 Western extent of the Sonar based SAV mapping

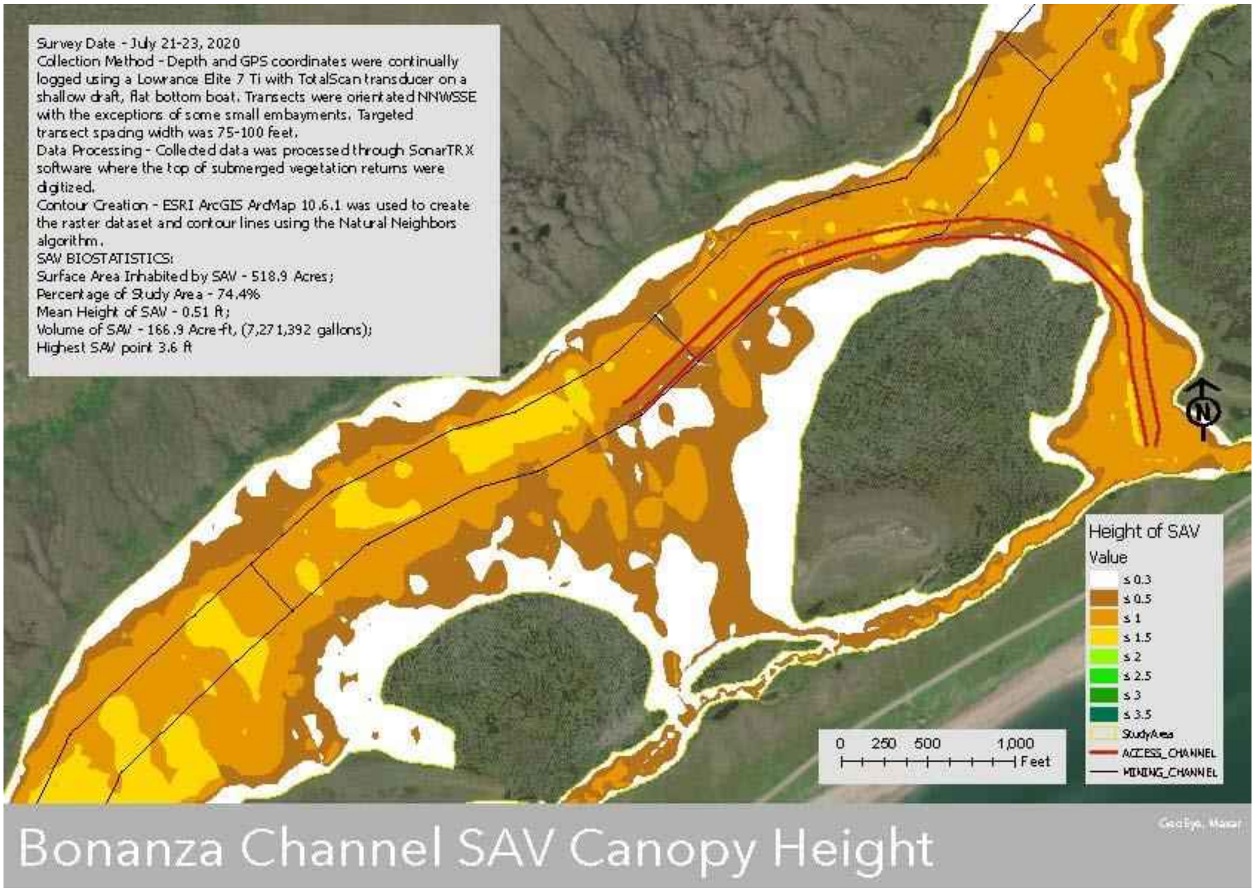


Figure 8 Central extent of the Sonar based SAV mapping

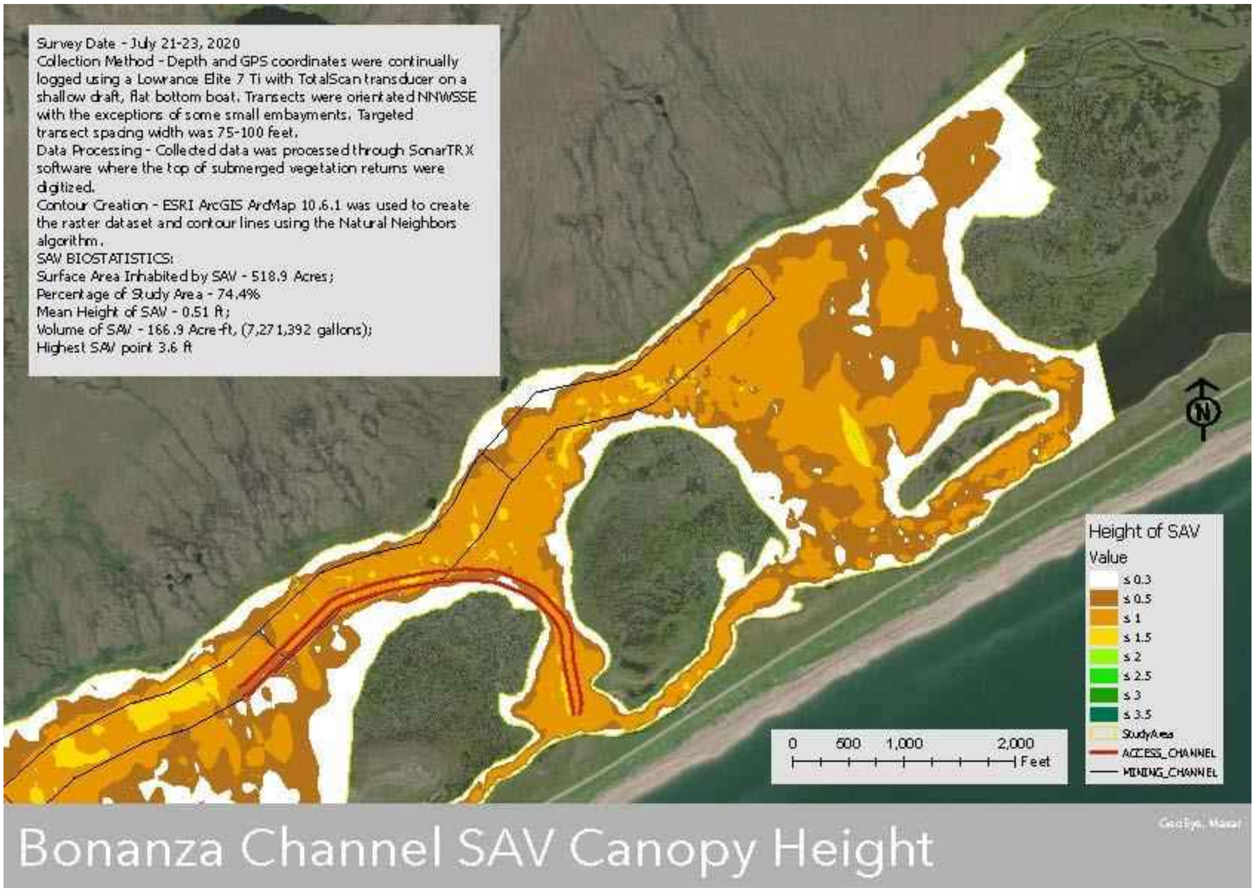


Figure 9 Eastern extent of the Sonar based SAV mapping

2) Visual Observation – During the bathymetric mapping transects, notes were taken as to the species present and waypoints were taken on the Lowrance Elite 7 Ti indicating where visually observable differences in species of submerged aquatic vegetation occur as well as where the density of submerged aquatic vegetation changes between dense, moderate and sparse/ patchy beds of submerged aquatic vegetation. Submerged aquatic vegetation beds will be defined using the USACE approved method **Eelgrass Delineation Method A:** An eelgrass bed is defined as a minimum of 3 shoots per 0.25 m^2 (1/4 square meter) within 1 meter of any adjacent shoots. To identify the bed boundary, proceed in a linear direction and find the last shoot that is within **1** meter of an adjacent shoot along that transect. The bed boundary (edge) is defined as the point 0.5 meter past that last shoot, in recognition of the average length of the roots and rhizomes extending from an individual shoot (Washington Dept. of Natural Resources (WADNR) 2012). During the visual observation, a single patchy

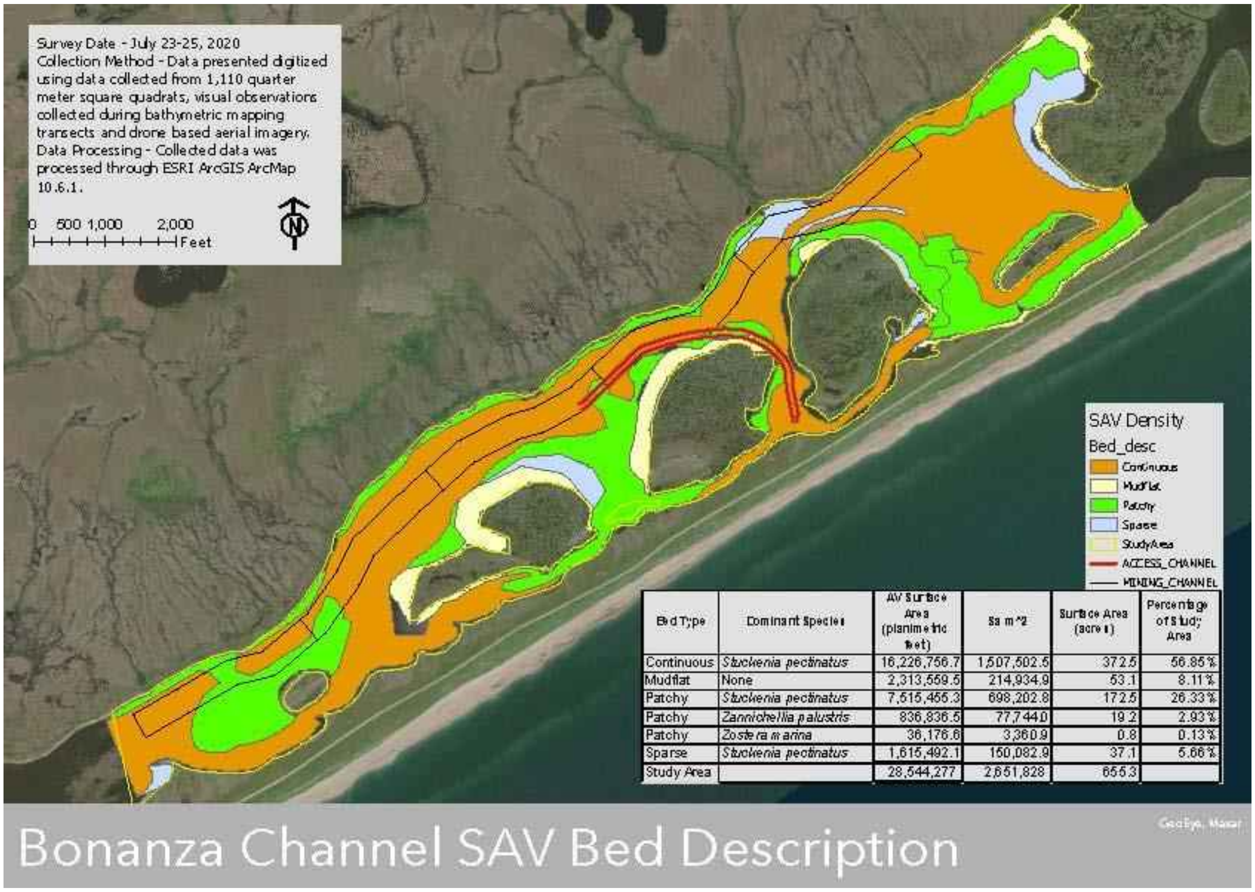
bed of *Zostera marina* was observed and video was obtained. The *Zostera* bed was intermixed with *Stuckenia* and covered approximately a 200ftx200ft area centered at 64.52477N, 164.54091W. *Zostera* was not observed again in the study area.

The majority of the study area was dominated by robust growth of a mixture of *Stuckenia pectinatus*, *Zannichellia palustris* and *Ruppia maritima.* Approximately 86.2% of the surface area of the study region contained submerged aquatic vegetation. A summary of data is given in Table 1 below. Figure 10 shows the distribution of continuous, patchy, sparse and mudflats graphically in the study

Table 1 Summary statistics of the visual submerged aquatic vegetation survey

Bed Type	Dominant Species	AV Surface Area (planimetric feet)	Sa m^2	Surface Area (acres)	Percentage of Study Area
Continuous	*Stuckenia pectinatus*	16,226,756.7	1,507,502.5	372.5	56.85%
Mudflat	None	2,313,559.5	214,934.9	53.1	8.11%
Patchy	*Stuckenia pectinatus*	7,515,455.3	698,202.8	172.5	26.33%
Patchy	*Zannichellia palustris*	836,836.5	77,744.0	19.2	2.93%
Patchy	*Zostera marina*	36,176.6	3,360.9	0.8	0.13%
Sparse	*Stuckenia pectinatus*	1,615,492.1	150,082.9	37.1	5.66%
Study Area		28,544,277	2,651,828	655.3	

Figure 11 looks at the dominant species of the submerged aquatic vegetation community from the same visual observation dataset. *Stuckenia pectinatus* occupied the highest percentage of the submerged aquatic vegetation community.



Bed Type	Dominant Species	AV Surface Area (planimetric feet)	Sq m^2	Surface Area (acres)	Percentage of Study Area
Continuous	*Stuckenia pectinatus*	16,226,756.7	1,507,502.5	372.5	56.85%
Mudflat	None	2,313,559.5	214,934.9	53.1	8.11%
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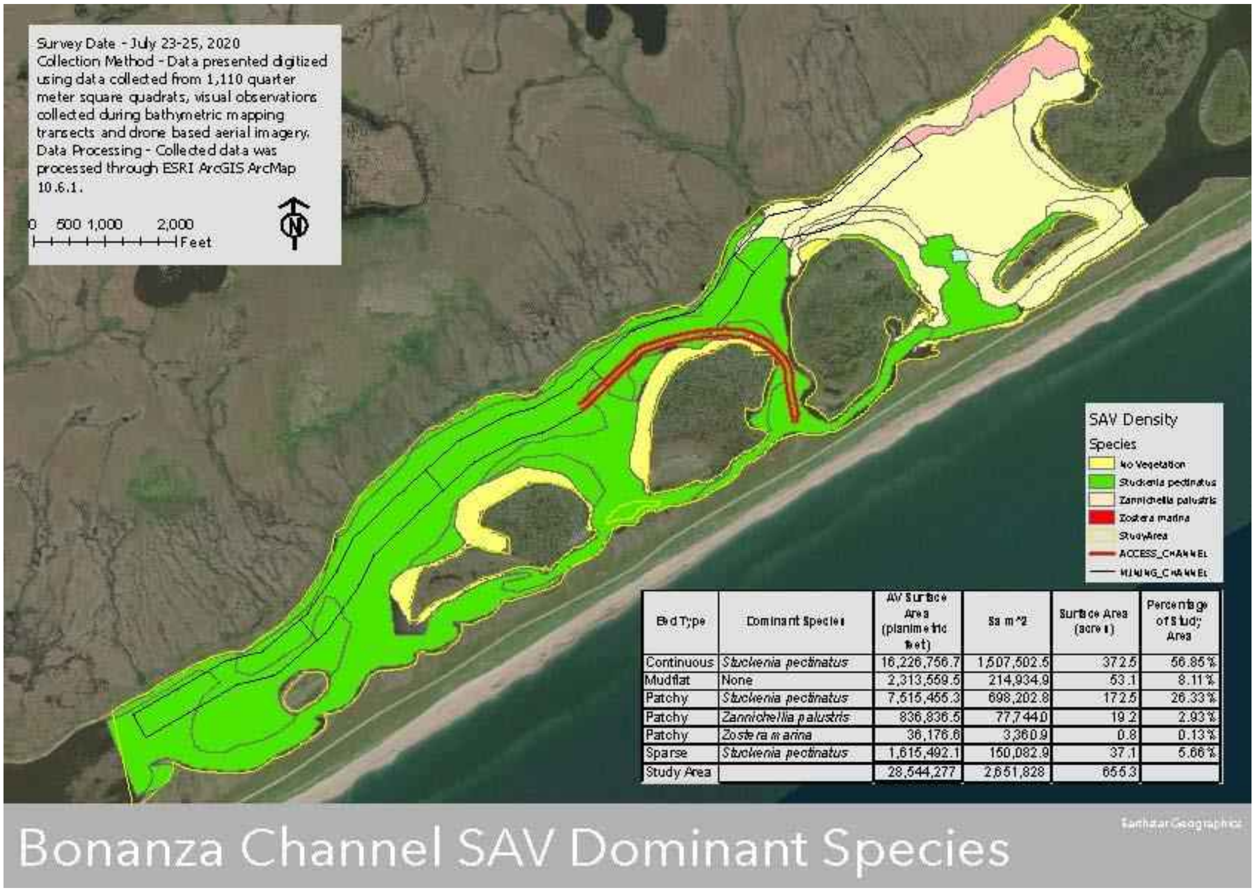
Figure 10 A map of submerged aquatic vegetation bed density classifications



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Study Area		28,544,277	2,651,828	655.3	

Figure 11 Distribution of dominant species in the submerged aquatic vegetation community

Further sampling of the submerged aquatic vegetation community was conducted to verify species present and percent coverage values using a ¼ m^2 weighted PVC frame. The quadrat was randomly deployed while wading the study area. At each deployment a GPS enabled GoPro Hero 8 Black mounted to an extension pole was utilized to take a photograph centered above the quadrat. From this photograph, species visible, dominant species and modified Braun-Blanquet values were generated for the submerged aquatic vegetation community based on the coded values in Table 2.

Table 2 Braun-Blanquet cover categories for random quadrats

Score	Cover
0	Taxa absent from quadrat
0.1	Taxa represented by a solitary shoot, <5% cover
0.5	Taxa represented by a few (<5) shoots, >5% cover
1	Taxa represented by many (>5) shoots, <5% cover
2	Taxa represented by many (>5) shoots, 5 - 25% cover
3	Taxa represented by many (>5) shoots, 25 - 50% cover
4	Taxa represented by many (>5) shoots, 50 - 75% cover
5	Taxa represented by many (>5) shoots, 75 - 100% cover

Sampling began 7/23/2020 11:00 and concluded 7/25/2020 15:54. A total of 1,110 quadrats were examined with a mean Braun-Blanquet value of 3.64 (25-50 % coverage of a 1/4m^2 quadrat. The distribution of Braun-Blanquet cover values for the samples are shown in Table 3. Figure 12 displays the location and Braun-Blanquet based coverage values for each of the 1,110 quadrat samples.

Table 3 Distribution of Braun-Blanquet scores for all quadrats

Score	Number of Quadrats
0	12
0.1	8
0.5	42
1	91
2	123
3	161
4	172
5	501

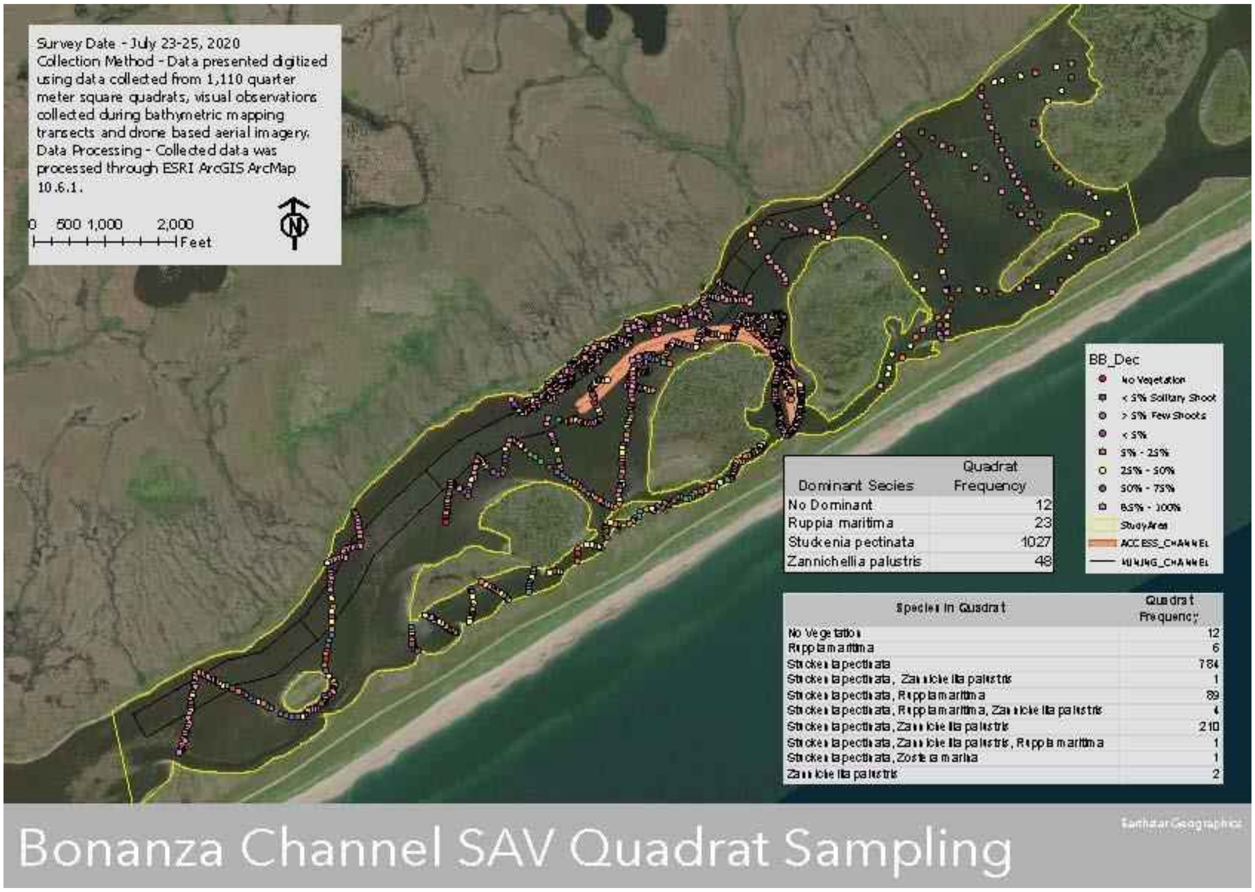


Figure 12 Quadrat sampling locations and Braun-Blanquet coverage values

Similarly, the dataset from the quadrats can also be examined in terms of the dominant species identified in each quadrat. This is graphically shown in Figure 13. Table 4 summarizes the distribution of dominant species in the quadrat dataset. Table 5 looks at all species identified in the quadrats.

Table 4 Frequency of dominant species in quadrat samples

Dominant Secies	Quadrat Frequency
No Dominant	12
Ruppia maritima	23
Stuckenia pectinata	1027
Zannichellia palustris	48

Table 5 Species found in quadrat samples

Species in Quadrat	Quadrat Frequency
No Vegetation	12
Ruppia maritima	6
Stuckenia pectinata	784
Stuckenia pectinata, Zannichellia palustris	1
Stuckenia pectinata, Ruppia maritima	89
Stuckenia pectinata, Ruppia maritima, Zannichellia palustris	4
Stuckenia pectinata, Zannichellia palustris	210
Stuckenia pectinata, Zannichellia palustris, Ruppia maritima	1
Stuckenia pectinata, Zostera marina	1
Zannichellia palustris	2

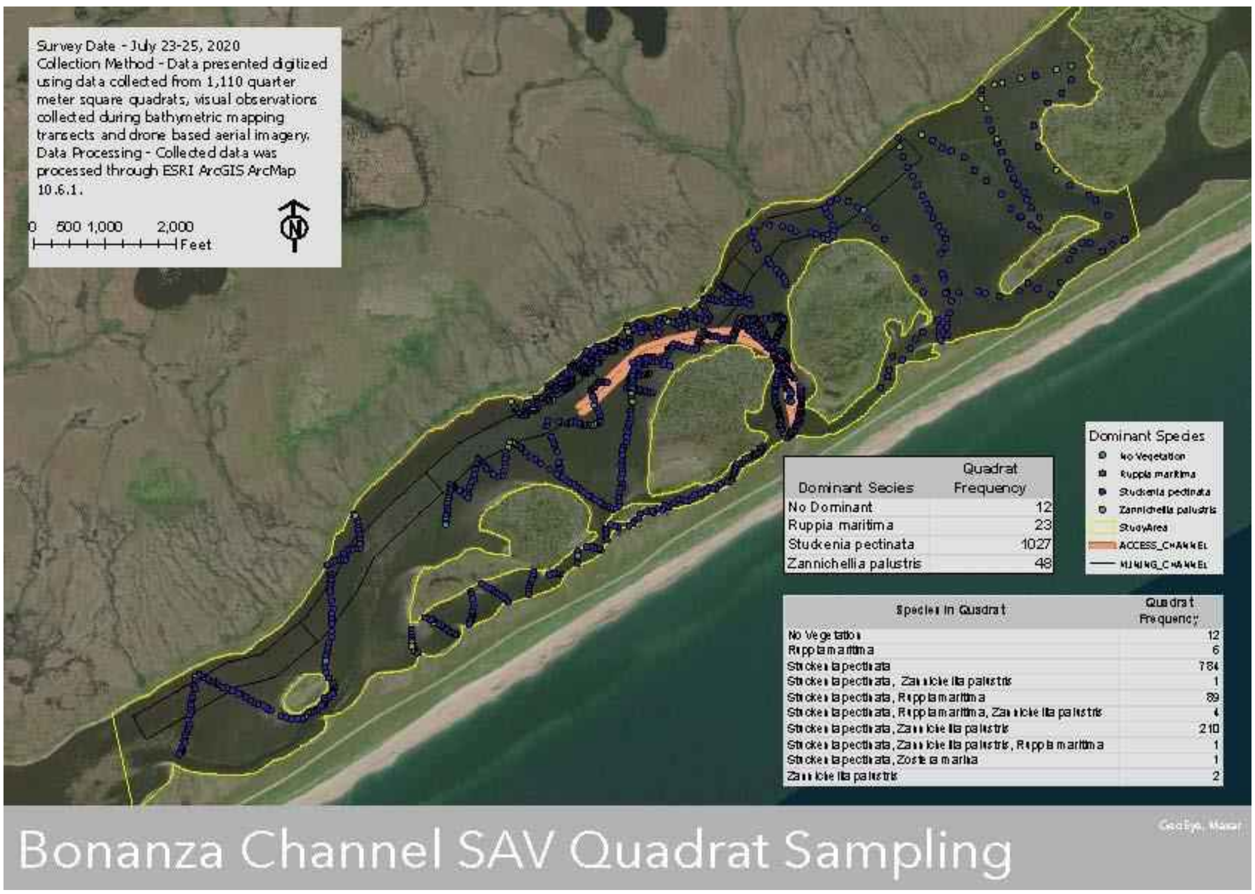


Figure 13 Dominant species identified in each quadrat

Summary

The Bonanza Channel study area is a shallow estuary with a mean depth of 2.3 feet and a maximum depth of 7.1 feet. The study area comprises 697.8 acres of aquatic habitat and contains approximately 517,471,412 gallons of water. The deeper portions of the study area are in defined channels along the southern shore in the eastern and western extents and along the northern shore in the center of the study area.

The submerged aquatic vegetation community is robust in the study area. The dominant species observed were *Stuckenia pectinatus*, *Ruppia maritima* and *Zannichellia palustris*. *Zostera marina* was observed in a small patchy density bed in the eastern portion of the study area.

Bonanza Channel Placer Project

Near Nome, Alaska

2020 Model Dredge Test SAV Recovery Report

November 19, 2021

Prepared for:

IPOP, LLC
9811 West Charleston Boulevard
Suite 2-444
Las Vegas, Nevada 89117

Prepared by:

David Eilers, M.S. (Environmental Scientist)

Introduction

This report describes the evidence of recovery of submerged aquatic vegetation (SAV) in 2021 at test pits (or divots) created during the 2020 model-scale dredge test in Bonanza Channel.

Background

2020 Model Dredge Test

As part of environmental baseline studies for the proposed Bonanza Channel Placer Project, IPOP LLC executed a model-scale dredge test in the Bonanza Channel in September 2020 (Otero Engineering, Inc. [OEI] 2021). The primary purpose of the model dredge test was to determine the effectiveness of the turbidity curtain that will be used around the dredging operations for the project.

Methods used for the model dredge test are described by OEI (2021). The 2020 model dredge test was overseen by William Goulet, CPG (OEI) and David T. Eilers (MS, biological scientist). Figure 1 shows a GoogleEarth image of the August 2020 model dredge test area. Figure 2 is an August 2020 drone photo of the deployed turbidity curtain for the model dredge test. Note that Figure 1 has a georeferenced feature for comparison in Figure 2. The 2020 model dredge test included creating 10 test pits in the Bonanza Channel to various depths (1.5 to 4 feet below mudline) and 3 to 4 feet square (Figure 3).

The 2020 conditions of the pits at the end of the model dredge test are listed on Table 1.

2020 Bathymetry and SAV Survey

In 2020 a survey of bathymetry and seagrass was conducted by David Eilers, M.S. in Bonanza Channel (Eilers 2020). In summer 2021, another bathymetry survey and SAV survey was conducted (Eilers 2021).

Table 1. Test Pit Information and 2021 SAV Underwater Drone Observations

Test Pit	Initial Depth of pit (ft)	Status of Pit at End of Model Dredge Test (2020)	Replanted (Yes/No)	October 2021 Underwater Drone Image Observations
1	3.0	Backfilled with organic muck	Yes	No apparent relic pit, SAV abundant, tubers visible
2	3.0	Backfilled with organic muck	Yes	No apparent relic pit, SAV abundant
3	1.5	unbackfilled	No	No apparent relic pit, SAV abundant, tubers visible
4	4.0	unbackfilled	No	No apparent relic pit, SAV abundant, tubers visible
5	3.0	Backfilled with coarse material and muck.	No	No apparent relic pit, SAV abundant
6	3.0	Backfilled with coarse material and muck.	No	No apparent relic pit, SAV abundant, tubers visible
7	1.5	Attempted to backfill with much	No	No apparent relic pit, SAV abundant, tubers visible
8	3.0	Backfilled with coarse material and muck	No	No apparent relic pit, SAV abundant
9	3.0	Backfilled with muck to extent possible	Yes	No apparent relic pit, SAV abundant
10	1.5	Attempt to backfill with muck	No	No apparent relic pit, SAV abundant

Figure 1. Turbidity Curtain and Model Dredge Test Location ("Turbidity Curtain Test Location")

Figure 2. August 2020 Drone Image of Model Dredge Test Area within Turbidity Curtain Deployed

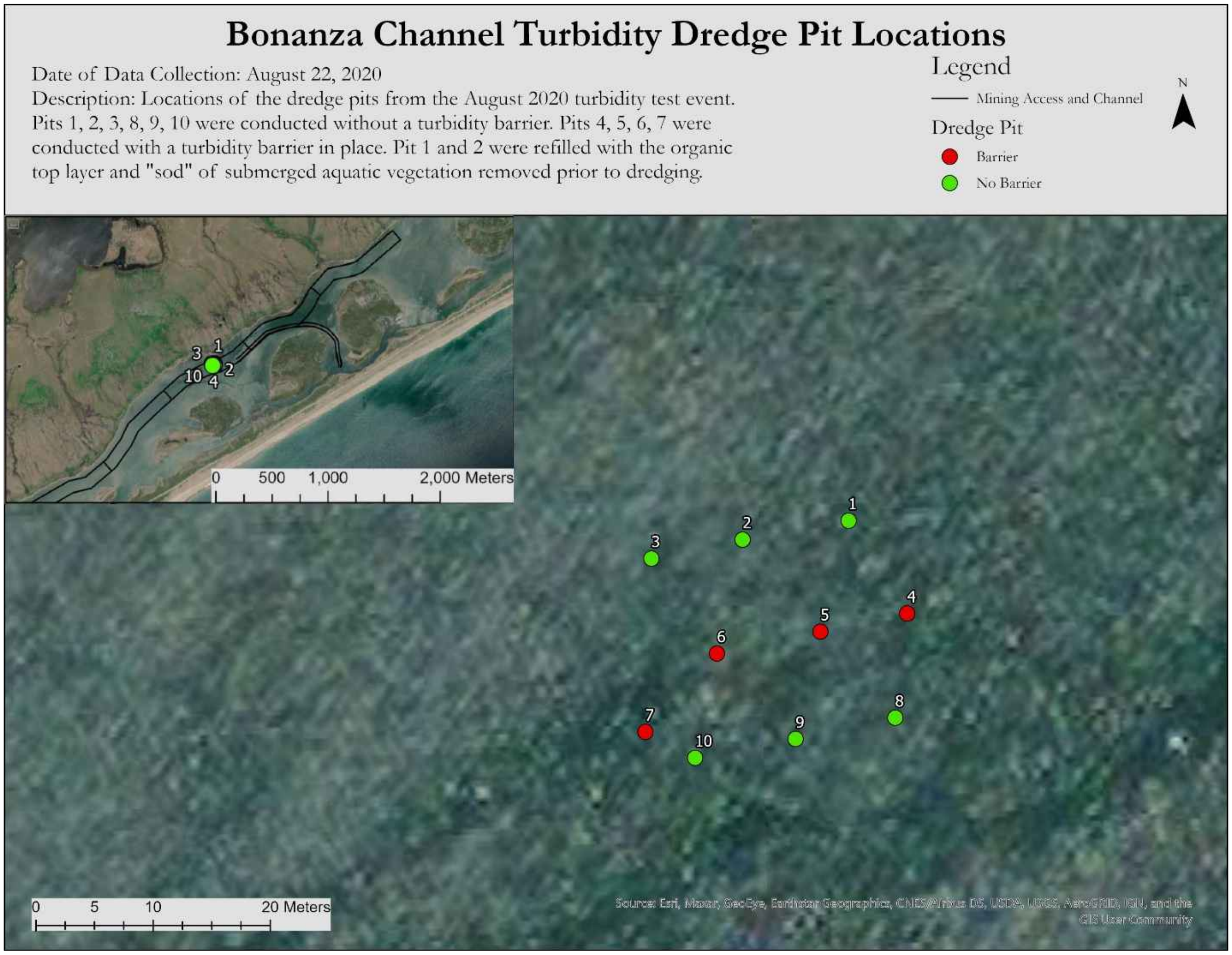


Figure 3. Layout of Test Pits during 2020 Model Dredge Test

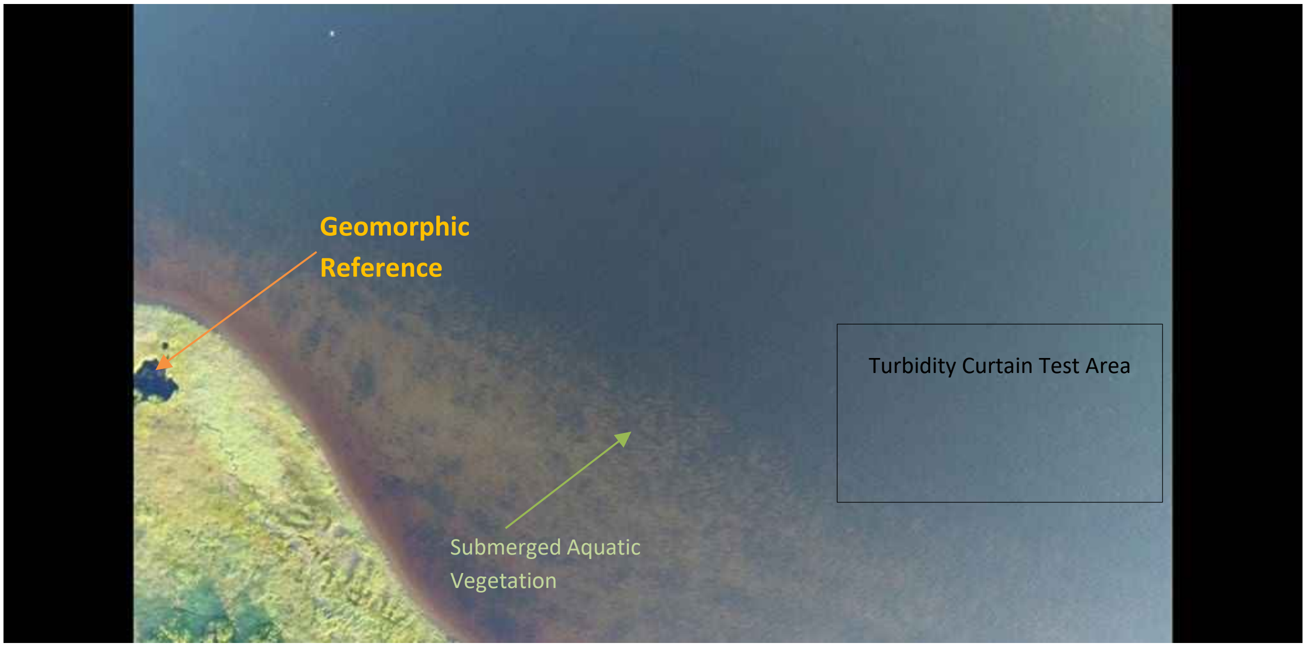
Summary of 2021 Observations at Test Pit Locations

<u>Summer 2021 Observations and Aerial Drone Images</u>

The model-scale dredge test area was revisited by representatives of IPOP, OEI, and David Eilers multiple times during summer 2021 to observe:

- whether or not the pits had naturally backfilled during the seasonal storm events
- the degree of SAV recovery in test pits that were backfilled, but not replanted
- the degree of SAV recovery in the backfilled and replanted test pits.

Multiple attempts were made throughout the summer 2021 to take underwater drone videos of the 2020 test pits; however, the water was too turbid during the summer visits to get clear underwater footage of the SAV and test pit sites. Instead IPOP personnel took overhead drone photos of the test area. Figure 4 is a summer 2021 drone image of the test area (same georeferenced feature as in Figure 1).



Note: The geomorphic reference is shown in Figure 1.

Figure 4. August 2021 Drone Image of SAV and 2020 Turbidity Curtain Test Area

The aerial drone images show a dense growth of SAV in the model dredge test area. The Eilers (2020) report documents the SAV species and canopy heights in the test area.

Figure 5 shows the 2020 turbidity curtain test location for comparison with Figure 6 (August 2021 drone image of SAV and the test area) .

Figure 5. 2020 Turbidity Curtain Test Area

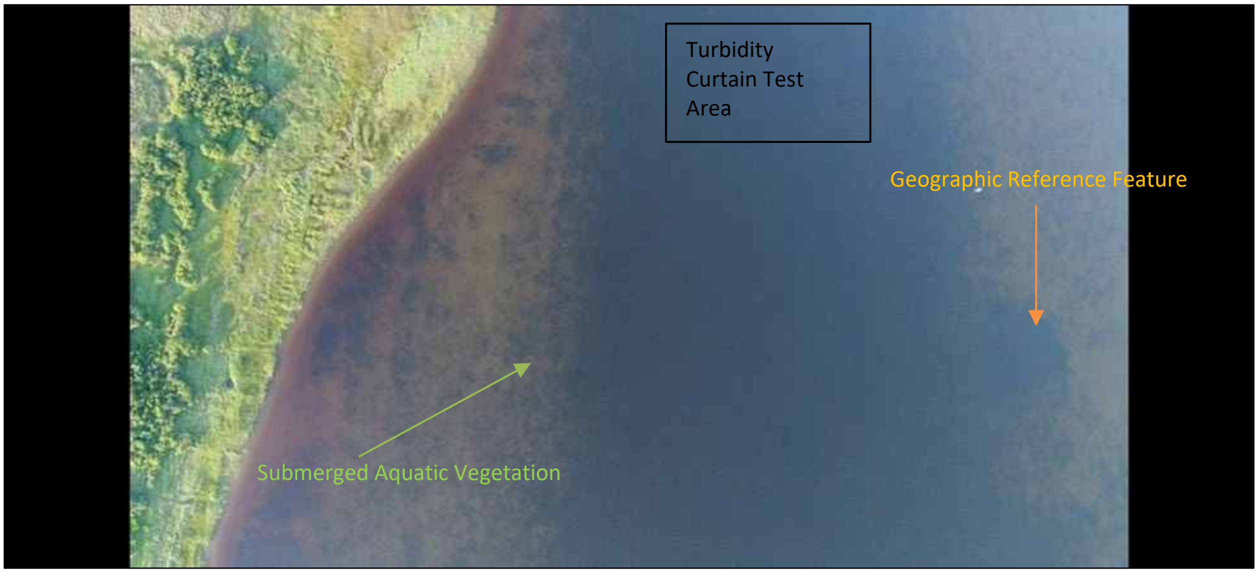


Figure 6. August 2021 Drone Image

<u>October 2021 Underwater Photos at 2020 Test Pit Locations</u>

In late October 2021, the water in the Bonanza Channel water was clear enough and effective underwater drone footage was obtained of the test pit sites and SAV in its late-season state. The georeferenced underwater images are provided in Appendix A.

Table 1 lists the October 2021 underwater observations at each test pit. All of the test pits from the 2020 model dredge test were very well revegetated in 2021, regardless of backfill material, backfill depth, placement of ecological memory, or whether or not they were replanted with SAV (that was removed before the test). These observations illustrate the robust nature of the SAV species present in the Bonanza Channel, and the ability of the environment to naturally restore.

References

Otero Engineering, Inc. (OEI). 2021. Model dredging program, environmental baseline studies and water quality monitoring during model dredging in the Bonanza Channel near Nome, Alaska.

Eilers, D. 2020. Bonanza Channel environmental baseline studies – updated submerged aquatic vegetation sampling. August 13, 2020.

Eilers, D. 2021. Bonanza Channel bathymetry and submerged aquatic vegetation survey. August 2021.

Appendix A

October 2021 Underwater Photos of Test Pit Locations

PIT 1

PIT 2

PIT 3

PIT 4

PIT 5

PIT 6

PIT 7

PIT 8

PIT 9

PIT 10

David Eilers, M.S.

Eilers Environmental LLC.

On Behalf of IPOP LLC

Bonanza Channel SAV Characteristics and Potential for Reestablishment

IPOP LLC has proposed a placer gold mining project in the Bonanza Channel between the mouth of the Bonanza River and the outlet of the Bonanza Channel in Safety Sound. This physical alteration to the Bonanza Channel will subsequently need to have ecosystem function and structure restored to pre-mining conditions once activities are complete. The dominant aquatic habitat in the Bonanza Channel is a robust SAV community that is seasonal in nature and provides a vital source of nutrition to migratory water fowl.

In the Bonanza Channel, disturbance maintains the submerged aquatic vegetation (SAV) community in an early successional stage compared to the more stable *Zostera marina* dominated SAV found in Safety Sound. When compared to other locations within the distribution of these species, the climatic factors of the Bonanza Channel provide a dramatic amount of disturbance (extreme variations in water and air temperatures, salinity fluctuations, sunlight availability, physical disturbance by grounded ice and seasonal herbivory by migrating water fowl) which leads to each species relying on their plasticity to not only survive but also thrive in this location.

There is a great volume of available research on the three dominant species of submerged aquatic vegetation in the Bonanza Channel. *Zannichellia palaustris, Stuckenia pectinata* (formally *Potamogeton pectinatus*, reclassified around 2006) and *Ruppia martima* each have a near worldwide distribution. Each species can be found in alkaline fresh and brackish waters, standing and flowing waters and waters of various trophic status. This wide ecological niche requires a great deal of plasticity in terms of life cycles, growth forms, and reproductive strategies. This plasticity is also responsible for each species r-selected abilities to re-establish following disturbances. R-selected species emphasize high growth rates and produce high numbers of offspring or reproductive structures such as seeds, achenes and tubers to overcome the stresses of disturbance. These three species are often found together and are known competitors often leading to temporal shifts in dominance throughout seasons (Kantrund 1991). This temporal variation in species coverage and dominance is seen in the submerged aquatic vegetation community in Bonanza Channel both within a season and between seasons (Eilers 2020, 2021). Tyler-Walters (2002) also mentions that *Stuckenia pectinata* replaces *Ruppia* dominated beds when the salinity is consistently low as opposed to variable. All three of the principal species have specific characteristics that support such rapid recolonization. Idestam-Almquist (2000) shows a high colonization rate and tolerance to disturbance for most of the relevant species.

Adaptations

Each of these species have adaptations to continue one season to the next under the Bonanza Channel climate regime. Many of the adaptations result in an increased growth rate and creation of seed and tubers. One of the adaptations these species utilize is the alteration of life cycles from perennial form to an annual form. Van Wijk (1988) notes that in *Stuckenia pectinata* populations that experience frequent high disturbance from strong winds and profound winters had a very condensed growing season between May and July with the majority of above and below ground plant gone by August, leaving only tubers in the sediments and achenes along the windblown shoreline. Pilon et al (2003) showed how *Stuckenia pectinata* changes its growth form and strategy with high latitude populations showed an annual growth habit with higher production of smaller tubers and increased leaf production. In addition to the tubers borne along the rhizome, this species can also produce axillary tubers along the growing branches. These axillary tubers serve an important role in establishing populations elsewhere as they are transported together with the above ground shoots shed at the end of the growing season (Kantrud 1990). *Stuckenia pectinata* is able to root from fragments of rhizome and stem, so that recovery from dredging is expected to be rapid (Tyler-Walters 2002). *Stuckenia pectinata* also grows on a wide range of sediments (Tyler-Walters 2002) reducing concerns of unsuitable sediment texture post-dredging.

In temperate regions, *Ruppia martima* typically persists as a weak perennial through multi-branched rhizomes, however in climates that feature physical conditions that do not allow survival of vegetative plant parts during parts of the year (such as grounded ice) *Ruppia* survives as an annual. Verhoeven and van Vierssen (1978) note that *Ruppia* species in this climate dies back completely in winter and survive as seed in the sediments. “To colonize and recolonize such areas, the plants possess a number of special properties. Detached vegetative parts of the plants remain floating for a long time; when they reach the bottom, rooting starts immediately on a wide range of sediments (Kantrud 1991). In the same manner, the ripe seeds can be transported by drifting plant parts. After desiccation, dried plant parts together with attached seeds can be transported by the wind over considerable distances. Further, several bird species {coot, teal, wigeon, mute swan, tufted duck) contribute to dispersal (Verhoeven 1979). Kantrud (1991) Seeds of Ruppia have a hard durable seed coat and form a persistent seed bank in sediments for up to three years.

Zannichellia palustris is an annual species which re-establishes each year from newly produced seed from the previous season. This species produces abundant seeds that require an extended period (>2 months) of below 4^{o}C in order to germinate. In addition, these seeds are tolerant to desiccation if exposed (common in temporary water bodies and in shallow littoral fringes) allowing them to germinate the following season.

Each of these species undergo abscission during the fall shedding their above ground (and majority of below ground structures. The resulting drift of this material, along with attached achenes, seeds, tuber, turions and viable rhizomes allows for the recolonization of the submerged aquatic vegetation community the following growing season (Van Vierssen 1982) (Verhoeven 1979) (Van Wijk 1988). The usefulness of adjacent submerged aquatic vegetation beds in reestablishing vegetation has been demonstrated in a variety of contexts (Baastrup-Spohr et al. 2016) showed surprisingly high diversity and coverage only two years after reclamation of a Norwegian lake from farmland due to the deposition of seed and vegetative materials from surround populations.

Resiliency

The adaptations each of these species have to persist with the climatic conditions of the Bonanza Channel also lead them to be resilient in the habitat. Numerous studies show that *Zannichellia* and *Ruppia* are "fast colonizers" ((Arnold *et al.* 2000); Stevenson *et al.* (1993)). This is important because studies show a wide range of recolonization rates for various species when habitat is disturbed. *E.g.*, Barrat-Segretain *et al.* (1998). *Zannichellia palustris* is also commonly known as a species identified as an indicator of habitat disturbance due to this ability to rapidly colonize open sediment (Hilgartner 1991). (Vari *et al.* 2017) and (Capers 2003) suggest that fragment rooting is the most important mechanism for recolonization, suggesting that redeposit of muck is highly likely to be effective. Henry (1996) also refers to fragments as important for recolonization after dredging in a French river, with rapid reestablishment of numerous species. Although Spencer & Kasander (2002) show that burial of *Z. palustris* seeds more than 2 cm deep prevents germination, storms may stir up deeper seeds, making a viable seed bank. *Stuckenia pectinata* is often actively managed in reservoirs and moving water as its robust growth can slow water flows and increase sedimentation (Ganie et al. 2016).

Restoration Methods

The adaptations and life cycle strategies of these three species allow for the restoration method of harvesting and storing the organic veneer (upper 6" of sediment) prior to dredging, storing the material on site and redepositing the veneer as the final process after re-contouring the bathymetry to be successful. This upper 6" of organic veneer contains tubers, achenes and seeds from the previous season as well as any viable rhizome material from the previous season's growth. The redepositing of the organic veneer also ensures that a suitable sediment texture is in place for the growth of these species. All three show the ability to establish and grow in both soft organic sediment and sands. VanZomeren et al. (2020) and Wilbur (1992) provide a useful discussion on "thin layer placement of sediments for restoring ecological function to salt marshes" for restoring habitat functions. Each species specializations for rapid growth, production of seeds and tubers and ability to regrow from rhizome fragments will allow for a high degree of success for revegetation following dredging activities in the Bonanza Channel. This will occur by the existing rhizomes, tubers, seeds and achenes in the organic veneer after replacement and from recruitment from the robust SAV communities surrounding the dredging activity site.

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Bonanza Channel Placer Project

Near Nome, Alaska

2021 Field Survey and Desktop Study

Rev. 1

December 2021

IPOP, LLC
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TABLES

FIGURES

Note to the Reader: This revision of 2021 Field Survey and Desktop Study (report) (Rev.1, December 2021) has been prepared to provide results of additional recent surveys and studies (August – November 2021) to best describe the physical and biological aspects and processes in the project area and adjacent waterbodies. Three sections have been added: Fish, Birds, and Submerged Aquatic Vegetation. This Rev. 1 report is cited in several project documents that support permit application (e.g., Essential Fish Habitat Assessment [November 2021] and the revised Reclamation Plan [December 2021]).

1. AUTHORITY

This report was conducted on behalf of IPOP, LLC to support planning and permitting of the Bonanza Channel Placer Project (BCPP) approximately 25 miles east of Nome, Alaska. A comprehensive project description is available in the 2020 Narrative and Plan of Operations for the Bonanza Channel Placer Project, Nome, Alaska in POA-2018-00123, as amended by the Bonanza Channel Case Study Amendment and other materials.

2. PURPOSE AND BACKGROUND

This report was developed based on several sources of information to describe the hydrologic relationships and water quality of the Flambeau, Solomon, and Bonanza rivers; Safety Sound; and Bonanza Channel including the July-August 2021 Field Study. The purpose of the report is to present the data and findings from the 2021 Field Study and provide a comprehensive description of hydrologic and water quality conditions and influencing factors in the project area based on available information.

3. PREVIOUS STUDIES AND SOURCES

In addition to the 2021 Field Study (original, dated August 2021), previous project-related studies in the vicinity and relevant sources are listed below and information from these sources was considered and incorporated into this comprehensive report.

- Eilers, D. 2020. Bonanza Channel bathymetric mapping and seagrass study.
- Otero Engineering, Inc. (OEI). 2021. Model dredging program, environmental baseline studies and water quality monitoring during model dredging in the Bonanza Channel near Nome, Alaska. January 2021.
- D. Eilers 2020 and 2021 (two studies). Bonanza Channel environmental baseline studies submerged aquatic vegetation sampling, 2020 and 2021.
- Alaska Department of Fish and Game (ADF&G). 2018. Use of Acoustic Tags to Examine Movement of Chum Salmon in Nearshore Marine Waters of Northern Norton Sound, 2015-2016. Fishery Data Series No. 18-15. Chapter 3.2, An ecological comparison of juvenile chum salmon from two watersheds in Norton Sound, Alaska: timing, diet, estuarine habitat, and fish community assemblage. (LGL Alaska Research Associates, Inc. Anchorage, Alaska and North Sound Economic Development Corporation. Anchorage, Alaska)

4. 2021 FIELD SURVEY

A field study was conducted from July 28 to August 13, 2021, to characterize hydrology, water quality, and substrate/vegetation in the vicinity of the Flambeau River, Safety Sound, Bonanza River, Solomon River, and the Bonanza Channel project area. This report presents the findings of the field survey and incorporates results of a desktop study of previous studies, other relevant sources, and other recorded in-field observations to describe the existing environment in each area.

There are seven field survey areas ranging west to east from Flambeau River to the outlet of the Solomon River. The areas are depicted on Figure 4-1 and listed below.

- Upper Flambeau River
- Lower Flambeau River
- Western Safety Sound
- Central Safety Sound
- Eastern Safety Sound/Bonanza Channel Mouth
- Bonanza Channel
- Bonanza River Mouth to Solomon Outlet

These areas were included in the survey to enable development of a comprehensive characterization of water bodies directly or indirectly connected to the Bonanza Channel.

2021 Field Survey Areas | **2021 FIELD SURVEY**

Figure 4-1. 2021 Field Survey Areas

The following measurements or characteristics were recorded at sample stations along the transects.

- Substrate/Vegetation type – In particular, the presence or absence of eelgrass was recorded.
- Water depth
- Flow
- Temperature
- Salinity

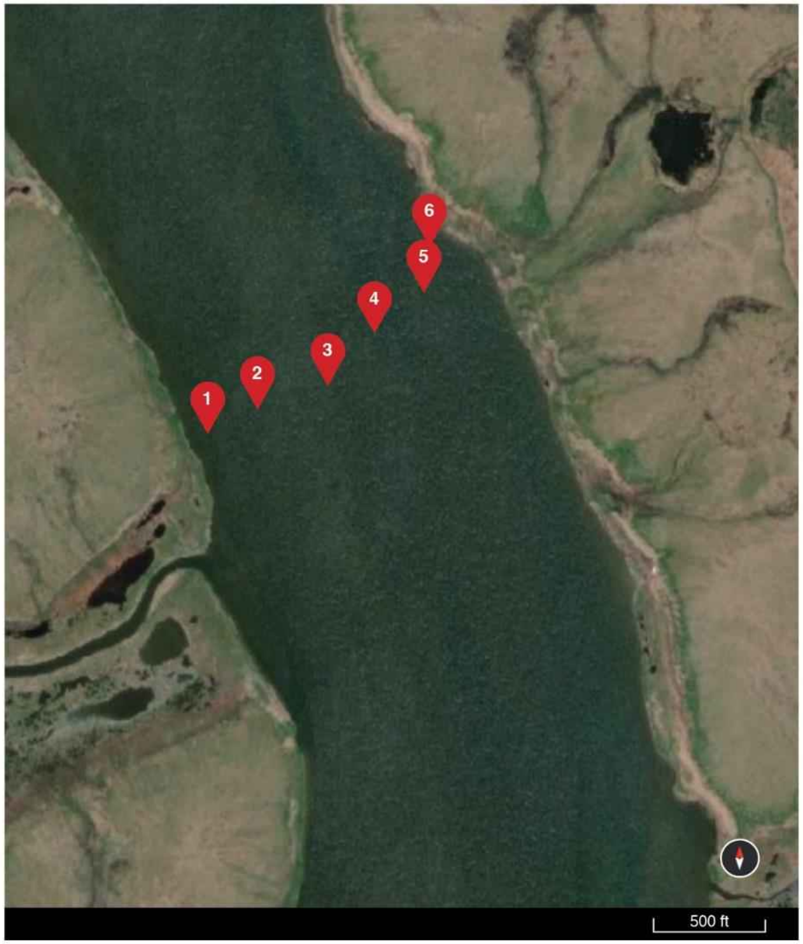
5. FIELD SURVEY AREA DESCRIPTIONS

5.1. UPPER FLAMBEAU

Figure 5-1 depicts the Upper Flambeau transect and sample stations. Data listed on Figure 5-1 indicates the Upper Flambeau is a freshwater system characterized by low salinities, water temperatures of 8.5 degrees Celsius (°C) to 10.3 °C, and freshwater-preferent SAV species. The low flows and SAV species are indicative of a silt/muck substrate associated with a depositional sediment regime (Figure 5-2). Substrate samples indicate absence of SAV at the deepest measured depth of 7.5 ft, indicating a euphotic threshold. Water temperatures and salinity correspond to ranges documented by ADF&G (2018).

Upper Flambeau – Sample Stations and Characteristics

2021 FIELD SURVEY



STATION	VEGETATION	DEPTH (ft)	FLOW (ft/sec)	TEMP (°C)	SALINITY (psu)
1	RUPPIA, ALGAE	4.0	NM	10.3	0.16
2	RUPPIA, ALGAE	5.0	0.8	9.6	0.14
3	ALGAE	3.5	0.0	9.4	0.14
4	NO SAV	7.5	0.8	9.3	0.14
5	ALGAE	5.0	0.6	9.1	0.14
6	RUPPIA	2.8	NM	8.5	0.14

NM=Not measured

Figure 5-1. Upper Flambeau River – Sample Stations and Characteristics

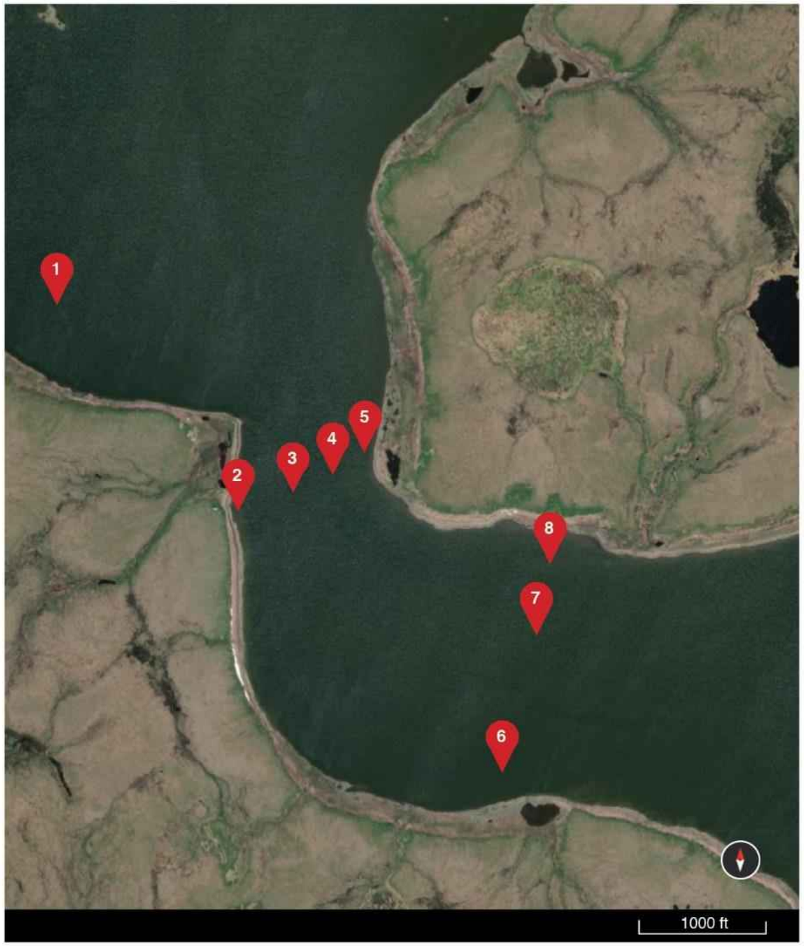
Figure 5-2. Upper Flambeau Substrate/Vegetation

5.2. LOWER FLAMBEAU

Figure 5-3 depicts the transects and sample stations on the Lower Flambeau. Data listed on Figure 5-3 indicate that the Lower Flambeau is a freshwater system characterized by low salinities, water temperatures from 10.1^{o}C to 11.7^{o}C, and freshwater-preferent SAV species. Compared to the Upper Flambeau, salinity and flow increased slightly (1.8 feet per second [ft/sec]) at discrete stations but were still oligohaline (0.5 to 5.0 practical salinity units [psu]). The low flows and SAV species are indicative of a silt/muck substrate associated with a depositional sediment regime (Figure 5-4). Sampling showed absence of SAV at the deepest measured depth of 6.5 ft indicating a euphotic threshold for the SAV. Water temperatures and salinity correspond to ranges documented by ADF&G (2018).

Lower Flambeau – Sample Stations and Characteristics

2021 FIELD SURVEY



STATION	VEGETATION	DEPTH (ft)	FLOW (ft/sec)	TEMP (°C)	SALINITY (psu)
1	RUPPIA	5.0	0.0	10.3	0.15
2	TRACE OF RUPPIA, ALGAE	3.5	0.0	11.7	0.38
3	ABUNDANT RUPPIA	5.0	0.4	11.7	0.25
4	ABUNDANT RUPPIA	5.0	0.6	10.1	0.14
5	MINOR RUPPIA	3.0	1.3	10.2	0.16 POSSIBLY GROUND WATER
6	NO SAV	6.5	NM	NM	NM
7	RUPPIA	4.0	0.2	10.3	0.13
8	ABUNDANT RUPPIA	4.0	0.8	10.5	0.14

NM=Not measured

Figure 5-3. Lower Flambeau – Sample Stations and Characteristics

Figure 5-4. Lower Flambeau Substrate/Vegetation

5.3. WESTERN SAFETY SOUND

Figure 5-5 depicts the sample stations in Western Safety Sound. Data listed on Figure 5-5 indicates that Western Safety Sound is a boundary condition exhibiting low salinities, increased overall water temperature (11.5^{o}C), increased depth, and transition to an eelgrass-dominated vegetative community as compared to the Upper and Lower Flambeau conditions (Stations 2 through 4, Figure 5-5). The depths and vegetation community are indicative of a sand-dominated substrate likely associated with flushing flows provided by tidal influences (Figure 5-6 and Figure 5-7). Water temperatures and salinity correspond to ranges documented by ADF&G (2018).

Western Safety Sound – Sample Stations and Characteristics

2021 FIELD SURVEY

STATION	VEGETATION	DEPTH (ft)	FLOW (ft/sec)	TEMP (°C)	SALINITY (psu)
1	MUD FLAT, NO SAV	1.5	NM	11.4	0.16
2	EELGRASS, RUPPIA	4.0	NM	11.3	0.16
3	EELGRASS, ALGAE	4.0	0.2	11.4	0.16
4	EELGRASS OUTER LIMITS	5.5	0.4	11.5	0.16
5	EELGRASS OUTER LIMITS	5.0	0.4	11.5	0.37

NM=Not measured

Figure 5-5. Western Safety Sound – Sample Stations and Characteristics

Figure 5-6. Western Safety Sound Substrate/Vegetation

Figure 5-7. Western Safety Sound Substrate/Vegetation

5.4. CENTRAL SAFETY SOUND

Figure 5-8 depicts the sample stations in Central Safety Sound. Data listed on Figure 5-8 indicate Central Safety Sound exhibits an eelgrass vegetation community boundary condition directly associated with depth and salinity. The data indicate a salinity boundary condition of 11.23 psu and depth of 5.5 ft. Figure 5-9 through Figure 5-11 show representative eelgrass densities and canopy height trending across the sample transect from west to east.. Water temperatures and salinity correspond to ranges documented by ADF&G (2018).

Central Safety Sound – Sample Stations and Characteristics

2021 FIELD SURVEY

STATION	VEGETATION	DEPTH (ft)	FLOW (ft/sec)	TEMP (°C)	SALINITY (psu)
1 (black)	NO EELGRASS, LIGHT RUPPIA	1.5	0.0	12.1	3.03
2 (black)	NO SAV	2.5	0.6	12.1	7.14
3 (black)	NO SAV	2.0	0.2	12.5	11.70
4 (black)	NO SAV	2.0	1.2	12.7	11.58
5 (black)	NO SAV	2.5	0.0	12.8	13.70
6 (black)	NO SAV	2.5	0.2	12.5	11.23
1 (yellow)	EELGRASS ABUNDANT	5.5	0.4	12.7	15.60
2 (yellow)	EELGRASS ABUNDANT	6.5	0.2	13.2	15.94
3 (yellow)	EELGRASS ABUNDANT	6.0	0.2	12.8	17.03
4 (yellow)	EELGRASS ABUNDANT	7.0	0.0	12.5	12.69
5 (yellow)	EELGRASS ABUNDANT	7.0	1.4	13.1	16.62
6 (yellow)	EELGRASS ABUNDANT	7.0	NM	13.0	14.70
7 (yellow)	MUCK BOTTOM, EELGRASS OUTER LIMITS	6.5	0.2	12.8	11.35

NM=Not measured

Figure 5-8. Central Safety Sound – Sample Stations and Characteristics

Figure 5-9. Central Safety Sound Representative SAV

Figure 5-10. Central Safety Sound Vegetation

Figure 5-11. Central Safety Sound Vegetation

5.5. EASTERN SAFETY SOUND/BONANZA CHANNEL MOUTH

Figure 5-12 depicts the sample stations in Eastern Safety Sound/Bonanza Channel Mouth. Data listed on Figure 5-12 indicate that the area is a freshwater system compared to Central Safety sound, characterized by lower salinities, shallower depths, and lower water temperatures. This area is a geomorphological shoal feature with coarse sand substrate with sparse SAV (Figure 5-13).

Eastern Safety Sound/Bonanza Channel Mouth – Sample Stations and Characteristics

2021 FIELD SURVEY

STATION	VEGETATION	DEPTH (ft)	FLOW (ft/sec)	TEMP (°C)	SALINITY (psu)
1	SHOAL TO WEST OF BONANZA CHANNEL	3.0	0.1	11.4	1.15
2	SPARSE RUPPIA	3.5	0.4	11.2	1.22
3	WAYPOINT ONLY				

Figure 5-12. Eastern Safety Sound/Bonanza Channel Mouth – Sample Stations and Characteristics

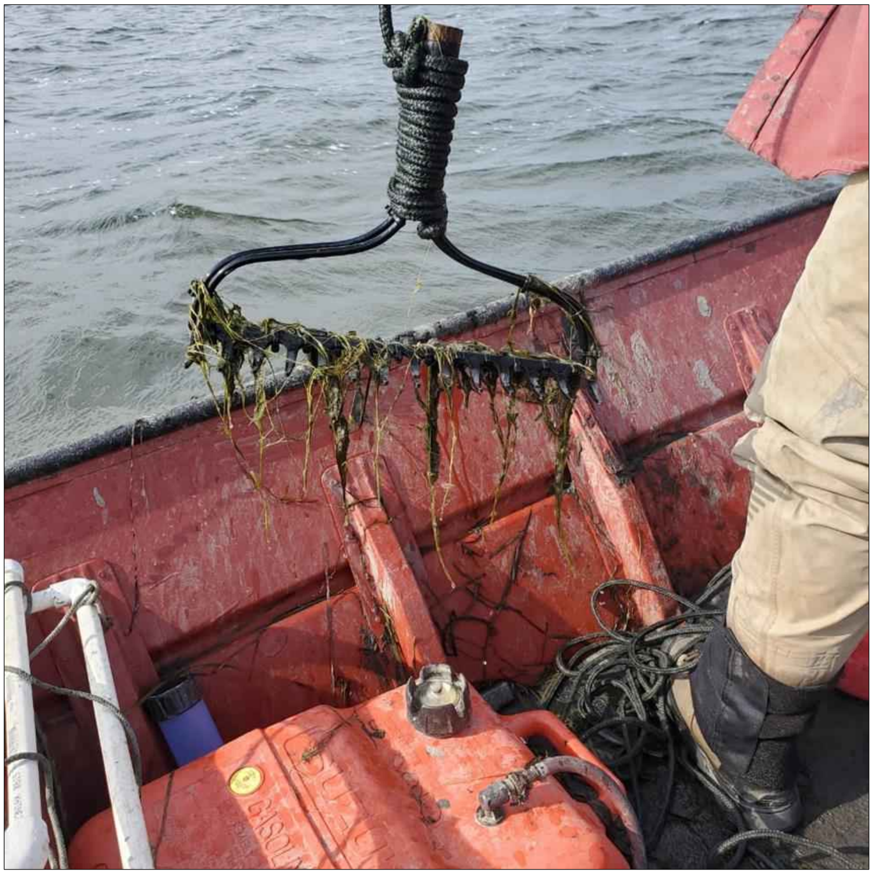


Figure 5-13. Eastern Safety Sound/Bonanza Channel Representative Vegetation

5.6. BONANZA CHANNEL

Water quality data were collected in August 2021 to further characterize the existing environmental conditions in the IPOP Bonanza Channel Placer Project claim area and adjoining waterbodies. The August 2021 dataset includes data from the mouth of the Solomon River northeast of the claims area to the Bonanza River/Bonanza Channel confluence to inform the hydraulic processes associated with the Bonanza Channel.

The August 2021 data were compared to results of water quality data collected August 2020. The August 2020 data were collected immediately prior to initiation of the small-scale dredge test (OEI 2021).

Figure 5-14 and Figure 5-14 depict August 2021 sample locations and results for salinity and temperature, respectively.

Figure 5-14. August 2021 – Salinity (psu)

Figure 5-15. August 2021 – Temperature (^{o}C)

The average water temperature in the Bonanza Channel in 2021 was roughly similar to the average temperature in 2020 (OEI 2021).

The average water temperature measured in August 2020 was 13.84°C and average water temperature in August 2021 was 14.64°C. This indicates water temperatures in 2021 were about 6% greater than in 2020. The average temperature in the Bonanza River confluence was generally similar to the claim area (most recordings were within a degree or two °C). Measured temperature in August 2021 at the Safety Sound outlet was 12.11°C and measured temperatures at Solomon River outlet were 9.5°C to 10.5°C.

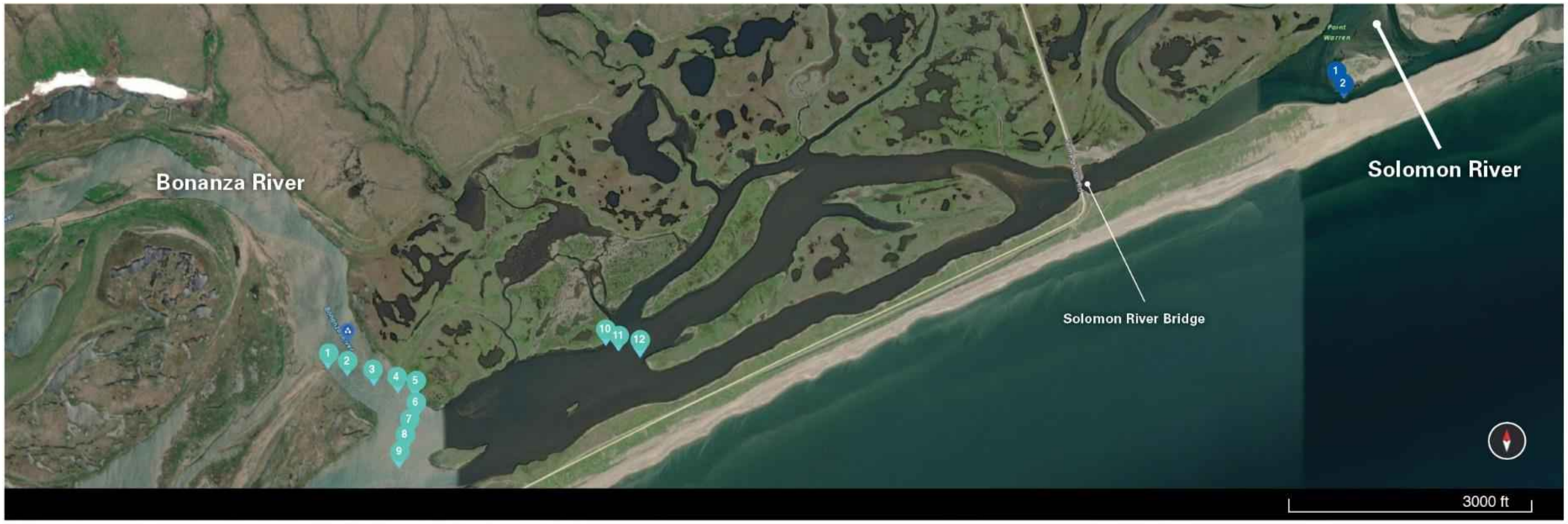
Average salinity in the Bonanza Channel from the August 2021 measurements was substantially lower than average salinity in August 2020. The average salinity encountered in August 2021 was 2.53 psu and average salinity in August 2020 was 14.27 psu. August 2021 average salinity was approximately 80% less than the average salinity in August 2020.

5.7. BONANZA RIVER/BONANZA CHANNEL CONFLUENCE

Figure 5-16 depicts the sample stations at the Bonanza River mouth to the outlet of the Solomon River. Data listed on Figure 5-16 indicate that the Bonanza River/Bonanza Channel confluence is a freshwater system, characterized by low salinities, shallow depths, and low water temperatures, with no detected salinities until nearly the Solomon River outlet to Norton Sound. This area is a geomorphological shoal feature with a coarse sand substrate with sparse SAV (Figure 5-17).

Bonanza River Mouth to Solomon Outlet – Sample Stations and Characteristics

2021 FIELD SURVEY



STATION	VEGETATION	DEPTH (ft)	FLOW (ft/sec)	TEMP (°C)	SALINITY (psu)
1	NO SAV	3.0	0.0	7.9	0.12
2	LIGHT RUPPIA	2.0	0.0	7.9	0.13
3	ALGAE	2.0	NM	7.9	0.13
4	NO SAV	3.5	0.0	7.7	0.15
5	NM	3.0	0.0	7.7	0.16
6	NO SAV	3.5	0.0	7.7	0.15
7	NM	2.0	0.4	7.8	0.14

STATION	VEGETATION	DEPTH (ft)	FLOW (ft/sec)	TEMP (°C)	SALINITY (psu)
8	NO SAV	2.0	0.6	7.9	0.18
9	NO SAV, OUTER EDGE OF HYDRAULIC HEAD	2.0	0.2	7.9	0.16
10	NO SAV	1.5	0.2	7.9	0.30
11	ALGAE	4.0	0.6	7.9	0.18
12	NO SAV	4.0	0.2	7.8	0.23
1	–MEASURED FOR SALINITY ONLY–				10.23
2	–MEASURED FOR SALINITY ONLY–				9.20

NM=Not measured

Figure 5-16. Bonanza River Mouth to Solomon River Outlet – Sample Stations and Characteristics

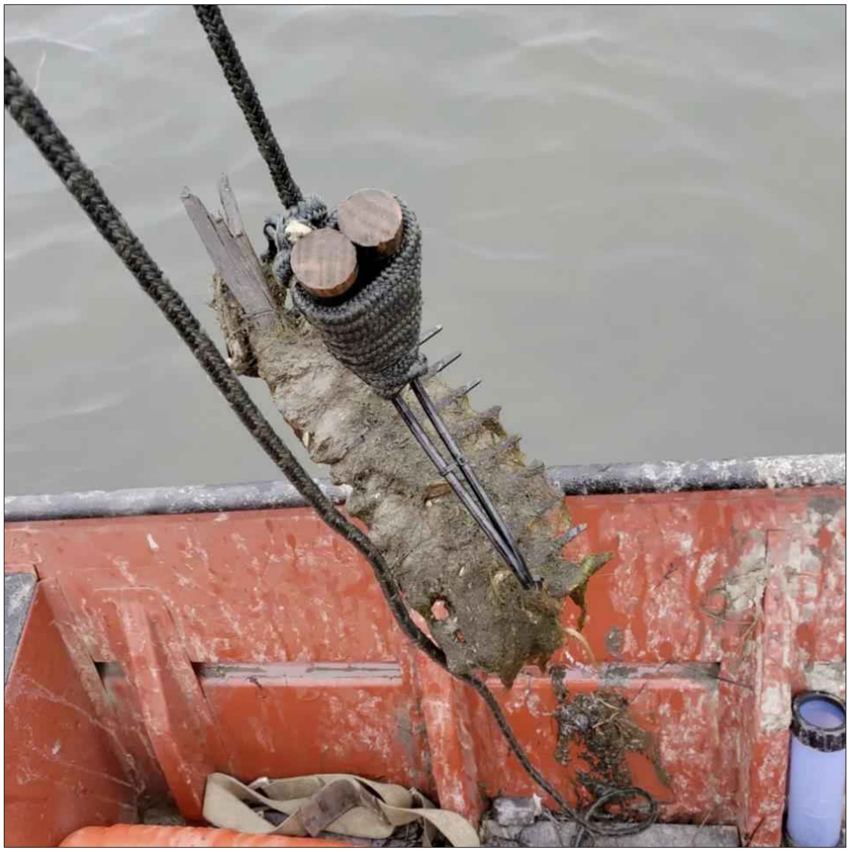


Figure 5-17. Bonanza River Mouth to Solomon River Outlet Substrate

5.8. EELGRASS PRESENCE

Figure 5-18 depicts the salinity and depth measurements to eelgrass presence from the Flambeau River to the Safety Sound/Bonanza Channel confluence. Abundant eelgrass occurs off the north shore of Safety Sound, in relatively deep water (up to 7 ft) and in saline conditions. Quantitative surveys of SAV and presence of eelgrass in the project area are provided in Eilers (2020 and 2021).

Salinity and Depth Related to Eelgrass Presence

2021 FIELD SURVEY

	Area	Vegetation Summary	Depth (ft)	Flow (ft/sec)	Temp (°C)	Salinity (psu)
A.	Upper Flambeau	none, algae, ruppia	2.8 - 7.5	0.0 - 0.8	8.5 - 10.3	0.14 - 0.16
B.	Lower Flambeau	none, algae, ruppia (traces - abundant)	3.0 - 6.5	0.0 - 1.3	10.1 - 11.7	0.13 - 0.38
C.	Western Safety Sound	none, algae, eelgrass, ruppia	1.5 - 5.5	0.2 - 0.4	11.3 - 11.5	0.16 - 0.37
D.	North Shore	none, light ruppia	1.5 - 2.5	0.0 - 1.2	12.1 - 12.8	3.03 - 13.7
E.	Off North Shore	abundant eelgrass	5.5 - 7.0	0.0 - 1.4	12.5 - 13.2	11.35 - 17.03
F.	Bonanza Channel Mouth	sparse ruppia	3.0 - 3.5	0.1 - 0.4	11.2 - 11.4	1.15 - 1.22
G.	Case Study Area	ruppia, sago pondweed, horned pondweed	2.2	0.1 - 0.4	13.0 - 19.33	0.10 - 0.32
H.	Bonanza River Mouth	none, algae, light ruppia	1.5 - 4.0	0.0 - 0.6	7.7 - 7.9	0.12 - 0.30
I.	Solomon Outlet	--Measured for Salinity Only--				9.2 - 10.23

Figure 5-18. Salinity and Depth Related to Eelgrass Presence

6. WATER CIRCULATION

There is no publicly available information regarding flows in the Eldorado or Bonanza/Solomon rivers complex. The surrounding landscape is comprised of relatively flat coastal wetlands, grassland, and tidal mudflats. Freshwater hydrology is primarily influenced by the Solomon and Bonanza rivers. Smaller freshwater inputs from the north shore of Bonanza Channel include Pine Creek and Secret Creek. Other nearby freshwater rivers include the Eldorado/Flambeau rivers complex which contribute to the waters of Safety Sound.

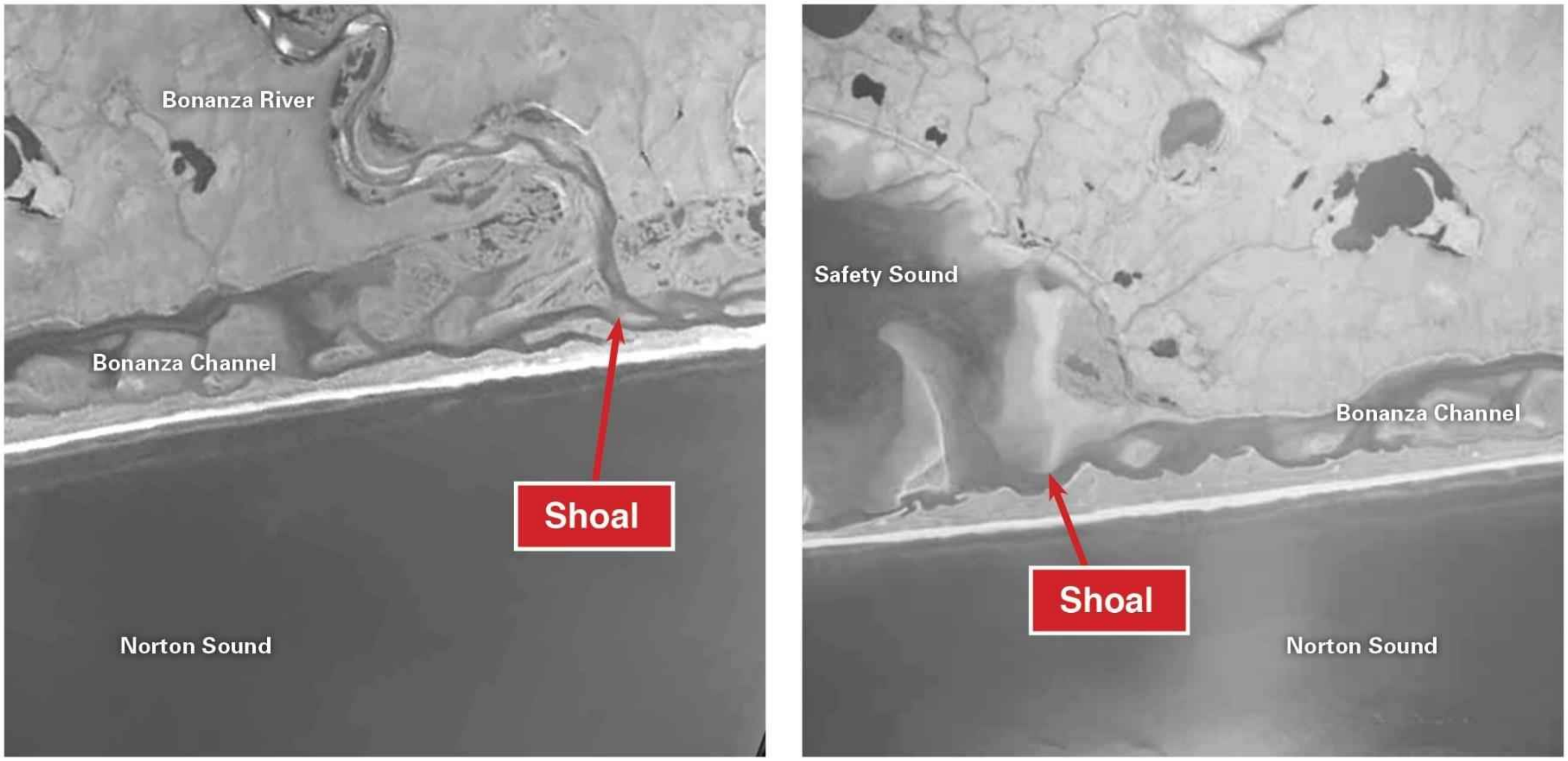
In June 2020, the project collected hydrologic flow data from 122 locations in Bonanza Channel with a single point maximum of 0.5 ft/sec, mean flow of 0.3 ft/sec, and average flow of 0.2 ft/sec (OEI 2021). These data suggested the Eldorado and Bonanza/Solomon rivers complex exert hydrostatic control throughout the project area. The valley width, well-vegetated low banks, and absence of visible bank erosion indicate that large inland storm events are mitigated by hydrologic storage in Safety Sound and the Bonanza/Solomon rivers complex. Flushing flows are provided by tidal action that rarely exceeds 3 ft in elevation.

A review of historical aerial photographs (c. 1950 to 1951) was initiated to evaluate channel stability and shoals in Bonanza Channel (Figure 6-1). Figure 6-2 and Figure 6-3 are recent photographs of the shoals. Historical aerial photographs were also evaluated regarding the flow patterns in the Flambeau River and Bonanza River (Figure 6-4) drainages prior to any impacts associated with the installation of the bridges across the Safety Sound outlet and the Bonanza Channel on the Nome-Council Highway. Of note are shoals at the Bonanza River/Safety Sound Confluence and the Bonanza River/Bonanza Channel confluence that have been persistent geomorphic features since 1950. The shoal at Bonanza River/Bonanza Channel directs surface flow past the Bonanza Channel confluence eastward to the mouth of the Solomon River.

Flows in the vicinity of the shoals were measured in 2021. The data indicate that the Bonanza River contributes minimal surface flow to the Bonanza Channel westward to the confluence with Safety Sound.

Shoal Presence in USGS Images c.1950-1951

2021 FIELD SURVEY



Bonanza Channel Islands and Shoal

Bonanza Channel/Safety Sound Confluence Shoal

Figure 6-1. Shoal Features in Historical Photos (1950-1951)

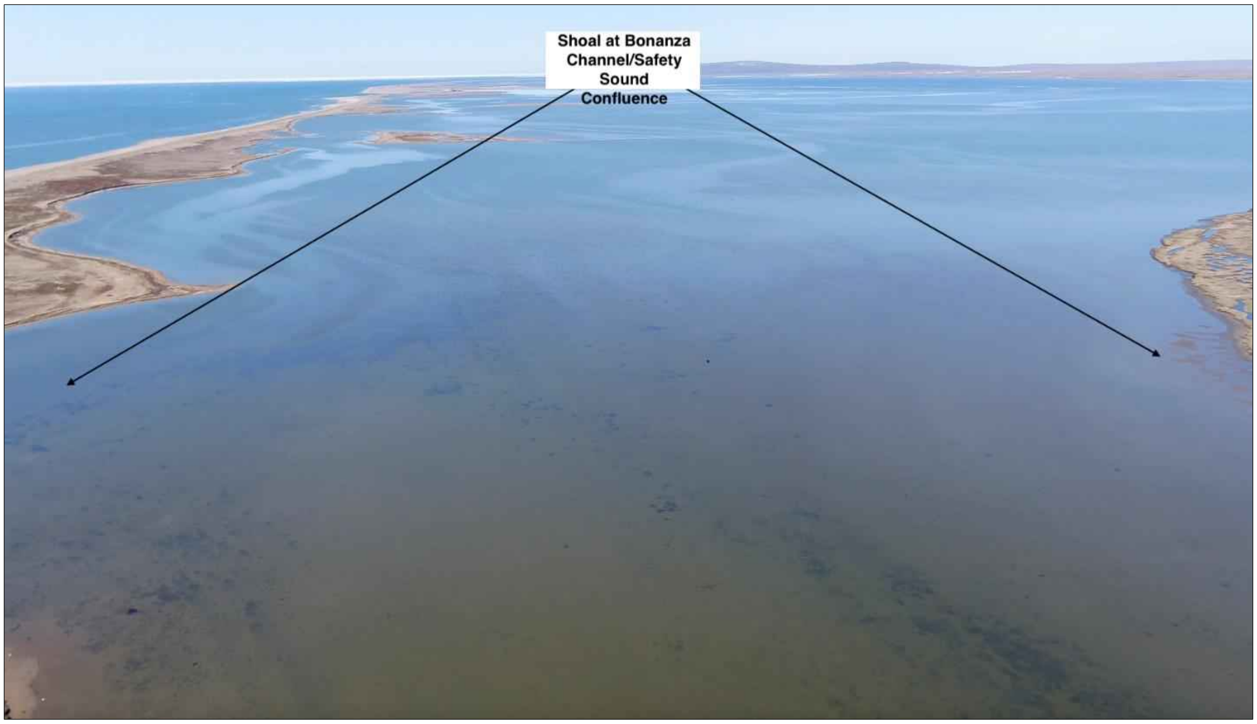


Figure 6-2. Shoal at Bonanza Channel/Safety Sound Confluence, View to West (2021)

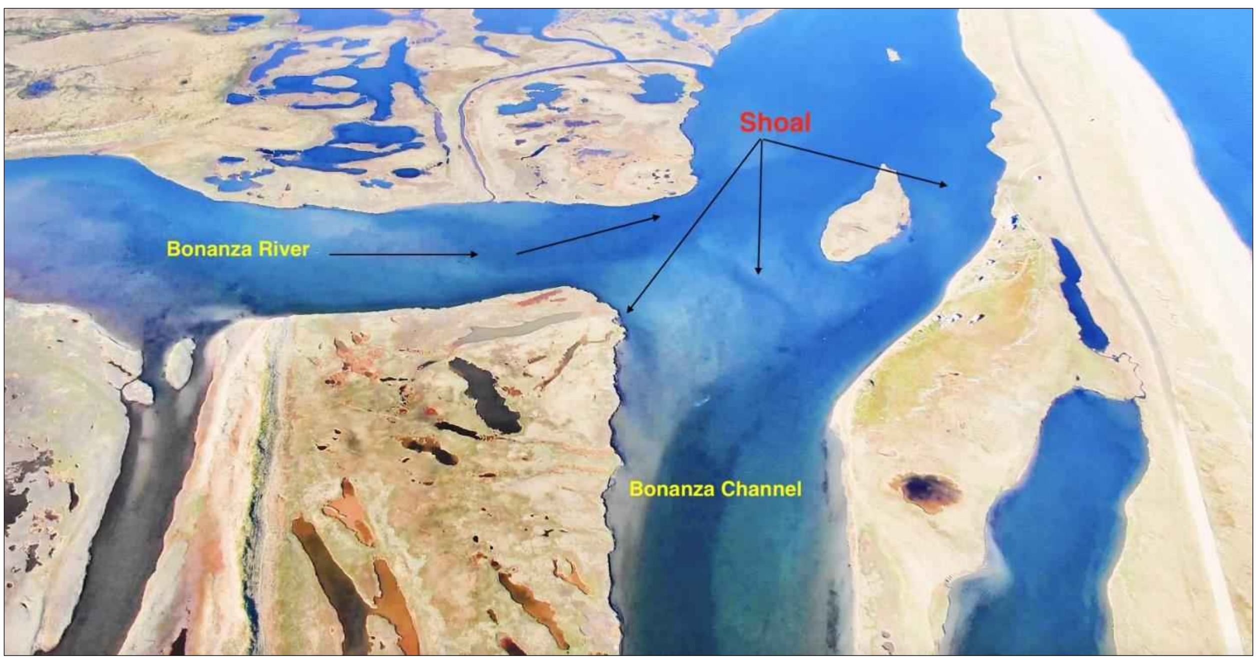
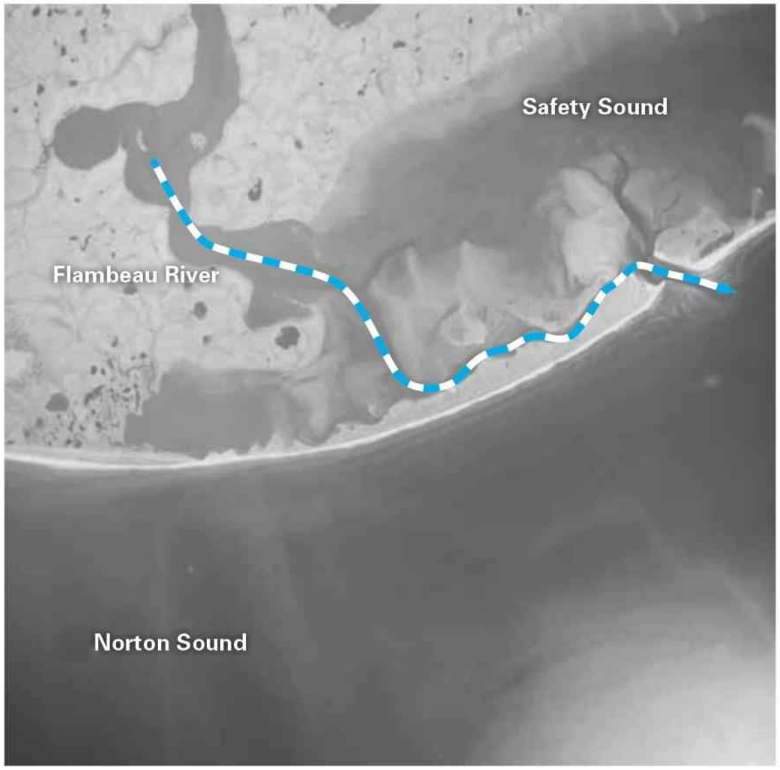
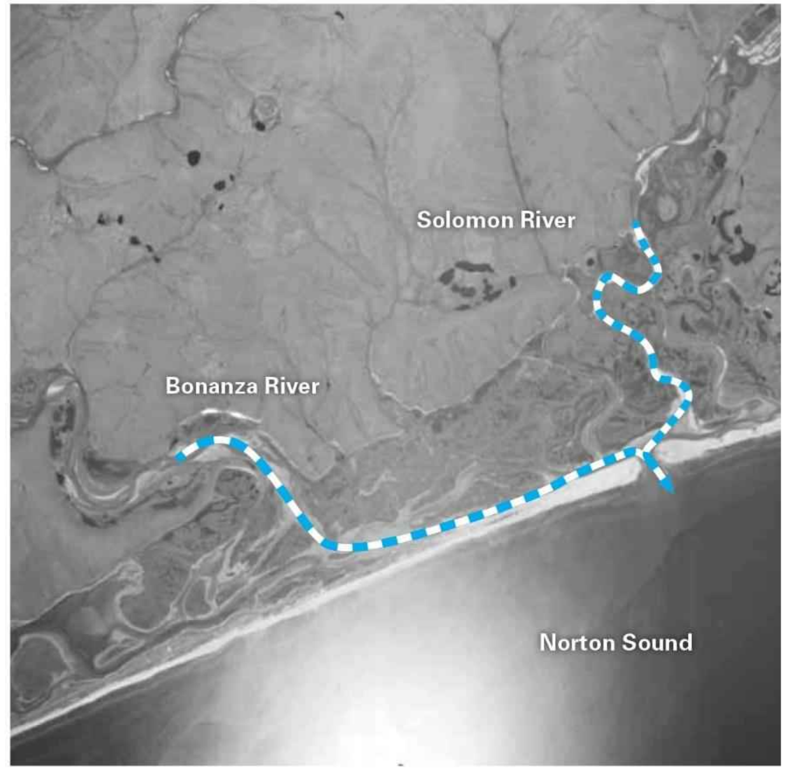


Figure 6-3. Shoal at Bonanza River/Bonanza Channel Confluence. View to East (2021)

Water Flow USGS Images c.1950-1951	2021 FIELD SURVEY



Flambeau River Flow Direction



Bonanza and Solomon Rivers Flow Direction

Figure 6-4. Flow Patterns of Flambeau and Bonanza Rivers in Historical Photos (1950-1951)

6.1. Hydrology of the Flambeau, Bonanza/Solomon Rivers

There is no direct stream flow data associated with rivers in the project area; however, there is a USGS gage station on the Snake River in Nome, approximately 25 miles to the west. The data from this station (USGS 15621000SNAKE R NR NOME AK) is proximate and in the same hydro-physiographic region, thus appropriate for comparative analysis of stream flow. A flood frequency analysis was performed on 27 years of record for the Snake River and extrapolated by drainage area to the Flambeau, Bonanza, and Solomon rivers (Table 6-1).

Table 6-1. Results of Flood Frequency Analysis for Snake River, Alaska as Extrapolated for Project Area Rivers

River	Drainage Area (sq mi)	Bankfull Discharge (cfs)
Snake	86	2,330
Flambeau/Eldorado	240	6,291
Bonanza	86	2,330
Solomon	135	3,728

sq mi = square mile(s) (rounded to nearest mile)
cfs = cubic feet per second
Source: USGS 15621000SNAKE R NR NOME AK Peak Discharge for 27 years of record.
https://waterdata.usgs.gov/ak/nwis/uv?site_no=15621000
USGS HUC-12 Watershed Boundary Data Set

The 2021 field survey included determining flow patterns of the Bonanza River from July 29 to August 14 during a period of high water (as exhibited by data recorded at USGS gage 15621000) . A simple current indicator was deployed in the 2021 field survey and tracked downstream to the Bonanza Channel bridge on the Nome-Council Highway. The current indicator was then deployed at the Bonanza River/Bonanza Channel confluence and subsequent flow measurements recorded. Flow measurements were also recorded at the Safety Sound/Bonanza Channel confluence and are shown in Figure 5-12.

Results of analysis of the bankfull discharge from the Flambeau and Bonanza/Solomon rivers from Table 6-1 is shown in Figure 6-3. The Bonanza and Solomon rivers share the same outlet to Norton Sound and function as a single hydrologic connection with a combined drainage area (221 sq mi) and discharge (6,058 cfs) that is almost identical to the Flambeau River (drainage area 240 sq mi) and a discharge of 6,291 cfs . This creates a hydraulic head on eastern and western confluences of Bonanza Channel, resulting in little to no flow as indicated by flow measurements collected in 2020 and 2021. The water in Bonanza Channel is most likely the result of groundwater capture from the Bonanza River and hillslope runoff from the north bank and Pine and Secret creeks (Figure 6-4).

Note: Data are listed in Table 6-1.

Figure 6-3 Bankfull Discharges from Flambeau River and Bonanza/Solomon Rivers Complex

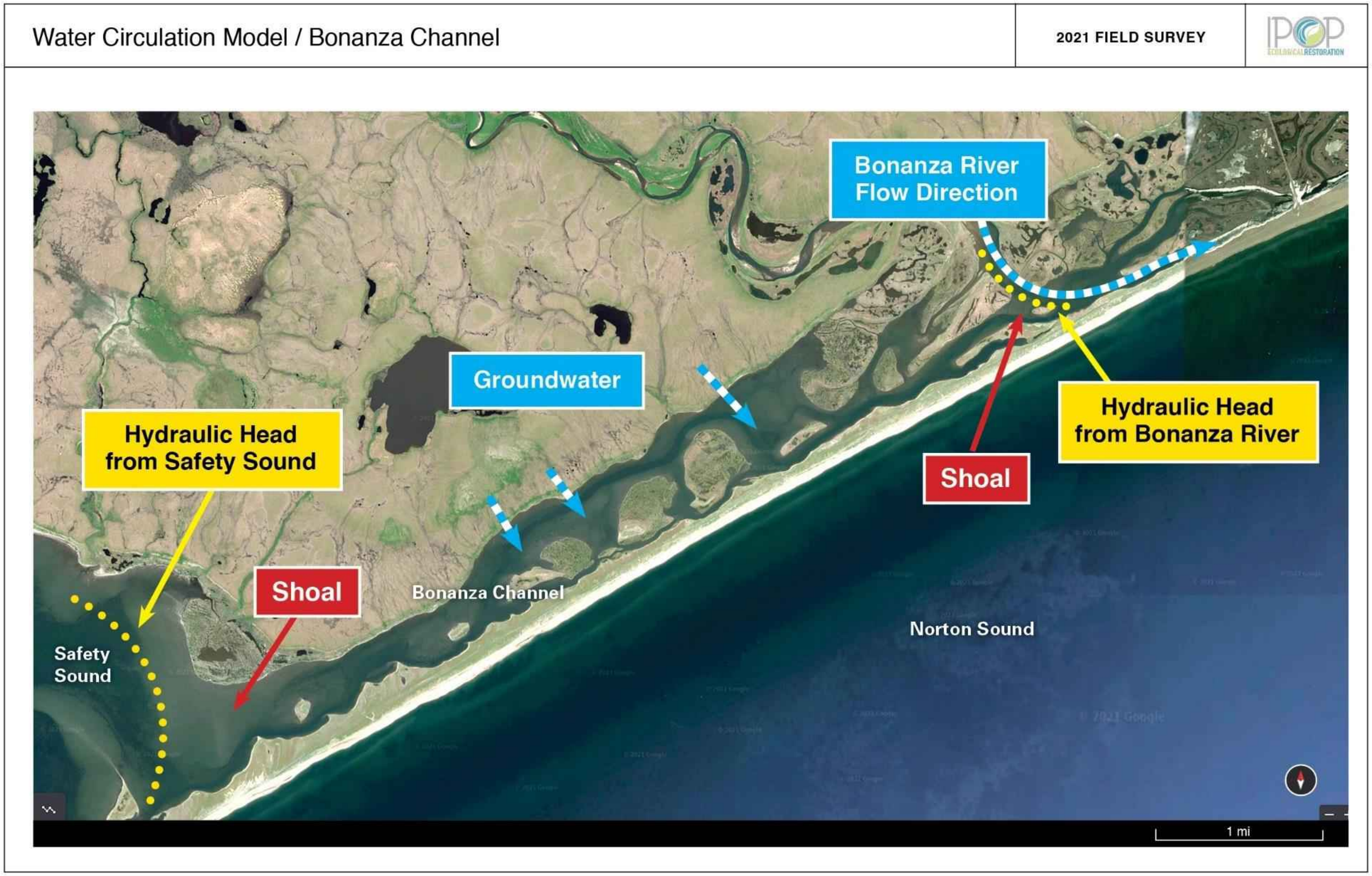


Figure 6-4. Water Circulation Model/Bonanza Channel

6.2. Channel Stability and Flow Patterns – Safety Sound Outlet

Historical documents and aerial photographs were reviewed to evaluate previous channel stability and flow patterns in both the Flambeau and Bonanza rivers drainages before installation of the bridges across Safety Sound outlet and Bonanza Channel along the Nome-Council Highway. The Draft the Environmental Impact Statement, Safety Sound Estuary Bridge Project (Alaska Department of Highways 1973) states:

> "The gap at Safety Inlet is approximately one third of a mile in width. Ferries have been utilized to cross this inlet and various types have been in use for more than 60 years….The proposed bridge project would replace and existing ferry facility on the Nome-Council Highway…The 805 foot bridge and a 900 foot long causeway would provide passage across an inlet called Safety Inlet. Two approaches to the bridge and causeway of 2400 feet and 1900 feet respectively, will tie the new facility to the existing road."

Figure 6-5 shows the Safety Sound outlet in 1950, specifically noted are the Flambeau River outlet, a swale on the eastern shore and the perpendicular orientation of the channel outlet to Norton Sound.

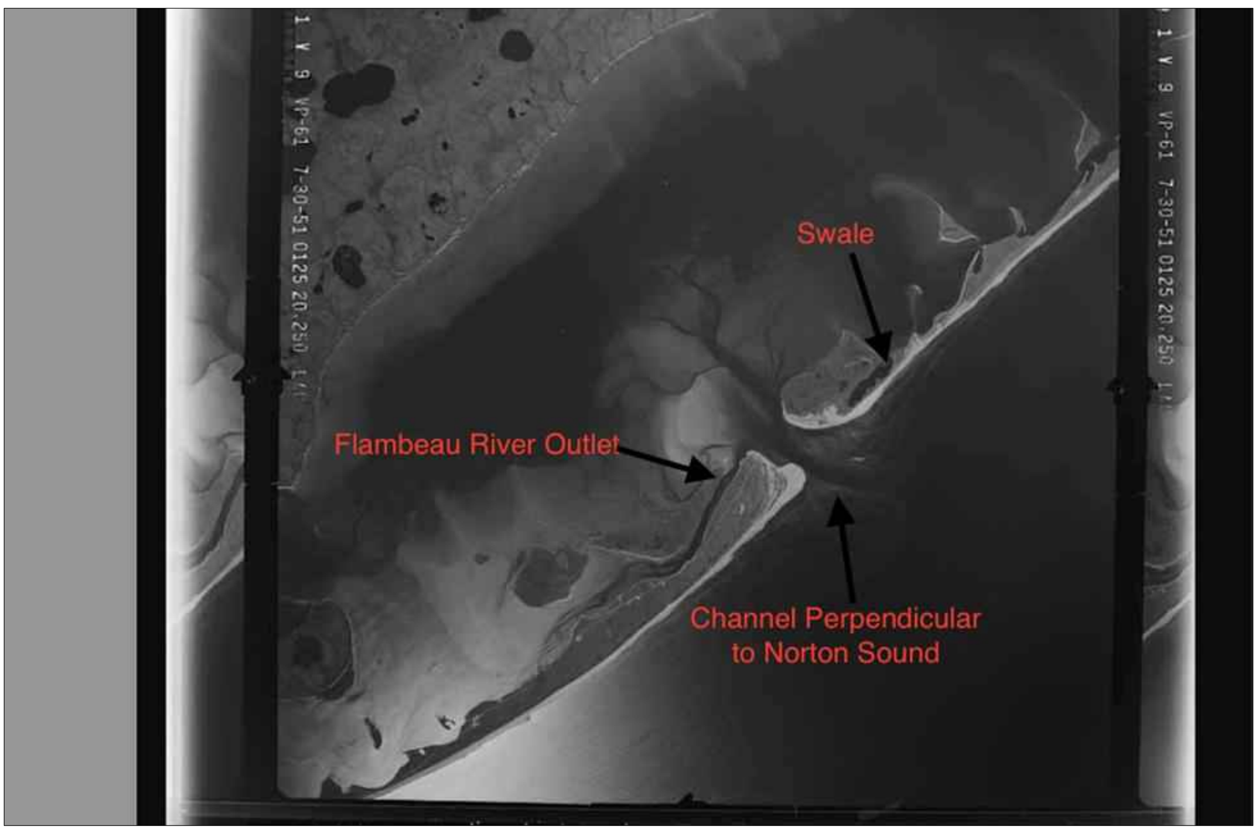


Figure 6-5 Safety Sound in 1950

Figure 6-6 shows the existing condition of the bridge and outlet from current imagery. The bridge, approaches and causeway have changed the morphology and flow patterns, in particular:

- The approaches and bridge narrowed the outlet by approximately 1,000 ft

- The Flambeau River outlet has significantly narrowed as a result of impingement between the bridge approach and sandbar.
- Increased shoaling to the west of the outlet which has altered the perpendicular orientation to Norton Sound, pushing the outlet channel to the east, resulting in erosive forces on the eastern road prism.
- The low swale to the east has been impacted by both channel migration and likely increases in the base level of Safety Sound due to the narrowing of the outlet and resultant impoundment above base elevations upstream of the bridge.

Source: Google Earth 2021

Figure 6-6. Safety Sound Outlet Bridge 2021

6.3. Channel Stability And Flow Patterns – Bonanza Channel Bridge and Outlet

Historical photographs show that the Bonanza Channel was a single-thread channel flowing west to east in an apparent shared outlet with the Solomon River into Norton Sound (Figure 6-7). At the time of the imagery, the Bonanza Channel/Solomon River outlet was perpendicular to the barrier island, approximately 3,500 ft to the west of the present location.

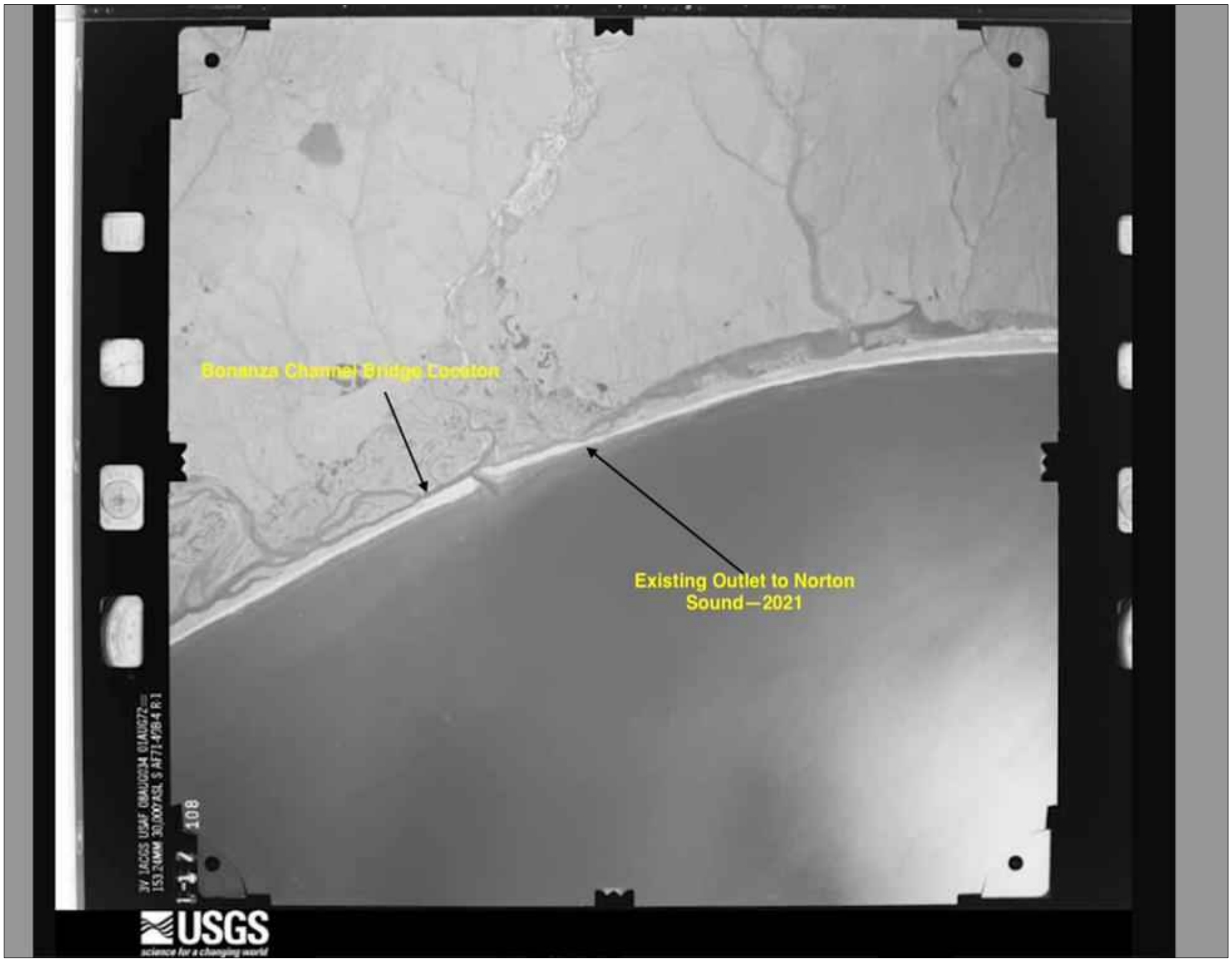
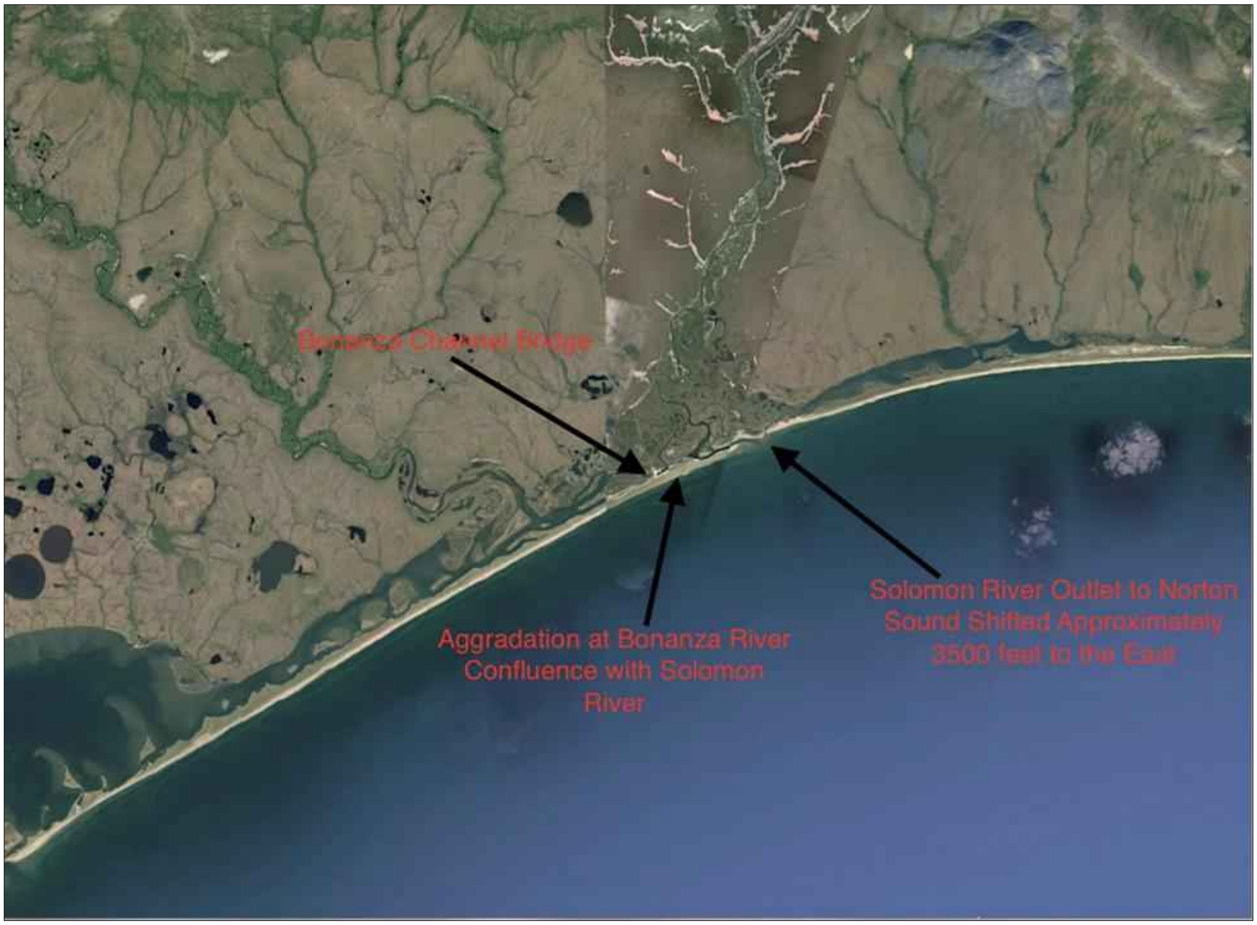


Figure 6-7. Historical Aerial Photograph of Bonanza Channel and Bridge Location

Figure 6-8 and Figure 6-9 show the currently existing condition downstream of the Bonanza Channel bridge and outlet. The channel dimensions, outlet morphology and flow patterns have changed, in particular:

- The barrier island at the historical outlet increased in width, likely from both littoral sediment transport from Norton Sound and fluvial aggradation at the historical Bonanza River/Solomon rivers confluence.
- The outlet to Norton Sound has moved approximately 3,500 ft to the east
- The outlet to Norton Sound has changed orientation from perpendicular to trending parallel to Norton Sound (this may affect seawater circulation patterns).
- The Bonanza Channel is approximately 500 ft wide above the bridge.
- The current bridge opening is approximately 175 ft, less than half of the existing channel upstream, likely impounding water at all flows.



Source: Google Earth 2021

Figure 6-8 Bonanza Channel Bridge and Outlets to Norton Sound (2021)

Source: Drone photography 2021

Figure 6-9 of Bonanza Channel Bridge Opening (2021)

7. GRAIN SIZE ANALYSIS

This section describes grain size versus suspension and bedload transport, predicted vs. observed, in the Bonanza Channel, based on data collected in August 2020 and August 2021.

The purpose of this analysis is to compare the theoretical ability of the waters of the Bonanza Channel to hold small-sized particles in suspension over distance (during non-storm related, normal wind, and tidal events) with the empirically obtained data collected during the dredge test completed without a turbidity curtain in 2020 (OEI 2021). In addition, the Hjulstrom[1] diagram, along with the Bernoulli Principle, and the Froude Number were considered.

<u>Definitions and assumptions:</u>

The Froud Number (F_r) for the Bonanza Channel is assumed to be <1; F_r = flow velocity/(acceleration of gravity * force of inertia)

$F_r = V/\sqrt{(gD)}$

Where:

- V=velocity

[1] The Hjulstrom diagram, or curve, is a graph used by hydrologists and geologists to determine if a stream will erode, transport, or deposit sediment. The graph accounts for sediment particle size and water velocity.

- D=depth of flow
- g=gravitational constant.

Consequences:

- **F_r < 1** results in **tranquil flow**. The velocity of **gravity waves** is greater than the flow velocity (i.e., waves can move upstream).
- **F_r > 1** results in **rapid flow**. The velocity of **gravity waves** is less than the flow velocity, so no waves propagate upstream.

(University of Maryland 2021)

The sediment, itself, is transported as three distinct **loads**:

- **Dissolved load**: The fraction in solution as ions
- **Suspended load**: That fine portion that is kept in constant suspension by electrostatic and viscous interactions with the surrounding water. Generally clay or silt sized particles.
- **Bed load**: That portion that cannot be kept in constant suspension. Generally sand-sized and larger. The bed load moves in two manners:
    - **saltation**: bouncing along the stream bed, or being repeatedly picked up and put down by F_F.
    - **Traction**: The remainder that **rolls** or **slides** in constant contact with the bed.

Froud Number calculations were conducted for Bonanza Channel (generally calculated in metric system; final result converted to standard units). Based on Table 7-1, no Fr approach a value of 1 for measurements obtained in the Bonanza Channel, indicating tranquil flow.

FROUD Number Calculations						
$F_r = V/\sqrt{(gD)}$		**VELOCITY (ft/s)**	**0.1000**	**0.2000**	**0.3000**	**0.5000**
		VELOCITY (cm/s)	**3.0480**	**6.0960**	**9.1440**	**15.2400**
		VELOCITY (m/s)	**0.0350**	**0.0700**	**0.0914**	**0.1524**
	D Depth (m)	**D Depth (ft)**				
Average	**0.584**	**1.916**	0.015	0.029	0.038	0.064
Mid	**0.914**	**3**	0.012	0.023	0.031	0.051
Deep	**1.514**	**5**	0.009	0.018	0.024	0.040

Table 7-1. FROUD Number Calculation for Bonanza Channel

The depth and velocities shown generally correspond to minimum/average or mean/maximum obtained, August 2020. For example, Recorded Average Depth of 23 inches or 1.916 ft (based on August 2020 Bathymetry Survey, Eilers, 2020).

Based on the calculated results, **F_r < 1** results in **tranquil flow**. This is evident upon examination of the bottom structures of the channel, which is largely featureless, ripple-less mud flat, or small ripple bedforms. These represent the lowest energy fluvial environments as documented (Wondzell and Gooseff. 2013).

Applying Hjulstrom, the flow regime of the Bonanza Channel results in settlement of suspended particles, rather than transport, with the maximum flow rate measured in Bonanza Channel (0.5 ft/sec or 15.24 centimeters per second) (Figure 7-1).

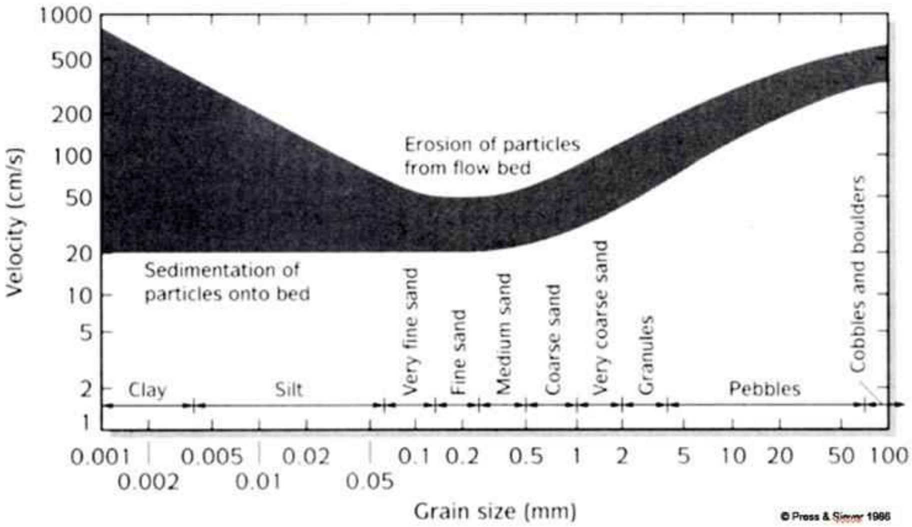


Figure 7-1. Hjulstrom Diagram

There is a relationship between stream velocity (i.e., energy) and the grain size clast that it can transport. Intuitively, larger clasts need more energy to be moved than smaller ones, but reality is more subtle. This is shown in the Hjulstrom diagram (Figure 7-1), that shows a zone of sediment transport in black. The upper limit is the velocity at which a clast of a given size is entrained, the lower limit is the velocity at which an entrained clast is deposited (University of Maryland 2013).

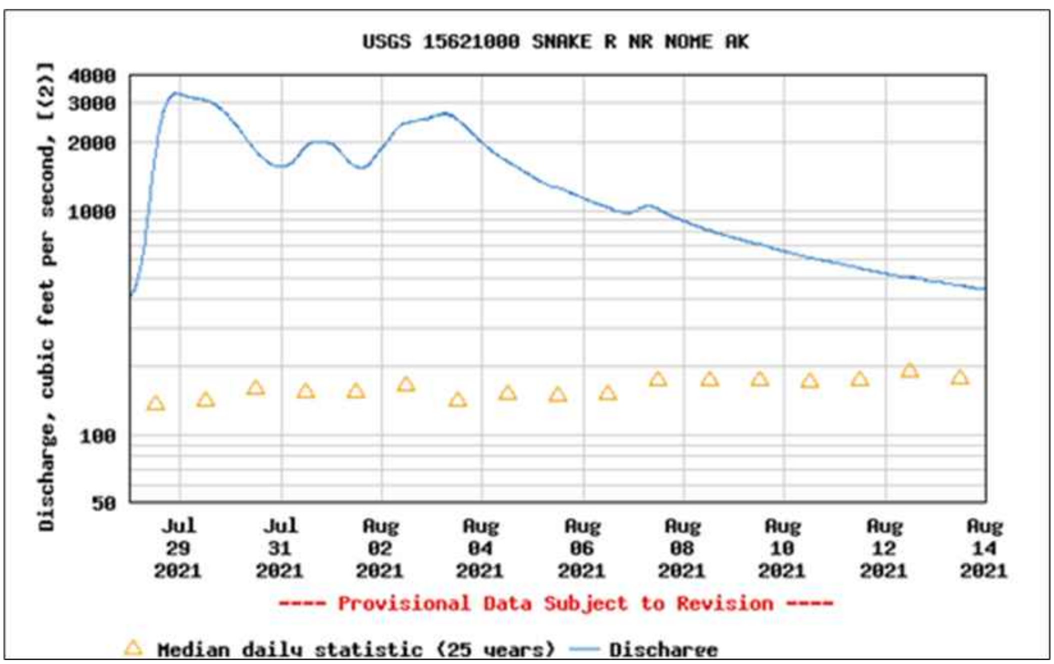
Further, results of the dredge test without use of a turbidity curtain (August 2020) showed minimal or no remaining turbidity above seasonal high background levels at a distance of approximately 300 ft. The entrance to Safety Sound is approximately 3,700 ft from the westernmost proposed full-scale dredge channel, and approximately 13,400 ft west of the proposed Case Study area.

8. SALINITY ANALYSIS IN BONANZA CHANNEL

During the 2020 survey, measured salinity values throughout the project area in Bonanza Channel were consistently uniform, ranging from 13 to 16 psu indicating a halosaline system. Conversely, during 2019 and 2021 field surveys, measured salinity values in the Bonanza Channel and Bonanza River were uniformly indicative of a freshwater system. Figure 8-1 shows USGS gage station data for the Snake River from August 2020 and Figure 8-2 shows the data from 2021.

Note: Orange triangles are median daily discharge for 25 years of record.

Figure 8-1. USGS Gage Station Hydrograph, Snake River. August 19-31, 2020



Note: Orange triangles are median daily discharge for 25 years of record.

Figure 8-2. USGS Gage Station Hydrograph, Snake River, July 29-August 14, 2021

Higher salinities recorded in 2020 than in the 2021 field study [OEI 2021). Figure 8-1 and Figure 8-2 essentially bracket the high/low extremes in flows, which helps to explain the ranges in salinity and variability in the system.

The 2021 salinity measurements in Safety Sound indicate a "salt wedge" boundary condition extending to the vicinity of Bonanza Channel/Safety Sound confluence. Increased freshwater discharge recorded in 2021 and result in an increased hydraulic head which extends the mixing zone toward the ocean.

Typical freshwater /seawater mixing zones under high flow and low flow conditions are depicted in Figure 8-3 and Figure 8-4, respectively.

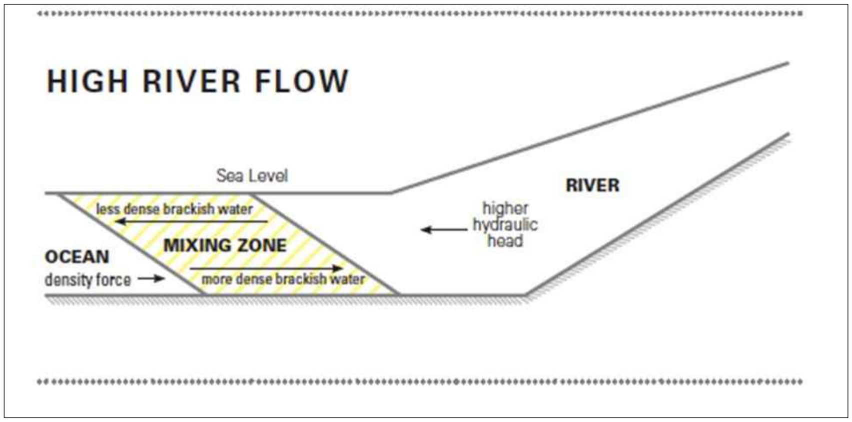


Figure 8-3. High River Flow Mixing Zone

Lower freshwater discharges was reported in 2020 and shown in Figure 5-27, result in a lower hydraulic head which extends the mixing zone towards freshwater, in this case the Bonanza Channel, and results in increased salinities.

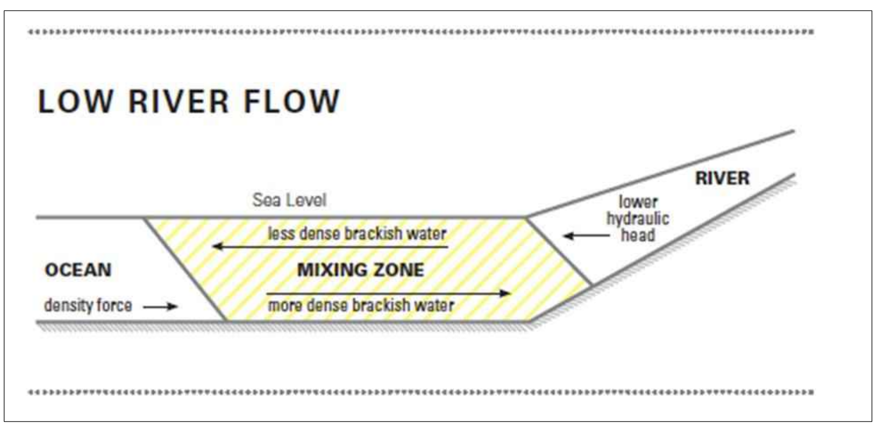
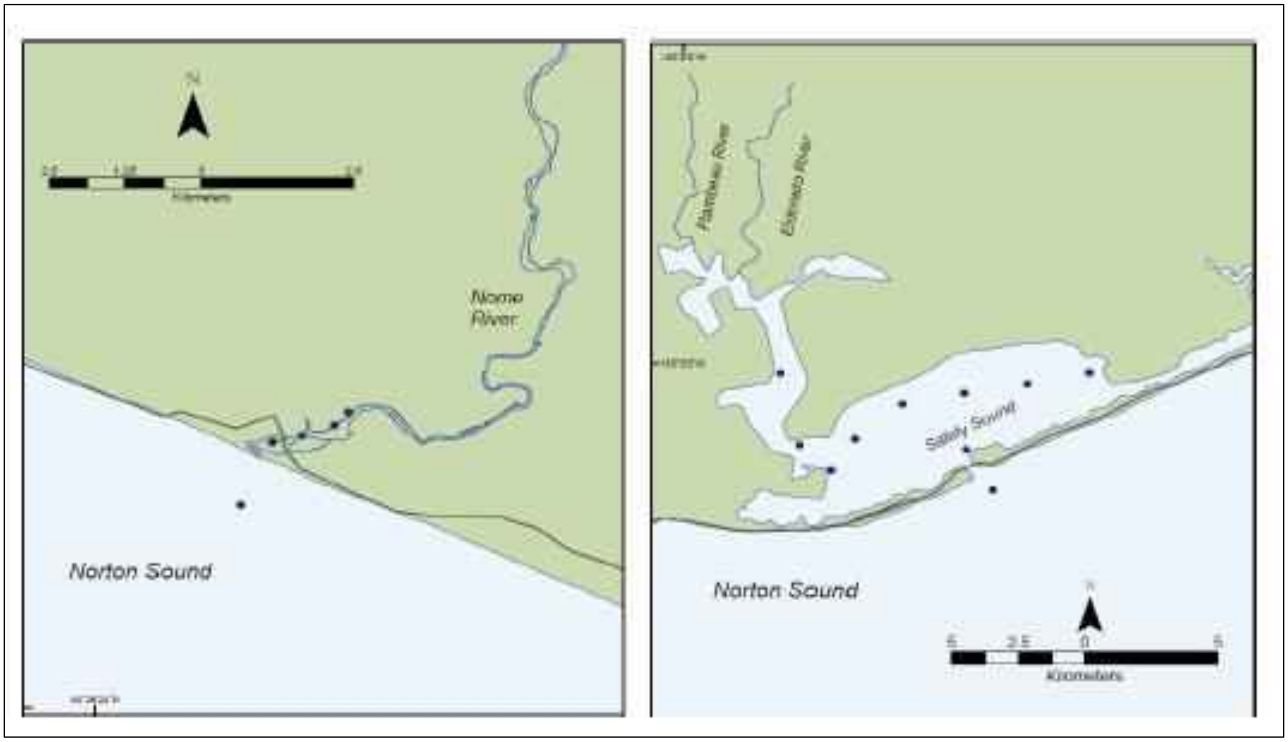


Figure 8-4. Low River Flow Mixing Zone

The discharge data represents the extremes of the possible freshwater/saltwater interface in the Bonanza Channel and demonstrates the wide range of natural variability in the system and the perturbances and stresses in which the biotic community is exposed. Using the SAV surveys in the Flambeau River an analog, the SAV community in the Bonanza Channel is more similar to freshwater than saltwater.

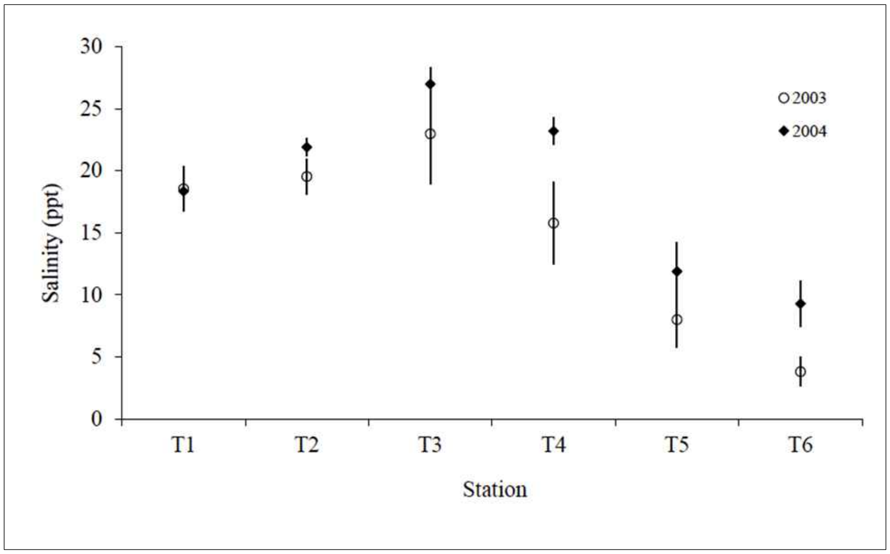
Figure 8-5 depicts sample locations for temperature and salinity measurements near the mouth of the Nome River east of the project area (years 2004 and 2005), and in Safety Sound and Flambeau/Eldorado rivers complex (years 2003 and 2005). Figure 8-6 is a graph of the salinity data from these surveys.



Note: Salinity the sample locations is on Figure 8-6.
Source: ADF&G 2018

Figure 8-5. Temperature and Salinity Sample Locations in the Nome (2004 and 2005) and Eldorado River watersheds

Figure 8-6 is an excerpt from ADF&G (2018). The project's 2021 field survey data closely correlates with the ADF&G data with declining salinities trending west to east at the Bonanza Channel/Safety Sound confluence.



Source: ADF&G 2018
Notes: Survey stations are listed east to west as depicted in Figure 8-5. Vertical lines are 1 SE. Transects were not performed in 2005.

Figure 8-6. Mean Salinity Across Safety Sound, 2003 and 2004

9. WETLAND CONFIRMATION SAMPLING

Confirmation sampling was conducted for National Wetlands Inventory mapping designations.

Wetlands were sampled to confirm desktop wetlands analysis shown in Figure 9-1. Confirmation test pit locations are shown on Figure 9-2. Results were photo-interpreted by a certified wetland scientist. Figure 9-3 through Figure 9-7 are photographs of test pit 1 through 4 and test pit 6. In addition to the wetland confirmation sampling, the field team investigated the soil conditions on the north shore of Bonanza Channel and determined this area is underlain by permafrost with an overlying vegetative mat about 3 ft thick.

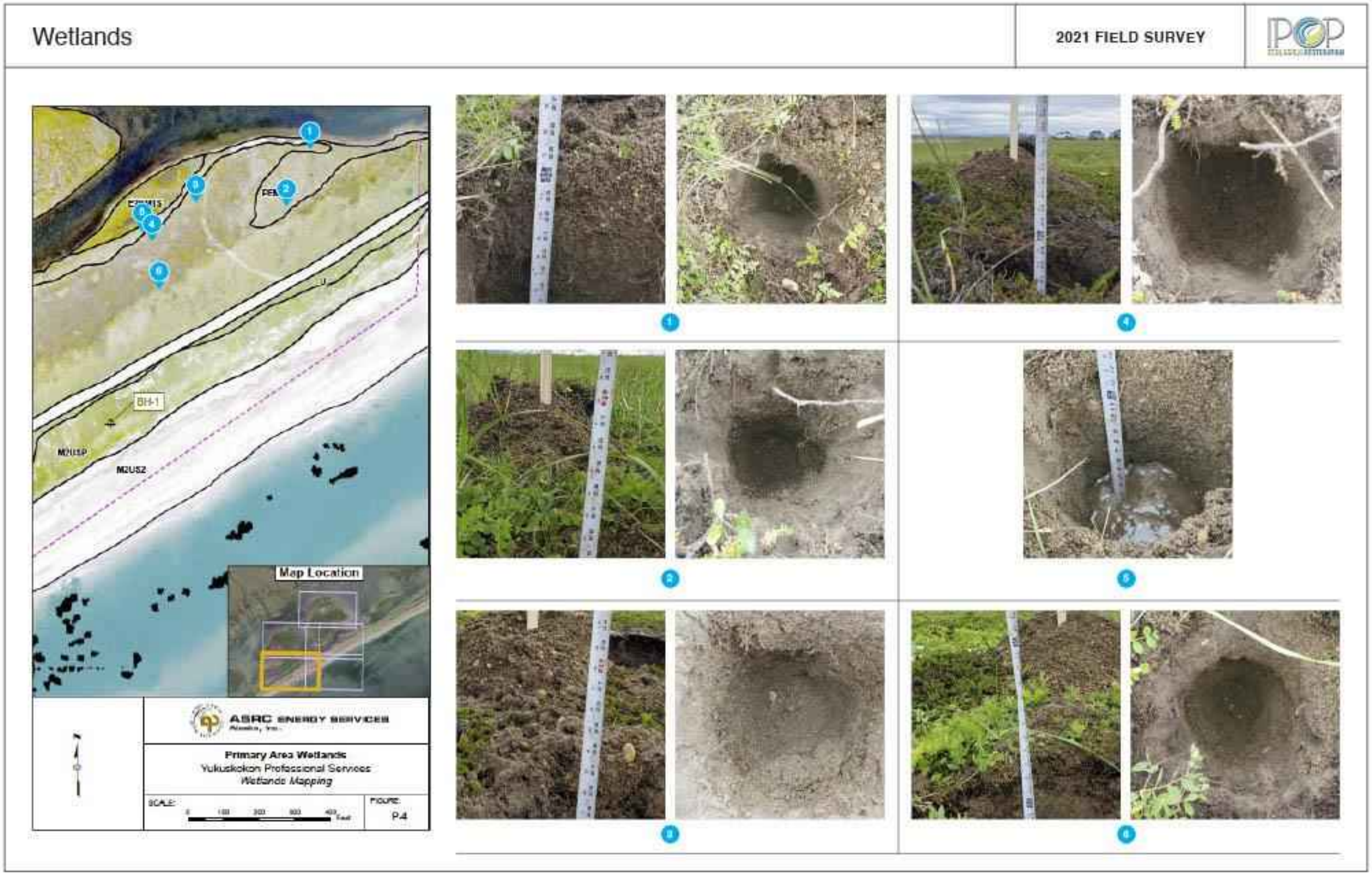
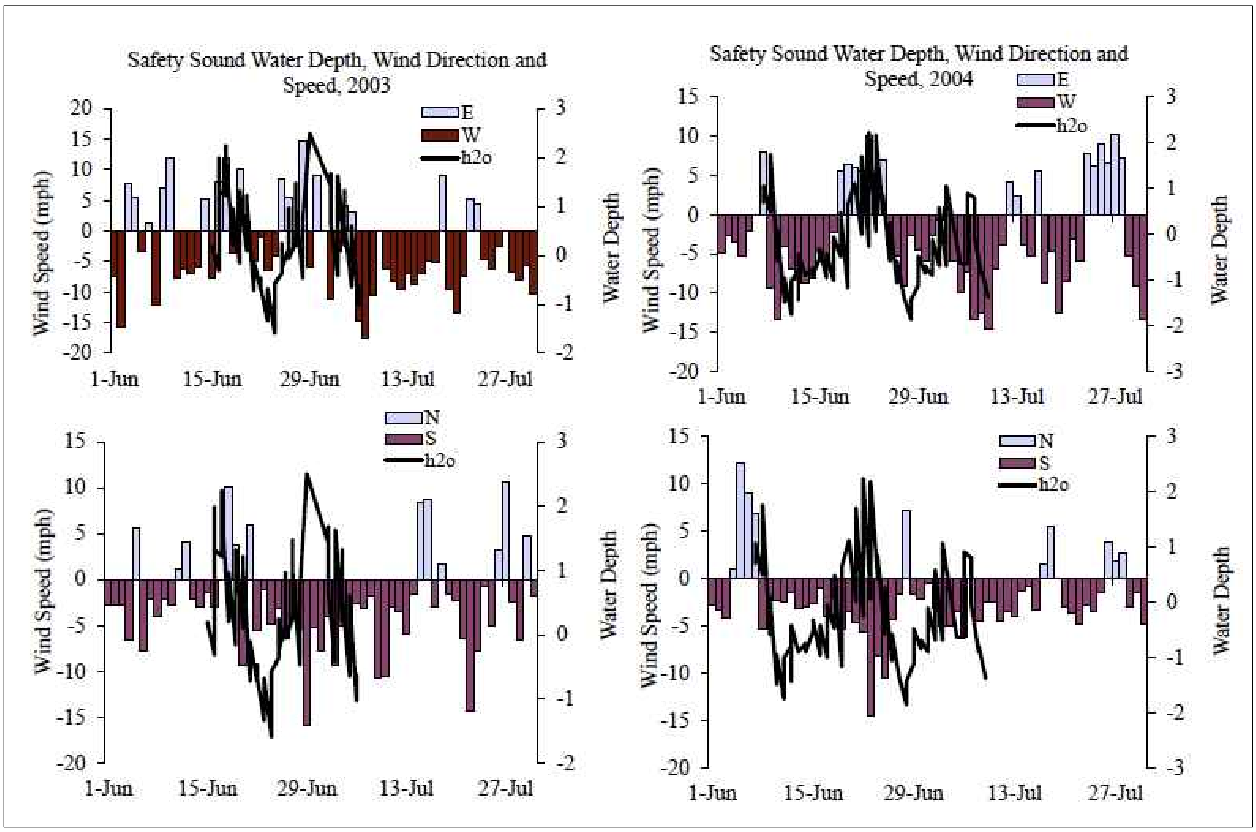


Figure 9-1. Primary Area Wetlands and Test Pits for Wetland Mapping Confirmation August 2021

10.NATURAL VARIABLITY WIND AND STORM EVENTS RELATED TO WATER LEVELS

The environmental conditions in the Safety Sound/Bonanza Channel are subject to a wide range of natural variability, mainly driven by prevailing wind, storm frequency, and winter precipitation. As shown in Section 8 (Figure 8-1 and Figure 8-2) there can be over 100 percent difference in interannual surface water discharge, which effects water levels, water quality, and habitat availability/reliability for certain species. Wind direction and storm events have a strong influence on water levels in Bonanza Channel. Figure 10-1 depicts graphs of the relationship between water levels related to wind speed and direction (ADF&G 2018). Generally, winds from the south to west raise water levels in Safety Sound and Bonanza Channel, and wind from the north to east lowers the water levels by, driving water from the waterbody.



Source: ADF&G 2018

Figure 10-1. Safety Sound Water Depth and Wind Direction and Speed Recorded at the City of Nome Airport, June and July 2003 and 2004

The variability in water levels on the islands in Bonanza Channel can affect habitat reliability for certain life stages and certain species, especially nesting birds. Figure 10-2 shows the islands during low water in 2021. Figure 10-3 and Figure 10-4 show the Case Study Area during High Water Conditions in (August 2021)

Figure 10-2. Proposed Case Study Area during Low Water Conditions 2021, View to West.

Figure 10-3. Proposed Case Study Area during High Water Condition (August 3, 2021), View to West

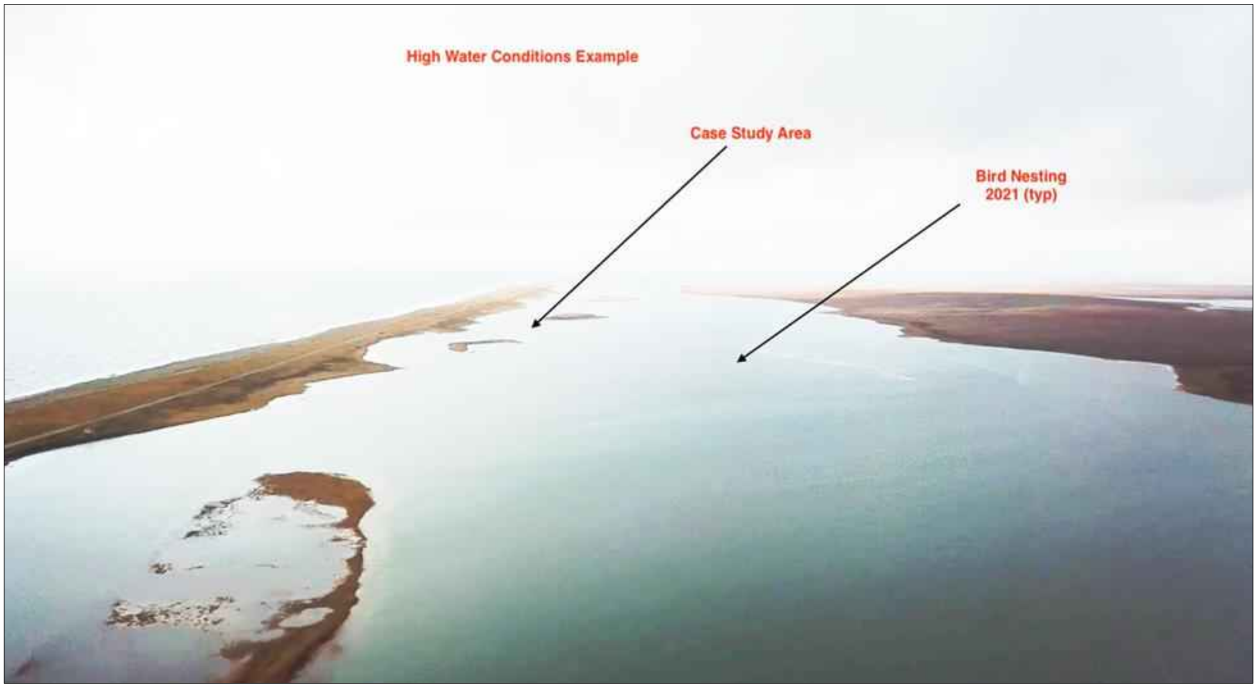


Figure 10-4. Proposed Case Study Area during High Water Condition (August 3, 2021)

11. FISH

11.1. Fisheries Surveys

11.1.1. 2002 to 2005 – summary of results form EFHA

Fisheries studies were conducted from 2002 to 2005 in Safety Sound in conjunction with Norton Sound Economic Development Corporation and the Norton Sound Disaster Relief Fund in response to declining chum salmon runs from 1980 to 1999 (Nemeth et. al 2003; ADF&G 2018). These studies examined fish assemblages and environmental data in Safety Sound and are summarized below and compared to more recently collected data by IPOP in the claim area. Fish were sampled by fyke nets and beach seines at locations shown on Figure 11-1.

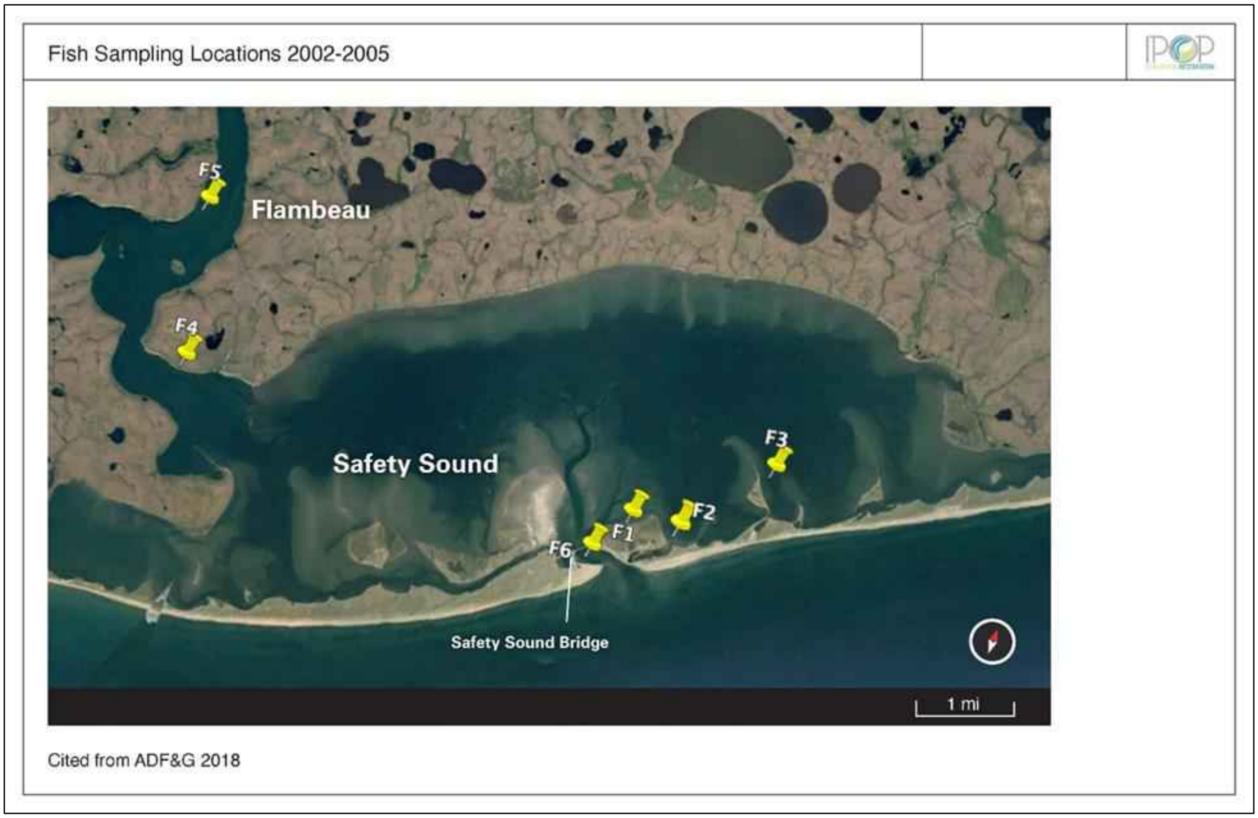


Figure 11-1. Fish Sampling Locations, 2002-2005

Thirty-two (32) different fish species were identified in the study area from 2002 to 2005 from sampling locations named on Figure 11-2. In the years 2003 to 2005, catch-per-unit-effort (CPUE) increased from 455 fish per day in 2003 to 4,055 fish per day in 2005 because of a 5,000% to 6,000% increase in threespine stickleback and ninespine stickleback.

Table 2. Total catch and % catch by year for species in Safety Sound and the Nome River, 2002-2005.

		Safety Sound								Nome River			
		2002[a]		2003		2004		2005		2004		2005	
Common Name	Scientific Name	n	%	n	%	n	%	n	%	n	%	n	%
Alaska blackfish	*Dallia pectoralis*			1	0%					2	0%	3	0%
Arctic flounder	*Pleuronectes glacialis*	3,014	36%	11,963	15%	16,294	5%	7,863	1%	136	0%	12	0%
Arctic grayling	*Thymallus arcticus*			18	0%	3	0%	437	0%	1,271	3%	1,404	2%
Bering cisco	*Coregonus laurettae*	990	12%	1,894	2%	131	0%	84	0%	14	0%	8	0%
Bering poacher	*Occella dodecaedron*			1	0%	5	0%						
Bering wolffish	*Anarhichas orientalis*			1	0%								
Broad whitefish	*Coregonus nasus*					11	0%						
Burbot	*Lota lota*			2	0%	16	0%	38	0%	3	0%	3	0%
Capelin	*Mallotus villosus*	2	0%										
Chum salmon (juvenile)	*Onchorhynchus keta*	213	3%	694	1%	120	0%	395	0%	610	1%	75	0%
Chum salmon (adult)	*Onchorhynchus keta*	10	0%							3	0%	1	0%
Coho salmon (juvenile)	*Onchorhynchus kisutch*	9	0%	272	0%	59	0%	353	0%	8,753	20%	33,154	53%
Coho salmon (adult)	*Onchorhynchus kisutch*									1	0%	1	0%
Crested sculpin	*Blepsias bilobus*	1	0%										
Dolly varden	*Salvelinus malma*	228	3%	129	0%	62	0%	219	0%	372	1%	2,147	3%
Four horn sculpin	*Myoxocephalus quadricornis*	285	3%	2,976	4%	3,126	1%	1,632	0%	17	0%	5	0%
Humpback whitefish	*Coregomus pidschian*			3,459	4%	489	0%	2,302	0%				
Inconnu (sheefish)	*Stenodus leucichthys*			6	0%								
King salmon (juvenile)	*Onchorhychus tshawytscha*	2	0%	17	0%	14	0%	2	0%	58	0%	21	0%
King salmon (adult)	*Onchorhychus tshawytscha*					2	0%						
Least cisco	*Coregonus sardinella*	608	7%	18,141	23%	18,819	6%	15,073	2%	122	0%	61	0%
Ninespine stickleback	*Pungitius pungitius*			3,268	4%	3,761	1%	146,426	19%	1,601	4%	1,072	2%
Pacific herring	*Clupea pallasi*	19	0%	49	0%	18	0%	263	0%	7	0%		0%
Pacific lamprey	*Lampetra tridentata*					2	0%			1	0%	1	0%
Pink salmon (juvenile)	*Onchorhynchus gorbuscha*			2,020	3%	14	0%	109	0%	16,447	37%	1,118	2%
Pink salmon (adult)	*Onchorhynchus gorbuscha*	292	3%	8	0%	120	0%	54	0%	734	2%	269	0%
Pond smelt	*Hypomesus olidus*									1	0%		
Rainbow smelt	*Osmerus mordax*	515	6%	9,649	12%	2,373	1%	1,915	0%	6	0%	4	0%
Rainbow trout / steelhead	*Oncorhynchus mykiss*			1	0%								
Round whitefish	*Prosopium cylindraceum*			3,253	4%	1,281	0%	123	0%	1,069	2%	594	1%
Saffron cod	*Eleginus navaga*	1,545	18%	10,398	13%	51,292	16%	3,042	0%	10	0%	3	0%
Sockeye salmon (juvenile)	*Onchorhynchus nerka*	8	0%			217	0%	886	0%	188	0%	493	1%
Starry flounder	*Platichthys stellatus*	85	1%	2,413	3%	2,201	1%	2,602	0%	3,152	7%	2,602	4%
Threespine stickleback	*Gasterosteus aculeatus*	415	5%	7,766	10%	213,586	68%	564,008	75%	9,646	22%	19,766	31%
Tubenose poacher	*Pallasina barbata*	19	0%	35	0%	40	0%	3,523	0%				
Unidentified greenling	*Hexagrammidae*					9	0%	1	0%				
Unidentified juvenile	*Salmonidae*	46	1%										
Unidentified sculpin	*Cottidae*	53	1%	66	0%	744	0%	201	0%	529	1%	291	0%
Unidentified fish		14	0%	19	0%			3	0%	3	0%		
Total		8,373	100%	78,519	100%	314,809	100%	751,554	100%	44,756	100%	63,108	100%

[a]Nemeth et al. 2003

Source: ADF&G 2018

Figure 11-2. Total Catch and Percent Catch by Year for Species in Safety Sound and the Nome River, 2002-2005

One of the most significant changes from 2003 and 2004 to 2005 in Safety Sound was the increased abundance of stickleback, combined with the decreased abundance of all species in the family Salmonidae. Sticklebacks were ubiquitous in 2004 and 2005; they were caught in nearly every sampling event in Safety Sound and comprised most of every catch through the season. Saffron cod catches also spiked in 2004.

In 2002, fish assemblages clearly differed between sites from the inlet (Figure 11-1, locations F4 and F5) those in the middle (Figure1 1-1, locations F1, F2, F3) and the outlet to Norton Sound (Figure 11-1, location F6). The middle and outlet sites had higher numbers of Arctic flounder, threespine stickleback, and saffron cod. At the inlet sites Arctic flounder, Bering cisco, least cisco, and Dolly Varden had higher abundance, with lower numbers of saffron cod.

Juvenile Chum Salmon: Chum salmon were captured in two distinct peaks in mid-late June and July 6-16 (ADF&G 2018). Comparatively, only small numbers (n=20) of juvenile chum salmon were captured at the eastern- most net site (F3) (Nemeth et al. 2003) nearest the project area compared to the outlet (F6) in all sampling years.

Environmental: Results of the 2002-2005 studies clearly indicate that Safety Sound serves as a transition zone between the mouth of the Eldorado/Flambeau River and the exit to Norton Sound, with temperature and salinities relatively consistent by geographical location across sampling years (Figure 8-5 and Figure 8-6).

At the eastern and northwestern ends of Safety Sound, environmental conditions (temperature and salinity) are intermediate between freshwater and marine; whereas in the central part of the Sound the conditions are mostly marine (ADF&G 2018). Data collected by IPOP in 2021 correlates with the ADF&G (2018) data (Figure 8-5 and Figure 8-6). Chum salmon that migrate from the Eldorado River can thus find areas in Safety Sound in which to acclimate to marine temperatures and salinities.

11.1.2. 2021 Fish Sampling

FISHEYE Consulting (FISHEYE) set nine wire-mesh minnow traps at selected locations within the claim area in Bonanza Channel on July 29 and 30, 2021. A beach seine was used at three locations in early August (also 2021) (Figure 1-3).

Figure 11-3. Fish Sampling Locations, 2021

Summary: Threespine stickleback were the dominant species captured (87%) in both the minnow traps and beach seines, followed by lesser numbers of starry flounder, rainbow smelt, least cisco, and sculpin. There were two distinct size classes of both stickleback and starry flounder with the majority of the catch being in the 0 to 25 millimeter (mm) size range. The fish captured in Bonanza Channel are associated with intertidal habitats and were similar to (ADF&G 2018) fish documented at the inlet sites (F4 and F5) to include flounder (*sp*), least cisco, and rainbow smelt with saffron cod being absent, probably due to low salinities.

Red King Crab eDNA: Water samples for red king crab (RKC) environmental DNA (eDNA) were collected at 11 locations in Bonanza Channel, Safety Sound, and nearshore Norton Sound. The samples were collected and preserved according to the protocol of Jonah Ventures, the eDNA laboratory recommended by ADF&G. Analysis of those samples did not reveal any RKC eDNA at any sampling station (Figure 11-4).

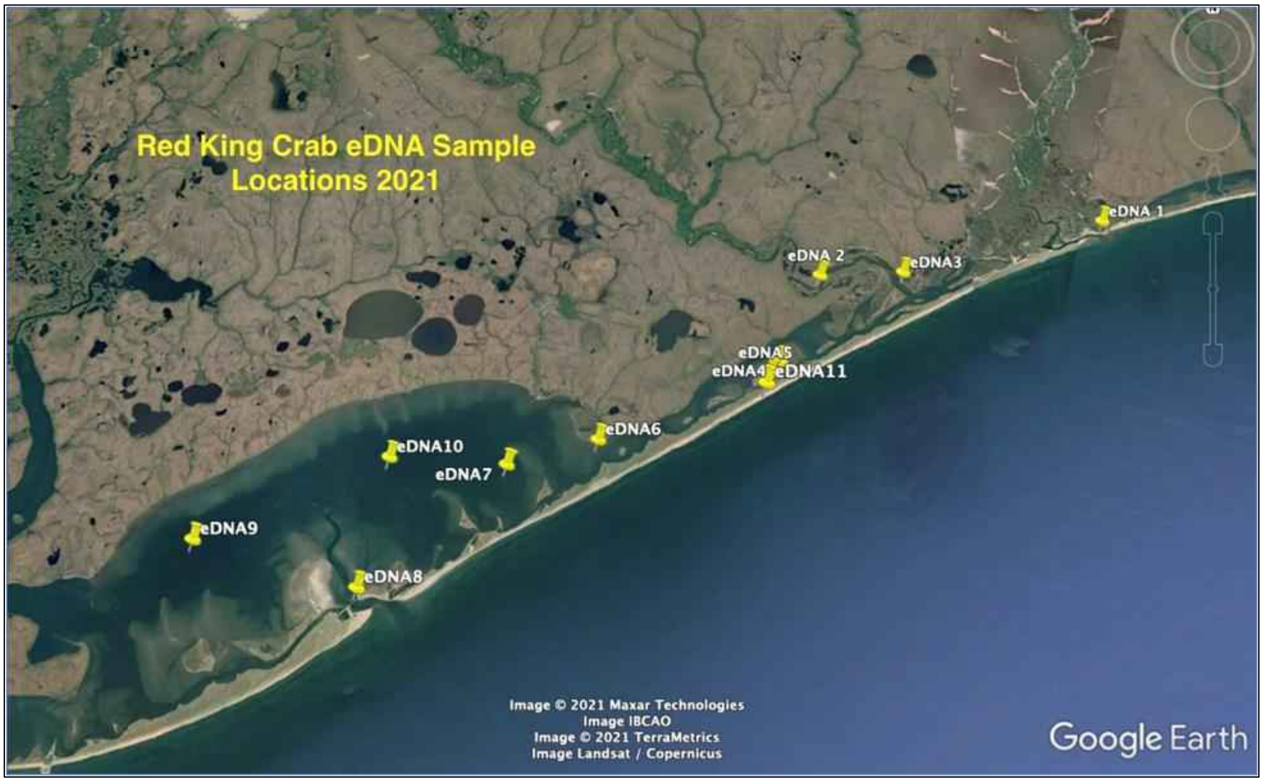


Figure 11-4. Red King Crab eDNA Sampling Locations, 2021

11.2. Managed Fish Species and Habitat

11.2.1. Limiting Factors

The Alaska Department of Environmental Conservation water quality standards for rearing habitat is 15°C (18 Alaska Administrative Code 70). A habitat suitability index and instream flow suitability curves for chum salmon was developed by Hale et al. (1985) to include rearing habitat. Using this suitability index, the existing habitat parameters found in the Bonanza Channel are suboptimal to limiting for juvenile chum salmon rearing habitat and other life stages in relation to:

- Temperature-Rearing: Limiting factor in June as temperatures can reach levels close to lethal 23.8°C (Brett 1952) compared to 22°C (OEI 2021). Limiting to suboptimal average temperatures in July averaging near or above 15°C.

- Temperature-Migration: Limiting factor from June to mid-August for migration as minimal adult chum salmon migration behavior has been documented above 15°C.
- Water Flows-Spawning: Limiting factor for spawning due to no obvious expressions of groundwater in project area.
- Substrate-Spawning: Limiting for spawning because of size (sand vs gravel), additional evidence also provided in Wolman and Kondolf (1993). Fines associated with the "muck" layer would likely imbricate and/or smother redds post spawning.

11.2.2. Submerged Aquatic Vegetation

Three species of pondweeds, *Stuckenia pectinatus* (sago pondweed)[2], *Ruppia spp.* (widgeon weed) and *Zannichellia palustris* (horned pondweed) are present in varying densities, from patchy to continuous, throughout the project area (Eilers 2020, 2021). While there is substantial literature documenting the habitat association between eelgrass and juvenile chum salmon (including Safety Sound), there is no documentation of habitat association between juvenile chum salmon and the pondweeds that dominate the SAV community in the Bonanza Channel. Beyond the limiting factors previously discussed, chum salmon have generally departed for nearshore waters by the time SAV is fully established in the Bonanza Channel in late summer. *Zostera marina* (eelgrass) was documented (Eilers 2020, 2021) in two small locations outside the project footprint associated with deeper parts of a relic channel. Given other limiting factors previously discussed, and the distribution, density and geographical separation from Safety Sound, the eelgrass beds adjacent to the project area are unlikely to currently provide juvenile chum salmon rearing habitat. These beds will not be affected by project activities. Salinity and depth profiles associated with the eelgrass beds in Safety Sound (2021) are mostly absent throughout the project area and further colonization of eelgrass through recruitment from Safety Sound is unlikely under existing geomorphic and hydrological conditions.

12. BIRDS

12.1. Bird Surveys – 2021

Avian spot mapping surveys were conducted along transects located approximately 50 m apart on state lands contained within three islands near proposed dredging operations in the Bonanza Channel on July 4 and 5 and August 18 and 19, 2021 to assess breeding and post-breeding bird abundance and habitat associations. Instantaneous scan sampling of tundra swans (*Cygnus columbianus*) on lands and waters of the Bonanza Channel and Safety Sound area were conducted September 12-15, 2021 to assess swan time budgets, feeding behaviors, and feeding depths.

12.2. Results

12.2.1. Bird Abundance

The most abundant species in July was the Savannah sparrow (n=44), followed in descending order by glaucous gull (n=36), common eider (n=17), semipalmated sandpiper (n=15), and red-necked phalarope

[2] Sago pondweed was renamed *Potamogeton pectinatus* in 2006.

(n=11). The most abundant species in August was the northern pintail (n=282), followed in descending order by American wigeon (n=155), tundra swan (n=98), unidentified small sandpiper (n=76), and semipalmated sandpiper (n=38). No designated threatened, endangered, or eagle species was observed in either July or August. Overall bird abundance was substantially higher in August (n=729 individuals) than in July (n=167). In September, one adult bald eagle was observed outside the project area near Solomon. (Booms 2021a, b, c).

12.2.2. Bird Nests

In July 2021, 15 occupied glaucous gull nests (2 with eggs) (Figure 12-1), 3 common eider nests (all with eggs) (Figure 12-2), and one Lapland longspur nest with eggs were detected. All ground nests may have failed and were washed away during a storm surge prior to the August survey because many of the nests found in July were gone and recent flotsam was present on vegetation upslope from nests.

12.2.3. Habitat Associations

Breeding semipalmated sandpipers were associated with upland tundra habitats whereas glaucous gulls, common eiders, and red-necked phalaropes were associated with lowland sedge and forb habitats that cover most of the east and west islands. The distribution of shorebirds in August was highly influenced by water levels dictating the extent of exposed mudflats in and around the islands where shorebirds were observed feeding. Unlike during the July survey, no shorebirds were observed using vegetated terrestrial habitat in August. Waterfowl appeared to be closely associated with shallow water located in the ponds and along the shores of the islands and surrounding area.

Figure 12-1. Glaucous Gull Nest Distribution, July 2021

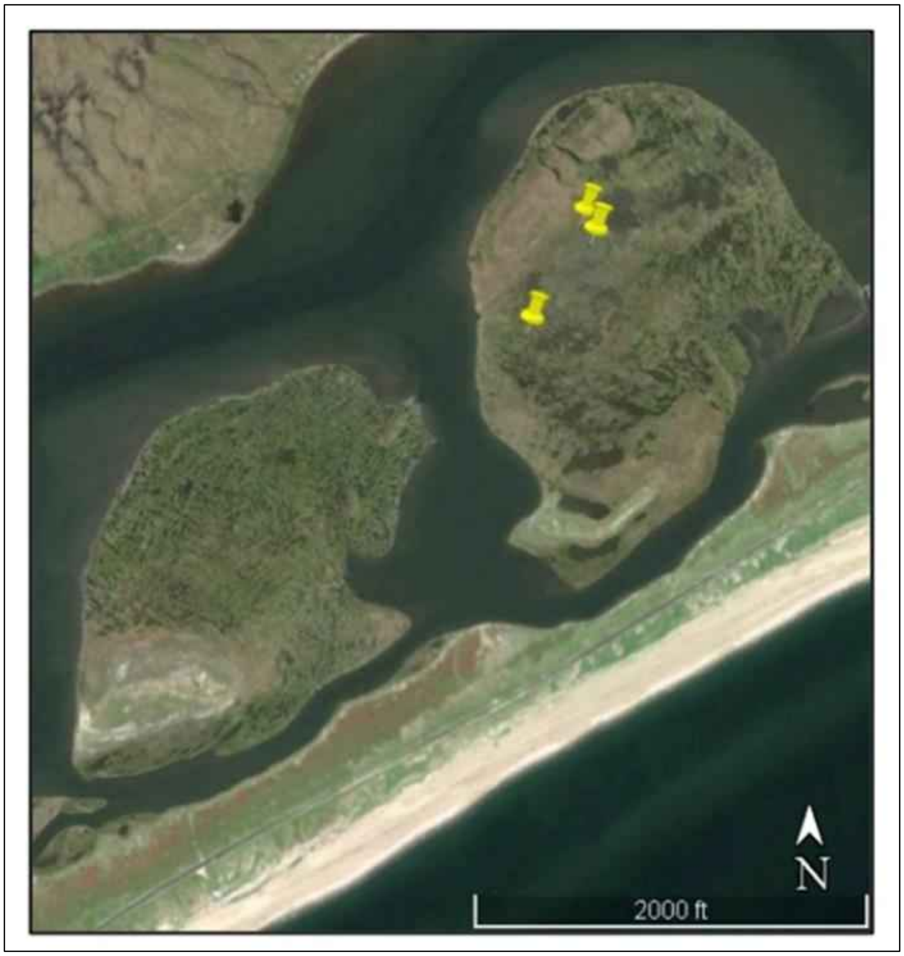


Figure 12-2. Common Eider Nest Distribution, July 2021

12.2.4. Swan Feeding Behavior

Mr. Travis Booms recorded 25,918 tundra swan behavioral observations in the project area during 93 scan sampling occasions of swan flocks ranging in size from 101 to 951 individuals (Figure 12-3 and Figure 12-4) (Booms 2021c). Swans were feeding in 74% of observations. Surface and submerged head feeding behaviors each made up only 1% of all observations of swans on water (n=23,903). Swans used submerged neck and tip feeding in nearly identical proportions (36% each) when observed on water. Average distance from the tip of the bill to the base of the neck of hunter-killed swans was 65 cm (25.6 inches, approximate maximum depth of submerged neck feeding) (Figure 12-5). Average distance from the tip of the bill to either knee was 85 cm (33.5 inches, approximate maximum depth of tip feeding) (Figure 12-6). Based on these measurements and swan feeding behaviors, swans spent almost all their feeding time (98%) in waters with a maximum depth of approximately 60 to 90 cm (23.6 to 35.4 inches). Swan foraging locations in the project area are influenced by multiple variables in the fall including water level, hunters, wind direction and speed, and food availability and are not predictable from day to day (Booms 2021c).

Figure 12-3. Bonanza Channel Swan Flock Locations during Behavioral Scan Sampling, Sept. 12-15, 2021

Figure 12-4. Safety Sound Swan Flock Locations during Behavioral Scan Sampling, Sept. 13-14, 2021

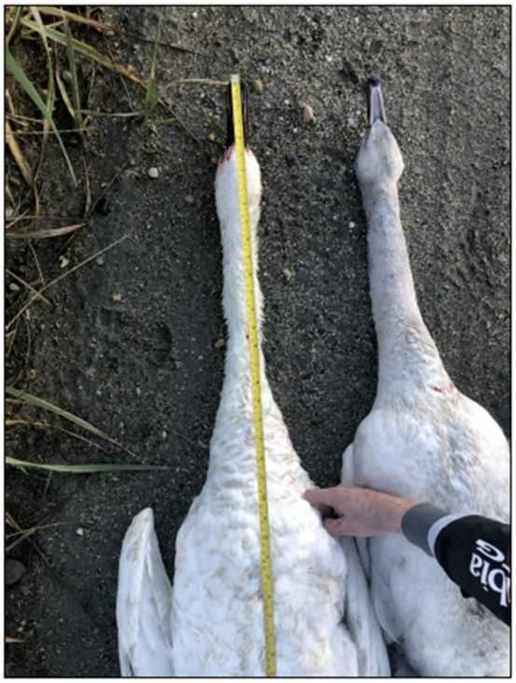


Figure 12-5. Submerged Neck Feeding Measurement

Figure 12-6. Tip Feeding Measurement

12.3. Bird Species and Habitat

Bird use in the claim area depends on the amount of habitat available – which is determined by the local physiography, tides, and flow patterns. Surveys by Eilers (2020, 2021) determined that mudflats used by shorebirds represented only 3.5 % of the claim area. This is likely attributable to the rather steep near-shore topography, which slopes abruptly from MHHW to approximately 2.5 ft to 3.0 ft deep, creating a "bowl" shape to the existing lagoon morphology (Figure 12-7 and Figure 12-8). Because tides in the claim area rarely exceed 3 ft, shorebird mudflat habitat is limited by the existing channel morphology and sediment transport regime.

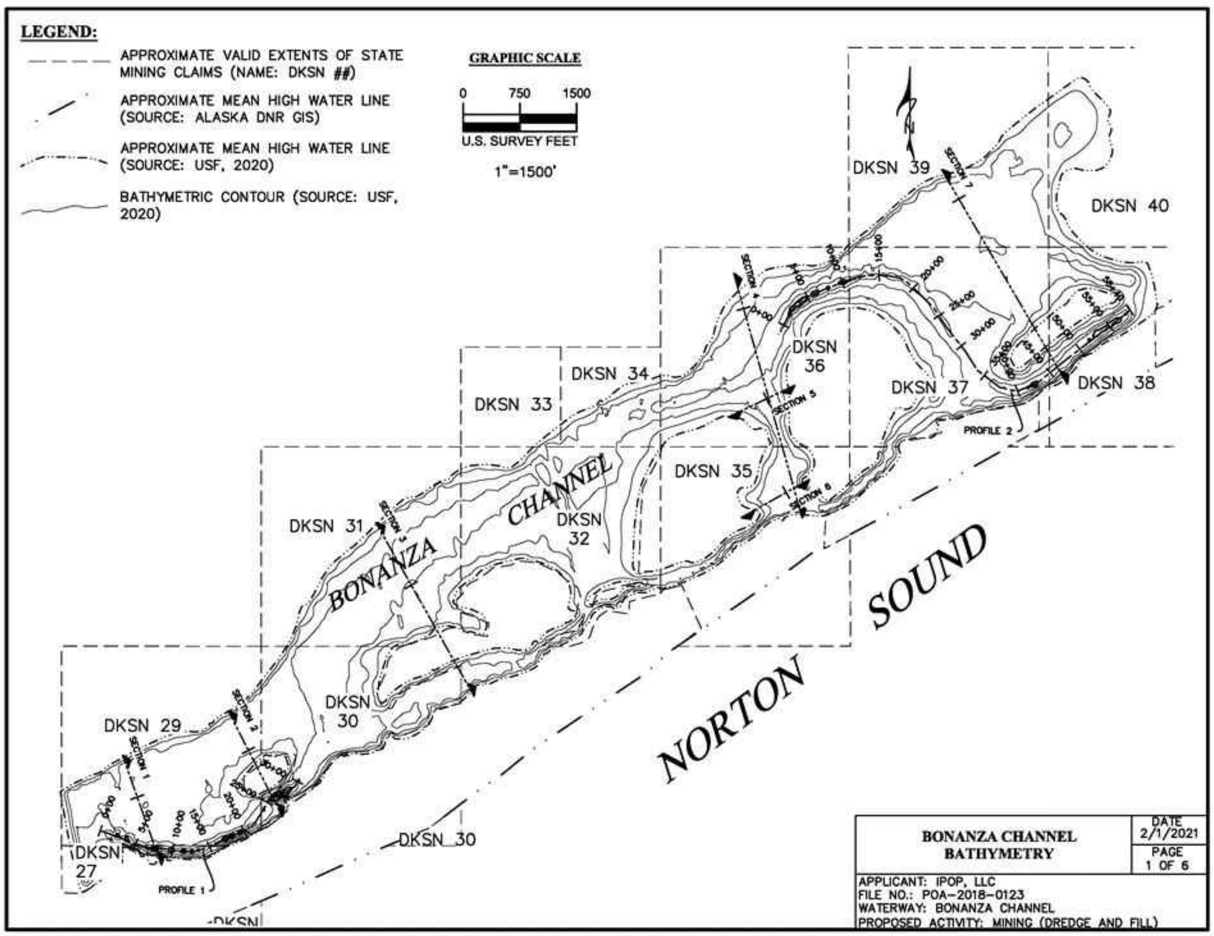


Figure 12-7. Bonanza Channel Bathymetry and Cross-Section Locations

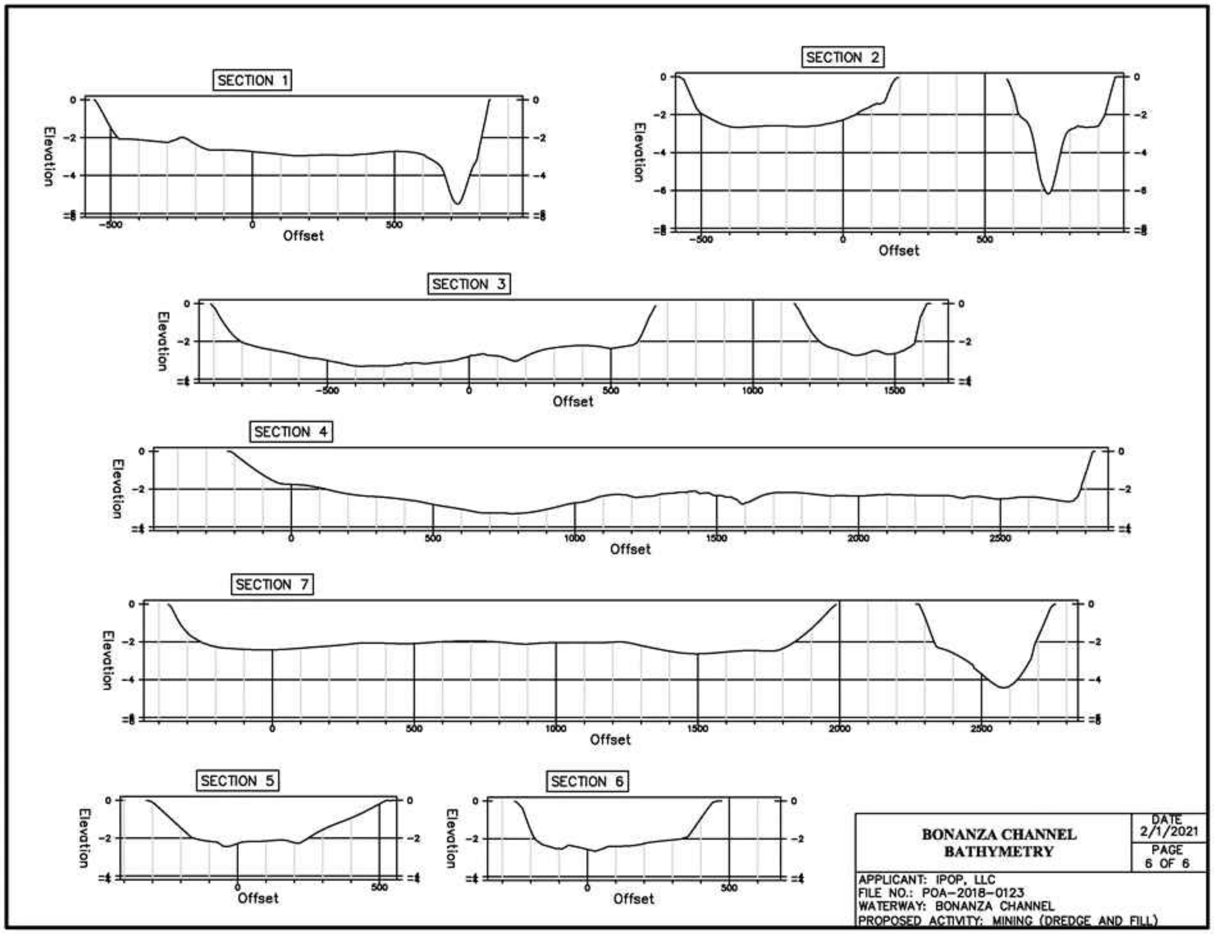


Figure 12-8. Bonanza Channel Bathymetry Cross-Sections 1 through 7

Water depth is considered to be one of the most important factors influencing habitat utilization by waterbirds because of the restrictions of bird morphology, such as the lengths of tarsometatarsi or necks (Isola et al., 2000; Ma et al., 2010). Behney (2014) reported that the majority of mallard feeding occurred at water depths less than 19 inches—corresponding to Guillemain et al. (2000) and Pöysä (1983). Zou et al. (2019) found that foraging densities of tundra swans were significantly positively correlated with water depths of 8 to 19 inches in seven natural wetlands. Figure 12-9 depicts the currently existing bathymetry of the five-year mining plan and proposed disposal sites.

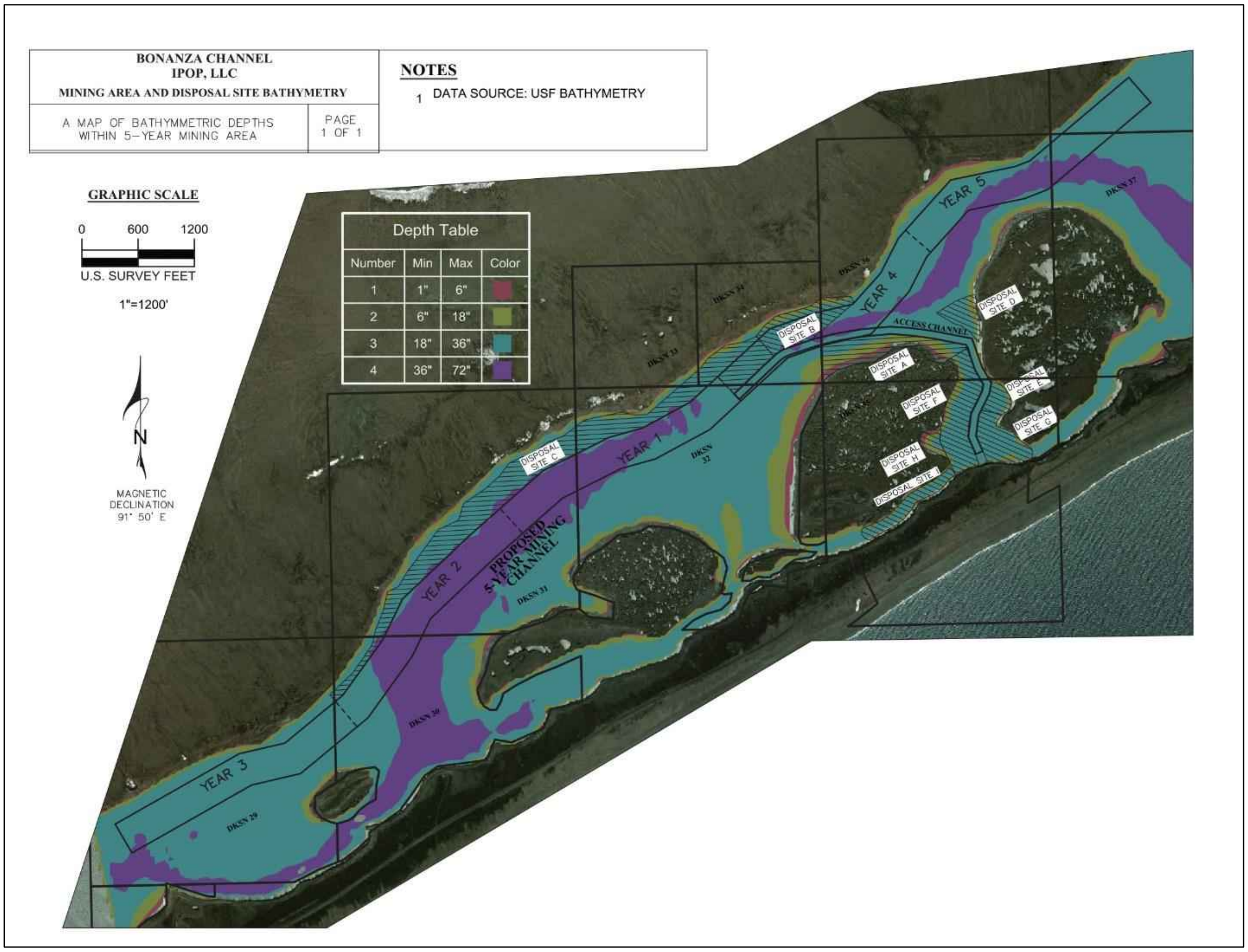


Figure 12-9. 2021 Bathymetry of the Five-Year Operations Area and Disposal Sites

13.SUBMERGED AQUATIC VEGETATION

13.1. Occurrence of SAV in the Bonanza Channel

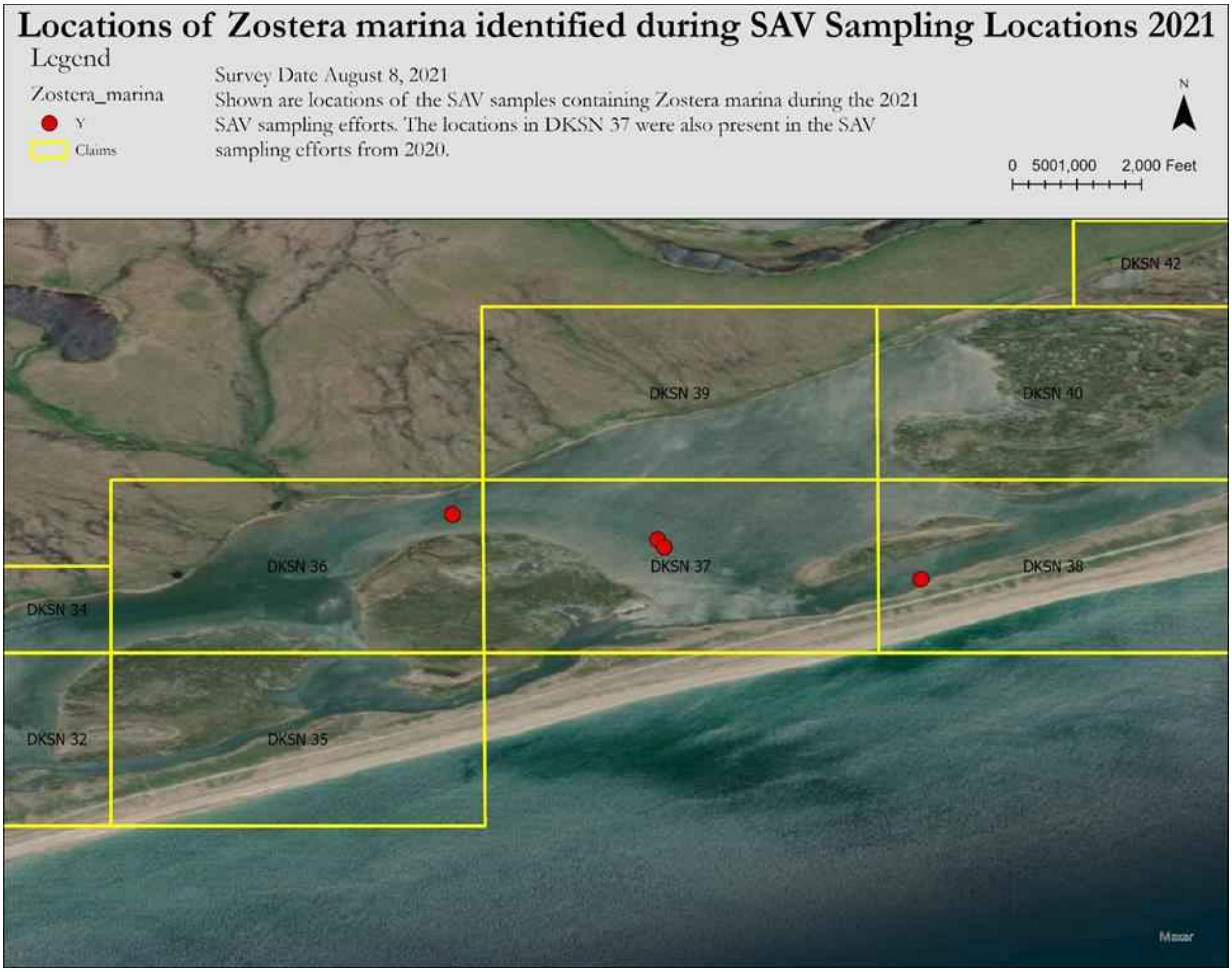
All three prevalent species of SAV in the project area (sago pondweed, horned pondweed, and widgeon weed) are widely distributed in Alaska and the Lower 48 states. Sago pondweed, the dominant species in the study area, is described by Kantrud (1990) and summarized below.

Sago pondweed (sago) occurs circumboreally to latitude 70°and from sea level to 16,000 ft above sea level in the mountains of Venezuela and Tibet. It is found in semi-permanent to permanently flooded areas in water depths less than 8.5 ft and flows of 4 ft/sec or less. It grows in nearly all bottom sediments and can tolerate a range of water quality variables. It does not grow well in water with consistently high turbidity.

Sago is one of only three or four North American species of the genus Potamogeton that bear starchy underground perennating organs called turions or tubers, although a few other species have tuberous root stalks. Sago is generally classified as a ruderal (i.e., capable of occupying mechanically disturbed areas), has multiple regenerative strategies, and is a stress tolerant competitive plant that, depending on exposure to wave action, can alter its allocation of resources to different reproductive organs. Because of these regenerative strategies, sago is considered a pioneering and survivor species, as it will rapidly colonize disturbed or altered ecosystems.

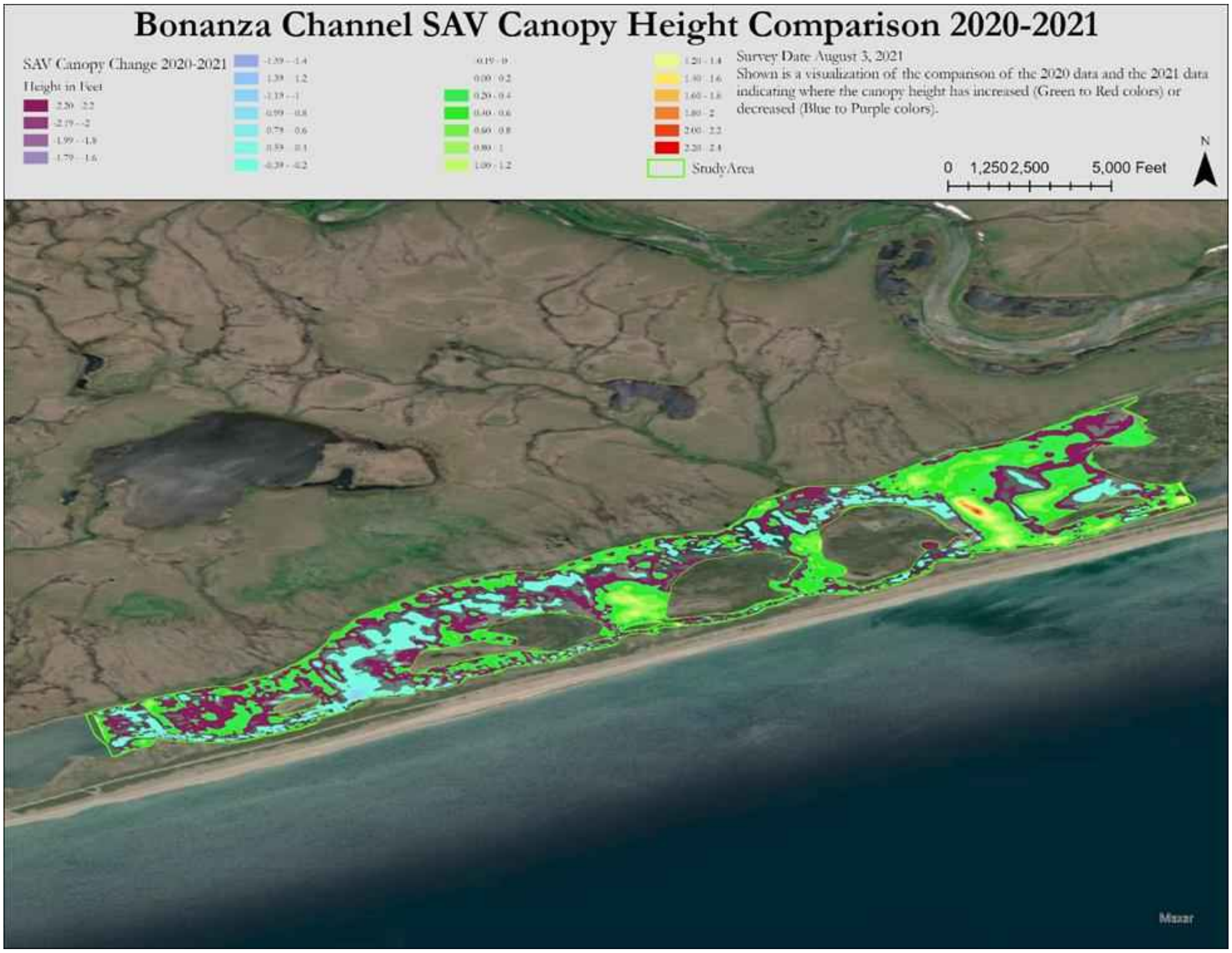
Sago is a common inhabitant of heavily traveled boat canals, where bottoms are frequently disturbed or dredged (Murphy and Eaton 1983; Haslam 1987). Davis and Brinson (1980) placed sago into a group of five species of submersed hydrophytes in North America able to maintain dominance in disturbed ecosystems and considered this consistent with sago's widespread abundance. Sago occurred in wetlands subject to both weed removal and heavy recreational boating (Kaul and Zutshi 1967). Stuckey (1980) also remarked on sago's tolerance to physical destruction by boat traffic.

Zostera marina (eelgrass) was documented (Eilers 2020, 2021) in three locations in Bonanza Channel outside the project footprint and associated with deeper sections of a relic channel (Figure 13-1). Figure 13-2 shows the SAV canopy height comparison between the Eilers 2020 and 2021 surveys .



Source: Eilers 2021

Figure 13-1. Locations of Zostera marina Identified at SAV Sampling Locations, 2021



Source: Eilers 2021

Figure 13-2. Bonanza Channel SAV Canopy Height Comparison, 2020-2021

13.2. 2020 Model-Scale Dredge Test and SAV Recovery

As part of environmental baseline studies for the proposed Bonanza Channel Placer Project, IPOP LLC executed a model-scale dredge test in the Bonanza Channel in September 2020 (OEI 2021). The primary purpose of the model dredge test was to determine the effectiveness of the turbidity curtain that will be used around the dredging operations for the project.

Methods used for the model dredge test are described by OEI (2021). Figure 13-3 shows a GoogleEarth image of the August 2020 model dredge test area. Figure 13-4 is an August 2020 drone photo of the deployed turbidity curtain for the model dredge test. Note that Figure 13-3 shows a georeferenced feature for comparison in Figure 13-4.

Figure 13-3. Model-Scale Dredge Test Area ("Turbidity Curtain Test Location")

Figure 13-4. August 2020 Drone Image of Model Dredge Test Area (within deployed turbidity curtain)

The 2020 model dredge test included creating 10 test pits in the Bonanza Channel to various depths (1.5 to 4 feet below mudline) and 3 to 4 feet square (Figure 13-5). The 2020 conditions of the pits at the end of the model dredge test are listed on Table 13-1.

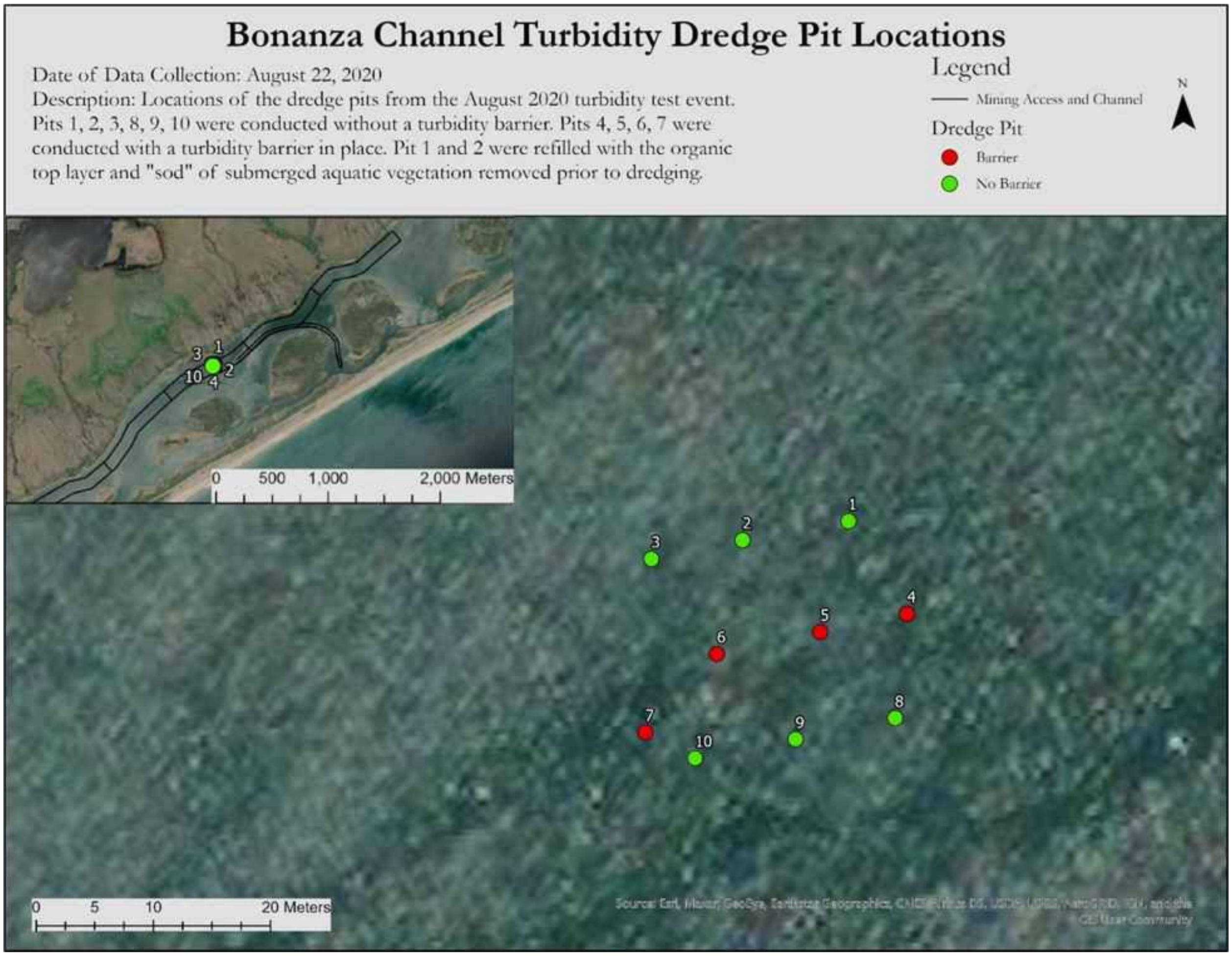


Figure 13-5. Layout of Test Pits during 2020 Model-Scale Dredge Test

Table 13-1. Test Pit Information and 2021 SAV Underwater Observations

Test Pit	Initial Depth of pit (ft)	Status of Pit at End of Model Dredge Test (2020)	Replanted (Yes/No)	October 2021 Underwater Drone Image Observations
1	3.0	Backfilled with organic muck	Yes	No apparent relic pit, SAV abundant, tubers visible
2	3.0	Backfilled with organic muck	Yes	No apparent relic pit, SAV abundant
3	1.5	unbackfilled	No	No apparent relic pit, SAV abundant, tubers visible
4	4.0	unbackfilled	No	No apparent relic pit, SAV abundant, tubers visible
5	3.0	Backfilled with coarse material and muck.	No	No apparent relic pit, SAV abundant
6	3.0	Backfilled with coarse material and muck.	No	No apparent relic pit, SAV abundant, tubers visible
7	1.5	Attempted to backfill with much	No	No apparent relic pit, SAV abundant, tubers visible
8	3.0	Backfilled with coarse material and muck	No	No apparent relic pit, SAV abundant
9	3.0	Backfilled with muck to extent possible	Yes	No apparent relic pit, SAV abundant
10	1.5	Attempt to backfill with muck	No	No apparent relic pit, SAV abundant

October 2021, the water in the Bonanza Channel water was clear enough and effective underwater drone footage was obtained of the test pit sites and SAV in its late-season state. The georeferenced underwater images are provided in Appendix A.

Table 13-1 lists the October 2021 underwater observations at each test pit. All of the test pits from the 2020 model dredge test were very well revegetated in 2021, regardless of backfill material, backfill depth, placement of ecological memory, or whether or not they were replanted with SAV (that was removed before the test) (IPOP LLC 2021). These observations illustrate the robust nature of the SAV species present in the Bonanza Channel, and the ability of the environment to naturally restore.

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APPENDIX A

October 2021 Underwater SAV Images of

2020 Model-Scale Dredge Test Pits 1 through 10

(See Figure 13-5 in main body of report for locations)

PIT 1

PIT 2

PIT 3

PIT 4

PIT 5

PIT 6

PIT 7

PIT 8

PIT 9

PIT 10