State of Alaska
Department of Fish and Game
Division of Sport Fish

Nomination Form
Anadromous Waters Catalog & Atlas

Region: Arctic

USGS Quad(s): SOLOMON C-5, C-6

Nomination proposes the following revisions: *(check all that apply)*

☑ Addition ☑ Correction ☑ Deletion ☐ Supporting Information

AWC Number of Water Body: *(if known)* 333-10-11650 (-~~2001~~) -0010 333-10-11700-~~2001~~ -0010

Name of Water Body: *(if known)* *Bonanza Channel, *Solomon Channel, Bonanza River

☑ Official USGS Name ☑ *Local or Unofficial Name

For Official Use Only

Nomination # : 24-008

Revision Year : 2025

Revision(s) to: Atlas ☐ Catalog ☐ Both ☒

Revision Code(s) : D-2, A-2, B-1, B-2

Adam Reimer — Fisheries Scientist — Date 12-31-2024

Ron Benkert — Habitat F&G Coordinator — Date 12/13/2024

Joseph Giefer — AWC Project Biologist — Date 13 Dec 2024

P C — GIS Analyst — Date 12/31/2024

For fish observations, please provide the upper most point (Lat/Long) where any two individuals of observed species & life stage were documented. Please use Decimal Degree's with a minimum of 5 decimal places. Please see Supplemental Information Form if you need more room for species observation data and comments.

Species	Date Observed	Latitude	Longitude	Anadromous	Adult Presence	Spawning	Rearing
chum salmon	29-Jun-2022	64.545822	-164.428967	☐	☑	☐	☐
pink salmon	7-Sep-2022	64.545822	-164.428967	☐	☑	☑	☐
coho salmon	29-Jun-2022	64.535231	-164.481302	☐	☐	☑	☐
humpback whitefish	14-Jun-2022	64.518005	-164.556084	☐	☑	☐	☐
least cisco	7-Sep-2022	64.535231	-164.481302	☐	☐	☑	☐

IMPORTANT: Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish species, including; number of fish observed; photographs of each species & life stage observed or captured; sampling methods, duration and location(s) sampled; copies of data sheets and/or field notes, etc. Please attache a copy of a map showing location of lower and upper observed extents of each species & life stage, as well as other pertinent information such as specific locations of stream reaches where spawning or rearing individuals were observed or captured, and the location, type and heights of any barriers to fish fish passage, etc.

Comments:

Please see the attached document.

See following page for Nom update instructions & summary.

***After discussing the current mapping layout of the inter-coastal water bodies behind the barrier islands adjacent to Safety Sound near Nome AK with the Habitat Section biologist responsible for this region, it was determined that using AWC LAKE feature would better to delineate the areas of inter-coastal water body channels that are not well represented by AWC Stream Lines which require an UPPER and LOWER stream point be defined. This is consistent with other inter-coastal zones that have been identified in the AWC (i.e.; the adjacent Safety Sound, Imuruk Basin, Hotham Inlet, etc.). These inter-coastal channels do not have directional flow or specific UPPER & LOWER extents, and access through the barrier islands is often not limited to one location or outlet and there are multiple access points. Much of these channels are part of the intertidal zone and may have areas above and below MLLW. Sampling results from the enclosed survey effort also provided a variety new species observations all along these channels in locations off the barrier islands, which will be added to the new features as part of this revision.*

Observers Signature Deilah Johnson — Date 9/17/20

Observer Name: *(Please Print)* Deilah Johnson

Agency or Organization: Village of Solomon

Address: PO Box 2053
Nome, AK 99762

For Official Use Only

Signature of Area Biologist — *Date*

Name of Area Bioligist (Please Print):

Nom #24-008 Update.Instructions

1) ~UPDATE/ADJUST lower hydrography segment and mouth point of existing AWC Stream #333-10-11650 "Bonanza River"

2) ~DELETE existing AWC Stream line #333-10-11650-2001 "*Bonanza Channel" and corresponding Stream Points.

   a) ~ADD new AWC Lake #333-10-11650-0010 "*Bonanza Channel" with CHp, COp, Kp, Pp, Sp, DVp and LCp.

   b) ~ADD new species BROAD and HUMPBACK whitefish PRESENT and BERING cisco and POND smelt REARING to AWC Lake #333-10-11650-0010 "*Bonanza Channel".

   c) ~ADD new species life-phases PINK and COHO salmon REARING to AWC Lake #333-10-11650-0010 "*Bonanza Channel".

3) ~DELETE existing AWC Stream line #333-10-11700-2001 "*Solomon Channel" and corresponding Stream Points.

   a) ~ADD new AWC Lake #333-10-11700-0010 "*Solomon Channel" with CHp, COp, Pp and DVp,

   b) ~ADD new species BERING cisco REARING & PRESENT, HUMPBACK whitefish PRESENT and LEAST cisco REARING AWC Lake #333-10-11700-0010 "*Solomon Channel".

   c) ~ADD species life-phase COHO and PINK salmon REARING to AWC Lake #333-10-11700-0010 "*Solomon Channel".

State of Alaska
Department of Fish and Game
Division of Sport Fish

Nomination Form
Anadromous Waters Catalog & Atlas

Region: Arctic

USGS Quad(s): Solomon C-5

Nomination proposes the following revisions: *(check all that apply)*

☑ *Addition* ☐ *Correction* ☐ *Deletion* ☑ *Supporting Information*

AWC Number of Water Body *(if known)*: 333-10-11700 - 0010

Name of Water Body *(if known)*: *Solomon Channel of Safety Sound

☐ *Official USGS Name* ☑ **Local or Unofficial Name*

For Official Use Only

Nomination # : 24-008 - site #1

Revision Year : 2025

Revision(s) to: *Atlas* ☐ *Catalog* ☐ *Both* ☐

Revision Code(s) :

Fisheries Scientist *Date*

Habitat F&G Coordinator *Date*

AWC Project Biologist *Date*

GIS Analyst *Date*

For fish observations, please provide the upper most point (Lat/Long) where any two individuals of observed species & life stage were documented. Please use Decimal Degree's with a minimum of 5 decimal places. Please see Supplemental Information Form if you need more room for species observation data and comments.

Species	Date Observed	Latitude	Longitude	Anadromous	Adult Presence	Spawning	Rearing
pink salmon	29-Jun-2022	64.545822	164.428967	☑	☐	☐	☑
Bering cisco	29-Jun-2022	same	same	☑	☑	☐	☐
pink salmon	9-Jul-2022	same	same	☑	☑	☐	☐
chum salmon	9-Jul-2022	same	same	☑	☑	☐	☐
				☐	☐	☐	☐

IMPORTANT: Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish species, including; number of fish observed; photographs of each species & life stage observed or captured; sampling methods, duration and location(s) sampled; copies of data sheets and/or field notes, etc. Please attache a copy of a map showing location of lower and upper observed extents of each species & life stage, as well as other pertinent information such as specific locations of stream reaches where spawning or rearing individuals were observed or captured, and the location, type and heights of any barriers to fish fish passage, etc.

Comments:

Sampling Site #1

See attached data sheet for numbers & lengths.

From USACE report: Solomon Environmental Baseline Technical Assistance - Solomon, Alaska. Published April 2023
Author: Chris Hoffman (christopher.a.hoffman@usace.army.mil)

Observers Signature Chris Hoffman

Date

Observer Name: *(Please Print)* Chris Hoffman

Agency or Organization: USACE

Address: 2204 3rd St
JBER, AK 99506

For Official Use Only

Signature of Area Biologist *Date*

Name of Area Biolgist (Please Print):

State of Alaska
Department of Fish and Game
Division of Sport Fish

Nomination Form
Anadromous Waters Catalog & Atlas

Region: Arctic

USGS Quad(s): Solomon C-5

Nomination proposes the following revisions: *(check all that apply)*

☑ *Addition* ☐ *Correction* ☐ *Deletion* ☑ *Supporting Information*

AWC Number of Water Body: *(if known)* 333-10-11700 - 0010

Name of Water Body: *(if known)* * Solomon Channel of Safety Sound

☐ *Official USGS Name* ☑ **Local or Unofficial Name*

For Official Use Only

Nomination # : 24-008 site #2

Revision Year : 2025

Revision(s) to: *Atlas* ☐ *Catalog* ☐ *Both* ☐

Revision Code(s) :

Fisheries Scientist *Date*

Habitat F&G Coordinator *Date*

AWC Project Biologist *Date*

GIS Analyst *Date*

For fish observations, please provide the upper most point (Lat/Long) where any two individuals of observed species & life stage were documented. Please use Decimal Degree's with a minimum of 5 decimal places. Please see Supplemental Information Form if you need more room for species observation data and comments.

Species	Date Observed	Latitude	Longitude	Anadromous	Adult Presence	Spawning	Rearing
humpback whitefish	14-Jun-2022	64.535231	164.481302	☑	☑	☐	☐
pink salmon	29-Jun-2022	same	same	☑	☐	☐	☑
coho salmon	29-Jun-2022	same	same	☑	☐	☐	☑
Bering cisco	9-Jul-2022	same	same	☑	☐	☐	☑
least cisco	9-Jul-2022	same	same	☑	☐	☐	☑

IMPORTANT: Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish species, including; number of fish observed; photographs of each species & life stage observed or captured; sampling methods, duration and location(s) sampled; copies of data sheets and/or field notes, etc. Please attache a copy of a map showing location of lower and upper observed extents of each species & life stage, as well as other pertinent information such as specific locations of stream reaches where spawning or rearing individuals were observed or captured, and the location, type and heights of any barriers to fish fish passage, etc.

Comments:

Sampling Site #2

See attached data sheet for numbers & lengths.

From USACE report: Solomon Environmental Baseline Technical Assistance - Solomon, Alaska. Published April 2023
Author: Chris Hoffman (christopher.a.hoffman@usace.army.mil)

Observers Signature Chris Hoffman

Date

Observer Name: *(Please Print)* Chris Hoffman

Agency or Organization: USACE

Address: 2204 3rd St.
JBER, AK 99506

For Official Use Only

Signature of Area Biologist ***Date***

Name of Area Biolgist (Please Print):

State of Alaska
Department of Fish and Game
Division of Sport Fish

Nomination Form
Anadromous Waters Catalog & Atlas

Region: Arctic

USGS Quad(s): Solomon C-6

Nomination proposes the following revisions: *(check all that apply)*

☑ *Addition* ☐ *Correction* ☐ *Deletion* ☑ *Supporting Information*

AWC Number of Water Body: *(if known)* 333-10-11650- -0010

Name of Water Body: *(if known)* * Bonanza Channel of Safety Sound

☐ *Official USGS Name* ☑ **Local or Unofficial Name*

For Official Use Only

Nomination # : 24-008 Site #3

Revision Year : 2025

Revision(s) to: *Atlas* ☐ *Catalog* ☐ *Both* ☐

Revision Code(s) :

Fisheries Scientist *Date*

Habitat F&G Coordinator *Date*

AWC Project Biologist *Date*

GIS Analyst *Date*

For fish observations, please provide the upper most point (Lat/Long) where any two individuals of observed species & life stage were documented. Please use Decimal Degree's with a minimum of 5 decimal places. Please see Supplemental Information Form if you need more room for species observation data and comments.

Species	Date Observed	Latitude	Longitude	Anadromous	Adult Presence	Spawning	Rearing
broad whitefish	29-Jun-2022	64.527511	164.514659	☑	☑	☐	☐
pink salmon	9-Jul-2022	same	same	☑	☑	☐	☐
				☐	☐	☐	☐
humpback whitefish	24-Aug-2022	same	same	☑	☑	☐	☐
pond smelt	24-Aug-2022	same	same	☑	☐	☐	☑

IMPORTANT: Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish species, including; number of fish observed; photographs of each species & life stage observed or captured; sampling methods, duration and location(s) sampled; copies of data sheets and/or field notes, etc. Please attache a copy of a map showing location of lower and upper observed extents of each species & life stage, as well as other pertinent information such as specific locations of stream reaches where spawning or rearing individuals were observed or captured, and the location, type and heights of any barriers to fish fish passage, etc.

Comments:

Sampling Site #3

See attached data sheet for numbers & lengths.

From USACE report: Solomon Environmental Baseline Technical Assistance - Solomon, Alaska. Published April 2023
Author: Chris Hoffman (christopher.a.hoffman@usace.army.mil)

Observers Signature Chris Hoffman

Date

Observer Name: *(Please Print)* Chris Hoffman

Agency or Organization: USACE

Address: 2204 3rd St.
JBER, AK 99506

For Official Use Only

Signature of Area Biologist *Date*

Name of Area Biolgist (Please Print):

State of Alaska
Department of Fish and Game
Division of Sport Fish

Nomination Form
Anadromous Waters Catalog & Atlas

Region: Arctic

USGS Quad(s): Solomon C-6

Nomination proposes the following revisions: *(check all that apply)*

- [x] *Addition*
- [ ] *Correction*
- [ ] *Deletion*
- [x] *Supporting Information*

AWC Number of Water Body *(if known)*: 333-10-11650- -0010

Name of Water Body *(if known)*: * Bonanza Channel of Safety Sound

- [ ] *Official USGS Name*
- [x] **Local or Unofficial Name*

For Official Use Only

Nomination # : 24-008 Site #4

Revision Year : 2025

Revision(s) to: *Atlas* ☐ *Catalog* ☐ *Both* ☐

Revision Code(s) :

Fisheries Scientist — *Date*

Habitat F&G Coordinator — *Date*

AWC Project Biologist — *Date*

GIS Analyst — *Date*

For fish observations, please provide the upper most point (Lat/Long) where any two individuals of observed species & life stage were documented. Please use Decimal Degree's with a minimum of 5 decimal places. Please see Supplemental Information Form if you need more room for species observation data and comments.

Species	Date Observed	Latitude	Longitude	Anadromous	Adult Presence	Spawning	Rearing
humpback whitefish	14-Jun-2022	64.518005	164.556084	☑	☑	☐	☐
pink salmon	14-Jun-2022	same	same	☑	☐	☐	☑
coho salmon	14-Jun-2022	same	same	☑	☐	☐	☑
coho salmon	29-Jun-2022	same	same	☑	☐	☐	☑
chum salmon	29-Jun-2022	same	same	☑	☑	☐	☐

IMPORTANT: Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish species, including; number of fish observed; photographs of each species & life stage observed or captured; sampling methods, duration and location(s) sampled; copies of data sheets and/or field notes, etc. Please attache a copy of a map showing location of lower and upper observed extents of each species & life stage, as well as other pertinent information such as specific locations of stream reaches where spawning or rearing individuals were observed or captured, and the location, type and heights of any barriers to fish fish passage, etc.

Comments:

Sampling Site #4

See attached data sheet for numbers & lengths.

From USACE report: Solomon Environmental Baseline Technical Assistance - Solomon, Alaska. Published April 2023
Author: Chris Hoffman (christopher.a.hoffman@usace.army.mil)

Observers Signature Chris Hoffman

Date

Observer Name: *(Please Print)* Chris Hoffman

Agency or Organization: USACE

Address: 2204 3rd St.
JBER, AK 99506

For Official Use Only

Signature of Area Biologist — ***Date***

Name of Area Biolgist (Please Print):

State of Alaska
Department of Fish and Game
Division of Sport Fish

Nomination - Supplemental Information Form
Anadromous Waters Catalog & Atlas

For Official Use Only

Nomination #: 24-008 site #4
Revision Year: 2025

AWC #: 333-10-11650-0010
(if known)

Name of Water Body: *Bonanza Channel of Safety Sound
(if known)

This supplemental information sheet is provided for when there are more observations, locations, and or species and life-stage information than can be documented in the one page Nomination Form.
For location description, please provide latitude and longitude of the upper most point that two individuals of any observed species and life-stage were documented. Please use Decimal Degrees with a minimum of 5 decimal places.

Waypoint ID	Date Observed	Species	Latitude	Longitude	Anadromous	Adult Presence	Spawning	Rearing	Observation Notes *Mortalities, Deformities, Disease, Behavior, Habitat, Etc.*
	9/7/22	pink salmon	64.518005	164.556084	☑	☑	☐	☑	both adults and juvenile caught same date
	9/7/22	coho salmon	same	same	☑	☐	☐	☑	
	9/7/22	least cisco	same	same	☑	☐	☐	☑	
					☐	☐	☐	☐	
					☐	☐	☐	☐	
					☐	☐	☐	☐	
					☐	☐	☐	☐	
					☐	☐	☐	☐	
					☐	☐	☐	☐	
					☐	☐	☐	☐	

Comments:

Sampling Site #4

See attached data sheet for numbers & lengths.

From USACE report: Solomon Environmental Baseline Technical Assistance - Solomon, Alaska. Published April 2023
Author: Chris Hoffman (christopher.a.hoffman@usace.army.mil)

State of Alaska
Department of Fish and Game
Division of Sport Fish

Nomination Form
Anadromous Waters Catalog & Atlas

Region: Arctic

USGS Quad(s): Solomon C-6

Nomination proposes the following revisions: *(check all that apply)*
☑ *Addition* ☐ *Correction* ☐ *Deletion* ☑ *Supporting Information*

AWC Number of Water Body: *(if known)* 333-10-11650-0010

Name of Water Body: *(if known)* *Bonanza Channel of Safety Sound
☐ *Official USGS Name* ☑ **Local or Unofficial Name*

For Official Use Only

Nomination # : 24-008 Site #5

Revision Year : 2025

Revision(s) to: *Atlas* ☐ *Catalog* ☐ *Both* ☐

Revision Code(s) :

Fisheries Scientist *Date*

Habitat F&G Coordinator *Date*

AWC Project Biologist *Date*

GIS Analyst *Date*

For fish observations, please provide the upper most point (Lat/Long) where any two individuals of observed species & life stage were documented. Please use Decimal Degree's with a minimum of 5 decimal places. Please see Supplemental Information Form if you need more room for species observation data and comments.

Species	Date Observed	Latitude	Longitude	Anadromous	Adult Presence	Spawning	Rearing
humpback whitefish	14-Jun-2022	64.506102	164.602632	☑	☑	☐	☐
coho salmon	14-Jun-2022	same	same	☑	☐	☐	☑
coho salmon	29-Jun-2022	same	same	☑	☐	☐	☑
coho salmon	9-Jul-2022	same	same	☑	☐	☐	☑
Bering cisco	9-Jul-2022	same	same	☑	☐	☐	☑

IMPORTANT: Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish species, including; number of fish observed; photographs of each species & life stage observed or captured; sampling methods, duration and location(s) sampled; copies of data sheets and/or field notes, etc. Please attache a copy of a map showing location of lower and upper observed extents of each species & life stage, as well as other pertinent information such as specific locations of stream reaches where spawning or rearing individuals were observed or captured, and the location, type and heights of any barriers to fish fish passage, etc.

Comments:

Sampling Site #5

See attached data sheet for numbers & lengths.

From USACE report: Solomon Environmental Baseline Technical Assistance - Solomon, Alaska. Published April 2023
Author: Chris Hoffman (christopher.a.hoffman@usace.army.mil)

Observers Signature Chris Hoffman

Date

Observer Name: *(Please Print)* Chris Hoffman

Agency or Organization: USACE

Address: 2204 3rd St.
JBER, AK 99506

For Official Use Only

Signature of Area Biologist *Date*

Name of Area Biolgist (Please Print):

From: Brase, Audra L (DFG)
To: Giefer, Joe (DFG)
Subject: RE: AWC Nomination/ updated information - Bonanza Channel of Safety Sound
Date: Thursday, October 10, 2024 11:12:01 AM

Hi Joe, I like your idea of turning the area behind the barrier island(s) into a polygon rather than trying to force it into a "stream" model.

Speaking of polygons, I haven't been able to see any on polygons in the fish resource monitor for a while, is there something wrong in the database?

Thanks!
Audra

-----Original Message-----
From: Giefer, Joe (DFG) <joe.giefer@alaska.gov>
Sent: Tuesday, October 1, 2024 3:02 PM
To: Brase, Audra L (DFG) <audra.brase@alaska.gov>
Subject: RE: AWC Nomination/ updated information - Bonanza Channel of Safety Sound

Hi Audra,

I wanted to show you this layout before proceeding to make sure its what you are expecting.

This is a little weird area for the AWC, these coastal channels aren't really streams with a true upper and lower stream point, so some of the upstream/downstream based linear organization falls apart.

In the attached picture you can see (in Pink) Sample Sites #1 & 2 would add species to 333-10-11700-2001 "*Solomon Channel".

Sites #3, 4, & 5 would add species to 333-10-11650-2001 "*Bonanza Channel".

Does that look correct?

You can also see another Nom plotted here that will add King & Sockeye salmon present up the Bonanza River to the location of the weir site.

Ideally I would like to fix the whole area and replace the stream lines for the "channels" and turn them into a polygon boundary that would cover the entire intertidal zone behind the barrier islands with no up/down references. It could be one long area or broken up into 2 or even three (incl *Cache Channel) with the bridge near the mouth of the Solomon being one transition point? But I'll leave that up to you, let me know if you want to make that change too.

Any questions please let me know.
Regards,

Joe Giefer
Habitat Biologist III
Anadromous Waters Catalog (AWC)
Alaska Dept. of Fish & Game
Division of Sport Fish – RTS
333 Raspberry Road, Anchorage AK 99518
Office 907-267-2336

Submit AWC Nominations electronically through the Online Portal here:

https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=nomSubmit.home

-----Original Message-----
From: Brase, Audra L (DFG) <audra.brase@alaska.gov>
Sent: Tuesday, October 1, 2024 9:37 AM
To: Giefer, Joe (DFG) <joe.giefer@alaska.gov>
Subject: RE: AWC Nomination/ updated information - Bonanza Channel of Safety Sound

OK, the ones I submitted have much more detail RE specific locations, which is important.

Also, they caught adult salmon, but did not appear to document spawning, that needs to be clarified.

Thanks,
Audra

-----Original Message-----
From: Giefer, Joe (DFG) <joe.giefer@alaska.gov>
Sent: Tuesday, October 1, 2024 9:30 AM
To: Brase, Audra L (DFG) <audra.brase@alaska.gov>
Subject: RE: AWC Nomination/ updated information - Bonanza Channel of Safety Sound

Sure, here's what they submitted mid Sept. I hadn't processed it so far as they had not responded to my request for photos yet.

Anything else please let me know.
Regards,

Joe Giefer
Habitat Biologist III
Anadromous Waters Catalog (AWC)
Alaska Dept. of Fish & Game
Division of Sport Fish – RTS
333 Raspberry Road, Anchorage AK 99518
Office 907-267-2336

Submit AWC Nominations electronically through the Online Portal here:
https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=nomSubmit.home

-----Original Message-----
From: Brase, Audra L (DFG) <audra.brase@alaska.gov>
Sent: Tuesday, October 1, 2024 9:23 AM
To: Giefer, Joe (DFG) <joe.giefer@alaska.gov>
Subject: RE: AWC Nomination/ updated information - Bonanza Channel of Safety Sound

Oh interesting, I was told they didn't submit the information, that's why I offered to assist them.

Could you send me #24-008?

-----Original Message-----
From: Giefer, Joe (DFG) <joe.giefer@alaska.gov>
Sent: Tuesday, October 1, 2024 8:53 AM
To: Brase, Audra L (DFG) <audra.brase@alaska.gov>
Cc: Hoffman, Christopher CIV USARMY CEPOA (USA) <Christopher.A.Hoffman@usace.army.mil>;

Deilah@villageofsolomon.org; Ashley Hadley <ashley@villageofsolomon.org>; Scanlon, Brendan P (DFG) <brendan.scanlon@alaska.gov>; Clark, Kevin J (DFG) <kevin.clark@alaska.gov>
Subject: RE: AWC Nomination/ updated information - Bonanza Channel of Safety Sound

Hi Audra,

Most of this already was submitted under Nom #24-008, so I will add the report and data sheets you attached to that file.

I had inquired if there were any photos to help confirm fish ID's and the report looks to have some of that. I will get to processing this asap and will reach out if I have any questions.

Regards,

Joe Giefer
Habitat Biologist III
Anadromous Waters Catalog (AWC)
Alaska Dept. of Fish & Game
Division of Sport Fish – RTS
333 Raspberry Road, Anchorage AK 99518
Office 907-267-2336

Submit AWC Nominations electronically through the Online Portal here:
https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=nomSubmit.home

-----Original Message-----
From: Brase, Audra L (DFG) <audra.brase@alaska.gov>
Sent: Monday, September 30, 2024 2:51 PM
To: Giefer, Joe (DFG) <joe.giefer@alaska.gov>
Cc: Scanlon, Brendan P (DFG) <brendan.scanlon@alaska.gov>; Clark, Kevin J (DFG) <kevin.clark@alaska.gov>; Hoffman, Christopher CIV USARMY CEPOA (USA) <Christopher.A.Hoffman@usace.army.mil>; Deilah@villageofsolomon.org
Subject: AWC Nomination/ updated information - Bonanza Channel of Safety Sound

Hi Joe,

In 2022 the USACE and Village of Solomon did some beach seining in the Bonanza Channel of Safety Sound and caught anadromous fish in the portion of the channel adjacent to the Nome Council Road. The attached nominations are updates to the catalog. I have also included a copy of their final report, the raw catch data spreadsheet and a map showing the sampling sites.

Please let me know if you need anything else, I was assisting them with their nomination submittal.

Have a great day,
Audra

Audra Brase
Regional Supervisor
ADF&G Habitat - Fairbanks
907-459-7282

Bonanza Channel of Safety Sound 333-10-11650-2001

1 of 4

Solomon 2022															
	Site 1			Site 2			Site 3			Site 4			Site 5		
Trip 1 14 June 22	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)
Starry flounder (YOY)	23		43				2	40, 105	73	5		51	1	215	
unidentified sculpin (L)	2	16, 15	16												
Three-spined stickleback (A)	5		83	10		80	11	40, 105	81				1,212		83
Humpback whitefish (A)				1	395					10		81	1	435	
pink salmon (J)										2	32, 35	39			
coho salmon(J)										1		80	3	106, 99, 104	103
beligerent sculpin (J)										6		125			
Trip 2 29 June 22	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)
Starry flounder (YOY)	25		37	9		116	11		77	4		105	4		53
Starry flounder (J)	1	143											1	145	
unidentified sculpin (L)				1		26									
Three-spined stickleback (A)	44		82	167		85	58		83	246		84	121		83
Broad Whitefish (A)							1		460						
pink salmon (J)	1	37		2	58, 58	58									
coho (J)				9		101				2	120, 118	119	1		84
beligerent sculpin (J)	5		22							5		140			
capelin (LARVAL)	69		45	6		52	2		45	47		50	44		43
Bering Cisco (A)	1	310													
Poacher, tubenose (YOY)	1	31													
unidentified whitefish (J)													1		150
Arctic shanny (YOY)							1	29							
Chum salmon (A)										3		643			
Trip 3 9 July 22	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)
Starry flounder (YOY)	10		57							4		63	3		91
Starry flounder (J)	7		154	5		269									
unidentified sculpin (YOY)	1		30												
Three-spined stickleback (A)	14		78	79		81	139		83	279		80	169	133, 76, 67	85
Pink salmon (A)	100		450				19		418	18		not rec			
Pink salmon (J)										1	62	62			
Coho salmon (J)										3		132	1	120	120
beligerent sculpin (J)										2		186	5		110
capelin (A)							1		210	200		52			
capelin (LARVAL)													49		57
Bering Cisco (J)				2	145, 210	178							1	135	135
Chum salmon (A)	2	600, 600	600												
Cisco, least (J)				4		249				1	190	190			
Trip 4 24 Aug 22	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)	No.	Lenghts	Avg TL (mm)
Starry flounder (YOY)	6		39	5		61	12		35	23		34	1		50
Starry flounder (J)	9		141	14		114	10		92	3		100	4		136

Solomon 2022															
		Site 1			Site 2			Site 3			Site 4			Site 5	
unidentified sculpin (YOY)															
Three-spined stickleback (YOY)	175		22	320		23	270		21	415		19	240		20
Three-spined stickleback (A)				1		75	2		78	7		78	12		64
Humpback whitefish (A)							1		340						
beligerent sculpin (J)	7		69	1		77	3		102	9		90	3		114
poacher, tubenose (J)	6		73	1		69				6		66	12		74
Sandlance, pacific (J)	2	55, 63	59	4		60				1		72	4		56
cod, saffron (J)	2	65,105	85												
Herring, Pacific (YOY)				4		37	2		42						
Flounder, arctic (J)				1		189				4		118			
Smelt, Pond (J)							1		82						
unidentified, osmeridae (J)										1		89			

	Location				Date				
Site	Latitude (°N)	Longitude (°W)		14-Jun-22	29-Jun-22	9-Jul-22	24-Aug-22		# of sets
1	64.545822	-164.428967		X	X	X	X		4
2	64.535231	-164.481302		X	X	X	X		4
3	64.527511	-164.514659		X	X	X	X		4
4	64.518005	-164.556084		X	X	X	X		4
5	64.506102	-164.602632		X	X	X	X		4
	Number of sets			5	5	5	5		20

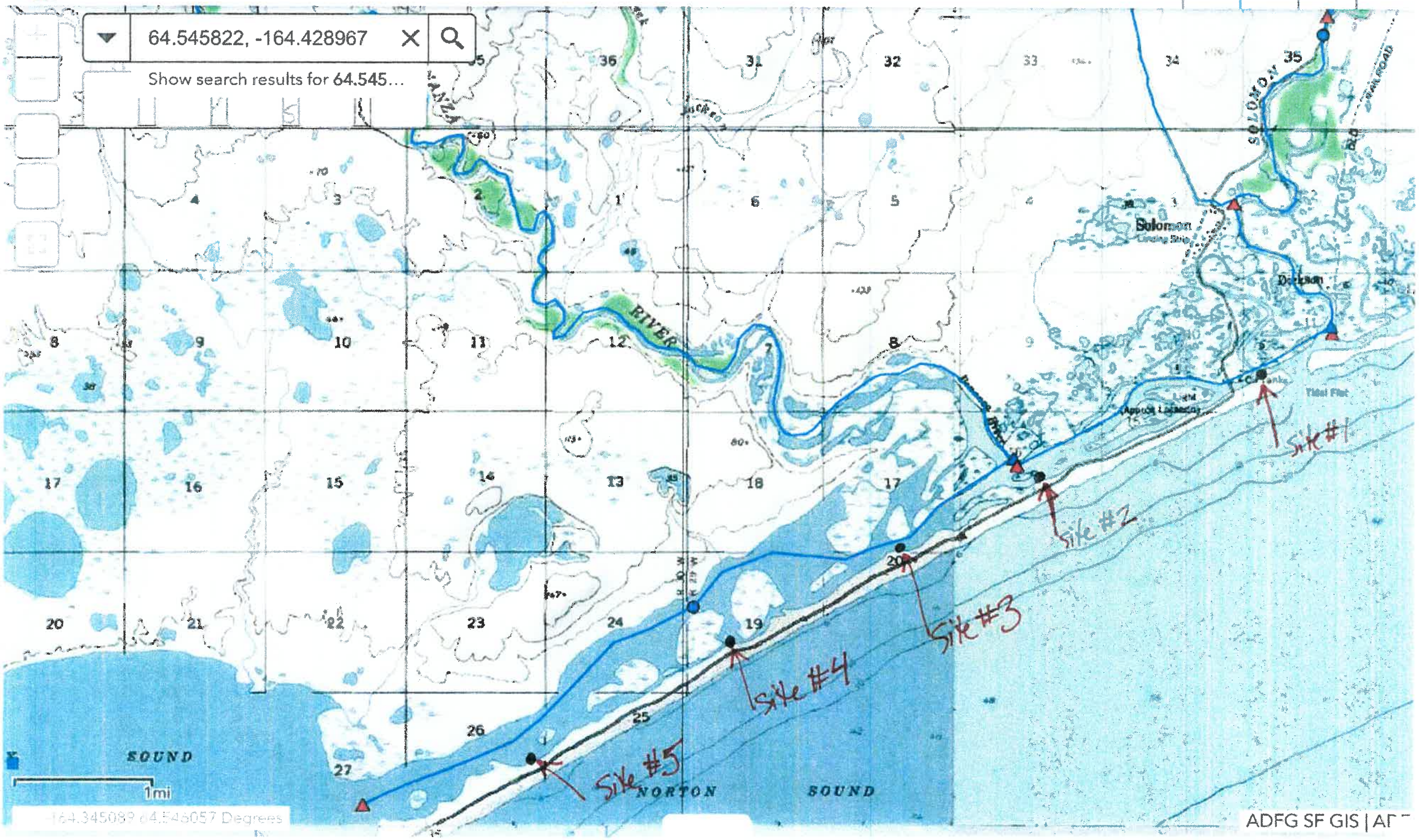
Bonanza channel of Safety Sound
333-10-11650-2001

4 of 4

Alaska Fish Resource Monitor

AWC Fish Passage AFFI Pike Habitat Permits Aquatic Farming Lake Bathymetry

AWC User Guide



~UPDATE/ADJUST lower hydrography segment and mouth point of existing AWC Stream #333-10-11650 "Bonanza River"

~DELETE existing AWC Stream line #333-10-11650-2001 "*Bonanza Channel" and corresponding Stream Points.

~ADD new AWC Lake #333-10-11650-0010 "*Bonanza Channel" with CHp, COp, Kp, Pp, Sp, DVp and LCp.

~ADD new species BROAD and HUMPBACK whitefish PRESENT and BERING cisco and POND smelt REARING to AWC Lake #333-10-11650-0010 "*Bonanza Channel".

~ADD new species life-phases PINK and COHO salmon REARING to AWC Lake #333-10-11650-0010 "*Bonanza Channel".

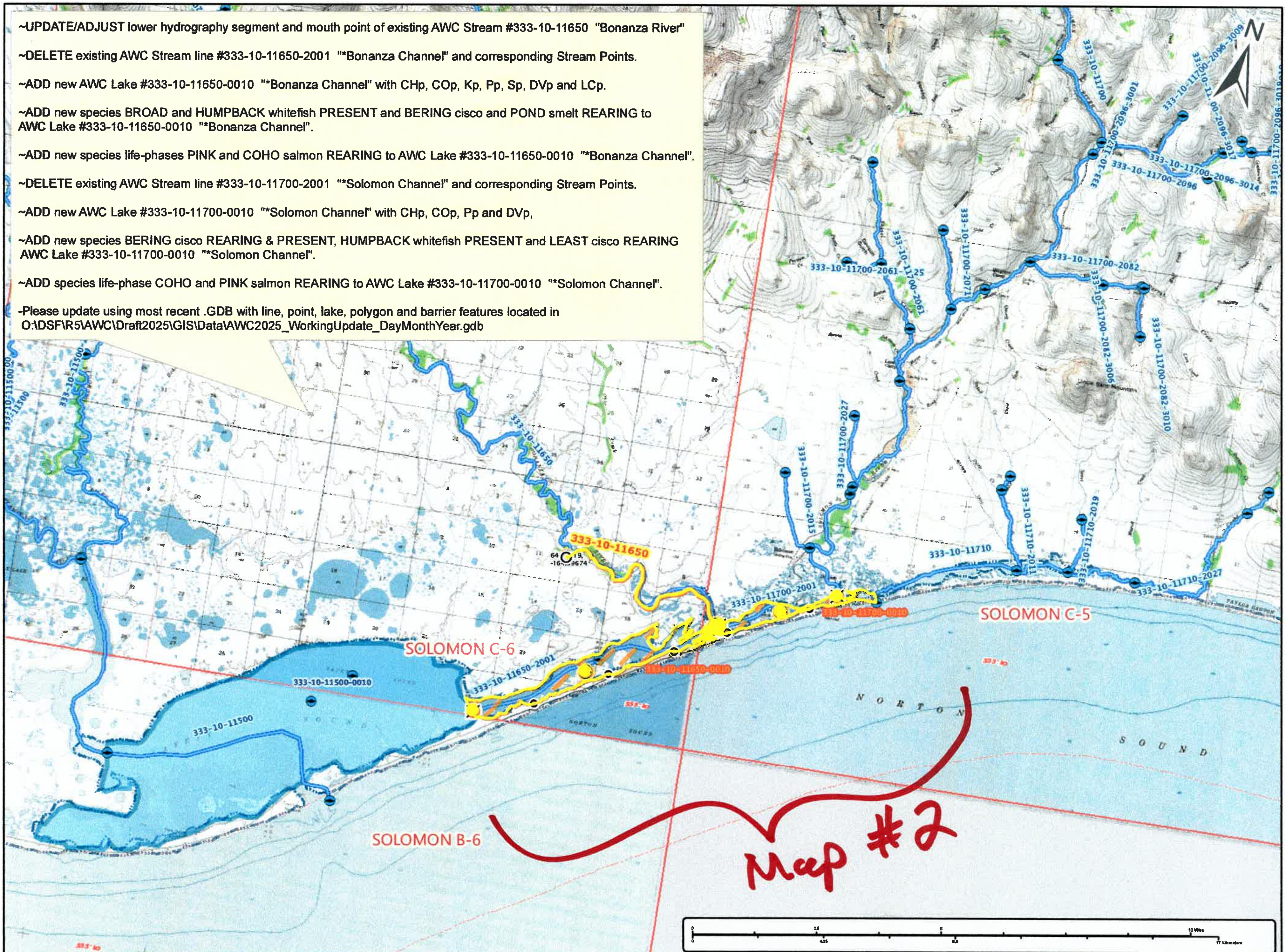
~DELETE existing AWC Stream line #333-10-11700-2001 "*Solomon Channel" and corresponding Stream Points.

~ADD new AWC Lake #333-10-11700-0010 "*Solomon Channel" with CHp, COp, Pp and DVp,

~ADD new species BERING cisco REARING & PRESENT, HUMPBACK whitefish PRESENT and LEAST cisco REARING AWC Lake #333-10-11700-0010 "*Solomon Channel".

~ADD species life-phase COHO and PINK salmon REARING to AWC Lake #333-10-11700-0010 "*Solomon Channel".

-Please update using most recent .GDB with line, point, lake, polygon and barrier features located in O:\DSF\R5\AWC\Draft2025\GIS\Data\AWC2025_WorkingUpdate_DayMonthYear.gdb



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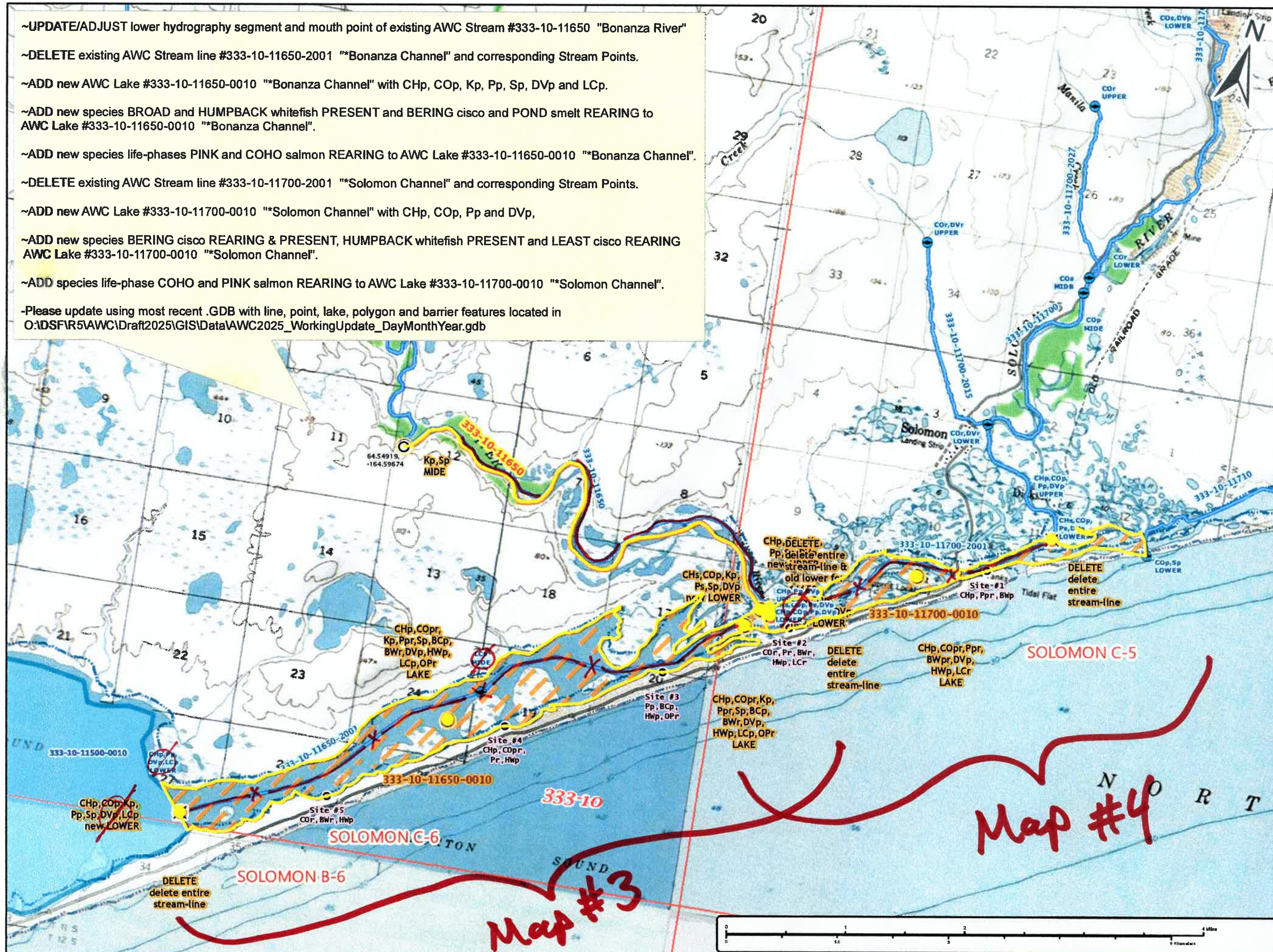
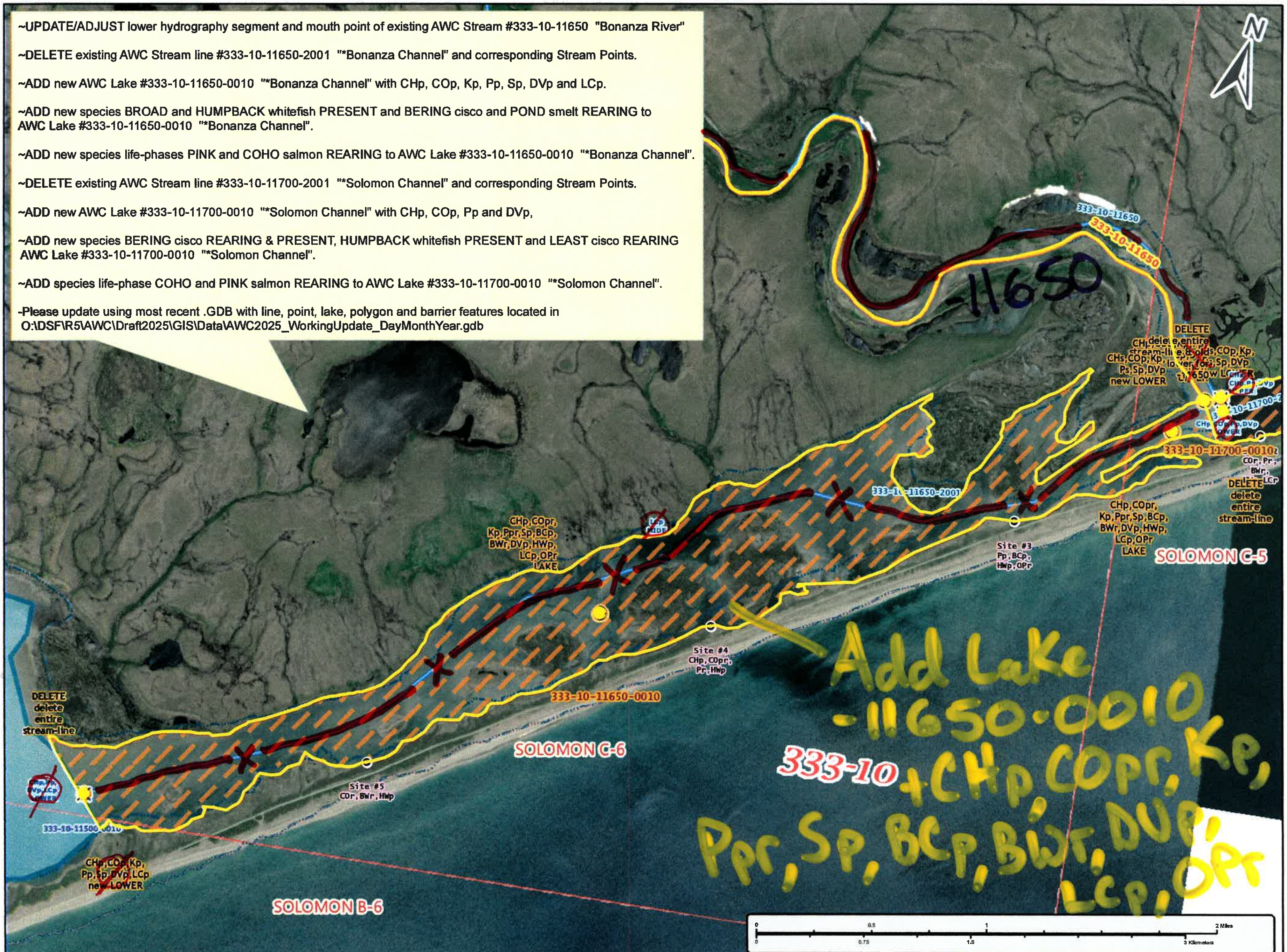
Map #1



Nom #24-008

Map #2



Nom #24-008

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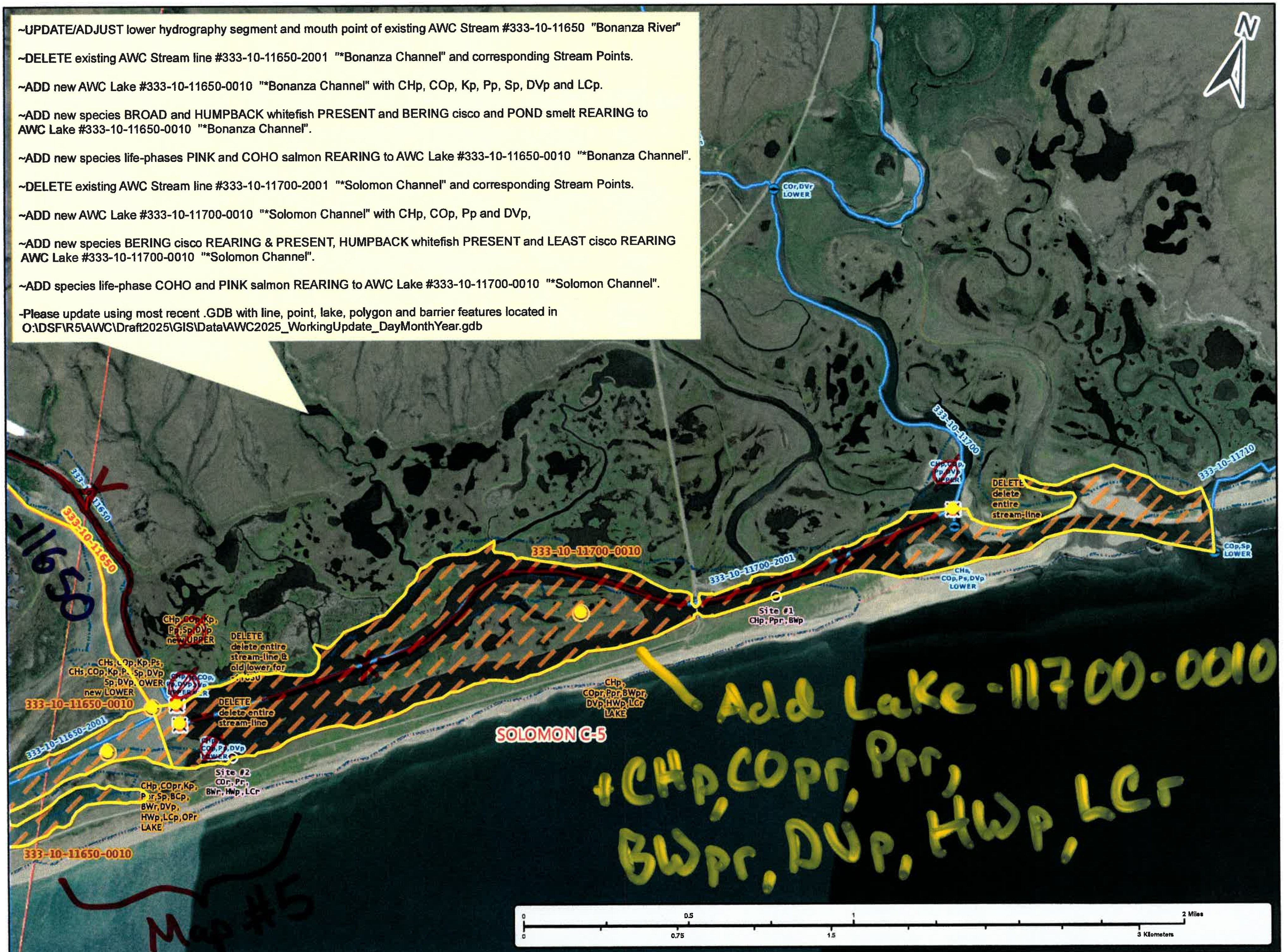

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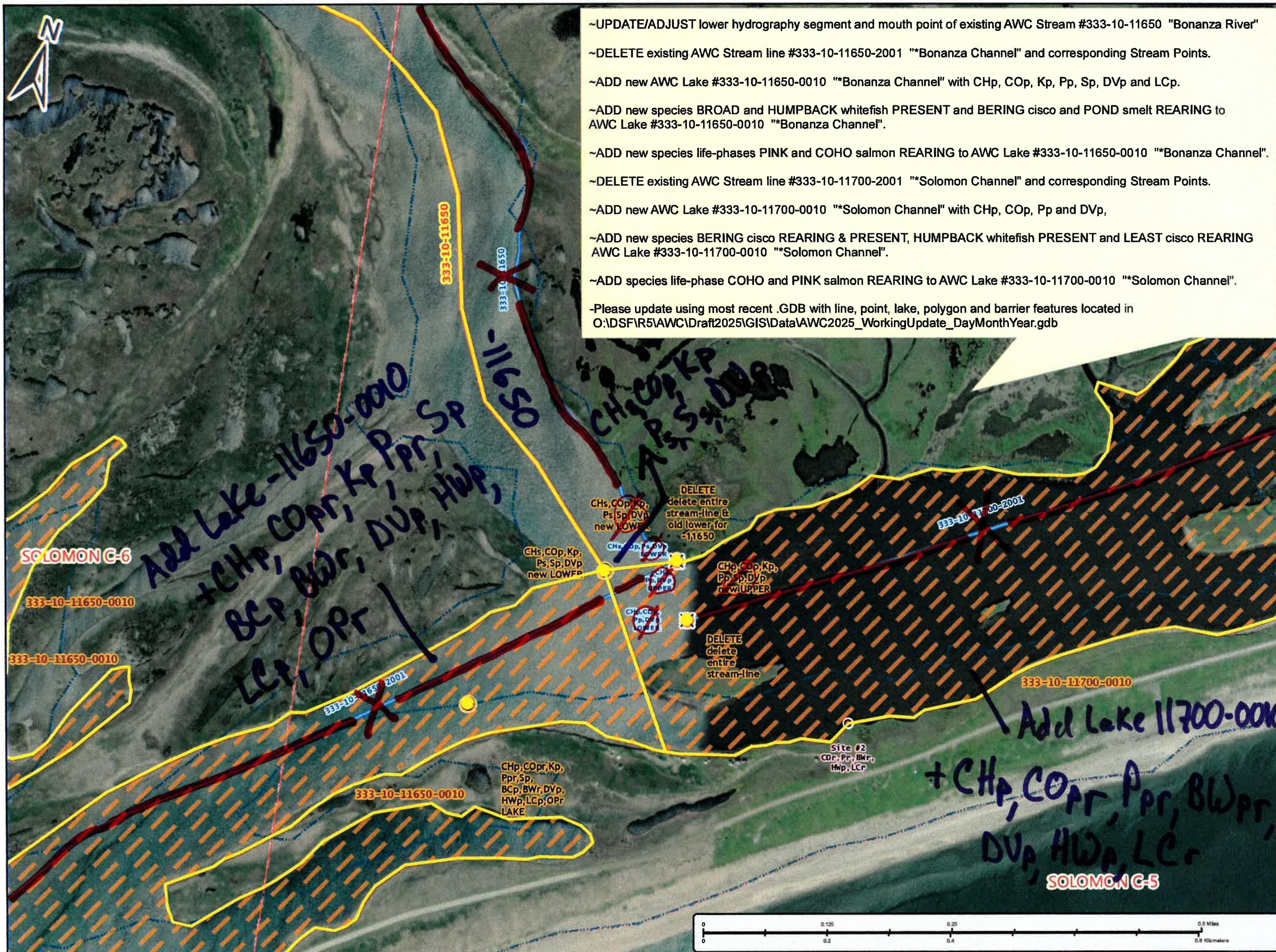
Map #4



Nom #24-008

Map #5

US Army Corps of Engineers®

Planning Assistance to States
Technical Report

Solomon Environmental Baseline Technical Assistance

Solomon, Alaska

APRIL 2023

Planning Assistance to States Technical Report

Environmental Baseline Technical Assistance

Solomon, Alaska

Prepared By:

U.S. Army Corps of Engineers
Alaska District

APRIL 2023

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1.0 INTRODUCTION

1.1 Authority

The Planning Assistance to States (PAS) program authorizes the U.S. Army Corps of Engineers (USACE) to provide Technical Assistance concerning water resource management to an eligible non-Federal interest. Technical Assistance studies through the PAS program are cost shared on a 50% Federal and 50% non-Federal basis. The PAS program is authorized under Section 22 of the Water Resources Development Act (WRDA) of 1974, as amended (42 U.S.C. §1962d—16). Section 1156 of the WRDA of 1986 (33 U.S.C. §2310), as amended, provides a cost sharing waiver of up to $530,000 under current policy for the non-Federal sponsor. Section 208 of 1992 WRDA (33 U.S.C. §2338) amended the WRDA of 1974 to authorize USACE to partner with federally recognized Native American Tribes in addition to State and local governments.

1.2 Background

In a letter dated 13 April 2021, the Village of Solomon (the current non-Federal sponsor) requested a technical assistance survey through the PAS program under Section 22 of the WRDA. The purpose of this survey was to provide data collection and technical assistance to establish baseline environmental data of both the natural and subsistence resources within the area. As a result of this request, a PAS agreement between the Department of the Army and the Village of Solomon for technical assistance was prepared and then executed on 31 August 2021.

1.3 Investigation Purpose and Objectives

USACE Alaska District prepared this PAS report with the purpose of providing technical assistance to establish baseline environmental data within Safety Sound and the surrounding area of Solomon. The objectives of this investigation were to assess the seasonal presence and species richness of terrestrial, freshwater, and estuarine biota within the area. The Village of Solomon is seeking to ensure that their activities, and those of other interests, proceed in a way that minimizes potential adverse impacts to these natural resources and the habitats that these resources rely upon.

1.4 Location

The Village of Solomon (64.561°N, -164.439°W) is located on the Seward Peninsula in northwestern Alaska, approximately 48 kilometers east of Nome on the Nome-Council Road. The Village of Solomon sits on the west bank of the Solomon River, near the northern shore of Norton Sound (Figure 1).

Figure 1. Vicinity map of Solomon, Alaska.

Solomon sits on the west bank of the Solomon River, approximately 1.6 kilometers north of Norton Sound and 48 kilometers east of Nome. Solomon is located on the Seward Peninsula (red inset box, upper left), in northwestern Alaska.

1.5 Stakeholders

The Village of Solomon is located within the Nome Census Area within the Bering Strait Region of Alaska. The Village of Solomon is a federally recognized tribe under the Indian Reorganization Act of 1993.

1.6 Scope of Work

This investigation aims to provide a baseline environmental analysis and survey of the natural resources within Safety Sound and the area near Solomon. Safety Sound and the area near Solomon is a subsistence-use area for residents of the Bering Strait region; therefore, survey locations were chosen based on key subsistence areas. USACE Alaska District selected the following survey sites to evaluate environmental resources: the eastern portion of Safety Sound near the mouth of the Bonanza River; the Solomon River, its western tributaries Jerome Creek and Shovel Creek (Figure 1), as well as some smaller unnamed side channels. USACE Alaska District visited the Village of Solomon in 2021 and 2022 to become familiar with site conditions, conduct surveys of natural resources, and to observe the current extent of human activity within the area.

2.0 RELATED REPORTS AND STUDIES

There are numerous reports and studies prepared by other agencies on the environmental conditions and natural resources within Safety Sound and the area near Solomon. These reports and studies have been referenced or cited throughout this environmental report.

Natural resources have been previously assessed by the Bureau of Land Management. This information has been summarized in Figures 2, 3, and 4. Information regarding subsistence and commercial harvest of fish and game species is available from various state and federal agencies. These agencies include the Alaska Department of Fish and Game (ADFG), National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service (USFWS).

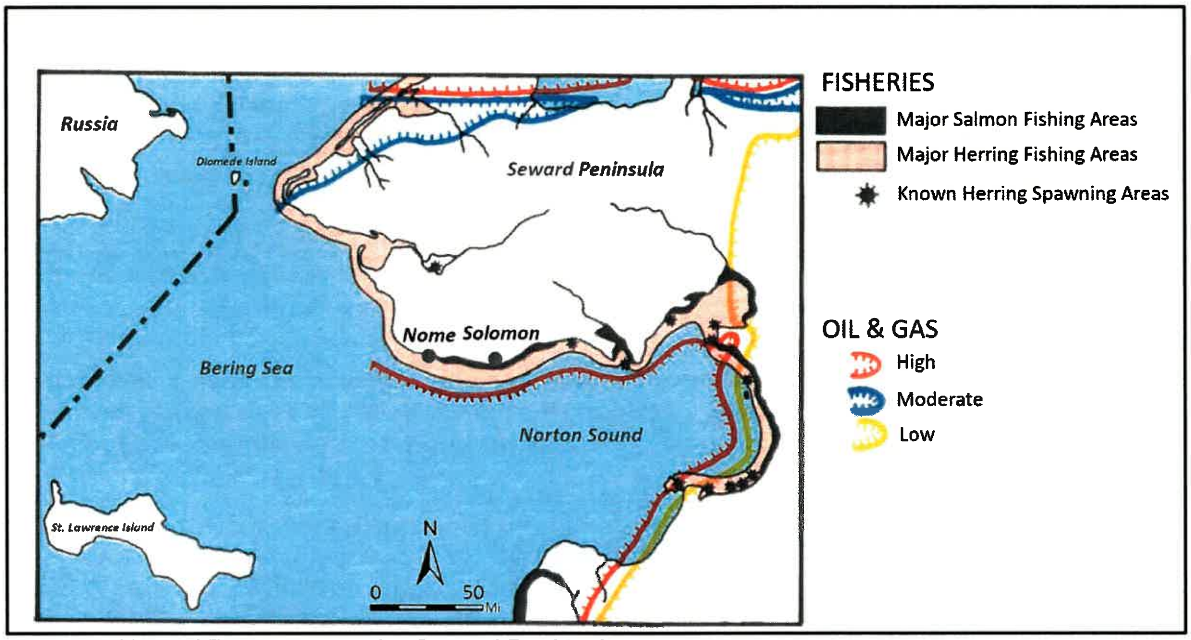


Figure 2. Natural Resources on the Seward Peninsula.

Map was data obtained from Community Map of Solomon, through the Bureau of Land Management (BLM, 1980). Information on levels of oil and gas basin-occurrence supplied by BLM Alaska Outer Continental Shelf Office (1980). Fisheries data adapted from the Alaska Department of Fish and Game, Alaska Fisheries Atlas (1978).

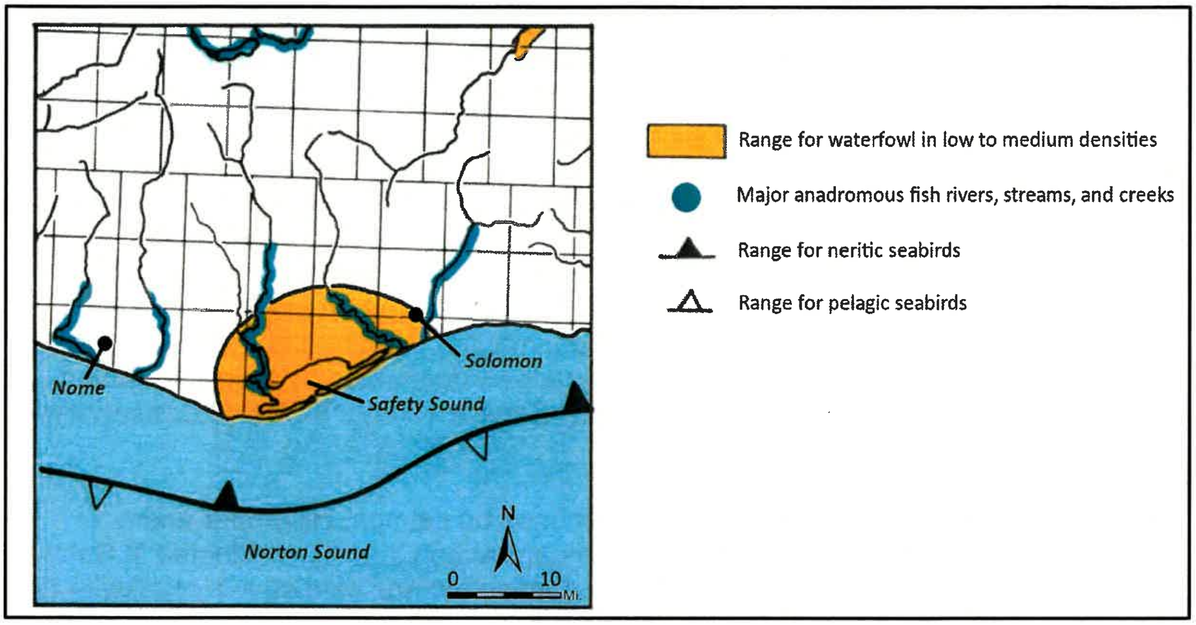


Figure 3. Ranges of Birds and Fish in Solomon, Alaska.

Anadromous waters are important for spawning, rearing, or migration of anadromous fishes. Neritic seabirds tend to occupy a shallow marine environment, while pelagic seabirds spend most of their time on the open ocean. Map was data obtained from Community Map of Solomon, through the Bureau of Land Management (BLM, 1980).

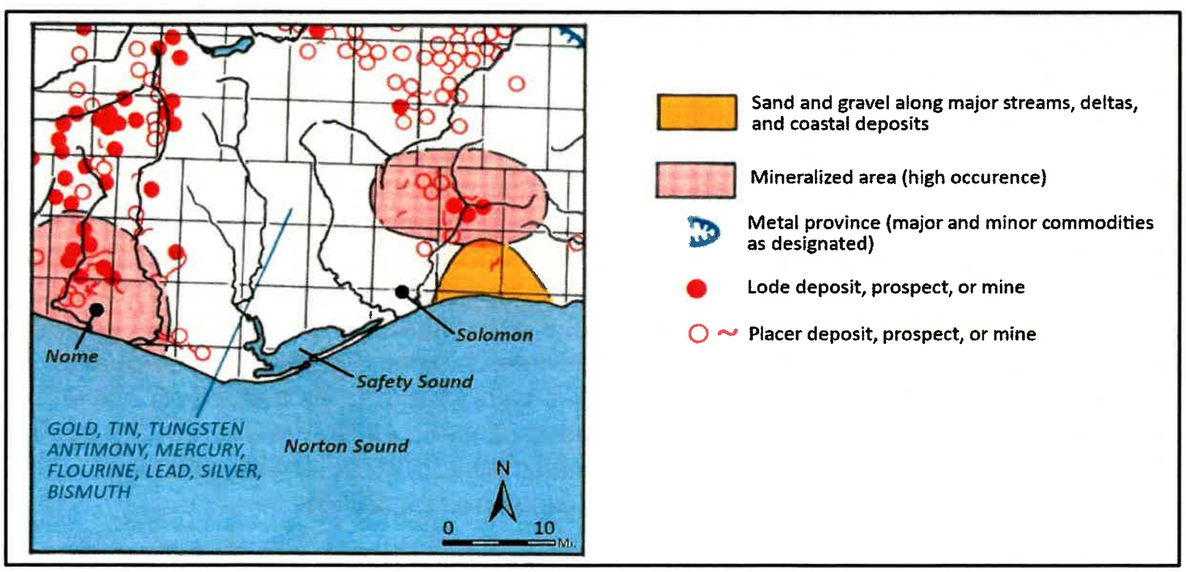


Figure 4. Minerals in Solomon, Alaska.

Map was data obtained from Community Map of Solomon, through the Bureau of Land Management (BLM, 1980).

3.0 EXISTING CONDITIONS SUMMARY

Safety Sound is an estuary that extends 16 kilometers southwest of the Village of Solomon and runs along the coast of Norton Sound (Figure 1; Orth, 1971). A near continuous barrier island separates Safety Sound from Norton Sound and the Bering Sea. The Nome-Council Road runs along this barrier island. The habitat within the lowlands of Safety Sound is broadly characterized by estuarine wetlands with sandy soils that are covered by moist coastal tundra and marsh vegetation. This area experiences periodic inundation and flooding during coastal storm surges (Alaska Maritime National Wildlife Refuge, 1995). Habitat types common along the coastal lowlands of Safety Sound include beach dunes, maritime tundra (i.e., tussock tundra, coastal tundra with lichen-sedge), and wet meadows dominated by tussock-forming sedge (Kessel, 1989; USDA Soil Conservation Service 1984; USDA Soil Conservation Service 1994).

To date, fishery data on Safety Sound has focused on salmon. Hillgruber and Zimmerman (2009) provide a summary of historic salmon studies conducted in Safety Sound from 2002 to 2004, as well as other estuarine salmon studies in Kuskokwim Bay and Kotzebue Sound. From both a commercial and subsistence perspective, a focus on salmon is rational. However, studies that focus on a single species are often limited in scope with regard to understanding the intricate components and function of the ecosystem as a whole. Given that this knowledge gap exists, documenting the baseline inventory of fish species within Safety Sound is warranted.

Safety Sound is a significant refugia for many species of migratory bird. Seasonal migrants, such as waterfowl and shorebirds, use the area for breeding and nesting activities throughout the boreal summer. Safety Sound acts as a stopover site, and abundant resources within the estuary provide excellent foraging habitat for a diverse range of avian species. Likewise, Safety Sound and the greater extent of the Seward Peninsula is a key area for intercontinental overlap for Holarctic taxa that occur across Beringia. The large overlap of Eurasian and North American migration systems causes extensive seasonal contact between these lineages and populations. Rare and casual vagrants do occur on the Seward Peninsula; usually in small numbers on the perimeter of Alaska, or at irregular intervals coinciding with seasonal and regional patterns. Many Eurasian migratory species of bird have isolated breeding populations within this area (Kessel, 1989; Winker et al., 2023). Threatened and vulnerable avian species, such as the spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*), are occasionally present within Safety Sound; often using the area as a stopover site while migrating to breeding grounds at higher latitudes (Kessel, 1989; Petersen et al., 2020; Fredrickson, 2020). Eastern Norton Sound is also an important molting area for spectacled eiders from summer through fall (Sexson et al., 2016).

Many waterfowl and shorebird species are a common staple in the subsistence diet of local residents. Waterfowl in particular account for a large proportion of the annual wild bird harvest, making up approximately 85% of migratory birds taken for subsistence in Alaska (Naves et al., 2017). Safety Sound is also a prime waterfowl hunting and egg collecting area due to the abundance of birds in the area (Alaska Maritime National

Wildlife Refuge, 1995). Continued access to traditional subsistence resources within Safety Sound is an important consideration for community resilience and planning.

Large terrestrial and marine mammals are present within the area near Solomon and Safety Sound. Large terrestrial mammal species include caribou (*Rangifer tarandus granti*), muskox (*Ovibos moschatus*), moose (*Alces alces*), grizzly bear (*Ursus arctos horribilis*), arctic fox (*Alopex lagopus*), and red fox (*Vulpes vulpes*). Small mammals e.g., voles and lemmings (subfamily *Arvicolinae*), and arctic ground squirrel (*Urocitellus parryii*) inhabit tussock tundra habitat. Marine mammals, such as the spotted seal (*Phoca largha*) are often observed within Safety Sound. Both terrestrial and marine mammals are harvested for traditional subsistence use by local residents.

Current levels of anthropogenic activity within Safety Sound and the area near Solomon are minimal. However, during the gold rush era of the early 1900s, the area near the mouth of the Solomon River was the starting point of the Council City and Solomon River Railroad in the early 1900s. The abandoned steam locomotive, known as the "*The Last Train to Nowhere*" is still visible in the wetlands near Solomon (Figure 5).

Figure 5. "*The Last Train to Nowhere*" near Solomon.

In the early 1900s and sporadically thorough the mid-1900s, the Solomon River was the site of extensive placer mining, where gold and other heavily eroded minerals were separated from sand and gravel substrate through dredging. Most of the extensive riverbed altering activity was located between 4 kilometers and 8 kilometers north of Solomon along the Solomon River, and the dredge tailings are still obvious today (Figure 6). The pre-mining conditions of the river in this area are unknown.

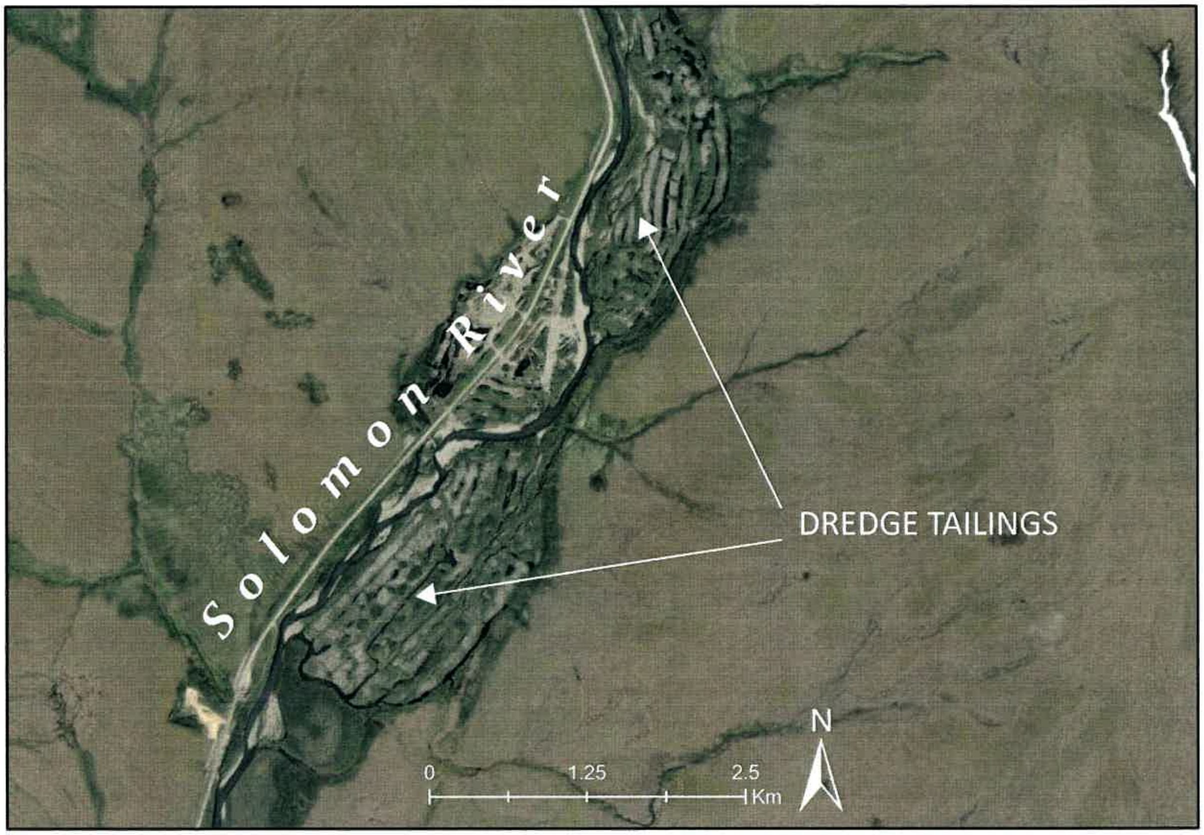


Figure 6. Evidence of dredge tailings on the Solomon River.

Dredge tailings from historic mining operations on the Solomon River are located approximately 4 kilometers north of Solomon.

At present, Safety Sound and the area near Solomon are primarily used for subsistence practices (i.e., fishing, hunting, and gathering) by local residents within the Nome area. There are a number of seasonal subsistence cabins and fish camps located on the Nome-Council Road between Nome and Solomon. In early summer each year, this area, as well as the entire road system out of Nome, is visited by a large number of recreational bird watchers.

4.0 ASSESMENT OF NATURAL RESOURCES

In this assessment, USACE Alaska District collected data to assess composition of the terrestrial, freshwater, and estuarine environments. Traditional survey techniques were paired with contemporary molecular analysis to assess the biotic environment. Measurements to assess changes in the abiotic environment were also collected throughout the field season.

USACE Alaska District incorporated the analysis of environmental DNA (eDNA) into the research design to complement traditional nearshore fish surveys. Using both molecular and observational methods provide an opportunity for a thorough taxonomic assessment of the nearshore fish community within Safety Sound. These data can be used to fill knowledge gaps on distribution and composition of nearshore fish species within the estuary.

Safety Sound and the surrounding wetland complex is heavily used by birds throughout the boreal summer. We conducted observational waterfowl surveys to assess the diversity of avian species within Safety Sound near Solomon. Counting the number of individuals present at a field site, and monitoring the change in species composition across time, is a standard survey method for avian research. These data can be used to estimate the species-specific influx of migrants within an area, and their relative magnitude across a temporal scale.

4.1 Metagenomic Analysis – eDNA

An emerging method that improves detection of many aquatic species is environmental DNA (eDNA), which determines the presence of a species based on the collection, extraction, and amplification of DNA from the environment (Ficetola et al., 2008; Laramie et al., 2015). Sources of eDNA in can include sloughed cells, feces, and bodily secretions. eDNA can be obtained from various environmental samples and reveals important information about the biodiversity within an ecosystem (Pederson et al., 2015; Shu et al., 2020). For fish species, investigations into their distribution and ecology are often hindered by the challenge and complexity of working in these aquatic ecosystems (Goldberg et al., 2011). In aquatic environments, eDNA is diluted and distributed by currents and other hydrological processes, but it's persistence and retention are dependent on environmental conditions (Dejean et al., 2011). However, detection of eDNA within aquatic ecosystems is a reliable and cost-effective method for determining the distribution of various fish species (Jerde et al., 2011; Thomsen et al., 2011; Shu et al., 2020).

In this investigation, metabarcoding techniques targeting short fragments of the mitochondrial genome (mtDNA) were used to characterize the nearshore fish community within of Safety Sound. The aim was to conduct a multispecies taxonomic assessment of the area using eDNA metagenomic analysis, a complementary tool to traditional survey approaches (Xiong et al., 2022).

4.1.1 Sampling Area

For eDNA collection, 1-Liter water samples were collected at five site locations in eastern Safety Sound during the 2022 field season (Figure 7). Nearshore beach seining and eDNA collection occurred at the same sites to ensure that seining results were directly comparable to the molecular taxonomic assessment of the nearshore community. Sites were chosen to ensure sufficient distance between sampling sites. At each sampling location, three replicate samples were taken to detect any potential inconsistencies in our filtering techniques or downstream metagenomic library preparation. A total of 80 water samples were collected across five sampling dates distributed throughout the 2022 field season (75 eDNA samples, five negative controls; Supplementary Table 1), which is an adequate level of sampling according to standard procedures outlined by Gerhi et al., (2021) and Larson et al., (2022).

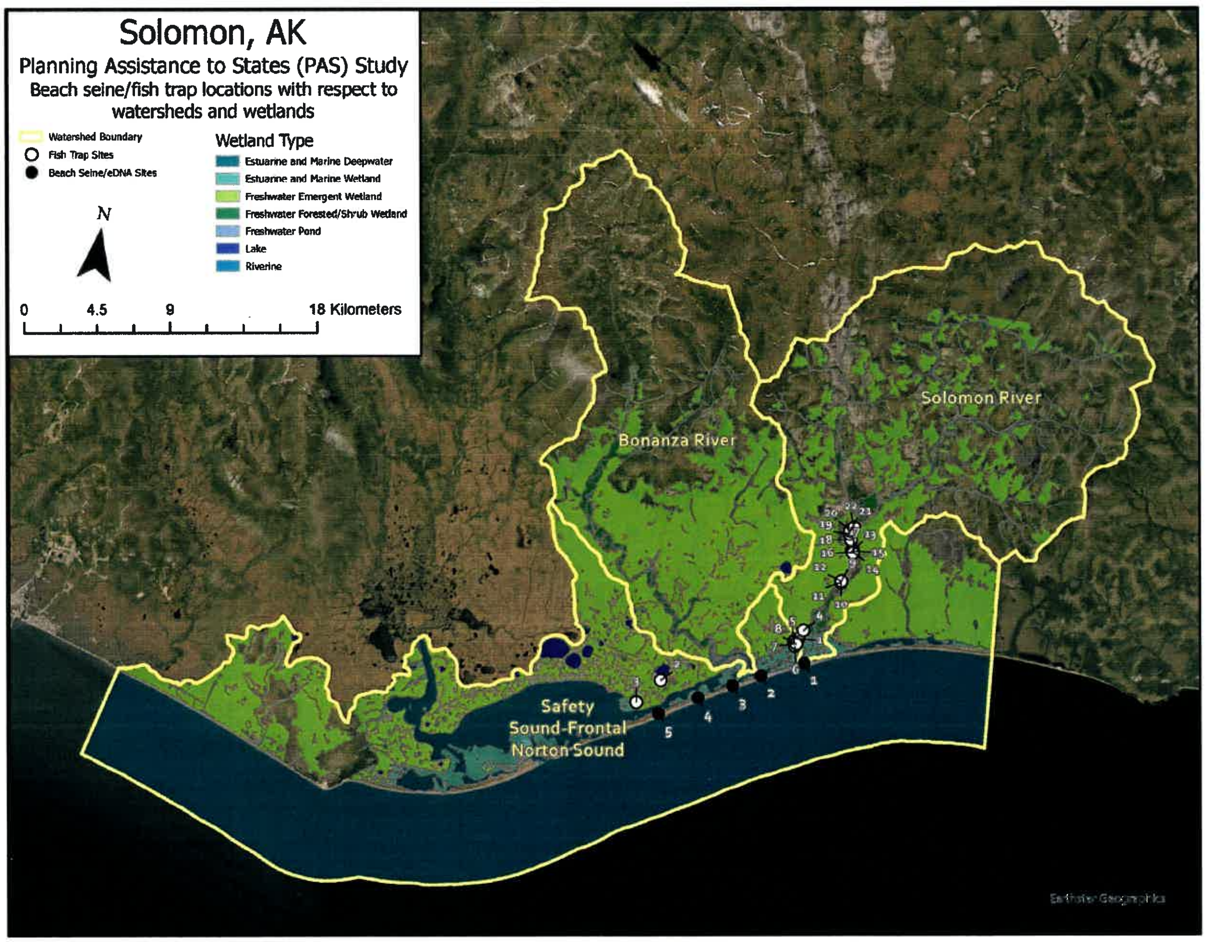


Figure 7. Sampling site locations with respect to wetlands and watersheds.

Site locations for nearshore beach seining, minnow traps, and eDNA are shown with respect to wetland habitat and major watershed boundaries. Sites were selected to fall along a shoreline transect to ensure an adequate sampling area. Seining and eDNA sites are shown in black, and minnow trap sites are shown in white. See Supplementary Table 1 for detailed eDNA voucher information. See Table 1 for detailed beach seining set and site information.

4.1.2 Field Collection of eDNA

Collected water samples were filtered through a Thermo Scientific™ Nalgene™ 250 milliliter single use analytical funnel with a 47 millimeter diameter cellulose nitrate filter with a 0.45 micrometer pore size. A manual, hand driven vacuum pump was used to filter samples following procedures outlined in *Protocol #1* of Laramie et al., 2015. Cross-contamination was mitigated for by disinfecting surfaces and instruments with 10% bleach solution and then rinsing with distilled water between processing replicates from different field sites. In addition to the three replicate samples collected at each field site, a negative control containing only distilled water was filtered to ensure our methods were effective in mitigating cross-contamination.

4.1.3 Laboratory and Molecular Analysis

Samples were sent to the U.S. Army Engineer Research and Development Center's Genetics Reconnaissance Team (Environmental Processes Branch, Environmental Laboratory; CEERD-EPP) for DNA extraction, sequencing, and bioinformatic analysis. Extractions followed a modified cetyltrimethylammonium bromide (CTAB) protocol outlined in Doyle and Doyle, 1987. Two metabarcoding primers were chosen, MiFish-U (Miya et al., 2015) and AKOncCytB (Menning et al., 2020). MiFish-U is a universal primer that targets the 12S-rRNA gene and possesses robust detection potential across numerous freshwater and marine fish taxa. However, MiFish-U exhibits low discriminatory power among salmonid species (Polanco et al., 2021; Miya et al., 2020). Thus, the AKOncCytB metabarcoding primer specifically designed for detection and discrimination of salmonid species in the cytochrome-B gene was used in conjunction with MiFish-U. The combined use of multiple primer pairs targeted for more than one gene marker (e.g., 12S-rRNA and cytochrome-B) is recommended to improve classification, reduce primer bias and false negatives, and better perform community-level analyses (Xiong et al., 2022).

High throughput sequencing (HTS) libraries were generated for both markers for each sample using recommended library preparation protocols (Bourlat et al., 2016). Quality assurance and control (QA/QC) measures, specifically negative controls were incorporated into DNA extraction and HTS workflow to detect any potential issues with contamination. A positive control was included in early stages of the HTS workflow to ensure successful amplification. For the positive control, water filtrate samples from aquarium tanks containing only zebrafish (*Danio rerio*) were used. Zebrafish are found within the subfamily *Danioninae* of the family *Cyprinidae*. The only fish found within *Cyprindae* in Alaska is the lake chub (*Couesius plumbeus*) from the subfamily *Leuciscinae*. Thus, with only one distantly related species in Alaska, any sample cross-contamination from the zebrafish eDNA positive controls should not pose a challenge to accurate identification of eDNA from Alaskan fish. Marker libraries from half of the samples were combined for the first sequencing run on an Illumina MiSeq, using V2 500 cycle kits. A run of combined marker libraries for the remaining (i.e., second half) of samples was then conducted using the same protocols.

4.1.4 Bioinformatics

Resulting raw sequence data was concatenated across the two HTS runs. These data were processed following the MiFish bioinformatics pipeline (version 3.87, Sato et al., 2018; Zhu et al., 2023). In short, low-quality bases and adapters were removed. Resulting paired-end reads were then merged, and erroneous reads and primers were removed. Unique sequence reads, or amplified sequence variants (ASVs), were identified and ASV read counts for each sample were calculated. Species-level taxonomic assessment was preformed using a sequence similarity search against available references on the MitoFish mtDNA database. For reads generated by the AKOncCytB marker, low-quality bases and adapters were removed. A matrix of error rates for forward and reverse reads were created. These error rates were used to denoise the reads and remove sequence errors. Denoised reads were merged to create ASVs. ASVs were assigned to species based on the best observed match at greater than 97% sequence identity to salmonids in a database created of all NCBI (National Center for Biotechnology Information) sequences (as of 7 February 2023) associated with the cytochrome-B region of 18 salmonid species present in this region of Alaska (courtesy of D. Menning, US Geological Survey Alaska Science Center). Following this initial ASV classification via the MiFish and Menning databases, classifications were further curated by identifying ASVs with equivalent sequence matches (i.e., identical E-value scores) to more than one taxon. These ASVs were entered into BLASTn (Basic Local Alignment Search Tool, nucleotides) searches against the entire NCBI GenBank DNA sequence archive. In cases where only one of the equivalent matches (in GenBank) was known to occur in Alaskan waters, the ASV was assigned to that taxon. In cases where more than one of the equivalent matches was known to occur in Alaskan waters, the ASV was assigned to a genus or subfamily, depending on the phylogenetic breadth of the matching sequences. In cases where the best observed sequence match for an ASV was between 95% to 97%, the ASV was assigned to the genus containing the best match (or matches).

4.2 Observational Data – Waterfowl and Fish Surveys

USACE Alaska District conducted multiple environmental surveys throughout 2021 and 2022 to characterize terrestrial, freshwater, and estuarine biodiversity within Safety Sound and the area near Solomon. These included beach seining for nearshore fishes within Safety Sound, setting minnow traps within freshwaters, and conducting traditional waterfowl surveys.

4.2.1 Survey Categories

4.2.1.1 Fishes

We focused on sampling the estuarine fish communities within the eastern end of Safety Sound. Assessing fish communities within estuarine environments is important since these areas are critical for species during sensitive early life stages (Dahlgren et al., 2006; Larson et al., 2022). While previous fish research in Safety Sound had a species-specific focus on salmon (Hillgruber and Zimmerman, 2009), our methods expanded the focus to a multi-species approach to encompass fish within Safety Sound across all life-history stages (i.e., larval to adult fish). The intent of our choice in methodology was to provide a broader picture of fish species present in Safety Sound. Additionally, sampling efforts in our investigation included a temporal and spatial component. Sampling occurring across the summer and fall of 2022, and our five beach seining sites were spread over 11.1 kilometers of coastline (Figure 7; Table 1).

Minnow traps were also used in freshwater lakes near Solomon and in tributaries of the Solomon River (Figure 7; Table 2). The goal here was to document the presence of juvenile salmonids and other fishes to expand the understanding of these important anadromous habitats. While known species and spatial extents of anadromous fish are documented in the anadromous catalog, species presence and habitat use data were lacking for juvenile fishes. Minnow traps were also used on a small number or pond and channel sites in Safety Sound near Solomon where beach seines could not be used.

4.2.1.2 Waterfowl

In Alaska, many species of waterfowl migrate to the Arctic to breed during the boreal summer (Winker and Gibson, 2010). Safety Sound and the surrounding nearshore environment is ideal habitat for waterfowl species. These wetlands provide critical stopover habitat during migration in addition to ideal breeding grounds. In Solomon, waterfowl are a key subsistence resource that are harvested throughout the spring and summer months as well as during fall migration (Alaska Migratory Bird Co-management Council, 50 CFR Part 92). The influx of migrants across this wetland complex can vary on a temporal scale throughout the spring and fall migration season. To quantify the diversity and magnitude of waterfowl within the area near Solomon, observational surveys focused on estimating the influx of migrants across the field season. Notes were taken on casual observations of small shorebird and songbird species, though these species were not the focus of the surveys. The observation distances were too great to detect and confidently identify smaller birds accurately or reliably.

4.2.2 Sampling Area

4.2.2.1 Nearshore Beach Seining

Beach seines were set during daylight hours within the eastern portion of the Safety Sound at five sites (Figure 7). Fish were sampled in water less than 3 meters deep and less than 15 meters from shore. Seine hauls were made at five sites for four summer sampling events, for a total of 20 sets (Table 1). Seine length was 37 meters long with variable mesh, tapering from 5 meters deep at the center to 1 meter deep at the ends. The two end panels were each 10 meters long with 32-millimeter stretch mesh, the two intermediate panels were each 4 meters long with 6-millimeter square mesh, and the bunt was 9 meters long with 3.2-millimeter square mesh. The seine was equipped with a leadline and a floatline so that the bottom edge of the net would maintain contact with the bottom substrate and the top would float on the water surface. Two braided nylon lines, approximately 25-30 meters long, were attached to the seine – one per end. The seine was set as a round haul from the bow of a small jet-powered boat due to shallow water conditions. One line was held on the beach while the net was paid out from the boat in a semi-circle to a second position on the beach about 18 meters from the starting point. The net was brought onto shore by pulling together on both lines from shore, trapping fish and other organisms within the net. The captured fish and other organisms were quickly transferred to aerated buckets of brackish site water for identification and measurement.

Table 1. Nearshore beach seining site and set information.

Seining occurred across a temporal scale at each of the five site locations. Site locations correspond to those in Figure 7.

	Location		Date			
Site	Latitude (°N)	Longitude (°W)	14-Jun-2022	29-Jun-2022	9-Jul-2022	24-Aug-2022
1	64.545822	-164.428967	X	X	X	X
2	64.535231	-164.481302	X	X	X	X
3	64.527511	-164.514659	X	X	X	X
4	64.518005	-164.556084	X	X	X	X
5	64.506102	-164.602632	X	X	X	X
		Number of sets	5	5	5	5

Tidal variation is minimal in Norton Sound; the maximum daily variation during our sampling occurred on 14-Jun-2022 when the daily variation was ~0.5 meters with a variation during the beach seining period of ~0.2 meters. On the three other sampling events (29-Jun-2022, 9-Jul-2022, and 24-Aug-2022) daily tidal variation was ~0.3 meters and variation during the beach seining period was ~0.03 meters. When beach seining is done in areas with a large tide differential, the goal is to sample at low tide to both standardize the sampling protocol and to sample the richest habitat. For sampling in Safety Sound, this was not an option due to logistical constraints for the boat support and was less important due to the very small tide differential and the gentle slope at each sample site. A similar situation was encountered on previous studies at sites in the Arctic where tidal variation was minimal and weather constrained sampling periods.

Water temperature (°C) and salinity (Practical Salinity Scale, PSS) were measured with a YSI Castaway CTD at each seining site. Each seining site was ~1 meter deep, so the point measurement mode was used on the CTD. Point measurements are for surface waters and depth is not recorded in point measurement mode.

4.2.2.2 Minnow Traps

Surveys of fish present in surrounding waters were conducted using minnow traps. Fish were sampled with both minnow traps with ~4 millimeter wire mesh and a three-chambered hoop trap with a ~3 millimeter nylon mesh net. A total of 22 sites were sampled in anadromous waters within the area near Solomon to assess the composition of the freshwater community (Table 2; Figure 7). These waters included streams, tributaries, sloughs, and ponds.

Traps were placed within four general areas; the Solomon River, Jerome Creek, Shovel Creek, and two small lakes near the hill locally known as "Sunrise" near Safety Sound (Supplementary Figure 1). The Solomon River (AWC: 333-10-11700) flows west-southwest 35 kilometers into Norton Sound, and is 1.3 kilometers southeast of Solomon (Orth, 1971). Jerome Creek (not listed on AWC) is a western tributary to the lower Solomon River, located 6.4 kilometers northeast of Solomon along Nome-Council Road. Shovel Creek (AWC: 333-10-11700-2061) is north of Jerome Creek, and is a western tributary of the Solomon River. "West" Lake and "Sunrise" Lake, the two unnamed lakes west of a hill locally known as "Sunrise" are located 5.3 and 7.2 kilometers west of the mouth of the Bonanza River (AWC: 333-10-11650), which is located 3.2 kilometers southwest of Solomon and empties into eastern Safety Sound. Traps were baited with approximately 8 ounces of cured salmon roe and were pulled approximately 24 hours after being set. Traps were labeled with appropriate permit numbers and contact information per Alaska Department of Fish and Game regulations.

Table 2. Minnow trap site and trap information.

Trapping occurred across multiple sites across the field season. Site locations correspond to points given in Figure 7 and site photographs in Supplementary Figure 1.

Location			Date Pulled					
Trap	Latitude (°N)	Longitude (°W)	14-Jun-22	15-Jun-22	27-Jun-22	9-Jul-22	26-Jul-22	23-Aug-22
1	64.558551	-164.441610	X					
2	64.524226	-164.606623		X				
3	64.510305	-164.633007		X				
4	64.563520	-164.436640			X			
5	64.556558	-164.446089			X			
6	64.554179	-164.444294			X			
7	64.555676	-164.443115			X			
8	64.555535	-164.442646			X			
9	64.593058	-164.398361				X		
10	64.592694	-164.398355				X		
11	64.592761	-164.398300				X		
12	64.593336	-164.397991				X		
13	64.610512	-164.390523					X	
14	64.610555	-164.390546					X	
15	64.610608	-164.388901					X	
16	64.609888	-164.389575					X	
17	64.609555	-164.388835					X	
18	64.616663	-164.393968						X
19	64.619662	-164.397035						X
20	64.621506	-164.397170						X
21	64.621298	-164.396375						X
22	64.623485	-164.392134						X
		Number of traps	1	2	5	4	5	5

4.2.2.3 Waterfowl Surveys

Waterfowl surveys were conducted throughout the summer and fall field season in three areas along Safety Sound (Figure 8). Boundaries of survey areas were selected to minimize potential overlap of species observed and mitigate for accidental recounting of individuals. During each survey, counts of each species were recorded within each area. Though our surveys focused on waterfowl, the presence of other avian taxa (i.e., gulls, loons, ravens) within the area were recorded. Surveys were conducted using a combination of 10x42 binoculars and a 20-60X spotting scope on a tripod.

Figure 8. Waterfowl survey areas in eastern Safety Sound.

Three survey areas were coded as area 1 (green), area 2 (yellow), and area 3 (red). Boundaries of these three survey areas were chosen to minimize overlap and mitigate for accidental recounting.

4.2.3 Field Collection of Observational Data

4.2.3.1 Nearshore Beach Seining

For nearshore beach seining the catch was sorted, counted, and individuals were identified to the lowest taxon (Figure 9). Data collected included the number of species caught, the average total length to the nearest millimeter of 10 individuals within each age cohort, and any incidental notes. Fish life stages (i.e., young-of-the-year – YOY, juvenile, and adult) were assigned in the field based on phenotypic characteristics using Johnson et al., 2015 as a key.

Catch data were expressed by absolute (i.e., total catch and species richness) and relative (i.e., catch-per-unit-effort – CPUE) metrics. The total number of individuals captured is reported as total catch. The total number of unique taxa captured is reported as species richness. CPUE was calculated by dividing the total catch by the number of sets; representing the relative abundance of taxa.

Figure 9. Sorting and recording catch data from nearshore beach seining.

USACE Alaska District staff and community members from the Village of Solomon work to sort and record seining catch data.

4.2.3.2 Minnow Traps

For minnow traps the catch was sorted, counted, and individuals were identified to the lowest taxon. Data collected included the number of species caught, the total lengths of these individuals to the nearest millimeter, and any incidental notes. Length metrics of minnow trap catch were combined and summarized across all traps. Unlike nearshore seining methods, minnow trap catch was not categorized by life stage.

4.2.3.3 Waterfowl Surveys

Waterfowl point count data was compiled for each survey date, with the number of species observed within each zone recorded along with the date and time. Survey dates include 18-Sept-21, 19-Sept-21, 15-Jun-22, 28-Jun-22, 10-Jul-22, 26-Jul-22, 24-Aug-22, and 15-Sept-22. Species that could not be identified in the field were identified to the lowest taxon based on field markings presented in the *Birds of North America Field Guide* (National Geographic Society, 1999).

5.0 RESULTS AND RECCOMENDATIONS

5.1 Results

Surveys conducted by the Alaska District throughout the 2021 and 2022 field seasons provided insight into the seasonal presence and relative abundance of terrestrial, freshwater, and estuarine biodiversity within Safety Sound near Solomon. This investigation incorporated both contemporary molecular analysis and traditional survey techniques to thoroughly assess the biotic environment. The goal of this investigation was to provide baseline environmental data that could be incorporated into future studies and assessments.

5.1.1 Metagenomic Analysis – eDNA

Taxonomic assessment of the nearshore community within Safety Sound using eDNA detected a diverse range of fish species (Table 3). In general, eDNA data suggests that sites 1, 2, and 3, appear to have a slightly greater diversity of species than sites 4 and 5. This pattern may be explained by the east-to-west gradient in site location, suggesting an environmental cline in estuarine habitat (Figure 7). Across all sites herring (*Clupea* spp.), whitefish (*Coregonus* spp.), sculpin (*Cottus* spp., *Myoxocephalus* spp.), three-spined stickleback (*Gasterosteus* spp.), salmon (*Oncorhynchus* spp.), and starry flounder (*Platichthys stellatus*) were consistently present. Species with more incidental rates of detection, likely due to seasonality or site fidelity include Pacific sand lance (*Ammodytes hexapterus*), Alaska blackfish (*Dallia pectoralis*), capelin (*Mallotus villosus*), rainbow smelt (*Osmerus mordax*), and Dolly Varden (*Salvelinus malma*).

The presence of some birds (Table 4) and mammals (Table 5) were also detected in eDNA samples. Though the detection of birds and mammals was not the focus or aim of the eDNA analysis, incidental amplification of non-target taxa are inevitable (Ritter et al., 2022). Bird species detected in eDNA includes various species waterbirds (i.e., orders Anseriformes and Charadriiformes). For mammals, both terrestrial and marine species were present, including moose (*Alces alces*), vole (*Microtus* sp.), spotted seal (*Phoca largha*), beluga whale (*Delphinapterus leucas*), and harbor porpoise (*Phocoena phocoena*). These data do provide some insight of bird and mammal species that may occur within or near Safety Sound. However, since birds and mammals are non-target species given the molecular and bioinformatic approaches used; interpretation of these data warrants caution.

Table 3. Taxonomic assessment of fish species in eDNA samples.

Species of fish detected in eDNA samples (green squares), for each sampling date across all five sampling sites. Sequences with low taxonomic resolution were classified to the lowest taxon given percent sequence identity. As a taxonomic assessment, species were sorted by scientific name rather than common name to improve clarity of eDNA results. Asterisks (*) by species name indicate species caught in nearshore seining efforts.

Species	Scientific Name	SITE 1					SITE 2					SITE 3					SITE 4					SITE 5				
		27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22
Pacific sand lance *	*Ammodytes hexapterus*	.	.		.		.		.	.		.					.									
Warty poacher	*Chesnonia verrucosa*																		.					.		
Pacific herring *	*Clupea pallasii*	.	.	.	.		.		.	.		.		.			.					.				
unidentified herring	*Clupea sp.*											.														
unidentified whitefish *	*Coregonus sp.*		.		.	.	.	.		.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	
unidentified sculpin *	*Cottus sp.*	.	.	.	.	.	.		.		.		.	.		.	.		.	.	.			.		
Alaska blackfish	*Dallia pectoralis*				.						.	.		.												
Saffron cod *	*Eleginus gracilis*		.	.	.	.		.		.	.				.	.					.			.		.
Three-spined stickleback *	*Gasterosteus aculeatus*	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
unidentified three-spined stickleback	*Gasterosteus sp.*											.										.				
Threaded sculpin	*Gymnocanthus pistilliger*				.					.																
Whitespotted greenling	*Hexagrammos stelleri*									.																
Pond smelt *	*Hypomesus olidus*				.															.					.	
unidentified snailfish	*Liparis sp.*													.												
Capelin *	*Mallotus villosus*						.					.														
Belligerent sculpin *	*Megalocottus platycephalus*		.		.			.		.			.					.		.					.	.
Fourhorn sculpin	*Myoxocephalus quadricornis*					.					.		.						.	.	.	.	.			.
unidentified sculpin *	*Myoxocephalus sp.*		.		.			.		.			.													
Pink salmon *	*Oncorhynchus gorbuscha*	.	.	.	.		.	.	.	.	.	.	.	.	.		.	.	.	.		.	.	.	.	.
Chum salmon *	*Oncorhynchus keta*		.	.	.	.		.	.	.	.		.	.	.		.		.					.		.
Coho salmon *	*Oncorhynchus kisutch*	.			.	.		.		.	.		.	.	.	.			.	.			.			.
Steelhead trout	*Oncorhynchus mykiss*						.																			
Sockeye salmon	*Oncorhynchus nerka*	.				.					.					.			.		.					
Chinook salmon	*Oncorhynchus tshawytscha*												.										.			
Rainbow smelt	*Osmerus mordax*		.		.			.		.			.				.			.		.		.	.	
Starry flounder *	*Platichthys stellatus*		.	.	.	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.
Alaska plaice	*Pleuronectes quadrituberculatus*								.			.														
Whitebarred prickleback	*Poroclinus rothrocki*						.																			.
unidentified nine-spine stickleback	*Pungitius sp.*				.				.		.			.	.	.			.	.						.
Dolly Varden	*Salvelinus malma*	.			.				.	.				.											.	
unidentified shanny	*Stichaeus sp.*											.		.			.									
unidentified grayling	*Thymallus sp.*													.												

5.1.2 Observational Data – Waterfowl and Fish Surveys

Traditional survey methods provided key observational data of the natural environment of Safety Sound and the area near Solomon. Nearshore beach seining in Safety Sound provided catch data that is directly comparable to our taxonomic assessment obtained through the metagenomic analysis of eDNA samples. Likewise, the minnow trap data complement the assessment of the nearshore estuarine environment of Safety Sound by providing an assessment of anadromous waters within the area. Finally, waterfowl surveys provide an estimate into the magnitude of influx of avian species to the area throughout the summer.

5.1.2.1 Nearshore Beach Seining

A total of 4,911 individuals were caught across all sites and dates, representing at least 21 taxa. Variation in catch was observed by site and by sampling date (Figure 10; Figure 13; Table 6; Table 7). Three-spined stickleback (*Gasterosteus aculeatus*) represented the greatest catch at 81.4%. Capelin (*Mallotus villosus*), starry flounder (*Platichthys stellatus*), and pink salmon (*Oncorhynchus gorbuscha*) followed, representing 8.5%, 4.1%, and 2.9% of the total catch (respectively). By date, three-spined stickleback was the most abundant species caught on each sampling date (Figure 10; Figure 13; Table 6). Starry flounder were the second most abundant species by date, excluding 9-Jul-2022 where capelin and pink salmon were second most abundant (250 individuals and 138 individuals, respectively; Figure 12). Regarding total catch by site, nearly 81.3% of capelin were caught at sites 4 and 5 distributed across two sampling dates, 29-Jun-2022 and 9-Jul-2022 (Figure 11; Figure 12; Table 7). The majority of pink salmon, 70.6% of the catch, were caught at site 1 on 9-Jul-2022 (Figure 12; Table 7).

Many fish species caught during seining efforts were also detected with eDNA (Table 3). In general, the diversity of species caught in the seine was corroborated with eDNA results. Likewise, the consistent detection of certain species in eDNA samples was supported by the seine results. Regarding changes in seine catch metrics across a temporal scale, these results appear to be correlated with the detection of species with eDNA (Table 3; Figure 10; Figure 11; Figure 12; Figure 13). There were also multiple fish species detected with eDNA that were not caught with the seine. These species may be more difficult to catch with traditional seining techniques or were unable to be caught due to low abundance, different life-history characteristics, or habitat affinities; or were simply not present. The detection of these additional species show case the utility of eDNA for fine scale detection of species present within a community that may be more elusive.

Though species abundance cannot be confidently quantified with eDNA, the relative rates of a species presence and absence is an insightful metric. Pairing a contemporary molecular technique such as eDNA with a traditional survey method, provides a thorough assessment of the nearshore fish community. By implementing both complementary approaches in this investigation, the results of this assessment of the nearshore fish community with Safety Sound are robust.

Table 4. Taxonomic assessment of bird species in eDNA samples.

Species of bird detected in eDNA samples (green squares), for each sampling date across all five sampling sites. As a taxonomic assessment, species were sorted by scientific name rather than common name to improve clarity of eDNA results. Sequences with low taxonomic resolution were classified to the lowest taxon given percent sequence identity.

Species	Scientific Name	SITE 1					SITE 2					SITE 3					SITE 4					SITE 5				
		27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22
unidentified dabbling duck	*Anas sp.*				.	.									.									.	.	
unidentified sandpiper	*Calidris sp.*			.																						
Pacific loon	*Gavia pacifica*			.																						
Red-throated loon	*Gavia stellata*		.									.														
unidentified gull	*Larus sp.*				.				.																	
unidentified grey-crowned rosy-finch	*Leucosticte sp.*						.																			
Red-breasted merganser	*Mergus serrator*												.	.												
Common eider	*Somateria mollissima*													.												

Table 5. Taxonomic assessment of mammal species in eDNA samples.

Species of mammal detected in eDNA samples (green squares), for each sampling date across all five sampling sites. As a taxonomic assessment, species were sorted by scientific name rather than common name to improve clarity of eDNA results. Sequences with low taxonomic resolution were classified to the lowest taxon given percent sequence identity.

Species	Scientific Name	SITE 1					SITE 2					SITE 3					SITE 4					SITE 5				
		27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22	27-Jun-22	10-Jul-22	25-Jul-22	24-Aug-22	18-Oct-22
Moose	*Alces*						.		.				.	.												
American beaver	*Castor canadensis*															.										
Beluga whale	*Delphinapterus leucas*					.																				.
Bearded seal	*Erignathus barbatus*					.																				
Canadian lemming	*Lemmus trimucronatus*																			.						
North American river otter	*Lontra canadensis*									.											.					
unidentified vole	*Microtus sp.*				.					.									.							
Spotted seal	*Phoca largha*				.		.			.																
Harbor seal	*Phoca vitulina*	.					.					.										.				
Harbor porpoise	*Phocoena*	.					.	.														.				
unidentified ground squirrel	*Urocitellus sp.*																			.						

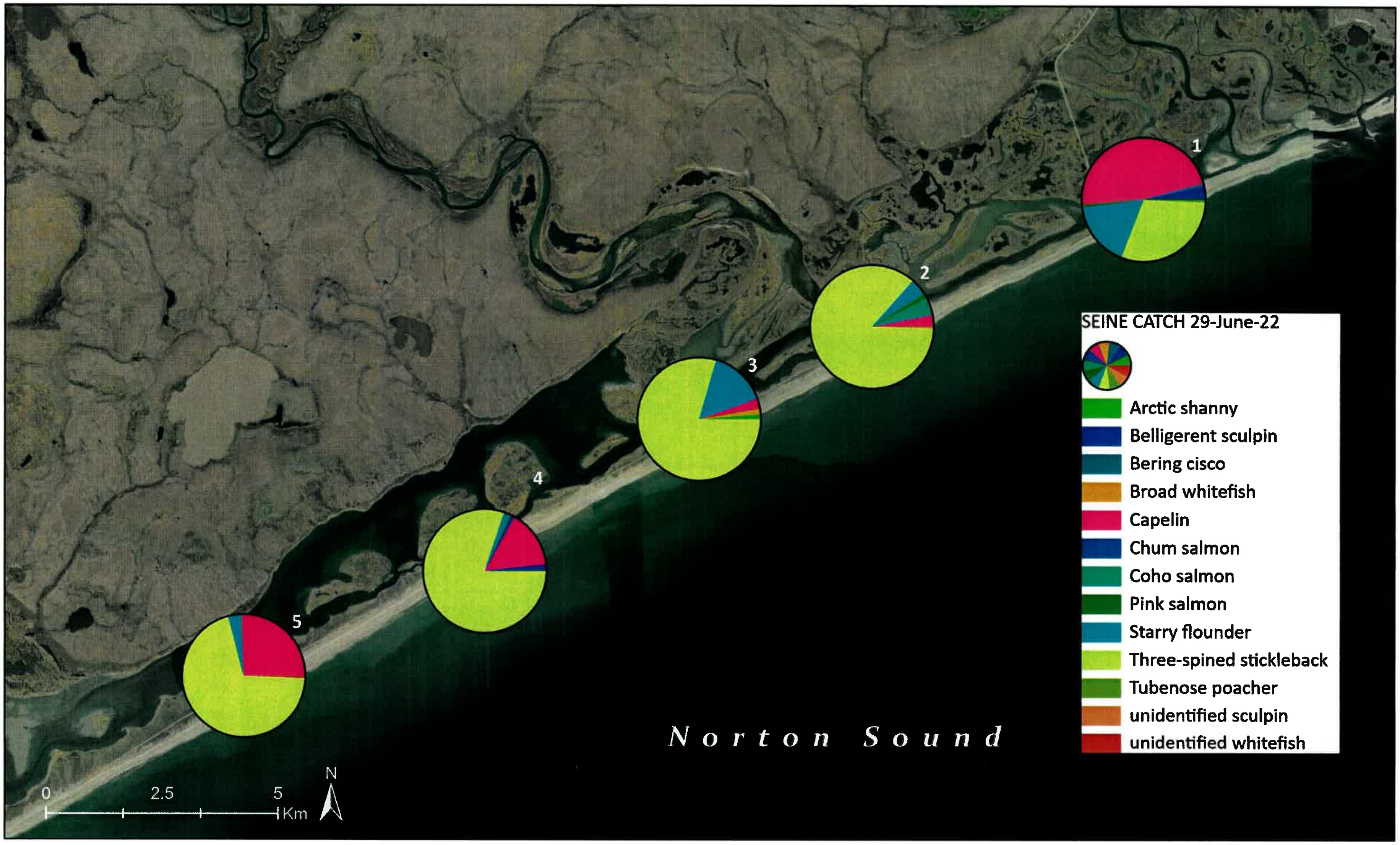


Figure 11. Nearshore seining catch metrics – 29 June 2022.

For each of the five seining sites, the proportion of species caught out of the total catch is visualized. Tabulated data of catch metrics by site and date is reported in Table 6 and Table 7.

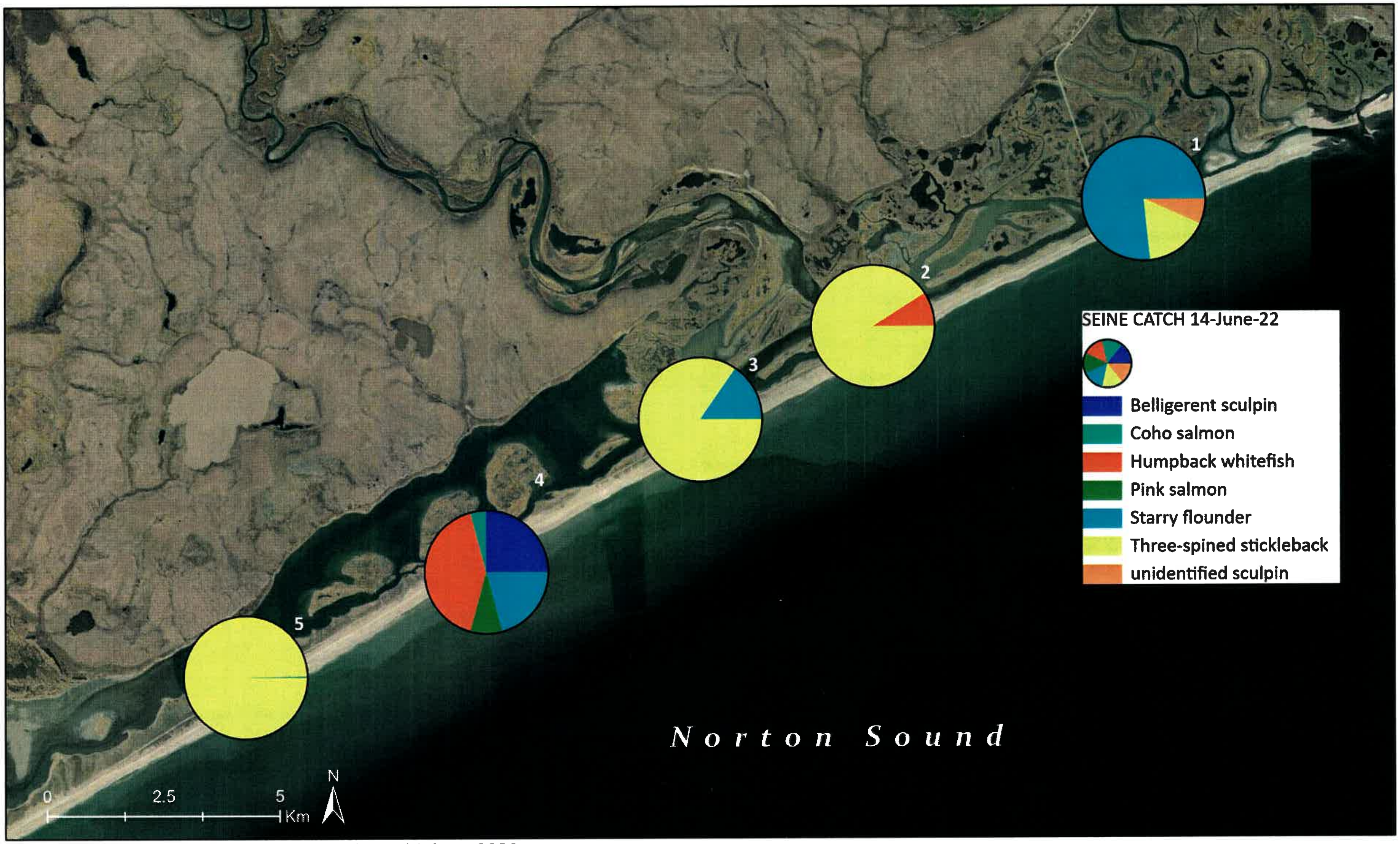


Figure 10. Nearshore seining catch metrics – 14 June 2022.

For each of the five seining sites, the proportion of species caught out of the total catch is visualized. Tabulated data of catch metrics by site and date is reported in Table 6 and Table 7.

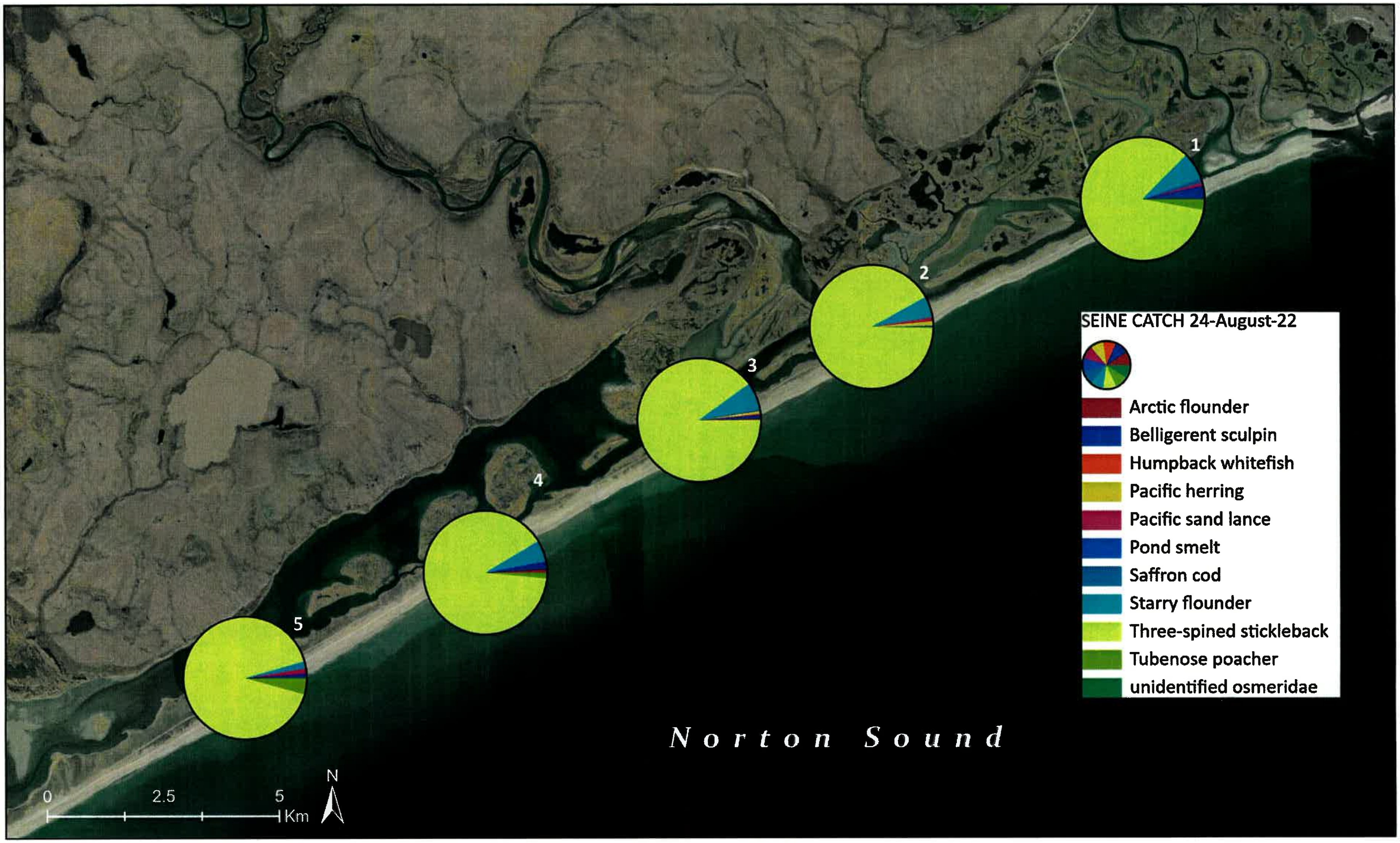


Figure 13. Nearshore seining catch metrics – 24 August 2022.

For each of the five seining sites, the proportion of species caught out of the total catch is visualized. Tabulated data of catch metrics by site and date is reported in Table 6 and Table 7.

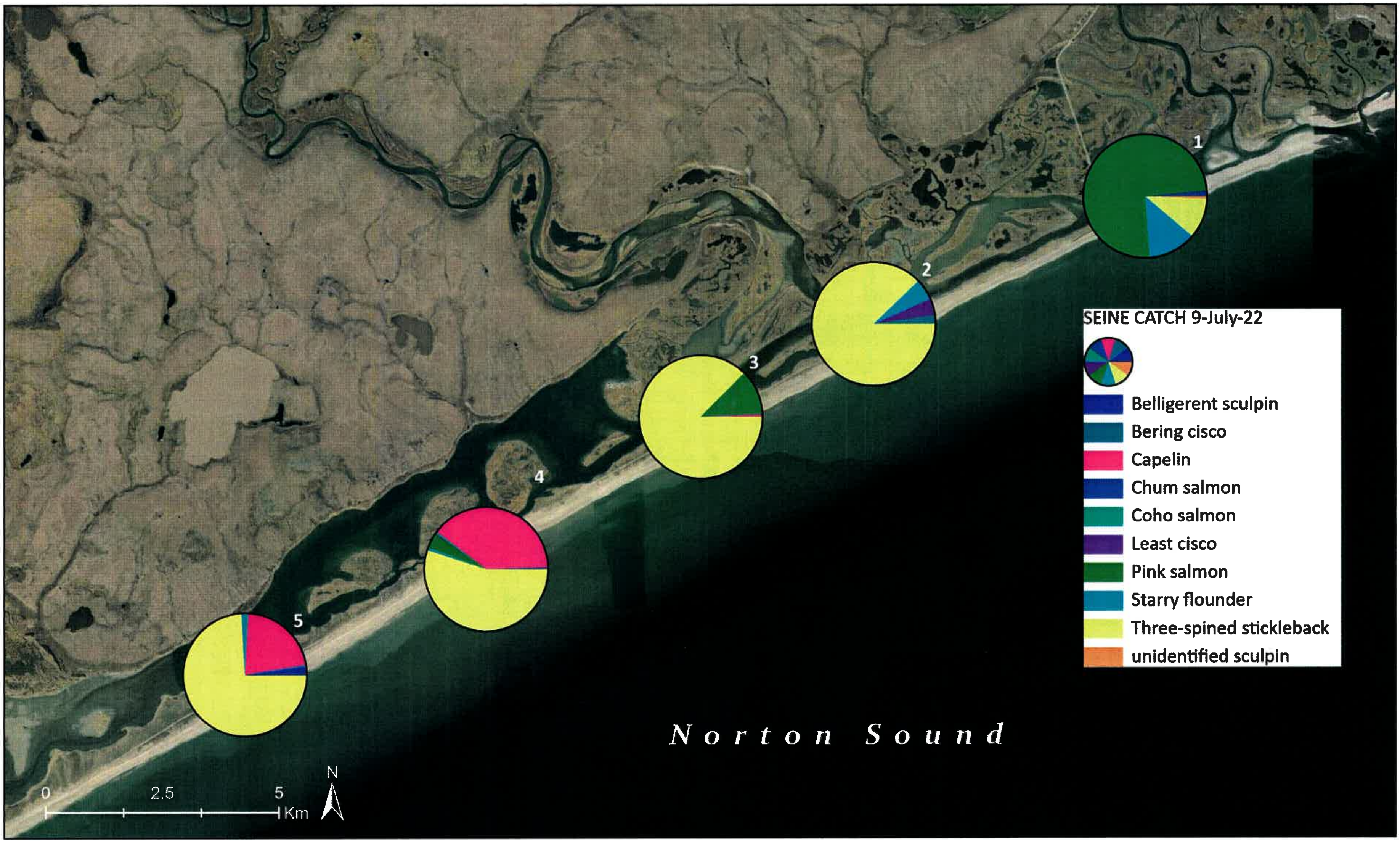


Figure 12. Nearshore seining catch metrics – 9 July 2022.

For each of the five seining sites, the proportion of species caught out of the total catch is visualized. Tabulated data of catch metrics by site and date is reported in Table 6 and Table 7.

Table 6. Total catch by trip date for nearshore beach seining.

Total catch and catch-per-unit-effort (CPUE, unit = set) of fishes captured in eastern Safety Sound by trip date. Life-stage cohorts were combined to represent a single catch metric. See Table 1 for site and set information.

		14-Jun-22		29-Jun-22		9-Jul-22		24-Aug-22	
Species	Scientific Name	CATCH	CPUE	CATCH	CPUE	CATCH	CPUE	CATCH	CPUE
Arctic flounder	*Pleuronectes glacialis*	-	-	-	-	-	-	5	1
Arctic shanny	*Stichaeus punctatus*	-	-	1	0.2	-	-	-	-
Belligerent sculpin	*Megalocottus platycephalus*	6	1.2	10	2	7	1.4	23	4.6
Bering cisco	*Coregonus laurettae*	-	-	1	0.2	3	0.6	-	-
Broad whitefish	*Coregonus nasus*	-	-	1	0.2	-	-	-	-
Capelin	*Mallotus villosus*	-	-	168	33.6	250	50	-	-
Chum salmon	*Oncorhynchus keta*	-	-	3	0.6	2	0.4	-	-
Coho salmon	*Oncorhynchus kisutch*	4	0.8	12	2.4	4	0.8	-	-
Humpback whitefish	*Coregonus pidschian*	12	2.4	-	-	-	-	1	0.2
Least cisco	*Coregonus sardinella*	-	-	-	-	5	1	-	-
Pacific herring	*Clupea pallasii*	-	-	-	-	-	-	6	1.2
Pacific sand lance	*Ammodytes hexapterus*	-	-	-	-	-	-	11	2.2
Pink salmon	*Oncorhynchus gorbuscha*	2	0.4	3	0.6	138	27.6	-	-
Pond smelt	*Hypomesus olidus*	-	-	-	-	-	-	1	0.2
Saffron cod	*Eleginus gracilis*	-	-	-	-	-	-	2	0.4
Starry flounder	*Platichthys stellatus*	31	6.2	55	11	29	5.8	87	17.4
Three-spined stickleback	*Gasterosteus aculeatus*	1,238	247.6	636	127.2	680	136	1,442	288.4
Tubenose poacher	*Pallasina barbata*	-	-	1	0.2	-	-	25	5
unidentified sculpin		2	0.4	1	0.2	1	0.2	-	-
unidentified whitefish		-	-	1	0.2	-	-	-	-
unidentified osmeridae		-	-	-	-	-	-	1	0.2
TOTAL CATCH BY DATE		1,295		893		1,119		1,604	

Table 7. Total catch by site for nearshore beach seining.

Total catch of fishes captured in eastern Safety Sound by site. Life-stage cohorts were combined to represent a single catch metric. Sampling sites correspond to Figure 7.

Species	Scientific Name	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5
Arctic flounder	*Pleuronectes glacialis*	-	1	-	4	-
Arctic shanny	*Stichaeus punctatus*	-	-	1	-	-
Belligerent sculpin	*Megalocottus platycephalus*	12	1	3	22	8
Bering cisco	*Coregonus laurettae*	1	2	-	-	1
Broad whitefish	*Coregonus nasus*	-	-	1	-	-
Capelin	*Mallotus villosus*	69	6	3	247	93
Chum salmon	*Oncorhynchus keta*	2	-	-	3	-
Coho salmon	*Oncorhynchus kisutch*	-	9	-	6	5
Humpback whitefish	*Coregonus pidschian*	-	1	1	10	1
Least cisco	*Coregonus sardinella*	-	4	-	1	-
Pacific herring	*Clupea pallasii*	-	4	2	-	-
Pacific sand lance	*Ammodytes hexapterus*	2	4	-	1	4
Pink salmon	*Oncorhynchus gorbuscha*	101	2	19	21	-
Pond smelt	*Hypomesus olidus*	-	-	1	-	-
Saffron cod	*Eleginus gracilis*	2	-	-	-	-
Starry flounder	*Platichthys stellatus*	81	33	35	39	14
Three-spined stickleback	*Gasterosteus aculeatus*	238	577	480	947	1,754
Tubenose poacher	*Pallasina barbata*	7	1	-	6	12
unidentified sculpin		3	1	-	-	-
unidentified whitefish		-	-	-	-	1
unidentified osmeridae		-	-	-	1	-
TOTAL CATCH BY SITE		518	646	546	1,308	1,893

Length metrics of seining catch indicate the presence of fish at various life-stages in Safety Sound (Table 8). Of the life stage categories, the majority of the total catch was represented by young-of-the-year and adult life stages – namely from three-spined sticklebacks at 1,420 and 2,576 individuals (respectively). However, juveniles represented the greatest species diversity; representing 12 species out of the 21 total species caught. Larval life forms were mostly capelin, at 217 individuals. Reference photographs of various taxa caught during seining efforts are shown in Figure 14.

A clear division of life stages among three-spined sticklebacks was evident based on sampling dates. While three-spined stickleback catches in June and July were comprised of exclusively adult three-spined sticklebacks, catches in late August were predominately young of the year. Spawned out (dead) three-spined sticklebacks were abundant in the shallow water near the shoreline late August.

Figure 14. Photographs of some of the taxa represented in seining catch.

A) belligerent sculpin (*Megalocottus platycephalus*); B) capelin (*Mallotus villosus*); C) tubenose poacher (*Pallasina barbata*); D) pink salmon (*Oncorhynchus gorbuscha*) in the seining net.

Table 8. Length metrics of nearshore beach seining catch categorized by life stage.

Length metrics (i.e., number measured and average total length) of fishes caught in Safety Sound, categorized by four life stages (i.e., young-of-the-year – YOY, juvenile, adult, and larval). Measurements for average total length (Avg. TL) are listed in millimeters (mm).

			YOY		JUVENILE		ADULT		LARVAL	
Species	Scientific Name	CATCH	n	Avg. TL	n	Avg. TL	n	Avg. TL	n	Avg. TL
Arctic flounder	*Pleuronectes glacialis*	5	-	-	-	-	5	153.50	-	-
Arctic shanny	*Stichaeus punctatus*	1	-	-	-	-	1	-	-	-
Belligerent sculpin	*Megalocottus platycephalus*	46	-	-	46	103.50	-	-	-	-
Bering cisco	*Coregonus laurettae*	4	-	-	3	156.50	1	310.00	-	-
Broad whitefish	*Coregonus nasus*	1	-	-	-	-	1	460.00	-	-
Capelin	*Mallotus villosus*	418	-	-	-	-	201	131.00	217	48.67
Chum salmon	*Oncorhynchus keta*	5	-	-	-	-	5	621.50	-	-
Coho salmon	*Oncorhynchus kisutch*	20	-	-	20	92.38	-	-	-	-
Humpback whitefish	*Coregonus pidschian*	13	-	-	-	-	13	210.50	-	-
Least cisco	*Coregonus sardinella*	5	-	-	5	219.50	-	-	-	-
Pacific herring	*Clupea pallasii*	6	6	39.50	-	-	-	-	-	-
Pacific sand lance	*Ammodytes hexapterus*	11	-	-	11	61.75	-	-	-	-
Pink salmon	*Oncorhynchus gorbuscha*	143	-	-	6	53.00	137	-	-	-
Pond smelt	*Hypomesus olidus*	1	-	-	1	82.00	-	-	-	-
Saffron cod	*Eleginus gracilis*	2	-	-	2	85.00	-	-	-	-
Starry flounder	*Platichthys stellatus*	202	148	61.56	54	143.71	-	-	-	-
Three-spined stickleback	*Gasterosteus aculeatus*	3,996	1,420	21.00	-	-	2,576	79.93	-	-
Tubenose poacher	*Pallasina barbata*	26	1	-	25	70.50	-	-	-	-
unidentified sculpin		4	1	15.00	-	-	-	-	3	14.00
unidentified whitefish		1	-	-	1	150.00	-	-	-	-
unidentified osmeridae		1	-	-	1	89.00	-	-	-	-
TOTAL CATCH		4,911								

Temperature measurements from CTD readings (Figure 15) show a general increase in temperature over time across sites. Temperature rose steadily during summer from 14-Jun-2022 to 9-Jul-2022, and then a decreased near the end of the summer season on 24-Aug-2022. The general increase in temperature can be observed from an east-to-west gradient across sites (Figure 7; Figure 15). This trend in temperature observed across sites is constant on a temporal scale. However, temperatures are notable for the 9-Jul-2022 sampling date. Sites 2, 3, 4, and 5 had temperatures between 17.83˚C and 20.12˚C (64˚F – 68˚F); yet there were still coho salmon, chum salmon, pink salmon, capelin, starry flounder, Bering cisco, and least cisco present in the seine catch (Table 6; Figure 12). Three-spined sticklebacks were also present, though this is less surprising given their tolerance for a wide variety of water temperatures.

Salinity measurements from CTD readings decreased from east-to-west (Figure 15). However, the trend in decreasing salinity was relatively inconsistent, with varying levels of change between sites. The cause of the inconsistent gradient in salinity is unknown. However, it is possible that saline water on an incoming tide is segregated into pockets since there is flow into Safety Sound from the Solomon River and the Bonanza River on the eastern end of Safety Sound. Saline water also flows into Safety Sound on the western end near the Safety Roadhouse, though there is an influx of freshwater in this area from the Eldorado River as well.

Temperature and salinity were the two habitat variables that exhibited the largest variation between sites. While it is common to have physical variation in habitat between sites (i.e., gradient, exposure, substrate composition, vegetation), our sampling sites in eastern Safety Sound had minimal differences in physical characteristics. Site 1 has less fines in the sand and gravel, and less vegetation than the other four sites. Site 2 had a shelf with a ~1 meter drop at the shoreline, but shallow gradient beyond the shelf. Sites 3, 4, and 5 were very similar. In general, across all sites there was little variation in physical habitat features. This contrasts to other areas of Alaska where short coastal distances can result in physical features that vary from protected sandy beaches to exposed, steep, rocky headlands with kelp beds.

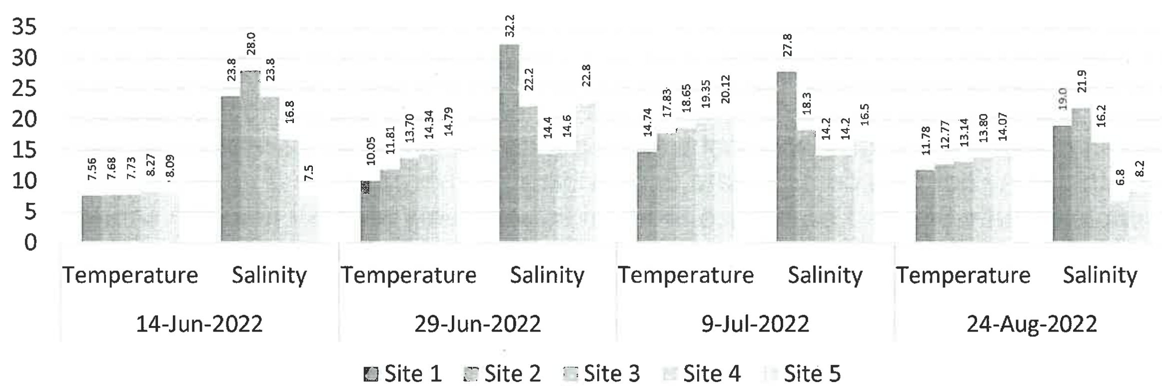


Figure 15. Temporal variation of temperature and salinity.

For each site visit, temperature (°C) and salinity (PSS) measurements are reported for each site. Sites correspond to eDNA and beach seining site locations (Figure 7).

5.1.2.2 Minnow Trap Data

A total of 362 individuals were caught across all minnow trap sites, representing only five taxa (Table 9). Of the total 22 traps set, approximately 30% of traps yielded no catch (trap numbers: 2, 3, 9, 10, 14, 15, and 22). Three-spined sticklebacks were caught in the greatest numbers at 281 individuals, followed by Dolly Varden (*Salvelinus malma*) and coho salmon (*Oncorhynchus kisutch*) with 43 and 30 individuals (respectively). A single Alaska blackfish (*Dallia pectoralis*) was caught. The remainder of the minnow trap catch included 7 unidentified sculpin.

Length metrics of minnow trap catch (Figure 16) indicate a variety of individual lengths present. Across all minnow traps, Dolly Varden had the highest range in length, with a minimum length of 41 millimeters, maximum length of 153 millimeters, and average length of 100 millimeters. Coho salmon had a minimum length of 70 millimeters, maximum length of 140 millimeters, and average length of 92 millimeters. Only one Alaska blackfish was caught, measuring 58 millimeters. Unidentified sculpin species had a minimum length of 35 millimeters, maximum length of 87 millimeters, and average length of 67 millimeters. In an effort to reduce mortality events due to high numbers of catch, length metrics for three-spined sticklebacks were not recorded, although all three-spined sticklebacks were adults. Reference photographs of various taxa caught during minnow trapping efforts are shown in Figure 17.

Catch metrics showed that the diversity catch was dependent upon the sampling location and environment, following an upstream gradient as sites moved from an estuarine environment along Safety Sound to a more freshwater environment on the Solomon River (Figure 18). Traps located near the mouth of the Solomon River in a more estuarine environment only caught three-spined sticklebacks. Traps located about 6.4 kilometers upstream on Jerome Creek began to catch a greater range of species – namely coho salmon, Dolly Varden, and unidentified sculpin. Traps located on or near Shovel Creek (located about 0.8 kilometers upstream from Jerome Creek) caught mostly Dolly Varden. The single Alaska blackfish individual was caught in trap 16.

The trend of yielding no catch in some of the minnow traps is possibly due to the local environment at these sampling locations. Traps 2 and 3 ("Sunrise Lake" and "West Lake", respectively) yielded no catch; however, both lakes had outflow drainages. The length of these drainages were not walked during the site visit, therefore it is possible that they may not provide adequate accessibility for fish passage (Figure 7; Supplementary Figure 1). Likewise, both lakes were very shallow near the shoreline, and it is possible that they may completely freeze to the bottom during the winter (though this hypothesis has not been confirmed). Traps 9 and 10 were located in an off-channel pool with good connectivity to the Solomon River, and the Solomon River mainstem (respectively), and it is unknown why no catch was observed. Trap 11 (a hoop trap; Supplementary Figure 1) was adjacent to trap 10 and yielded coho salmon, Dolly Varden, and three-spine stickleback. It is possible that a hoop trap was more efficient or had better retention at this locality than a standard minnow trap. Trap 12 was in a side-channel pool above trap 10, where juvenile salmon were visible yet there was no catch. Upon retrieval of trap 12, the water was notably colder than the surrounding area. Water temperature at this site was 7°C, indicating a likely site of groundwater upwelling. Trap 14 was placed in a dredge tailing pond above a small beaver dam (less than 1 meter in depth) and yielded no catch. However, trap 13 was located immediately downstream of the beaver dam and yielded several coho salmon. Trap 22 was set at the end of long dredge tailing pond and yielded no catch.

Table 9. Total catch by trap for minnow traps.

Total catch of fishes caught within anadromous streams within the area near Solomon. Traps that yielded no catch were omitted in tabulated results. See Table 2 for site information and Supplementary Figure 1 for location photographs.

Species	Scientific Name	TRAP 1	TRAP 4	TRAP 5	TRAP 6	TRAP 7	TRAP 8	TRAP 11	TRAP 13	TRAP 16	TRAP 17	TRAP 18	TRAP 19	TRAP 20	TRAP 21
Alaska blackfish	*Dallia pectoralis*	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Dolly Varden	*Salvelinus malma*	-	-	-	-	-	-	1	-	-	5	2	28	5	2
Coho salmon	*Oncorhynchus kisutch*	-	3	-	-	-	-	3	9	6	3	-	6	-	-
Three-spined stickleback	*Gasterosteus aculeatus*	16	2	6	28	31	197	1	-	-	-	-	-	-	-
unidentified sculpin		-	-	-	-	-	-	-	-	4	3	-	-	-	-
TOTAL CATCH BY TRAP		16	5	6	28	31	197	5	9	11	11	2	34	5	2

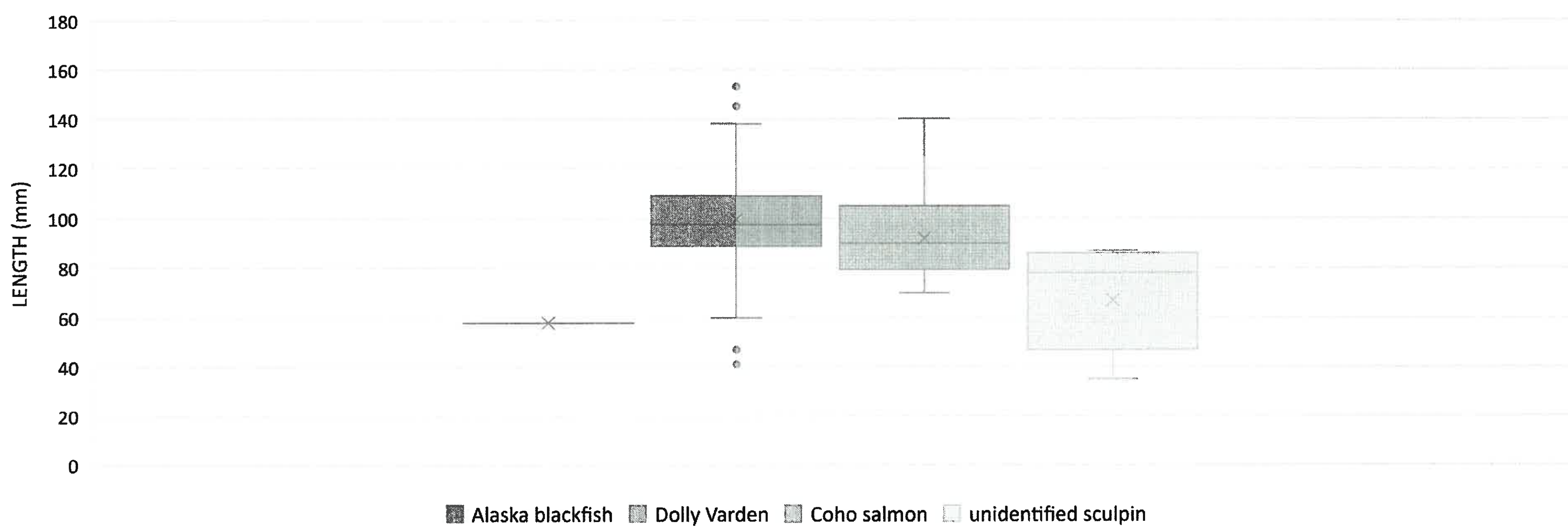


Figure 16. Length metrics of minnow trap catch.

Length metrics of fishes caught across all traps in anadromous waters within the area near Solomon. Box plots show the descriptive statistics of the measurement data collected. Length measurements for three-spined sticklebacks were not recorded due to the high catch numbers, however all three-spined sticklebacks caught in these traps were within the adult size range. Measurements for length are listed in millimeters (mm).

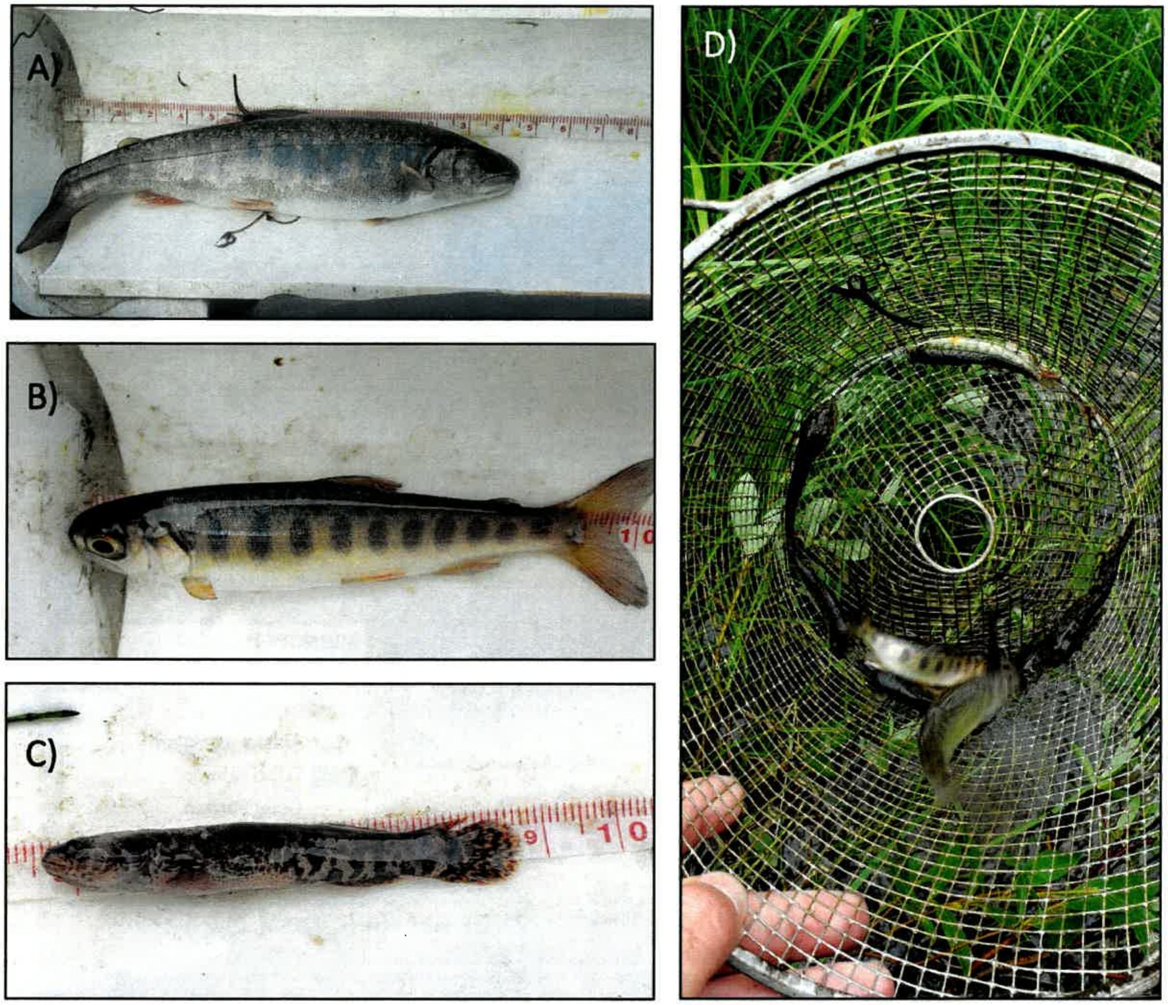


Figure 17. Photographs of some of the taxa represented in minnow trap catch.

A) Dolly Varden (*Salvelinus malma*); B) coho salmon (*Oncorhynchus kisutch*); C) Alaska blackfish (*Dallia pectoralis*); D) minnow trap catch from trap 17.

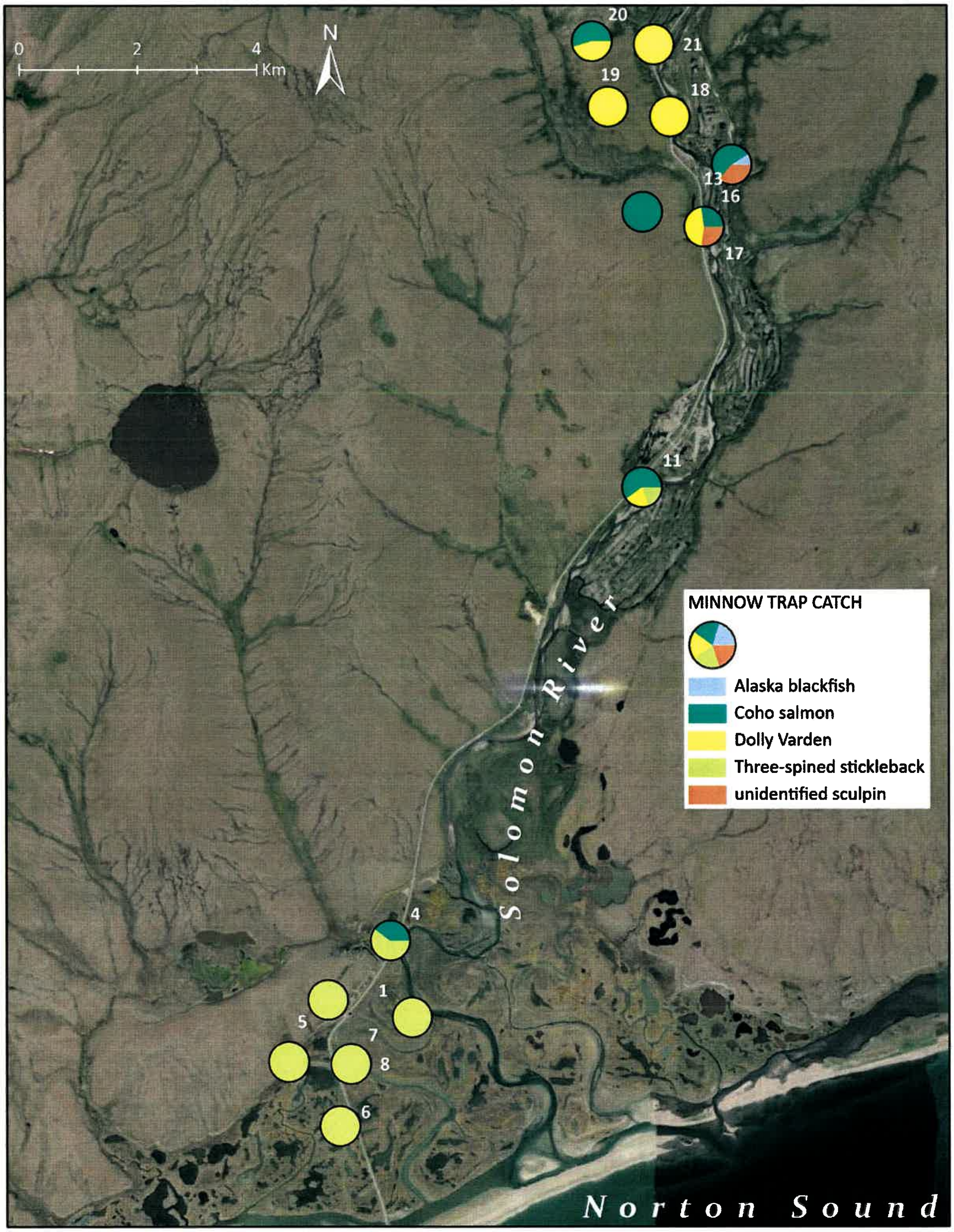


Figure 18. Catch metrics of minnow traps.

For each trap that yielded a catch, the proportion of species caught out of the total catch is visualized. Tabulated data of catch metrics is reported in Table 9. See Table 2 for site information and Supplementary Figure 1 for location photographs.

5.1.2.3 Waterfowl Surveys

Results from the waterfowl survey showed a large influx of species during the months of peak migration (Table 10; Figure 19). In addition to Safety Sound being used as a stopover site, various species used the area for breeding and nesting activities.

In general, dabbling ducks i.e., mallard (*Anas platyrhynchos*) and northern pintail (*Anas acuta*), were consistently observed throughout the summer months of June and July. Likewise, diving and sea ducks, such as the red-breasted merganser (*Mergus serrator*) and the common eider (*Somateria mollissima*) were also observed in high numbers throughout the summer months. The consistent presence of these species throughout the breeding and nesting season indicates Safety Sound is used for breeding and nesting activities. The unidentified scaup species observed on 26-Jul-22 was either greater scaup (*Aythya marila*) or lesser scaup (*Aythya affinis*). Given the date of observation and the range of distribution of each of these scaup species (Kessel et al., 2020; Anteau et al., 2020), we suspect that this individual was likely a greater scaup.

In contrast, Canada goose (*Branta canadensis*) and tundra swan (*Cygnus columbianus*) were observed in the highest numbers during September 2021 and September 2022 suggesting that these species use Safety Sound as a stopover site. Although they were outside of our survey area, tundra swans were often observed on the tundra in the higher ground around the hill locally known as "Sunrise" (Figure 8). We surmise that species observed using Safety Sound as a stopover site would have been observed in high numbers during spring migration. However, our field season did not encompass that period of time.

It has been documented that Safety Sound is a key area for intercontinental overlap of for Holarctic avian taxa (Kessel 1989; Winker and Gibson 2010; UAM, 2023; Winker et al., 2023). A single Eurasian wigeon (*Mareca penelope*), a sister lineage to the American wigeon (*Mareca americana*), was observed on 15-Jun-23. The observation of a Eurasian-origin vagrant within Safety Sound indicates that both North American and Eurasian avian taxa are present within this area during the breeding and nesting season.

In addition to waterfowl, Safety Sound is a refugia for other avian species; such as loons, gulls, cranes, and various shorebirds species. Glaucous gulls (*Larus hyperboreus*) were observed across all survey dates. This is likely due to the species being an opportunistic forager, taking advantage of changes in food availability across time. During field visits, notable observations were made regarding the presence of other avian taxa outside of the three defined waterfowl survey areas in eastern Safety Sound. The tabulated summaries and reference photographs for these observations are given in Supplementary Table 2 and Supplementary Figure 2 since they are an important component to understanding the full scope of avian species present with Safety Sound and the area near Solomon.

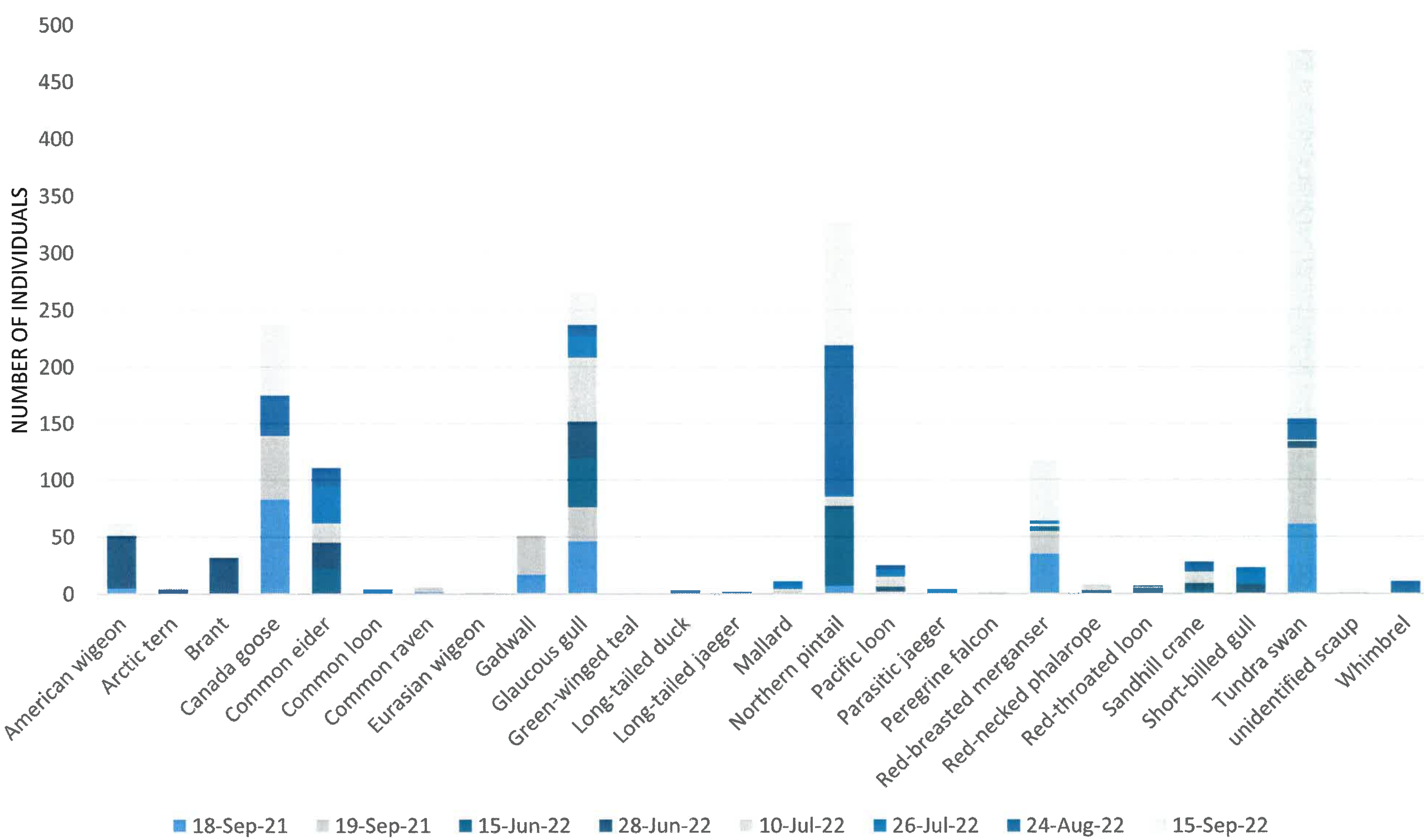
Table 10. Waterfowl survey results.

Survey results are categorized by date, and observation area. Observation areas from Figure 8 are shown as A1 (area 1), A2 (area 2), and A3 (area 3).

		18-Sep-21			19-Sep-21			15-Jun-22			28-Jun-22			10-Jul-22			26-Jul-22			24-Aug-22			15-Sep-22		
Species	Scientific Name	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3
American wigeon	*Mareca americana*	5	-	-	-	-	-	-	-	-	-	46	-	-	-	-	-	-	-	-	-	-	-	8	3
Arctic tern	*Sterna paradisaea*	-	-	-	-	-	-	-	-	-	3	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Brant	*Branta bernicla*	-	-	-	-	-	-	-	-	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canada goose	*Branta canadensis*	73	10	-	32	24	-	-	-	-	-	-	-	-	-	-	-	-	-	36	-	-	-	62	-
Common eider	*Somateria mollissima*	-	-	-	-	-	-	18	3	1	21	2	-	4	7	6	12	20	1	16	-	-	-	-	-
Common loon	*Gavia immer*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	2	-	-	-	-	-	-
Common raven	*Corvus corax*	1	1	-	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Eurasian wigeon	*Mareca penelope*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gadwall	*Mareca strepera*	6	11	-	16	7	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glaucous gull	*Larus hyperboreus*	35	3	8	20	9	1	22	13	8	18	10	5	16	20	20	14	3	2	-	4	6	16	7	5
Green-winged teal	*Anas crecca*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long-tailed duck	*Clangula hyemalis*	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-
Long-tailed jaeger	*Stercorarius longicaudus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Mallard	*Anas platyrhynchos*	-	-	-	2	-	1	-	-	-	-	-	-	-	-	1	-	7	-	-	-	-	-	-	-
Northern pintail	*Anas acuta*	2	-	5	-	-	-	8	56	3	2	-	1	-	1	7	-	2	-	-	114	18	11	73	24
Pacific loon	*Gavia pacifica*	1	-	-	-	1	-	-	-	-	3	-	1	3	4	2	5	-	1	-	4	-	-	-	-
Parasitic jaeger	*Stercorarius parasiticus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-
Peregrine falcon	*Falco peregrinus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Red-breasted merganser	*Mergus serrator*	35	-	-	20	-	-	2	-	2	-	-	-	-	-	2	-	1	2	-	-	-	-	53	-
Red-necked phalarope	*Phalaropus lobatus*	-	-	-	-	-	-	-	-	-	-	3	-	-	-	5	-	-	-	-	-	-	-	-	-
Red-throated loon	*Gavia stellata*	-	-	-	-	-	-	-	-	2	-	1	2	-	1	-	-	-	-	-	1	-	-	-	-
Sandhill crane	*Antigone canadensis*	-	-	-	-	-	-	-	-	3	-	-	6	2	-	8	-	-	-	-	7	2	-	-	-
Short-billed gull	*Larus brachyrhynchus*	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	7	2	6	-	-	-	-	-	-
Tundra swan	*Cygnus columbianus*	35	16	10	47	5	15	-	-	-	6	-	-	1	-	-	-	-	-	2	15	2	135	36	153
unidentified scaup		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Whimbrel	*Numenius phaeopus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-
TOTAL NUMBER		193	41	23	140	46	29	51	73	19	86	70	17	28	33	51	44	37	14	55	156	29	162	239	185

Figure 19. Number of waterfowl observed by date.

The number of individuals observed is broken down by species. Observations are summarized by date, omitting the specific area observed for clarity.



Since waterfowl are a key subsistence resource for residents within the area, waterfowl survey data were put into context with respect to historical harvest statistics for the state of Alaska (Naves et al., 2021). In general, the waterfowl species observed and their relative magnitudes of abundance across all survey dates reflect trends observed in subsistence harvest statistics. Top species observed throughout the 2021 and 2022 field season within eastern Safety Sound (Table 10) are commonly harvested in the greater region of Alaska (Supplementary Table 3). Species harvested within the Bering Strait-Norton Sound region across the spring, summer, and fall hunting seasons (Supplementary Table 4) are well represented in our waterfowl survey results (Table 10).

5.2 Recommendations

5.2.1 Future Investigations

The results of this report provide an environmental baseline for terrestrial, freshwater, and estuarine biodiversity within Safety Sound and the area near Solomon. The intention of this report was to document the environmental conditions observed during the time of this investigation. In an effort to ensure accessibility, this report and the subsequent data collected during this investigation is publicly available (see the Data Availability Statement). Future work by other agencies, organizations, or tribal entities could expand upon these results to provide further insight into the biotic and abiotic conditions within Safety Sound and the area near Solomon.

Three additional nearshore beach seine sampling events were planned for 2022 but were not completed due to weather. The sampling event in late July was planned, but a persistent strong southwestern wind raised the water level in Safety Sound by ~0.7 meters and inundated the beaches. The high wind was too strong to be able to operate a jet powered skiff to properly set the seine. The sampling event planned for September was cancelled due to the incoming remnants of typhoon Merbok, a storm that ravaged Nome and northern Norton Sound communities. After the extensive road damage on the Nome-Council Road from typhoon Merbok was mostly repaired, an early October sampling event was planned. However, the shoreline in Safety Sound had frozen over, and working from a boat to seine was not possible. Notably, we were able to take eDNA samples at our five beach seine sites during the late July and early October trips (Supplementary Table 1). The eDNA samples from October were obtained at breaks in the shorefast ice.

If sampling during these times were feasible, these additional data would have provided a more complete picture of the nearshore community of eastern Safety Sound. However, prior to typhoon Merbok, we were able to collect a robust dataset of many biotic and environmental variables in Safety Sound across multiple field sites. These data provide a unique opportunity for other agencies to examine the effects of a major storm surge on a high latitude coastal estuarine ecosystem.

5.2.2 Community Resilience

In September of 2022, typhoon Merbok caused extreme levels of coastal flooding across western Alaska and the Bering Sea. The storm heavily impacted Safety Sound and the surrounding area of Solomon. Complete washout occurred on the Nome-Council Road along Safety Sound. Portions of the barrier islands along Safety Sound experienced coastal erosion, and the high inundation created a new outflow into Norton Sound.

The high levels of coastal flooding experienced during the storm heavily impacted local infrastructure, specifically seasonal subsistence camps. Nearly every subsistence cabin and fish camp located along Safety Sound was destroyed, and in most cases not even debris was left behind. Several of the subsistence cabins were washed into Safety Sound and subsequently sank. Elevated water levels and high winds caused many other cabins to float across Safety Sound, eventually becoming stranded on higher ground on the northern shore. The Nome-Council Road was mostly inundated with sand and fine gravel, though in some areas beach sand was pushed over the road and well into Safety Sound. Rural communities in Alaska rely upon the land to maintain their traditional, customary, and subsistence-based practices. Communities that have relied on the integrity of the land for generations are now having to adjust their activities in response to changes in climate (Kofinas et al., 2010; Cochran et al., 2013; Wilson 2014; Trainor et al., 2017). The dependence on climate-sensitive resources and infrastructure makes communities in Alaska, particularly sensitive to climate change and its subsequent effects (McCarthy et al., 2001; Symon et al., 2005; Parry et al., 2007). The ability to adapt to such changes is a critical aspect when discussing community resilience and planning.

Changes in habitat and estuarine environment were also observed after the storm. Offshore of the barrier islands along Safety Sound, there are new shoals that were previously not evident before the storm. Likewise, the severe coastal flooding and inundation of marine water, sand, and gravel into Safety Sound has altered the topography of coastal lowlands. As is often the case, a storm of this magnitude can change the composition and availability of habitat. Though disturbance and loss of habitat is common after a major stochastic event, opportunities for fish and wildlife can also be created. Environmental shifts and subsequent ecological succession can provide an opportunity for various species occupy available niches.

6.0 CONCLUSIONS

The general intent of this investigation was to provide a baseline environmental analysis and survey of natural resources within Safety Sound and the area near Solomon. To provide a thorough analysis, our investigation incorporated both contemporary molecular techniques and traditional survey methods to assess the biotic environment. This complementary approach was used to provide a thorough and comprehensive environmental analysis of the area, filling key knowledge gaps.

Pairing eDNA data with traditional survey techniques valuable insight to the overall assessment of biodiversity within Safety Sound. Data from eDNA provided an indication of species present that were not caught in beach seines. Given that some species are difficult to catch due to low abundance, behavioral traits, or habitat affinities; the incorporation of eDNA into the design of this investigation was key. Likewise, eDNA confirmed species that were caught in the beach seine – offering a complementary approach to confirm seine catch metrics. The traditional beach seine surveys were valuable since catch could be identified with taxonomic keys based on phenotype. Likewise, additional metrics concerning size, age, and body condition (i.e., net marks, seal bites, lesions) could be thoroughly assessed. In summary, the use of molecular and traditional approaches in this investigation provided an overall robust assessment of the biodiversity within Safety Sound.

6.1 Potential Future USACE Assistance

Additional technical assistance studies can be implemented using the Planning Assistance to States (PAS) program. The cost sharing for such efforts would be 50% federal and 50% non-federal. However, under current policy for Section 1156 the first $530,000 of the project costs when partnering with Tribal entities are eligible for a cost-sharing waiver.

The Continuing Authorities Program (CAP) allows for the planning, design, and construction of a water resource project with a federal cost to not exceed the $10 million threshold. Upon receipt of a written request from a potential sponsor and when funding is available, at federal expense USACE initiates a preliminary federal interest determination to determine if a potential project meets program requirements and federal participation is justified. If a federal interest is determined, a feasibility study occurs that identifies and comprehensively evaluates alternatives and recommends a plan for implementation. The CAP program has a cost share of 50% federal and 50% non-federal for the feasibility phase. The cost share during the construction phase is 65% federal and 35% non-federal.

6.2 Acknowledgments

We thank the community members from the Village of Solomon for their assistance and efforts with this investigation. The U.S. Army Engineer Research and Development Center's Genetics Reconnaissance Team (Environmental Processes Branch, Environmental Laboratory; CEERD-EPP) provided DNA extraction, sequencing, and bioinformatic analysis.

6.3 Data Availability Statement

Original sequence data for eDNA samples have been deposited on NCBI Sequence Read Archive (SRA; Supplementary Table 1; BioProject number PRJNA950353). Catch data for nearshore beach seining have been added to the Nearshore Fish Atlas of Alaska. Corresponding authors of this investigation are Chris Hoffman and Fern Spaulding.

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8.0 APPENDIX A

Supplementary Table 1. Voucher information for eDNA samples.

Original sequence data have been deposited on the NCBI Sequence Read Archive (SRA). Samples with too low of read count to be given an SRX accession number are denoted with the SAMN BioSample number. All reads are available under BioProject number PRJNA950353.

Site	Replicate	Date	Location	Latitude (°N)	Longitude (°W)	SRA Number (MiFish-U)	SRA Number (AKOncCytB)
1	1	27-Jun-22	Safety Sound	64.545822	-164.428967	SRX19880089	SRX19880198
1	2	27-Jun-22	Safety Sound	64.545822	-164.428967	SRX19880090	SRX19880200
1	3	27-Jun-22	Safety Sound	64.545822	-164.428967	SRX19880178	SRX19880201
2	1	27-Jun-22	Safety Sound	64.535231	-164.481302	SRX19880120	SRX19880202
2	2	27-Jun-22	Safety Sound	64.535231	-164.481302	SRX19880131	SRX19880203
2	3	27-Jun-22	Safety Sound	64.535231	-164.481302	SRX19880229	SRX19880204
3	1	27-Jun-22	Safety Sound	64.527511	-164.514659	SRX19880240	SRX19880205
3	2	27-Jun-22	Safety Sound	64.527511	-164.514659	SRX19880229	SRX19880206
3	3	27-Jun-22	Safety Sound	64.527511	-164.514659	SRX19880199	SRX19880207
4	1	27-Jun-22	Safety Sound	64.518005	-164.556084	SRX19880210	SRX19880208
4	2	27-Jun-22	Safety Sound	64.518005	-164.556084	SRX19880091	SRX19880209
4	3	27-Jun-22	Safety Sound	64.518005	-164.556084	SRX19880102	SRX19880211
5	1	27-Jun-22	Safety Sound	64.506102	-164.602632	SRX19880134	SRX19880212
5	2	27-Jun-22	Safety Sound	64.506102	-164.602632	SRX19880145	SRX19880213
5	3	27-Jun-22	Safety Sound	64.506102	-164.602632	SRX19880156	SRX19880214
method blank	-	27-Jun-22	N/A	-	-	SRX19880167	SRX19880215
1	1	10-Jul-22	Safety Sound	64.545822	-164.428967	SRX19880174	SRX19880216
1	2	10-Jul-22	Safety Sound	64.545822	-164.428967	SRX19880175	SRX19880217
1	3	10-Jul-22	Safety Sound	64.545822	-164.428967	SRX19880176	SRX19880218
2	1	10-Jul-22	Safety Sound	64.535231	-164.481302	SRX19880177	SRX19880219
2	2	10-Jul-22	Safety Sound	64.535231	-164.481302	SRX19880179	SRX19880220
2	3	10-Jul-22	Safety Sound	64.535231	-164.481302	SRX19880180	SRX19880092
3	1	10-Jul-22	Safety Sound	64.527511	-164.514659	SRX19880181	SRX19880093
3	2	10-Jul-22	Safety Sound	64.527511	-164.514659	SRX19880113	SRX19880094
3	3	10-Jul-22	Safety Sound	64.527511	-164.514659	SRX19880114	SRX19880095
4	1	10-Jul-22	Safety Sound	64.518005	-164.556084	SRX19880115	SRX19880096
4	2	10-Jul-22	Safety Sound	64.518005	-164.556084	SRX19880116	SRX19880097
4	3	10-Jul-22	Safety Sound	64.518005	-164.556084	SRX19880117	SRX19880098
5	1	10-Jul-22	Safety Sound	64.506102	-164.602632	SRX19880118	SRX19880099
5	2	10-Jul-22	Safety Sound	64.506102	-164.602632	SRX19880119	SRX19880100
5	3	10-Jul-22	Safety Sound	64.506102	-164.602632	SRX19880121	SRX19880101
method blank	-	10-Jul-22	N/A	-	-	SRX19880122	SAMN33986424
1	1	25-Jul-22	Safety Sound	64.545822	-164.428967	SRX19880123	SRX19880103
1	2	25-Jul-22	Safety Sound	64.545822	-164.428967	SAMN33986346	SRX19880104
1	3	25-Jul-22	Safety Sound	64.545822	-164.428967	SRX19880124	SRX19880105
2	1	25-Jul-22	Safety Sound	64.535231	-164.481302	SRX19880125	SRX19880106
2	2	25-Jul-22	Safety Sound	64.535231	-164.481302	SRX19880126	SRX19880107
2	3	25-Jul-22	Safety Sound	64.535231	-164.481302	SRX19880127	SRX19880108
3	1	25-Jul-22	Safety Sound	64.527511	-164.514659	SRX19880128	SRX19880109
3	2	25-Jul-22	Safety Sound	64.527511	-164.514659	SRX19880129	SRX19880110
3	3	25-Jul-22	Safety Sound	64.527511	-164.514659	SRX19880130	SRX19880111
4	1	25-Jul-22	Safety Sound	64.518005	-164.556084	SRX19880132	SRX19880112
4	2	25-Jul-22	Safety Sound	64.518005	-164.556084	SRX19880133	SRX19880135
4	3	25-Jul-22	Safety Sound	64.518005	-164.556084	SRX19880221	SRX19880136
5	1	25-Jul-22	Safety Sound	64.506102	-164.602632	SRX19880222	SRX19880137
5	2	25-Jul-22	Safety Sound	64.506102	-164.602632	SRX19880223	SRX19880138

Site	Replicate	Date	Location	Latitude (°N)	Longitude (°W)	SRA Number (MiFish-U)	SRA Number (AKOncCytB)
5	3	25-Jul-22	Safety Sound	64.506102	-164.602632	SRX19880224	SRX19880139
method blank	-	25-Jul-22	N/A	-	-	SRX19880225	SAMN33986440
1	1	24-Aug-22	Safety Sound	64.545822	-164.428967	SRX19880226	SRX19880140
1	2	24-Aug-22	Safety Sound	64.545822	-164.428967	SRX19880227	SRX19880141
1	3	24-Aug-22	Safety Sound	64.545822	-164.428967	SRX19880228	SRX19880142
2	1	24-Aug-22	Safety Sound	64.535231	-164.481302	SRX19880230	SRX19880143
2	2	24-Aug-22	Safety Sound	64.535231	-164.481302	SRX19880231	SRX19880144
2	3	24-Aug-22	Safety Sound	64.535231	-164.481302	SRX19880232	SRX19880146
3	1	24-Aug-22	Safety Sound	64.527511	-164.514659	SRX19880233	SRX19880147
3	2	24-Aug-22	Safety Sound	64.527511	-164.514659	SRX19880234	SRX19880148
3	3	24-Aug-22	Safety Sound	64.527511	-164.514659	SRX19880235	SRX19880149
4	1	24-Aug-22	Safety Sound	64.518005	-164.556084	SRX19880236	SRX19880150
4	2	24-Aug-22	Safety Sound	64.518005	-164.556084	SRX19880237	SRX19880151
4	3	24-Aug-22	Safety Sound	64.518005	-164.556084	SRX19880238	SRX19880152
5	1	24-Aug-22	Safety Sound	64.506102	-164.602632	SRX19880239	SRX19880153
5	2	24-Aug-22	Safety Sound	64.506102	-164.602632	SRX19880241	SRX19880154
5	3	24-Aug-22	Safety Sound	64.506102	-164.602632	SRX19880242	SRX19880155
method blank	-	24-Aug-22	N/A	-	-	SRX19880243	SRX19880157
1	1	18-Oct-22	Safety Sound	64.545822	-164.428967	SRX19880244	SRX19880158
1	2	18-Oct-22	Safety Sound	64.545822	-164.428967	SRX19880182	SRX19880159
1	3	18-Oct-22	Safety Sound	64.545822	-164.428967	SRX19880183	SRX19880160
2	1	18-Oct-22	Safety Sound	64.535231	-164.481302	SRX19880184	SRX19880161
2	2	18-Oct-22	Safety Sound	64.535231	-164.481302	SRX19880185	SRX19880162
2	3	18-Oct-22	Safety Sound	64.535231	-164.481302	SRX19880186	SRX19880163
3	1	18-Oct-22	Safety Sound	64.527511	-164.514659	SRX19880187	SRX19880164
3	2	18-Oct-22	Safety Sound	64.527511	-164.514659	SRX19880189	SRX19880165
3	3	18-Oct-22	Safety Sound	64.527511	-164.514659	SRX19880190	SRX19880166
4	1	18-Oct-22	Safety Sound	64.518005	-164.556084	SRX19880191	SRX19880168
4	2	18-Oct-22	Safety Sound	64.518005	-164.556084	SRX19880192	SRX19880169
4	3	18-Oct-22	Safety Sound	64.518005	-164.556084	SRX19880193	SRX19880170
5	1	18-Oct-22	Safety Sound	64.506102	-164.602632	SRX19880194	SRX19880171
5	2	18-Oct-22	Safety Sound	64.506102	-164.602632	SRX19880195	SRX19880172
5	3	18-Oct-22	Safety Sound	64.506102	-164.602632	SRX19880196	SRX19880173
method blank	-	18-Oct-22	N/A	-	-	SRX19880197	SAMN33986472

N/A – Not Applicable.

Supplementary Table 2. Incidental observations of avian species.

Species	Scientific Name	Date	Locality	Description of Notes
Common eider	*Somateria mollissima*	28-Jun-22	Alaska: Seward Peninsula, eastern Safety Sound	An active nest was observed near beach seine site 2. Eggs had not yet hatched.
Common eider	*Somateria mollissima*	9-Jul-22	Alaska: Seward Peninsula, eastern Safety Sound	Same nest observed on 28-Jun-22 near beach seine site 2. Female was still on the nest.
Common eider	*Somateria mollissima*	10-Jul-22	Alaska: Seward Peninsula, eastern Safety Sound	Same nest observed on 28-Jun-22 near beach seine site 2. Nest was empty, eggshells were present with no obvious signs of predation. Surmise that the chicks hatched successfully. Other common eiders were seen with very young broods on the water outside the survey area.
Common eider	*Somateria mollissima*	late July, 2022	Alaska: Seward Peninsula, Safety Sound	Numerous chicks observed on the water.
Dunlin	*Calidris alpina*	16-Jun-22	Alaska: Seward Peninsula, Solomon, tundra lakes near "Sunrise" hill	Numerous individuals observed.
Gyrfalcon	*Falco rusticolus*	28-Jun-22	Alaska: Seward Peninsula, Solomon, Solomon River, East Fork Bridge	Observed three chicks sitting on the deck of the East Fork Bridge. Nest was located under the bridge deck on an abutment (Supplementary Figure 2). The chick was already banded; silver band on right leg and blue band on left leg. Numbers were not readable from photos or binoculars. Chicks were observed streaming when a parent was approaching the nest. Adults were often viewed being harassed by long-tailed jaegers.
Lapland longspur	*Calcarius lapponicus*	16-Jun-22	Alaska: Seward Peninsula, Solomon, tundra lakes near "Sunrise" hill	Numerous individuals observed.
Long-tailed jaeger	*Stercorarius longicaudus*	13-Jun-22	Alaska: Seward Peninsula, Solomon	Numerous individuals observed.
Long-tailed jaeger	*Stercorarius longicaudus*	14-Jun-22	Alaska: Seward Peninsula, Solomon	Numerous individuals observed.
Long-tailed jaeger	*Stercorarius longicaudus*	15-Jun-22	Alaska: Seward Peninsula, Solomon	Numerous individuals observed.
Mallard	*Anas platyrhynchos*	late July, 2022	Alaska: Seward Peninsula, Safety Sound	Numerous chicks observed on the water.
Red-necked phalarope	*Phalaroupus lobatus*	16-Jun-22	Alaska: Seward Peninsula, Solomon, tundra lakes near "Sunrise" hill	Numerous individuals observed.
Rough-legged hawk	*Buteo lagopus*	28-Jun-22	Alaska: Seward Peninsula, Solomon, Solomon River near Big Hurrah Creek	Nesting pair with active nest on cliff overlooking the Solomon River.
Rough-legged hawk	*Buteo lagopus*	28-Jun-22	Alaska: Seward Peninsula, Solomon, Solomon River, south of East Fork Bridge	Nesting pair with active nest on a large granite tor.
Western sandpiper	*Calidris mauri*	13-Jun-22	Alaska: Seward Peninsula, Solomon, near the old airstrip behind the Solomon B&B	Nest with eggs observed.
Western sandpiper	*Calidris mauri*	16-Jun-22	Alaska: Seward Peninsula, Solomon, tundra lakes near "Sunrise" hill	Numerous individuals observed.
Western sandpiper	*Calidris mauri*	late July, 2022	Alaska: Seward Peninsula, Safety Sound	Very abundant, especially along the Nome-Council Road along Safety Sound. Several mortalities from vehicles were observed on the roadway.

Supplementary Table 3. Commonly-harvested waterfowl species in Alaska.

Harvest (number of birds) and coefficient of variation (CV) for each of the commonly-harvested species in Alaska across the years 2016-2019. Data were obtained from the Alaska Migratory Bird Co-Management Council (Naves et al., 2021).

	2016		2017		2018		2019	
Species	Harvest	CV	Harvest	CV	Harvest	CV	Harvest	CV
American wigeon	21,165	0.58	3,562	0.48	7,594	0.34	5,765	0.27
Black scoter	12,304	0.35	9,476	0.33	9,414	0.35	5,929	0.42
Black brant	16,502	0.52	11,111	0.49	8,868	0.29	10,156	0.41
Cackling/Canada goose	45,565	0.26	23,433	0.19	28,933	0.22	36,128	0.16
Canvasback	1,117	0.58	179	0.71	297	0.83	206	0.94
Common eider	9,127	0.43	3,278	0.40	13,222	0.48	5,626	0.45
Greater white-fronted goose	88,338	0.38	26,057	0.18	52,445	0.19	49,095	0.22
King eider	20,297	0.34	22,928	0.48	26,798	0.32	7,697	0.60
Long-tailed duck	2,520	0.41	454	0.49	10,754	0.66	418	0.48
Mallard	28,246	0.54	15,004	0.31	15,250	0.19	26,170	0.27
Northern pintail	26,137	0.42	9,025	0.26	20,023	0.35	8,986	0.24
Scaup	6,792	0.41	7,607	0.53	12,088	0.36	6,470	0.60
Snow goose	11,421	0.59	5,602	0.68	7,471	0.28	15,360	0.65
Surf scoter	1,033	0.43	452	0.51	2,726	0.44	3,290	0.63
White-winged scoter	2,796	0.36	898	0.76	1,606	0.41	5,522	0.47
Species mean		0.44		0.45		0.38		0.45
Total	**293,359**	**0.30**	**139,067**	**0.19**	**217,490**	**0.17**	**186,817**	**0.15**

Sources Otis et al. (2017) for 2016, Otis and Doherty (2018) for 2017, and Otis and Naves (2019) for 2018, and this study for 2019.

Note CV = Coefficient of variation. Confidence Interval Percentage (CIP) = 2 × CV.

Supplementary Table 4. Waterfowl harvest within Bering Strait-Norton Sound region.

The total number of individuals within each species that was harvested during the year 2019 distributed across the hunting seasons (i.e., spring, summer, and fall). Harvest data were obtained from the Alaska Migratory Bird Co-Management Council (Naves et al., 2021).

Species	Yearly bird harvest			Spring		Summer		Fall	
	Reported	Estimated	CIP	Estimated	CIP	Estimated	CIP	Estimated	CIP
Ducks									
* American wigeon	11	206	193%	206	193%	0		0	
Gadwall	0	0		0		0		0	
Teal	4	133	193%	0		0		133	193%
* Mallard	18	337	188%	319	188%	0		19	195%
* Northern pintail	41	972	96%	772	109%	0		200	194%
Northern shoveler	0	0		0		0		0	
* Black scoter	0	0		0		0		0	
* Surf scoter	0	0		0		0		0	
* White-winged scoter	0	0		0		0		0	
Bufflehead	0	0		0		0		0	
Goldeneye	0	0		0		0		0	
* Canvasback	0	0		0		0		0	
* Scaup	0	0		0		0		0	
* Common eider	8	150	195%	150	195%	0		0	
* King eider	0	0		0		0		0	
Spectacled eider	0	0		0		0		0	
Steller's eider	0	0		0		0		0	
Harlequin duck	1	33	197%	0		0		33	197%
* Long-tailed duck	0	0		0		0		0	
Merganser	0	0		0		0		0	
Duck (unidentified)	0	0		0		0		0	
Total ducks	83	1,832	107%	1,447	140%	0		385	177%
Geese									
* Black brant	118	3,804	180%	2,053	170%	0		1,752	193%
* Cackling/Canada goose	169	3,517	59%	2,905	69%	0		612	113%
* Greater white-fronted goose	45	874	109%	856	108%	0		19	195%
Emperor goose	3	100	197%	100	197%	0		0	
* Snow goose	161	3,331	73%	3,222	73%	0		108	120%
Total geese	496	11,626	34%	9,135	24%	0		2,491	139%
Swan	6	127	124%	108	116%	0		19	195%

**Commonly-harvested species.*
CIP – Confidence interval as a percentage of estimated harvest.

Supplementary Figure 1. Photographs of site locations for minnow traps.

Coordinate data and trap information corresponds to Figure 7; Figure 18; Table 2; Table 9.

Trap 1. Solomon General Store.

Trap 4. Culvert off the Solomon River.

Trap 2. Unnamed lake near “Sunrise Hill”, denoted here as “Sunrise” Lake.

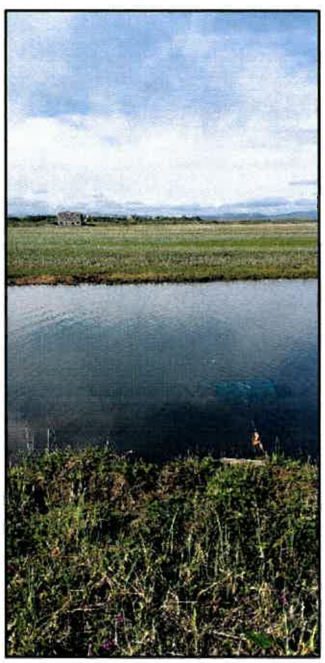
Trap 5. Along Nome-Council Road south of the Solomon B&B.

Trap 3. Unnamed lake near “Sunrise Hill”, denoted here as “West” Lake.

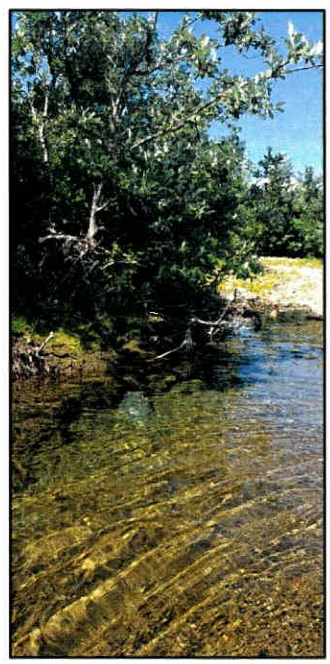
Trap 6. Along Nome-Council Road south of the Solomon B&B, further south than trap 5.

Trap 7. Along Nome-Council Road south of the Solomon B&B, on the eastern side.

Trap 9. Riparian bank habitat, off channel pool with connectivity to the mainstem of the Solomon River.



Trap 8. Along Nome-Council Road south of the Solomon B&B, hoop trap near trap 7.



Trap 10. Riparian bank habitat off the mainstem of the Solomon River.

Trap 11. Riparian bank habitat off the mainstem of the Solomon River, hoop trap adjacent to trap 10.

Trap 13. Jerome Creek, downstream of a beaver dam.

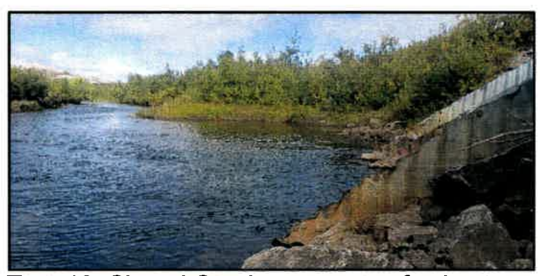
Trap 12. Deep pool off the mainstem of the Solomon River, spring fed at 7°C (colder than mainstem).

Trap 14. Jerome Creek, upstream from a beaver dam.

Trap 15. Side channel off the Solomon River.

Trap 17. Jerome Creek, hoop trap downstream of culverts on the Nome-Council Road, at the confluence of the Solomon River.

Trap 16. Jerome Creek, upstream of culverts on the Nome-Council Road.



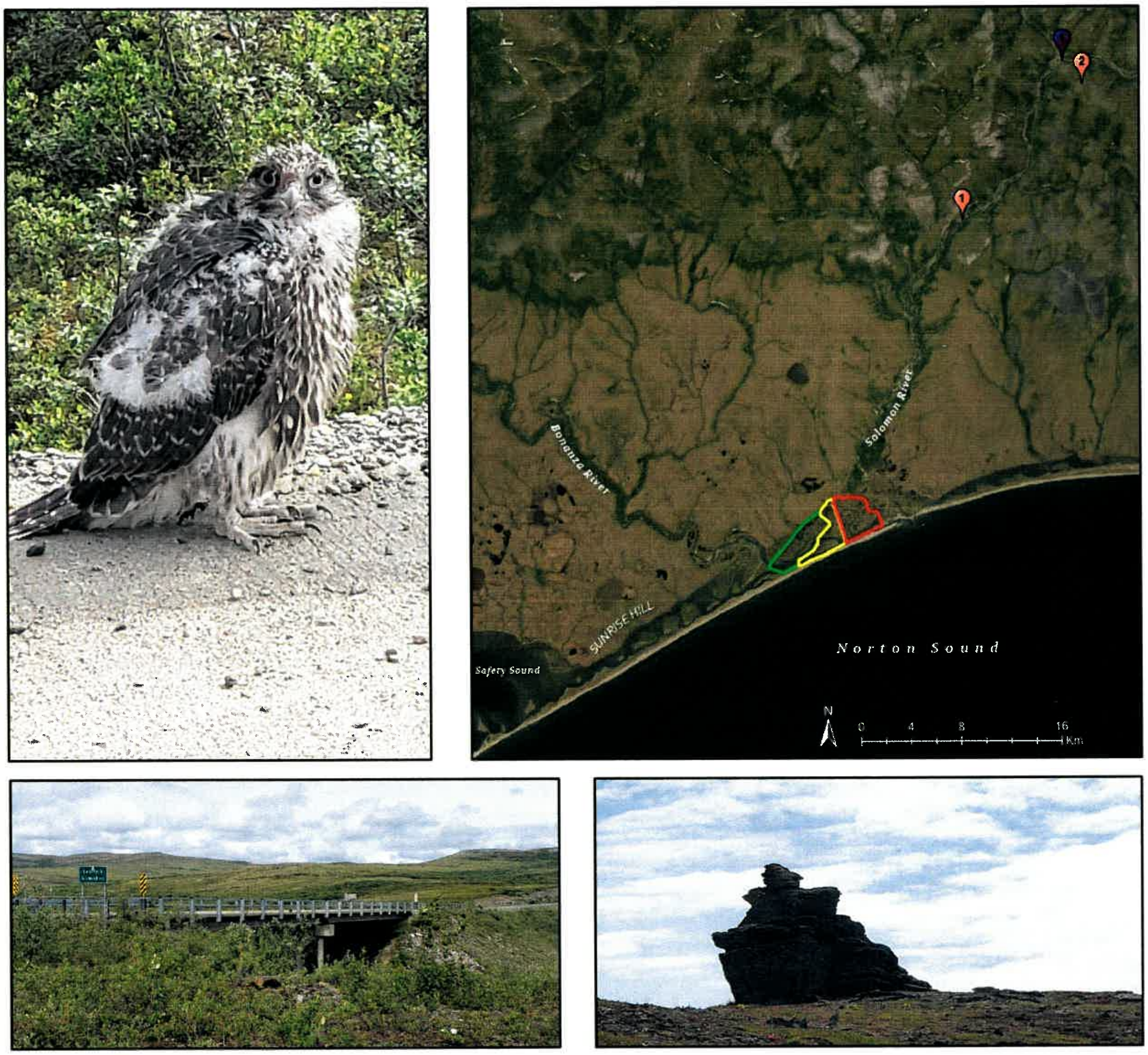
Trap 18. Shovel Creek, upstream of culverts on the Nome-Council Road.

Trap 19. Shovel Creek, cut bank with southwestern direction.

Trap 21. Shovel Creek vegetated off channel near trap 20.

Trap 20. Shovel Creek, cut bank with depth of 1 meter.

Trap 22. Shovel Creek vegetated strip pond.



Supplementary Figure 2. Photographs of incidental avian observations.

A) immature gyrfalcon (*Falco rusticolus*); B) map showing locations of the two rough-legged hawk nests (pink icons, labels 1 and 2) and gyrfalcon nest (purple icon, label 1) with respect to the three waterfowl survey areas and surrounding landmarks near Safety Sound and the area near Solomon; C) East Fork Bridge where active gyrfalcon (*Falco rusticolus*) nest was observed; D) the large granite tor where an active rough-legged hawk (*Buteo lagopus*) nest was observed (pink icon, label 2).