



FINAL REPORT

Chapter 3.0 Marine Sediment Quality

2021 Marine Environmental Effects Monitoring Program (MEEMP) and Non-Indigenous Species/Aquatic Invasive Species (NIS/AIS) Monitoring Program

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21 October 2022

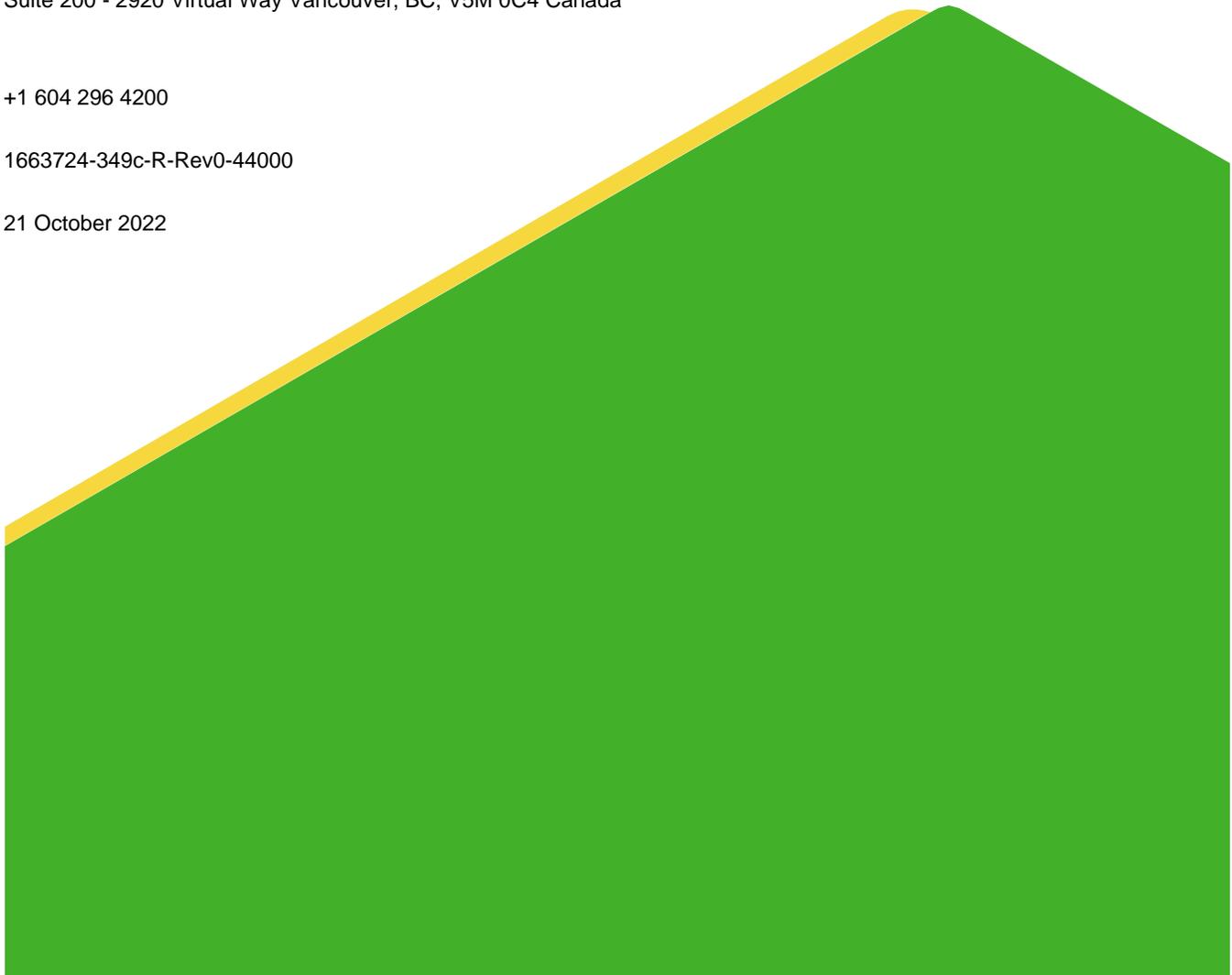


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ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
ALS	ALS Canada Ltd.
BC MOE	BC Ministry of Environment and Climate Change Strategy
CCME	Canadian Council of Ministers of the Environment
Cm	centimetres
DQOs	Data Quality Objectives
FCSAP	Federal Contaminated Sites Action Plan
ISQGs	Interim Sediment Quality Guidelines
m ²	metre squared
MDL	Method Detection Limit
MEEMP	Marine Environmental Effects Monitoring Program
MEWG	Marine Environmental Working Group
NOAA	National Oceanic and Atmospheric Administration
PAHs	Polycyclic aromatic hydrocarbons
PELs	Probable Effect Level
%	percent
QA/QC	Quality Assurance / Quality Check
QC	Quality Check
QIA	Qikiqtani Inuit Association
RPD	Relative Percent Difference
SW	West Transect
VOCs	Volatile Organic Compounds
WSQG	Working Sediment Quality Guidelines

3.0 SEDIMENT QUALITY

3.1 Introduction

The 2021 sediment sampling program for the MEEMP was focussed on targeted sediment sampling at station SW-2, located along the West transect between the Ore Dock and the mouth of Phillips Creek. Station SW-2 was considered an outlier in the 2020 sediment dataset because of considerably lower fines and higher sand content compared to other stations sampled along the West transect in 2020 and, also, when compared to previous years of sampling at this location. Through the Marine Environmental Working Group (MEWG) process, the Qikiqtani Inuit Association (QIA) requested data from previous years of sampling at SW-2 be revisited to investigate whether changes observed at this station could be Project-related (Technical Comment 25 on the 2020 MEEMP Report), and Baffinland committed to conduct directed sampling during the 2021 open-water season to address this.

This component was developed in consideration of the monitoring requirements outlined in the PC Conditions described in Chapter 1.0, Table 1-2. Project Certificate (PC) Conditions related to the monitoring include PC Conditions No. 76, 87, 89, 91, 99 (a), and 99 (c).

3.1.1 Objectives

The overall MEEMP objectives are outlined in Section 1.3. The objectives of the targeted SW-2 sampling for 2021 are to:

- Conduct targeted follow-up sampling of sediment composition and quality at Station SW-2 to evaluate whether the changes at this station observed in 2020 have persisted and whether they are Project-related.
- Verify predictions made in the FEIS and other submissions to the Nunavut Impact Review Board (NIRB) regarding effects on sediment quality, as applicable.
- Recommend any necessary and appropriate changes to the sediment quality component of the MEEMP for future years.
- Address comments provided by the QIA and MEWG on the 2020 MEEMP Report.

3.2 Study Design

3.2.1 Modifications to the Program (2021)

In the 2020 MEEMP Report, Golder (2021a) reported that monitoring results to date have not identified Project-induced changes to sediment quality in the marine receiving environment. Given there have been three consecutive years of implementation, the joint radial benthic and sediment sampling program was not conducted in 2021 – commensurate with the lack of directional trends observed to date which indicate that the Project has not adversely impacted marine sediments in Milne Inlet. The data show that measured parameters are generally consistent with previous years, within thresholds in the interim CCME sediment quality guidelines, and do not show spatial patterns attributable to Project activities. The power analysis provided in Appendix 3E confirms that in 2019 and 2020 there was adequate statistical power to be able to detect Project-related changes, despite a reduced number of stations sampled in 2019 due to logistical challenges.

Baffinland is committed to continued implementation of the full sampling program with an adjusted monitoring frequency of every 3 years, which is more consistent with routine biological sampling for other mining effects monitoring programs (e.g., the federal Environmental Effects Monitoring Program [EEM]).

3.2.2 Sampling Parameters and Indicators

For marine sediment quality, parameters measured included particle size, organic carbon, nutrients, metals, and hydrocarbons. A sub-set of these parameters (i.e., percent fines, nutrients, metals, and hydrocarbons) were identified as sediment quality indicators to assess the potential for environmental effects from the Project. To provide early warning of environmental effects from the Project, applicable sediment quality guidelines were used as thresholds, where they exist (i.e., Canadian Council of Ministers of the Environment [CCME] sediment quality guidelines for the protection of aquatic life in marine environments [CCME 2014]).

3.3 Materials and Methods

3.3.1 Field Methodology

One sediment sample and one duplicate sample were collected from SW-2 (Table 3-1; Figure 8-1) along with a co-located benthic infauna sample (Section 4.0). The sample was submitted for the same chemical analyses performed in 2020 for the MEEMP program (i.e., particle size, organic carbon, nutrients, metals, and hydrocarbons).

Table 3-1: Sediment Sampling Locations at Milne Port (2021)

Station Name	UTM Coordinates (Zone 17W)		Approximate Lateral Distance Along Transect (m)	Water Depth in Chart Datum (m)
	Easting	Northing		
West Transect				
SW-2	503064	7976526	224	15.1

Sediment samples were collected using a standard Van Veen grab sampler (area of 0.1 m²). Each grab sample was examined for acceptability based on the following criteria:

- The sampler was fully closed.
- There was adequate penetration depth (i.e., sediment volume greater than 25% full).
- The sample did not appear overfilled or disturbed, and the sample did not appear to have been collected on an angle.
- The sampler did not appear to be leaking sediment at a substantial rate (i.e., the top of the sediment profile did not appear to be sloping inwards).

Upon acceptance, the overlying water in the grab was removed using a siphon tube or turkey baster, taking care to minimize the loss of sediment from the surface of the grab contents. After decanting, the sample consisted of sediment with minimal overlying water visible. Two terra core samples were taken from the undisturbed sediments and placed into pre-labeled methanol preserved vials for volatile organic compounds (VOCs). A description of the

sediment with respect to colour, particle size, depth of sediment horizon sampled, grab penetration depth and presence of non-sediment materials (e.g., shells, debris, biota) was recorded on the sediment collection log. Prior to the sample collection, a stainless-steel spoon and bowl were cleaned with laboratory-grade detergent and rinsed with de-ionized (analyte-free) water. The remaining top 5 cm of sediment from the grab sample was removed from the center of the grab using a stainless-steel spoon and transferred to a stainless-steel bowl. The sediment was then homogenized, and aliquots transferred to clean, laboratory supplied sampling containers. Photographs were taken of the sample in the grab and homogenized (Appendix 3A).

Physical and chemical parameters were analyzed in the sediment sample collected from station SW-2 along the west transect. A field duplicate quality control (QC) sample was also collected. These samples were sent to ALS Canada Ltd. (ALS) for analysis of the following parameters:

- Particle size distribution (Wentworth scale)
- Organic and inorganic carbon
- Total petroleum hydrocarbons
- Volatile organic compounds
- Polycyclic aromatic hydrocarbons (PAHs)
- Trace metals (including mercury)

3.3.2 Data Analysis

Data analysis involved characterization of the physical composition of sediments and screening of parameters against applicable sediment quality guidelines.

3.3.2.1 Comparison to Sediment Quality Guidelines

Concentrations of metals and hydrocarbons were compared to CCME Interim Sediment Quality Guidelines (ISQGs) and Probable Effect Level (PELs) for the protection of aquatic life in the marine environment (CCME 2014), which apply in the Project jurisdiction. The CCME ISQGs are intended to represent concentrations below which adverse biological effects are rarely expected to occur. By comparison, the CCME PELs are intended to represent concentrations above which adverse effects are predicted to occur frequently, based on a concurrence data set with sediment chemical concentration and benthic invertebrate effects data from other sites. Notably, the Federal Contaminated Sites Action Plan (FCSAP) guidance for working harbours (FCSAP 2018) recommends use of PELs over ISQGs for screening primary contaminants of potential concern, as screening with ISQGs is considered overly conservative and does not always correlate well with observed effects under field conditions (FCSAP 2018).

To provide a screening value to inform the sediment evaluation, in the absence of a CCME guideline, metals and hydrocarbons were compared to British Columbia Working Sediment Quality Guidelines (WSQG) (BC MOE 2020a), and the National Oceanic and Atmospheric Administration (NOAA) sediment benchmarks (Buchman 2008), following direction provided by the MEWG.

3.3.3 Quality Management

The overall goal of the sediment sampling program is to collect high-quality data, which is achieved through the consistent application of QA/QC measures. These quality management procedures were applied to the field collection, data analysis, and reporting tasks for the targeted sampling in 2021 to verify that the data presented are valid and of acceptable quality to objectives outlined in Section 3.1.1.

3.3.3.1 Field QA/QC

Field staff were trained to be proficient in standardized sampling procedures, data recording using standard forms, and equipment operations applicable to the monitoring program. Field work was completed according to specified instructions and established technical procedures for standard sample collection, preservation, handling, storage, and shipping procedures.

General quality assurance and quality control (QA/QC) tasks applicable to the sediment quality program included, but were not limited to, the following:

- Preparing geo-referenced field maps for use during the surveys to accurately document sampling locations and project-specific data collection forms to standardize the field data collection process.
- Maintaining regular communications between the Project Manager and field staff.
- Collecting and processing samples by qualified experienced personnel.
- Placing samples in appropriate clean containers in such a way that no foreign material was introduced to the sample and handled carefully so there would be no loss of material.
- Collecting Quality Control (duplicate) sample in the field.
- Rinsing and filtering equipment including the Van Veen grab sampler, materials collection totes, field splitter and sieves with seawater between stations. Visual inspection confirmed that materials were not retained on equipment before use on the next station.
- Checking and validating field survey data sheets before leaving the station.
- Selecting accredited laboratories for sample analysis. Performance quality of selected laboratories were verified through Golder's internal vendor approval and assessment procedures.
- Using chain-of-custody documentation to track sample shipments to the individual subcontractor laboratories.
- Packaging and shipping samples to the laboratory in accordance with required holding times and storage conditions.

3.3.3.2 Laboratory and Data Analysis QA/QC

Laboratory QA/QC reports were reviewed upon receipt to confirm adherence to sample hold times and laboratory data quality objectives (DQOs), and that the appropriate QA/QC information had been reported. Laboratory QA/QC included verification of recommended sample holding times and the analysis of laboratory control samples, laboratory duplicates, and spiked samples to assess precision and accuracy of analytical methods.

One field duplicate was sampled and identified as Duplicate A (blind sample) collected from the same discrete homogenized grab sample (a split sample) as the “original” sample. To assess variability between field duplicates, the Relative Percent Difference (RPD) was calculated as follows:

$$RPD = \left(\frac{\text{sample} - \text{duplicate}}{(\text{sample} + \text{duplicate})/2} \right) \times 100$$

In accordance with the BC Field Sampling Manual (BC MOE 2020b) and CCME (2016), an RPD value of >50% was used to identify differences between original and duplicate samples. Values less than five times the Method Detection Limit (MDL) were not included in the RPD calculations because analytical variability near the MDL is higher and does not provide a good measure of variability associated with the collection of field samples.

3.3.4 Sediment Quality QA/QC Results

The 2021 sediment quality data are considered valid based on the following results of the QA/QC assessment:

- Chemical analyses on the sediment samples were completed within the sample hold time requirements
- Data reported by the laboratory are considered reliable according to the accredited laboratory QA/QC assessment
- There was low variability and high precision between duplicate samples, with the exception of a number of metals (Appendix 3D). Observed differences between the duplicate and the original sediment sample for these metals could be a result of heterogeneity in concentrations inherent within the sediment matrix, or ‘incomplete’ homogenization of the sediment sample such that subsampling for laboratory analysis may have introduced some variability. The data are considered to be reliable because accounting for variability does not substantially change the data screening results at the metal concentrations reported.

Overall, the QA/QC results indicate that the sediment data collected during the 2021 sampling program are of acceptable quality to meet the objectives stated in Section 3.1.

3.4 Results

3.4.1 Sediment Grain Size Composition

Sample photographs and sediment logs from the field program are provided in Appendix 3A and Appendix 3B, respectively. Analytical laboratory reports are provided in Appendix 3C and the compiled dataset screened to applicable sediment quality guidelines is provided in Appendix 3D along with the QA/QC results.

Sediment grain size at SW-2 appears to have become coarser/sandier with a decreased content of fines observed since 2018. Gravel content is highly variable, showing no directional trend (Table 3-2).

Table 3-2: Summary of SW-2 Sediment Grain Composition in 2018 to 2021.

Particle Size	Units	2018 ¹	2019	2020	2021
Clay (<0.004mm)	%	5.9	3.3	<1.0	<1.0
Silt (0.063-0.004mm)	%	26.2	11.2	2.7	2.6
Sand (2.0-0.063mm)	%	55.3	83.0	95.7	88.5
Gravel (>2.0mm)	%	12.6	2.5	<1.0	8.9

3.4.2 Comparison to Sediment Quality Guidelines

In 2021, concentrations of metals in sediment collected from SW-2 were below applicable sediment quality guidelines for the protection of aquatic life and hydrocarbon concentrations were not detected (Appendix 3D). Iron concentration in 2021 was comparable to concentrations measured in previous years at this station.

3.5 Discussion

Sediment grain size is shown to be more variable along the West and East transects than the offshore (North and NorthEast) transects, with both sand and fines present in variable proportions along the transects depending on the station location. This variability is likely largely driven by local interactions between sediment transport drivers (i.e., waves and currents), coastal topography, and freshwater inputs from Phillips Creek. However, several lines of evidence support the interpretation that the coarsening of sediment observed at SW-2 in recent years (i.e., decreased fines content) is related to propeller scour and not simply a result of natural variability. This includes direct observations in 2020 of high propeller wash events in the area (i.e., generated by tugs when operating inshore of the Ore Dock), propeller wash model results which indicate the zone of influence overlaps with SW-2, and diver observations of a large elliptical pocket of coarse substrate where the soft overlying sediment has been washed out (similar to other observed and modelled propeller wash scours).

Collectively, the available sediment quality data available for station SW-2 suggests localized physical disturbance to the substrate has occurred. Scour from propeller-generated currents by berthing ore carriers is the most likely mechanism given the site's proximity to the Ore Dock. The observed changes in sediment size distribution could be attributed to small-scale shifts in the position of bedforms formed under the propeller-generated currents,

¹ Value reported for 2018 is an average of the 3 replicate samples collected in that sampling year.

which act to mobilize finer sediments resulting in local coarsening of the substrate. Changes in sediment grain size can drive associated effects to benthic infaunal communities, as strong relationships exist between the distribution and abundance of infaunal invertebrates inhabiting soft-bottom environments and the size and texture of sediments.

Propwash effects around the Ore Dock in Milne Port are consistent with FEIS predictions, which forecasted the potential for minor and localized sediment disturbance associated with propwash and overall negligible residual effects on sediment quality in Milne Port. While substrates have remained predominantly sandy since 2018, there has been further coarsening in the last two years at station SW-2. While changes in sediment composition at this site impacted the benthic community, as evidenced by results documented in 2020, these impacts do not appear to be long-lasting; in 2021, the benthic community at SW-2 was substantially more diverse (returned to 2019 levels) and abundant (an order of magnitude increase) compared to 2020, which demonstrates the ability of these organisms to rebound and potentially reach a new, post-disturbance equilibrium (explained in greater detail in Chapter 4.0).

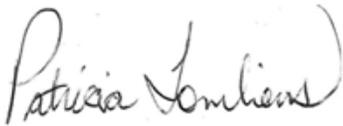
3.6 Conclusions and Recommendations

In general, the measured sediment quality parameters at SW-2 are consistent with previous years, are below CCME sediment quality guidelines, and do not suggest a compromised environment due to Project operations. However, available sediment monitoring data for station SW-2 (2018-2021) indicates that the grain size composition has changed at this location in a manner that is consistent with the expected effects of propellor wash (i.e., higher sand and lower fines content in the sediment). Overall, monitoring results remain within original FEIS predictions, which forecasted the potential for minor and localized sediment disturbance associated with propwash, which is expected to stabilize over time. It is recommended to continue targeted sampling in 2022 at SW-2 as part of ongoing monitoring of Project effects relative to impact predictions.

3.7 Closure

We trust this information is sufficient for your needs at this time. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 250-881-7372.

Golder Associates Ltd.



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3.8 References

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- BC Ministry of Environment and Climate Change Strategy (BC MOE). 2020b. British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Sample.
- Buchman, M.F., 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 4 p.
- CCME (Canadian Council of Ministers of the Environment). 2014. Canadian Environmental Quality Guidelines. [accessed February 2021]
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APPENDIX A

Photographs

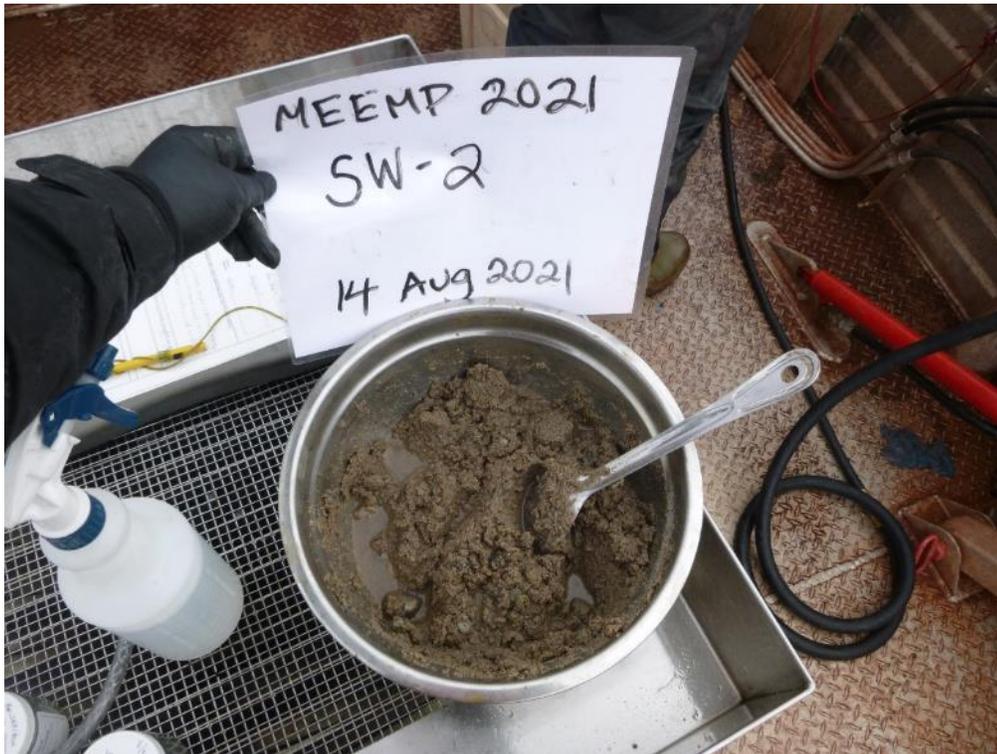


Photo 1 – Homogenized sediment sample collected at station SW-2 on 14 August 2021.



Photo 2 – Van Veen grab set and ready for deployment on 10 August 2021.



Photo 3 – Benthic sample on 1.0 cm sieve, collected at station SW-2 on 14 August 2021.



Photo 4 – Benthic sample on 0.5 mm sieve, collected at station SW-2 on 14 August 2021.

APPENDIX B

Marine Sediment Logs - 2021

SEDIMENT SAMPLING LOG

Project No: 1663724-44000/03 Project Title: Baffinland 2021 -
 Date: 14 Aug 2021 Inspected by: TT
 Station Number (ID): SW-2/DUP A Sampling Method: Van Veen
 Weather: light rain, 10-12 kts gusts to 18 kts) Lat/Longitude: Waypoint
 Sampling Depth: 17.6m
 # of Attempts to Obtain Sample: 1111 Time of Collection: 12:34 - 13:15

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

Sand - wet, loose, low plasticity, surface layer is brown overtop of greyish black layer, 60% fines, fine to coarse sand, 45% gravel (rounded), shell debris, Similipekten, no odour and no sheen present

Approx % collected in grab sample 1-15-20' l., 6cm), 2 (10-15' l., 5cm), 3-rock caught in grab % 4-(40-45' l., 6.5cm)

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

Photo of homogenized sample

Sample Control Number (SCN):

- Analysis for:
- Full Metals
 - Grain Size
 - PCB
 - Other VOC, BTEX
 - PAH
 - Benthic
 - Dioxins and Furans
 - TBT
 - AVS CEM
 - PFOA/PFOS

AEC: _____ # of Grabs for Analysis: _____
Other Notes: _____

6 jars, 4 vials and 2 bags

SAMPLE NUMBER: _____

APPENDIX C

Sediment Quality Laboratory Data



CERTIFICATE OF ANALYSIS

Work Order : **VA21B7543**
Client : **Golder Associates Ltd.**
Contact : Elaine Irving
Address : 200-2920 Virtual Way
Vancouver BC Canada V5M 0C4
Telephone : ----
Project : 1663724-44000-03
PO : ----
C-O-C number : 20-920782
Sampler : ----
Site : ----
Quote number : Q84262
No. of samples received : 5
No. of samples analysed : 5

Page : 1 of 6
Laboratory : Vancouver - Environmental
Account Manager : Amber Springer
Address : 8081 Lougheed Highway
Burnaby BC Canada V5A 1W9
Telephone : +1 604 253 4188
Date Samples Received : 19-Aug-2021 08:25
Date Analysis Commenced : 21-Aug-2021
Issue Date : 27-Aug-2021 16:37

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
Caleb Deroche	Lab Analyst	Metals, Burnaby, British Columbia
Hedy Lai	Team Leader - Inorganics	Inorganics, Saskatoon, Saskatchewan
Kevin Duarte	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Ophelia Chiu	Department Manager - Organics	Organics, Burnaby, British Columbia
Paul Cushing	Team Leader - Organics	Organics, Burnaby, British Columbia
Xihua Yao	Laboratory Analyst	Inorganics, Saskatoon, Saskatchewan



General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

<i>Unit</i>	<i>Description</i>
-	No Unit
%	percent
mg/kg	milligrams per kilogram
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Qualifiers

<i>Qualifier</i>	<i>Description</i>
LSRA	Low surrogate recovery was observed due to adsorptive material in sample (e.g. charcoal). Results for other analytes within the same test represent solvent extractable concentrations
SUR-ND	Surrogate recovery marginally exceeded ALS DQO. Reported non-detect results for associated samples were deemed to be unaffected.



Analytical Results

Sub-Matrix: Sediment

Client sample ID

(Matrix: Soil/Solid)

					TR Ref1	TR Ref2	DUP-B	SW-2	DUP A
Client sampling date / time					15-Aug-2021 15:45	15-Aug-2021 16:30	15-Aug-2021	14-Aug-2021 13:15	14-Aug-2021
Analyte	CAS Number	Method	LOR	Unit	VA21B7543-001	VA21B7543-002	VA21B7543-003	VA21B7543-004	VA21B7543-005
					Result	Result	Result	Result	Result
Physical Tests									
moisture	----	E144	0.25	%	24.6	39.7	39.6	14.7	14.4
pH (1:2 soil:water)	----	E108	0.10	pH units	8.37	8.22	8.21	8.90	8.89
Particle Size									
clay (<0.004mm)	----	EC184E	1.0	%	5.7	4.4	4.2	<1.0	<1.0
silt (0.063mm - 0.004mm)	----	EC184E	1.0	%	26.7	21.9	22.4	2.6	2.2
sand (2.0mm - 0.063mm)	----	EC184E	1.0	%	57.4	68.3	71.1	88.5	87.2
gravel (>2mm)	----	EC184E	1.0	%	10.2	5.4	2.3	8.9	10.6
Organic / Inorganic Carbon									
carbon, total [TC]	----	E351	0.050	%	1.16	1.39	1.45	1.27	1.11
carbon, inorganic [IC]	----	E354	0.050	%	0.524	0.355	0.378	0.936	0.811
carbon, inorganic [IC], (as CaCO3 equivalent)	----	E354	0.40	%	4.37	2.96	3.15	7.80	6.76
carbon, total organic [TOC]	----	EC356	0.050	%	0.636	1.04	1.07	0.334	0.299
organic matter	----	EC356	0.10	%	1.10	1.79	1.84	0.58	0.52
Metals									
aluminum	7429-90-5	E440	50	mg/kg	18400	6770	8260	8860	1450
antimony	7440-36-0	E440	0.10	mg/kg	0.16	<0.10	<0.10	<0.10	<0.10
arsenic	7440-38-2	E440	0.10	mg/kg	2.63	2.60	2.66	2.83	0.44
barium	7440-39-3	E440	0.50	mg/kg	48.6	32.7	32.0	32.2	4.46
beryllium	7440-41-7	E440	0.10	mg/kg	0.22	0.51	0.52	0.56	<0.10
bismuth	7440-69-9	E440	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20
boron	7440-42-8	E440	5.0	mg/kg	<5.0	19.1	36.5	35.1	9.1
cadmium	7440-43-9	E440	0.020	mg/kg	0.054	0.049	0.113	0.098	<0.020
calcium	7440-70-2	E440	50	mg/kg	11900	16100	9110	9550	23500
chromium	7440-47-3	E440	0.50	mg/kg	51.6	15.6	14.6	16.0	5.70
cobalt	7440-48-4	E440	0.10	mg/kg	10.3	3.59	3.97	4.28	0.97
copper	7440-50-8	E440	0.50	mg/kg	39.5	5.03	9.10	9.24	1.16
iron	7439-89-6	E440	50	mg/kg	28300	13000	12900	14400	3050
lead	7439-92-1	E440	0.50	mg/kg	1.52	5.18	6.96	7.33	1.06
lithium	7439-93-2	E440	2.0	mg/kg	4.9	16.1	17.7	17.8	6.2
magnesium	7439-95-4	E440	20	mg/kg	6020	11400	8870	10000	11200



Analytical Results

Sub-Matrix: Sediment

(Matrix: Soil/Solid)

					Client sample ID	TR Ref1	TR Ref2	DUP-B	SW-2	DUP A
					Client sampling date / time	15-Aug-2021 15:45	15-Aug-2021 16:30	15-Aug-2021	14-Aug-2021 13:15	14-Aug-2021
Analyte	CAS Number	Method	LOR	Unit	VA21B7543-001	VA21B7543-002	VA21B7543-003	VA21B7543-004	VA21B7543-005	
					Result	Result	Result	Result	Result	
Metals										
manganese	7439-96-5	E440	1.0	mg/kg	414	109	91.2	99.4	39.4	
mercury	7439-97-6	E510	0.0050	mg/kg	<0.0050	0.0063	0.0064	<0.0050	<0.0050	
molybdenum	7439-98-7	E440	0.10	mg/kg	2.11	0.80	1.70	1.66	0.11	
nickel	7440-02-0	E440	0.50	mg/kg	22.8	8.86	10.0	11.2	2.99	
phosphorus	7723-14-0	E440	50	mg/kg	365	662	410	483	80	
potassium	7440-09-7	E440	100	mg/kg	580	1730	2480	2590	740	
selenium	7782-49-2	E440	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	
silver	7440-22-4	E440	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	
sodium	7440-23-5	E440	50	mg/kg	774	3190	5800	6770	1520	
strontium	7440-24-6	E440	0.50	mg/kg	42.8	21.9	26.0	26.6	15.2	
sulfur	7704-34-9	E440	1000	mg/kg	<1000	<1000	2400	2500	<1000	
thallium	7440-28-0	E440	0.050	mg/kg	<0.050	0.100	0.115	0.115	<0.050	
tin	7440-31-5	E440	2.0	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	
titanium	7440-32-6	E440	1.0	mg/kg	2260	340	257	256	110	
tungsten	7440-33-7	E440	0.50	mg/kg	11.9	<0.50	<0.50	<0.50	<0.50	
uranium	7440-61-1	E440	0.050	mg/kg	0.253	2.13	1.82	1.78	0.213	
vanadium	7440-62-2	E440	0.20	mg/kg	95.3	22.4	21.2	22.3	4.91	
zinc	7440-66-6	E440	2.0	mg/kg	30.3	22.1	24.7	26.9	4.8	
zirconium	7440-67-7	E440	1.0	mg/kg	11.0	10.3	7.3	8.6	1.5	
Volatile Organic Compounds [Fuels]										
benzene	71-43-2	E611A	0.0050	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
ethylbenzene	100-41-4	E611A	0.015	mg/kg	<0.015	<0.015	<0.015	<0.015	<0.015	
toluene	108-88-3	E611A	0.050	mg/kg	<0.050	<0.050	<0.050	<0.050	<0.050	
xylene, m+p-	179601-23-1	E611A	0.050	mg/kg	<0.050	<0.050	<0.050	<0.050	<0.050	
xylene, o-	95-47-6	E611A	0.050	mg/kg	<0.050	<0.050	<0.050	<0.050	<0.050	
xylenes, total	1330-20-7	E611A	0.075	mg/kg	<0.075	<0.075	<0.075	<0.075	<0.075	
Volatile Organic Compounds Surrogates										
bromofluorobenzene, 4-	460-00-4	E611A	0.10	%	91.9	87.2	40.7 ^{SUR-N_D}	71.4	84.7	
difluorobenzene, 1,4-	540-36-3	E611A	0.10	%	97.2	87.3	41.0 ^{SUR-N_D}	83.0	100	
Hydrocarbons										
F1 (C6-C10)	----	E581.VH+F1	5.0	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	



Analytical Results

Sub-Matrix: Sediment

(Matrix: Soil/Solid)

					Client sample ID	TR Ref1	TR Ref2	DUP-B	SW-2	DUP A
					Client sampling date / time	15-Aug-2021 15:45	15-Aug-2021 16:30	15-Aug-2021	14-Aug-2021 13:15	14-Aug-2021
Analyte	CAS Number	Method	LOR	Unit	VA21B7543-001	VA21B7543-002	VA21B7543-003	VA21B7543-004	VA21B7543-005	
					Result	Result	Result	Result	Result	
Hydrocarbons										
F1-BTEX	----	EC580	5.0	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	
F2 (C10-C16)	----	E601.SG	30	mg/kg	<30	<30	<30	<30	<30	
F3 (C16-C34)	----	E601.SG	50	mg/kg	<50	56	51	<50	<50	
F4 (C34-C50)	----	E601.SG	50	mg/kg	<50	<50	<50	<50	<50	
chromatogram to baseline at nC50	----	E601.SG	-	-	Yes	Yes	Yes	Yes	Yes	
Hydrocarbons Surrogates										
bromobenzotrifluoride, 2- (F2-F4 surr)	392-83-6	E601.SG	1.0	%	85.2	83.8	81.9	83.9	86.2	
dichlorotoluene, 3,4-	97-75-0	E581.VH+F1	1.0	%	101	77.6	76.4	34.0 ^{LSRA}	28.6 ^{LSRA}	
Polycyclic Aromatic Hydrocarbons										
acenaphthene	83-32-9	E641A-L	0.0050	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
acenaphthylene	208-96-8	E641A-L	0.0050	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
acridine	260-94-6	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
anthracene	120-12-7	E641A-L	0.0040	mg/kg	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	
benz(a)anthracene	56-55-3	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
benzo(a)pyrene	50-32-8	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
benzo(b+j)fluoranthene	----	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
benzo(b+j+k)fluoranthene	----	E641A-L	0.015	mg/kg	<0.015	<0.015	<0.015	<0.015	<0.015	
benzo(g,h,i)perylene	191-24-2	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
benzo(k)fluoranthene	207-08-9	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
chrysene	218-01-9	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
dibenz(a,h)anthracene	53-70-3	E641A-L	0.0050	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
fluoranthene	206-44-0	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
fluorene	86-73-7	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
indeno(1,2,3-c,d)pyrene	193-39-5	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
methylnaphthalene, 1-	90-12-0	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
methylnaphthalene, 1+2-	----	E641A-L	0.015	mg/kg	<0.015	<0.015	<0.015	<0.015	<0.015	
methylnaphthalene, 2-	91-57-6	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
naphthalene	91-20-3	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
phenanthrene	85-01-8	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
pyrene	129-00-0	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	
quinoline	6027-02-7	E641A-L	0.010	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	



Analytical Results

Sub-Matrix: Sediment
 (Matrix: Soil/Solid)

					Client sample ID	TR Ref1	TR Ref2	DUP-B	SW-2	DUP A
					Client sampling date / time	15-Aug-2021 15:45	15-Aug-2021 16:30	15-Aug-2021	14-Aug-2021 13:15	14-Aug-2021
Analyte	CAS Number	Method	LOR	Unit	VA21B7543-001	VA21B7543-002	VA21B7543-003	VA21B7543-004	VA21B7543-005	
					Result	Result	Result	Result	Result	
Polycyclic Aromatic Hydrocarbons										
B(a)P total potency equivalents [B(a)P TPE]	----	E641A-L	0.020	mg/kg	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
IACR (CCME)	----	E641A-L	0.150	-	<0.150	<0.150	<0.150	<0.150	<0.150	<0.150
IACR AB (coarse)	----	E641A-L	0.10	-	----	----	----	<0.10	<0.10	<0.10
IACR AB (fine)	----	E641A-L	0.10	-	----	----	<0.10	<0.10	<0.10	<0.10
PAHs, total (BC Sched 3.4)	----	E641A-L	0.040	mg/kg	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
PAHs, total (EPA 16 - DAS)	----	E641A-L	0.140	mg/kg	----	----	<0.140	<0.140	<0.140	<0.140
PAHs, total (EPA 16)	----	E641A-L	0.040	mg/kg	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Polycyclic Aromatic Hydrocarbons Surrogates										
acridine-d9	34749-75-2	E641A-L	0.1	%	106	112	102	110	104	104
chrysene-d12	1719-03-5	E641A-L	0.1	%	123	127	116	129	123	123
naphthalene-d8	1146-65-2	E641A-L	0.1	%	102	105	94.6	104	100	100
phenanthrene-d10	1517-22-2	E641A-L	0.1	%	105	108	98.4	108	103	103

Please refer to the General Comments section for an explanation of any qualifiers detected.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: VA21B7543	Page	: 1 of 11
Client	: Golder Associates Ltd.	Laboratory	: Vancouver - Environmental
Contact	: Elaine Irving	Account Manager	: Amber Springer
Address	: 200-2920 Virtual Way Vancouver BC Canada V5M 0C4	Address	: 8081 Lougheed Highway Burnaby, British Columbia Canada V5A 1W9
Telephone	: ----	Telephone	: +1 604 253 4188
Project	: 1663724-44000-03	Date Samples Received	: 19-Aug-2021 08:25
PO	: ----	Issue Date	: 27-Aug-2021 16:37
C-O-C number	: 20-920782		
Sampler	: ----		
Site	: ----		
Quote number	: Q84262		
No. of samples received	: 5		
No. of samples analysed	: 5		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

- Anonymous:** Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- Duplicate outliers occur - please see following pages for full details.
- Test sample Surrogate recovery outliers exist for all regular sample matrices - please see following pages for full details.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.



Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **Soil/Solid**

Analyte Group	Laboratory sample ID	Client/Ref Sample ID	Analyte	CAS Number	Method	Result	Limits	Comment
Duplicate (DUP) RPDs								
Metals	Anonymous	Anonymous	lead	7439-92-1	E440	41.6 % DUP-H	40%	Duplicate RPD does not meet the DQO for this test.

Result Qualifiers

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Regular Sample Surrogates

Sub-Matrix: **Sediment**

Analyte Group	Laboratory sample ID	Client/Ref Sample ID	Analyte	CAS Number	Result	Limits	Comment
Samples Submitted							
Volatile Organic Compounds Surrogates	VA21B7543-003	DUP-B	bromofluorobenzene, 4-	460-00-4	40.7 %	70.0-130 %	Recovery less than lower data quality objective
Volatile Organic Compounds Surrogates	VA21B7543-003	DUP-B	difluorobenzene, 1,4-	540-36-3	41.0 %	70.0-130 %	Recovery less than lower data quality objective
Hydrocarbons Surrogates	VA21B7543-004	SW-2	dichlorotoluene, 3,4-	97-75-0	34.0 %	70.0-130 %	Recovery less than lower data quality objective
Hydrocarbons Surrogates	VA21B7543-005	DUP A	dichlorotoluene, 3,4-	97-75-0	28.6 %	70.0-130 %	Recovery less than lower data quality objective



Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: Soil/Solid

Evaluation: * = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Hydrocarbons : CCME PHC - F2-F4 by GC-FID										
Glass soil jar/Teflon lined cap DUP A	E601.SG	14-Aug-2021	24-Aug-2021	14 days	10 days	✓	27-Aug-2021	40 days	3 days	✓
Hydrocarbons : CCME PHC - F2-F4 by GC-FID										
Glass soil jar/Teflon lined cap SW-2	E601.SG	14-Aug-2021	24-Aug-2021	14 days	10 days	✓	27-Aug-2021	40 days	3 days	✓
Hydrocarbons : CCME PHC - F2-F4 by GC-FID										
Glass soil jar/Teflon lined cap DUP-B	E601.SG	15-Aug-2021	24-Aug-2021	14 days	9 days	✓	27-Aug-2021	40 days	3 days	✓
Hydrocarbons : CCME PHC - F2-F4 by GC-FID										
Glass soil jar/Teflon lined cap TR Ref1	E601.SG	15-Aug-2021	24-Aug-2021	14 days	9 days	✓	27-Aug-2021	40 days	3 days	✓
Hydrocarbons : CCME PHC - F2-F4 by GC-FID										
Glass soil jar/Teflon lined cap TR Ref2	E601.SG	15-Aug-2021	24-Aug-2021	14 days	9 days	✓	27-Aug-2021	40 days	3 days	✓
Hydrocarbons : VH and F1 by Headspace GC-FID										
Glass soil methanol vial DUP-B	E581.VH+F1	15-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	10 days	✓
Hydrocarbons : VH and F1 by Headspace GC-FID										
Glass soil methanol vial TR Ref1	E581.VH+F1	15-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	10 days	✓



Matrix: **Soil/Solid**

Evaluation: * = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis				
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval	
				Rec	Actual			Rec	Actual		
Hydrocarbons : VH and F1 by Headspace GC-FID											
Glass soil methanol vial TR Ref2	E581.VH+F1	15-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	10 days	✓	
Hydrocarbons : VH and F1 by Headspace GC-FID											
Glass soil methanol vial DUP A	E581.VH+F1	14-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	11 days	✓	
Hydrocarbons : VH and F1 by Headspace GC-FID											
Glass soil methanol vial SW-2	E581.VH+F1	14-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	11 days	✓	
Metals : Mercury in Soil/Solid by CVAAS											
Glass soil jar/Teflon lined cap DUP-B	E510	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	28 days	10 days	✓	
Metals : Mercury in Soil/Solid by CVAAS											
Glass soil jar/Teflon lined cap TR Ref1	E510	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	28 days	10 days	✓	
Metals : Mercury in Soil/Solid by CVAAS											
Glass soil jar/Teflon lined cap TR Ref2	E510	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	28 days	10 days	✓	
Metals : Mercury in Soil/Solid by CVAAS											
Glass soil jar/Teflon lined cap DUP A	E510	14-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	28 days	11 days	✓	
Metals : Mercury in Soil/Solid by CVAAS											
Glass soil jar/Teflon lined cap SW-2	E510	14-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	28 days	11 days	✓	
Metals : Metals in Soil/Solid by CRC ICPMS											
Glass soil jar/Teflon lined cap DUP-B	E440	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	180 days	10 days	✓	



Matrix: **Soil/Solid**

Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis				
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval	
				Rec	Actual			Rec	Actual		
Metals : Metals in Soil/Solid by CRC ICPMS											
Glass soil jar/Teflon lined cap TR Ref1	E440	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	180 days	10 days	✔	
Metals : Metals in Soil/Solid by CRC ICPMS											
Glass soil jar/Teflon lined cap TR Ref2	E440	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	180 days	10 days	✔	
Metals : Metals in Soil/Solid by CRC ICPMS											
Glass soil jar/Teflon lined cap DUP A	E440	14-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	180 days	11 days	✔	
Metals : Metals in Soil/Solid by CRC ICPMS											
Glass soil jar/Teflon lined cap SW-2	E440	14-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	180 days	11 days	✔	
Organic / Inorganic Carbon : Total Carbon by Combustion											
LDPE bag DUP A	E351	14-Aug-2021	----	----	----		24-Aug-2021	180 days	0 days	✔	
Organic / Inorganic Carbon : Total Carbon by Combustion											
Glass soil jar/Teflon lined cap DUP-B	E351	15-Aug-2021	----	----	----		24-Aug-2021	180 days	0 days	✔	
Organic / Inorganic Carbon : Total Carbon by Combustion											
LDPE bag SW-2	E351	14-Aug-2021	----	----	----		24-Aug-2021	180 days	0 days	✔	
Organic / Inorganic Carbon : Total Carbon by Combustion											
LDPE bag TR Ref1	E351	15-Aug-2021	----	----	----		24-Aug-2021	180 days	0 days	✔	
Organic / Inorganic Carbon : Total Carbon by Combustion											
LDPE bag TR Ref2	E351	15-Aug-2021	----	----	----		24-Aug-2021	180 days	0 days	✔	



Matrix: Soil/Solid

Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag DUP A	E354	14-Aug-2021	----	----	----		23-Aug-2021	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
Glass soil jar/Teflon lined cap DUP-B	E354	15-Aug-2021	----	----	----		23-Aug-2021	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag SW-2	E354	14-Aug-2021	----	----	----		23-Aug-2021	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag TR Ref1	E354	15-Aug-2021	----	----	----		23-Aug-2021	----	----	
Organic / Inorganic Carbon : Total Inorganic Carbon by Acetic Acid pH Standard Curve										
LDPE bag TR Ref2	E354	15-Aug-2021	----	----	----		23-Aug-2021	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap DUP A	E144	14-Aug-2021	----	----	----		24-Aug-2021	0 days	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap DUP-B	E144	15-Aug-2021	----	----	----		24-Aug-2021	0 days	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap SW-2	E144	14-Aug-2021	----	----	----		24-Aug-2021	0 days	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap TR Ref1	E144	15-Aug-2021	----	----	----		24-Aug-2021	0 days	----	



Matrix: Soil/Solid

Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap TR Ref2	E144	15-Aug-2021	----	----	----		24-Aug-2021	0 days	----	
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap DUP-B	E108	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	30 days	10 days	✔
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap TR Ref1	E108	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	30 days	10 days	✔
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap TR Ref2	E108	15-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	30 days	10 days	✔
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap DUP A	E108	14-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	30 days	11 days	✔
Physical Tests : pH by Meter (1:2 Soil:Water Extraction)										
Glass soil jar/Teflon lined cap SW-2	E108	14-Aug-2021	25-Aug-2021	----	----		25-Aug-2021	30 days	11 days	✔
Polycyclic Aromatic Hydrocarbons : PAHs by Hex:Ace GC-MS (Low Level CCME)										
Glass soil jar/Teflon lined cap DUP A	E641A-L	14-Aug-2021	24-Aug-2021	14 days	10 days	✔	26-Aug-2021	40 days	2 days	✔
Polycyclic Aromatic Hydrocarbons : PAHs by Hex:Ace GC-MS (Low Level CCME)										
Glass soil jar/Teflon lined cap SW-2	E641A-L	14-Aug-2021	24-Aug-2021	14 days	10 days	✔	26-Aug-2021	40 days	2 days	✔
Polycyclic Aromatic Hydrocarbons : PAHs by Hex:Ace GC-MS (Low Level CCME)										
Glass soil jar/Teflon lined cap DUP-B	E641A-L	15-Aug-2021	24-Aug-2021	14 days	9 days	✔	26-Aug-2021	40 days	2 days	✔



Matrix: **Soil/Solid**

Evaluation: * = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis				
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval	
				Rec	Actual			Rec	Actual		
Polycyclic Aromatic Hydrocarbons : PAHs by Hex:Ace GC-MS (Low Level CCME)											
Glass soil jar/Teflon lined cap TR Ref1	E641A-L	15-Aug-2021	24-Aug-2021	14 days	9 days	✓	26-Aug-2021	40 days	2 days	✓	
Polycyclic Aromatic Hydrocarbons : PAHs by Hex:Ace GC-MS (Low Level CCME)											
Glass soil jar/Teflon lined cap TR Ref2	E641A-L	15-Aug-2021	24-Aug-2021	14 days	9 days	✓	26-Aug-2021	40 days	2 days	✓	
Volatile Organic Compounds [Fuels] : BTEX by Headspace GC-MS											
Glass soil methanol vial DUP-B	E611A	15-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	10 days	✓	
Volatile Organic Compounds [Fuels] : BTEX by Headspace GC-MS											
Glass soil methanol vial TR Ref1	E611A	15-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	10 days	✓	
Volatile Organic Compounds [Fuels] : BTEX by Headspace GC-MS											
Glass soil methanol vial TR Ref2	E611A	15-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	10 days	✓	
Volatile Organic Compounds [Fuels] : BTEX by Headspace GC-MS											
Glass soil methanol vial DUP A	E611A	14-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	11 days	✓	
Volatile Organic Compounds [Fuels] : BTEX by Headspace GC-MS											
Glass soil methanol vial SW-2	E611A	14-Aug-2021	24-Aug-2021	----	----		26-Aug-2021	40 days	11 days	✓	

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).



Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: * = QC frequency outside specification; ✓ = QC frequency within specification.

Quality Control Sample Type	Method	QC Lot #	Count		Frequency (%)		Evaluation
			QC	Regular	Actual	Expected	
Analytical Methods							
Laboratory Duplicates (DUP)							
BTEX by Headspace GC-MS	E611A	275058	1	15	6.6	5.0	✓
CCME PHC - F2-F4 by GC-FID	E601.SG	274450	1	5	20.0	5.0	✓
Mercury in Soil/Solid by CVAAS	E510	274452	1	10	10.0	5.0	✓
Metals in Soil/Solid by CRC ICPMS	E440	274451	1	11	9.0	5.0	✓
Moisture Content by Gravimetry	E144	274458	1	16	6.2	5.0	✓
PAHs by Hex:Ace GC-MS (Low Level CCME)	E641A-L	274448	1	14	7.1	5.0	✓
pH by Meter (1:2 Soil:Water Extraction)	E108	274457	1	10	10.0	5.0	✓
Total Carbon by Combustion	E351	274583	1	10	10.0	5.0	✓
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354	273818	1	10	10.0	5.0	✓
VH and F1 by Headspace GC-FID	E581.VH+F1	275057	1	15	6.6	5.0	✓
Laboratory Control Samples (LCS)							
BTEX by Headspace GC-MS	E611A	275058	1	15	6.6	5.0	✓
CCME PHC - F2-F4 by GC-FID	E601.SG	274450	1	5	20.0	5.0	✓
Mercury in Soil/Solid by CVAAS	E510	274452	2	10	20.0	10.0	✓
Metals in Soil/Solid by CRC ICPMS	E440	274451	2	11	18.1	10.0	✓
Moisture Content by Gravimetry	E144	274458	1	16	6.2	5.0	✓
PAHs by Hex:Ace GC-MS (Low Level CCME)	E641A-L	274448	1	14	7.1	5.0	✓
pH by Meter (1:2 Soil:Water Extraction)	E108	274457	1	10	10.0	5.0	✓
Total Carbon by Combustion	E351	274583	2	10	20.0	10.0	✓
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354	273818	2	10	20.0	10.0	✓
VH and F1 by Headspace GC-FID	E581.VH+F1	275057	1	15	6.6	5.0	✓
Method Blanks (MB)							
BTEX by Headspace GC-MS	E611A	275058	1	15	6.6	5.0	✓
CCME PHC - F2-F4 by GC-FID	E601.SG	274450	1	5	20.0	5.0	✓
Mercury in Soil/Solid by CVAAS	E510	274452	1	10	10.0	5.0	✓
Metals in Soil/Solid by CRC ICPMS	E440	274451	1	11	9.0	5.0	✓
Moisture Content by Gravimetry	E144	274458	1	16	6.2	5.0	✓
PAHs by Hex:Ace GC-MS (Low Level CCME)	E641A-L	274448	1	14	7.1	5.0	✓
Total Carbon by Combustion	E351	274583	1	10	10.0	5.0	✓
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354	273818	1	10	10.0	5.0	✓
VH and F1 by Headspace GC-FID	E581.VH+F1	275057	1	15	6.6	5.0	✓
Matrix Spikes (MS)							
BTEX by Headspace GC-MS	E611A	275058	1	15	6.6	5.0	✓
CCME PHC - F2-F4 by GC-FID	E601.SG	274450	1	5	20.0	5.0	✓
PAHs by Hex:Ace GC-MS (Low Level CCME)	E641A-L	274448	1	14	7.1	5.0	✓
VH and F1 by Headspace GC-FID	E581.VH+F1	275057	1	15	6.6	5.0	✓



Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
pH by Meter (1:2 Soil:Water Extraction)	E108 Vancouver - Environmental	Soil/Solid	BC Lab Manual	pH is determined by potentiometric measurement with a pH electrode at ambient laboratory temperature (normally $20 \pm 5^\circ\text{C}$), and is carried out in accordance with procedures described in the BC Lab Manual (prescriptive method). The procedure involves mixing the dried (at $<60^\circ\text{C}$) and sieved (10mesh/2mm) sample with ultra pure water at a 1:2 ratio of sediment to water. The pH is then measured by a standard pH probe.
Moisture Content by Gravimetry	E144 Vancouver - Environmental	Soil/Solid	CCME PHC in Soil - Tier 1	Moisture is measured gravimetrically by drying the sample at 105°C . Moisture content is calculated as the weight loss (due to water) divided by the wet weight of the sample, expressed as a percentage.
Total Carbon by Combustion	E351 Saskatoon - Environmental	Soil/Solid	CSSS (2008) 21.2 (mod)	Total Carbon is determined by the high temperature combustion method with measurement by an infrared detector.
Total Inorganic Carbon by Acetic Acid pH Standard Curve	E354 Saskatoon - Environmental	Soil/Solid	CSSS (2008) 20.2	Total Inorganic Carbon is determined by acetic acid pH standard curve, where a known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.
Metals in Soil/Solid by CRC ICPMS	E440 Vancouver - Environmental	Soil/Solid	EPA 6020B (mod)	This method is intended to liberate metals that may be environmentally available. Samples are dried, then sieved through a 2 mm sieve, and digested with HNO_3 and HCl . Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Silicate minerals are not solubilized. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Elemental Sulfur may be poorly recovered by this method. Analysis is by Collision/Reaction Cell ICPMS.
Mercury in Soil/Solid by CVAAS	E510 Vancouver - Environmental	Soil/Solid	EPA 200.2/1631 Appendix (mod)	Samples are dried, then sieved through a 2 mm sieve, and digested with HNO_3 and HCl , followed by CVAAS analysis.
VH and F1 by Headspace GC-FID	E581.VH+F1 Vancouver - Environmental	Soil/Solid	BC MOE Lab Manual / CCME PHC in Soil - Tier 1 (mod)	Volatile Hydrocarbons (VH and F1) is analyzed by static headspace GC-FID. Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.
CCME PHC - F2-F4 by GC-FID	E601.SG Vancouver - Environmental	Soil/Solid	CCME PHC in Soil - Tier 1	Sample extracts are subjected to in-situ silica gel treatment prior to analysis by GC-FID for CCME Fractions 2-4 (F2-F4).



Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
BTEX by Headspace GC-MS	E611A Vancouver - Environmental	Soil/Solid	EPA 8260D (mod)	Volatile Organic Compounds (VOCs) are analyzed by static headspace GC-MS. Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.
PAHs by Hex:Ace GC-MS (Low Level CCME)	E641A-L Vancouver - Environmental	Soil/Solid	EPA 8270E (mod)	Polycyclic Aromatic Hydrocarbons (PAHs) are extracted with hexane/acetone and analyzed by GC-MS. If reported, IACR (index of additive cancer risk, unitless) and B(a)P toxic potency equivalent (in soil concentration units) are calculated as per CCME PAH Soil Quality Guidelines fact sheet (2010) or ABT1.
Particle Size Analysis (Pipette) - MMER Classification	EC184E Saskatoon - Environmental	Soil/Solid	Metal Mining Technical Guidance for Environmental Effects Monitoring (2012)	The particle size determination is performed by various methods to generate a Grain Size curve. The data from the curve is then used to produce particle size ranges based on the Metal Mining Effluent Regulations (MMER) classification system for Environmental Effects Monitoring.
Total Organic Carbon (Calculated) in soil	EC356 Saskatoon - Environmental	Soil/Solid	CSSS (2008) 21.2	Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon (TIC).
F1-BTEX	EC580 Vancouver - Environmental	Soil/Solid	CCME PHC in Soil - Tier 1	F1-BTEX is calculated as follows: F1-BTEX = F1 (C6-C10) minus benzene, toluene, ethylbenzene and xylenes (BTEX).

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil:Water for pH/EC	EP108 Vancouver - Environmental	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Digestion for Metals and Mercury	EP440 Vancouver - Environmental	Soil/Solid	EPA 200.2 (mod)	Samples are dried, then sieved through a 2 mm sieve, and digested with HNO ₃ and HCl. This method is intended to liberate metals that may be environmentally available.
VOCs Methanol Extraction for Headspace Analysis	EP581 Vancouver - Environmental	Soil/Solid	EPA 5035A (mod)	VOCs in samples are extracted with methanol. Extracts are then prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.
PHCs and PAHs Hexane-Acetone Tumbler Extraction	EP601 Vancouver - Environmental	Soil/Solid	CCME PHC in Soil - Tier 1 (mod)	Samples are subsampled and Petroleum Hydrocarbons (PHC) and PAHs are extracted with 1:1 hexane:acetone using a rotary extractor.
Dry and Grind	EPP442 Saskatoon - Environmental	Soil/Solid	Soil Sampling and Methods of Analysis, Carter 2008	After removal of any coarse fragments and reservation of wet subsamples a portion of homogenized sample is set in a tray and dried at less than 60°C until dry. The sample is then particle size reduced with an automated crusher or mortar and pestle, typically to <2 mm. Further size reduction may be needed for particular tests.



QUALITY CONTROL REPORT

Work Order : VA21B7543

Page : 1 of 15

Client : Golder Associates Ltd.
Contact : Elaine Irving
Address : 200-2920 Virtual Way
Vancouver BC Canada V5M 0C4
Telephone : ----
Project : 1663724-44000-03
PO : ----
C-O-C number : 20-920782
Sampler : ----
Site : ----
Quote number : Q84262
No. of samples received : 5
No. of samples analysed : 5

Laboratory : Vancouver - Environmental
Account Manager : Amber Springer
Address : 8081 Lougheed Highway
Burnaby, British Columbia Canada V5A 1W9
Telephone : +1 604 253 4188
Date Samples Received : 19-Aug-2021 08:25
Date Analysis Commenced : 21-Aug-2021
Issue Date : 27-Aug-2021 16:37

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
● Matrix Spike (MS) Report; Recovery and Acceptance Limits
● Reference Material (RM) Report; Recovery and Acceptance Limits
● Method Blank (MB) Report; Recovery and Acceptance Limits
● Laboratory Control Sample (LCS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Table with 3 columns: Signatories, Position, Laboratory Department. Rows include Caleb Deroche (Lab Analyst, Metals, Burnaby, British Columbia), Hedy Lai (Team Leader - Inorganics, Inorganics, Saskatoon, Saskatchewan), Kevin Duarte (Supervisor - Metals ICP Instrumentation, Metals, Burnaby, British Columbia), Ophelia Chiu (Department Manager - Organics, Organics, Burnaby, British Columbia), Paul Cushing (Team Leader - Organics, Organics, Burnaby, British Columbia), and Xihua Yao (Laboratory Analyst, Inorganics, Saskatoon, Saskatchewan).

Page : 2 of 15
Work Order : VA21B7543
Client : Golder Associates Ltd.
Project : 1663724-44000-03



General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.

CAS Number = Chemical Abstracts Services number is a unique identifier assigned to discrete substances.

DQO = Data Quality Objective.

LOR = Limit of Reporting (detection limit).

RPD = Relative Percentage Difference

= Indicates a QC result that did not meet the ALS DQO.



Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Physical Tests (QC Lot: 274457)											
VA21B7509-001	Anonymous	pH (1:2 soil:water)	----	E108	0.10	pH units	6.15	6.17	0.3%	5%	----
Physical Tests (QC Lot: 274458)											
VA21B5201-028	Anonymous	moisture	----	E144	0.25	%	2.47	2.61	5.38%	20%	----
Organic / Inorganic Carbon (QC Lot: 273818)											
VA21B7543-001	TR Ref1	carbon, inorganic [IC]	----	E354	0.050	%	0.524	0.529	0.885%	20%	----
Organic / Inorganic Carbon (QC Lot: 274583)											
YL2101055-011	Anonymous	carbon, total [TC]	----	E351	0.050	%	7.81	7.81	0.0376%	20%	----
Metals (QC Lot: 274451)											
VA21B5201-024	Anonymous	aluminum	7429-90-5	E440	50	mg/kg	25500	23200	9.10%	40%	----
		antimony	7440-36-0	E440	0.10	mg/kg	0.85	0.66	26.1%	30%	----
		arsenic	7440-38-2	E440	0.10	mg/kg	6.48	7.00	7.64%	30%	----
		barium	7440-39-3	E440	0.50	mg/kg	85.9	76.2	12.0%	40%	----
		beryllium	7440-41-7	E440	0.10	mg/kg	0.41	0.40	0.01	Diff <2x LOR	----
		bismuth	7440-69-9	E440	0.20	mg/kg	<0.20	<0.20	0	Diff <2x LOR	----
		boron	7440-42-8	E440	5.0	mg/kg	<5.0	<5.0	0	Diff <2x LOR	----
		cadmium	7440-43-9	E440	0.020	mg/kg	0.295	0.266	10.2%	30%	----
		calcium	7440-70-2	E440	50	mg/kg	8540	7900	7.77%	30%	----
		chromium	7440-47-3	E440	0.50	mg/kg	30.6	25.1	19.9%	30%	----
		cobalt	7440-48-4	E440	0.10	mg/kg	11.8	13.1	10.4%	30%	----
		copper	7440-50-8	E440	0.50	mg/kg	32.3	29.7	8.29%	30%	----
		iron	7439-89-6	E440	50	mg/kg	33300	30800	7.90%	30%	----
		lead	7439-92-1	E440	0.50	mg/kg	9.08	5.95	41.6%	40%	DUP-H
		lithium	7439-93-2	E440	2.0	mg/kg	26.0	25.0	3.60%	30%	----
		magnesium	7439-95-4	E440	20	mg/kg	10000	9460	6.10%	30%	----
		manganese	7439-96-5	E440	1.0	mg/kg	588	553	6.14%	30%	----
		molybdenum	7439-98-7	E440	0.10	mg/kg	0.73	0.52	33.2%	40%	----
		nickel	7440-02-0	E440	0.50	mg/kg	21.7	19.3	11.3%	30%	----
		phosphorus	7723-14-0	E440	50	mg/kg	530	562	5.93%	30%	----
		potassium	7440-09-7	E440	100	mg/kg	1050	860	20.6%	40%	----
		selenium	7782-49-2	E440	0.20	mg/kg	0.27	<0.20	0.07	Diff <2x LOR	----
		silver	7440-22-4	E440	0.10	mg/kg	0.11	0.12	0.006	Diff <2x LOR	----



Sub-Matrix: Soil/Solid

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Metals (QC Lot: 274451) - continued											
VA21B5201-024	Anonymous	sodium	7440-23-5	E440	50	mg/kg	229	207	22	Diff <2x LOR	----
		strontium	7440-24-6	E440	0.50	mg/kg	61.5	52.5	15.6%	40%	----
		sulfur	7704-34-9	E440	1000	mg/kg	<1000	<1000	0	Diff <2x LOR	----
		thallium	7440-28-0	E440	0.050	mg/kg	0.078	0.077	0.0005	Diff <2x LOR	----
		tin	7440-31-5	E440	2.0	mg/kg	<2.0	<2.0	0	Diff <2x LOR	----
		titanium	7440-32-6	E440	1.0	mg/kg	1440	1340	7.00%	40%	----
		tungsten	7440-33-7	E440	0.50	mg/kg	<0.50	<0.50	0	Diff <2x LOR	----
		uranium	7440-61-1	E440	0.050	mg/kg	0.477	0.463	2.88%	30%	----
		vanadium	7440-62-2	E440	0.20	mg/kg	85.4	81.2	5.07%	30%	----
		zinc	7440-66-6	E440	2.0	mg/kg	85.9	81.7	5.03%	30%	----
		zirconium	7440-67-7	E440	1.0	mg/kg	6.7	7.2	7.91%	30%	----
Metals (QC Lot: 274452)											
VA21B7509-001	Anonymous	mercury	7439-97-6	E510	0.0500	mg/kg	0.0540	0.0556	0.0016	Diff <2x LOR	----
Volatile Organic Compounds (QC Lot: 275058)											
VA21B7543-001	TR Ref1	benzene	71-43-2	E611A	0.0050	mg/kg	<0.0050	<0.0050	0	Diff <2x LOR	----
		ethylbenzene	100-41-4	E611A	0.015	mg/kg	<0.015	<0.015	0	Diff <2x LOR	----
		toluene	108-88-3	E611A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		xylene, m+p-	179601-23-1	E611A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		xylene, o-	95-47-6	E611A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
Hydrocarbons (QC Lot: 274450)											
VA21B7543-001	TR Ref1	F2 (C10-C16)	----	E601.SG	30	mg/kg	<30	<30	0	Diff <2x LOR	----
		F3 (C16-C34)	----	E601.SG	50	mg/kg	<50	<50	0	Diff <2x LOR	----
		F4 (C34-C50)	----	E601.SG	50	mg/kg	<50	<50	0	Diff <2x LOR	----
Hydrocarbons (QC Lot: 275057)											
VA21B7543-001	TR Ref1	F1 (C6-C10)	----	E581.VH+F1	5.0	mg/kg	<5.0	<5.0	0	Diff <2x LOR	----
Polycyclic Aromatic Hydrocarbons (QC Lot: 274448)											
VA21B5201-028	Anonymous	acenaphthene	83-32-9	E641A-L	0.0050	mg/kg	<0.0050	<0.0050	0	Diff <2x LOR	----
		acenaphthylene	208-96-8	E641A-L	0.0050	mg/kg	<0.0050	<0.0050	0	Diff <2x LOR	----
		acridine	260-94-6	E641A-L	0.025	mg/kg	<0.025	<0.025	0	Diff <2x LOR	----
		anthracene	120-12-7	E641A-L	0.0040	mg/kg	<0.0040	<0.0040	0	Diff <2x LOR	----
		benz(a)anthracene	56-55-3	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		benzo(a)pyrene	50-32-8	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		benzo(b+j)fluoranthene	----	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		benzo(g,h,i)perylene	191-24-2	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		benzo(k)fluoranthene	207-08-9	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----



Sub-Matrix: **Soil/Solid**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Polycyclic Aromatic Hydrocarbons (QC Lot: 274448) - continued											
VA21B5201-028	Anonymous	chrysene	218-01-9	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		dibenz(a,h)anthracene	53-70-3	E641A-L	0.0050	mg/kg	<0.0050	<0.0050	0	Diff <2x LOR	----
		fluoranthene	206-44-0	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		fluorene	86-73-7	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		indeno(1,2,3-c,d)pyrene	193-39-5	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		methylnaphthalene, 1-	90-12-0	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		methylnaphthalene, 2-	91-57-6	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		naphthalene	91-20-3	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		phenanthrene	85-01-8	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		pyrene	129-00-0	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
		quinoline	6027-02-7	E641A-L	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----

Qualifiers

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.



Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: Soil/Solid

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 274458)						
moisture	----	E144	0.25	%	<0.25	----
Organic / Inorganic Carbon (QCLot: 273818)						
carbon, inorganic [IC]	----	E354	0.05	%	<0.050	----
Organic / Inorganic Carbon (QCLot: 274583)						
carbon, total [TC]	----	E351	0.05	%	<0.050	----
Metals (QCLot: 274451)						
aluminum	7429-90-5	E440	50	mg/kg	<50	----
antimony	7440-36-0	E440	0.1	mg/kg	<0.10	----
arsenic	7440-38-2	E440	0.1	mg/kg	<0.10	----
barium	7440-39-3	E440	0.5	mg/kg	<0.50	----
beryllium	7440-41-7	E440	0.1	mg/kg	<0.10	----
bismuth	7440-69-9	E440	0.2	mg/kg	<0.20	----
boron	7440-42-8	E440	5	mg/kg	<5.0	----
cadmium	7440-43-9	E440	0.02	mg/kg	<0.020	----
calcium	7440-70-2	E440	50	mg/kg	<50	----
chromium	7440-47-3	E440	0.5	mg/kg	<0.50	----
cobalt	7440-48-4	E440	0.1	mg/kg	<0.10	----
copper	7440-50-8	E440	0.5	mg/kg	<0.50	----
iron	7439-89-6	E440	50	mg/kg	<50	----
lead	7439-92-1	E440	0.5	mg/kg	<0.50	----
lithium	7439-93-2	E440	2	mg/kg	<2.0	----
magnesium	7439-95-4	E440	20	mg/kg	<20	----
manganese	7439-96-5	E440	1	mg/kg	<1.0	----
molybdenum	7439-98-7	E440	0.1	mg/kg	<0.10	----
nickel	7440-02-0	E440	0.5	mg/kg	<0.50	----
phosphorus	7723-14-0	E440	50	mg/kg	<50	----
potassium	7440-09-7	E440	100	mg/kg	<100	----
selenium	7782-49-2	E440	0.2	mg/kg	<0.20	----
silver	7440-22-4	E440	0.1	mg/kg	<0.10	----
sodium	7440-23-5	E440	50	mg/kg	<50	----
strontium	7440-24-6	E440	0.5	mg/kg	<0.50	----
sulfur	7704-34-9	E440	1000	mg/kg	<1000	----
thallium	7440-28-0	E440	0.05	mg/kg	<0.050	----



Sub-Matrix: Soil/Solid

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Metals (QCLot: 274451) - continued						
tin	7440-31-5	E440	2	mg/kg	<2.0	----
titanium	7440-32-6	E440	1	mg/kg	<1.0	----
tungsten	7440-33-7	E440	0.5	mg/kg	<0.50	----
uranium	7440-61-1	E440	0.05	mg/kg	<0.050	----
vanadium	7440-62-2	E440	0.2	mg/kg	<0.20	----
zinc	7440-66-6	E440	2	mg/kg	<2.0	----
zirconium	7440-67-7	E440	1	mg/kg	<1.0	----
Metals (QCLot: 274452)						
mercury	7439-97-6	E510	0.005	mg/kg	<0.0050	----
Volatile Organic Compounds (QCLot: 275058)						
benzene	71-43-2	E611A	0.005	mg/kg	<0.0050	----
ethylbenzene	100-41-4	E611A	0.015	mg/kg	<0.015	----
toluene	108-88-3	E611A	0.05	mg/kg	<0.050	----
xylene, m+p-	179601-23-1	E611A	0.05	mg/kg	<0.050	----
xylene, o-	95-47-6	E611A	0.05	mg/kg	<0.050	----
Hydrocarbons (QCLot: 274450)						
F2 (C10-C16)	----	E601.SG	25	mg/kg	<25	----
F3 (C16-C34)	----	E601.SG	50	mg/kg	<50	----
F4 (C34-C50)	----	E601.SG	50	mg/kg	<50	----
Hydrocarbons (QCLot: 275057)						
F1 (C6-C10)	----	E581.VH+F1	5	mg/kg	<5.0	----
Polycyclic Aromatic Hydrocarbons (QCLot: 274448)						
acenaphthene	83-32-9	E641A-L	0.005	mg/kg	<0.0050	----
acenaphthylene	208-96-8	E641A-L	0.005	mg/kg	<0.0050	----
acridine	260-94-6	E641A-L	0.01	mg/kg	<0.010	----
anthracene	120-12-7	E641A-L	0.004	mg/kg	<0.0040	----
benz(a)anthracene	56-55-3	E641A-L	0.01	mg/kg	<0.010	----
benzo(a)pyrene	50-32-8	E641A-L	0.01	mg/kg	<0.010	----
benzo(b+j)fluoranthene	----	E641A-L	0.01	mg/kg	<0.010	----
benzo(g,h,i)perylene	191-24-2	E641A-L	0.01	mg/kg	<0.010	----
benzo(k)fluoranthene	207-08-9	E641A-L	0.01	mg/kg	<0.010	----
chrysene	218-01-9	E641A-L	0.01	mg/kg	<0.010	----
dibenz(a,h)anthracene	53-70-3	E641A-L	0.005	mg/kg	<0.0050	----
fluoranthene	206-44-0	E641A-L	0.01	mg/kg	<0.010	----
fluorene	86-73-7	E641A-L	0.01	mg/kg	<0.010	----
indeno(1,2,3-c,d)pyrene	193-39-5	E641A-L	0.01	mg/kg	<0.010	----

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Client : Golder Associates Ltd.
Project : 1663724-44000-03



Sub-Matrix: **Soil/Solid**

<i>Analyte</i>	<i>CAS Number</i>	<i>Method</i>	<i>LOR</i>	<i>Unit</i>	<i>Result</i>	<i>Qualifier</i>
Polycyclic Aromatic Hydrocarbons (QCLot: 274448) - continued						
methylnaphthalene, 1-	90-12-0	E641A-L	0.01	mg/kg	<0.010	----
methylnaphthalene, 2-	91-57-6	E641A-L	0.01	mg/kg	<0.010	----
naphthalene	91-20-3	E641A-L	0.01	mg/kg	<0.010	----
phenanthrene	85-01-8	E641A-L	0.01	mg/kg	<0.010	----
pyrene	129-00-0	E641A-L	0.01	mg/kg	<0.010	----
quinoline	6027-02-7	E641A-L	0.01	mg/kg	<0.010	----



Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 274457)									
pH (1:2 soil:water)	---	E108	---	pH units	6 pH units	99.8	95.0	105	---
Physical Tests (QCLot: 274458)									
moisture	---	E144	0.25	%	50 %	98.9	90.0	110	---
Organic / Inorganic Carbon (QCLot: 273818)									
carbon, inorganic [IC]	---	E354	0.05	%	0.5 %	94.2	90.0	110	---
Organic / Inorganic Carbon (QCLot: 274583)									
carbon, total [TC]	---	E351	0.05	%	48 %	102	90.0	110	---
Metals (QCLot: 274451)									
aluminum	7429-90-5	E440	50	mg/kg	200 mg/kg	100	80.0	120	---
antimony	7440-36-0	E440	0.1	mg/kg	100 mg/kg	99.6	80.0	120	---
arsenic	7440-38-2	E440	0.1	mg/kg	100 mg/kg	95.9	80.0	120	---
barium	7440-39-3	E440	0.5	mg/kg	25 mg/kg	105	80.0	120	---
beryllium	7440-41-7	E440	0.1	mg/kg	10 mg/kg	104	80.0	120	---
bismuth	7440-69-9	E440	0.2	mg/kg	100 mg/kg	97.9	80.0	120	---
boron	7440-42-8	E440	5	mg/kg	100 mg/kg	100	80.0	120	---
cadmium	7440-43-9	E440	0.02	mg/kg	10 mg/kg	95.8	80.0	120	---
calcium	7440-70-2	E440	50	mg/kg	5000 mg/kg	104	80.0	120	---
chromium	7440-47-3	E440	0.5	mg/kg	25 mg/kg	97.8	80.0	120	---
cobalt	7440-48-4	E440	0.1	mg/kg	25 mg/kg	96.6	80.0	120	---
copper	7440-50-8	E440	0.5	mg/kg	25 mg/kg	96.2	80.0	120	---
iron	7439-89-6	E440	50	mg/kg	100 mg/kg	96.8	80.0	120	---
lead	7439-92-1	E440	0.5	mg/kg	50 mg/kg	100	80.0	120	---
lithium	7439-93-2	E440	2	mg/kg	25 mg/kg	107	80.0	120	---
magnesium	7439-95-4	E440	20	mg/kg	5000 mg/kg	102	80.0	120	---
manganese	7439-96-5	E440	1	mg/kg	25 mg/kg	100	80.0	120	---
molybdenum	7439-98-7	E440	0.1	mg/kg	25 mg/kg	104	80.0	120	---
nickel	7440-02-0	E440	0.5	mg/kg	50 mg/kg	98.1	80.0	120	---
phosphorus	7723-14-0	E440	50	mg/kg	1000 mg/kg	88.0	80.0	120	---
potassium	7440-09-7	E440	100	mg/kg	5000 mg/kg	101	80.0	120	---
selenium	7782-49-2	E440	0.2	mg/kg	100 mg/kg	98.0	80.0	120	---
silver	7440-22-4	E440	0.1	mg/kg	10 mg/kg	101	80.0	120	---
sodium	7440-23-5	E440	50	mg/kg	5000 mg/kg	95.8	80.0	120	---



Sub-Matrix: Soil/Solid

Analyte	CAS Number	Method	LOR	Unit	Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		Qualifier
					Concentration	LCS	Low	High	
Metals (QCLot: 274451) - continued									
strontium	7440-24-6	E440	0.5	mg/kg	25 mg/kg	103	80.0	120	----
sulfur	7704-34-9	E440	1000	mg/kg	5000 mg/kg	91.5	80.0	120	----
thallium	7440-28-0	E440	0.05	mg/kg	100 mg/kg	98.4	80.0	120	----
tin	7440-31-5	E440	2	mg/kg	50 mg/kg	95.8	80.0	120	----
titanium	7440-32-6	E440	1	mg/kg	25 mg/kg	93.7	80.0	120	----
tungsten	7440-33-7	E440	0.5	mg/kg	10 mg/kg	98.3	80.0	120	----
uranium	7440-61-1	E440	0.05	mg/kg	0.5 mg/kg	100	80.0	120	----
vanadium	7440-62-2	E440	0.2	mg/kg	50 mg/kg	98.9	80.0	120	----
zinc	7440-66-6	E440	2	mg/kg	50 mg/kg	93.9	80.0	120	----
zirconium	7440-67-7	E440	1	mg/kg	10 mg/kg	96.6	80.0	120	----
Metals (QCLot: 274452)									
mercury	7439-97-6	E510	0.005	mg/kg	0.1 mg/kg	108	80.0	120	----
Volatile Organic Compounds (QCLot: 275058)									
benzene	71-43-2	E611A	0.005	mg/kg	2.5 mg/kg	103	70.0	130	----
ethylbenzene	100-41-4	E611A	0.015	mg/kg	2.5 mg/kg	93.6	70.0	130	----
toluene	108-88-3	E611A	0.05	mg/kg	2.5 mg/kg	98.1	70.0	130	----
xylene, m+p-	179601-23-1	E611A	0.05	mg/kg	5 mg/kg	99.1	70.0	130	----
xylene, o-	95-47-6	E611A	0.05	mg/kg	2.5 mg/kg	100	70.0	130	----
Hydrocarbons (QCLot: 274450)									
F2 (C10-C16)	----	E601.SG	25	mg/kg	618.75 mg/kg	108	70.0	130	----
F3 (C16-C34)	----	E601.SG	50	mg/kg	1242.49 mg/kg	100	70.0	130	----
F4 (C34-C50)	----	E601.SG	50	mg/kg	993.9 mg/kg	93.4	70.0	130	----
Hydrocarbons (QCLot: 275057)									
F1 (C6-C10)	----	E581.VH+F1	5	mg/kg	93.6 mg/kg	123	70.0	130	----
Polycyclic Aromatic Hydrocarbons (QCLot: 274448)									
acenaphthene	83-32-9	E641A-L	0.005	mg/kg	0.5 mg/kg	113	60.0	130	----
acenaphthylene	208-96-8	E641A-L	0.005	mg/kg	0.5 mg/kg	109	60.0	130	----
acridine	260-94-6	E641A-L	0.01	mg/kg	0.5 mg/kg	104	60.0	130	----
anthracene	120-12-7	E641A-L	0.004	mg/kg	0.5 mg/kg	112	60.0	130	----
benz(a)anthracene	56-55-3	E641A-L	0.01	mg/kg	0.5 mg/kg	107	60.0	130	----
benzo(a)pyrene	50-32-8	E641A-L	0.01	mg/kg	0.5 mg/kg	112	60.0	130	----
benzo(b+j)fluoranthene	----	E641A-L	0.01	mg/kg	0.5 mg/kg	108	60.0	130	----
benzo(g,h,i)perylene	191-24-2	E641A-L	0.01	mg/kg	0.5 mg/kg	108	60.0	130	----
benzo(k)fluoranthene	207-08-9	E641A-L	0.01	mg/kg	0.5 mg/kg	115	60.0	130	----



Sub-Matrix: Soil/Solid

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Polycyclic Aromatic Hydrocarbons (QCLot: 274448) - continued									
chrysene	218-01-9	E641A-L	0.01	mg/kg	0.5 mg/kg	114	60.0	130	----
dibenz(a,h)anthracene	53-70-3	E641A-L	0.005	mg/kg	0.5 mg/kg	109	60.0	130	----
fluoranthene	206-44-0	E641A-L	0.01	mg/kg	0.5 mg/kg	114	60.0	130	----
fluorene	86-73-7	E641A-L	0.01	mg/kg	0.5 mg/kg	112	60.0	130	----
indeno(1,2,3-c,d)pyrene	193-39-5	E641A-L	0.01	mg/kg	0.5 mg/kg	107	60.0	130	----
methylnaphthalene, 1-	90-12-0	E641A-L	0.01	mg/kg	0.5 mg/kg	101	60.0	130	----
methylnaphthalene, 2-	91-57-6	E641A-L	0.01	mg/kg	0.5 mg/kg	94.6	60.0	130	----
naphthalene	91-20-3	E641A-L	0.01	mg/kg	0.5 mg/kg	88.2	50.0	130	----
phenanthrene	85-01-8	E641A-L	0.01	mg/kg	0.5 mg/kg	112	60.0	130	----
pyrene	129-00-0	E641A-L	0.01	mg/kg	0.5 mg/kg	118	60.0	130	----
quinoline	6027-02-7	E641A-L	0.01	mg/kg	0.5 mg/kg	95.8	60.0	130	----



Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level $\geq 1 \times$ spike level.

Sub-Matrix: **Soil/Solid**

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 275058)										
VA21B7543-001	TR Ref1	benzene	71-43-2	E611A	3.27 mg/kg	4.6875 mg/kg	125	60.0	140	----
		ethylbenzene	100-41-4	E611A	2.96 mg/kg	4.6875 mg/kg	113	60.0	140	----
		toluene	108-88-3	E611A	3.09 mg/kg	4.6875 mg/kg	118	60.0	140	----
		xylene, m+p-	179601-23-1	E611A	6.20 mg/kg	9.375 mg/kg	119	60.0	140	----
		xylene, o-	95-47-6	E611A	3.16 mg/kg	4.6875 mg/kg	121	60.0	140	----
Hydrocarbons (QCLot: 274450)										
VA21B7543-002	TR Ref2	F2 (C10-C16)	----	E601.SG	450 mg/kg	618.75 mg/kg	95.9	60.0	140	----
		F3 (C16-C34)	----	E601.SG	842 mg/kg	1242.49 mg/kg	89.3	60.0	140	----
		F4 (C34-C50)	----	E601.SG	606 mg/kg	993.9 mg/kg	80.4	60.0	140	----
Hydrocarbons (QCLot: 275057)										
VA21B7543-002	TR Ref2	F1 (C6-C10)	----	E581.VH+F1	147 mg/kg	187.5 mg/kg	105	60.0	140	----
Polycyclic Aromatic Hydrocarbons (QCLot: 274448)										
VA21B7509-001	Anonymous	acenaphthene	83-32-9	E641A-L	0.389 mg/kg	0.5 mg/kg	98.6	50.0	140	----
		acenaphthylene	208-96-8	E641A-L	0.376 mg/kg	0.5 mg/kg	95.4	50.0	140	----
		acridine	260-94-6	E641A-L	0.321 mg/kg	0.5 mg/kg	81.4	50.0	140	----
		anthracene	120-12-7	E641A-L	0.391 mg/kg	0.5 mg/kg	99.2	50.0	140	----
		benz(a)anthracene	56-55-3	E641A-L	0.375 mg/kg	0.5 mg/kg	95.0	50.0	140	----
		benzo(a)pyrene	50-32-8	E641A-L	0.385 mg/kg	0.5 mg/kg	97.6	50.0	140	----
		benzo(b+j)fluoranthene	----	E641A-L	0.366 mg/kg	0.5 mg/kg	92.9	50.0	140	----
		benzo(g,h,i)perylene	191-24-2	E641A-L	0.369 mg/kg	0.5 mg/kg	93.7	50.0	140	----
		benzo(k)fluoranthene	207-08-9	E641A-L	0.381 mg/kg	0.5 mg/kg	96.6	50.0	140	----
		chrysene	218-01-9	E641A-L	0.382 mg/kg	0.5 mg/kg	96.8	50.0	140	----
		dibenz(a,h)anthracene	53-70-3	E641A-L	0.374 mg/kg	0.5 mg/kg	94.8	50.0	140	----
		fluoranthene	206-44-0	E641A-L	0.382 mg/kg	0.5 mg/kg	96.9	50.0	140	----
		fluorene	86-73-7	E641A-L	0.388 mg/kg	0.5 mg/kg	98.4	50.0	140	----
		indeno(1,2,3-c,d)pyrene	193-39-5	E641A-L	0.366 mg/kg	0.5 mg/kg	92.8	50.0	140	----
		methylnaphthalene, 1-	90-12-0	E641A-L	0.370 mg/kg	0.5 mg/kg	93.8	50.0	140	----
		methylnaphthalene, 2-	91-57-6	E641A-L	0.349 mg/kg	0.5 mg/kg	88.5	50.0	140	----
		naphthalene	91-20-3	E641A-L	0.348 mg/kg	0.5 mg/kg	88.3	50.0	140	----
		phenanthrene	85-01-8	E641A-L	0.382 mg/kg	0.5 mg/kg	97.0	50.0	140	----
		pyrene	129-00-0	E641A-L	0.405 mg/kg	0.5 mg/kg	103	50.0	140	----

Page : 13 of 15
 Work Order : VA21B7543
 Client : Golder Associates Ltd.
 Project : 1663724-44000-03



Sub-Matrix: **Soil/Solid**

					<i>Matrix Spike (MS) Report</i>					
					<i>Spike</i>		<i>Recovery (%)</i>	<i>Recovery Limits (%)</i>		
<i>Laboratory sample ID</i>	<i>Client sample ID</i>	<i>Analyte</i>	<i>CAS Number</i>	<i>Method</i>	<i>Concentration</i>	<i>Target</i>	<i>MS</i>	<i>Low</i>	<i>High</i>	<i>Qualifier</i>
Polycyclic Aromatic Hydrocarbons (QCLot: 274448) - continued										
VA21B7509-001	Anonymous	quinoline	6027-02-7	E641A-L	0.326 mg/kg	0.5 mg/kg	82.7	50.0	140	----



Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix: **Soil/Solid**

Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Reference Material (RM) Report				
					RM Target Concentration	Recovery (%) RM	Recovery Limits (%)		Qualifier
							Low	High	
Organic / Inorganic Carbon (QCLot: 273818)									
QC-273818-003	RM	carbon, inorganic [IC]	----	E354	0.383 %	93.7	80.0	120	----
Organic / Inorganic Carbon (QCLot: 274583)									
QC-274583-003	RM	carbon, total [TC]	----	E351	1.4 %	104	80.0	120	----
Metals (QCLot: 274451)									
QC-274451-003	SCP SS-2	aluminum	7429-90-5	E440	9817 mg/kg	110	70.0	130	----
QC-274451-003	SCP SS-2	antimony	7440-36-0	E440	3.99 mg/kg	102	70.0	130	----
QC-274451-003	SCP SS-2	arsenic	7440-38-2	E440	3.73 mg/kg	109	70.0	130	----
QC-274451-003	SCP SS-2	barium	7440-39-3	E440	105 mg/kg	109	70.0	130	----
QC-274451-003	SCP SS-2	beryllium	7440-41-7	E440	0.349 mg/kg	111	70.0	130	----
QC-274451-003	SCP SS-2	boron	7440-42-8	E440	8.5 mg/kg	128	40.0	160	----
QC-274451-003	SCP SS-2	cadmium	7440-43-9	E440	0.91 mg/kg	99.7	70.0	130	----
QC-274451-003	SCP SS-2	calcium	7440-70-2	E440	31082 mg/kg	104	70.0	130	----
QC-274451-003	SCP SS-2	chromium	7440-47-3	E440	101 mg/kg	110	70.0	130	----
QC-274451-003	SCP SS-2	cobalt	7440-48-4	E440	6.9 mg/kg	103	70.0	130	----
QC-274451-003	SCP SS-2	copper	7440-50-8	E440	123 mg/kg	102	70.0	130	----
QC-274451-003	SCP SS-2	iron	7439-89-6	E440	23558 mg/kg	103	70.0	130	----
QC-274451-003	SCP SS-2	lead	7439-92-1	E440	267 mg/kg	107	70.0	130	----
QC-274451-003	SCP SS-2	lithium	7439-93-2	E440	9.5 mg/kg	110	70.0	130	----
QC-274451-003	SCP SS-2	magnesium	7439-95-4	E440	5509 mg/kg	104	70.0	130	----
QC-274451-003	SCP SS-2	manganese	7439-96-5	E440	269 mg/kg	110	70.0	130	----
QC-274451-003	SCP SS-2	molybdenum	7439-98-7	E440	1.03 mg/kg	113	70.0	130	----
QC-274451-003	SCP SS-2	nickel	7440-02-0	E440	26.7 mg/kg	105	70.0	130	----
QC-274451-003	SCP SS-2	phosphorus	7723-14-0	E440	752 mg/kg	102	70.0	130	----
QC-274451-003	SCP SS-2	potassium	7440-09-7	E440	1587 mg/kg	116	70.0	130	----
QC-274451-003	SCP SS-2	sodium	7440-23-5	E440	797 mg/kg	105	70.0	130	----
QC-274451-003	SCP SS-2	strontium	7440-24-6	E440	86.1 mg/kg	106	70.0	130	----
QC-274451-003	SCP SS-2	thallium	7440-28-0	E440	0.0786 mg/kg	105	40.0	160	----
QC-274451-003	SCP SS-2	tin	7440-31-5	E440	10.6 mg/kg	102	70.0	130	----
QC-274451-003	SCP SS-2	titanium	7440-32-6	E440	839 mg/kg	118	70.0	130	----



Sub-Matrix: **Soil/Solid**

Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Reference Material (RM) Report				
					RM Target Concentration	Recovery (%) RM	Recovery Limits (%)		Qualifier
							Low	High	
Metals (QCLot: 274451) - continued									
QC-274451-003	SCP SS-2	uranium	7440-61-1	E440	0.52 mg/kg	114	70.0	130	----
QC-274451-003	SCP SS-2	vanadium	7440-62-2	E440	32.7 mg/kg	109	70.0	130	----
QC-274451-003	SCP SS-2	zinc	7440-66-6	E440	297 mg/kg	100	70.0	130	----
QC-274451-003	SCP SS-2	zirconium	7440-67-7	E440	5.73 mg/kg	96.3	70.0	130	----
Metals (QCLot: 274452)									
QC-274452-003	SCP SS-2	mercury	7439-97-6	E510	0.059 mg/kg	101	70.0	130	----



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Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

COC Number: 20 - 920782

Page 1 of 1

Report To Contact and company name below will appear on the final report		Reports / Recipients			Turnaround Time (TAT) Requested				AFFIX ALS BARCODE LABEL HERE (ALS use only)																	
Company: <u>Golden Associated</u>		Select Report Format: <input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL)			<input checked="" type="checkbox"/> Routine [R] if received by 3pm M-F - no surcharges apply																					
Contact: <u>Trish Tomliens/Elaine Irving</u>		Merge QC/QCI Reports with COA <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> N/A			<input type="checkbox"/> 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum																					
Phone: <u>250-881-7372</u>		<input type="checkbox"/> "Compare Results to Criteria on Report" - provide details below if box checked			<input type="checkbox"/> 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum																					
Company address below will appear on the final report		Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX			<input type="checkbox"/> 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum																					
Street: <u>200-2920 Virtual Way</u>		Email 1 or Fax: <u>ptomliens@golden.com</u>			<input type="checkbox"/> 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum																					
City/Province: <u>Vancouver BC</u>		Email 2: <u>Elaine-Irving@golden.com</u>			<input type="checkbox"/> Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests																					
Postal Code: <u>V5M 0C4</u>		Email 3:			Date and Time Required for all E&P TATs: dd-mm-yy hh:mm am/pm																					
Invoice To		Invoice Recipients			Analysis Request																					
Same as Report To <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX			For all tests with rush TATs requested, please contact your AM to confirm availability.																					
Copy of Invoice with Report <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO		Email 1 or Fax:			Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below																					
Company:		Email 2:			NUMBER OF CONTAINERS	Particle Size	Moisture	PAH	TOC, TIC	Metals	BTEX/FI	F2-F4	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)											
Contact:		Email 3:																								
Project Information		Oil and Gas Required Fields (client use)																								
ALS Account # / Quote #: <u>084262</u>		AFE/Cost Center: PO#																								
Job #: <u>1663724-44000-03</u>		Major/Minor Code: Routing Code:																								
PO / AFE:		Requisitioner:																								
LSD:		Location:																								
ALS Lab Work Order # (ALS use only): <u>75243</u>		ALS Contact:																								
Sampler:																										
ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mm-yy)	Time (hh:mm)	Sample Type																						
1	TR Ref 1	15-Aug-21	15:45	sediment	6	X	X	X	X	X	X	X														
2	TR Ref 2	15-Aug-21	16:30	sediment	6	X	X	X	X	X	X	X														
3	DUP-B	15-Aug-21		sediment	5	X	X	X	X	X	X	X														
4	SW-2	14-Aug-21	13:15	sediment	6	X	X	X	X	X	X	X														
5	DUP A	14-Aug-21		sediment	6	X	X	X	X	X	X	X														

Environmental Division
Vancouver
Work Order Reference
VA21B7543

Telephone: +1 804 253 4188

Drinking Water (DW) Samples (client use)		Evaluation by selecting from drop-down below (Excel COC only)		SAMPLE RECEIPT DETAILS (ALS use only)				
Are samples taken from a Regulated DW System? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO				Cooling Method: <input type="checkbox"/> NONE <input type="checkbox"/> ICE <input checked="" type="checkbox"/> ICE PACKS <input type="checkbox"/> FROZEN <input type="checkbox"/> COOLING INITIATED				
Are samples for human consumption/ use? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO				Submission Comments identified on Sample Receipt Notification: <input type="checkbox"/> YES <input type="checkbox"/> NO				
				Cooler Custody Seals Intact: <input type="checkbox"/> YES <input type="checkbox"/> N/A Sample Custody Seals Intact: <input type="checkbox"/> YES <input type="checkbox"/> N/A				
				INITIAL COOLER TEMPERATURES °C		FINAL COOLER TEMPERATURES °C		
				9		3.8		
SHIPMENT RELEASE (client use)		INITIAL SHIPMENT RECEPTION (ALS use only)		FINAL SHIPMENT RECEPTION (ALS use only)				
Released by: <u>Westman</u>	Date: <u>17-AUG 2021</u>	Time: <u>17:15</u>	Received by:	Date:	Time:	Received by: <u>JC</u>	Date: <u>19 Aug 2021</u>	Time: <u>8:25 AM</u>

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION
WHITE - LABORATORY COPY YELLOW - CLIENT COPY
Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.
1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

APPENDIX D

**Marine Sediment - Screening Table
and QA/QC Results**

Table D.1 - Sediment Analytical Results for Milne Port Sampling Station SW-2
Baffinland 2018-2021

Sample ID Date Sampled Time Sampled Laboratory Sample ID QA/QC Parent Sample ID	Lowest Detection Limits	Units	CCME ¹		NOAA Sediment Benchmarks							Eco Tox EqP(@1% TOC)	SW-2-1	SW-2-2	SW-2-3	SW-2	SW-2	SW-2	
			ISQG	PEL	T ₂₀	TEL	ERL	T ₅₀	PEL	ERM	AET		11-Aug-2018 12:55 L2148903-4	11-Aug-2018 13:00 L2148903-5	11-Aug-2018 13:05 L2148903-6	27-Sep-2019 10:25 L2359868-3	5-Aug-2020 L2487428-2	14-Aug-2021 13:15 VA21B7543-004 FDA	
Physical Parameters																			
Moisture	0.25	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (1:2 soil:water)	0.1	pH units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Particle Size																			
clay (<0.004mm)	1	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
silt (0.063mm - 0.004mm)	1	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sand (2.0mm - 0.063mm)	1	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
gravel (>2mm)	1	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Organic / Inorganic Carbon																			
carbon, inorganic	0.05	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
carbon, total	0.05	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
carbon, total organic	0.05	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
carbon, inorganic (as CaCO3 equivalent)	0.4	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
organic matter	0.1	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals																			
Aluminum	50	mg/kg	-	-	-	-	-	-	-	-	-	18000	-	-	-	-	-	-	-
Antimony	0.1	mg/kg	-	-	0.63	-	-	-	2.4	-	-	-	9.3	-	-	-	-	-	-
Arsenic	0.1	mg/kg	7.24	41.6	7.4	7.24	8.2	20	41.6	70	35	-	-	-	-	-	-	-	-
Barium	0.5	mg/kg	-	-	-	130.1	-	-	-	-	48	-	-	-	-	-	-	-	-
Beryllium	0.1	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth	0.2	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	5	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	0.02	mg/kg	0.7	4.2	0.38	0.68	1.2	1.4	4.21	9.6	3	-	-	-	-	-	-	-	-
Calcium	50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	0.5	mg/kg	52.3	160	49	52.3	81	141	160	370	62	-	-	-	-	-	-	-	-
Cobalt	0.1	mg/kg	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-
Copper	0.5	mg/kg	18.7	108	32	18.7	34	94	108	270	390	-	-	-	-	-	-	-	-
Iron	50	mg/kg	-	-	-	-	-	-	-	-	220000	-	-	-	-	-	-	-	-
Lead	0.5	mg/kg	30.2	112	30	30.24	46.7	94	112	218	400	-	-	-	-	-	-	-	-
Lithium	2	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	20	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	1	mg/kg	-	-	-	-	-	-	-	-	260	-	-	-	-	-	-	-	-
Mercury	0.005	mg/kg	0.13	0.7	0.14	0.13	0.15	0.48	0.7	0.71	0.41	-	-	-	-	-	-	-	-
Molybdenum	0.1	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	0.5	mg/kg	30 ^(a)	50 ^(a)	15	15.9	20.9	47	42.8	51.6	110	-	-	-	-	-	-	-	-
Phosphorus	50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	100	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	0.2	mg/kg	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Silver	0.1	mg/kg	1 ^(a)	2.2 ^(a)	0.23	0.73	1	1.1	1.77	3.7	3.1	-	-	-	-	-	-	-	-
Sodium	50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	0.5	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur	1000	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	0.05	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	2	mg/kg	-	-	-	0.048	-	-	-	-	3.4	-	-	-	-	-	-	-	-
Titanium	1	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tungsten	0.5	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.05	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	0.2	mg/kg	-	-	-	-	-	-	-	-	57	-	-	-	-	-	-	-	-
Zinc	2	mg/kg	124	271	94	124	150	245	271	410	410	-	-	-	-	-	-	-	-
Zirconium	1	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VOCs																			
benzene	0.0050	mg/kg	-	-	-	-	-	-	-	-	-	0.06	-	-	-	-	-	-	-
ethylbenzene	0.015	mg/kg	-	-	-	-	-	-	-	-	0.004	3.6	-	-	-	-	-	-	-
toluene	0.050	mg/kg	-	-	-	-	-	-	-	-	-	0.67	-	-	-	-	-	-	-
xylene, m+p-	0.050	mg/kg	-	-	-	-	-	-	-	-	-	0.025	-	-	-	-	-	-	-
xylene, o-	0.050	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
xylenes, total	0.075	mg/kg	-	-	-	-	-	-	-	-	0.004	-	-	-	-	-	-	-	-
Hydrocarbons																			
F1 (C6-C10)	5.0	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F1-BTEX	5.0	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F2 (C10-C16)	30	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F3 (C16-C34)	50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F4 (C34-C50)	50	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table D.1 - Sediment Analytical Results for Milne Port Sampling Station SW-2
Baffinland 2018-2021

Sample ID Date Sampled Time Sampled Laboratory Sample ID QA/QC Parent Sample ID	Lowest Detection Limits	Units	CCME ¹		NOAA Sediment Benchmarks							Eco Tox EqP(@1% TOC)	SW-2-1	SW-2-2	SW-2-3	SW-2	SW-2	SW-2	
			ISQG	PEL	T ₂₀	TEL	ERL	T ₅₀	PEL	ERM	AET		11-Aug-2018 12:55 L2148903-4	11-Aug-2018 13:00 L2148903-5	11-Aug-2018 13:05 L2148903-6	27-Sep-2019 10:25 L2359868-3	5-Aug-2020 L2487428-2	14-Aug-2021 13:15 VA21B7543-004 FDA	
PAHs																			
acenaphthene	0.0050	mg/kg	0.00671	0.0889	0.019	0.007	0.016	0.116	0.089	0.500	0.130	-	<0.0050	-	-	<0.0050	< 0.0050	<0.0050	
anthracene	0.0040	mg/kg	0.0469	0.245	0.034	0.0469	0.0853	0.29	0.245	1.1	0.28	-	<0.0040	-	-	<0.0040	< 0.0040	<0.0040	
benz(a)anthracene	0.010	mg/kg	0.0748	0.693	0.061	0.0748	0.261	0.466	0.693	1.6	0.96	-	<0.010	-	-	<0.010	< 0.010	<0.010	
benzo(a)pyrene	0.010	mg/kg	0.0888	0.763	0.069	0.0888	0.43	0.52	0.763	1.6	1.1	-	<0.010	-	-	<0.010	< 0.020	<0.010	
benzo(b+j)fluoranthene	0.010	mg/kg	-	-	0.13	-	-	1.107	-	-	1.8	-	<0.010	-	-	<0.010	< 0.010	<0.010	
benzo(b+k)fluoranthene	0.015	mg/kg	-	-	-	-	-	-	-	-	-	-	<0.015	-	-	<0.015	< 0.015	<0.015	
benzo(g,h,i)perylene	0.010	mg/kg	0.31 ^(a)	0.78 ^(a)	-	-	-	-	-	-	-	-	<0.010	-	-	<0.010	< 0.010	<0.010	
benzo(k)fluoranthene	0.010	mg/kg	2.3 ^(a)	4.5 ^(a)	0.07	-	-	0.537	-	-	1.8	-	<0.010	-	-	<0.010	< 0.010	<0.010	
chrysene	0.010	mg/kg	0.108	0.846	0.082	0.108	0.384	0.65	0.846	2.8	0.95	-	<0.010	-	-	<0.010	< 0.010	<0.010	
dibenz(a,h)anthracene	0.0050	mg/kg	0.00622	0.135	0.019	0.00622	0.0634	0.113	0.135	0.26	0.23	-	<0.0050	-	-	<0.0050	< 0.0050	<0.0050	
fluoranthene	0.010	mg/kg	0.113	1.494	0.119	0.113	0.6	1.034	1.494	5.1	1.3	-	<0.010	-	-	<0.010	< 0.010	<0.010	
fluorene	0.010	mg/kg	0.0212	0.144	0.019	0.0212	0.019	0.114	0.144	0.54	0.12	0.54	<0.010	-	-	<0.010	< 0.010	<0.010	
indeno(1,2,3-c,d)pyrene	0.010	mg/kg	0.34 ^(a)	0.88 ^(a)	0.068	-	-	0.488	-	-	0.6	-	<0.010	-	-	<0.010	< 0.010	<0.010	
methylnaphthalene, 1+2-	0.015	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 0.010	<0.015	
methylnaphthalene, 1-	0.010	mg/kg	-	-	0.021	-	-	0.094	-	-	-	-	<0.050	-	-	<0.050	< 0.010	<0.010	
methylnaphthalene, 2-	0.010	mg/kg	0.0202	0.201	0.021	0.0202	0.07	0.128	0.201	0.67	0.064	-	<0.010	-	-	<0.010	< 0.010	<0.010	
naphthalene	0.010	mg/kg	0.0346	0.391	0.03	0.0346	0.16	0.217	0.391	2.1	0.23	0.48	<0.010	-	-	<0.010	< 0.010	<0.010	
phenanthrene	0.010	mg/kg	0.0867	0.544	0.068	0.0867	0.24	0.455	0.544	1.5	0.66	-	<0.010	-	-	<0.010	< 0.010	<0.010	
pyrene	0.010	mg/kg	0.153	1.398	0.125	0.153	0.665	0.932	1.398	2.6	2.4	-	<0.010	-	-	<0.010	< 0.010	<0.010	
quinoline	0.010	mg/kg	-	-	-	-	-	-	-	-	-	-	<0.050	-	-	<0.050	< 0.050	<0.010	
B(a)P total potency equivalents [B(a)P TPE]	0.020	mg/kg	-	-	-	-	-	-	-	-	-	-	<0.020	-	-	<0.020	< 0.020	<0.020	
IACR (CCME)	0.150	-	-	-	-	-	-	-	-	-	-	-	<0.15	-	-	<0.15	< 0.15	<0.150	
IACR AB (coarse)	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.10	
IACR AB (fine)	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.10	
PAHs, total (BC Sched 3.4)	0.040	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.040	
PAHs, total (EPA 16 - DAS)	0.140	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.140	
PAHs, total (EPA 16)	0.040	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.040	

Notes

¹ Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg, MB.

^(a) Guideline value substituted with the BC ENV Working Sediment Guideline in the absence of an applicable CCME Sediment Guideline
BC ENV = British Columbia Ministry of Environment; CCME = Canadian Council of Ministers of the Environment; ISQG = interim sediment quality guidelines; mg/kg = milligram per kilogram; NOAA = National Oceanic and Atmospheric Administration; PEL = probable effects levels; REL = Effect Range Low; SWQG = working sediment quality guidelines; T20 = Concentrations corresponding to 20% probability of observing toxicity; TEL = Threshold Effects Levels; T50 = Concentrations corresponding to 50% probability of observing toxicity; PEL = Probable Effect Levels; pH = scale of acidity; % = percentage; "-" = no value or no result available

Value	Greater than CCME ISQG guideline
Value	Greater than CCME ISQG and PEL guidelines
Value	Greater than BC ENV working lower SWQG
Value	Greater than BC ENV working upper SWQG
Value	Greater than NOAA sediment Benchmarks T ₂₀ guideline
Value	Greater than NOAA sediment Benchmarks TEL guideline
Value	Greater than NOAA sediment Benchmarks ERL guideline
Value	Greater than NOAA sediment Benchmarks T ₅₀ guideline
Value	Greater than NOAA sediment Benchmarks PEL guideline

Date Sampled	Lowest Detection Limits	Units	14-Aug-2021	14-Aug-2021	Relative Percent Difference (RPD)
Time Sampled			13:15	00:00	
Laboratory Sample ID			VA21B7543-004	VA21B7543-005	
QA/QC			FDA	FD	
Parent Sample ID				SW-2	
Physical Parameters					
Moisture	0.25	%	14.7	14.4	2%
pH (1:2 soil:water)	0.1	pH units	8.90	8.89	0%
Particle Size					
clay (<0.004mm)	1	%	<1.0	<1.0	NA
silt (0.063mm - 0.004mm)	1	%	2.6	2.2	NA
sand (2.0mm - 0.063mm)	1	%	88.5	87.2	1%
gravel (>2mm)	1	%	8.9	10.6	17%
Organic / Inorganic Carbon					
carbon, inorganic	0.05	%	0.936	0.811	14%
carbon, total	0.05	%	1.27	1.11	13%
carbon, total organic	0.05	%	0.334	0.299	11%
carbon, inorganic (as CaCO3 equivalent)	0.4	%	7.80	6.76	14%
organic matter	0.1	%	0.58	0.52	11%
Metals					
Aluminum	50	mg/kg	8860	1450	144%
Antimony	0.1	mg/kg	<0.10	<0.10	NA
Arsenic	0.1	mg/kg	2.83	0.44	146%
Barium	0.5	mg/kg	32.2	4.46	151%
Beryllium	0.1	mg/kg	0.56	<0.10	NA
Bismuth	0.2	mg/kg	<0.20	<0.20	NA
Boron	5	mg/kg	35.1	9.1	118%
Cadmium	0.02	mg/kg	0.098	<0.020	NA
Calcium	50	mg/kg	9550	23500	84%
Chromium	0.5	mg/kg	16.0	5.70	95%
Cobalt	0.1	mg/kg	4.28	0.97	126%
Copper	0.5	mg/kg	9.24	1.16	155%
Iron	50	mg/kg	14400	3050	130%
Lead	0.5	mg/kg	7.33	1.06	149%
Lithium	2	mg/kg	17.8	6.2	97%
Magnesium	20	mg/kg	10000	11200	11%
Manganese	1	mg/kg	99.4	39.4	86%
Mercury	0.005	mg/kg	<0.0050	<0.0050	NA
Molybdenum	0.1	mg/kg	1.66	0.11	175%
Nickel	0.5	mg/kg	11.2	2.99	116%
Phosphorus	50	mg/kg	483	80	143%
Potassium	100	mg/kg	2590	740	111%
Selenium	0.2	mg/kg	<0.20	<0.20	NA
Silver	0.1	mg/kg	<0.10	<0.10	NA
Sodium	50	mg/kg	6770	1520	127%
Strontium	0.5	mg/kg	26.6	15.2	55%
Sulfur	1000	mg/kg	2500	<1000	NA
Thallium	0.05	mg/kg	0.115	<0.050	NA
Tin	2	mg/kg	<2.0	<2.0	NA
Titanium	1	mg/kg	256	110	80%
Tungsten	0.5	mg/kg	<0.50	<0.50	NA
Uranium	0.05	mg/kg	1.78	0.213	157%
Vanadium	0.2	mg/kg	22.3	4.91	128%
Zinc	2	mg/kg	26.9	4.8	139%
Zirconium	1	mg/kg	8.6	1.5	141%

Date Sampled	Lowest Detection Limits	Units	14-Aug-2021	14-Aug-2021	Relative Percent Difference (RPD)
Time Sampled			13:15	00:00	
Laboratory Sample ID			VA21B7543-004	VA21B7543-005	
QA/QC			FDA	FD	
Parent Sample ID				SW-2	
VOCs					
benzene	0.0050	mg/kg	<0.0050	<0.0050	NA
ethylbenzene	0.015	mg/kg	<0.015	<0.015	NA
toluene	0.050	mg/kg	<0.050	<0.050	NA
xylene, m+p-	0.050	mg/kg	<0.050	<0.050	NA
xylene, o-	0.050	mg/kg	<0.050	<0.050	NA
xylenes, total	0.075	mg/kg	<0.075	<0.075	NA
Hydrocarbons					
F1 (C6-C10)	5.0	mg/kg	<5.0	<5.0	NA
F1-BTEX	5.0	mg/kg	<5.0	<5.0	NA
F2 (C10-C16)	30	mg/kg	<30	<30	NA
F3 (C16-C34)	50	mg/kg	<50	<50	NA
F4 (C34-C50)	50	mg/kg	<50	<50	NA
PAHs					
acenaphthene	0.0050	mg/kg	<0.0050	<0.0050	NA
acenaphthylene	0.0050	mg/kg	<0.0050	<0.0050	NA
acridine	0.010	mg/kg	<0.010	<0.010	NA
anthracene	0.0040	mg/kg	<0.0040	<0.0040	NA
benz(a)anthracene	0.010	mg/kg	<0.010	<0.010	NA
benzo(a)pyrene	0.010	mg/kg	<0.010	<0.010	NA
benzo(b+j)fluoranthene	0.010	mg/kg	<0.010	<0.010	NA
benzo(b+j+k)fluoranthene	0.015	mg/kg	<0.015	<0.015	NA
benzo(g,h,i)perylene	0.010	mg/kg	<0.010	<0.010	NA
benzo(k)fluoranthene	0.010	mg/kg	<0.010	<0.010	NA
chrysene	0.010	mg/kg	<0.010	<0.010	NA
dibenz(a,h)anthracene	0.0050	mg/kg	<0.0050	<0.0050	NA
fluoranthene	0.010	mg/kg	<0.010	<0.010	NA
fluorene	0.010	mg/kg	<0.010	<0.010	NA
indeno(1,2,3-c,d)pyrene	0.010	mg/kg	<0.010	<0.010	NA
methylnaphthalene, 1+2-	0.015	mg/kg	<0.015	<0.015	NA
methylnaphthalene, 1-	0.010	mg/kg	<0.010	<0.010	NA
methylnaphthalene, 2-	0.010	mg/kg	<0.010	<0.010	NA
naphthalene	0.010	mg/kg	<0.010	<0.010	NA
phenanthrene	0.010	mg/kg	<0.010	<0.010	NA
pyrene	0.010	mg/kg	<0.010	<0.010	NA
quinoline	0.010	mg/kg	<0.010	<0.010	NA
B(a)P total potency equivalents [B(a)P TPE]	0.020	mg/kg	<0.020	<0.020	NA
IACR (CCME)	0.150	-	<0.150	<0.150	NA
IACR AB (coarse)	0.10	-	<0.10	<0.10	NA
IACR AB (fine)	0.10	-	<0.10	<0.10	NA
PAHs, total (BC Sched 3.4)	0.040	mg/kg	<0.040	<0.040	NA
PAHs, total (EPA 16 - DAS)	0.140	mg/kg	<0.140	<0.140	NA
PAHs, total (EPA 16)	0.040	mg/kg	<0.040	<0.040	NA
Notes					
CCME = Canadian Council of Ministers of the Environment; DAS = Disposal at Sea; FDA = field duplicate available; IACR = index of additive cancer risk; ID = identification; mg/kg = milligram per kilogram; NA = not applicable; PAH = Polycyclic Aromatic Hydrocarbons; QA/QC = quality assurance / quality control; RPD = Relative Percent Difference; % = percent, < = below detection limit; > = greater than; - = no data					
Bold values indicate an exceedance of the acceptable RPD of 50%.					

APPENDIX E

Power Analysis - Marine Sediment

POWER ANALYSIS - METHODS

A Type I error is concluding there is a significant effect when none exists (i.e., a false positive). Alpha (α) is the probability of committing a Type I error. A Type II error is the probability of concluding there is no significant effect when there is a real effect of some specified magnitude (i.e., a false negative). Beta (β) is the probability of committing a Type II error. The power of a statistical test ($1 - \beta$) is the probability of detecting a real effect. In this analysis, the Type I error-rate (α), also referred to as the significance level, was set to 0.05. The desired minimum statistical power was 80%, which corresponds to a type II error-rate of 0.2. Power analyses were conducted to assess the power of statistical tests under multiple effect sizes. For each model, a set of effect sizes was created, based on preliminary power analyses, so that power >80% was achieved at the largest absolute values of effect sizes, but also so that power is assessed at a range of effect sizes. Both negative and positive effect sizes were used, to assess the power of detecting either a reduction or an increase in values of the response variables. Since the analysis focused on assessment of changes to statistical power at different effect sizes, the power analysis used the observed samples sizes from the collected data.

Data Simulation following Effect Size Application

The power to detect statistically significant effects was estimated using residual bootstrapping in R v. 4.0.3 (R 2020), following the approach of Fox and Weisberg (2018). The general approach was to simulate data based on the model selected for interpretation, the observed sample size, and the residuals, and re-run the models that were used for the original analysis using the simulated data. The data simulation and analysis were repeated 1,000 times, and the proportion of repetitions where the P -values of interest were significant ($P < 0.05$) was interpreted as the statistical power of the test.

To produce simulated data, the original model was used to predict values of the response variable, and the raw residuals (i.e. the difference between the predicted and observed value for each observation) from the original model were calculated and retained. The predicted values were then adjusted according to the effect size, depending on analysis (see below for details). For each iteration of the simulation, the residuals from the original analysis were sampled with replacement, and then summed with effect size-adjusted model predictions, to produce a set of simulated data. Adding the residuals to the effect size-adjusted predictions was done to create a level of variability in the simulated data that was similar to the observed data. The simulated data were then analyzed using the same model structure as the original analysis.

Effect sizes and statistical tests were applied differently to different models and datasets, as detailed below.

Effect Sizes

In this power analysis, the question of interest was the models' power to detect between-year differences at various distances within transect. To assess this, the effect size was applied to the effect of year. Specifically, the effect size was applied as a percentage difference relative to the observed values in 2020. Where the response variable was transformed prior to analysis, the effect sizes were applied to back-transformed values on the original scale of the response variable. An example of the effect size application to a dataset with a parabolic relationship between the response variable and year is provided in Figure 1. For datasets with a linear relationship with distance, the application of the year-based effect size would be similar but result in parallel lines.

The simulated data based on effect sizes applied to values of the response variable from 2020 were combined with simulated data from previous years (with an effect size of zero). This combined dataset was analyzed using the model from the original analysis in the main report and the *P*-values for the effects of year on the response variable were retained, which included both the main effect of year and any interactions with year. If any of these *P*-values were less than 0.05, it was considered a significant overall effect of year. The proportion of repetitions with *P*-values less than 0.05 was interpreted as the statistical power.

Following the test of the overall year effect, multiple comparisons between years at several distances along each transect were performed with the Dunn–Šidák adjustment for multiple comparisons using the package emmeans (Lenth 2019). The *P*-values of each comparison were retained, and the magnitude of difference between the least squares means (i.e., model predictions) at each comparison was calculated as a simple difference between the predicted value of a previous year and the predicted value of the next year (e.g., estimate in 2014 minus estimate in 2020). The values were back-transformed prior to magnitude calculation, if applicable. Only comparisons with 2020 were shown in the results, since the effect size was applied to the 2020 data. For each effect size, the median value of magnitude of difference was retained, and the proportion of repetitions with *P*-values less than 0.05 at each transect and distance was interpreted as the statistical power of the multiple comparisons to detect a year effect. Comparing values from previous years to simulated data from 2020 was done to assess how much higher or lower the 2020 values would have to be to detect a significant difference relative to previous years.

Power Analysis – Reporting of Results

Power curves were produced, showing statistical power as a function of effect size in percentages (for overall effects) or the median magnitude of difference between the two values compared in multiple comparisons. Reporting the effect size as a magnitude of difference in the original units of the response variable, rather than as a percent difference from 2020 values, was done to make the results easier to interpret, as the ecological importance of the difference may be easier to judge on the original scale of the variable. Horizontal lines were added to visualize statistical power values of 0.8 (hereafter sufficient power) and 0.9 (hereafter high power), and a vertical line was added to visualize the magnitude of difference (or the slope value, for linear relationships) that was observed in the original data.

In the multiple comparisons of year effects, an effect size equal to twice the standard deviation (SD) of the residuals for each transect in 2020 was calculated as a simple difference between predicted and observed values. This was displayed on the plots in addition to the observed between-year effect sizes, to visualize the magnitude difference required to have sufficient power to detect between-year effects in relation to the observed variability in 2020.

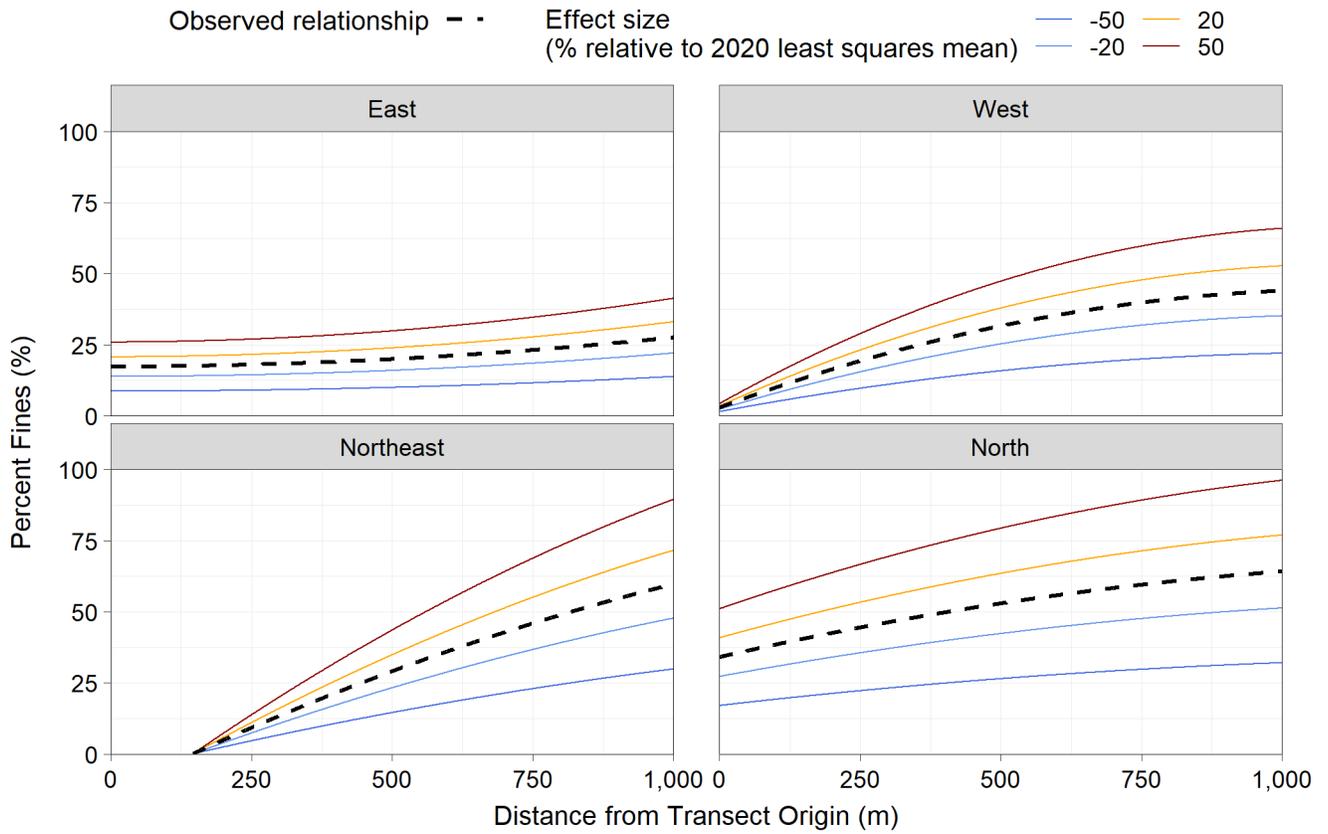


Figure 1 Application of effect sizes to examine effect of sampling year in a parabolic relationship (2019-2020 percent fines model).

POWER ANALYSIS – RESULTS

Sediment Quality – Percent Fines in 2019-2020

The power analysis indicated that the analysis of percent fines data collected in 2019-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 2). This is consistent with the finding of a significant three-way interaction between distance, sampling year, and transect in the original analysis of percent fines (Section 3.4.5.1 in the 2020 MEEMP report [Golder 2021]).

In multiple comparisons between 2019 and 2020, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences at effect sizes of ± 2 SDs at most distances along the transect (Figure 3). Observed magnitudes of difference were small, ranging between -6% (at 200 m) and -0.3% (at 1,000 m). Along the Northeast Transect, there was sufficient power to detect differences at the ± 2 SD effect size at distances of 1,000 m and 1,500 m (Figure 4). Observed magnitudes of difference were between -14% (at 500 m) and +1% (at 1,000 m). Along the Northwest Transect, statistical power was sufficient to detect a ± 2 SD effect size at 500 m and 1,000 m distances (Figure 5). The observed magnitudes of difference in percent fines ranged between -18% and +2% at distances from 200 m to 1,500 m. Along the West Transect, statistical power was sufficient to detect a ± 2 SD effect size at 500 m and 1,000 m distances (Figure 6). The observed magnitudes of difference in percent fines ranged between -9% (at 1,000 m) and +8% (at 500 m).

Overall, power to detect effects between years was highest mid-transect (i.e., 500 m and 1,000 m from the Ore Dock) along all four examined transects. Power was sufficient to detect a ± 2 SD effect size, however observed effect sizes were small, resulting in lack of significant differences between years in the original analysis (Section 3.4.5.1 in Golder 2021).

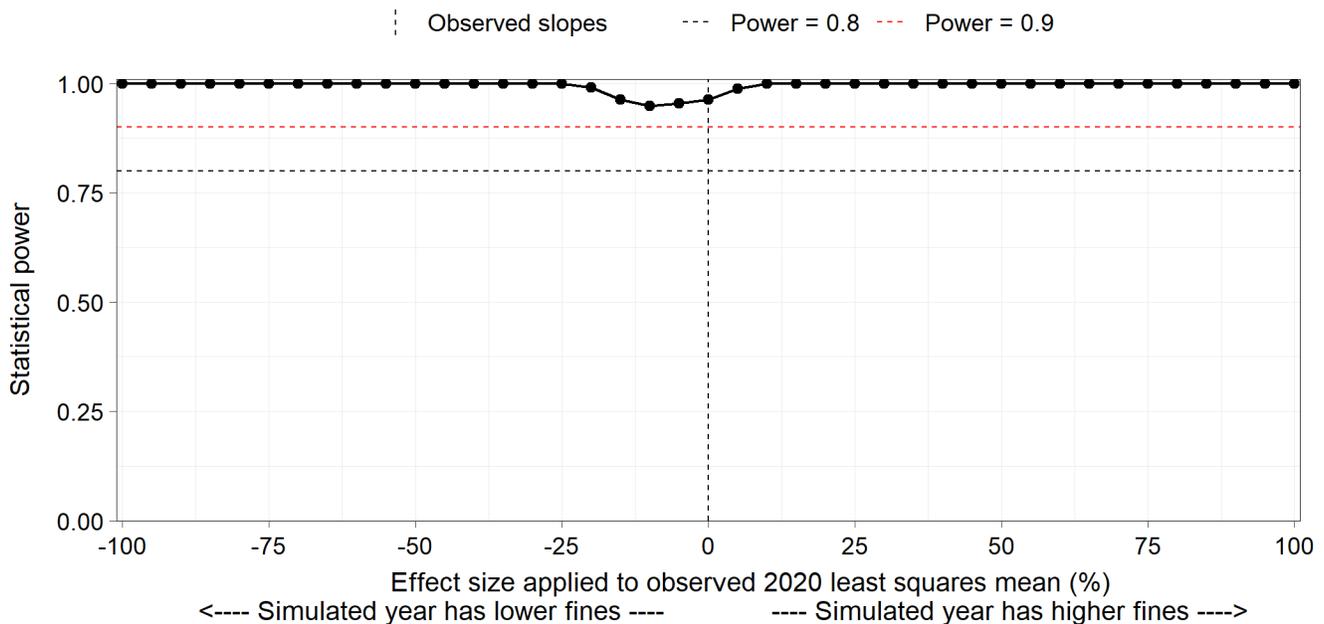


Figure 2 Statistical power of the overall model of 2019-2020 percent fines to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

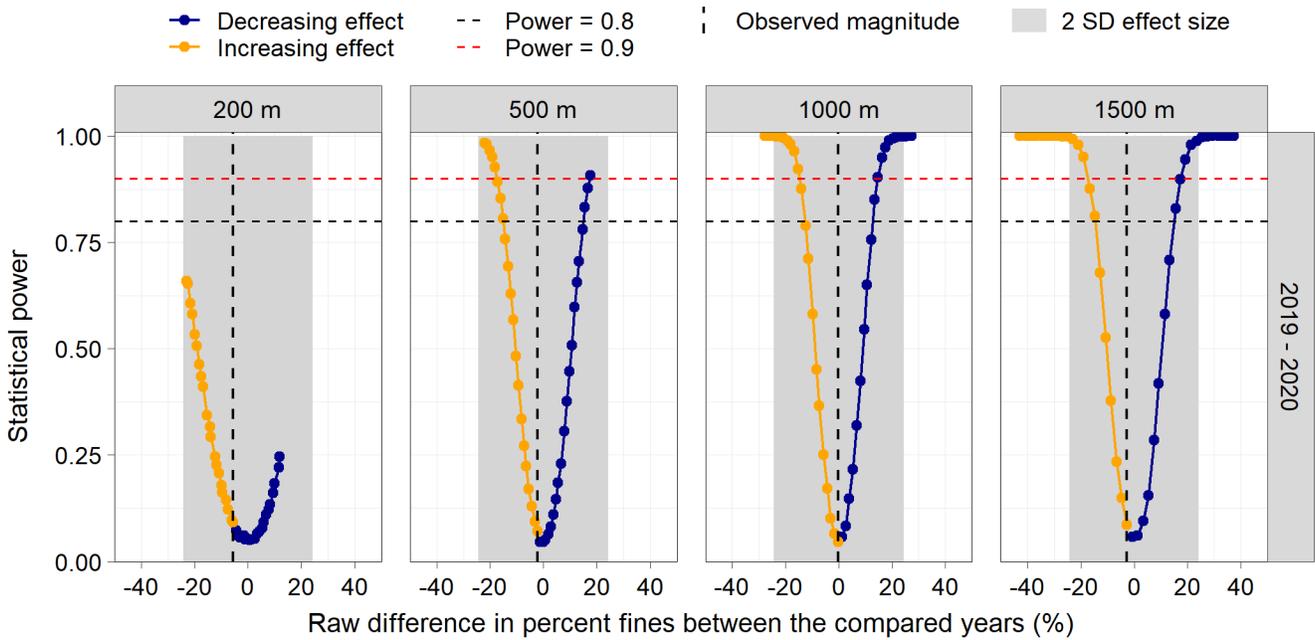


Figure 3 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in percent fines. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

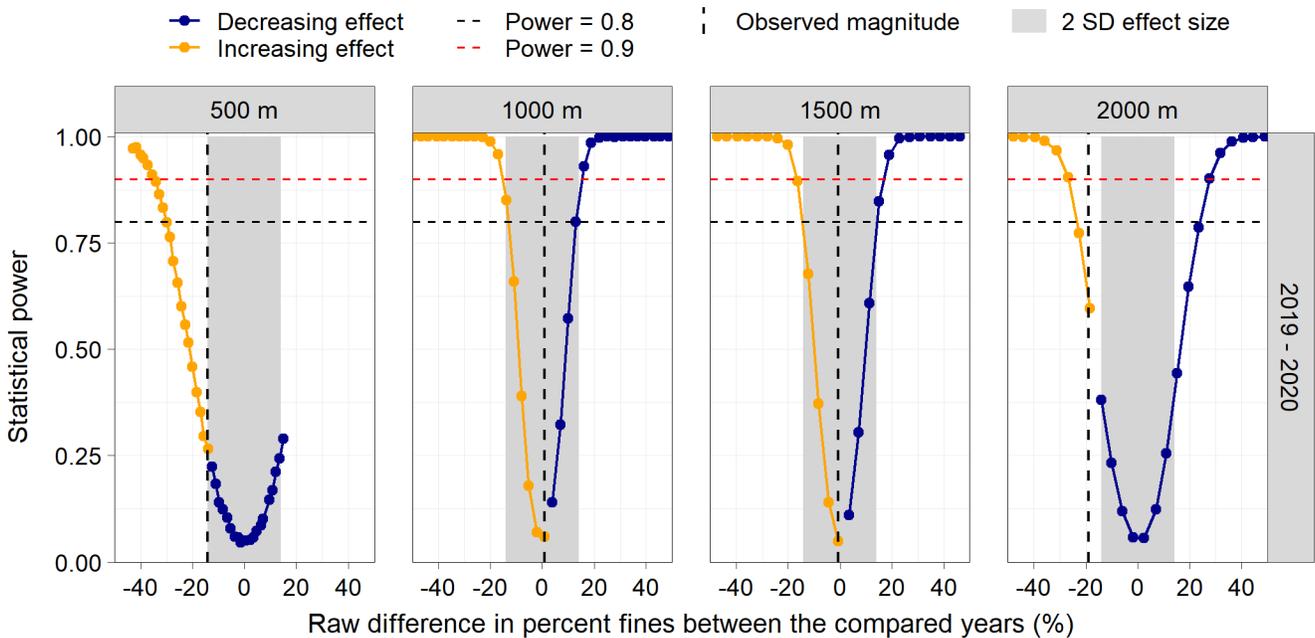


Figure 4 Statistical power of multiple comparisons between years at select distances along the Northeast Transect relative to the difference in percent fines. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

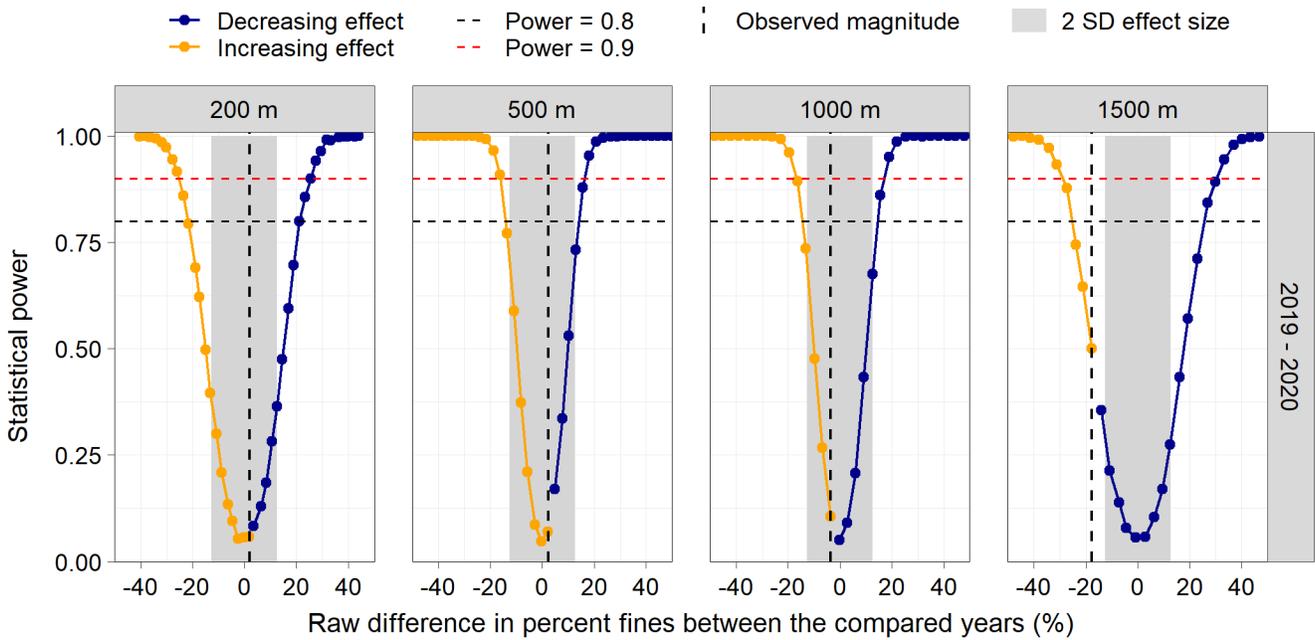


Figure 5 Statistical power of multiple comparisons between years at select distances along the Northwest Transect relative to the difference in percent fines. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

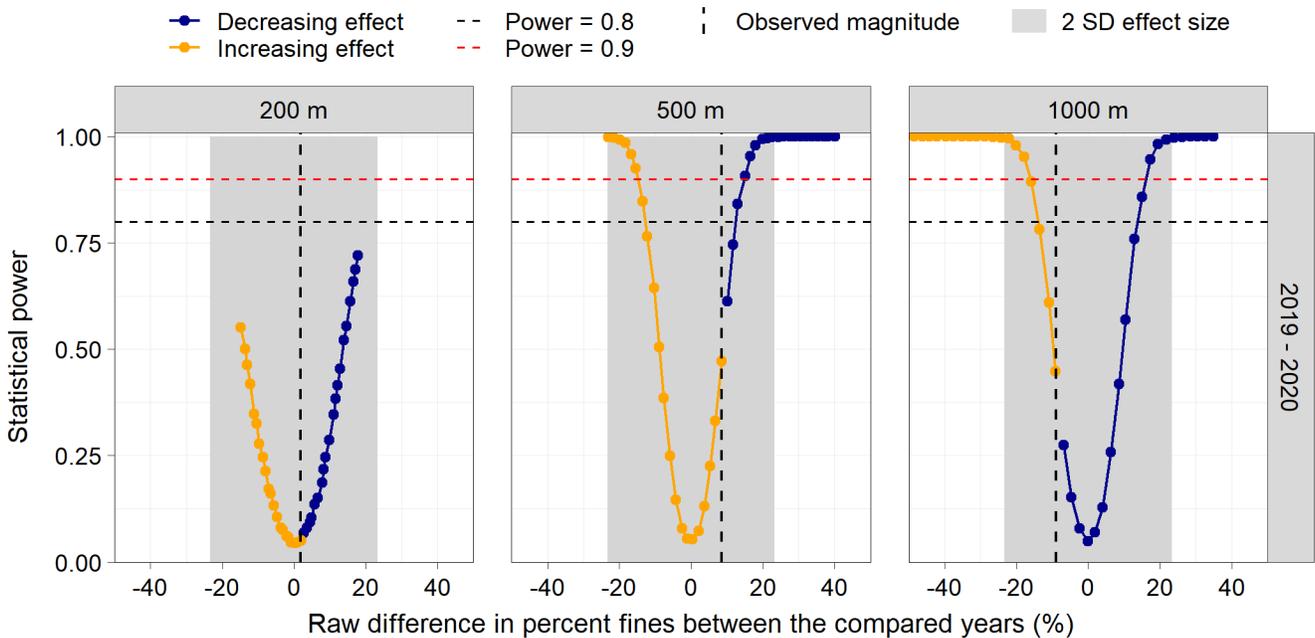


Figure 6 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in percent fines. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

Sediment Quality – Percent Fines in 2014-2020

The power analysis indicated that the analysis of 2014-2020 percent fines data had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 7). This is consistent with the finding of a significant three-way interaction between, distance, sampling year, and transect in the original analysis of percent fines (p-value <0.001; Section 3.4.5.1 in Golder 2021).

In multiple comparisons between all years, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences at ± 2 SD magnitudes of difference in percent fines at 500 m, 1,000 m, and 1,500 m distances from the Ore Dock (Figure 8). Along the North Transect, there was low power to detect differences at the observed magnitudes and at the ± 2 SD effect size at all distances (Figure 9). Along the North Transect, the magnitude of difference in percent fines between 2020 and a previous sampling year had to be at least 25% for a statistical power value of 0.8 at a distance of 200 m, at least 18% at a distance of 500 m, and at least 19% at a distance of 1,000 m. In comparison, the 2 SD effect size was only equivalent to ~6% fines, and the test therefore had insufficient power to detect a difference of ± 2 SD at all distances. Along the West Transect, there was sufficient power to detect significant differences under the observed the ± 2 SD effect size relative to 2020 transect-specific regression residuals at 500 m (most years) and 1,000 m (2015-2020 and 2019-2020 comparisons; Figure 10).

Overall, power to detect effects between years was highest mid-transect (e.g., 500 m) along all three examined transects, and not sufficient to detect observed effect sizes. This is consistent with not finding significant differences between years at any of the examined transects and distances in the original analysis (Section 3.4.5.1 in Golder 2021). Power to detect ± 2 SD effect sizes was sufficient (>0.8) at multiple distances and year comparisons along the East and West transects, but not along the North Transect, where a minimum of 18% difference in percent fines between 2020 and a previous sampling year was required for sufficient power.

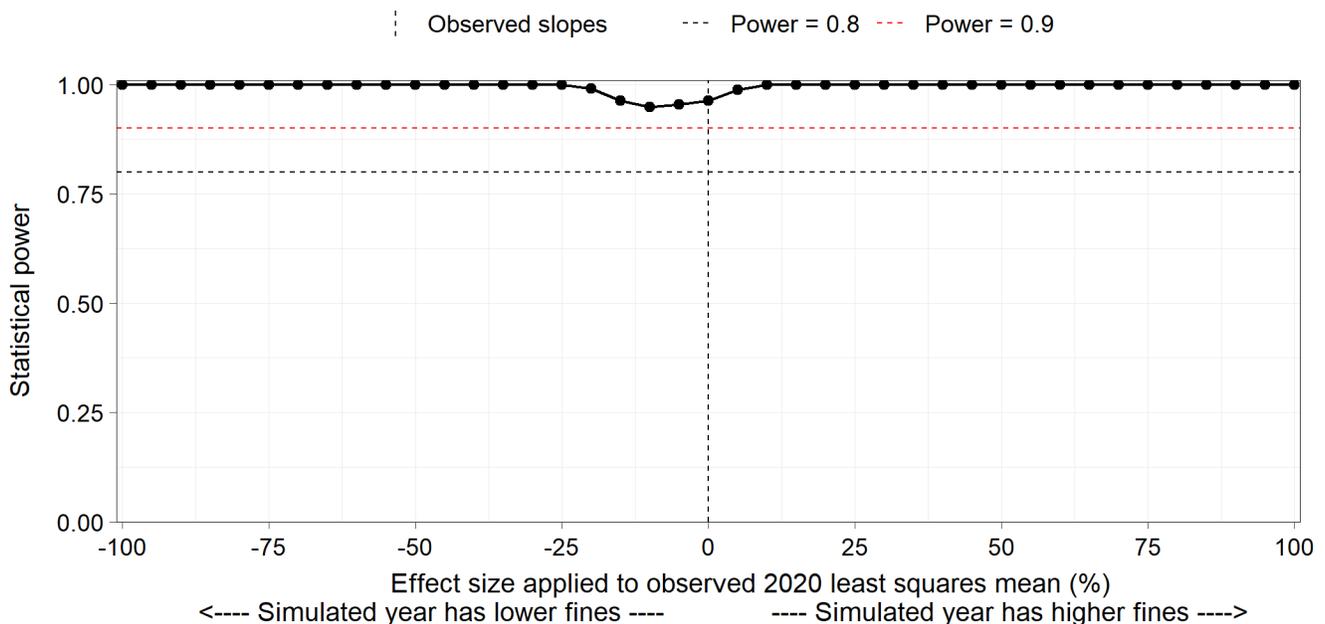


Figure 7 Statistical power of the overall model of 2014-2020 percent fines to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

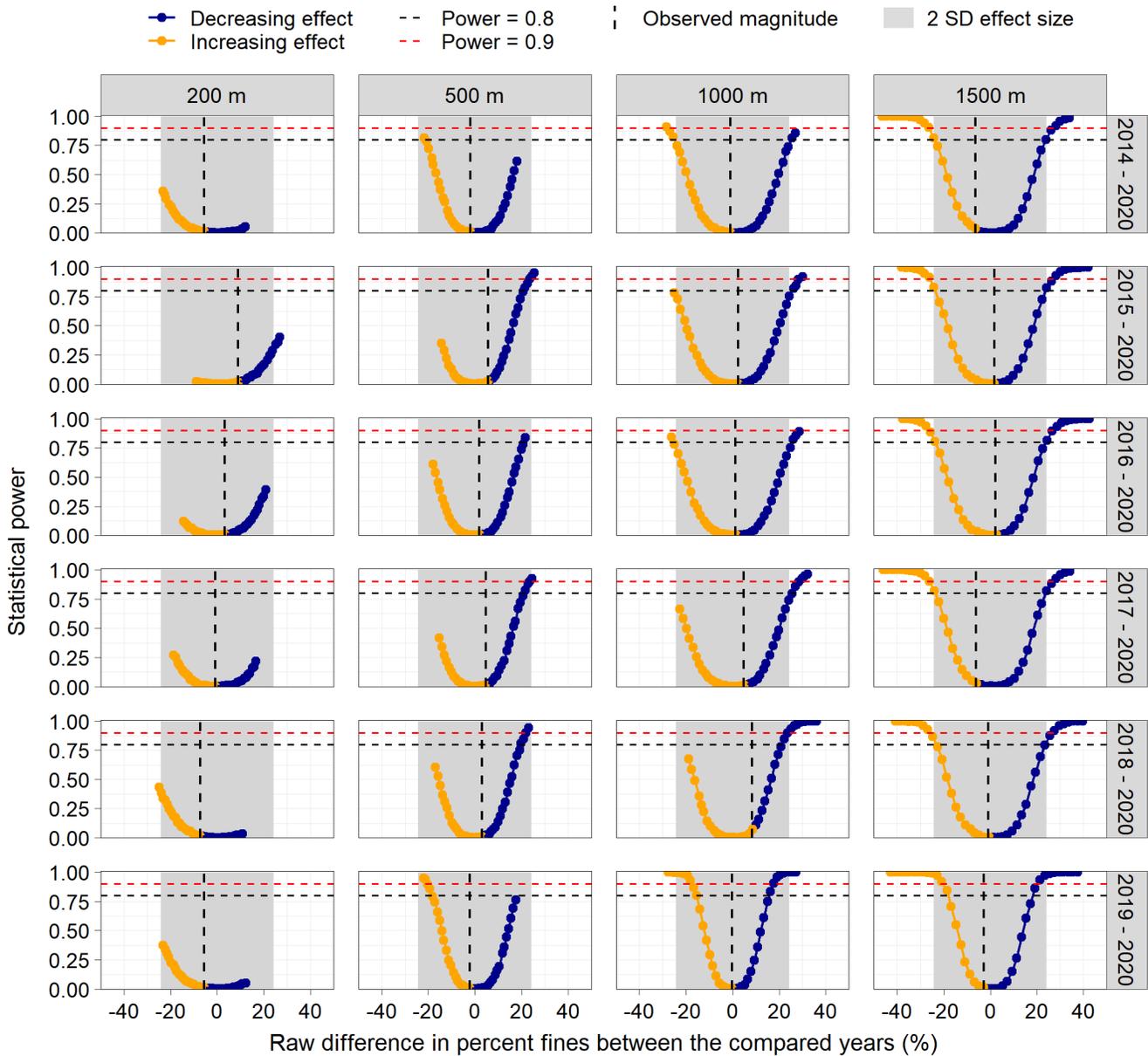


Figure 8 Statistical power of multiple comparisons between years at three distances along the East Transect relative to the difference in percent fines between the compared years. Each panel shows a separate comparison, with the years compared displayed on the right and the distance at which the comparison is performed displayed at the top.

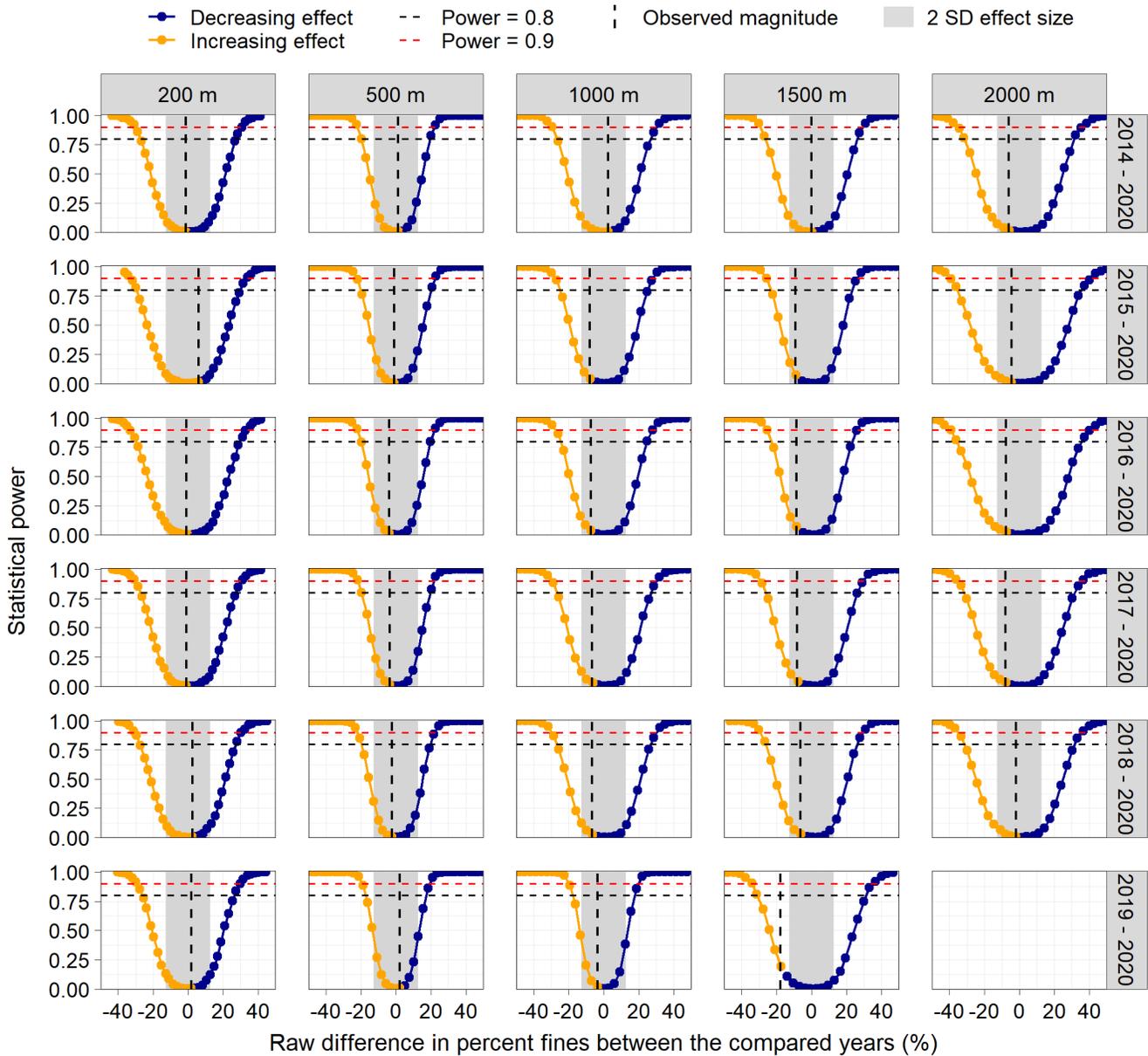


Figure 9 Statistical power of multiple comparisons between years at three distances along the North Transect relative to the difference in percent fines between the compared years. Each panel shows a separate comparison, with the years compared displayed on the right and the distance at which the comparison is performed displayed at the top.

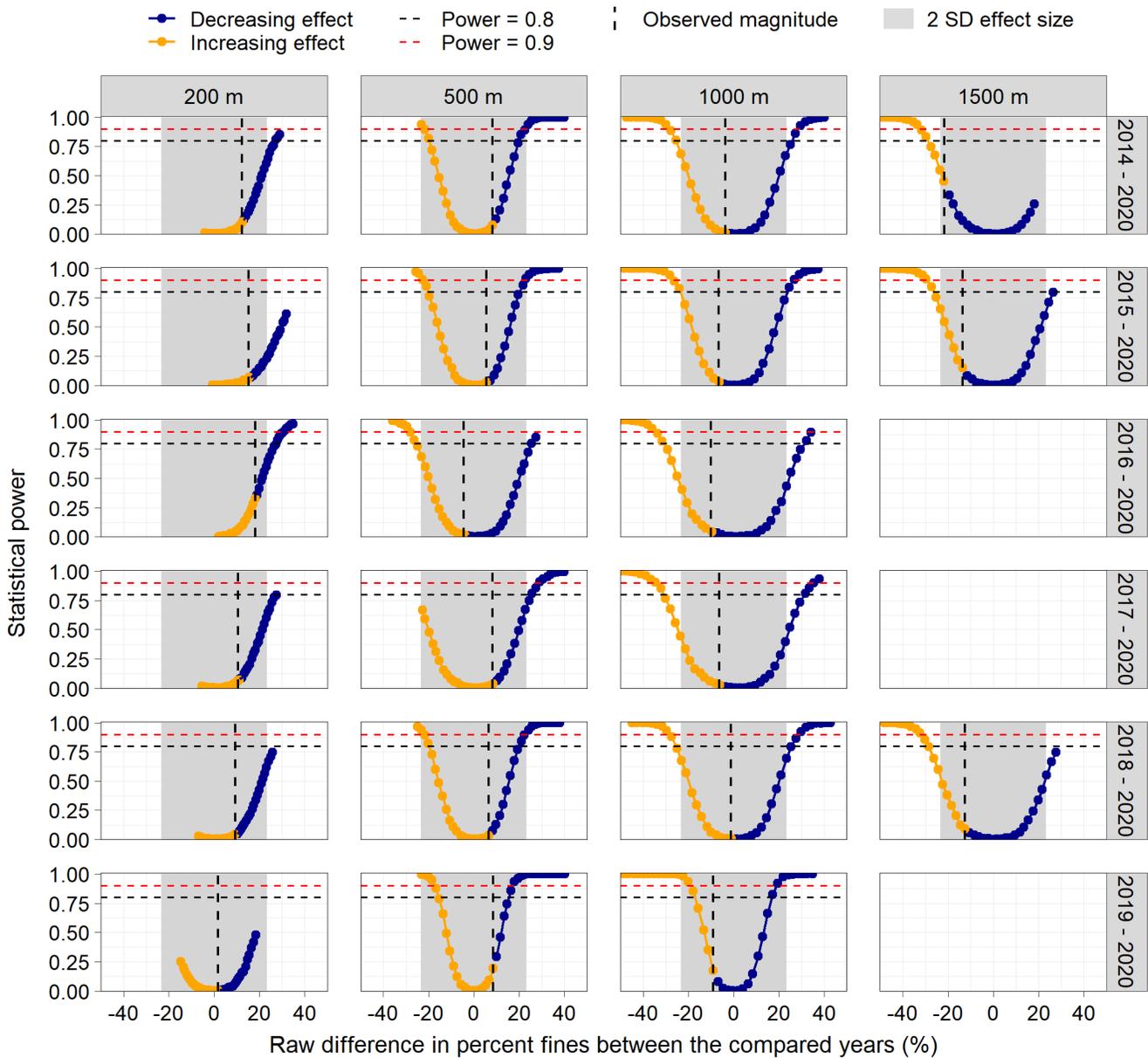


Figure 10 Statistical power of multiple comparisons between years at three distances along the West Transect relative to the difference in percent fines between the compared years. Each panel shows a separate comparison, with the years compared displayed on the right and the distance at which the comparison is performed displayed at the top.

Sediment Quality – Iron Content in 2019-2020

The power analysis indicated that the analysis of fines-adjusted iron content collected in 2019-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 11). This is consistent with the finding of a significant three-way interaction between distance, sampling year, and transect in the original analysis of percent fines (Section 3.4.6.1 in Golder 2021).

In multiple comparisons between 2019 and 2020, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences at effect sizes of ± 2 SDs at most distances along the transect (Figure 12). Along the Northeast Transect, there was not sufficient power to detect differences at the ± 2 SD effect size (Figure 13), since the low variability resulted in a very low standard deviation value (2.0 mg iron/g fines). Observed magnitudes of difference were between +3.6 mg/g fines (at 1,500 m) and +6.1 mg/g fines (at 500 m). Along the Northwest Transect, statistical power was also not sufficient to detect a ± 2 SD effect size (Figure 14), due to the very low variability (standard deviation of 2.1 mg iron/g fines). The observed magnitudes of difference in fines-adjusted iron content ranged between -1.7 mg iron/g fines (200 m and 500 m) and +12.2 mg iron/g fines (at 1,500 m, where power was sufficient to detect the observed effect size). Along the West Transect, statistical power was sufficient to detect a ± 2 SD effect size at the three assessed distances (Figure 15). The observed magnitudes of difference in fines-adjusted iron content ranged between -11.8 mg/g fines (at 200 m) and +6.8 mg/g fines (at 1,000 m).

Overall, power to detect effects between years was highest mid-transect (i.e., 500 m and 1,000 m from the Ore Dock) along all four examined transects. Power was sufficient to detect a ± 2 SD effect size, and some observed effect sizes (e.g., West Transect at 500 m) were sufficient for high power, consistent with the detection of significant differences between years in the original analysis (Section 3.4.6.1 in Golder 2021).

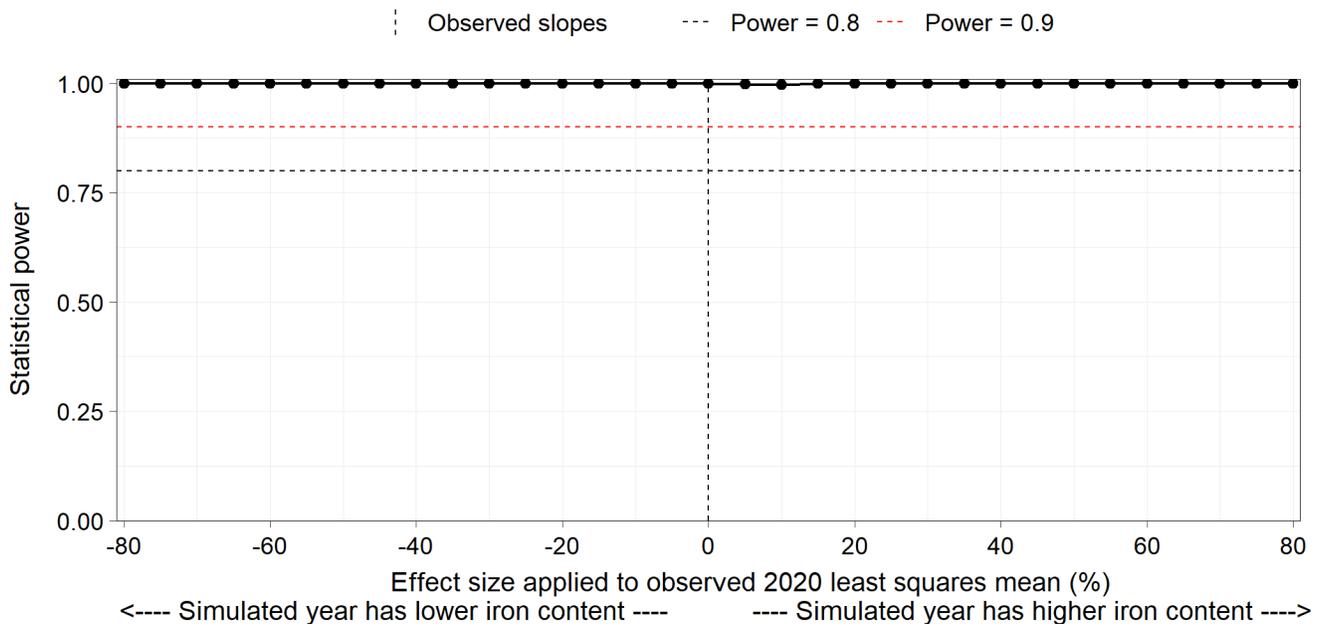


Figure 11 Statistical power of the overall model of 2019-2020 fines-adjusted iron content to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

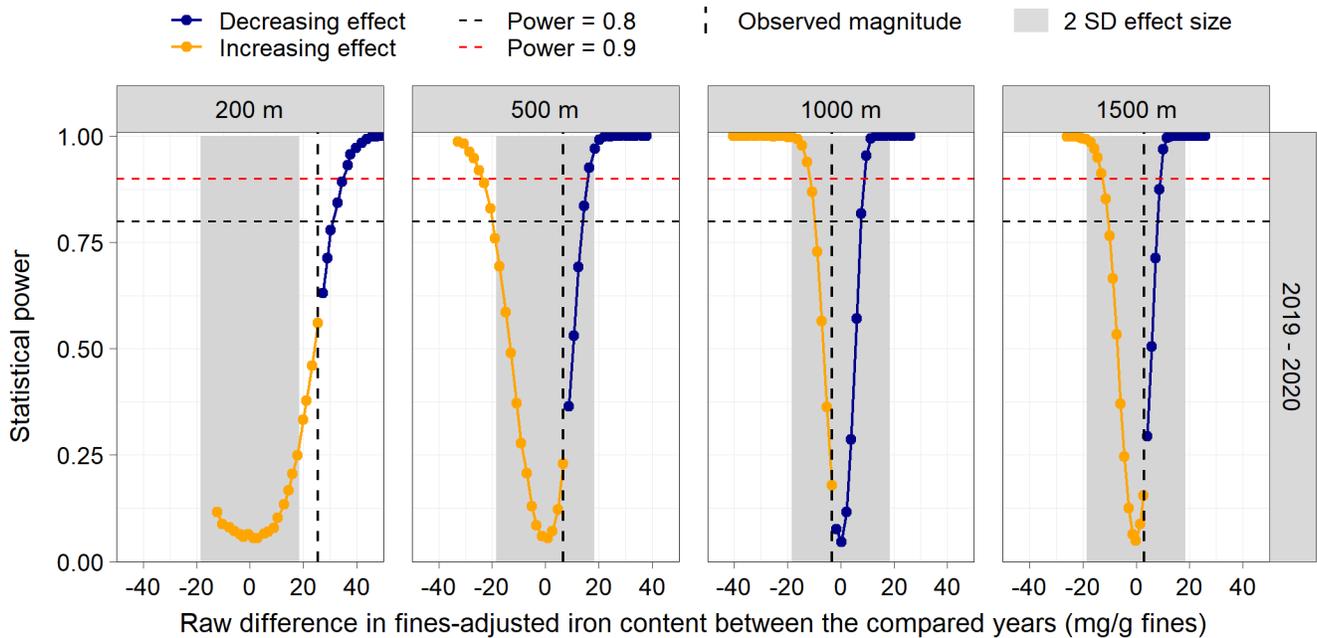


Figure 12 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in fines-adjusted iron content. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

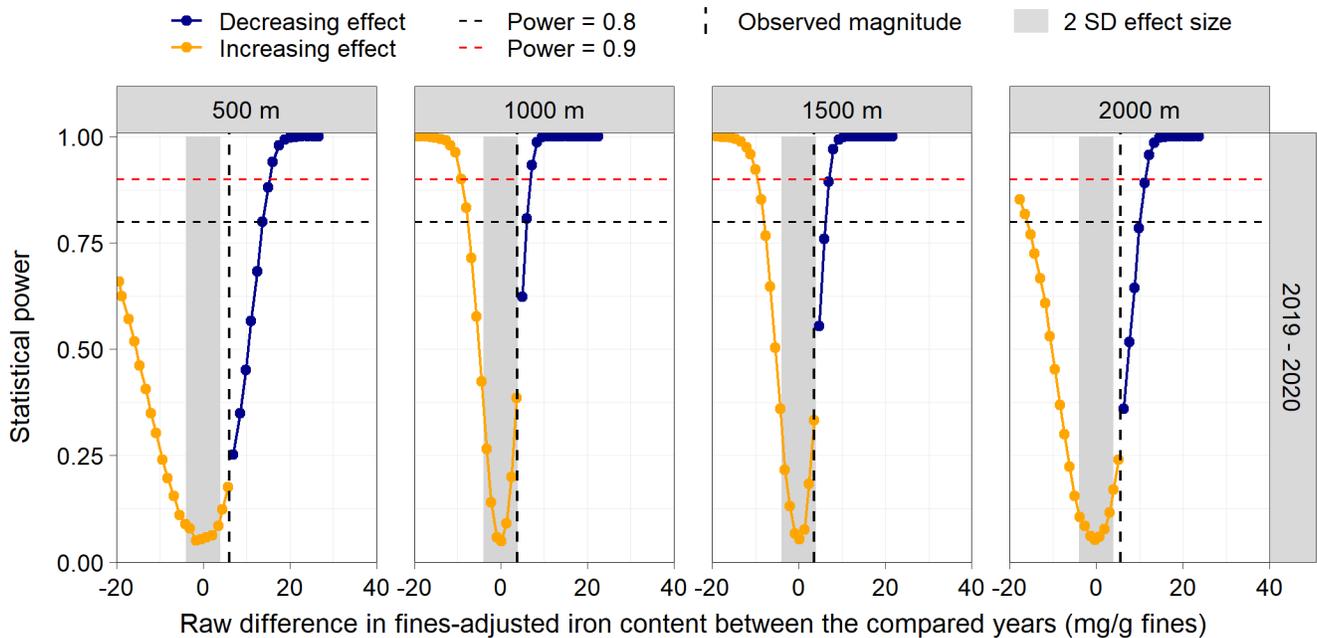


Figure 13 Statistical power of multiple comparisons between years at select distances along the Northeast Transect relative to the difference in fines-adjusted iron content. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

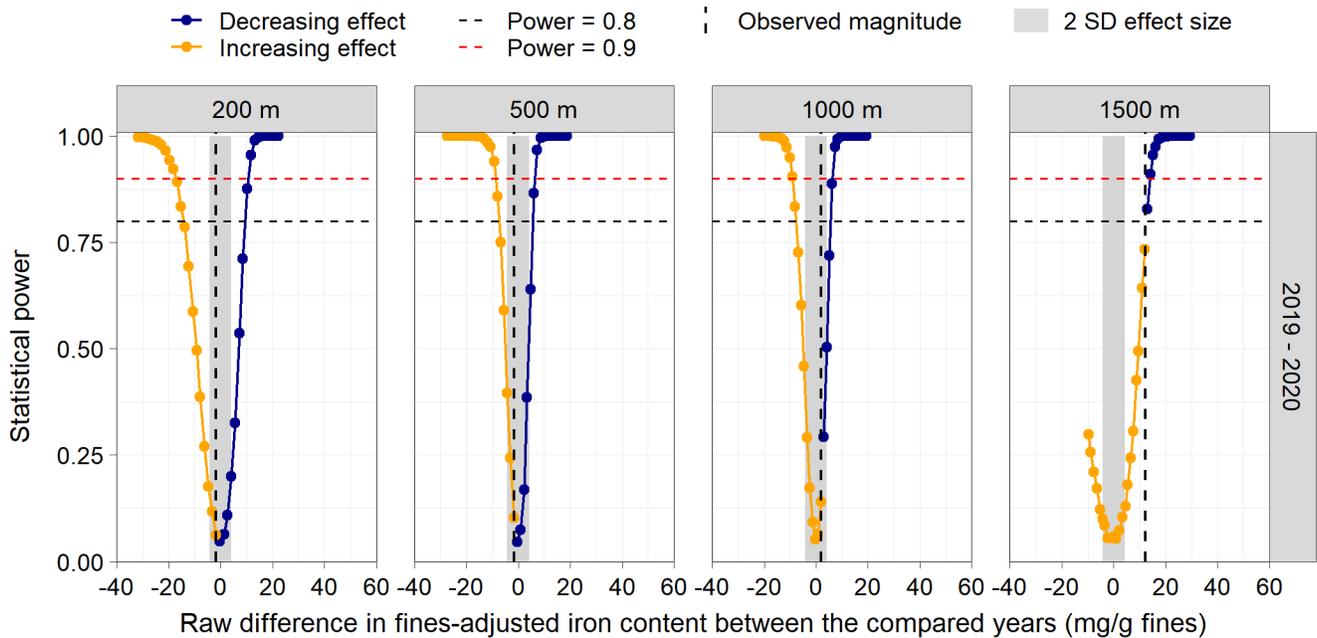


Figure 14 Statistical power of multiple comparisons between years at select distances along the Northwest Transect relative to the difference in fines-adjusted iron content. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

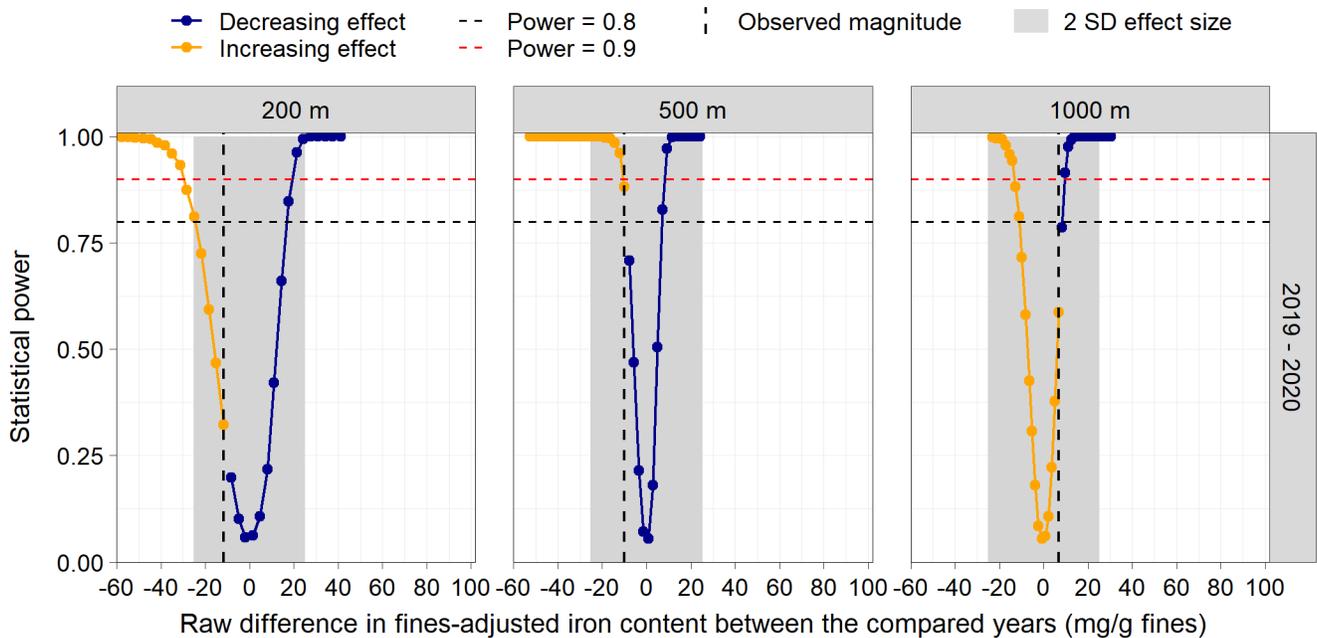


Figure 15 Statistical power of multiple comparisons between years at select distances along the West Transect relative to the difference in fines-adjusted iron content. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

Sediment Quality – Iron Content in 2014-2020

The power analysis indicated that the analysis of 2014-2020 percent fines data had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 16). This is consistent with the finding of a significant three-way interaction between distance, sampling year, and transect in the original analysis of fines-adjusted iron (p-value=0.001; Section 3.4.6.1 in Golder 2021).

In multiple comparisons between all years, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences at ± 2 SD magnitudes of difference fines-adjusted iron content at 500 m, 1,000 m, and 1,500 m distances from the Ore Dock (Figure 17). Along the North Transect, there was low power to detect differences at the ± 2 SD effect size at all distances (Figure 18), due to the low variability in iron levels at this transect (standard deviation value of 2.1 mg iron/g fines). Along the North Transect, the magnitude of difference in fines-adjusted iron content between 2020 and a previous sampling year had to be at least 10% for a statistical power value of 0.8 at a distance of 200 m, at least 9 mg/g fines at a distance of 500 m, and at least 8 mg/g fines at a distance of 1,000 m. In comparison, the 2 SD effect size was only equivalent to ~4 mg iron/g fines, and the test therefore had insufficient power to detect a difference of ± 2 SD at all distances.

Along the West Transect, there was sufficient power to detect significant differences under the ± 2 SD effect size relative to 2020 transect-specific regression residuals at 200 m (all years, increasing effect only), 500 m (most years) and 1,000 m (most years; Figure 19).

Overall, power to detect effects between years was highest mid-transect (e.g., 500 m) along all three examined transects. Power to detect ± 2 SD effect sizes was sufficient (>0.8) at multiple distances and year comparisons along the East and West transects, but not along the North Transect, where a minimum of 8 mg/g fines difference in iron content between 2020 and a previous sampling year was required for sufficient power. Most observed effect sizes were small, resulting in low power to detect them. This is consistent with not finding significant differences between most years at the examined transects and distances in the original analysis (Section 3.4.6.1 in Golder 2021).

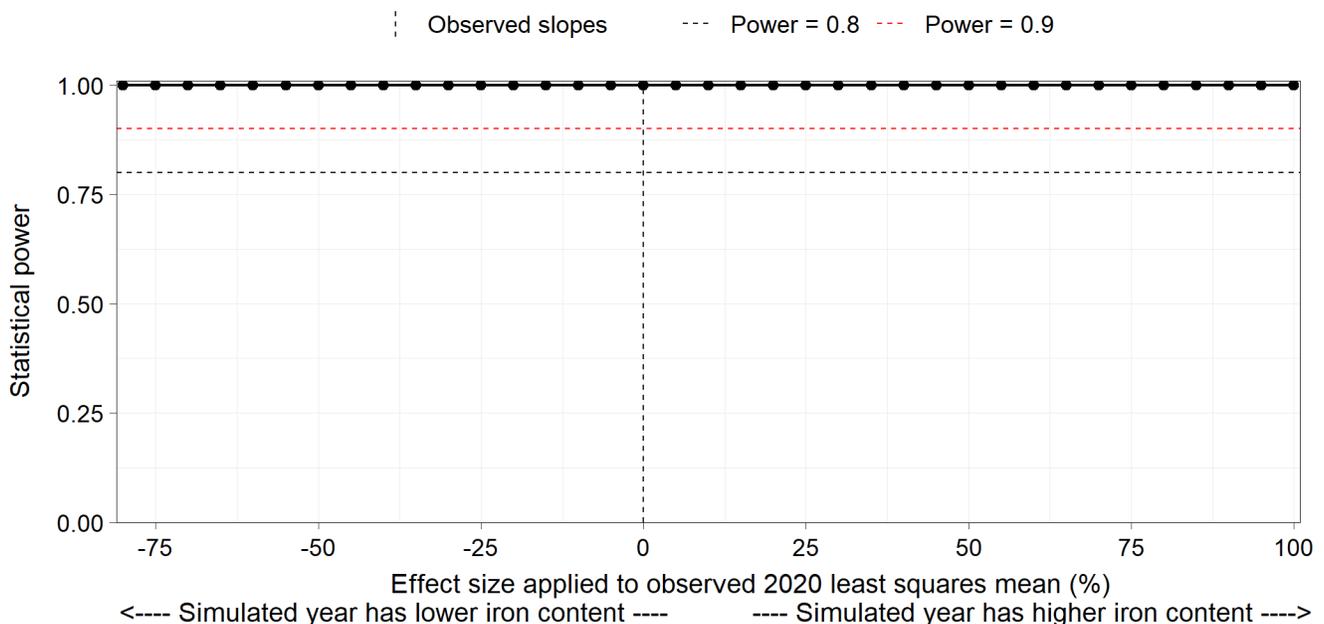


Figure 16 Statistical power of the overall model of 2014-2020 fines-adjusted iron content to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

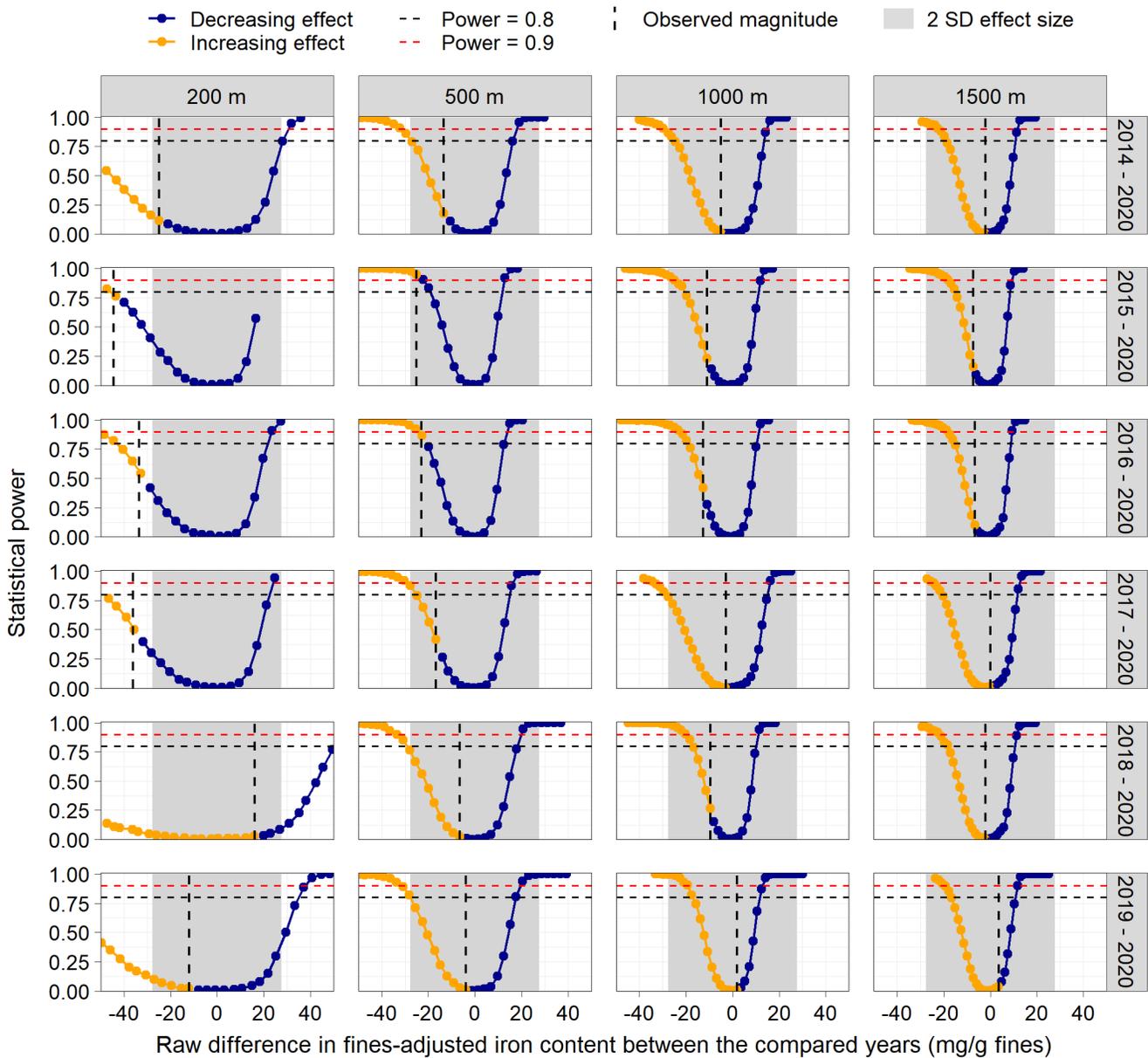


Figure 17 Statistical power of multiple comparisons between years at three distances along the East Transect relative to the difference in fines-adjusted iron content between the compared years. Each panel shows a separate comparison, with the years compared displayed on the right and the distance at which the comparison is performed displayed at the top.

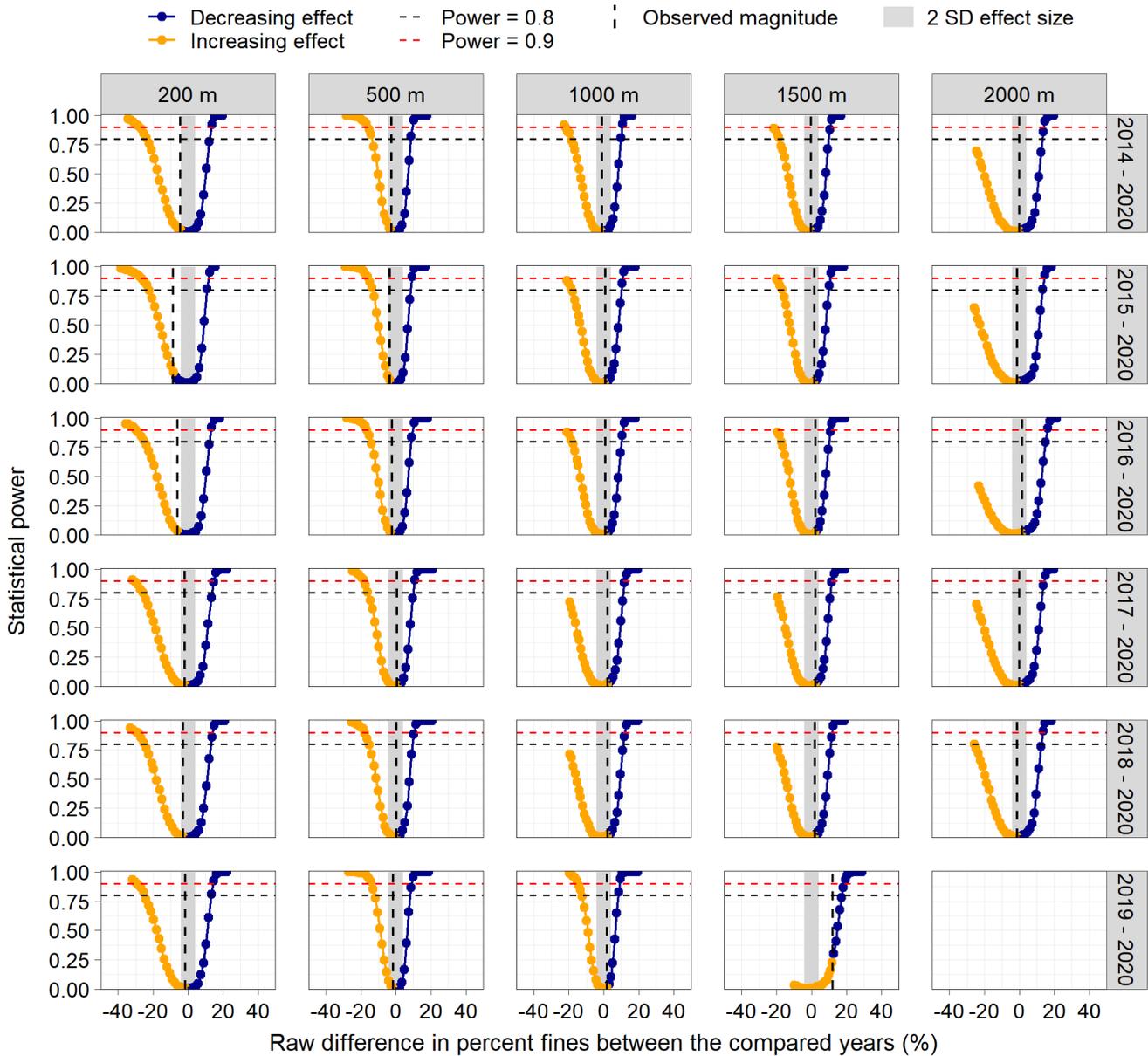


Figure 18 Statistical power of multiple comparisons between years at three distances along the North Transect relative to the difference in fines-adjusted iron content between the compared years. Each panel shows a separate comparison, with the years compared displayed on the right and the distance at which the comparison is performed displayed at the top.

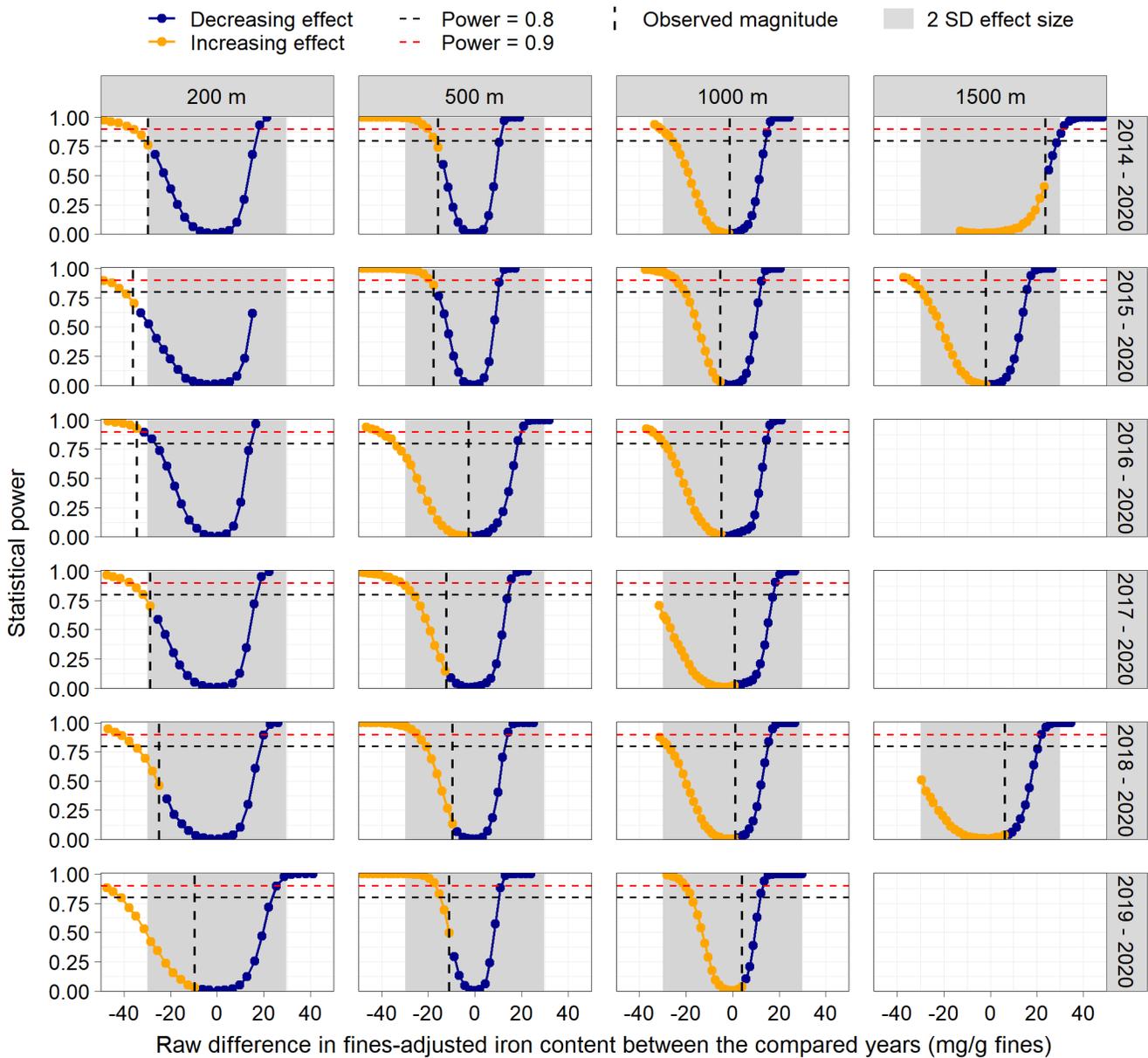


Figure 19 Statistical power of multiple comparisons between years at three distances along the West Transect relative to the difference in fines-adjusted iron content between the compared years. Each panel shows a separate comparison, with the years compared displayed on the right and the distance at which the comparison is performed displayed at the top.

Benthos – Total Density in 2019-2020

The power analysis indicated that the analysis of benthos density collected in 2019-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 20). This is consistent with the finding of a significant two-way interaction between sampling year and transect in the original analysis of benthos density (Section 4.4.3.1.1 in Golder 2021).

In multiple comparisons between 2019 and 2020, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences at effect sizes of ± 2 SDs at most distances along the transect (Figure 21). The variability of benthos density was high, resulting in a wide ± 2 SD effect size (standard deviation value of 10,967 organisms/m²). The analysis had sufficient power to detect considerably smaller effect sizes – e.g., a raw difference of 8,500 organisms/m² at 650 m and 6,100 organisms/m² at 1,000 m from the Ore Dock. Along the Northeast Transect, there was sufficient power to detect differences at the +2 SD effect size (but not -2 SD effects) at both 650 m and 1,000 m distances (Figure 22). Observed magnitudes of difference were between 1,116 organisms/m² (at 1,500 m) and 2,750 organisms/m² (at 650 m). Along the Northwest Transect, statistical power was also sufficient to detect a +2 SD effect size at both 650 m and 1,000 m from the Ore Dock (Figure 23). The observed magnitudes of difference in benthos density ranged between -3,634 organisms/m² (at 1,000 m) and -1,256 organisms/m² (150 m). The original analysis detected a significant difference between 2019 and 2020 at both 650 m and 1,000 m from the Ore Dock (Section 4.4.3.1.1 in Golder 2021). Along the West Transect, statistical power was not sufficient to detect a ± 2 SD effect size at the three assessed distances (Figure 24). The observed magnitudes of difference in benthos density ranged between 3,244 organisms/m² (at 150 m) and 4,244 organisms/m² (at 1,000 m).

Overall, power to detect effects between years was highest mid-transect (i.e., 500 m from the Ore Dock) along all four examined transects. Power was sufficient to detect a ± 2 SD effect size at three of the four transects. Some observed effect sizes (e.g., Northwest Transect at 650 m and 1,000 m) were sufficient for high power, consistent with the detection of significant differences between years in the original analysis (Section 4.4.3.1.1 in Golder 2021).

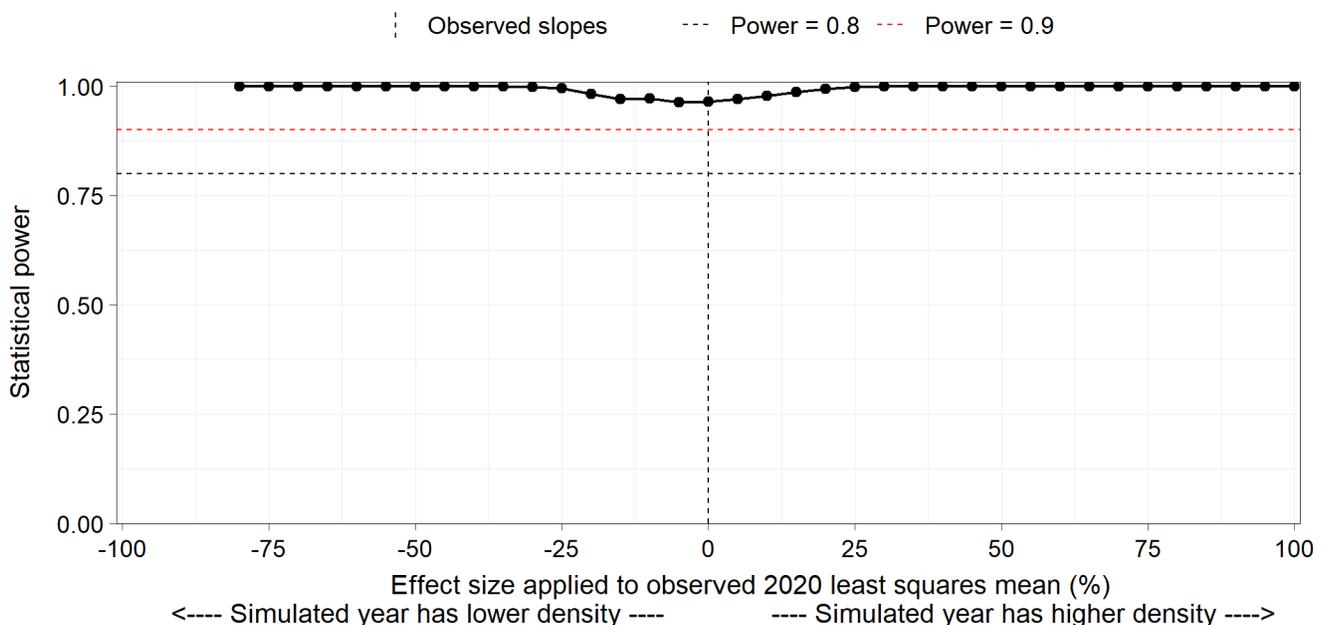


Figure 20 Statistical power of the overall model of 2019-2020 benthos density to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

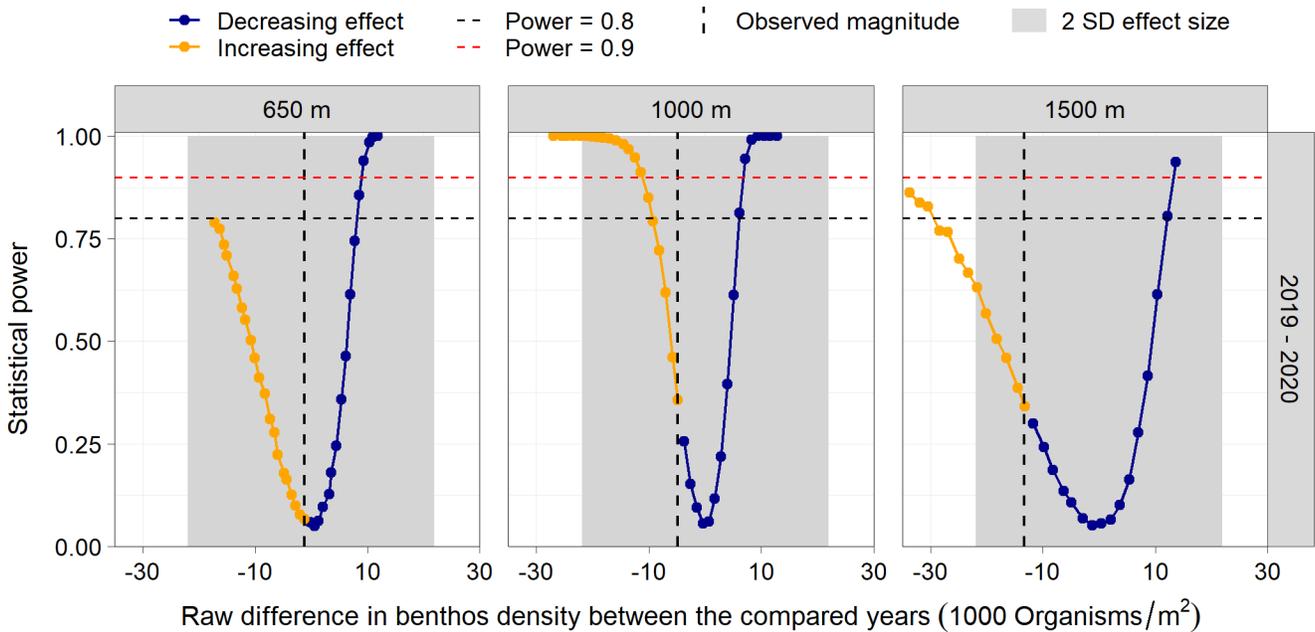


Figure 21 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in benthos density. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

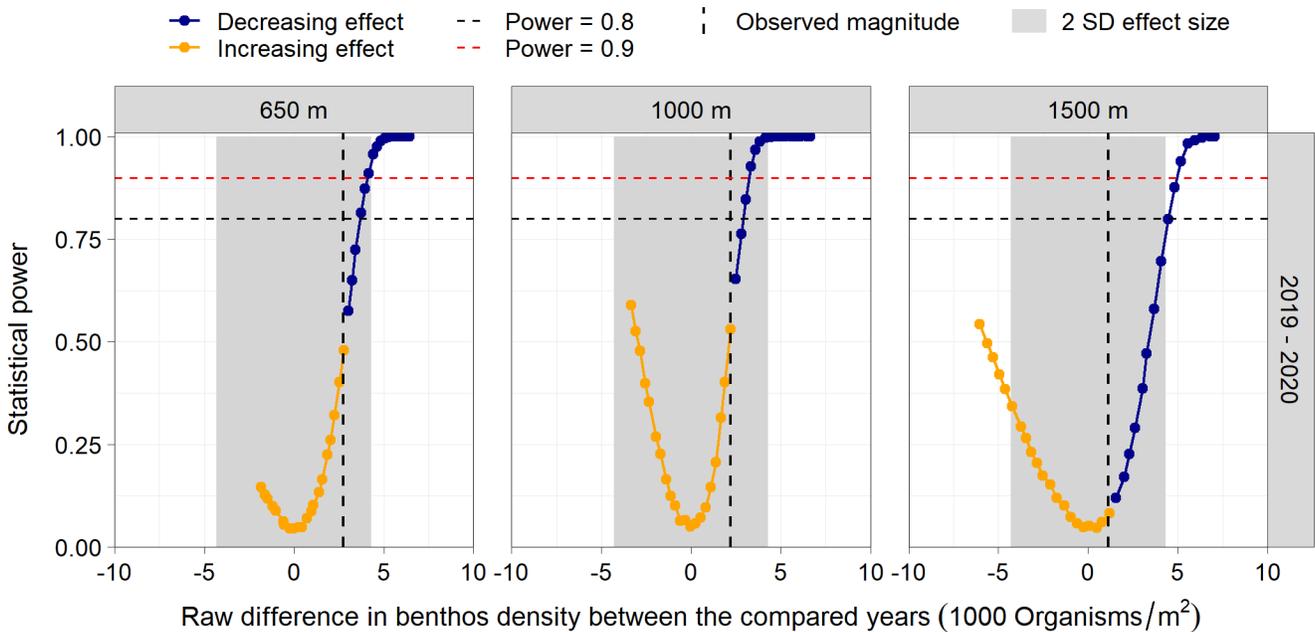


Figure 22 Statistical power of multiple comparisons between years at select distances along the Northeast Transect relative to the difference in benthos density. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

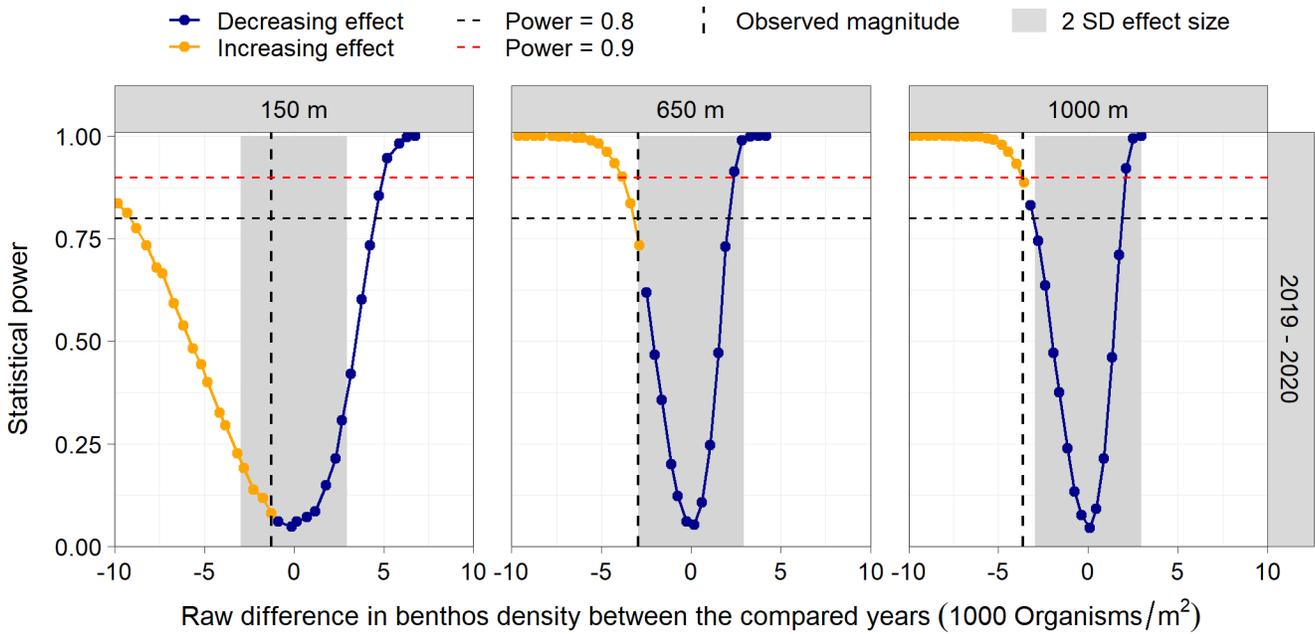


Figure 23 Statistical power of multiple comparisons between years at select distances along the Northwest Transect relative to the difference in benthos density. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

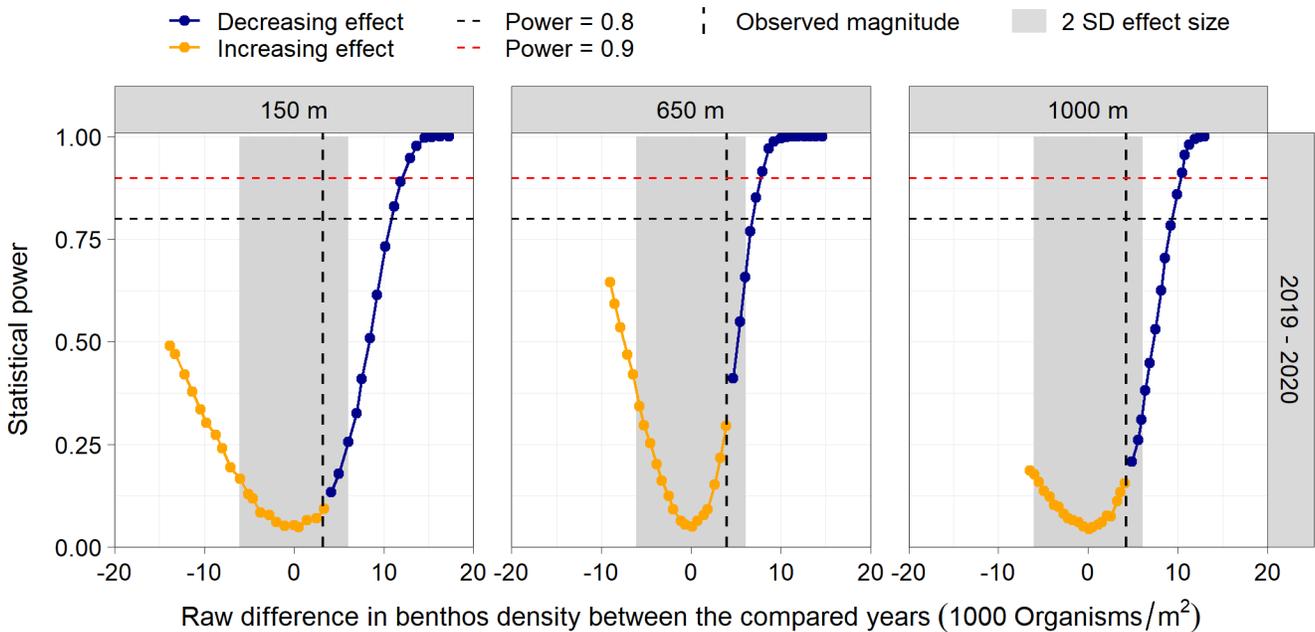


Figure 24 Statistical power of multiple comparisons between years at select distances along the West Transect relative to the difference in benthos density. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

Benthos – Total Density in 2018-2020

The power analysis indicated that the analysis of benthos density collected in 2018-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 29). This is consistent with the finding of a significant main effect of sampling year in the original analysis of benthos density (Section 4.4.3.1.2 in Golder 2021).

In multiple comparisons between sampling years, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences between the three sampling years at effect sizes of ± 2 SDs at all distances along the transect (Figure 26). The variability of benthos density was high, resulting in a wide ± 2 SD effect size (standard deviation value of 10,659 organisms/m²). The analysis had sufficient power to detect considerably smaller effect sizes – e.g., a raw difference of 5,878 organisms/m² at 1000 m from the Ore Dock. Along the North Transect, there was sufficient power to detect differences at the +2 SD effect size (but not -2 SD effects) at all distances except for 150 m, and a -2 SD difference at a distance of 1,000 m when comparing between 2019 and 2020 (Figure 27). Observed magnitudes of difference were between -3,125 organisms/m² (at 1,500 m, 2019-2020 comparison) and -1,507 organisms/m² (at 150 m, 2019-2020 comparison). The original analysis detected a significant difference between 2019 and 2020 at both 650 m and 1,000 m from the Ore Dock (Section 4.4.3.1.2 in Golder 2021). Along the West Transect, statistical power was sufficient to detect a +2 SD (but not -2 SD) effect size at three of the four assessed distances in comparisons between 2018 and 2020 (Figure 28).

Overall, power to detect effects between years was high along the North Transect, and at 1,000 m from the Ore Dock at the East and West transect. Power was sufficient to detect a ± 2 SD effect size for at least some of the comparisons at the three transects. Two observed effect sizes (i.e., North Transect at 650 m and 1,000 m) were sufficient for high power, consistent with the detection of significant differences between years in the original analysis (Section 4.4.3.1.2 in Golder 2021).

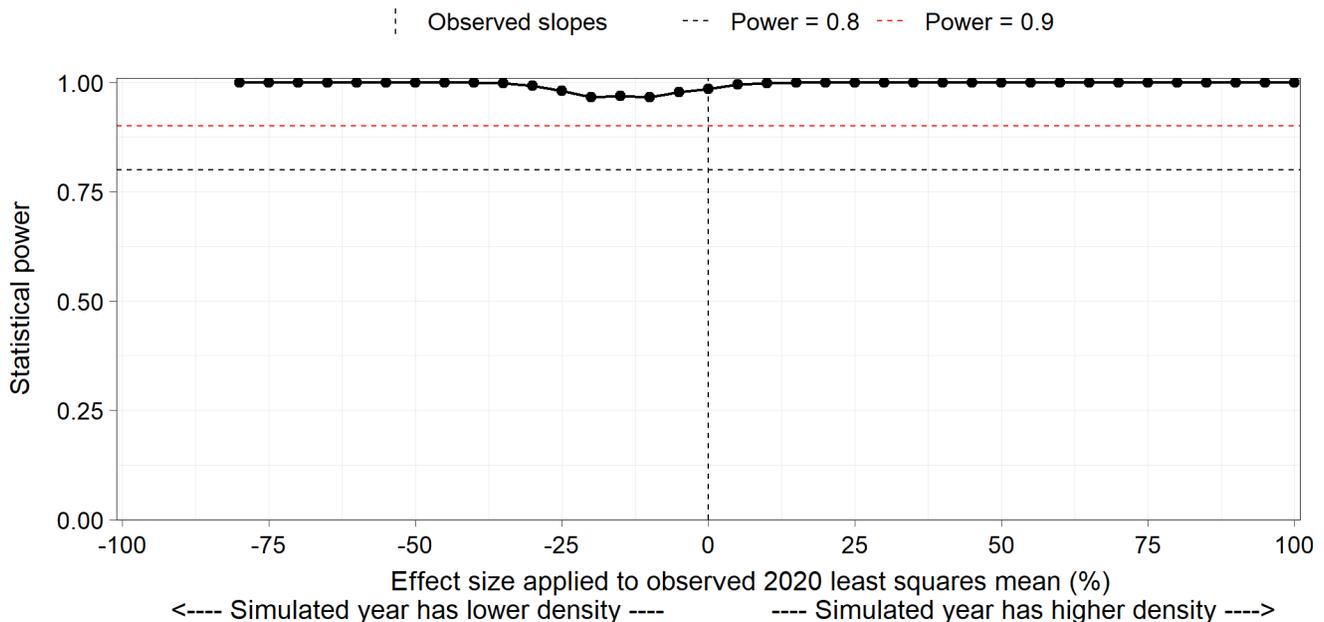


Figure 25 Statistical power of the overall model of 2018-2020 benthos density to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

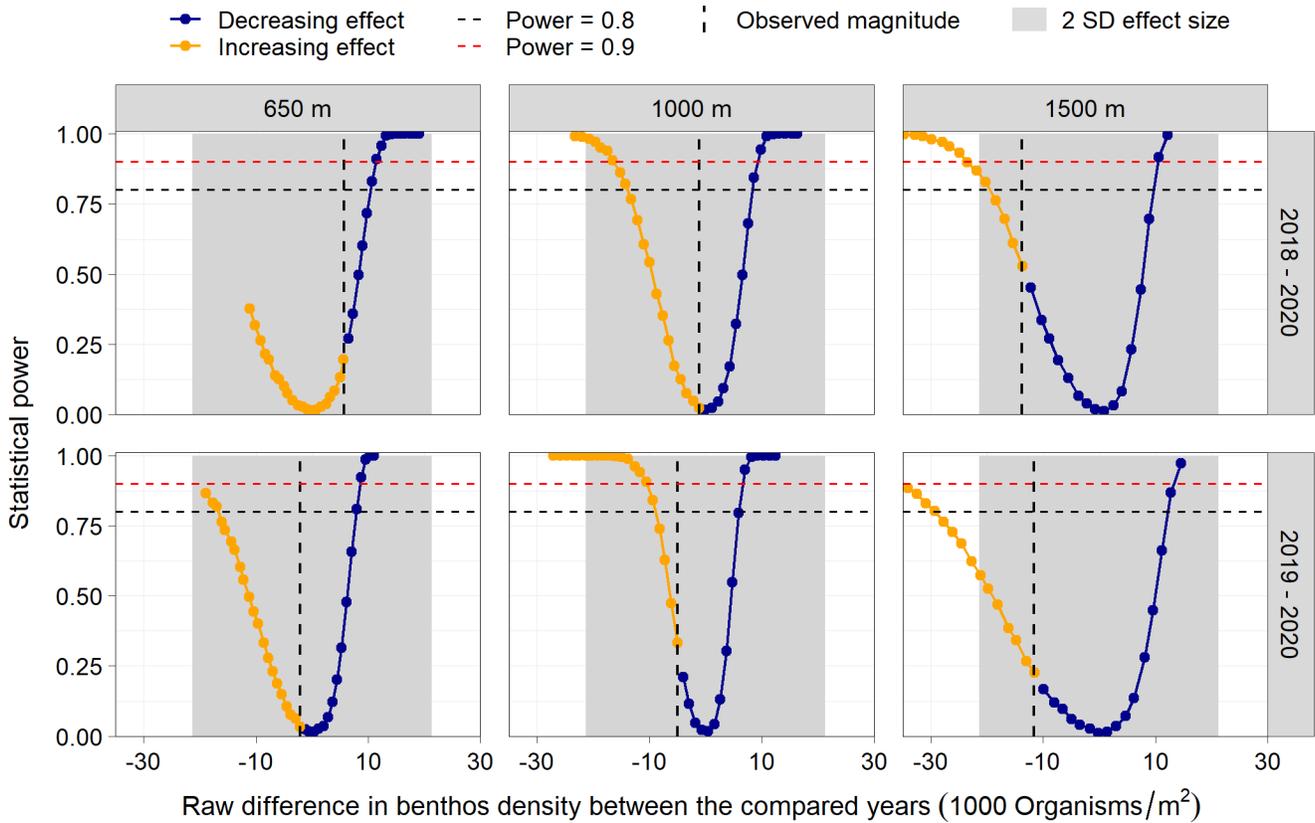


Figure 26 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in benthos density. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

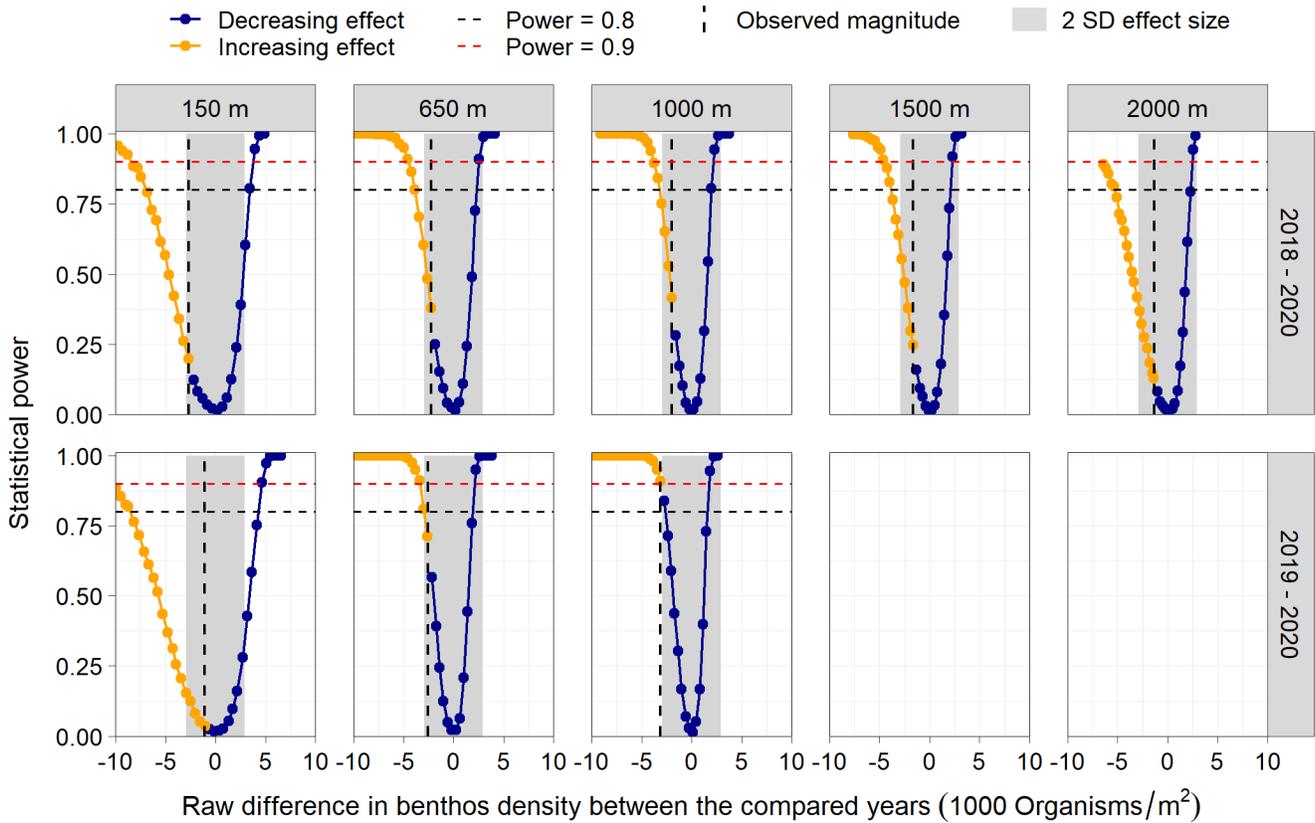


Figure 27 Statistical power of multiple comparisons between years at select distances along the North Transect relative to the difference in benthos density. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

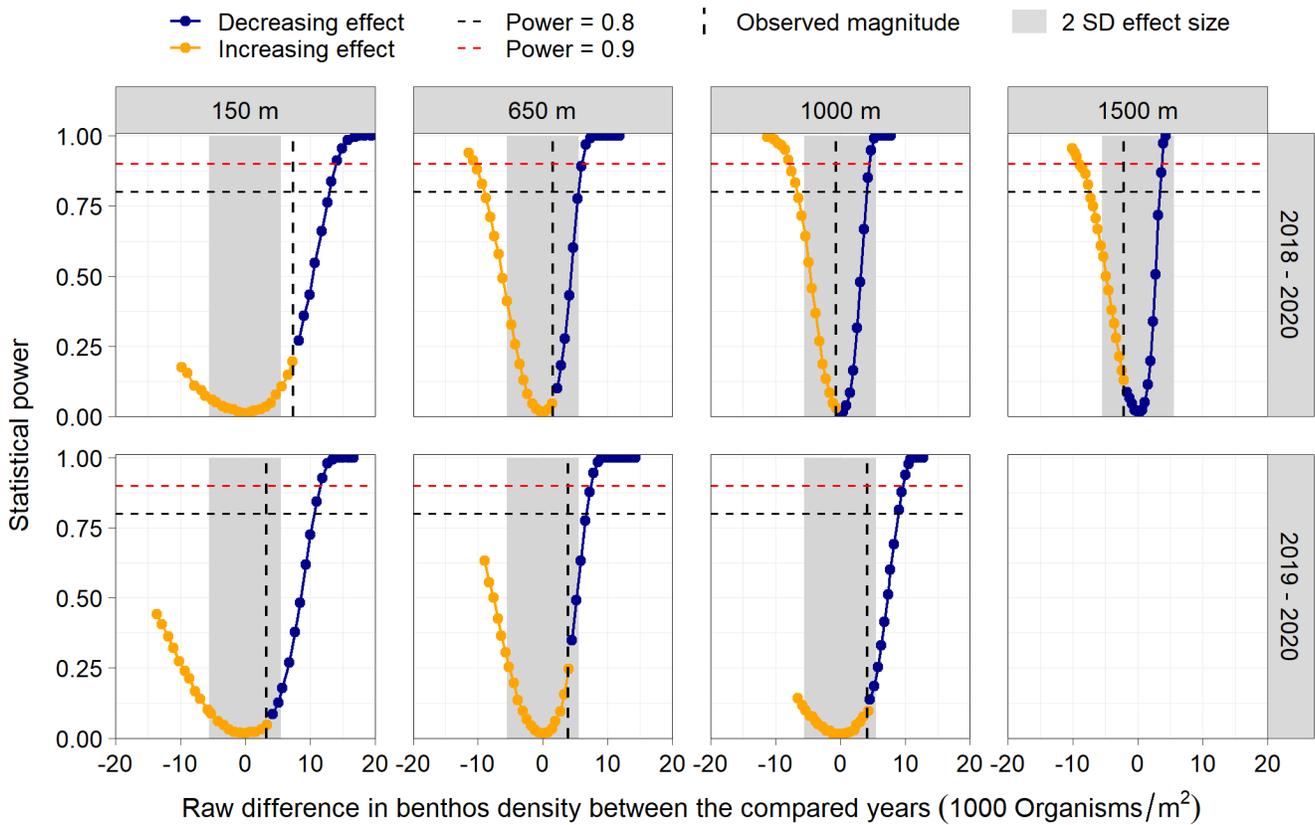


Figure 28 Statistical power of multiple comparisons between years at select distances along the West Transect relative to the difference in benthos density. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

Benthos – Total Richness in 2019-2020

The power analysis indicated that the analysis of benthos density collected in 2019-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 29). This is consistent with the finding of a significant main effect of sampling year in the original analysis of benthos density (Section 4.4.3.2.1 in Golder 2021).

In multiple comparisons between 2019 and 2020, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences at effect sizes of ± 2 SDs at 1,000 m but not the other two examined distances (Figure 30). Observed effect sizes were smaller, resulting in lack of significant differences between years in the original analysis. Along the Northeast Transect, there was sufficient power to detect differences at the ± 2 SD effect size at all three examined distances (Figure 31). Observed magnitudes of difference were between 4 taxa (at 1,500 m) and 13 taxa (at 650 m). A significant difference between years was detected at 1,000 m (difference of 9 taxa between years). Along the Northwest Transect, statistical power was also sufficient to detect a ± 2 SD effect size, but only at 650 m from the Ore Dock (Figure 32). Along the West Transect, statistical power was sufficient to detect a ± 2 SD effect size at 1,000 m and a $+2$ SD effect size at 650 m from the Ore Dock (Figure 33). The largest observed magnitude (26 taxa) was recorded at 150 m from the Ore Dock and was found to be significantly different (Section 4.4.3.2.1 in Golder 2021).

Overall, power to detect effects between years was highest at 650 m for both West and Northwest transect, and at 1,000 m for both East and Northeast transects. Power was sufficient to detect a ± 2 SD effect size at all four transects. Some observed effect sizes (e.g., Northeast Transect at 1,000 m and West Transect at 150 m) were sufficient for high power, consistent with the detection of significant differences between years in the original analysis (Section 4.4.3.2.1 in Golder 2021).

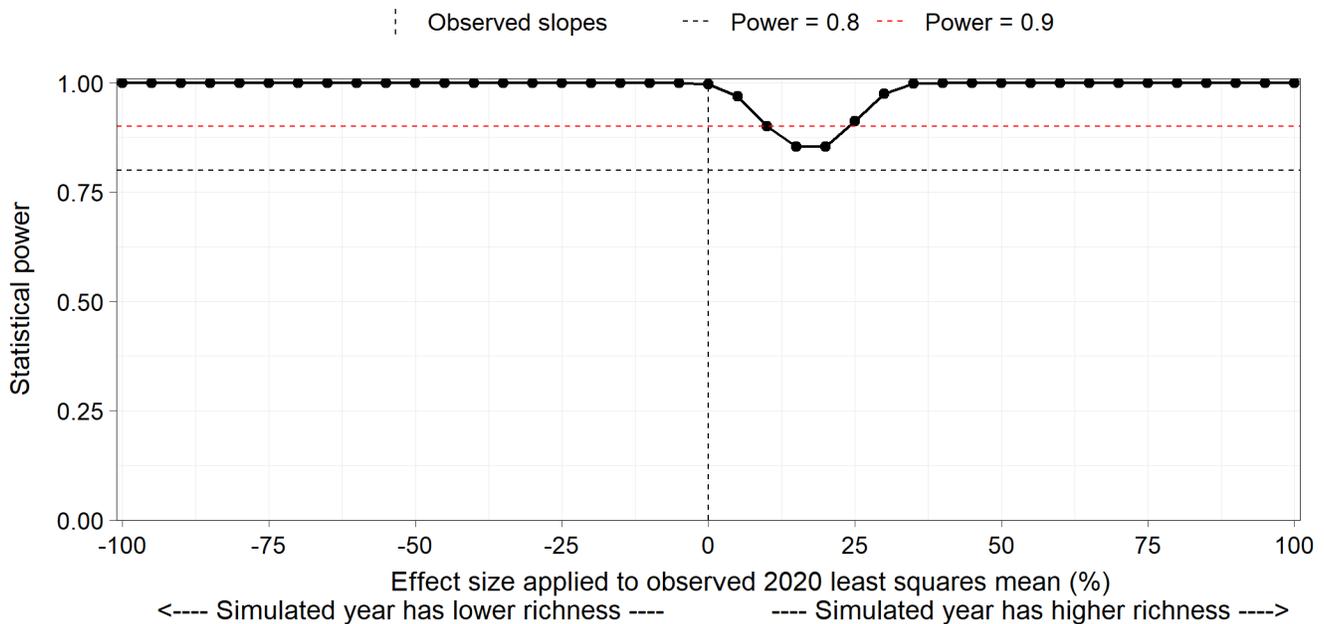


Figure 29 Statistical power of the overall model of 2019-2020 benthos richness to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

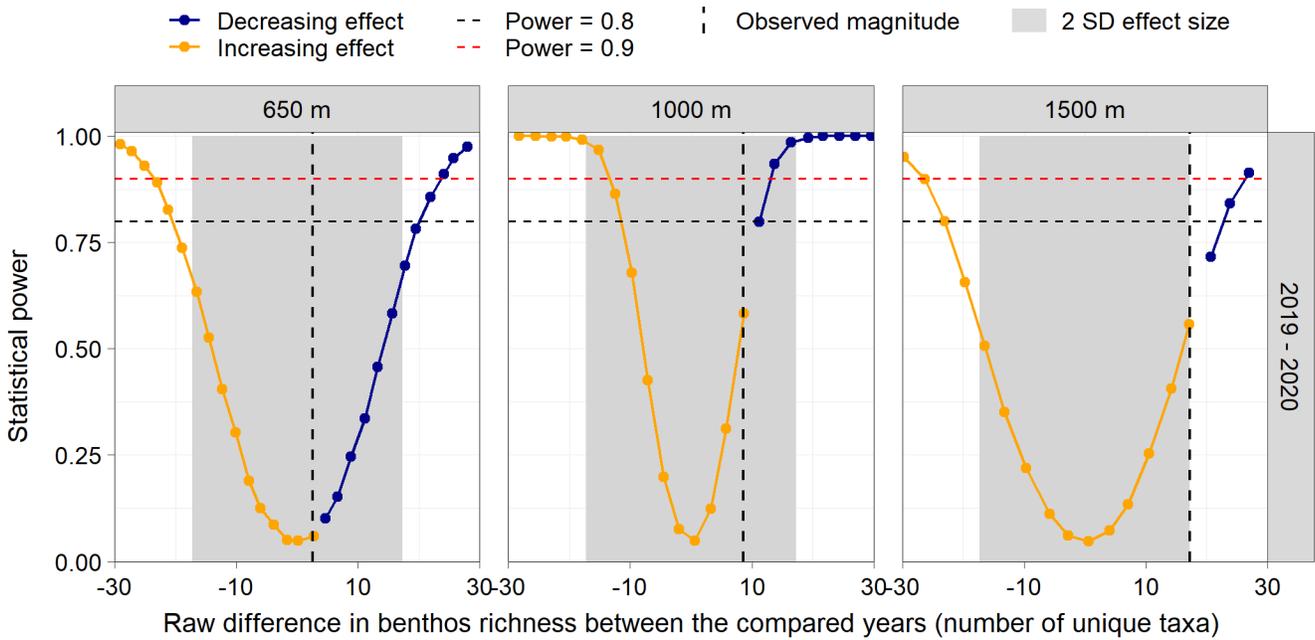


Figure 30 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in benthos richness. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

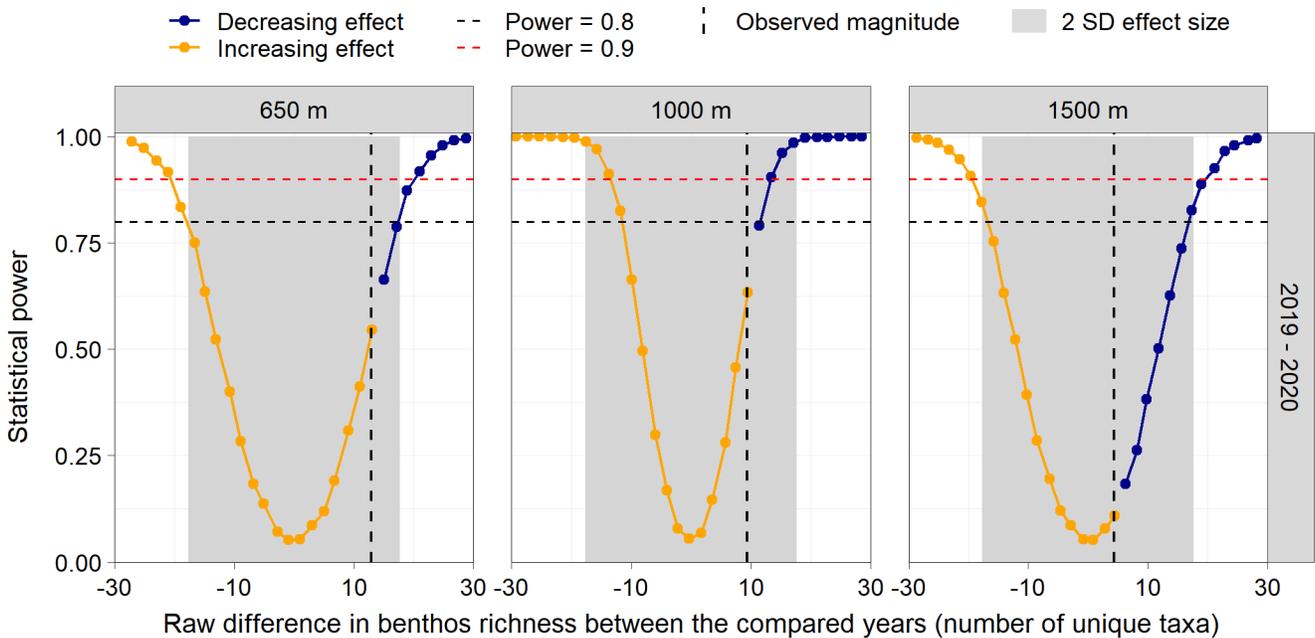


Figure 31 Statistical power of multiple comparisons between years at select distances along the Northeast Transect relative to the difference in benthos richness. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

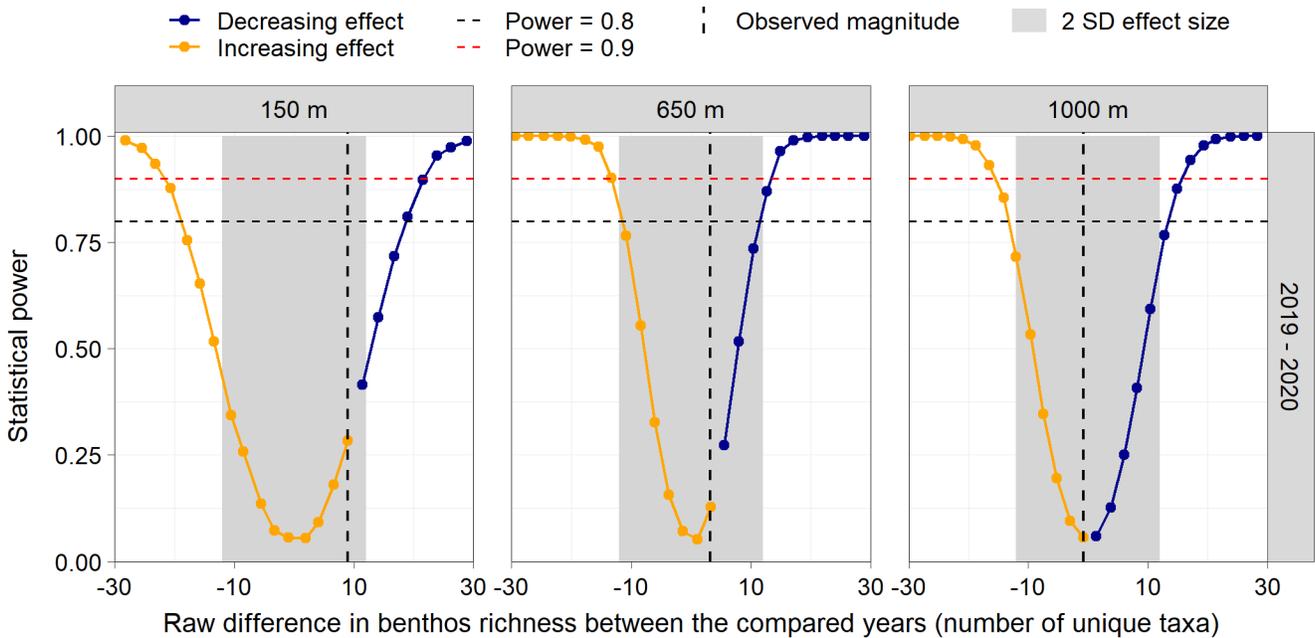


Figure 32 Statistical power of multiple comparisons between years at select distances along the Northwest Transect relative to the difference in benthos richness. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

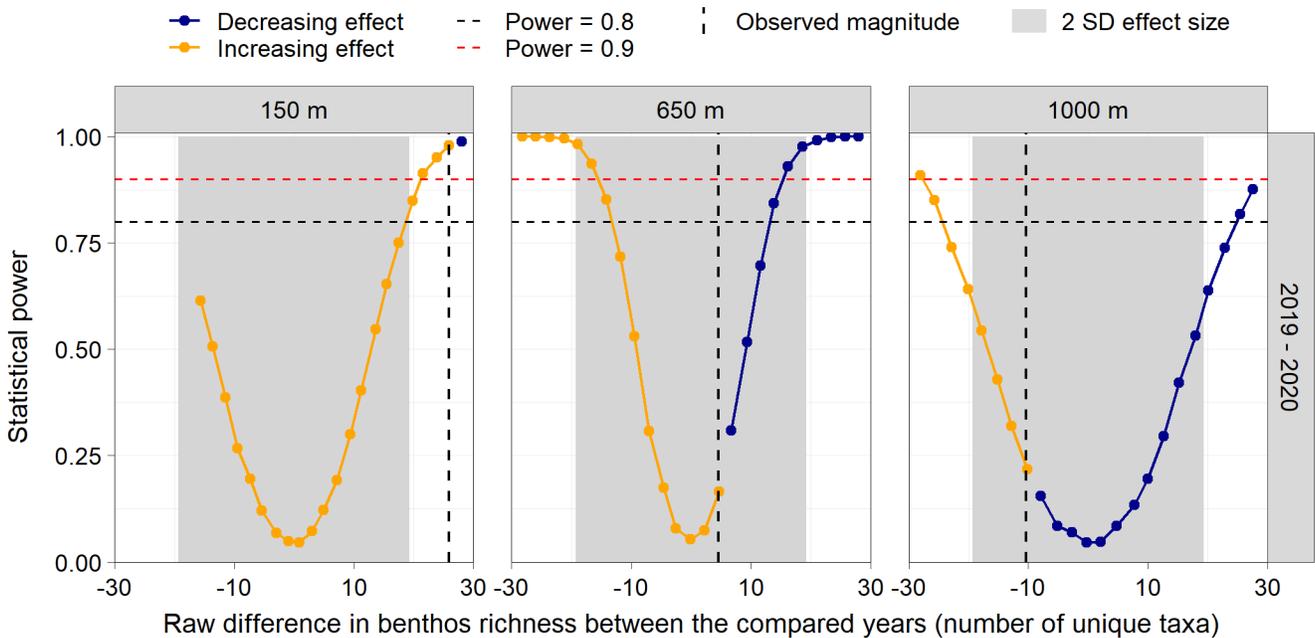


Figure 33 Statistical power of multiple comparisons between years at select distances along the West Transect relative to the difference in benthos richness. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

Benthos – Total Richness in 2018-2020

The power analysis indicated that the analysis of benthos richness collected in 2018-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 34). This is consistent with the finding of a significant three-way interaction between distance, transect, and sampling year in the original analysis of benthos richness (Section 4.4.3.2.2 in Golder 2021).

In multiple comparisons between sampling years, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences between the three sampling years at effect sizes of ± 2 SDs 1,000 m (comparisons of 2018-2020 and 2019-2020) and at a distance of 650 m (2018-2020 comparison only; Figure 35). The analysis had sufficient power to detect a raw difference of 11 taxa at 1,000 m from the Ore Dock (2019-2020 comparison). Along the North Transect, there was sufficient power to detect differences at the ± 2 SD effect size only at 650 m when comparing between 2019 and 2020 (Figure 36). Observed magnitudes of difference were between -1 taxa (at 1,000 m, 2019-2020 comparison) and 16 taxa (at 2000 m, 2018-2020 comparison). The original analysis detected a significant difference between 2018 and 2020 at 1,000 m from the Ore Dock (Section 4.4.3.2.2 in Golder 2021). Along the West Transect, statistical power was sufficient to detect a ± 2 SD effect size at three of the four assessed distances in comparisons between 2018 and 2020 and at 650 m in comparisons between 2019 and 2020 (Figure 37). The original analysis detected a significant difference between 2019 and 2020 at 150 m from the Ore Dock (Section 4.4.3.2.2 in Golder 2021).

Overall, power to detect effects between years was sufficient to detect a ± 2 SD effect size for at least some of the comparisons at the three transects. Several observed effect sizes (e.g., West Transect at 150 m when comparing between 2019 and 2020) were sufficient for high power, consistent with the detection of significant differences between years in the original analysis (Section 4.4.3.2.2 in Golder 2021).

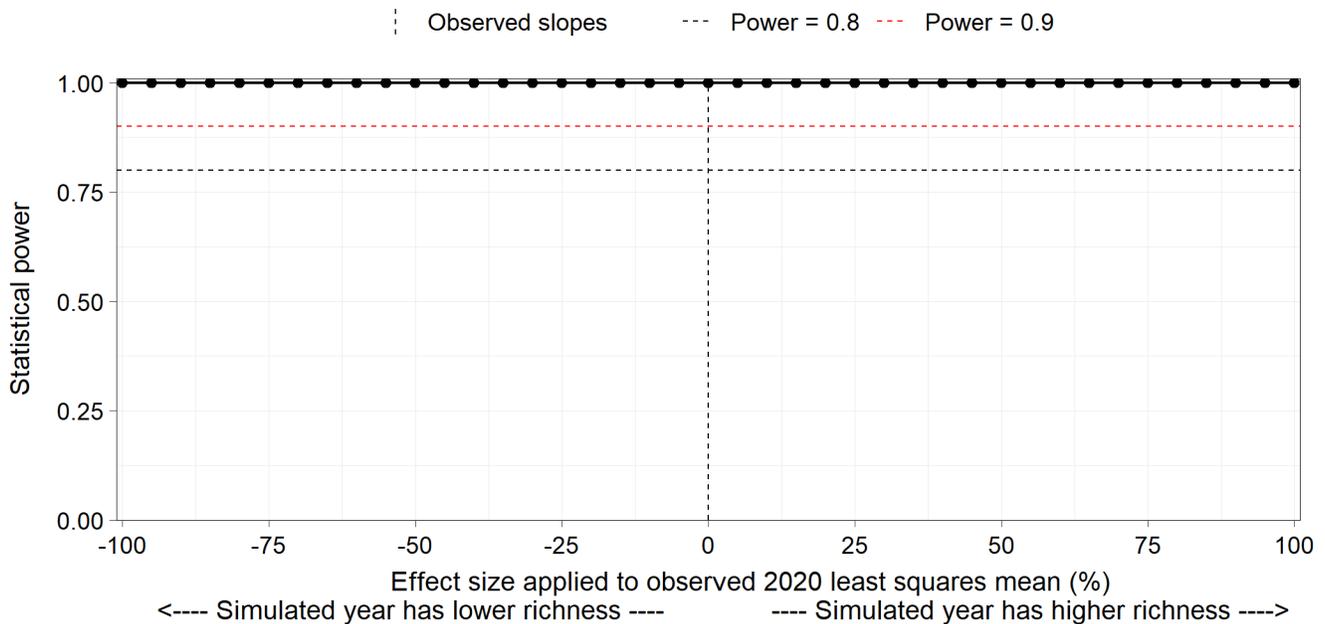


Figure 34 Statistical power of the overall model of 2018-2020 benthos richness to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

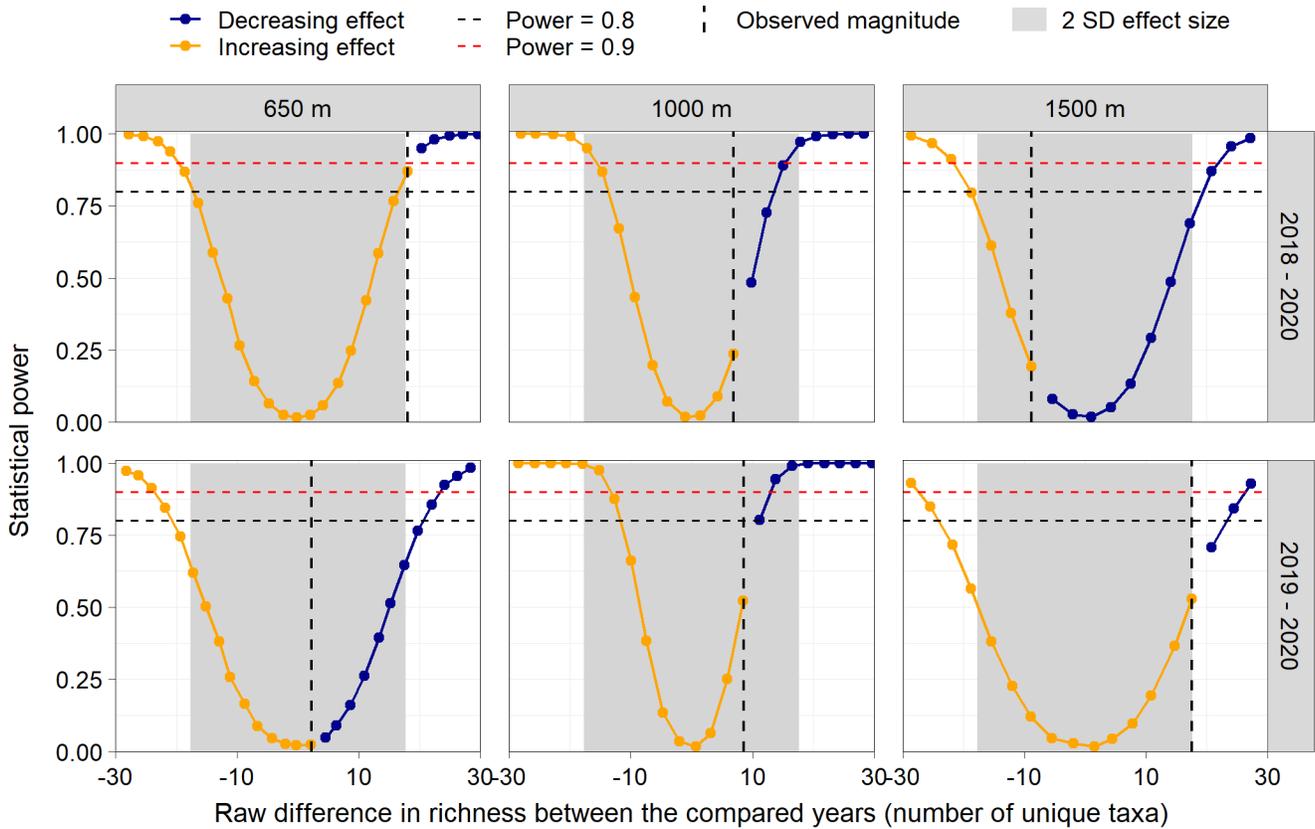


Figure 35 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in benthos richness. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

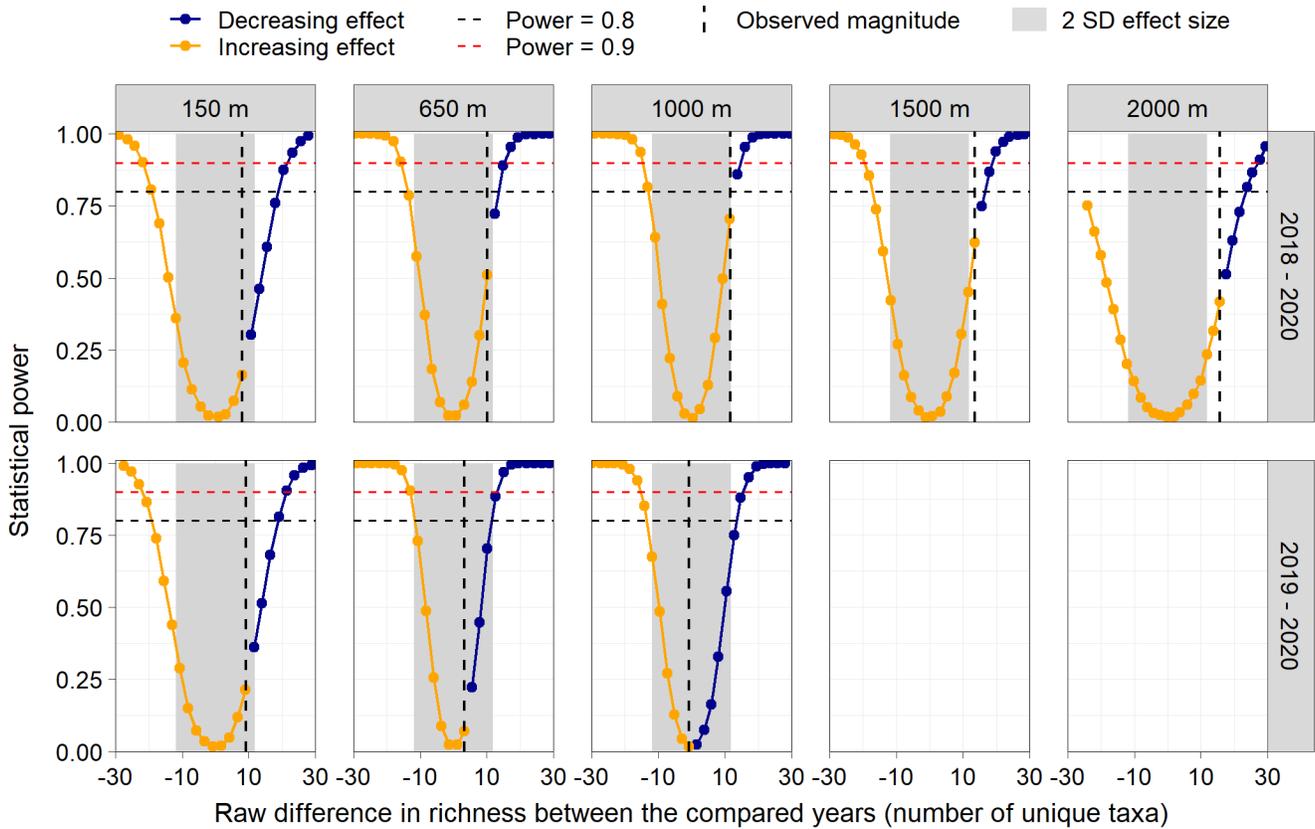


Figure 36 Statistical power of multiple comparisons between years at select distances along the North Transect relative to the difference in benthos richness. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

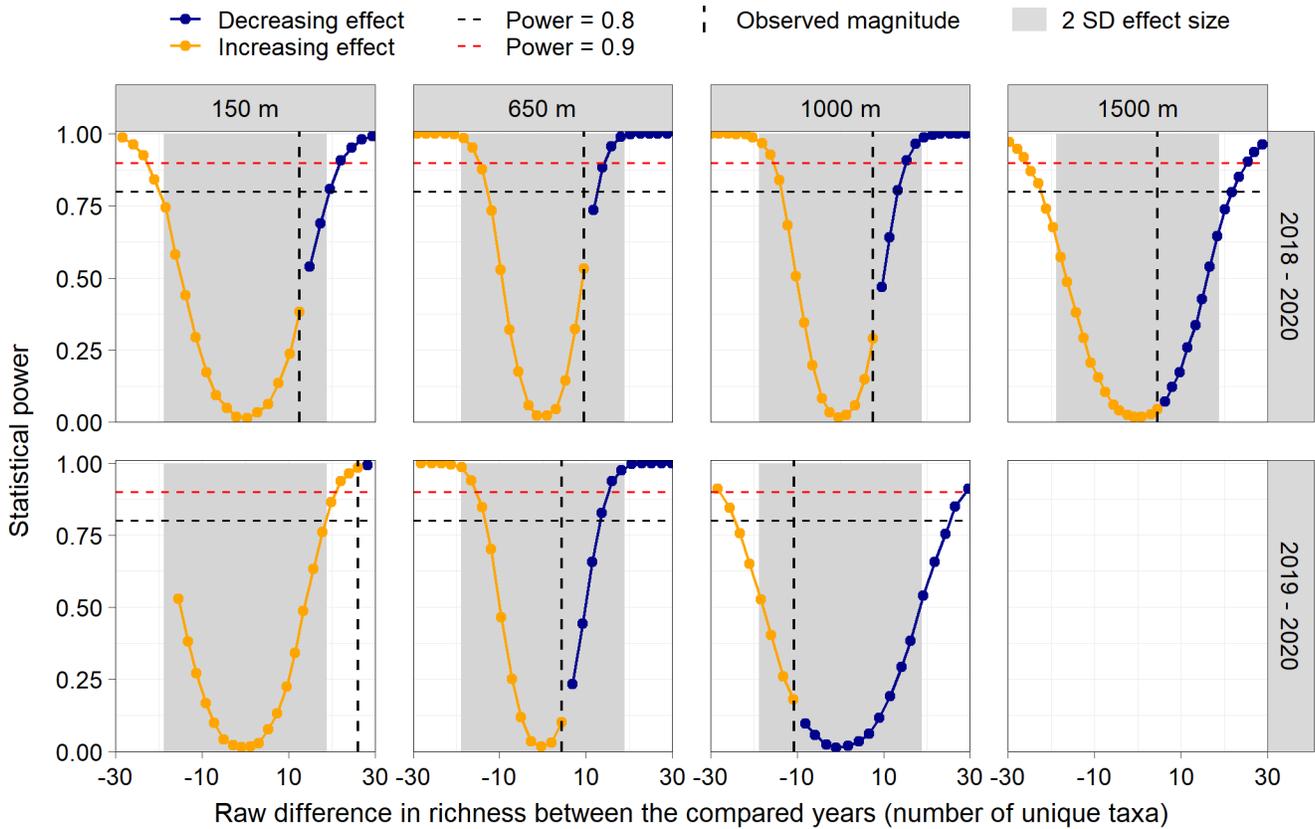


Figure 37 Statistical power of multiple comparisons between years at select distances along the West Transect relative to the difference in benthos richness. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

Benthos – SDI in 2019-2020

The power analysis indicated that the analysis of benthos SDI collected in 2019-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 38). This is consistent with the finding of a significant three-way interaction between distance from the Ore Dock, transect, and sampling year (Section 4.4.3.3.1 in Golder 2021).

In multiple comparisons between 2019 and 2020, the power analysis indicated that along the East Transect, there was not sufficient power to detect significant differences at effect sizes of ± 2 SDs (Figure 39), due to the low data variability (standard deviation value of 0.018). Observed effect sizes were larger, ranging from -0.071 (at 65 m) to +0.011 (at 1,000 m), resulting in a significant difference between years in the original analysis at 650 m from the Ore Dock. Along the Northeast Transect, there was sufficient power to detect differences at the ± 2 SD effect size at 650 m and 1,000 m distances (Figure 40). Observed magnitudes of difference were much lower, resulting in lack of significant differences found in the original analysis. Along the Northwest Transect, statistical power was not sufficient to detect a ± 2 SD effect size at any of the distances (Figure 41) due to the low variability in the data (standard deviation value of 0.014). Observed effect sizes were similar or smaller than the ± 2 SD value, resulting in lack of significant differences between years in the original analysis. Along the West Transect, statistical power was sufficient to detect a ± 2 SD effect size at 650 m but not at the two other distances (Figure 42). At both 650 m and 1,000 m distances, observed magnitudes were larger than ± 2 SD (values of 0.216 and 0.490), resulting in significant differences between years (Section 4.4.3.3.1 in Golder 2021).

Overall, power to detect effects between years was highest at 650 m for both West and Northwest transect, and at 1,000 m for both East and Northeast transects. Power was sufficient to detect a ± 2 SD effect size at Northeast and West transects, but not at Northwest and East transects. Some observed effect sizes (e.g., East Transect at 650 m and West Transect at 650 m) were sufficient for high power, consistent with the detection of significant differences between years in the original analysis (Section 4.4.3.3.1 in Golder 2021).

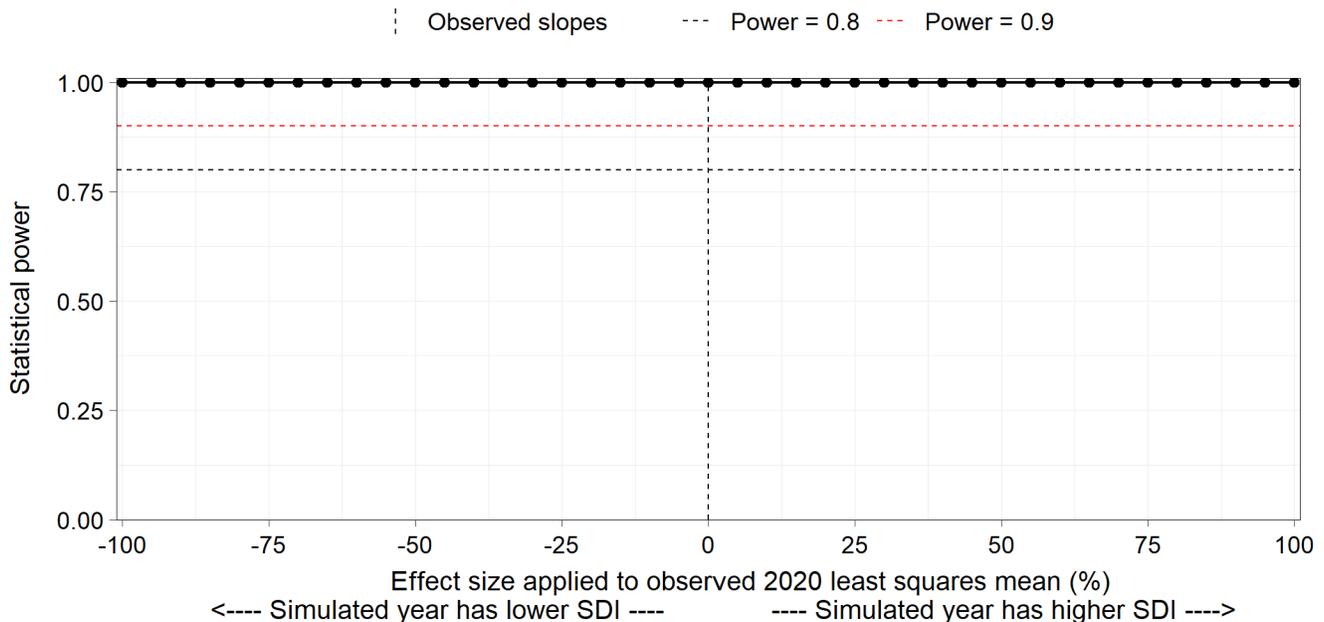


Figure 38 Statistical power of the overall model of 2019-2020 benthos SDI to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

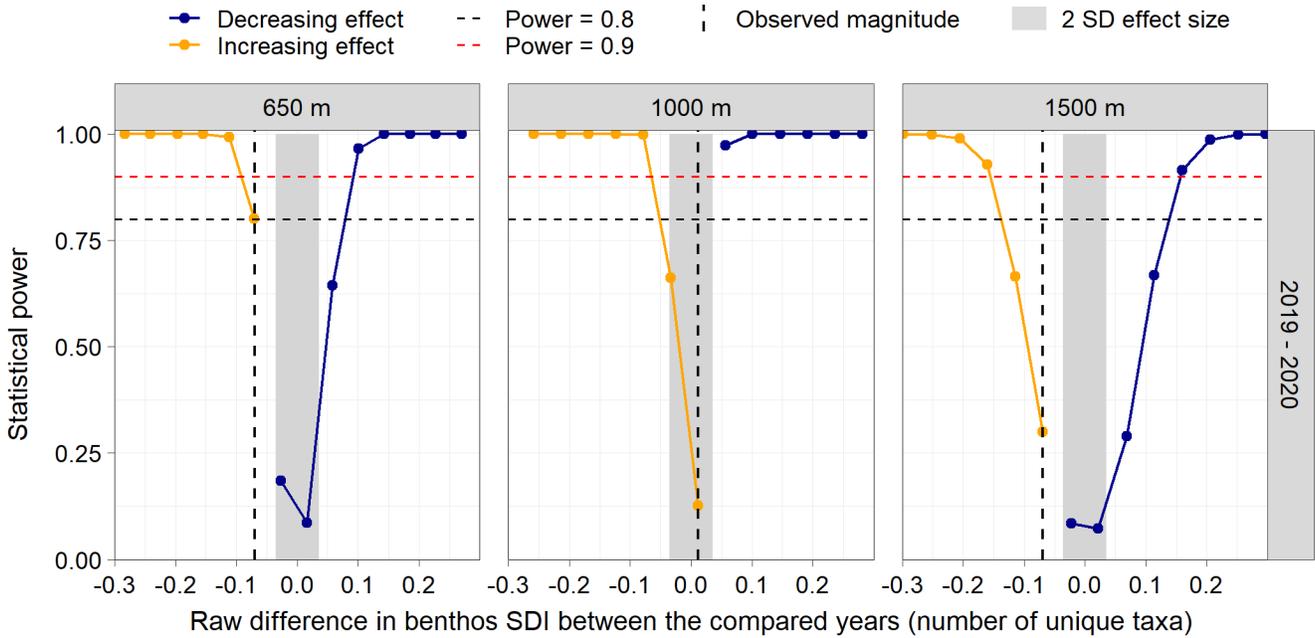


Figure 39 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in benthos SDI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

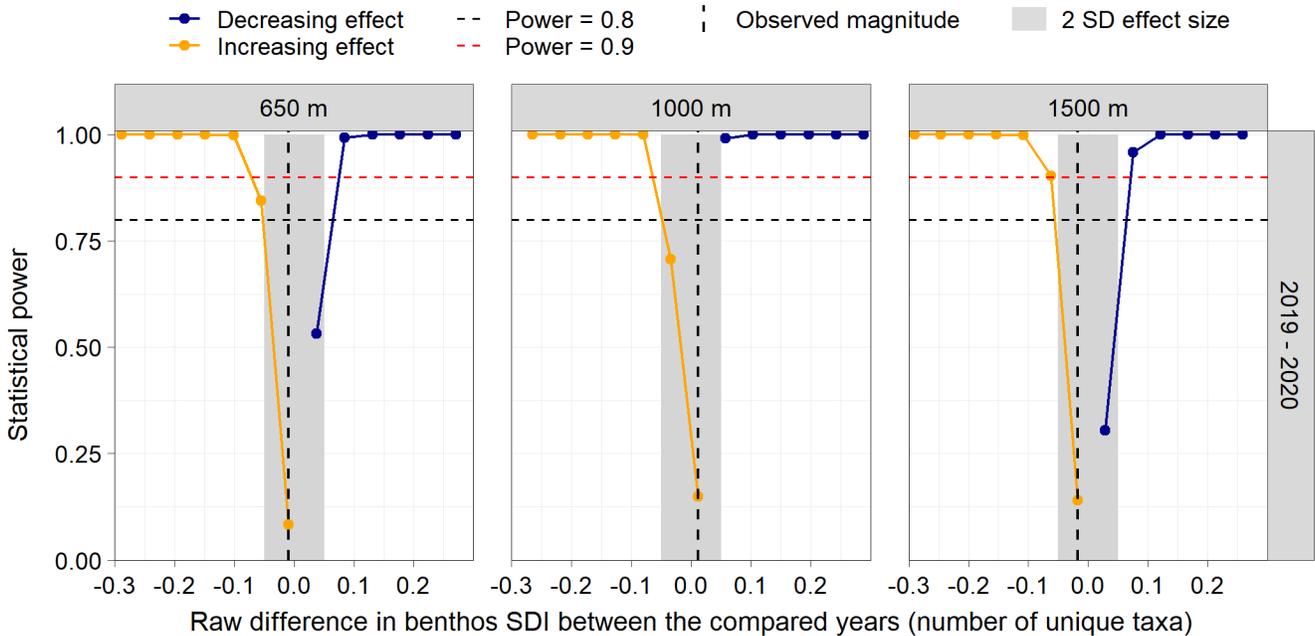


Figure 40 Statistical power of multiple comparisons between years at select distances along the Northeast Transect relative to the difference in benthos SDI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

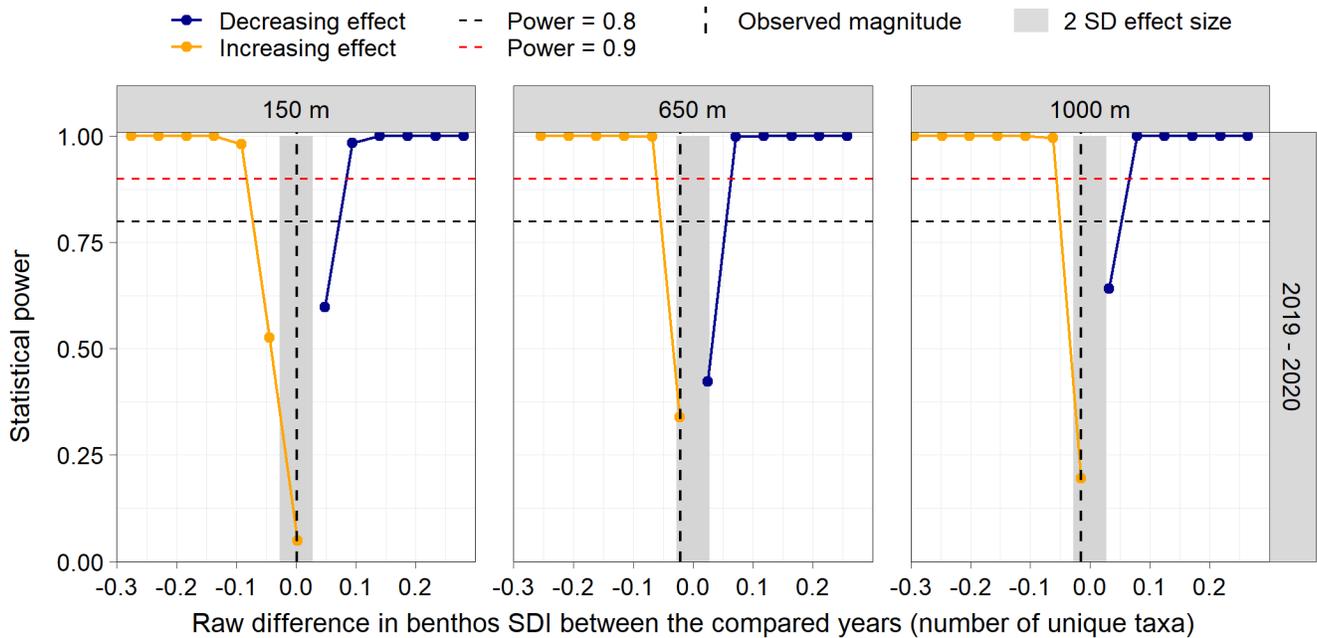


Figure 41 Statistical power of multiple comparisons between years at select distances along the Northwest Transect relative to the difference in benthos SDI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

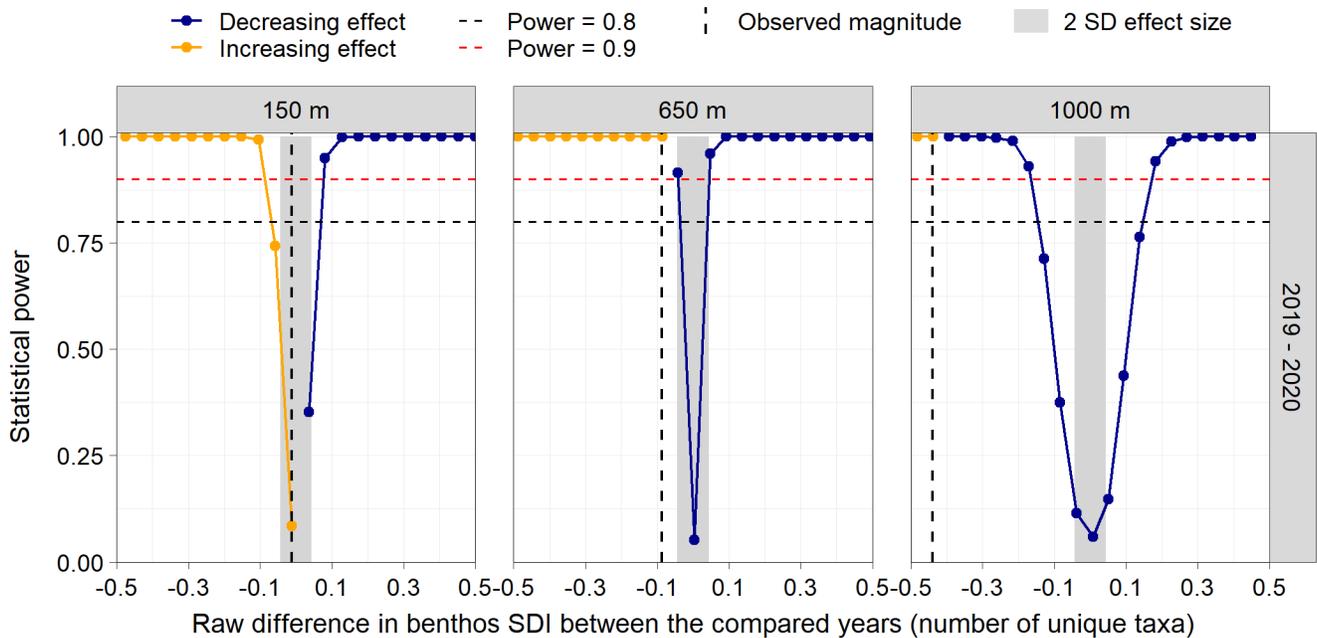


Figure 42 Statistical power of multiple comparisons between years at select distances along the West Transect relative to the difference in benthos SDI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

Benthos – SEI in 2019-2020

The power analysis indicated that the analysis of benthos SEI collected in 2019-2020 had high power (>0.9) to detect an overall effect of year or an overall significant difference in year effects between the sampled transects and distances at the observed effect size (indicated by the vertical line in Figure 43). This is consistent with the finding of a significant main effect of sampling year in the original analysis (Section 4.4.3.4.1 in Golder 2021).

In multiple comparisons between 2019 and 2020, the power analysis indicated that along the East Transect, there was sufficient power to detect significant differences at effect sizes of ± 2 SDs at 1,000 m distance (Figure 44). Along the Northeast Transect, there was also sufficient power to detect differences at the ± 2 SD effect size at 650 m distance (Figure 45). Observed magnitudes of difference were larger than the ± 2 SD effects at 650 m and 1,500 m distances (raw difference in SEI values of -0.122 and -0.133, respectively), resulting in significant differences found in the original analysis. Along the Northwest Transect, statistical power was sufficient to detect a ± 2 SD effect size at both 650 m and 1,000 m distances (Figure 46), with the 650 m observed effect size (SEI difference of -0.119) being sufficient to be detected in the original analysis. Along the West Transect, statistical power was sufficient to detect a ± 2 SD effect size at 650 m but not at the two other distances (Figure 47). At both 150 m and 650 m distances, observed magnitudes were larger than ± 2 SD (SEI differences of -0.144 and -0.198, respectively), resulting in significant differences between years (Section 4.4.3.4.1 in Golder 2021).

Overall, power to detect effects between years was highest at 650 m for both West and Northwest transect, and at 1,000 m for both East and Northeast transects. Power was sufficient to detect a ± 2 SD effect size at all four transects. Some observed effect sizes (e.g., Northeast Transect at 650 m and West Transect at 150 m) were sufficient for high power, consistent with the detection of significant differences between years in the original analysis (Section 4.4.3.4.1 in Golder 2021).

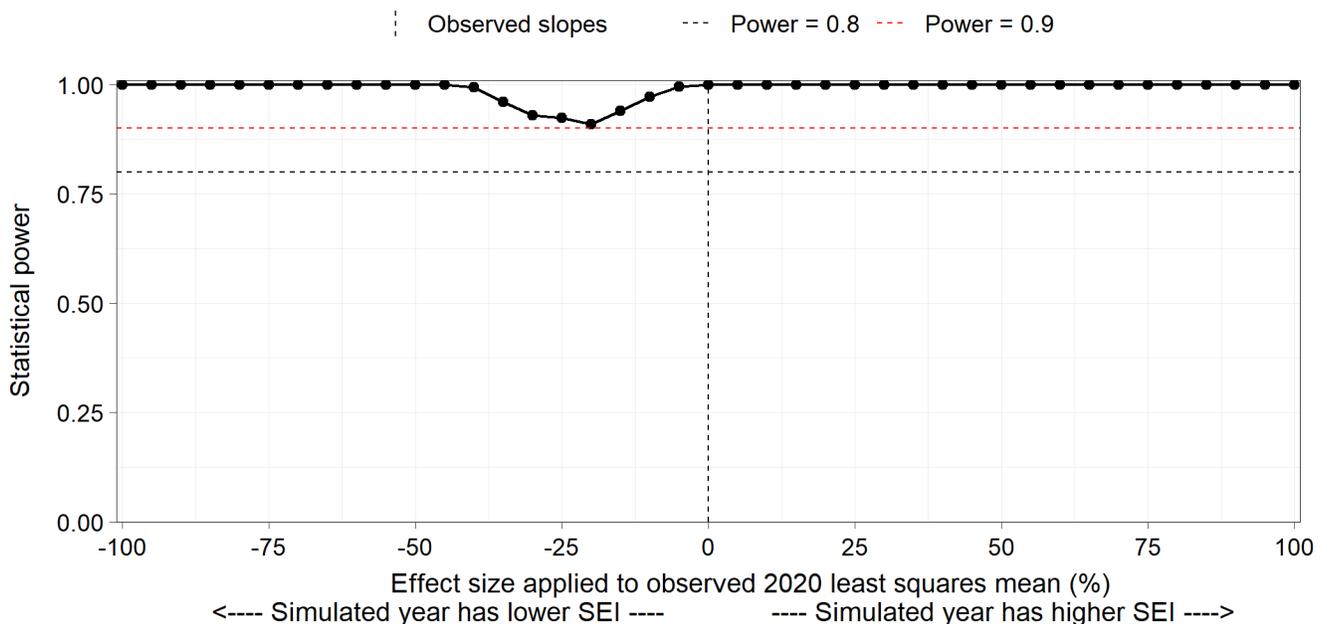


Figure 43 Statistical power of the overall model of 2019-2020 benthos SEI to detect a significant year effect (as main effect or interaction with either distance or distance and transect).

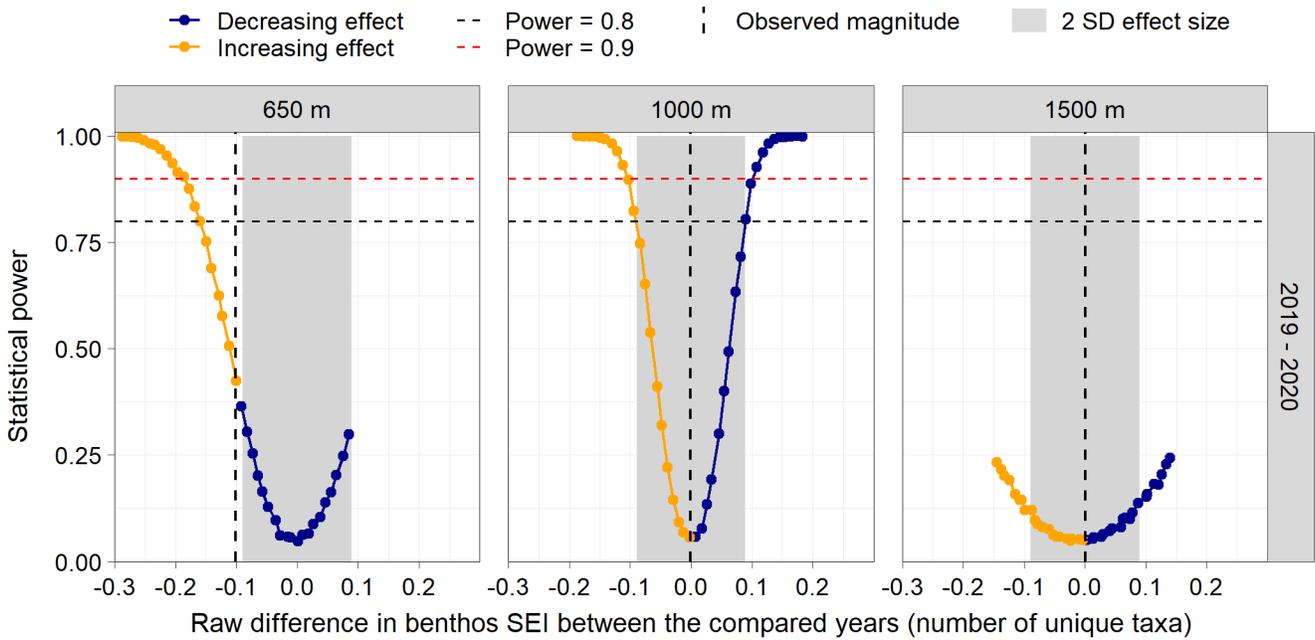


Figure 44 Statistical power of multiple comparisons between years at select distances along the East Transect relative to the difference in benthos SEI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

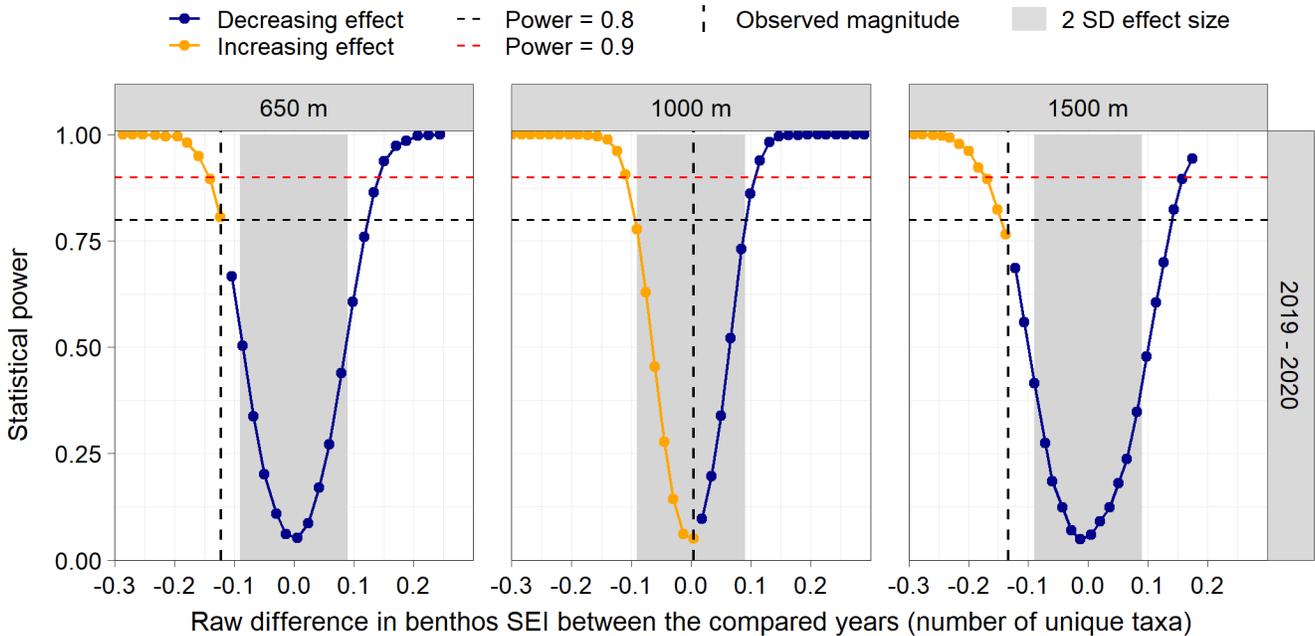


Figure 45 Statistical power of multiple comparisons between years at select distances along the Northeast Transect relative to the difference in benthos SEI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

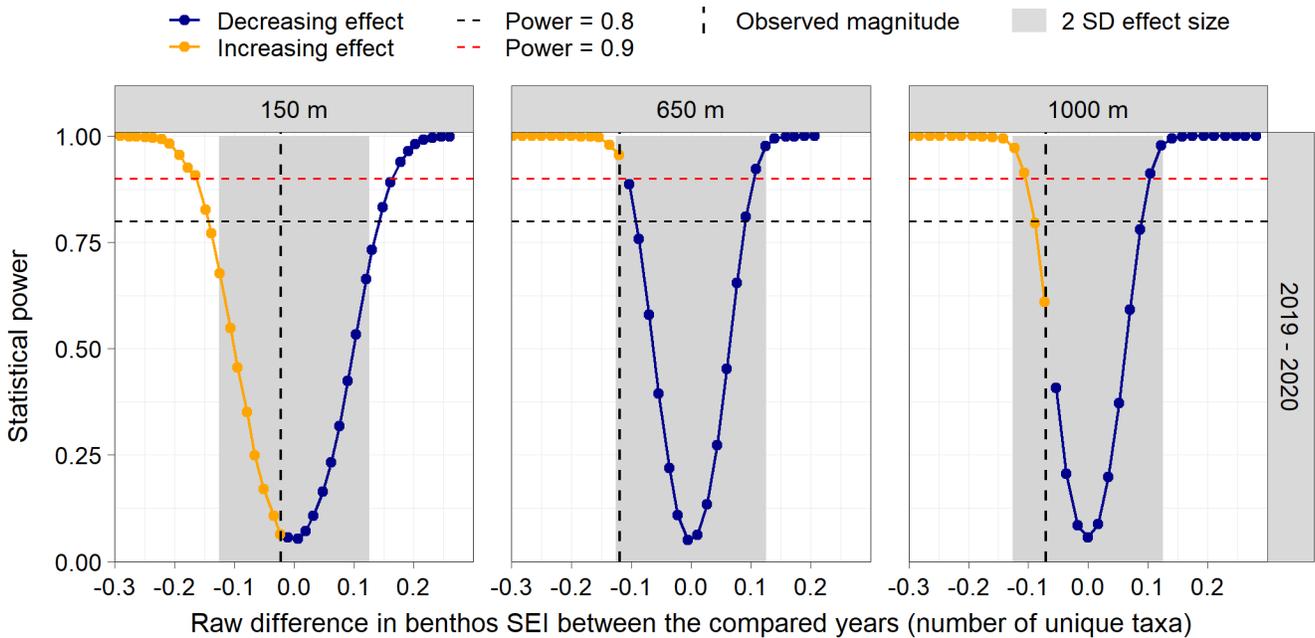


Figure 46 Statistical power of multiple comparisons between years at select distances along the Northwest Transect relative to the difference in benthos SEI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

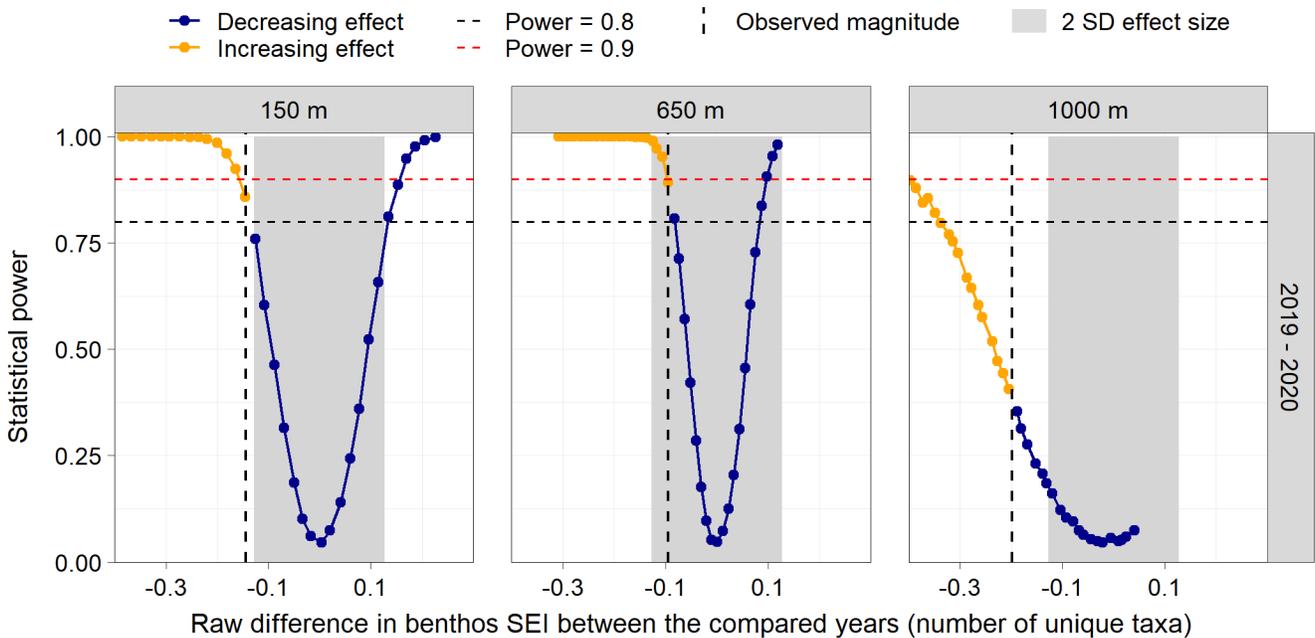


Figure 47 Statistical power of multiple comparisons between years at select distances along the West Transect relative to the difference in benthos SEI. Each panel shows a separate comparison, with the distances compared displayed at the top of the panel.

POWER ANALYSIS – SUMMARY

Summary of Findings

- Percent fines, 2019-2020 – statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and 2019 sampling years at three of the four transects.
- Percent fines, 2014-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and a previous sampling year at two of the three transects.
- Iron content, 2019-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and 2019 sampling years at two of the four transects.
- Iron content, 2014-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and a previous sampling year at two of the three transects
- Benthos total density, 2019-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and 2019 sampling years at three of the four transects.
- Benthos total density, 2018-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and a previous sampling year at two of the three transects.
- Benthos richness, 2019-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and 2019 sampling years at all four transects.
- Benthos richness, 2018-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and a previous sampling year at all three transects.
- Benthos SDI, 2019-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and 2019 sampling years at two of the four transects.
- Benthos SEI, 2019-2020 - statistical power was sufficient to detect magnitude differences of $\pm 2SD$ between 2020 and 2019 sampling years at all four transects.

Implications of Power Analysis Results

- The results suggested sufficient power to detect distance effects (within 2019 data) for all variables, under reasonable magnitudes of effect. That is, data collected in 2019 are deemed sufficient to identify ecologically relevant changes in the variables of interest along the sampled transects.
- The results suggested that to detect a year effect, magnitude differences had to be considerably higher than the magnitude differences required to detect a distance effect within 2019 data (e.g., 16-18% fines to detect a year effect, versus 2-4% fines to detect a distance effect). In the case of sediment quality, these magnitude differences were deemed ecologically reasonable given their observed values (e.g., 16-18% fines, 1,000-1,400 mg/kg iron content). In the case of benthos, the detection of year effects required a high magnitude of difference (e.g., 2,000-8,000 organisms/m² change in density and 12-13 taxa/sample). Therefore, for benthos analyses, it is possible that the current sample size may not be sufficient to detect a year effect under an ecologically significant effect size.

- In 2019, the number of benthos samples collected was lower than planned, due to technical difficulties. It is expected that the number of samples going forward will match the full sampling design, thereby increasing sample size and improving power. Since current sample size is sufficient to detect distance effects within the sampling year, and since sample size in the future is expected to increase relative to 2019, the statistical power of the analyses will be assessed in 2020, and the sampling design will be re-evaluated if deemed necessary.

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