



MOREV Tool



Mineral Occurrence Revenue Estimation & Visualization Tool

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www.mtri.org

www.mtri.org/mineraloccurrence.html

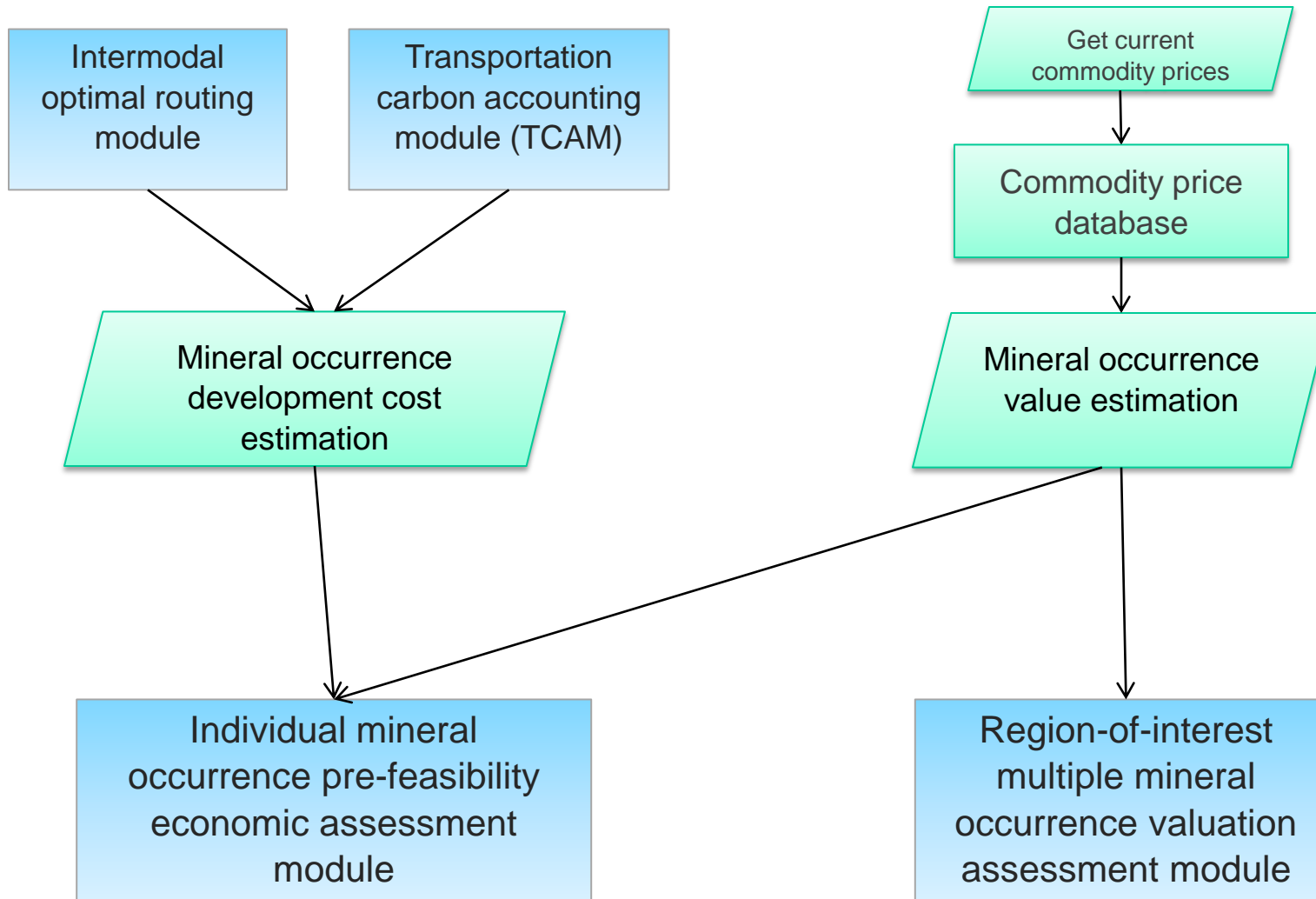
What is the MOREV Tool?

- An ArcMap-based suite of tools developed in order to effectively assess and communicate the value of mineral occurrences within regions of interest in Alaska, Yukon Territory, and British Columbia
- Primary purpose: spatialized mineral occurrence valuation
- Auxiliary functions:
 - Pre-feasibility economic assessments of individual mineral occurrences
 - Ability to modify commodity prices, or use the most recently available commodity prices
 - Intermodal (road, rail, water) transportation network for optimal routing
 - e.g., how much does it cost to ship the ore to a processing facility in China?
 - Carbon emissions accounting from transportation

Potential Users

- Small to midsized exploration interests in pre-feasibility stages of project planning for new mining projects
- Transportation & infrastructure planners
 - State & local government
- Potential for helping in permitting process
 - Example: Preparation of NI 43-101 mineral project disclosures in Canada
- Government agencies & resource database maintainers
- Investment community & lenders
- Researchers (geological, transportation, economic, etc.)

Tool Components



Example Single Mineral Occurrence Selection

MOREVT Commodity Price Database

Save and Close Cancel Load Defaults

Show historical prices from: 2005 ▾

Show commodities in deposit model: ALL ▾

Double-click on a historical price to load that price as the active value.
 Double-click on a column heading to load prices for all commodities for that category

Commodity	Value	Units	Source	Current	2011	2010	2009	2008	2007	2006	2005
Antimony	6.350	\$/lb	2011	4.87 (02-28-13)	6.350	4.700	2.220	2.560	2.567	2.381	1.606
Asbestos	642.200	\$/ton	2010	0 (NA)	0.000	642.200	1,060.400	851.000	430.000	410.000	508.000
Barite	43.200	\$/ton	2010	0 (NA)	0.000	43.200	43.200	47.080	62.000	50.000	50.000
Chromite	1,396.000	\$/ton	2011	0 (NA)	1,396.000	1,360.000	1,612.000	3,496.000	2,096.000	1,390.000	1,368.000
Cobalt	18.900	\$/lb	2011	11.96 (03-09-13)	18.900	20.000	20.520	23.435	24.766	13.925	15.241
Copper	3.500	\$/lb	2011	3.44 (03-19-13)	3.500	3.500	2.240	2.780	3.280	3.147	1.735
Gold	1,770.000	\$/tr oz	2011	1607.66 (03-19-13)	1,770.000	1,225.029	962.030	907.530	696.718	606.518	444.780
Iridium	1,031.383	\$/tr oz	2011	1023 (03-19-13)	1,031.383	642.034	420.000	488.246	444.430	349.450	169.510
Iron	155.280	\$/ton	2011	0 (NA)	155.280	108.570	92.000	68.000	54.000	48.000	40.000
Lead	1.233	\$/lb	2011	.98 (03-19-13)	1.233	1.089	0.862	1.153	1.238	0.776	0.612
Manganese	260.000	\$/ton	2011	0 (NA)	260.000	1,221.071	1,140.000	0.000	0.000	0.000	0.000
Mercury	1,082.098	\$/flask	2010	0 (NA)	0.000	1,082.098	613.992	634.112	533.361	674.198	558.529
Molybdenum	14.500	\$/lb	2011	11.11 (03-19-13)	14.500	17.000	9.370	23.564	30.295	24.775	31.797
Nickel	8.800	\$/lb	2011	7.58 (03-19-13)	8.800	10.000	6.548	12.453	16.874	10.977	6.668
Niobium	5.518	\$/lb	2009	0 (NA)	0.000	0.000	5.518	12.638	10.523	7.394	7.257
Osmium	169.097	\$/tr oz	2011	0 (NA)	169.097	250.491	252.000	0.000	0.000	0.000	0.000
Palladium	746.606	\$/tr oz	2011	1330.26 (03-19-13)	746.606	525.566	203.730	1,209.971	1,308.440	1,144.420	899.510
Phosphate	83.800	\$/ton	2011	0 (NA)	83.800	58.760	105.914	0.000	0.000	0.000	0.000
Platinum	1,748.023	\$/tr oz	2011	1742.83 (03-19-13)	1,748.023	1,608.960	1,084.590	846.538	357.340	322.930	203.540
Rare Earth Oxide	286.700	\$/lb	2009	0 (NA)	0.000	0.000	286.700	0.000	0.000	0.000	0.000
Rhodium	2,074.011	\$/tr oz	2011	1265 (03-19-13)	2,074.011	2,383.543	1,175.000	982.422	6,203.089	4,561.059	2,059.730
Silver	34.971	\$/tr oz	2011	28.83 (03-19-13)	34.971	20.229	14.430	15.329	17.107	11.602	7.340
Thorium-oxide	136.000	\$/lb	2009	0 (NA)	0.000	0.000	136.000	136.000	0.000	0.000	0.000
Tin	16.800	\$/lb	2011	10.49 (03-19-13)	16.800	10.250	6.070	8.881	8.981	5.670	4.808
Tungsten	136.000	\$/ton	2011	0 (NA)	136.000	136.000	136.000	157.800	158.800	166.000	118.000
Uranium	49.290	\$/lb	2010	37.5 (03-14-13)	0.000	49.290	46.000	46.000	33.000	18.500	14.600
Zinc	1.120	\$/lb	2011	.86 (03-19-13)	1.120	1.020	0.720	1.345	1.542	1.588	0.671

Example Multiple Mineral Occurrence Selection

Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1.0.000.000

MOREVT Multiple Occurrence Value Evaluator

Selected Occurrences (fid:name:model)

- 27: Independence: 36a
- 28: Lucky Shot; Willow Creek Mines Inc.: 36a
- 29: War Baby; Willow Creek Mines Inc.: 36a
- 30: Gold Bullion; New Bullion; Ready Bullion; \
- 31: Fern; Fern Gold Mining Co.; Fern Gold Lea
- 32: Martin; Alaska Free Gold Mining Co.: 36a
- 33: Gold Cord; Gold Cord Mining, Milling, and f
- 34: Mabel: 36a
- 35: High Grade; Kloss and Associates; Kloss a
- 36: Wet Gulch: 39a
- 37: Grubstake Gulch and Willow Creek area: C
- 38: Wolverine: 36a
- 39: Panhandle: 36a
- 40: Golden Top; Gold Top; Gold Top Mining C
- 41: Comeback; Gray Eagle: 36a
- 42: Rainbow: NA
- 43: Golden Light: NA
- 44: Ryan: NA
- 45: Prairie Creek: NA

Remove from List

Zoom To

Evaluate Individual Occurrence

Change Commodity Prices Recalculate

EGMV refers to estimated GMV, which is GMV multiplied by Probability of Development. For the 10th and 50th percentiles, Probability of Development is 0.001. For 90th percentile, it is 0.0005.

Deposit Model Summary

DM	Model Name	#	EGMV 10%	EGMV 50%	EGMV 90%
36a	LOW-SULFIDE Au-QUARTZ VEINS	104	\$32,214	\$2,577,120	\$105,165,151
39a	PLACER Au-PGE	88	\$6,397	\$999,460	\$54,596,784
NA	Not available	45	\$0	\$0	\$0
23	BASALTIC Cu	23	\$0	\$0	\$0
20c	PORPHYRY Cu-Au	8	\$6,965,000	\$44,510,000	\$149,980,800
22c	POLYMETALLIC VEINS	8	\$469	\$67,613	\$5,126,450
8a	PODIFORM CHROMITE	6	\$22	\$479	\$4,190
17	PORPHYRY Cu	3	\$1,236,900	\$15,876,000	\$161,373,300
24a	CYPRUS MASSIVE SULFIDE	2	\$8,820	\$380,800	\$7,684,579
21a	PORPHYRY Cu-Mo	2	\$5,001,852	\$35,883,500	\$136,403,137
6a	KOMATIITIC Ni-Cu	2	\$49,984	\$865,856	\$11,556,308
21b	PORPHYRY Mo, LOW-F	2	\$510,400	\$4,634,200	\$21,112,000
27d	Simple Sb	2	\$31	\$1,600	\$41,481
18a	PORPHYRY CU, SKARN-RELATED	1	\$714,000	\$5,569,600	\$31,115,000
39c	SHORELINE PLACE Ti	1	\$0	\$0	\$0
15b	Sn VEINS	1	\$2,822	\$104,832	\$1,738,800
15c	Sn GREISEN	1	\$45,696	\$677,376	\$5,132,400
39b	PLACER PGE-Au	1	\$219	\$14,021	\$300,904
25a	HOT-SPRING Au-AG	1	\$129,062	\$3,489,850	\$25,812,500
18b	Cu SKARN	1	\$1,666	\$66,640	\$2,121,842
24b	BESSHI MASSIVE SULFIDE	1	\$538	\$23,100	\$548,881
26a	CARBONATE-HOSTED Au-Ag	1	\$39,183	\$658,219	\$4,891,800
28a	KUROKO MASSIVE SULFIDE	1	\$3,780	\$235,980	\$6,371,821
27b	ALMADEN Hg	1	\$0	\$0	\$0
TOTAL:		306	\$14,749,054	\$116,636,246	\$731,078,129



- A route is calculated from mineral occurrence **origin** to **destination** point (port, cities, or facilities in U.S., Canada or overseas)
- Most cost efficient route is automatically chosen, but user can force route through waypoints
- Like Google/Yahoo Maps! Except intermodal.

MOREVT Optimal Routing Module

Step 1: Select destination point

	Lat.	Lon.	Mineral occurrence name
Origin:	68.420	-144.600	Koness River Headwaters

	Type	Region	Name
Destination:	Port		

Step 2: Select waypoints (optional)

An optimal route will be calculated that minimizes total shipping cost. To force the route through a particular city or port, insert up to four locations below.

	Include	Type	Region	Name
WP1:	<input type="checkbox"/>	Port		
WP2:	<input type="checkbox"/>	Port		
WP3:	<input type="checkbox"/>	Port		
WP4:	<input type="checkbox"/>	Port		

Step 3: Set options

Search tolerance: km Maximum distance from waypoint to network

Include road routes Include ALL proposed rail routes
 Include inland water routes
 Include ocean routes
 Include existing rail routes

Step 4: Calculate route

(may take s...)

Step 5: Review and save



Intermodal Optimal Routing Module

Users can choose origins & destinations

- After a route is successfully calculated, you can review, export the route to SHP/KML, and save the values, which are loaded directly into the costing calculations

MOREVT Optimal Routing Module

Step 1: Select destination point

Origin:	Lat.	Lon.	Mineral occurrence name
TUMMEL	62.547	-134.816	TUMMEL

Destination:	Type	Region	Name
Port	China	Dalian	

Step 2: Select waypoints (optional)

An optimal route will be calculated that minimizes total shipping cost. To force the route through a particular city or port, insert up to four locations below.

	Include	Type	Region	Name
WP1:	<input checked="" type="checkbox"/>	Port	Alaska	MackKenzie
WP2:	<input type="checkbox"/>	Port	Alaska	Anchorage
WP3:	<input type="checkbox"/>	Port	Alaska	Anchorage
WP4:	<input type="checkbox"/>	Port	Alaska	Anchorage

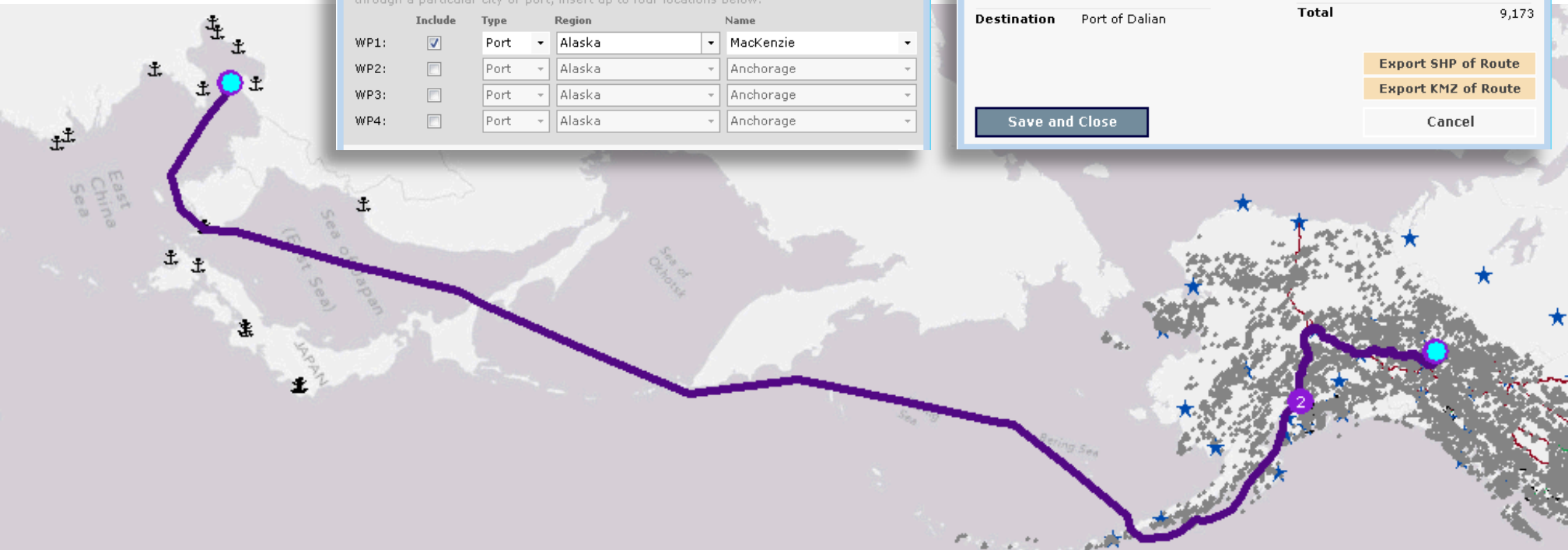
Step 5: Review and save

Values will show once route is successfully calculated.

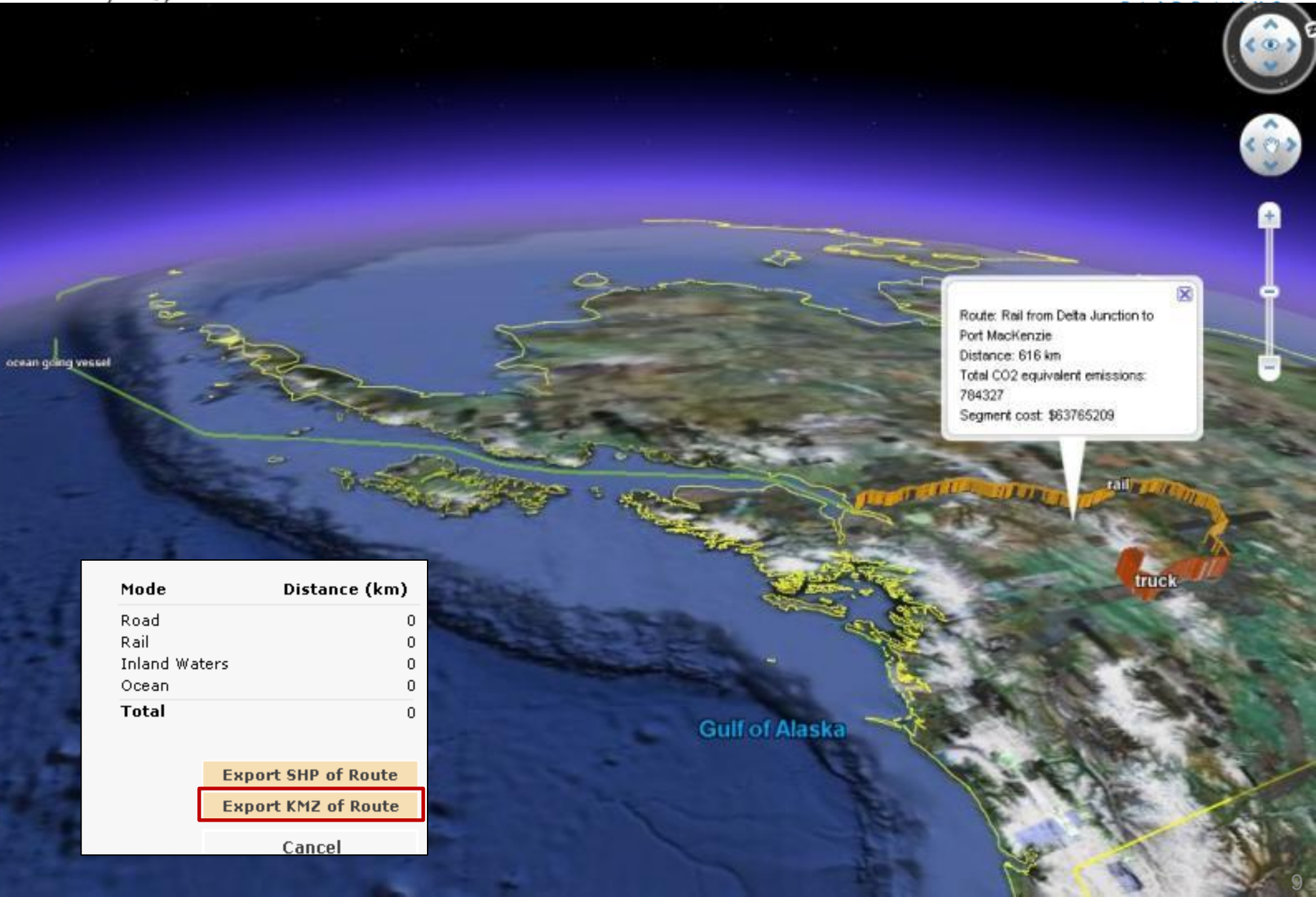
Origin	Mode	Distance (km)
TUMMEL	Road	0
WP1 MackKenzie	Rail	1,403
	Inland Waters	0
	Ocean	7,769
Destination Port of Dalian	Total	9,173

Export SHP of Route
Export KMZ of Route

Save and Close
Cancel



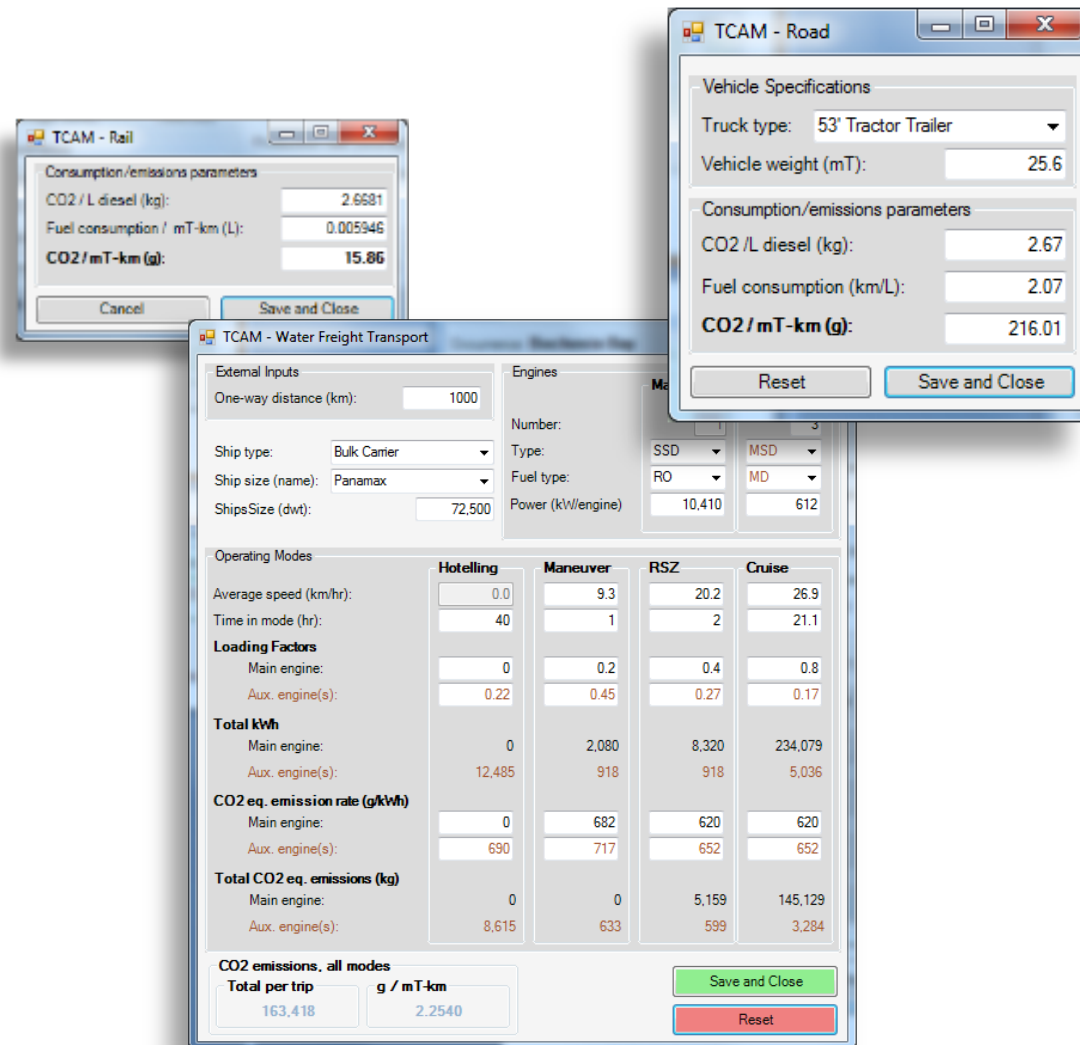
Route KML in Google Earth



Carbon Accounting

Transportation Carbon Accounting Module (TCAM)

- Rail, truck, barge, and OGV (ocean going vessel) emissions models are incorporated
- Mode-specific calculator forms show model assumptions and allow user-modification of default parameters
- Uses CO₂ equivalent values (includes: CO₂, CH₄, and N₂O)
- Sources for fuel consumption/emissions model data:
 - **Rail:** Association of American Railroads, US EPA
 - **Truck:** USDOT Federal Highway Administration, Vehicle Inventory and Use Survey (VIUS) 2002, US EPA
 - **Water:** MAN Diesel, European Environment Agency, US EPA, ICF International, Lloyd's Register



The screenshot displays three overlapping windows from the TCAM software:

- TCAM - Rail:** Shows consumption/emissions parameters for rail transport.

CO ₂ / L diesel (kg):	2.6681
Fuel consumption / mT-km (L):	0.005946
CO ₂ / mT-km (g):	15.86
- TCAM - Road:** Shows vehicle specifications and consumption/emissions parameters for road transport.

Truck type:	53' Tractor Trailer
Vehicle weight (mT):	25.6
CO ₂ / L diesel (kg):	2.67
Fuel consumption (km/L):	2.07
CO ₂ / mT-km (g):	216.01
- TCAM - Water Freight Transport:** Shows a detailed calculator for water freight transport.

One-way distance (km):	1000
Ship type:	Bulk Carrier
Ship size (name):	Panamax
ShipsSize (dwt):	72,500

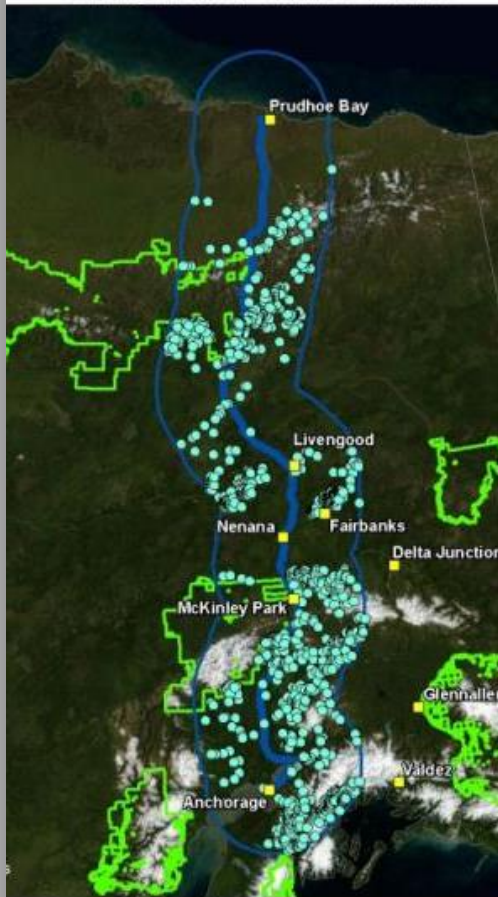
Operating Modes	Hotelling	Maneuver	RSZ	Cruise
Average speed (km/hr):	0.0	9.3	20.2	26.9
Time in mode (hr):	40	1	2	21.1
Loading Factors				
Main engine:	0	0.2	0.4	0.8
Aux. engine(s):	0.22	0.45	0.27	0.17
Total kWh				
Main engine:	0	2,080	8,320	234,079
Aux. engine(s):	12,485	918	918	5,036
CO₂ eq. emission rate (g/kWh)				
Main engine:	0	682	620	620
Aux. engine(s):	690	717	652	652
Total CO₂ eq. emissions (kg)				
Main engine:	0	0	5,159	145,129
Aux. engine(s):	8,615	633	599	3,284

CO₂ emissions, all modes	
Total per trip	163,418
g / mT-km	2.2540

Example MOREV Tool Analyses: Alaska Pipeline Project

- We used the MOREV Tool to evaluate potential revenue from mineral occurrences within corridors of two separate pipeline routes

ENSTAR Bullet Line



Alaska Gasline Project



Alaska Pipeline Project - Updated 11/2/2010 with Development Probability						
Model Code	Name	Metals	Amt	GMV (10th Perc.)	GMV (50th Perc.)	GMV (90th Perc.)
10	Carbonatite	Niobium - Rare Earth	1	\$771,795,431	\$9,329,300,739	\$38,420,308,164
26a	Carbonate-Hosted Au-Ag	Au-Ag	1	\$277	\$4,707	\$33,641
27b	Almaden Hg	Hg	1	\$0	\$0	\$0
30a	Sandstone-Hosted Pb-Zn	Pb-Zn-Ag	1	\$9,896	\$304,823	\$4,793,022
31b	Bedded Barite	Barite	1	\$1,489	\$30,713	\$260,597
38a	Lateritic Ni	Ni-Co	1	\$1,247,069	\$9,779,654	\$38,216,657
39b	Placer PGE-Au	Pt-Au-Os-Ir-Pl	1	\$157	\$11,918	\$253,611
9	Alaskan PGE and Epithermal Veins	Pt	1	\$0	\$0	\$0
14b	Sn Skarn	Sn	2	\$45,007	\$630,525	\$4,768,965
15b	Sn Veins	Sn	2	\$1,818	\$67,510	\$1,119,755
25g	Epithermal Mn	Mn	2	\$2,523	\$39,424	\$275,968
39c	Shoreline Placer Ti	Zr-Ti	2	\$149,486	\$7,742,151	\$152,147,019
6a	Komatiitic Ni-Cu	Ni-Au-Cu	2	\$31,998	\$540,902	\$6,552,870
15c	Sn Greisen	Sn	3	\$44,141	\$654,326	\$4,957,754
20b	Sn-polymetallic veins	Au-Ag-Pb-Zn	3	\$0	\$0	\$0
32a	Mississippi Valley Zn-Pb	Pb-Zn	3	\$0	\$0	\$0
24c	Volcanogenic Mn	Mn	4	\$7,065	\$207,528	\$2,343,891
31a	Sedimentary Exhalative Zn-Pb	Zn-Pb	4	\$469,315	\$9,963,579	\$106,186,580
18a	Porphyry Cu Skarn	Cu-Ag-Au-Mo	5	\$3,135,635	\$23,837,669	\$90,867,849
8e	Serpentine-Hosted Asbestos	Asbestos	6	\$61,078	\$588,154	\$2,950,605
18d	Fe Skarn	Fe	7	\$654,326	\$19,828,066	\$277,592,918
19a	Polymetallic Replacement	Pb-Zn-Cu-Ag-Au	7	\$57,062	\$1,872,126	\$30,815,076
18c	Zn-Pb Skarn	Zn-Pb-Cu	8	\$72,529	\$1,594,558	\$17,322,805
21a	Porphyry Cu-Mo	Cu-Mo-Au-Ag	8	\$15,788,676	\$110,237,308	\$397,001,891
21b	Porphyry Mo, Low F	Mo	9	\$1,789,382	\$16,246,773	\$74,015,336
25a	Hot Spring Au-Ag	Au-Ag	12	\$0	\$0	\$0
17	Porphyry Cu	Cu-Ag-Au-Mo	19	\$6,709,091	\$86,823,819	\$632,182,850
34c	Phosphates	PrOs-P	19	\$0	\$0	\$0
20c	Porphyry Cu-Au	Cu-Au-Ag-Mo	23	\$11,927,285	\$67,332,511	\$202,579,108
14a	W Skarn	W	24	\$9,738	\$422,162	\$8,821,286
24b	Besshi Massive Sulphide	Cu-Ag-Au-Pb-Zn	28	\$13,550	\$574,074	\$11,034,567
8a	Poiciform Chromite	Cr	33	\$82,492,478	\$10,453,592,312	\$59,085,521,764
18b	Cu Skarn	Cu-Ag-Au	34	\$35,981	\$1,442,311	\$27,864,929
27d	Simple Sb Deposits	Sb-Ag-Au	34	\$138	\$7,222	\$186,206
5b	Noril'sk Cu-Ni-PGE	Au-Pd-Pt	50	\$0	\$0	\$0
24a	Cyprus Massive Sulphide	Cu-Ag-Au-Pb-Zn	52	\$206,510	\$8,853,963	\$115,958,480
28a	Kuroko Massive Sulphide	Cu-Pb-Zn-Au-Ag	79	\$344,782	\$14,664,440	\$285,809,883
23	Basaltic Copper	Au-Ag-Cu-Ni-Zn-Co	88	\$0	\$0	\$0
22c	Polymetallic Veins	Ag-Au-Pb-Zn-Cu	115	\$1,596	\$152,342	\$7,481,083
36a	Low Sulphide Au-Quartz Veins	Au-Ag	367	\$591	\$47,265	\$6,399,194
	No Description		405	\$0	\$0	\$0
39a	Placer Au-PGE	Au-Ag	520	\$3,309	\$39,426	\$2,150,505
TOTALS			1987	\$897,109,410	\$20,167,434,999	\$100,018,774,830

Example MOREV Tool Analyses: Klondike Highway Freight Forecasts

- We provided estimated freight volumes from mineral occurrence development to the Alaska Department of Transportation (AKDOT) for their 20 year freight forecasts.
- These forecasts are used to inform the toll rates required to pay for highway maintenance

Freight Volume Projections from MOREV

BC Highway 37

Corridor length (km) 461

Mineral Occurrence Summary

w/in corridor 1357

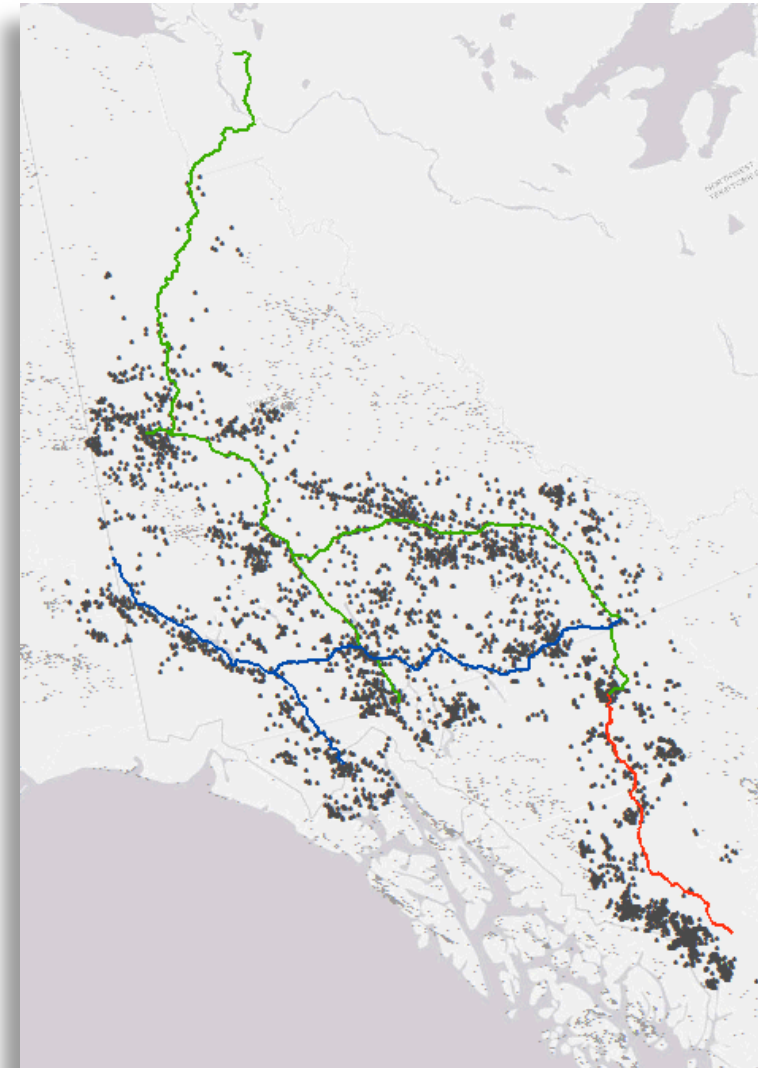
w/ assigned DMs 730

w/ quantified DMs 711

unquantified DMs in gray italics

Freight Volume by Mineral Occurrence (mT/day)

Deposit model	#	10th Percentile		50th Percentile				90th Percentile					
		per occurrence		all occurrences		per occurrence		all occurrences		per occurrence		all occurrences	
		Above	Under	Above	Under	Above	Under	Above	Under	Above	Under	Above	Under
NA	627	0	0	0	0	0	0	0	0	0	0	0	0
22c	544	0.2	0.3	109	163	9	8	4733	4134	272	180	147968	98083
17	67	38.6	17.3	2586	1159	246	93	16469	6211	1683	532	112761	35637
36a	31	0	0	0	0	0	0	0	0	0	0	0	0
21b	23	3.6	1.6	83	37	17	7	400	156	85	28	1946	651
39a	22	0	0	0	0	0	0	0	0	0	0	0	0
18a	21	65.7	29.3	1380	615	310	123	6514	2579	1497	526	31435	11048
22a	19	0	0	0	0	0	0	0	0	0	0	0	0
23	2	143	100.6	286	201	1214	644	2428	1287	2932	1383	5864	2765
18b	1	1.4	1.1	1	1	22	13	22	13	311	149	311	149
TOTAL	1357			4,445	2,177			30,565	14,381			300,285	148,333
Normalized by PoD (mT/day)				4.4	2.2			30.6	14.4			300.3	148.3
Mean per quantified DM (mT/day)				0.0065	0.0032			0.0430	0.0202			0.4358	0.2153
Annual projected (mT/yr)				1,600	784			11,004	5,177			108,103	53,400
Annual projected (mT/km/yr)				3.5	1.7			23.9	11.2			234.5	115.8





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