From: David Dunnison [redacted]
Sent: Sunday, January 23, 2022 2:43 PM
To: Islands2050
Subject: Addendum to Submission
Attachments: Islands 2050 Addendum - The Precautionary Principle and Carbon Sequestration.pdf

Hi,

As noted, the following is an explanatory addendum to yesterday's (22 January 2022) submission to Islands 2050 on The Precautionary Principle and Commitment to Science.

A pdf version has also been attached for convenience.

Regards, David
dunnison@dunnison.com

Addendum for Islands 2050 Submission: The Precautionary Principle and Commitment to Science

David Dunnison, 23 January 2022

This Addendum analyzes the singular study, Schuster (2014), utilized to claim a carbon storage and sequestration advantage in the Islands Trust Area. This Addendum reveals where the math has been mistaken and how it does not support the claimed advantage but reveals a marked comparative disadvantage.

From the 22 January 2022 Submission:

> *"The Islands Trust has claimed 43% advantage in carbon sequestration based upon a singular, effectively in-house study that has not been independently verified.[i] Rather than the advantage claimed, the numbers in the sole, unconfirmed study reveal that Islands Trust forests are at a 27% sequestration rate disadvantage. There is an arithmetic mistake and the Islands Trust analysis has not compared apples to apples; or, in this case, trees to trees. Rather, the Islands Trust is mistakenly comparing proportion of forested areas to overall land areas, rather than forest or tree quality and performance. Yes, unsurprisingly, the Islands Trust area does have proportionately more forested area than less rural areas nearby. But the numbers reveal that these Islands Trust Area forests are not as good at sequestering carbon."*

Analyzing Schuster (2014)

The first Figure from Schuster (2014) provides a helpful overview to begin an analysis of this work.

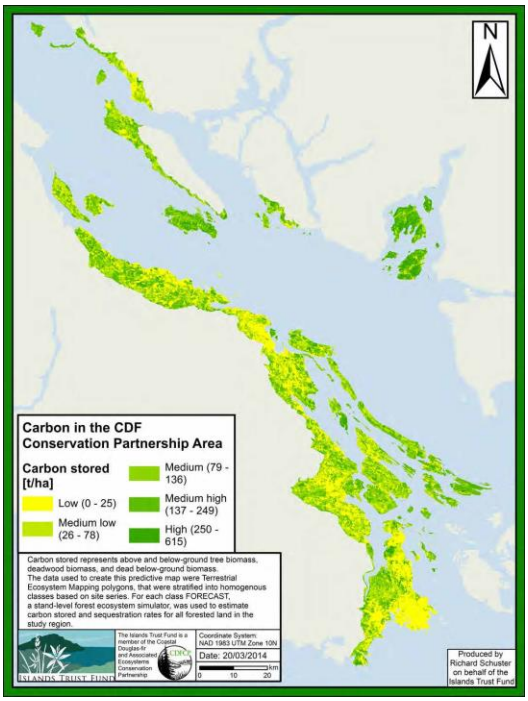

Figure 1: Carbon in the CDC Conservation Partnership Area from Schuster 2014[ii]

This Figure offers an insight into where carbon is stored throughout the overall area of the CDF Zone. As one might expect, urban and less rural areas of the CDF such as the BC provincial capital of Victoria as well as Duncan, Esquimalt, Ladysmith, Nanaimo, North Saanich, Oak Bay, Parksville, Pender Harbour, Sechelt and View Royal have more yellow shading indicating proportionately less forest and 'Low' carbon storage. The commercial and residential buildings and other infrastructure present in the Non-Islands Trust Area have negligible carbon sequestration potential. The islands of the Islands Trust Area, by contrast, almost entirely rural and with little or no urban area have considerably fewer yellow areas and more areas shaded in green indicating more carbon storage. The Islands Trust Area also has roughly 20% of its land base in protected areas.

The core mistake that has been made in the Schuster (2014) analysis is that it has mistakenly compared proportions of forested area to overall land area, rather than considered forest or tree quality and performance. The proportion of forest to overall land is irrelevant to comparisons of Standing Carbon and Sequestration Potential in actual forests

This carbon storage dichotomy is confirmed in Table 1 of Schuster (2014). The two rows providing carbon storage and sequestration information along with the Total Area row have been highlighted here for the discussion that follows below:

Table 1: Standing Carbon and Carbon Sequestration Comparison from Schuster (2014)[iii]

Conservation Feature	Overall CDF	Non Islands Trust Area	Islands Trust Area	% total in IT	Importance IT/CDF (%)	Importance IT/Non_IT (%)
Bird Diversity	122,742	72,545	50,197	40.9	22.8	38.6
Standing Carbon [t]	24,314,351	12,806,439	11,507,913	47.3	43	81.6
Sequestration Potential [t/yr]	459,934	269,355	190,578	41.4	25.2	43
Beta + StC	56,369	30,505	25,864	45.9	37.8	69.8
Beta + SeqC	80,246	48,185	32,060	40	20	33.3
Total Area [km2]	2,402	1,604	798	33.2		

Admittedly, while the table isn't all that large, the row and column titles can at first appear somewhat confusing. Please first consider the numbers in the first three columns before considering the derived numbers in the last three columns. The entire story can be understood from just these first three columns.

For the purposes of illustration, let us simplify this table to focus initially on the Standing Carbon and the Sequestration Potential. This information is provided in Table 2. Please note that the numbers for Standing Carbon and Sequestration Potential are the same as provided in Table 1 reproduced above from Schuster (2014).

Table 2: Carbon Storage and Sequestration data extracted from Table 1 of Schuster (2014)[iv]

Conservation Feature *	CDF	Non Islands Trust	Non IT % of CDF	Islands Trust	IT % of CDF
Standing Carbon [t]	24,314,351	12,806,439	53%	11,507,913	47%
Sequestration Potential [t/yr]	459,934	269,355	59%	190,578	41%

Schuster (2014) reports that the Islands Trust Area has slightly less Standing Carbon than the Non-Islands Trust Area. Thus, the Non-Islands Trust Area is a more important Standing Carbon resource by virtue of the larger amount of Standing Carbon. There are 12.8 million Tonnes of Standing Carbon in the Non-Islands Trust Area as compared to 11.5 million Tonnes in the Islands Trust Area. This is close to a 50:50 relationship with a Non-IT:IT split of 53:47 (53% to 47%).

Of even greater significance in the favor of the Non-Islands Trust Area is that, while stored carbon is not that dissimilar, the annual carbon sequestration potential is considerably lower in the Islands Trust Area.

Schuster (2014) observes that there is a Sequestration Potential of 269,355 Tonnes/year in the Non-Islands Trust Area versus 190,578 Tonnes per year in the Islands Trust Area. This is close to a 60:40 relationship with a 59% to 41% advantage (a 59:41 split) for the Non-Islands Trust Area over the Islands Trust Area.

This is all the information needed to understand the comparative advantages: the Islands Trust Area is disproportionately less capable of sequestering carbon.

Schuster (2014) Key Findings After Re-Assessment

The Non-Islands Trust Area is more important for Carbon Storage than the Islands Trust Area on an absolute basis due to the higher amount of Standing Carbon as well as due to a higher Sequestration Potential in the Non-Islands Trust Area. Schuster (2014) unequivocally illustrates this.

As the higher Sequestration Potential of the Non-Islands Trust Area applies to its larger amount of Standing Carbon, the annual increment of Standing Carbon is much higher in the Non-Islands Trust Area than it is in the Islands Trust Area and its Gulf Islands forests.

To complete the forensics, though, it is instructive to compare these two ratios: the ratio of standing carbon and the ratio of sequestration potential.

The Non-Islands Trust Area advantage in Sequestration Potential (59:41 ratio) is higher than the comparative difference in Stored Carbon (53:47 ratio) confirming a fundamental sequestration advantage for the Non-Islands Trust Area. If the ratio of Sequestration Potential was the same as the ratio of Stored Carbon (53:47), then the areas would have equivalent Sequestration Potential. For the Islands Trust Area to be superior in sequestration, then the Non-Islands Trust:Islands Trust ratio of Sequestration Potential would have to be lower than a 53:47 split (or, inverting, higher than 47:53 for Islands Trust:Non-Islands Trust)

In other words, what this Table reveals is that the Islands Trust Area forests are not as capable as the Non-Islands Trust Area forests at sequestering carbon. The Non-Islands Trust Area forests are considerably more capable of sequestering carbon.

In fact, based upon the figures in this table, the Non-Islands Trust Area is 27% more efficient at sequestering carbon than the IT Area. Were we to extend the relationship over time, the Standing Carbon in the Non-Islands Trust Area would eclipse that of the IT Area on both an absolute basis, as it already does, as well as on an area proportional basis (i.e. weighted by its overall area and with more carbon stored as a proportion of the total, less forested, area) without having to increase the actual size of its forested portion.

Schuster (2014) Importance IT/CDF Ratios

Now we can look at the last three columns in Table 1 of Schuster (2014) and reproduced in Table 1 above. Expressing the numbers presented in those columns in a written explanation, what the information in this Table reveals is that 47.3% of the total sequestered Carbon in the CDF is found in the IT area.

Because the Islands Trust Area is only 33.2 % of the total area (bottom row), then the Islands Trust Area has proportionately 1.43 times more stored carbon over its area than the Non-Islands Trust area. The Islands Trust Area has less carbon stored, but proportionately more on an area basis (square kilometer) because its area is smaller than the Non-Islands Trust Area.

This relationship makes sense as illustrated in Figure 1 above: The Islands Trust area has proportionately more green area (medium storage density or higher) than yellow area (low storage density) than we find in the Non-Islands Trust Area.

Or, in Schuster's nomenclature, there is an "Importance IT/CDF (%)" for Standing Carbon of 43%. In the smaller IT portion, there is proportionately more Standing Carbon.

The formula for Schuster's Standing Carbon "Importance IT/CDF (%)" is as follows:

(% Total in IT / % Total Area) – 1 = (47.3/33.2) – 1 = 43%

Using a similar formula, Schuster also calculated a representative measure of Sequestration Potential of 1.25, or an "Importance IT/CDF" of 25.2%.

Even though Schuster (2014) clearly reveals this simply by presenting these numbers, what was not observed or explained is that just as in the case for the actual numbers, because this ratio of 1.25 (or 25% Importance) for Sequestration is lower than the 1.43 ratio of Standing Carbon (or 43% importance), then the forests of the IT Area have a lower Carbon Sequestration Potential as compared to those in the Non-Islands Trust Area.

Consider that if the two portions of the CDF (Island Trust Area versus Non-Islands Trust) had equivalent sequestration capability, then the ratio would be 1.43 for both, the same as with Standing Carbon, and Schuster's Importance would similarly be a comparable 43%. If the "Importance" were higher (i.e. greater than 43%), then the Islands Trust Area would have a higher Sequestration Potential than the Non Islands Trust Area. The Sequestration Potential Importance number, however, is lower than the Standing Carbon Importance and the Islands Trust Area is not as efficient at Sequestering Carbon.

Schuster (2014) Importance IT/Non_IT Ratios

The next column in Table 1 of Schuster (2014), and provided in Table 1 above, "Importance IT/Non_IT (%)" has a formula that is a bit more complicated, and it might be easier to explain this in words than take up more space here. The analysis, however, does support the exact same observation as we have seen already: The IT Area is not as capable of sequestering carbon as the Non-Islands Trust Area.

Notably, the Importance ratio (IT/Non_IT (%) in Schuster (2014) Table 1) for Sequestration Potential with a value of 43% is lower than the Importance ratio for Standing Carbon, with a value of 81.6%. This is the critical relationship.

The two numbers aren't even close to one another as the "Importance" of Sequestration Potential (43%) is almost one-half that of the "Importance" of Standing Carbon (81%). Sequestration Potential Importance is markedly lower than Standing Carbon Importance. On an Importance basis defined by Schuster (2014), the Islands Trust Area is not as good, or relatively 'unimportant' at sequestering carbon. If the Islands Trust Area were comparable, for example, then these Importance Ratios would be equivalent.

Summary

As it already stores more carbon than the Islands Trust Area, the Non-Islands Trust Area is more important for stored carbon than the Islands Trust Area. Going forward, we can make the further observation that, as the absolute amount of carbon stored in the Non-Islands Trust Area is higher than that stored in the Islands Trust Area and as the Non-Islands Trust Area sequesters more carbon annually than the Islands Trust Area, the Non-Islands Trust Area is much more important for sequestering carbon than the Islands Trust Area. To repeat: the Non-Islands Trust is more important for Stored Carbon and much mor important for Sequestration Potential.

Given what the data reveals about a disadvantage in Sequestration Potential for the Islands Trust Area, it may have some significance that Schuster (2014) 'high-graded' or 'cherry picked' the information from within the IT Area such that:[v]

> *"Some of the limitations of this report include that existing reserve networks were not taken into account, as they might not be located in the highest carbon and biodiversity parts of the region…"*

In other words, Schuster (2014) tried to tip the scales in the analysis in favor of the Islands Trust Area by not including portions of the Islands Trust Area where the Standing Carbon and Sequestration Potential numbers were less favorable.

Squaring the Data with Other Zones

While it was outside the scope of the Schuster (2014) paper, it might be of some benefit to consider how the CDF compares to other BEC zones in the province when it comes to sequestering carbon. This might be useful to see whether the data on carbon sequestration supports assertions that the CDF itself is special or other assertions that the CDF has exceptional carbon sequestration ability.

A recent analysis prepared for the Yellowstone to Yukon Conservation Initiative, Mitchell and Bullen (2020), provides insights on comparative carbon storage and carbon storage hotspots for all BEC zones including the CDF.[vi]

Including an assessment of comparative carbon densities as well as freshwater provision, Mitchell and Bullen (2020) provides a refreshing perspective of the ability of ecosystems to supply services to people. The CDF does comparably well on a carbon storage basis but does not fare as well when compared on a freshwater provision basis.

Relevant tables from this report are provided here as Table 2: Average Carbon Densities and Table 3: Carbon Hotspot Densities by Biogeoclimatic Zone.

Table 3: Average Carbon Storage Density by Biogeoclimatic Zone[vii]

Biogeoclimatic Zone	Above Ground Carbon Density (MgC/ha)	Below Ground Carbon Density (MgC/ha)	Total Carbon Density (MgC/ha)
Coastal Western Hemlock - CMH	122.3	402.5	523.5
Mountain Hemlock - MH	57.8	404.0	461.7
Coastal Douglas-fir - CDF	89.8	342.1	430.2
Interior Cedar-Hemlock (Northern)	104.3	322.0	425.9

According to Mitchell and Bullen (2020), the CDF ranks third for Average Carbon Storage Density, just ahead of the northern portion of the Interior Cedar Hemlock (ICH) zone. The CDF ranking is driven largely by its favorable Below Ground Carbon Density. The Coastal Western Hemlock (CWH) zone is the clear leader within BC for average Above Ground, Below Ground and Total Carbon Storage Density.

Table 4: Carbon Hotspot Densities by Biogeoclimatic Zone[viii]

Biogeoclimatic Zone	Aboveground Carbon Hotspot Density (km2/100km2)	Belowground Carbon Hotspot Density (km2/100km2)	Total Carbon Hotspot Density (km2/100km2)	Overlapping Above- and Belowground Carbon Hotspot Density (km2/100km2)
Coastal Western Hemlock - CMH	66.9	55.1	75.4	36.7
Mountain Hemlock - MH	24.1	66.5	64.4	16
Interior Cedar-Hemlock (Northern)	56.8	20.9	38.5	13.3
Coastal Douglas-fir - CDF	43.9	27.3	36.5	7.7

In terms of Carbon Hotspot Density, the CDF still fares well as compared to most Biogeoclimatic zones, but Coastal Western Hemlock and Mountain Hemlock dominate where the CWH Total Carbon Hotspot Density is more than double that of the CDF.

Where the Schuster (2014) Report for the Islands Trust and the CDFCP was directed to seek an economic case to justify land purchases in the CDF based on carbon credits, the analysis done for the Yellowstone to Yukon Conservation Initiative underscores the much greater carbon sequestration potential the CWH zone offers over all other zones.

Epilog

It may be of anecdotal interest that the stated objective of Schuster (2014) was to support land purchases for conservation/protection "where land purchase costs were offset by selling forest carbon credits."[ix]

However, there was and is no carbon trading market under which Gulf Islands forests could or can receive carbon offset credits for carbon trading.[x] [xi] [xii] [xiii] [xiv] [xv] Gulf Island forests cannot receive carbon offset credit for avoided conversion forest projects nor improved management forest projects nor any other type of forest project.

No applicable program existed was known when Schuster (2014) was contracted by Islands Trust to investigate this concept. This situation is unchanged.

Should a carbon market exist where BC forests might qualify for carbon trading, the work of Mitchell and Bullen (2020) suggests that other areas of the province might receive more interest and attention than the Islands Trust Area.

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[i] Schuster, Richard (2014). Carbon and Biodiversity Mapping and Assessment for the Islands Trust Area. Islands Trust Fund. 19 p. Accessed at https://islandstrust.bc.ca/wp-content/uploads/2020/11/carbonassessment.pdf.
[ii] Ibid.
[iii] Ibid. p 3.
[iv] Ibid. p 3.
[v] Ibid. p 6.
[vi] Mitchell, M., and C. Bullen (2020) Ecosystem Services Assessment for British Columbia's Interior Temperate Rainforest, Upper Columbia Region, and Southern Mountain Caribou Populations. Prepared for Yellowstone to Yukon Conservation Initiative. 73p.
[vii] Ibid.
[viii] Ibid.
[ix] Schuster, Richard (2014). Carbon and Biodiversity Mapping and Assessment for the Islands Trust Area. Islands Trust Fund. pp 2. Accessed at https://islandstrust.bc.ca/wp-content/uploads/2020/11/carbonassessment.pdf.
[x] Dene Moore. B.C. carbon trust, capital commission chopped. 19 November 2013. The Canadian Press. Accessed at: https://globalnews.ca/news/976862/b-c-carbon-trust-capital-commission-chopped/ 23 January 2022.
[xi] Chin and Donnelly (2011). California Adopts Cap and Trade Program for Greenhouse Gas Emissions. Jones Day. Accessed at: https://www.jonesday.com/en/insights/2011/01/california-adopts-cap-and-trade-program-for-greenhouse-gas-emissions 16 January 2022.
[xii] Compliance Offset Protocol U.S. Forest Projects. California Environmental Protection Agency Aire Resources Board. pp 14-15. Accessed at https://ww2.arb.ca.gov/sites/default/files/cap-and-trade/protocols/usforest/forestprotocol2015.pdf 16 January 2022.
[xiii] International Carbon Action Partnership, USA – California Cap-and-Trade Program. RGGI. Accessed at https://icapcarbonaction.com/en/ets-map 16 January 2022.
[xiv] Ibid. Quebec.
[xv] Ibid.