

Supplement 10. Updated CARB-CAR Data for Howland Forest Research Forest

CARB-CAR data for the Howland Forest research project (CAR681) are updated with new issued carbon offsets (CAR1161). The update substantiates project invalidation by exceeding the CARB 5% overcrediting threshold relative to directly measured CO₂ NEE flux data (Ho-1 eddy covariance). Inconsistencies in the CARB-CAR forest carbon protocol are noted for the updated data including error in use of 30-minute NEE flux data (Ho-1) to define CARB-CAR forest growth rates for CAR1161, providing an additional criterion for invalidation. Documentation for the Howland projects is summarized in endnotes (Table 1- CAR681 and CAR1161 Project Linksⁱ, Table 2- CAR1161 Online Issued Offset Serial Numbersⁱⁱ, Table 3- CAR681 and CAR1161 Online Project Documentsⁱⁱⁱ).

Figure 1.

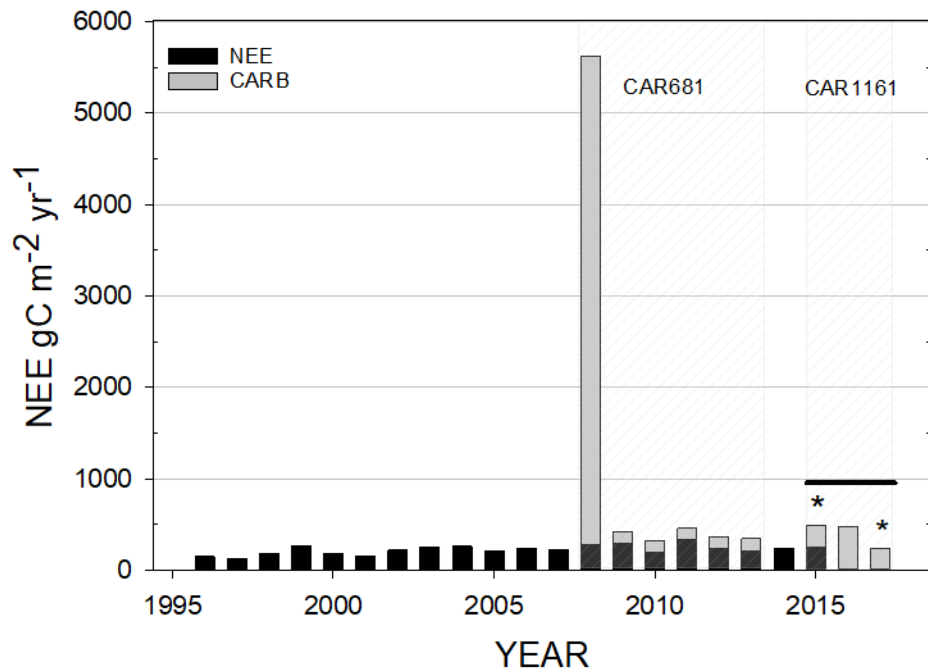


Figure 1 shows overlapping data for NEE (Ho-1, filled bars, 1996 – 2015) (Hollinger *et al.*, 2016) and CAR681 (2009 – 2013, shaded bars and cross hatch) and CAR1161 (2015 – 2017, shaded bars and cross hatch); no data were reported for 2014. Asterisks show partial annual intervals of average monthly CAR1161 data, the solid line shows total aggregate carbon for CAR1161. See Tables 1 and 2 for partial and annual offset totals.

The mean and standard deviation for the aggregate CAR681/1161 time series (2008 – 2103, 2015 – 2017) of $-768.1 \pm 1,716 \text{ gC m}^{-2} \text{ yr}^{-1}$ is $\sim 3x$ the mean of -226.4 and $\sim 34x$ the standard deviation of $51.2 \text{ gC m}^{-2} \text{ yr}^{-1}$, respectively, for Howland NEE, exceeding the 5% invalidation threshold and lying outside of the natural range for interannual NEE1 (Baldocchi, Chu and Reichstein, 2018) and NEE2 (Baldocchi and Penuelas, 2019) variance reported for forest carbon sequestration. The CAR1161 reporting of aggregate net sequestration across partial annual periods cannot reveal annual forest carbon trends and is inconsistent with established CARB-CAR annual offset recordation, documenting non-standard and discretionary reporting protocols.

CAR1161, like CARR681, excludes soil carbon or a term for ecosystem respiration required to determine the net carbon balance for a forest project (e.g., Baldocchi, Chu, and Reichstein 2018; Baldocchi and Penuelas 2019) (Table 3, documents 3,7 (CAR681); documents 9 – 12 (CAR1161)). CAR1161 citation of relevant Howland forest carbon sequestration academic literature is unchanged from the CAR681 report excluding directly measured Howland forest NEE data. For example, project developers and verifiers have not compared actual annual NEE flux data (Hollinger *et al.*, 2016) available for contemporaneous intervals (Figure 1) of CAR1161 data (Table 2) to verify annual growth

simulation model data or to test compliance with the mandated CARB-CAR 5% overcrediting invalidation threshold (Table 3, document 9, published October 9, 2019).

Rather than rely upon published annual NEE for CARB-CAR model verification (Hollinger *et al.*, 2016), the CAR1161 data update is dependent upon Howland 30-minute NEE flux data (Fig. 7, D. Hollinger et al. 2004) to derive monthly growth rates, an approach also employed by CAR681 (Table 3, document 3, page 34 (CAR681); document 10, page 35 (CAR1161)). However, the 30-minute NEE flux data are cited and used erroneously as follows: 1) both projects incorrectly rely upon a seven (7) year period, as cited in the project development documents, rather than the actual single and initial Ho-1 project year of 1996 (Fig. 7, D. Hollinger et al. 2004)^{iv}, obviating relevance to multiyear CARB-CAR model data or other inference, 2) the NEE Ho-1, Fig. 7, data represent measured and modeled 30-minute CO₂ fluxes for photosynthesis (i.e., carbon sequestration) and respiration (i.e., carbon efflux), not growth rates for standing pools of live biomass, and, 3) methods and calculations to transform 30-minute NEE data (i.e., μmoles CO₂ m⁻² s⁻¹) to tCO₂eq and to monthly forest “growth rates” (Table 3, document 3, page 34 (CAR681); document 10, page 35 (CAR1161)) are not provided and are subject to verification and demonstration of compatibility with CARB-CAR models that do not include terms for ecosystem respiration flux. A publicly available repository for CAR681 and CAR1161 raw data and model runs are not available to researchers interested in replicating results, in contradistinction to required raw data access for peer reviewed journals (e.g., Richardson et al. 2019).

In summary, substantiation of incomplete carbon accounting and erroneous forest growth model assumptions, resulting in overcrediting carbon offsets by >5% relative to actual values, arguably invalidate the CARB-CAR protocols employed for this CARB-CAR project. Claimed reductions in net CO₂ emissions, carbon offset creation and carbon market transactions cannot be validated with the available data for CAR1161 or for CAR681 reported initially. While invalidation criteria reported here do not alter the operational status of ARB issued offsets, such criteria could be employed in cases to invalidate issued offsets according to ARB offset material misstatement procedures or as otherwise required (California Air Resources Board, 2013).

ⁱ Table 1. CAR681 and CAR1161 Project Links (<https://thereserve2.apx.com/myModule/rpt/myrpt.asp?r=111>)

Project ID	ARB ID	Cooperative/Aggregate ID	Project Developer	Project Owner	Project Name	Offset Project Operator	Authorized Project Designer	Project Type	Status	ARB Project Status	Project Site Location	Project Site State	Number of Offset Credits Registered	Project Listed Date	Project Registered Date
CAR681	NA		Northeast Wilderness Trust	Northeast Wilderness Trust	Howland Research Forest			Improved Forest Management	Transitioned	Not ARB Eligible	Penobscot County	MAINE	48852	12/19/2013	3/13/2015
CAR1161	CAFR5161		Northeast Wilderness Trust	Northeast Wilderness Trust	Forest Carbon Partners - Northeast Wilderness Trust - Howland Research Forest	Northeast Wilderness Trust	Forest Carbon Partners, L.P.	Improved Forest Management - ARB Compliance	Registered	Active ARB Project	Penobscot County	MAINE	7762	2/26/2015	3/8/2019

This supplement updates NEE data for the Howland Forest Research project identified as CAR681 in the original publication covering CARB project data up to 09-01-2018. A new project number, CAR1161, documents a transition from an early action project to the ARB Forest Offset Improved Forest Management project. The CAR681 data of 48,852 tCO₂eq (10/8/2008 to 12/31/2013) and the CAR1161 data of 7,762 tCO₂eq (7/16/2015 to 7/15/2017) are provided. Offset data for CAR1161 are reported (7/16/2015 to 7/15/2017) without specifying data for partial years or the full year of 2016. In the absence of annually resolved data, Figure 1 data for CAR1161 represents monthly average sums for partial and full years. All other data reported for CAR681 including standing stock and common practice specifications remain unchanged in CAR1161 documentation.

ii Table 2. CAR1161 Online Issued Offset Serial Numbers

(<https://thereserve2.apx.com/mymodule/reg/TabProjectEmissions.asp?id1=1161&ad=Prpt&act=update&sBtn=&r=111&Type=PRO&tablename=cr&aProj=pub>)

Action	Date Issued	Status	Vintage	Quantity of Offset Credits	Quantity of Offset Credits to Buffer Pool	Issued Quantity	Reporting Period Begin	Reporting Period End	Offset Credit Serial Numbers	Buffer Offset Credit Serial Numbers
View	3/8/2019	Issued	2017	6,910	0	6,910	7/16/2015	7/15/2017	CAR-ROC-US-1161-125-467-ME-2017-5704-1 to 5583	CAR-ROC-US-1161-125-467-ME-2017-5705-1 to 1327
View	10/9/2019	Issued	2017	852	0	852	7/16/2015	7/15/2017	CAR-ROC-US-1161-125-467-ME-2017-5852-1 to 688	CAR-ROC-US-1161-125-467-ME-2017-5853-1 to 164

iii Table 3. CAR681 and CAR1161 Online Project Documents

(<https://thereserve2.apx.com/mymodule/reg/TabDocuments.asp?id1=681&action=&ad=Prpt&act=update&sBtn=&Type=PRO&r=111&tablename=doc&aProj=pub>;

<https://thereserve2.apx.com/mymodule/reg/TabDocuments.asp?r=111&ad=Prpt&act=update&type=PRO&aProj=pub&tablename=doc&id1=1161>)

Doc #	Vintage	Documents	Document Type	Document Category	upload Date	Uploaded by
CAR681						
1	2014	CAR-Forestry_NF_Howland_FinalVerificationReport_031115.pdf	Verification Report	Verification	3/11/2015 19:43	SCS Global Services
2	2008	CAR_NF_Howland_VerificationStatement_v3-0_120214.pdf	Verification Statement	Verification	12/3/2014 19:46	SCS Global Services
3	2008	Howland-Project-Design-Documents_2014-12-02.pdf	Project Design Document	Verification	12/3/2014 1:29	Northeast Wilderness Trust
4	2008	NWT Project Developer Attestation of Voluntary Implementation_Howland.pdf	Attestation of Voluntary Implementation	Verification	5/16/2014 21:21	Northeast Wilderness Trust
5	2008	NWT Project Developer Attestation of Regulatory Compliance_Howland.pdf	Attestation of Regulatory Compliance	Verification	5/16/2014 21:21	Northeast Wilderness Trust
6	2008	NWT Project Developer Attestation of Title_Howland.pdf	Attestation of Title	Verification	5/16/2014 21:20	Northeast Wilderness Trust
7	2008	Howland listing document submitted 121113 amended.pdf	Project Submittal Form	Project Submittal	12/16/2013 22:06	Northeast Wilderness Trust
8	2008	Map-Howland Forest Carbon v2.pdf	Physical Boundary Map	Project Submittal	9/22/2010 20:53	Northeast Wilderness Trust
CAR1161						
9	2017	CAFR5161_OVS_16aug2019.pdf	Offset Verification Statement	Verification	10/9/2019 21:49	The Climate Action Reserve
10	2017	Howland-COP-RP1-OPDR_20190306_Final.pdf	Offset Project Data Report	Verification	3/7/2019 18:05	Northeast Wilderness Trust
11	2015	ARB IFM LISTING FORM HOWLAND_20150225_Final.pdf	Offset Project Listing Information Form	Project Submittal	2/25/2015 18:59	Northeast Wilderness Trust
12	2015	Howland Compliance Listing Documents.zip	Offset Project Listing Information Form	Project Submittal	2/19/2015 21:55	Northeast Wilderness Trust

iv Caption Fig. 7 (Hollinger *et al.*, 2004): “Comparison of measured (gray symbols) and modeled (dark symbols) half-hourly net ecosystem C exchange (NEE) data in 1996. The modeled data do not adequately capture the seasonal variation in maximum daily uptake.”