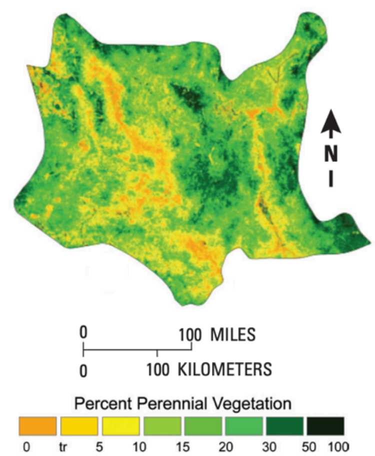
Appendix C
Reactions & Recommendations to Specific NWLCSS Draft Report Content

NWLCSS Item & Page #	Our Comment	Further Background
Page 6. “Sparsely Vegetated Lands -Lands characterized primarily by low levels of vegetation, including desert, beaches, and areas covered by ice, snow and bare rock.”	We take exception to the incorrect landscape categorization of the desert. Although it may be true that sparsely vegetated lands exist in the desert, this should, in no way, be the defining factor. To categorize the desert in the same functional landscape as ice, snow and bare rock negates the more important and unique aspects of the desert which include: high amounts of below-ground C in both organic and inorganic forms, event-driven potentially high rates of both sequestration and loss of large amounts of C, as well as an increasing threat of wildfire from climate-driven heat and drought which ice, snow, bare rock, and beach ecosystems do not experience. We also take exception to the categorization that all of the desert has less than 10% vegetative cover. While some areas of the desert do have less than 10% vegetative cover, much of the desert has been shown to have well over 10% vegetative cover, and in some instances, this amount reaches up to 50% vegetative cover.	Maps of perennial vegetation cover in the California desert have shown a higher percent cover than presented in the NWLCSS report. Research by USGS has shown that a substantial portion of the California desert has well over 10% vegetative cover.  This map by the USGS, shows the percentage of perennial vegetation cover in the Mojave Desert ecoregion within the area of each 250-meter MODIS satellite pixel.

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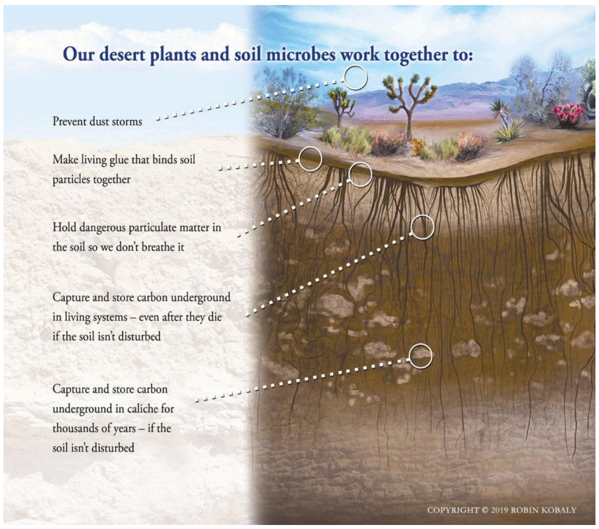
<tr><th>NWLCSS Item & Page #</th><th>Our Comment</th><th>Further Background</th></tr>
<tr><td>Page 6: “Consistent with international carbon counting methodologies, and set an aligned foundation on which we can model, analyze and measure climate action on our lands”</td><td>Scientists working in desert ecosystems have recognized and published on the importance of deep organic C since the International Biological Program (IBP) of the 1960s and 1970s. Simply focusing on above-ground C is well known to be inadequate.


</td><td>The above-ground standing crop C is low in California deserts, but that is generally less than 10% of the total organic C. Especially in microphyll woodlands and creosote bush scrub, atmospheric carbon is breathed in by deep-rooted plants and changed to organic C as sugars; these roots penetrate tens of meters to reach groundwater, and in the process, they are depositing organic C down through the roots and respiring CO_2 that further binds to soil Ca, adding to the caliche as inorganic C.</td></tr>
<tr><td>Page 6: “These lands consist of eight landscapes, organized by land cover…and developed by a team of scientific experts”…</td><td>Please provide us with the bios or relevant desert science experience of the scientists who provided their expertise on desert carbon sequestration and its ecosystem. Additionally, we request that the collective decades of scientific peer-reviewed publications on carbon sequestration in the desert provided by our team of regional UC-affiliated researchers be included in the analysis to provide scientific transparency and analytic depth.</td><td></td></tr>
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Page 18: CARB's Inventory of Ecosystem Carbon in California's Natural & Working Lands helps California understand trends in our ecosystem carbon stocks. The inventory tracks how much carbon exists in California's ecosystems and where that carbon is located at discrete moments in time. It also estimates how much carbon is moving in and out of the various land types and carbon pools.	Unfortunately, CARB's inventory of Ecosystem Carbon in California's Natural & Working Lands is woefully inadequate for the purposes of understanding trends in our ecosystem carbon stocks. CARB seems not to have any experts in desert carbon sequestration and has been unable to track nor correctly estimate how much carbon is moving in and out of the state ecosystem if the desert isn't included. Furthermore, since CARB is not including the California desert as part of its carbon modeling for the state, it demonstrates a lack of understanding of ecosystem carbon in the desert.	

NWLCSS Item & Page #	Our Comment	Further Background
Page 54: "Sequestering carbon - Additional carbon sequestration in desert soil with low vegetation is possible, but the extent and rate of sequestration is still unclear"	While sequestration is highly patchy spatially and temporally, it occurs continuously. These deserts have accumulated C at least since the Pleistocene, resulting in (overall) slow but continuous accumulation and a very large pool of sequestered C. Moreover, because of the nature of carbonate dynamics, events such as high precipitation may dramatically increase C sequestration over short periods. While the extent and rate of desert carbon sequestration may remain in need of further data, what is indisputable is that soil inorganic carbon [SIC] is a fundamental component of the global carbon cycle. There are 5 recognized Global Carbon Pools: 1. Oceanic 2. Geological (Fossil Fuels) 3. Pedologic - a. Soil Organic Carbon (SOC) b. Soil Inorganic Carbon (SIC) 4. Atmospheric 5. Biotic Within the Pedologic pool are the subcategories: (a) Soil Organic Carbon; and (b) Soil Inorganic Carbon. The Terrestrial Carbon Pool, which forms the crux of discussion for carbon sequestration, is composed of Pedologic and Biotic Carbon Pools. Thus, the removal of Soil Inorganic Carbon from analysis and consideration deconstructs the entire basis of the global carbon pool. We can't simply pretend that an arguably significant component of the carbon pool does not exist. Indeed, current research conducted in China points to SIC as a significant -- and "missing" -- carbon sink.	Schlesinger (1985, Geochemica et Cosmochimica Acta 49, p57) estimated an accumulation of 1 to 3.5g $CaCO_3/m^2/y$ over at least the past 20 millennia. In arid and semi-arid regions, scientists report extensive sequestration of dissolved inorganic carbon in terminal lakes of closed, or endorheic basins. Such basins can be found within the California desert region. The scientists conclude that endorheic basins globally represent carbon sequestration with a magnitude similar to deep ocean carbon burial. Scarcity of data on SIC in California's desert lands is not grounds for dismissal, but rather points to a dire need for funding to pursue the needed quantifiable data to support the conservation of extensive carbon sinks. Rattan, L.2007 August 30. Carbon sequestration. Philosophical Transactions of the Royal Society B. Li, Yu, et al. 2017 June 19. Substantial inorganic carbon sink in closed drainage basins globally. Nature Geoscience. 10. 501-506.

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Page 54: "Sparsely Vegetated lands cover 10% of the state (10.2 million acres), and include deserts, beaches and dunes…"	In this current NWLCSS report draft, the state is ignoring 15% of desert land as defined by the California Desert Conservation Area map. This map, as well as Bureau of Land Management (BLM) designations, show the California desert occupying a much larger area, approximately 25% of the entire state -- not the 10% claimed in this report. Ignoring this important fact puts other state and federal agencies at odds with each other and may generate faulty scientific models and outcomes.	
Page 55: "Similarly to sequestration rates, the level of carbon storage in desert soils is unclear and the duration or stability of carbon in these habitats are unknown".	While we do not know the level of carbon storage because of the patchiness of desert soils, in some cases it can be quite high.	Schlesinger (1982, Soil Science 133,247) estimated 800x10e15g of stored caliche C. In his 1985 paper, he estimated as much as 69kg/m2 in one of his profiles. This means that where caliche is present, a lot of C is likely sequestered. Moreover, once the C is buried, or is formed deeper in the soil profile, the inorganic C is sequestered for a very long period, baring disturbance.
Pg. 55: Limiting future carbon losses - Soil disturbance and habitat loss are the greatest risks for carbon loss in deserts.	We agree! Because deserts are so slow to recover from disturbance, the C lost to disturbance will likely never recover (at least for the foreseeable future) the C stored, potentially in large amounts.	

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Pg. 56: Priority Nature-Based Solutions. Sparsely Vegetated Lands A-F	There is no mention of the need to fund further studies for desert carbon sequestration as a priority. We urge the CNRA to acknowledge the importance of a holistic study of all available carbon sequestration. Above-ground carbon sequestration won't identify most of the carbon storage taking place in the desert underground. Please allocate resources so that these underground efforts to capture desert carbon can be fully understood and accounted for.	There are both modeling and measurement research approaches that California's ecological research community have pioneered over several decades that can and should be undertaken.
Pg. 61: SCIENCE TO INFORM ACTION AND MEASURE SUCCESS Data development, coordination, acquisition, analysis, synthesis, and utilization are central to any successful efforts for tracking nature-based solutions, their costs, outcomes, as well as to identify trends and recommend adjustments.	We agree that your description of needed research, analysis, and monitoring is critical to a successful strategy. We invite you to provide the public with ongoing updates and transparency for the data collection and analysis.	

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Pg. 62: Additional metrics to track collective climate smart land management actions and measure outcomes delivered include: Ecosystem Carbon and Greenhouse Gas Indicators -Metric tons of carbon stored in lands or metric tons of carbon dioxide equivalent sequestered or avoided as emissions.	We applaud these efforts. The best way to track this is by localized data collection on carbon sequestration at representative hot spots. Along with the distribution of inorganic and organic carbon coupled with standard models for studying carbon at a broader scale including will produce robust and reliable metrics. We suggest using CENTURY (organic C sequestration), HYDRUS (production of organic and inorganic C), and SLIC (production of CaCO3). All approaches are standardized and have been undertaken by University of California faculty. For additional context, see Appendix A and B of this document.	CENTURY: One version used in desert soils includes DayCENT: Parton, W. J., M. Hartman, D. Ojima, and D. Schimel. 1998. see: Rao, L.E., E.B. Allen and T. Meixner. 2010. Risk-based determination of critical nitrogen deposition loads for fire spread in southern California deserts. Ecological Applications 20: 1320-1335. DAYCENT and its land surface submodel: description and testing. Global and Planetary Change 19:35–48. HYDRUS: Simunek, J., M. T. Van Genuchten, and M. Sejna (2005), The HYDRUS-1D software for simulating the one-dimensional movement of water, heat, and multiple solutes in variably - saturated media, UC Riverside, Research Reports, 240. SLIC: Hirmas, D.R., C. Amrhein, and R.C. Graham. 2010. Spatial and process-based modeling of soil inorganic carbon storage in an arid piedmont. Geoderma 154:486-494. doi: These models have all been developed and/or run by UC faculty members.
Pg. 62: Ecological Indicators: Percent of desert landscapes whose crust and vegetation are undisturbed.	This is a great metric we can support! Having intact desert landscapes mapped will help inform us where we should or should not place large-scale developments.	

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Pg. 62: Economic Indicators *Number of workers contributing to climate smart land management. *Numbers of workers trained and placed into jobs, disaggregated by race, ethnicity and geography, with wages and other job quality indicators….	These are fantastic indicators to track as a whole for the state and as individual metrics to be tracked within each region.	
Pg. 63: Infrastructure Indicators *Soil water holding capacity.	Roots and soil fungal hyphae along with mycorrhizae are one indicator that accounts for soil water holding capacity and reduction of soil erosion in the desert. Disturbance results in the loss of soil organisms that produce soil aggregates and binds soil particles to sequester C.	Mycorrhizae and soil sequestration: Rillig, M.C., S.F. Wright, M.F. Allen and C.B. Field. 1999. Rise in carbon dioxide changes soil structure. Nature 400: 628. Disturbance and dust sources (including C): Frie, A, A Garrison, M Schaefer, S Bates, J Botthoff, M Maltz, S Ying, T Lyons, MF Allen, EL Aronson, R Bahreini. 2019. Dust Sources in the Salton Sea Basin: A Clear Case of an Anthropogenically Impacted Dust Budget. Environmental Science & Technology. 53(16):9378-9388. doi: 10.1021/acs.est.9b02137

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Pg. 63: Social Justice/Equity Indicators *Number of acres managed, transferred to, and owned by California Native American tribes…	Thank you for including this metric. We suggest connecting with the Native American Land Conservancy as a model for programs that engage and support nature based solutions -with little funding. Additional resources would yield scalable results.	
Pg. 63: Public Health Indicators *Access to nature or green spaces. *Air quality.	Agreed. If intact desert soils are disturbed, air quality will suffer. Intact desert soils hold particulate matter safely out of the air, but if disturbed, are prone to erosion and the release of pm10's and pm2.5's.	
Pg. 94: Lake Hodges, North Inland from summit of Bernardo Mountain Peak in Poway, CA	This breathtaking vista representing the Inland Region is not in the Inland Region. Poway, CA is in San Diego County and furthermore is not desert.	

(end)