Impacts of Regenerative Land Management at White Buffalo Land Trust: Measuring Ecosystem Indicators for Regenerative Agriculture Certifications

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Objectives:

This project will support White Buffalo Land Trust (WBLT) in its mission of promoting large-scale adoption of regenerative agriculture by identifying key indicators to track changes in ecosystem health of rangelands managed through regenerative principles. This will be achieved through the following objectives:

1. **Identify** the most informative and relevant indicator variables to track the impacts of regenerative grazing on the transition of Mediterranean rangelands from a degraded state to a biodiverse system with healthier soils, improved ecosystem functioning, and increased forage capacity.
2. **Assess** the accuracy of indicators by using satellite and field data to track changes in indicator values before and after implementation of regenerative grazing. **Compare and evaluate** indicator variable quantification methodologies based on their scientific robustness and ease of applicability for farmers and ranchers.
3. **Develop** a protocol to assist farmers and ranchers in monitoring a suite of ecological indicators in order to reduce capital and labor resources and increase accessibility of regenerative agriculture accreditation. **Communicate** the benefits of regenerative agriculture and an explanation of how to use this protocol to other land stewards through digital media and in-person presentations. Focus outreach on economically vulnerable farmers and ranchers.

Significance:

Regenerative agriculture techniques such as regenerative grazing have historically been more resource intensive in both labor and capital than conventional agriculture techniques. Certifications such as those being pursued by WBLT can generate income for farmers and thereby increase adoption of regenerative practices. This project will help WBLT understand and pursue relevant product certifications and payment-for-ecosystem-services (PES) credits, which will guide and incentivize their agricultural management. On a larger scale, this project seeks to bridge knowledge gaps between research institutions, PES companies, and regenerative agriculture practitioners. Achievement of this project's objectives will increase the quality and accessibility of ecological measurement protocols that showcase the benefits of regenerative agriculture and encourage farmers to adopt regenerative practices.

Background:

Rangelands cover 40-50% of the global land area (Mitchell, 2000) and provide essential forage for livestock and habitat for wildlife (Yu et al., 2010). Rangelands have been estimated to store up to 30% of the world's soil carbon, in addition to cycling and storing carbon in above ground biomass of trees, shrubs and grasses (Neely et al., 2009). Overgrazing and mismanagement of rangelands has resulted in degraded ecosystems with decreased forage and habitat, altering important ecosystem functions (Al-bukhari et al., 2018). Regenerative grazing practices such as adaptive multi-paddock (AMP) grazing hold the potential to restore degraded rangelands by integrating livestock as a means to improve soil health, biodiversity, and ecological functioning.

WBLT's recent acquisition of the 1000-acre Jalama Canyon Ranch (JCR) provides a unique opportunity to use satellite and field data to assess the impacts of regenerative grazing on degraded rangelands. Approximately 410-acres of the ranch consists of rangelands that have been grazed by European-introduced livestock since the early

20th century. Cattle were allowed to graze continuously, causing soil degradation and a succession toward annual grass-dominated systems with reduced ecosystem functioning, decreased biodiversity, eroded soils, and lower forage capacity.

After taking over ownership of JCR in April 2021, WBLT removed the existing herd of cattle and goats to allow the land time to rest. They began high frequency, low intensity grazing, a regenerative grazing technique, in January 2022. WBLT conducted the first round of monitoring to establish baseline conditions for certification programs in April 2021, with 3 long term monitoring sites and 5 short term monitoring sites. WBLT identified 40 sites within JCR's rangelands for soil sampling in Spring 2022 to quantify carbon stocks. This project will help WBLT set up data protocols that process field-sampled data and satellite data to monitor and quantify key indicators to gain insight on the ecological impacts of regenerative grazing and qualify WBLT for regenerative agriculture accreditation programs.

This project can enhance understanding of holistic land management, advance data protocols, and provide new opportunities for other land stewards to engage in ecosystem service markets by making the shift to regenerative agriculture. This project can also support USDA's OpenTeam (Open Technology for Ecosystem for Agricultural Management) Field Methods working group on their *methodology recipe cards* designed to support in-field measurement method decisions. WBLT is a contributing member of OpenTeam, supporting research efforts.

Equity:

The monitoring protocol outlined by this project has the potential to make the economic benefits of regenerative agriculture more accessible for low income farmers and ranchers. The project creates open-source tools for quantifying the ecological indicators necessary to participate in certification programs. The project team will consult with the farmer and rancher community to create communications materials that convey the economic benefits of regenerative agriculture and how to use tools developed in this project to realize those benefits. WBLT has access to a wide network of farmers and ranchers through their local Santa Barbara network and their participation in USDA's OpenTeam.

Data:

Objective 1: This objective will be achieved by reviewing literature on indicators of rangeland health (e.g., (NRCS, 2020), (Lepak et al., 2021), (Jones et al., 2020)), development of state and transition models for rangelands (e.g., (Bestelmeyer et al., 2017)), indicators by accreditation programs (Regenerative Organic Certification, Savory Institute's Ecological Outcome Verification and Regen Network CarbonPlus Grasslands) and other relevant work (Herrick et al., 2017).

Objective 2: WBLT will make soil data collected in April 2021 and April 2022 (*to be collected*) available for this project. Those samples were collected to meet the Ecological Outcome Verification accreditation. Additionally, 40 soil samples will be collected by WBLT between March-May 2022 to establish baseline rangeland carbon stocks for Regen Network's GrasslandPlus program. Samples will be analyzed for:

- *Soil Carbon: Bulk Density, Soil Organic Carbon*
- *Soil Health: pH, macronutrients (P,K,N) and micronutrients (Ca, Mg, K, Na, Al)*

Note: If 2022 data is for some reason not collected, April 2021 data (collected) ***will be sufficient for analysis.***

In addition to field data, indicator variables will be obtained from the following satellite imagery:

- IrriWatch Data: Paid service available through the IrriWatch platform. WBLT has subscribed to this service using their funding and will make IrriWatch daily imagery data available for the project.
- Vegetation Cover Data Sentinel 1/2: *open access available through ESA Copernicus Access Hub*
    - 10 day temporal resolution, 10m-20m spatial resolution
- Vegetation Cover Data Landsat 7,8,9: *open access available through USGS Earth Explorer*
    - 16 day temporal resolution, 30m resolution, historical data dating back to the 1970s.

- Planet Imagery (Optional): Apply for access to high resolution Planet Data through their Education and Research Program → *with approval, free access to download 5,000 km^2/month*

Field methodologies used by accreditation programs, OpenTeam, and the scientific community will be assessed. Selected field methodologies will be used by WBLT staff (and potentially a Bren intern) to collect data in Summer 2022, which will serve to ground truth indicator data obtained from the satellite sources mentioned above.

Objective 3: Data collected from objectives 1-2 will be used to fulfill this objective.

Possible Approaches:
Objective 1: Indicators of rangeland health will be identified through review of scientific literature on rangeland health, rangeland ecological state and transition model and indicators identified by regenerative agriculture accreditation programs (Regenerative Organic Certification, Savory Institute's Ecological Outcome Verification and Regen Network CarbonPlus Grasslands.)

Objective 2: The accuracy of indicators (as identified in Objective 1) to track rangeland health will be determined by quantifying change in indicator values before and after implementation of regenerative grazing. Historic satellite data, supplemented by field data will be used to evaluate temporal and spatial changes in indicators. Indicator variable quantification methodologies will be evaluated through a series of steps:

1) Commonly used field methodologies for indicator variable quantification will be identified through literature review, including scientific papers and accreditation programs.
2) Field methodologies will be used to ground truth indicator variable data from different satellite sources (IrriWatch, Sentinel 1/2, Landsat) and gain an understanding of variability in indicator values as quantified by different methodologies.
3) Field methodologies and satellite data will be ranked on accuracy and ease of use.

Objective 3: A data quantification and monitoring protocol will be developed using insights gained on the most powerful indicators for rangeland health and the most scientifically sound and accessible quantification methods. Communication tools and interactive web resources to disseminate results and workflows to financially vulnerable farmers will be made in RStudio and/or Google Earth Engine.

Deliverables:
The project final report will include: **1) Identification** of the most powerful indicator variables to track rangeland transitions and ecosystem restoration; **2) Recommendations** specifying which indicators may be the most informative for land management decisions and most aligned with accreditation programs of interest; **3) Data Workflows** integrating input from satellite imagery, field data, and IoT sensors to satisfy guidelines of relevant certifications; **4) Maps** illustrating the state of current ecosystem indicators within WBLT boundaries; and **5) Communication** materials that articulate these monitoring protocols for farmers transitioning to regenerative agriculture and how doing so can provide economic benefits.

Internships:
White Buffalo Land Trust is pursuing funding for interns through the UCSB Coastal Fund's spring grant cycle. If funded, WBLT will be able to support 1-2 students for $5000 each. The internships *are guaranteed regardless of funding*. Interns will report in the field to Ecology and GIS Manager Aarushi Jhatro and work closely with Ann Close, Director of Research and Education. The internship will focus on collection of field data to inform the creation of data collection protocols in service of accreditation programs and ecosystem service markets.

5. SUPPORTING MATERIALS:

Citations.

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Neely, C., Running, S. and Wilkes, A. 2009. Review of evidence on drylands pastoral systems and

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Yu, L., L. Zhou, W. Liu, and H.-K. Zhou. 2010. Using remote sensing and GIS technologies to estimate grass yield and livestock carrying capacity of alpine grasslands in Golog Prefecture, China. *Pedosphere* 20 (3): 342–351. https://doi.org/10.1016/S1002-0160(10)60023-9.

Budget and Budget Justification

The budget for this project is not projected to exceed the $1,300 provided by the Bren School of Environmental Science & Management. The funds may be applied to acquiring high resolution remote sensing imagery from platforms such as Planet or IrriWatch. Additionally, some of these funds may be set aside to present and attend a conference such as through AGU or ESRI.

Client letter of support. Clients must submit a letter of support to clearly describe their commitment to sponsor at least one Bren student summer intern, provide data, additional funding, and/or any other resources for the project. The details of these commitments must be articulated clearly in the letter of support addressed to the Group Project Committee.

WHITE BUFFALO
LAND TRUST

January 16, 2022

Group Project Committee
Bren School of Environmental Science & Management
2400 Bren Hall
University of California
Santa Barbara, CA 93106

Dear Group Project Committee:

On behalf of the White Buffalo Land Trust team, I write with great enthusiasm to support the proposed Master's Group Project entitled, "Impacts of Regenerative Land Management at White Buffalo Land Trust: Measuring Ecosystem Indicators for Regenerative Agriculture Certifications".

Founded in 2018, the White Buffalo Land Trust (WBLT) is a Santa Barbara County based non-profit focused on the practice, promotion and development of systems of regenerative agriculture. We work to grow food, fiber, medicine and other materials that will benefit soil health, water resources, increase biodiversity and support healthy and safe communities. Through our education programs, we work to increase ecological literacy and help farmers and ranchers develop their capacity in the practices and principles of regenerative agriculture. Our research programs focus on monitoring and quantifying the impacts of our practices for a better understanding of the relationship between applied principles and repeated outcomes. Finally, through our food brand, *Figure Ate*, we help complete the "how you eat can improve your world" link from producer to consumer.

After being conventionally farmed, the 1000-acre Jalama Canyon Ranch (JCR) was acquired by WBLT in April 2021 and now serves as WBLT's model for financially viable regenerative agriculture at scale. For this to be an effective model, it's critical to track the impacts of regenerative practices. The Bren School team will (1) identify key indicators to track the impacts of regenerative grazing at JCR, (2) test, evaluate and identity the most robust methods for quantifying indicators, (3) help to develop a data monitoring protocol, and communicate their findings to the farming/ranching community, helping in WBLT's mission to broaden the adoption of regenerative agriculture.

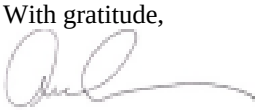
In support of their work, WBLT would like to offer one-two internships focusing on the collection of field data to track the impact of grazing, ground truth satellite data, and inform the creation of data collection protocols in service of certification/verification programs and ecosystem service markets. We are actively seeking funding for these internships and if successful, we will fund the students at $5000/student. If funding is not available (or is not available at the proposed rate), we would still welcome the student interns. The interns will report in the field directly to WBLT Ecology and GIS Manager (and Bren School Alum!) Aarushi Jhatro, but I look forward to being closely involved in the project. After more than two decades as the Associate Director of the USC Wrigley Institute for Environmental Studies on Catalina Island where we were home to a diverse range of graduate research projects every year, I have a deep love of working with graduate students and doing whatever I can to facilitate their research and broaden their graduate school experiences.

As such, we look forward to a rich offering of professional development opportunities to accompany the internships. These offerings include, but are not limited to, the following: In addition to learning techniques of soil sampling with the WBLT team, we will invite the students to engage with outside researchers also conducting soil research at JCR. Students will also engage on a regular basis with WBLT Director of Land Stewardship, Jesse Smith, with a deep, holistic understanding of the principles and practices of regenerative agriculture and an intimate knowledge of the JCR property. Marketing and Communications Director, Kyle Sullivan will work with the students and share his storytelling expertise as they work with local farmers and ranchers. He has also offered his assistance in any aspects of a Bren Student Instagram takeover, helping to reach both the UCSB and WBLT

social media community with this impactful work. We would also like to connect the students to the entrepreneurial arm of WBLT so that they better understand the business model of the entire organization.

We have a choice in our future, and the time is now to accelerate our understanding of the role the land can make in a positive scenario. The White Buffalo Land Trust team thanks all of you and looks forward to a positive consideration of this proposal.

With gratitude,



Ann Close
Director of Research and Education
White Buffalo Land Trust