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气候变化对文化景观之影响：
以美国太平洋沿岸地区国家公园为例

CLIMATE CHANGE IMPACTS ON
CULTURAL LANDSCAPES:
A PRELIMINARY ANALYSIS IN
U.S. NATIONAL PARKS ACROSS
THE PACIFIC WEST

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摘要

本文阐述了俄勒冈大学文化景观研究小组的一项研究，分析了关键气候变量可能对美国国家公园系统中太平洋沿岸地区文化景观造成的影响。本研究旨在气候变化的背景下确保国家公园系统文化景观弹性，并为未来的相关研究提供借鉴。

关键词

文化景观；气候变化；国家公园；全球性问题；风险；脆弱性

ABSTRACT

The study of climate change impacts on cultural landscapes in the Pacific West Region of the National Park System by the University of Oregon's Cultural Landscape Research Group, assessed how these landscapes might be affected by key climate variables, and developed recommendations for future research toward the agency's goal of ensuring cultural landscapes' resilience in light of climate change variables.

KEY WORDS

Cultural Landscapes; Climate Change; National Parks; Global Issue; Exposure; Vulnerability

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① “66计划”是美国国家公园管理局于1956年颁布的一项十年计划，旨在到公园管理局成立50周年之际（1966年），实现游客服务水平的大幅提升。

1. 从普乌科侯拉神庙国家历史遗址向西远眺位于夏威夷西海岸的佩勒肯恩海湾。预测的海平面变化将会对沿海地区（包括具有文化价值的椰树林）造成威胁。

1. View west from Pu'ukohola Heiau National Historical Site, overlooking Pelekane Bay on Hawaii's west coast. Projected change in sea level poses hazards for the coastal site, including the culturally significant grove of coconut palms.

引言

在过去的半个世纪中，美国国家公园系统（NPS）在其文化资源遗产推广方面取得了显著成果。其中，文化景观名录（CLI）体系的贡献尤为突出^{[1][2]}。自20世纪60年代以来，随着“66计划”^①的不断推进、《历史场所报告》的发布，以及1968年对历史遗迹的官方认证，文化景观的重要价值得到了越来越多的关注和认可^{[3]~[5]}。20世纪80年代初期，《文化景观：国家公园中的乡村历史古迹》等技术指南相继推出，这一新兴的资源管理领域让人们深深地意识到，人类与自然这两种截然不同的力量紧密交织并在大地之上留下了深刻的文化印迹^[6]。与此同时，这些文化印迹也塑造了文化景观的历史特征，正如卢多米尔·龙齐所强调的，它们赋予了人们同时享受自然与文化熏陶的机会^[7]。直至今日，这种交织关系仍指导着NPS的管理实践，以激发公园所在地的文化景观所固有的生命活力和文化活力。此外，由于此种关

系的存在，文化景观的独特性也在不断发生变化，虽然这种变化有时并不如人所愿。例如，一些存在已久的植物正濒临灭绝，雨水和暴风不断侵蚀土地……因此，有效的资源管理不仅要适应某一尺度下的气候变化，更应当在多重尺度上管理，甚至减缓这些变化。

如今，气候变化为我们认识和保护文化景观带来了更多的不确定性。那么，如何利用这些不断变化的自然或人为因素，提高现有景观保护措施（例如那些用于文化景观状态定期评估的方法）的功效？对功效这一目标的追求或许始终都在变化，且永无止境。未来，人们所熟知的气候现象和极端事件将出现新的变化（如气温和降水量变化），而这种变化的不确定性会引发人们长期的惶恐。例如，海平面上升已对位于沿海地区的夏威夷州普乌科侯拉神庙国家历史遗址产生了潜在的气候威胁。此外，在众多其他气候威胁中，森林野火愈发频繁肆虐，约塞米蒂国家公园和华盛顿奇兰湖国家游憩区等都曾遭到过野火的侵害。

<p>项目地址： 美国太平洋沿岸地区国家公园</p> <p>项目委托： 美国国家公园管理局</p> <p>项目负责人： Robert Z. Melnick</p> <p>项目团队： Noah P. Kerr、Veronica Malinay、Alison Lewis、Nadja Quiroz</p> <p>设计时间： 2016~2017年</p> <p>所获奖项： 2017年美国景观设计师协会研究类荣誉奖</p>	<p>LOCATION: National Parks, Pacific West Region, USA</p> <p>CLIENT: US National Park Service</p> <p>PROJECT LEADER: Robert Z. Melnick</p> <p>PROJECT TEAM: Noah P. Kerr, Veronica Malinay, Alison Lewis, Nadja Quiroz</p> <p>RESEARCH PERIOD: 2016 ~ 2017</p> <p>AWARD: 2017 ASLA Honor Award in Research Category</p>
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究其本质，正视其不确定性是应对气候变化的重中之重。而对于那些拥有丰富土地类型和网络的地区——例如太平洋沿岸地区的国家公园体系——而言尤其如此。严重的气候事件往往会带来深远的社会影响，并引发人们对此类事件的关注。以近年来的死亡谷国家公园降雨事件为例，2015年10月18日，对流性降雨导致葡萄藤峡谷暴发了严重的山洪。两天之内，整个地区的降雨量即已达到以往的年平均降雨量，远远超过了百年一遇洪水事件的级别^{[8][9]}。其间，洪水径流量超过了85m³/s，对死亡谷历史遗址斯科蒂城堡造成了严重破坏。为有效预测此类可能更

为频繁的、对更大范围内的文化景观有着重大破坏影响的极端事件，公园管理者应考虑运用能够明确场地基本情况的系统性方法^[10]。

文化景观名录和气候变化适应策略

CLI是经官方认证的、收录了NPS中所有重要景观的数据库，其对每一处特定文化景观的历史和现状都进行了评估，包括人类已知的由历史变迁带来的影响。本文所记录的研究涵盖了各个文化景观的整体状况及已有记录的历史影响，且均依据当前气候变化的预测数据进行了深入分析。整个过程在CLI

的现有管理框架下进行，旨在识别并量化预测的气候变化影响。通过与NPS的合作，研究团队完善了NPS最新的文化资源气候变化响应框架^{[11][12]}，以明确预测气候变化将会对美国西部地区 and 太平洋岛屿之上的文化景观产生何种影响。

由此，俄勒冈大学文化景观研究小组（CLRG）与太平洋沿岸地区的工作人员紧密协作，完成了历时两年的研究。该研究分为两个阶段：首先，在气候科学家和其他景观专业人员的协助下，研究小组将局地（即郡县级）预测报告进行了汇总，以评估区域内记录在册的文化景观与特定气候变量之间

- 案例研究所选择的6处文化景观代表了美国太平洋沿岸地区具有不同景观类型及区域分布特征的网络。
- “气候变化与文化景观：研究、规划与管理”决策树成为了项目现阶段的工作指南。
- The six cultural landscapes case studies represent the Pacific West Region networks, different landscape types, and regional distribution.
- The decision tree of “Climate Change and Cultural Landscapes: Research, Planning, and Stewardship” guides the current effort for this project.

的关系；由此生成的基础模型涵盖了该地区164处文化景观的所有典型性特征和已有记录的气候影响。这些历史文化景观场所全部达到了CLI的认证要求。

基础模型的提出也促进了分析性模型的初步开发。在分析性模型的帮助下，文化景观的脆弱性被量化为随单个景观特征而变化的函数。根据几种已知的环境灾害和主要的气候变化预测结果，研究以综合评分的方式展现出每处文化景观所面临的风险，这一评分也可在未来用于比对场地当前的风险和预测的气候变化可能对其造成的危害。项目选定了6个场地作为研究案例，并借此从气候变化的角度更新我们对于文化景观现状的认知——或者说，这6个场地为我们提供了了解地面真实情况的机会。项目团队对其中三个场地进行了回访，以验证对于场地脆弱性的初步评估。总体而言，本研究旨在气候变化的背景下确保美国国家公园系统文化景观弹性，并为未来的相关研究提供借鉴。

研究场地选择

项目中的6个案例研究场地主要依据以下三个选择标准：1）在太平洋沿岸地区的每个网络中选择一个案例研究场地（每个网络大致对应一个生态区域）；2）应涵盖所有经NPS认定的文化景观类型（如历史遗址、地方特色景观、人工设计类景观、民族志类景观等）；3）公园的工作人员能够参与并协助进行实地调查和研究。最终，加利福尼亚州红杉树国家公园里昂牧场、加利福尼亚州死亡谷国家公园斯科蒂城堡、加利福尼亚州尤金-奥尼尔国家历史遗址、华盛顿州北瀑布国家公园巴克纳庄园、夏威夷州普乌科侯拉神庙国家历史遗址，以及爱达荷州内兹珀斯国家历史公园“怪物之心”被选定为案例研究场地。

项目目标

本研究的目标可概括为4个方面：1）收集并整理太平洋沿岸地区43个公园内164处文化景观的气候变化预测数据，包括气温、

降水、海平面，以及其他多个方面的变化趋势；2）明确与这164个文化景观相关的气候变化潜在风险；3）开展针对6个案例的研究，评估选定的文化景观的当前状况及所受影响，并制定应对这些影响的措施，从而提升这些景观应对灾害的弹性；4）（在第一阶段中）对其中的三个案例进行深度分析，初步评估文化景观在已知和预测的气候变量影响下的脆弱性。

研究方法

本研究以一种全新的文化景观形式，对现有的气候变化影响管理框架进行了测试和完善。适用于每一块场地中的用以表示气候变量之下文化景观脆弱性的基本公式如下：
(风险 + 敏感程度) / 适应能力 = 脆弱性^[13]

气候预测

由于并非所有场地数据都对研究有所帮助，研究小组对数据进行了详细分析，以预测温度、降水量和海平面等方面的气候

变化趋势。研究所采纳的数据来源于大量经同行评议的区域气候预测结果，且参照了政府间气候变化专门委员会（IPCC）提出的代表性浓度路径（RCP）的高排放场景（RCP 8.5）^{[14]~[17]}。

灾害风险

基于地理信息系统（GIS）的分析，本研究评估了预测的气候变化结果可能会带来的相关危害。数据来源包括由美国国家海洋与大气管理局（NOAA）、美国地质勘探局（USGS）和美国林务局（USFS）等联邦机构发布的干旱、火灾、洪水和山体滑坡等风险的数据。

影响

在CLI现有的条件式评估体系的基础上，项目团队就可能引发特定文化景观灾害风险的影响因素进行了分析，包括生态环境破坏、植物物种的减少、侵蚀、暴露于恶劣天气下的可能、对危害的忽视、病虫害、人工修剪、对生物演替的影响、结构性损坏、气

温上升/极端高温、均温上升，以及植被入侵情况等。所有这些影响都在NPS的追踪记录范围内。在案例研究的过程中，团队也对每一种影响因素进行了实地验证和记录。

结果分析

2016年，在项目的第一阶段，研究团队建立了一个旨在对脆弱性进行评估的框架，以揭示文化景观特征可能面临的风险。根据公开发布的气候变化预测数据，风险的对象即“处于可能受到不利影响的地方和环境中的人员、生计、物种或生态系统、环境功能、环境服务、环境资源、基础设施，以及经济、社会或文化资产”（参见IPCC 2014年报告）^[18]。我们对这种解读进行了更新，进而分析气候变化如何对文化景观特征产生不利影响。该框架汇总了大量的数据，并对之进行了评分，除气候研究和模型之外，还包括实地细节和地理空间分析。脆弱性评估框架旨在协助NPS的决策层进行深入研究、现场评估，并提出应对方案。该基础模型从

4 © Noah P. Kerr / CURG, 2016

4.

巴克纳庄园历史保护区位于北瀑布国家公园中的奇兰湖湖口。由于气候变化等因素，森林野火愈加频发，人们对该处文化景观的关注度也随之提升。
5.

洪水侵袭了位于死亡谷国家公园的格雷普文峡谷，严重损坏了斯科蒂城堡历史保护区的道路，破坏了建筑物的稳定性，同时加剧了土壤流失。
4.

Buckner Homestead Historic District is situated near the head of Lake Chelan in North Cascades National Park. Increased wildfire frequency has heightened concern for cultural landscape resources here, potentially exacerbated by climate drivers.
5.

Aftermath from a severe flood event in Grapevine Canyon located in the Death Valley National Park, which damaged roads, destabilized buildings, and triggered extensive soil erosion in Scotty's Castle Historic District.

4个方面对每处文化景观进行评分：1）场地现状：对于场地的总体景观状况进行评估，包括基于CLI框架对其状况进行阐释；2）当前风险：辨别面临气候灾害风险的文化景观特征的空间特性（该赋值根据对当前GIS数据分析得出）；3）历史风险：主要通过基于CLI的分析，确定已知的当前及历史影响；4）预测风险：基于气候预测报告中的温度、海平面和降水量等数据对气候预测数据的强度和可信度进行计算（数据来源于美国郡县级尺度的气候预测和对外公布的公园尺度数据）。在第二阶段，项目团队对巴克纳庄园、死亡谷斯科蒂城堡和里昂牧场三处场地的文化景观特征脆弱性进行了详细研究。两个阶段的研究成果都将在未来为历史文化景观的保护工作提供重要依据。

团队协作

研究团队对CLI数据库中每个场地的信息进行了分析，并从各类已发表的和可获取的数据源中检索气候变化预测数据。通过这一过程，我们明确了已经认定的文化景观特征所面临的来自气候变化的潜在压力 and 影响。在NPS区域部门及公园工作人员的协助下，团队不仅获取了众多共享数据，更收集了来自各方的意见，充实了现有文献和一手资料，并与工作人员建立起了良好的沟通机制。这一过程需要定量和定性这两种类型数据的共同支持。

在这些案例研究中，项目团队十分重视在各区域和公园园区工作人员的协助下进行现场调查和文件记录，以更好地认识各种因素对当前文化景观特征的影响，进而深入理解这些景观的历史形态和意义。项目所施行的现场调查采用初步踏勘的方法，拍照记录了景观系统、地貌、植被、建筑物、景观结构及其他景观特征的信息，以记载并评估景观的状况和影响。通过这一方式，研究人员更加充分地了解了公园管理事务中的重点、对专业工作人员和资金支持的迫切需求，以及现有的历史气候数据和预测气候数据之间存在差值的原因。

结语

文化景观充满活力且不断发展演变，其独特的魅力赋予了我们无尽的遐想。但从现有的评估和管理方案来看，随着时间的推移，仍需挖掘一种易控的、可预测的均衡体系来管理这些场所^[19]。而这一体系必须能够及时更新，以有效应对不断变化的气候状况。无论是保有对文化景观中受到保护的历史属性的清晰认识，还是根据国家史迹名录（NRHP）和CLI的标准进行评估都已变得愈发困难。然而，我们仍然能够看到园艺师试图延迟观赏植物衰老期的到来，或是修复古建筑的工匠正面对越来越稀缺的老龄木材而苦苦挣扎^[20]。对于文化景观管理者来说，能够灵活而创造性地应对基于场地发展的新兴思潮和需求，将成为其职业素养的核心。2016年是美国《NPS组织法》颁布100周年，它不仅见证了时间的流逝，更记录了公园管理工作的悄然发展。

我们应当始终将文化景观视为不断发展的过程和物质体系，而非仅仅存在于某个场地中的珍宝。当意识到气候变量作为可变因素的关键作用之后，我们应更加明确将文化景观固有体系的变化与气候变化中隐含的不确定性因素区分开来的必要性。在此基础上，我们可以了解已知和预测的气候变化对公园特征的关键影响，进而深入理解安吉拉·里奇曼所强调的公园遗产中文化景观的“全貌”^[21]。这既是机会也是挑战，需要引起更加广泛的关注。**LAF**

注释

该项目研究成果及最新报告《气候变化与文化景观：研究、规划与管理指南》均由CLRG研究人员编写并授权国家公园管理局发布，欲了解详细内容请访问<https://www.nps.gov/subjects/culturallandscapes/climate-change.htm>。

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① Mission 66 was a United States National Park Service ten-year program issued in 1956 that was intended to dramatically expand Park Service's visitor services by 1966, in time for the 50th anniversary of the establishment of the Park Service.

Introduction

During the past half-century, the U.S. National Park System (NPS) has advanced the recognition of its cultural resource inheritance. The Cultural Landscape Inventory (CLI) system, in particular, offers a case in point^{[1][2]}. From the 1960s forward, expanding consideration for significant landscapes through prepared Historic Grounds Reports and formal recognition of historic sites (1968) communicated a broadening perception of cultural significance in the wake of Mission 66^{①[3]-[5]}. With the emergence of technical guidance by the early 1980s, such as Cultural Landscapes: Rural Historic Districts in the National Parks, this realm of resource stewardship highlighted a deeply entwined relationship: these resources exist as a nexus of distinct human and natural forces acting upon the land^[6]. Moreover, their lasting historic character remains defined by it and, as Ludomir Lonzy urges, this engenders a simultaneous experience of natural

and cultural realms^[7]. This relationship continues to inform NPS management practice today, underlining these places' inherent biological and cultural dynamism. Moreover, it guarantees persistent — and at times frustrating — changes in their distinguishing features: heritage plantings reach the end of their natural lifespan; rain and wind wear at soil. Effective stewardship requires accommodating change at one scale while managing and even slowing it at another.

Climate change now brings a new enigma to our conception and care of these places. How might shifting systems, both natural and human, influence the efficacy of existing tools in landscape preservation, such as techniques used for periodic condition assessment? The proverbial target appears to be moving, perhaps indefinitely. Projected shifts in familiar ranges of climate means and extremes invoke disquieting prospects for long term trends, including alterations to air temperature and precipitation. Concern regarding changing sea level, affecting

coastal environs such as Pu'ukohola Heiau National Historical Site on Hawaii, suggests one expression of potential climate hazards. Additionally, increased frequency and intensity in wildfires, among other threats, continue to loom over parklands from Yosemite National Park to Washington's Lake Chelan National Recreation Area.

At its core, acknowledging uncertainty is central to this endeavor, and is particularly important for a region encompassing diverse land forms and systems, such as the Pacific West Region (PWR) of NPS. Yet severe climate events frequently demonstrate a recognizable effect, and are rightly concerning. In one recent instance, in Death Valley National Park, convective rainfall triggered the October 18, 2015 flash flood of Grapevine Canyon; in two days, the locale received the rough equivalent of its annual historical norm, well beyond the levels accompanying a hundred-year event^{[8][9]}. Flooding wrought havoc across Death Valley Scotty Historic District, with

6.

俄勒冈大学文化景观研究小组成员和就职于美国国家公园管理系统太平洋沿岸地区的园艺师正在讨论尤金-奥尼尔国家历史遗址在文化景观管理工作上面临的挑战。
7.

在巴克纳庄园历史保护区，一个木制的涵洞仍然保留于人工开挖的沟渠系统中，用于灌溉这里的传统果园。此类文化景观具有重要的历史价值，且并未受到园区果农所采取的场地保护措施的影响。
6.

A member of the CLRG research team and a NPS PWR horticulturist discuss cultural landscape management challenges emerging at Eugene O'Neill National Historic Site.
7.

A wooden culvert maintained as a working component in this hand-dug ditch system is still used to irrigate heritage orchards at Buckner Homestead Historic District. Such cultural landscape features are historically significant, and compatible with preservation management practices used by the park orchardist.

discharge exceeding 85 m³/s. To effectively gauge the implications of potentially more frequent such extremes for cultural landscape features beyond a single park setting, managers would benefit from a systematic means of distinguishing baseline conditions^[10].

Cultural Landscape Inventory and Climate Adaptation Strategies

CLI is a certified database of all significant landscapes in NPS. Each CLI document assesses the history and conditions of a specific cultural landscape, including the known effects of historical change. In this project, data pertaining both to overall condition and recorded impacts for each cultural landscape were overlaid with, and analyzed according to current climate change projection data. This process follows the existing stewardship framework of the CLI, and is intended to identify and potentially

quantify anticipated climate change impacts. In partnership with NPS, the team refined the agency's recent framework for cultural resource climate change response^{[11][12]}, to better understand projected climate change impacts to cultural landscapes located in the western United States and Pacific Islands.

This work was conducted over two years by the University of Oregon's Cultural Landscape Research Group (CLRG), in two project phases, with close collaboration with PWR staff. Working with climate scientists and other landscape stewards, the research team first compiled localized (i.e. county-level) projections to assess how documented cultural landscapes within the region might be affected by selected climate variables. The resulting matrix summarizes all character-defining features and documented impacts for 164 cultural landscapes across the region. Each of these places meets CLI certification requirements.

Matrix development also prompted

early development of an analytical model. This tool is intended to quantify cultural landscape vulnerability as a function of individual landscape features. Aggregated scoring for each landscape summarizes exposure according to several known environmental hazards and key projected climate changes — enabling future comparisons related to sites’ exposure to both current risk and projected climate change. Six field case studies offered opportunities to refine — or “ground truth” — identification of current conditions, viewed through the lens of selected climate variable projections. Three of the above case studies were revisited, in order to inform preliminary vulnerability assessments. Together, this work informs recommendations for future research toward the agency’s goal of ensuring

cultural landscapes’ resilience in the era of climate change.

Selection of Sites for Case Study

Six case studies were selected using three criteria: 1) each is located in a different PWR network (a unit of organization roughly analogous to an ecological region); 2) all cultural landscape types recognized by NPS were represented (i.e. historic site, vernacular, design, ethnographic); and 3) that park staff were available to participate and assist with fieldwork and research. Case study selection resulted in the following field locations: Lyons Ranches Historic District, Redwood National Park, California; Death Valley Scotty Historic District, Death Valley National Park, California; Eugene

O’Neill National Historic Site, California; Buckner Homestead, North Cascades National Park, Washington; Pu’ukohola Heiau National Historic Site, Hawaii; Heart of the Monster, Nez Perce National Historical Park, Idaho.

Project Objectives

The project aims to 1) collect and compile climate change projection data for 164 cultural landscapes in 43 parks across the PWR, including, but not limited to, climate change trends in air temperature, precipitation, and sea level; 2) identify anticipated climate change related exposures specific to each of the 164 cultural landscapes; 3) conduct six case studies, assessing current condition and impacts in selected cultural landscapes, and

- 8-1. 美国国家公园管理系统太平洋沿岸地区预测气候变量中的污染气体排放量（历史值与愿景值）。为实现项目目标，气候分析与文化景观评估均基于代表性浓度路径的高排放场景（RCP 8.5）进行。详情参见：参考文献[22]。
- 8-2. 美国国家公园管理系统太平洋沿岸地区预测气候变量中的预测气温。在代表性浓度路径的高排放场景（RCP 8.5）下，到2100年，全球平均气温相较于1950年将上升3.3℃。

- 8-1. The observed emissions and projected emissions scenarios, one of the projecting climate variables in NPS PWR. For the purposes of this project, climatic analyses and cultural landscape assessments are based on the highest emissions scenario, RCP 8.5. See Ref. [22].
- 8-2. The projected temperature, one of the projecting climate variables in NPS PWR. Under the highest emissions projection (RCP 8.5), average air temperature is projected to increase by 3.3 °C by the year 2100 relative to 1950.

identifying steps towards ensuring impacts are addressed, to improve the landscape’s resiliency; 4) conduct additional work on three of the six case studies, assessing preliminary vulnerability of the cultural landscape features to the known and projected climate variables, as previously identified (within Phase I).

Methods

This project approach tested and refined an existing framework for managing the projected effects of climate change, in a new cultural landscape format. For each site, the basic formula adopted to express vulnerability to climate variables is as follows:

(exposure + sensitivity) / adaptive capacity = vulnerability^[13]

Climate Projections

Due to varying availability of data for study sites, the team delineated its analysis to consider projections for temperature, precipitation, and sea level. This scope adopts regional climate projections from a variety of peer-reviewed sources, with respect to Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP) emissions pathway 8.5^{[14]–[17]}.

Hazards

Geographic Information System (GIS) analysis evaluated hazards associated with projections. Hazards include drought, fire, flood, and landslide — derived from established risk data published by a range of federal agencies, including the National Oceanic and Atmospheric Administration

Park Alpha Code 公园字母代码	Cultural Landscape Inventory Name 《文化景观名录》目录	Condition Score 现状评分	Current Exposure Score 当前风险评分	Historical Exposure Score 历史风险评分	Combined Condition, Current, and Historical Exposure Score 现状、当前风险和历 史风险综合评分	Projected Exposure Score 预测风险评分
LAVO	Drakesbad Guest Ranch 德雷克斯巴德宾客牧场	66.00%	2.36%	9.39%	7.76%	1.26
LAVO	Lassen Volcanic National Park Highway 拉森火山国家公园高速公路	66.00%	0.00%	4.55%	3.00%	2.25
LAVO	Mineral Headquarters Historic District 矿产总部历史保护区	33.00%	0.00%	12.53%	4.14%	2.25
MANZ	Manzanar National Historic Site 曼扎拿国家历史遗址	66.00%	7.52%	11.88%	12.80%	4.11
MIIN	Minidoka Internment National Monument 米尼多卡集中营国家纪念碑	100.00%	2.84%	2.55%	5.39%	3.67
MOJA	Kelso Depot 科尔索火车站	100.00%	0.44%	4.50%	4.94%	4.67
MOJA	Mescal Historic Mining District 梅斯卡尔历史矿区	66.00%	1.70%	3.85%	3.67%	4.67
MOJA	Rock Springs Land and Cattle Company 罗克斯普林斯农业与畜牧业公司	66.00%	0.05%	1.03%	0.71%	4.67
MOJA	Soda Springs Historic District 苏打斯普林斯历史保护区	66.00%	0.00%	15.92%	10.51%	4.67
MOJA	Vulcan Mine Historic District 伏尔甘矿历史保护区	66.00%	2.78%	3.21%	3.94%	4.67
MORA	Camp Muir 缪尔营地	66.00%	5.56%	9.72%	10.08%	2.25
MORA	Christine Falls 克莉丝汀瀑布	33.00%	0.00%	11.67%	3.85%	2.25
MORA	East Side Highway 东区公路	33.00%	0.00%	3.21%	1.06%	2.25
MORA	Longmire Developed Area 朗迈尔氏发达地区	66.00%	0.34%	5.76%	4.02%	2.25
MORA	Mather Memorial Parkway (Route 410) 马瑟纪念公园大道（ 410号公路 ）	66.00%	2.56%	11.47%	9.27%	2.25
MORA	Mowich Lake Entrance Road 莫伊奇湖入口公路	33.00%	1.85%	2.81%	1.54%	2.25

High 高风险

Medium 中风险

Low 低风险

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(NOAA), United States Geological Survey (USGS), and the United States Forest Service (USFS).

Impacts

The team analyzed documented impacts to each specific cultural landscape, selected from an existing CLI conditional assessment typology, including disruption;

loss of plant species; erosion; exposure to elements; neglect; pests / diseases; pruning practices; release to succession; structural deterioration; temperature / hot extremes; temperature / warmer averages; and vegetation / invasive plants. Impacts are tracked by NPS for all cultural landscapes. For case studies, each impact was verified and documented in the field.

Results

In Phase I, 2016 efforts introduced a vulnerability assessment-focused matrix, as a means to index exposure of character-defining cultural landscape features. Based on publicly available climate change projection data, exposure describes “the presence of people, livelihoods, species

9.

从分析模型中提取的样本数据，可协助NPS管理人员评估某处区域所记录的文化景观面临的预测气候风险。
10.

位于普乌科侯拉神庙国家历史遗址的传统干砌石结构。在田野调查中，我们记录下了可能改变这些神圣构筑物结构的野山羊的行踪。
9.

Sample data from a component of the analytical model, developed to assist NPS stewards in assessing projected climate exposure among the region's documented cultural landscapes.
10.

Traditional dry-laid masonry construction located in Pu'ukohola Heiau National Historical Site. The activity of wild goats, which can alter these sacred structures, was documented during field investigation.

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10

or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected” (IPCC 2014)^[18]. This understanding is amended to frame how climate change might adversely affect the cultural landscape features. The matrix aggregates and scores a wide range of data, including both ground-level detail and geospatial analyses, alongside climate studies and models. This tool is intended to assist NPS decision-makers in directing further analysis, field assessment, and appropriate treatments. Four major criteria informed the scoring method within the matrix: condition, an overarching, landscape-scale assessment of condition, including interpretation of status evaluated within the CLI; current exposure, a spatially-specific identification of cultural

landscape features at risk to a climate hazard (this assigned value is predicated on analysis of current GIS data); historical exposure, identification of known current and historical impacts, primarily through CLI analysis; and projected exposure informed by the climate projections for temperature, sea level, and precipitation, which is a calculation of intensity and confidence of climate projection data (datasets are comprised of current climate projections delineated along U.S. county boundaries, as well as at park scale where available). Phase II of the study was conducted through detailed case studies of vulnerability at Buckner Homestead, Death Valley Scotty Historic District, and Lyons Ranches. Both phases will inform future management decisions for conservation of significant historic resources.

Collaboration

Team members analyzed the CLI database for each site and retrieved climate projection data from a variety of published and available data sources. This process shaped a determination of potential climate stresses and impacts on identified cultural landscape characteristics and features. Consultation with NPS regional and park staff enabled data sharing, collecting additional observations, and gathering new recommendations for current literature and primary source materials, as well as inviting further staff advice. The process employed both quantitative and qualitative data.

Case studies stressed field investigation and documentation of each site with regional and park staff, to achieve a better grasp of current impacts on cultural

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11

11. 公园工作人员和研究人員正在討論应用于里昂牧场中的火灾生态学和燃料管理实践，该处文化景观与红杉树国家公园中的巴尔德山原生山地草原相互交织。如何维护麋鹿营等场地中草原物种的活力和多样性仍颇具挑战性。
11. Park staff and researchers discuss fire ecology and fuels management practices used at Lyons Ranches, a cultural landscape interwoven with the native upland prairies of Redwood National Park's Bald Hills. Maintaining the visibility and composition of prairie species at sites like Elk Camp remains challenging.

landscape features that contribute to the understanding of the landscape's historic form and significance. Fieldwork followed a regimen of visual inspection and logged photo-documentation of landscape systems, topography, vegetation, buildings, structures, and other landscape features to document and assess condition and impacts. This offered researchers additional insight into park priorities, competing demands for staff expertise and funding, and the acknowledged gaps in available historical and projected climate data.

Concluding Comments

Cultural landscapes continue to invite our fascination as living, evolving systems. Yet existing evaluation and management protocols retain the underlying assumption that a controlled, predictable equilibrium

governs these places over time^[19]. This paradigm must shift along with effective climate response tools. Maintaining a clear sense of some historic attributes protected in these sites, meanwhile — as evaluated according to National Register of Historic Places (NRHP) and CLI protocols — becomes an increasingly slippery prospect. A horticulturalist works to delay entropy in elderly specimen plants, while a preservation carpenter grapples with an increasingly scarcity of old-growth timber for historically appropriate building repairs^[20]. The flexibility, and sometimes creativity, on the part of cultural landscape managers to respond to a guiding ethos and emerging needs onsite seems to comprise an increasingly vital aspect of their professional vocation. The passage of time marked in the 2016 NPS Organic Act centenary serves as a reminder of the depth of such changes quietly at work.

We must continue to understand cultural landscapes as processes and systems, rather than simply treasured objects gathered in the open air. Recognizing the critical role of climate variables as moving parts amplifies the need to differentiate inherent system change from the uncertainty implicit in climate shifts. To do so appreciates known and projected climate impacts together as a key influence upon park character, enabling us to better engage what Angela Richman emphasizes as the “whole story” of cultural landscapes in the Park legacy^[21]. It is an opportunity and a challenge in need of attention. **LAF**

NOTE

Findings from these efforts, as well as the recent Climate Change and Cultural Landscapes: A Guide to Research, Planning and Stewardship, were authored by CLRG researchers, and are made publically available through the National Park Service: <https://www.nps.gov/subjects/culturallandscapes/climate-change.htm>.

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12. 从校舍峰的火灾瞭望台远眺位于北加州的巴尔德山。里昂牧场文化景观的重要特征与系统结构在这里清晰可见，包括其历史悠久的道路网络、畜牧场、俄勒冈州白栎（*Quercus garryana*）林区和山地草原。
12. Northern California's Bald Hills as seen from the Schoolhouse Peak fire lookout. Several significant features and systems of the Lyons Ranches cultural landscape are visible here, including the ranches' historic road network, stockyards, Oregon white oak (*Quercus garryana*) habitat, and upland prairies.

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