



Objective 3: Co-develop site suitability, restoration and performance assessment frameworks

Results from Obj. 1 and 2 will inform development of several planning and assessment frameworks for advancing coastal dune restoration NbS across California. Frameworks will be developed in collaboration with community partners and federal, state and local end-users to help identify priority sites and methods for implementing, replicating and expanding dune restoration projects to improve coastal resilience. These will lay groundwork for developing common monitoring protocols and science-based metrics for comparing site conditions and tracking performance over time. Currently, a lack of common protocols for monitoring, reporting, site suitability and restoration are key challenges for dune restoration project permitting, feasibility and performance as a NbS for building coastal resilience. Task 3.1: Develop a framework for evaluating site suitability and appropriate dune restoration methods. No framework exists for assessing the suitability of, and prioritization of sites for, coastal dune restoration in California and the applicability of frameworks developed on other coasts (e.g. ReDune[9]) is limited given distinctly different climatic, geological, ecological, and oceanographic controls. Outputs from the comprehensive inventory (Task 1.1) and vulnerability assessment (Task 1.2), coupled with scientific expertise and local knowledge of end-users (Task 2.1), will provide the foundation for identifying sites where dune restoration could be implemented to improve ecosystem services and coastal resilience. This will also help recognize constraints for other sites (e.g. accommodation space, sand supply, wind climate) and limiting management practices (e.g. winter berm building, beach grooming, vehicle use). The resulting framework will provide a roadmap to identify sites, feasibility constraints and suitable restoration methods. A key goal of the framework is to help indicate where conditions and processes are capable of maintaining dunes that can persist and improve coastal resilience with limited intervention post-restoration, as well as sites where dune restoration could occur but might require more involved adaptive management (e.g., sand nourishment, supplemental planting). The site suitability framework will be informed by end-user workshops via the CDSN, as well as specifically engaging California’s Tribes via the Indigenous Coastal Stewardship Initiative of the Climate Science Alliance, to collectively solicit ideas and feedback on the dune inventory, vulnerability assessment and suitability framework drafts. The research team will also test this framework in each of the three geographic regions with support from community partners and end-users.

Task 3.2 Develop a performance assessment framework for resilience of dune restoration projects Using monitoring results from Obj. 2, an interdisciplinary framework for evaluating performance of dune restoration approaches will be created. Team members have already developed preliminary concepts for evaluating resilience through geomorphic and plant community responses from site-specific research[17,94]. Team members also led a scoping workshop in November 2022 with the CDSN that explored biophysical resilience indicators that would be leveraged to develop this framework[18](Fig. 4). The vulnerability assessment (Task 1.2) will help outline how performance indicators can indicate resilience and adaptive capacity (e.g. resistance to, and recovery from erosion, restoration potential, inland migration). The framework will also identify common monitoring protocols for evaluating project performance and resilience and for comparative evaluation across sites and restoration methods (see Task 2.2). Per Task 3.1, this framework will be co-developed with community partners and end-users through workshops that share results from Obj. 2, discuss monitoring plans and identify information needs on dune response to restoration and resilience over time. This task also will recognize and promote pathways for improving the leadership and engagement of underserved communities and Tribes in undertaking restoration, stewardship and implementation of coastal beach-dune NbS efforts.