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Living Shorelines & Resilience in Southern California: A Summary of a Series of Workshops held as part of The Resilient Coastlines Project of Greater San Diego

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Living Shorelines & Resilience in Southern California

A Summary of a Series of Workshops held as part of

The Resilient Coastlines Project of Greater San Diego

And in partnership with:

Climate Collaborative San Diego Region

Climate Science Alliance

Coastal Conservancy

NOAA

Tijuana River National Estuarine Research Reserve

Sea Grant University of Southern California

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Funders

NOAA Regional Resilience Grant program

State Coastal Conservancy – Prop 1 funding

Project

The *Resilient Coastlines of Greater San Diego* project represents a multi-faceted approach to building regional coastal resilience. The project is designed to connect several local sea-level rise initiatives, fill existing knowledge gaps that are barriers to resilience planning and implementation, and further engage scientific experts and community members in building coastal resilience for the San Diego region. The project is being led by the San Diego Regional Climate Collaborative and partners, including the Tijuana River National Estuarine Research Reserve and the Climate Science Alliance – South Coast. The effort is funded through the NOAA Regional Coastal Resilience Grant Program designed to directly support community-based coastal hazard planning.

For more information

Resilient Coastlines Project: http://www.resilientcoastlines.org/

Workshop materials: http://www.resilientcoastlines.org/livingshorelines

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Introduction

In 2016, a series of workshops were held to discuss living shorelines in Southern California. The workshops specifically focused on the unique benefits, challenges and opportunities for implementing living shorelines in the region, and the nexus between nature-based solutions and ongoing local adaptation planning. Approximately 140 participants partook in these dialogues, and some of the key themes that emerged include:

- Letting nature do the work for you
- Designing for the future
- Integrating nature into shoreline management projects
- Project goals distinguishing living shorelines
- Engineering and urban living shorelines
- Space constraints along urban coastlines
- Permitting pathways to support demonstration projects
- Living shorelines and phased sea level rise planning
- Designing with watersheds and sediment management in mind
- Exploring emerging commercial opportunities
- Public access and project success
- Planning for living shorelines alongside the community
- Sharing monitoring and best practices to ensure future success
- Citizen science and socio-ecological monitoring

The workshops provided the first ever opportunity for Southern California stakeholders to outline what is unique about designing living shorelines in the context of Southern California shorelines for state and federal entities.

Presentations

Access presentations at: http://www.resilientcoastlines.org/livingshorelines

Informational presentations

The State Coastal Conservancy provided two informational presentations at each of the three workshops to establish a basic understanding of living shoreline projects in California, and to better understand the status of science and policy behind living shorelines in Southern California.

Green to Grey: Spectrum of Living Shorelines

Evyan Sloane & Megan Cooper, State Coastal Conservancy

Coastal hardening has one benefit: it protects the coastline. However, these structures begin to degrade the day after construction and require frequent maintenance. Shoreline hardening negatively impacts the natural habitat surrounding it and cuts off ecosystem processes and connectivity (e.g., nesting and breeding areas). On average 14% of U.S. shorelines are hardened, with Southern California being one of the most hardened areas with over 75% of its coastline.

Figure 1: Three primary characteristics of living shorelines.

Nature-based infrastructure, or living shorelines, have many benefits compared to hardening: they can restore or maintain wildlife habitat, maintain coastal processes, as well as protect the coastline and coastal infrastructure (Refer to Figure 1). Deciding where a project lies on the “green-grey” spectrum can

be difficult: from projects with only natural components, to hard structures covered by vegetation, to seawalls or bulkheads, living shoreline projects often fall into a blurred area that contain both “green” and “grey” components. This can make it difficult to determine when a project no longer can be considered a living shoreline (Refer to Figure 2).

National policy and permitting advancements better encourage and enable living shorelines, but these are based on experiences in the Gulf and East Coast. The permitting of these projects is much less tested on the West Coast. Since the living shorelines approach is still relatively new and untested in California, these projects will require robust monitoring for physical and biological performance to determine efficacy. Demonstration project in Southern California will need a lot of public support and education to advance awareness and support for this approach.

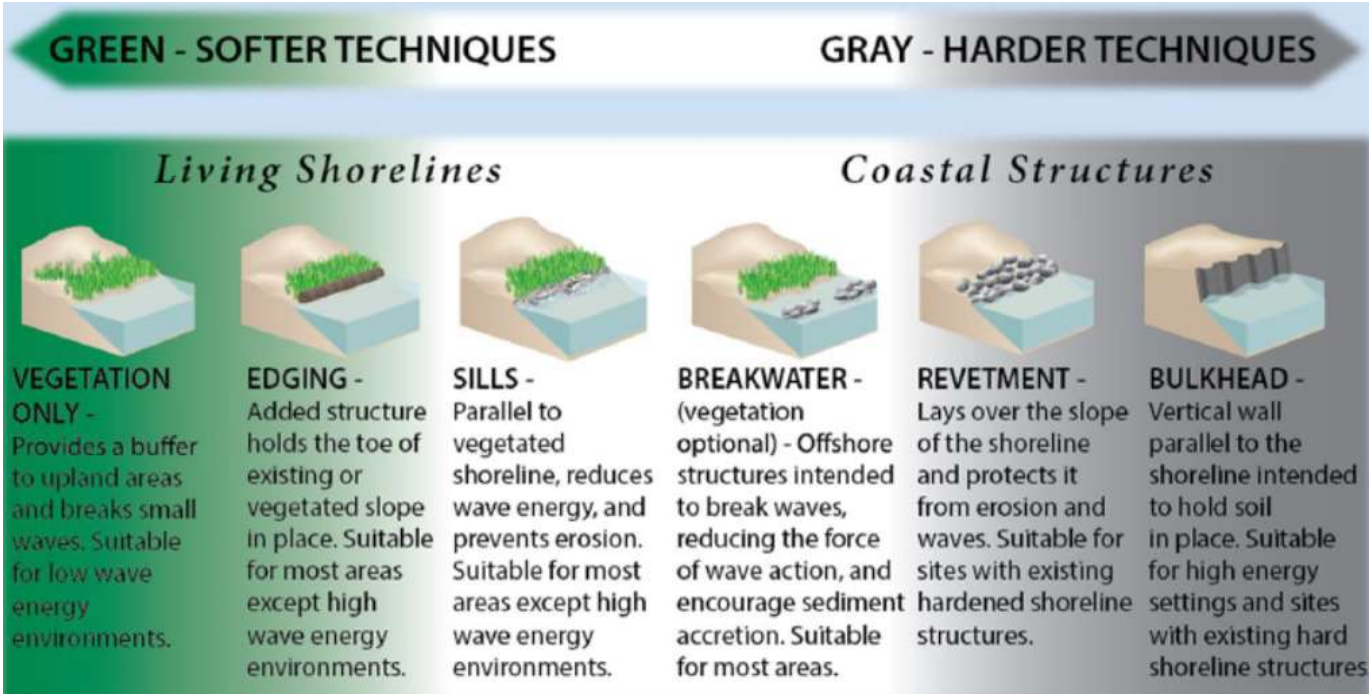

Figure 2: A continuum of green (soft) to grey (hard) shoreline stabilization techniques presented in more detail in the Systems Approach to Geomorphic Engineering (SAGE) Natural & Structural Measures for Shoreline Stabilization brochure. Source: Guidance for Considering the Use of Living Shorelines (2015), NOAA: http://www.habitat.noaa.gov/pdf/noaa_guidance_for_considering_the_use_of_living_shorelines_2015.pdf

Monitoring and Designing for Resilience

Evyan Sloane, State Coastal Conservancy

California living shoreline projects are designed with these goals in mind: habitat restoration/ enhancement, energy attenuation, and sediment accretion. Three California living shoreline projects were presented to highlight both protected bay and open shoreline efforts and the differing goals and associated monitoring strategies. The case studies included: Seal Beach Thin-layer Salt Marsh Sediment Augmentation; Surfer's Point; and San Francisco Bay Giant Marsh.

Figure 3: Surfer's Point project design.

Local presentations

In addition to the information presentations, each individual workshop featured local presenters to provide different insights into local perspectives and expertise. Summarized below are the presentations provided at each workshop.

Living Shorelines and Resilience

Kate Barba, Scripps Institution of Oceanography (San Diego workshop)

After Hurricane Katrina and Sandy, there was a big push for natural approaches to protect the shorelines. The Environmental Protection Agency (EPA) had been using the term “green infrastructure” for years in the context of sustainable urban planning, so “natural infrastructure” was developed as an official term among federal agencies when discussing these natural approaches of protection. U.S. Army Corps of Engineers, other federal and local government, academic, and non-governmental organizations launched a community of practice network called: Systems Approach to Geomorphic Engineering (SAGE) for coastal decision-makers. SAGE promotes consideration of a continuum of approaches that reflect “green to grey” engineering measures at a landscape scale. The SAGE website includes more than 100 examples of ongoing or completed projects that incorporate SAGE principles.

When seeking funding to support natural infrastructure projects to increase coastal resilience, it is critical to clearly articulate the objectives and goals of the project in order to align projects with potential funders. An important source of funding to support natural infrastructure projects is in post disaster recovery funding opportunities as an adaptation strategy to mitigate risk in the face of future extreme events. However, there are still many barriers: institutional bias towards grey coastal protection, Southern California has minimal undeveloped space for living shoreline projects, and it can be difficult to identify the champions who have the influence to push the project forward. Community is important, and is a key factor in determining how living shorelines may play a role on the local level (Refer to Figure 4). One must start early to develop and articulate benefits with stakeholders from the

Figure 4: Non-traditional components that must be considered when designing and implementing living shoreline projects.

beginning and articulate the protection of property, safety and quality of life as benefits for the community, as well as habitat and species protection.

An Engineering Perspective

Brian Leslie, Moffatt & Nichol (San Diego workshop)

The Cardiff State Beach Dune Restoration project is one of a few living shorelines projects being proposed along the open coast in Southern California. This project is proposed to protect Highway 101 against wave overtopping and prevent undermining of the roadway through use of a vegetated dune and buried rip rap. The project brought to light the fact that there is limited design guidance for Southern California for the design of coastal dunes for the purposes of shoreline protection. At this point it is trial-and-error, meaning any projects being completed now are seen as pilot projects for what could be done and its effectiveness. What we need is West Coast specific design guidance, similar to New Jersey's Dune Manual (Refer to Figure 5) or FEMA's 540 rule for the Gulf Coast and North Atlantic region. Another challenge for implementation of open coastal living shorelines in Southern California is adequate space: the space between development and the shoreline is limited in many areas and will become narrower (a phenomenon. This can cause performance issues by impacting a living shoreline project's ability to successfully mitigate threats, as well as provide viable habitat to an area.

Figure 5: Southern California needs a manual that provides specific design guidance, similar to this New Jersey manual outlining principles for designing dune restoration projects.

Perspective on Living Shorelines: ReWild Mission Bay

Rebecca Schwartz, San Diego Audubon Society (San Diego workshop)

Living shoreline projects should support natural habitats and processes along the coast, treat natural and built environment as one system, and resemble coastal features that used to exist along our shoreline. ReWild Mission Bay is a project of San Diego Audubon and our partners to protect and restore wetlands in the northeast corner of Mission Bay. The benefits of projects like ReWild Mission Bay, and living shorelines in general, are that they are flexible and meant to move and adapt to changes in ways that built structures cannot, plus they provide a multitude of co-benefits like giving people access to nature, improving property values, and providing a better return on investment. However, there are challenges: there is a difference between what ecosystem processes would be beneficial to restore, and what can be permitted or funded. In the ReWild Mission Bay Project, discussions were had to determine which species would be able to survive climate change and aid in both ecosystem and community resilience. Another consideration is what maintenance may be required of a living shoreline project. Finally, many projects try to use living shorelines for one goal, but should be viewed in a way that multiple goals and benefits can be achieved.

Figure 6: ReWild Mission Bay project area.

Natural Shoreline Infrastructure: A project under California's Fourth Climate Assessment

Jenna Judge, NOAA Sentinel Site Cooperative (Costa Mesa workshop)

The Project, "Identification of Natural Infrastructure Options for Adapting to Sea Level Rise" is a working document that helps communities evaluate nature-based shoreline techniques for their unique coastal setting. The project's goal is to increase familiarity and provide technical guidance for a range of natural shoreline approaches that reduce the risk of coastal hazards and improve ecosystem function. A wide range of coastal settings requires a wide range of approaches; one size does not fit all. The project is split into four parts to help communities evaluate optimal approaches for their landscape and needs: 1) The definition/typology of natural infrastructure; 2) Case studies specific to California; 3) Engineering guidelines; and 4) Spatial products called "blueprints" for Monterey Bay and Ventura areas that rate the feasibility of each approach given the physical factors present along a stretch of shoreline. This project is still under development and will be published as part of California's Fourth Climate Assessment. The California case studies can be accessed here: http://coastalresilience.org/wp-content/uploads/2017/11/tnc_Natural-Shoreline-Case-Study_hi.pdf

Physical Considerations for Living Shoreline Projects

Nick Garrity, ESA (Costa Mesa workshop)

Physical considerations are vital when designing a living shoreline project. For example, managed retreat is often seen as a viable option for reducing risk to certain infrastructure and making room for living shorelines but when considering this strategy it's important to determine if there is enough space available to actually retreat inland. Both Surfer's Point Restoration Project (Refer to Figure 7) and Chula Vista Bayside Shoreline Stabilization Project are two local examples where managed retreat was physically viable and successfully utilized. Another example of how physical parameters can shape a project is exemplified in the San Diego Native Oyster Restoration. In this instance, it was essential that the design team have a full understanding of how near shore reefs reduce erosion patterns, especially since this project's primary goal is to reduce wind wave erosion by inducing mudflat deposition. This San Diego Bay project is still in the design phase, but once completed will provide interesting insight into what physical conditions an oyster reef can be utilized in to increase resilience in Southern California.

Figure 7: Aerial photos of Surfer's Point before the restoration in 2010 (left) and after the restoration in 2013 (right).

Santa Monica Beach Restoration Pilot Project

Melodie Grubbs, The Bay Foundation (Costa Mesa workshop)

The Santa Monica Beach Restoration Pilot Project aims to return approximately three acres of beach to its natural state by fencing the area off on three sides and planting native vegetation to facilitate the creation of dunes (Refer to Figure 8 for photos). The project will ultimately serve as a model to show that heavy recreational use and habitat restoration are possible in the same area. This project began with full recognition of the importance of communication and engagement with the community. Through collaboration with the community the project team worked to design the project in a way that would have minimal to no impact on existing recreational uses of the beach and to maintain coastal access. Through the project, education and outreach programs were created to link active and passive activities, specifically the role of human actions in both degradation and restoration of natural environments, encouraging business and resident participation.

Partnerships with local government and beach managers, as well as stakeholder meetings and technical advisory group meetings were also an important part of the project's communication and outreach. Monitoring was vital for this project, as it was the first of its kind in California; it was important to understand how the project would react and change as time went on. The project plans to complete 10 years of monitoring. Throughout the project there were challenges: Santa Monica has a highly developed coastline, and since this is a pilot project, little to know previous data or information was available, and funding was a challenge to receive. However, through the struggles, the project continues to be a success.

Figure 8: Photos of the site before the restoration and an artistic rendering of what the site will look like once fully restored.

Living Shorelines and Resilience in Ventura and Santa Barbara Counties

Lily Verdone, The Nature Conservancy (Santa Barbara workshop)

The Nature Conservancy's Coastal Resilience program has been working for over 10 years to examine nature's role in reducing coastal flood risk globally. In California, Coastal Resilience first launched in 2010 in Ventura County (access map here: http://maps.coastalresilience.org/california/). Coastal Resilience Ventura has demonstrated the power of science and community support in numerous ways, including working to inform the permitting of a local power plant to ensure it is located in an area less vulnerable to coastal hazards, and developing a first-of-its-kind partnership with the Department of Defense to inform climate adaptation planning at Naval Base Ventura County. Moving forward, TNC is working with local community organizations such as CAUSE (Central Coast Alliance United for a Sustainable Economy) to ensure that the local community is engaged in regional planning processes, such as the restoration of Ormond Beach, a 630 acre coastal preserve that provides

Figure 9: TNC is working closely with CAUSE to engage community members in regional planning and restoration in Ormond Beach.

coastal access and flood risk reduction for residents of the City of Oxnard - a designated Disadvantaged Community, which ranks in the top 20 percent of environmentally burdened cities in the state.

Coastal Case Studies

David M. Hubbard, Coastal Restoration Consultants, Inc. (Santa Barbara workshop)

An important aspect of all coastal projects is that they are dynamic, and are able to accommodate natural coastal processes and extreme events. A successful living shoreline needs to be able to self-repair and adjust under changing conditions. Three different case studies highlight how to design with these guiding principles in mind. First, San Buenaventura State Beach demonstrated how a simple living shoreline can be established in the absence of beach grooming, and the experimental seeding of the area. Two years after beach grooming ended, all four native dune vegetation species were present on site. Thirteen years later, dune hummocks measured 2-3 feet tall, demonstrating an ability to store sand, build topography, and self-repair following extreme wave erosion (Refer to Figure 10). The next case study highlighted was The Bay Foundation's Santa Monica Dune Restoration project, which is in the early monitoring phase but has the potential to not only provide ecological benefits but resilience to sea level rise. Endangered snowy plovers have already nested on the site. This area will be important to keep an eye on over the next 5 years to see how dunes can be restored in one of the most highly disturbed and utilized areas in Southern California. The final case study discussed was Surfer's Point, which aimed to restore cobble berm, dunes and beach; limit frequency of wave overtopping of hardscape; provide resilience and offset risk to coastal hazards for the next 50 years; use no seawalls; and maintain surfing resources. This project has successfully been tested under big swell conditions but it continues to be important to monitor the sand budget of the site to ensure continued project success.

Figure 10: San Buenaventura State Beach site: (a) two years after the grooming ended and all four native dune species were established (left); and (b) thirteen years later dune hummocks 2-3 feet tall (right).

Living Shorelines: Local Government Perspective

Jackie Campbell, Formerly City of Carpinteria (Santa Barbara workshop)

There are numerous California Coastal Commission and City policies that provide a framework from within which living shorelines can begin to be explored. Each individual policy must be balanced against other policies, as the mission of some policies will unintentionally conflict with others (e.g., protect biological resources vs. maintain public and recreational access). Carpinteria has numerous case studies that can provide insights into some of the successes and challenges faced by local governments in making decisions about shoreline management. Berms are a common strategy for protecting coastal infrastructure, and many projects may be installed under a short-term emergency permit. Would a living shoreline be a more beneficial strategy than a berm? Is a berm the most cost effective strategy, or would a self-repairing living shoreline increase project effectiveness? Additional projects result from mitigation from development which brings along its own set of conundrums. For example, the Bacara Resort Hotel development resulted in dune restoration as part of project mitigation. Projects of this nature provide short-term funding for living shoreline projects but may not be designed with long-term goals in mind or have sustained funding. Is the site being sufficiently monitored? Were success criteria established? Local governments are constantly trying to balance competing land uses while coming to terms with the fact that the shoreline cannot be held in place. In terms of advancing living shorelines in Southern California local governments need access to information to better understand: what works best where; what local projects are successfully meeting goals as expected; how traditional structural, nonstructural and natural infrastructure work together; and how to track the strategy's life expectancy in the context of climate change.

Activities

Throughout the workshops, activities were planned to discuss important aspects and challenges of living shoreline projects in the Southern California region. Below are brief descriptions of each activity and discussion.

When does "green" become "grey"?

This activity encouraged dialogue around where different living shoreline projects lie on the green to grey spectrum (refer to the summary of the *Green to Grey: Spectrum of Living Shorelines* presentation above). Each group was given eight cards that described different shoreline projects. As a team, they were asked to place the examples in order from what they considered the most green to the most grey (Refer to Appendix E). At the end of the activity the groups reflected on the process.

What makes a living shoreline "living"?

Participants were encouraged to discuss what makes a living shoreline "living", and begin to identify some guiding principles or criteria by which Southern California practitioners can use to think about what a living shoreline is or is not.

What is unique about Southern California shorelines?

During this discussion, attendees participated in a dialogue around what specific issues could arise when planning for a living shoreline project in Southern California, exploring benefits, challenges, and opportunities. The facilitated dialogue elicited different perspectives about what specifically characterizes Southern California living shorelines.

Designing and monitoring for resilience

Participants were asked to brainstorm how to design and monitor a living shoreline project that has a primary goal of "increasing community resilience". This discussion encouraged participants to think beyond "biological" considerations and really think about the more socio-ecological interactions of living shoreline projects.

Insights

The following are insights and themes captured from the group activities and discussions outlined in the previous section.

Letting nature do the work for you: The natural component of a living shoreline project (oyster reef, marshland, sand dunes, etc.) should naturally work to protect the coastline with minimal maintenance. Numerous discussions revolved around the ability of a successful living shoreline project having the capacity to self-repair and adjust to changing conditions. As a living shoreline protects the coastline, natural weather events or seasonal cycles may damage the project site in the short-term but if it's truly resilient it should be able to bounce back and restore itself to a functioning natural ecosystem. A living shoreline should also be adaptive to changes we will see in the future. As sea level rise continues and climate change causes intensified coastal hazards, living shorelines should be able to self-repair or adjust to these new conditions. All projects must be able to change with an ever-changing coastal environment.

Designing for the future: Given the dynamics of coastal environments, participants emphasized the importance of designing and monitoring living shorelines looking forward. A great deal of conversation revolved around living shorelines having enough space to be resilient (e.g., space to migrate inland in response to rising seas). This will require integrated approaches that are both phased and look closely at transition zones in the context of possible relocation of infrastructure. Returning our shoreline to a historical natural state should not be the goal, as both human and natural changes have created an ever shifting baseline.

Integrating nature into shoreline management projects: Participants agreed that the term "living shoreline" is not easily defined but is an important concept for not only natural resource managers to understand but for city planners and government officials to embrace as they move forward with community plans. In its most basic form, a living shoreline must provide habitat while physically protecting the shoreline. It needs to become common practice among parties in charge of shoreline management (e.g., engineers, planners…) to ensure that as they are conceptualizing, designing, and monitoring projects they are maintaining, restoring, and enhancing natural shoreline components. Even an extremely "grey" strategy should have some element of "green" added in to increase both natural and community resilience.

Project goals distinguishing living shorelines: Many participants highlighted that a clearly stated project goal is central to determining if a specific project can be considered a living shoreline. For example, if a project does not state habitat restoration or biodiversity as a primary goal, attendees' were less likely to consider the project a living shoreline. However, participants also agreed that a living shoreline must have goals beyond simple habitat restoration, working towards multiple benefits (e.g., protect coastal infrastructure from erosion and coastal flooding, increase community resilience, improved aesthetics).

Engineering and urban living shorelines: Given how urbanized Southern California coasts are, attendees accepted that any living shoreline project would likely need to include an engineered component. Questions arose about what does "engineered" mean, and does it always signify a "grey" project? A definitive answer was not found, but collectively decided that solely hard structures (seawalls, revetments, dikes) or even beach nourishment are not living shoreline approaches unless habitat enhancement is a key goal and that measures are taken to preserve the already existing ecosystem.

Space constraints along urban coastlines: The Southern California coastline is highly urbanized which will constrain the area in which a living shoreline project can be successfully installed. There were numerous discussions about how to be successful

within such a constrained project footprint with many projects needing to have a smaller footprint than is ecologically ideal, and most projects being surrounded by development leaving little to no room for inland migration as seas rise. Many participants expressed their idea of an ideal project integrating some form of "retreat" or "relocation" of infrastructure to create space for restoring natural coastal processes that can accommodate changing conditions. In areas, where relocation isn't an option the participants explored how living shorelines can be successful in small spaces. With many projects being surrounded by urban development, they will need to be designed to withstand a wide variety of environmental conditions (e.g., wave energy) in a set footprint.

Permitting pathways to support demonstration projects: Permitting needs to be updated to encourage local governments to advance living shoreline projects in Southern California. Additionally, as coastal hazards become more frequent and/ or severe due to a changing climate, many participants felt it was important for emergency permits to not become the norm. Emergency permits are to fix short-term problems whereas living shoreline projects will support a longer-term community resilience goal but must be proactively planned for ahead of time. Overall, participants agreed that there needs to be more streamlined permitting to support demonstration projects and experimentation throughout Southern California.

Living shorelines and phased sea level rise planning: Numerous discussions revolved around how living shoreline projects can be integrated into local sea level rise planning. As City's are planning for sea level rise, living shorelines provide an option for local governments to "buy time" before having to make difficult infrastructure decisions. For instance, a dune restoration project next to a highway can help protect transportation routes from rising seas in the near term while a City figures out next steps (e.g., moving the highway inland). Or projects can be designed as a combination of living shoreline components integrated with more traditional hard infrastructure, and as seas rise the project may - transition from "green" to "grey" or visa versa. Given the close proximity of development to Southern California shorelines it's important to keep in mind that a living shoreline doesn't need to

be the final answer to sea level rise but may be a short-term or mid-term option within a long-term vision.

Designing with watersheds and sediment management in mind: Even though these workshops focused on living shorelines along the coast, participants were quick to discuss the importance of designing and monitoring coastal projects in the context of the broader watershed, especially when it comes to sediment management. Projects in the upper watershed (e.g., dams) can have huge implications for how much and what kind of sediment reaches our beaches to naturally replenish the sand supply. Given how highly managed coastal watersheds are in Southern California, it's important to think beyond the coast and look inland for potential challenges or opportunities that may arise from management in the upper watershed.

Exploring emerging commercial opportunities: There was interest in learning more about the possibility of living shorelines providing new commercial opportunities, such as harvesting oysters, kelp or eelgrass. Would commercial activities of this nature be feasible along Southern California's urban coast? Participants would like to better understand if this is a possibility in the region in the context of the coasts unique ecological and socioeconomic constraints. Many attendees noted that if the goal of a living shoreline project is specifically to provide new commercial opportunities a well thought out community engagement strategy will be central to project success.

Public access and project success: Participants noted multiple times how crucial it is to maintain both physical and visual access to the shoreline when designing a coastal project. Both coastal and inland residents and tourists use the beach for recreational purposes (e.g., walking, swimming, surfing), and beaches are also an enormous portion of coastal tourism. Given the large volume of people using the beaches, it's important to consider the challenges a living shoreline project may face given the number of people using the coastline (e.g., vandalism). If public access is blocked by the project the public will likely create disturbances that may ultimately hinder the project's success.

Planning for living shorelines alongside the community: The importance of community engagement and communication underpinned multiple discussions. When looking at the design of a project, community involvement and input from the very beginning was highlighted as vital to ensuring that residents understand the benefits of living shorelines, are reassured about their access to the beach, and begin to foster a sense of community value for the project site. For certain projects, ensuring fishing and tribal communities are informed and involved is an especially important part of the stakeholder engagement process. Many participants noted that it's important not to forget to engage those that visit the coast. The beach is a public good and is utilized and valued by people who don't live near the beach but are important to engage in the education and outreach process. In addition to in-person engagement, signage is an important tool to help educate the community on project purpose, and benefits for nature and the community.

Also, when designing a living shoreline project there's opportunity to be innovative with design elements (e.g., elevated walkways) that help encourage interaction, access, and stewardship of the living shoreline. Given the urban context of Southern California, the design options that ensure controlled access coupled with educational opportunities (e.g., interpretive signage) were discussed as ideal tools for engaging the community effectively. Several discussions focused on the possibility of using signs to help community members understand why the project is important in the context of past and future change, helping community members to embrace the changes associated with the project and better understand connections between resilience to climate change and living shorelines.

Sharing monitoring and best practices to ensure future success: Living shorelines in Southern California are only at the pilot project phase. With the area being in the infancy of understanding how to effectively implement living shorelines projects, many attendees discussed the importance of ensuring that data sharing is consistent throughout the region to ensure future projects choose appropriate monitoring baselines. Participants also expressed a need for additional regional monitoring of sand budgets throughout coastal watersheds. This monitoring would help resource managers better design living shoreline projects in the context of sand availability and

accretion rates along our shorelines. Consistent collaboration will help to develop and standardize best practices in our unique local context.

Citizen science and socio-ecological monitoring: After design and implementation, maintained and long-term monitoring is very important to ensure that project goals are being achieved. Many participants discussed opportunities beyond biological indicators, and began a dialogue around the importance of not only engaging community members in the monitoring process but collecting socioeconomic data to better understand how the public interacts with the living shoreline project. Locals and tourists can be involved in monitoring activities through citizen science initiatives, and can even assist with long-term upkeep helping to lower maintenance costs by creating volunteer groups and involving students.

In monitoring the socio-economic impact of the project, surveys are a tool that could be utilized to quantify direct and indirect financial benefits, as well as use of the area (whether it is beach attendance or visiting a new restoration site). Another aspect of monitoring could also be to evaluate the level of community education and awareness: Have the design efforts been successful in involving the community? Do community members understand the importance of the project? Participants agreed that c*ommunity* resilience needed to be a focal point of any successful living shoreline project in Southern California.

Next Steps

Southern California needs demonstration projects to increase understanding around how living shorelines can help advance community resilience planning efforts, and ensure healthy coastal ecosystems and habitats into the future. Demonstration projects will need to incorporate long-term monitoring plans to ensure successes and challenges are documented and shared throughout the region. Monitoring should go beyond biological monitoring to ensure that information on the socio-economic benefits of living shorelines is collected. This data can help to connect planning efforts with living shoreline projects, ultimately increasing local level support for future projects. In order to advance more demonstration projects consistent funding sources for both maintenance and monitoring will need to be identified, and permitting will need to be streamlined to support experimentation. Southern California is in a unique position to advance innovative methods for implementing living shoreline projects, and to develop creative pathways to increase local understanding and support for living shorelines along our urban coast.

Living shorelines and resilience in Southern California

June 20th | 8:30am – 1:00pm
San Diego Regional Water Quality Control Board
2375 Northside Dr., San Diego, CA 92108

TIME	SESSION
8:30am	**Refreshments & Registration**
9:00am	**Welcome & Introductions**
9:20am	**Grey to green: Spectrum of living shorelines** *Evyan Sloane, State Coastal Conservancy*
9:40am	**When does living become engineered?**
10:00am	**Perspectives on living shorelines** *Kate Barba, Scripps Institution of Oceanography* *Brian Leslie, Moffatt & Nichol* *Rebecca Schwartz, San Diego Audubon Society*
10:45am	**What makes a living shoreline "living"?**
11:15am	**Break**
11:25am	**What is unique about living shorelines in Southern California?**
12:05pm	**Monitoring and designing for resilience** *Evyan Sloane, State Coastal Conservancy*
12:20pm	**Increasing resilience with living shorelines**
12:50	**Wrap- Up**
1:00	**Adjourn**

Living shorelines and resilience in Southern California

August 10th | 9:30am – 3:00pm
Southern California Coastal Water Research Project (SCCWRP)
3535 Harbor Blvd., Costa Mesa, CA 92626

TIME	SESSION
9:30am	**Breakfast & Registration** *Continental breakfast provided by ESA*
10:00am	**Welcome & Introductions**
10:20am	**Grey to green: Spectrum of living shorelines** *Megan Cooper, State Coastal Conservancy*
10:40am	**When does living become engineered?** (*Discussion)*
11:00am	**Perspectives on living shorelines** *Jenna Judge, NOAA* Sentinel Site Cooperative *Nick Garrity, ESA* *Melodie Grubbs, The Bay Foundation*
11:45am	**What makes a living shoreline "living"?** (*Discussion)*
12:15am	**Lunch**
1:15pm	**What is unique about living shorelines in Southern California?** (*Discussion)*
1:40pm	**Monitoring and designing for success** *Evyan Sloane, State Coastal Conservancy*
2:00pm	**Designing and planning for resilience** (*Discussion)*
2:25pm	**Monitoring and evaluating for resilience** (*Discussion)*
2:50pm	**Wrap- Up**
3:00pm	**Adjourn**

Living Shorelines and Resilience in Ventura & Santa Barbara Counties

October 24th | 8:30am – 1:00pm
Santa Barbara Harbor, 2nd Floor Classroom
125 Harbor Way, Santa Barbara, CA 93101

TIME	SESSION
8:30am	**Refreshments & Registration**
9:00am	**Welcome & Introductions** *Rachel Couch, State Coastal Conservancy*
9:20am	**Grey to green spectrum of living shorelines** *Evyan Sloane, State Coastal Conservancy*
9:40am	**When does "green" become "grey"?** (*Discussion)*
10:10am	**Perspectives on living shorelines** *Lily Verdone, Coastal Project Director, The Nature Conservancy* *Dave Hubbard, President, Coastal Restoration Consultants* *Jackie Campbell, Former Community Development Director, City of Carpinteria*
11:00am	**Break**
11:15am	**What is unique about local living shorelines?** (*Discussion)*
11:50pm	**Monitoring and designing for resilience** *Evyan Sloane, State Coastal Conservancy*
12:10pm	**Increasing resilience with living shorelines** (*Discussion)*
12:50	**Wrap- Up**
1:00	**Adjourn**

of participants by organizational affiliation

Organizational affiliation	San Diego	Costa Mesa	Santa Barbara	TOTAL
Federal government	2	4	6	12
State government	11	2	8	21
County government	0	4	9	13
Regional government	3	4	2	9
Local government	5	10	5	20
Private Sector	6	5	7	18
Academia	6	13	4	23
NGO	11	4	5	20
TOTAL	**44**	**46**	**46**	**136**

Organizations represented at workshops

San Diego

- AECOM
- Batiquitos Lagoon Foundation
- California Coastal Commission
- California Coastal Conservancy
- California Department of Fish and Wildlife
- California Sea Grant
- California State Parks
- City of Carlsbad
- City of Chula Vista
- City of Coronado
- City of Imperial Beach
- City of Oceanside
- City of San Diego
- Climate Science Alliance - South Coast
- Everest International Consultants
- Kearns & West
- Moffatt & Nichol
- The Nature Conservancy
- Port of San Diego
- San Diego Audubon Society
- The San Diego Foundation
- San Diego Regional Climate Collaborative
- San Diego Association of Governments
- San Elijo Lagoon Conservancy
- Scripps Institution of Oceanography
- Summit Environmental Group
- Surfrider Foundation
- Terra Peninsular
- Tijuana River National Estuarine Research Reserve
- University of California: San Diego
- University of Southern California Sea Grant
- United States Fish and Wildlife Service - Refuges

Costa Mesa

- AECOM
- The Bay Foundation
- California Coastal Conservancy
- City of Dana Point
- City of Long Beach
- City of Los Angeles
- City of Malibu
- City of Santa Monica
- City of Los Angeles, Department of City Planning
- City of Los Angeles, Sanitation, Regulatory Affairs
- County of Orange
- California State University - Long Beach
- Dudek
- Heal the Bay
- ESA
- ICSD
- Los Angeles Waterkeeper
- Los Angeles County Beaches and Harbors
- Los Angeles Regional Water Quality Control Board
- Moffatt & Nichol
- NOAA Sentinel Site Cooperative
- Orange County Coastkeeper
- Pepperdine University
- Port of Long Beach
- RCD of the Santa Monica Mountains
- San Diego Regional Climate Collaborative
- Southern California Coastal Water Research Project
- Tijuana River National Estuarine Research Reserve
- University of California, Irvine
- University of Southern California Sea Grant
- United States Geographical Survey
- United States Fish and Wildlife Service

Santa Barbara

- Amec Foster Wheeler
- Assemblymember Monique Limon (staff)
- BEACON
- California Sea Grant
- California Coastal Commission
- California Coastal Conservancy
- City of Carpinteria
- City of Santa Barbara
- Coastal Resource Information Center
- Coastal Restoration Consultants
- Congressman Carbajal
- County of Santa Barbara
- County of Ventura - Harbor Department
- Dudek
- MERITO Foundation
- Naval Base Ventura County
- National Marine Fisheries Service
- Revell Coastal
- Rincon Consultants, Inc.
- Santa Barbara County Office of Emergency Management
- Santa Barbara County Parks
- Santa Barbara Foundation
- Surfrider Foundation
- Tetra Tech
- The Nature Conservancy
- University of California, Santa Barbara
- University of Southern California Sea Grant
- Ventura County – Planning Division

Category 1:
Coastal Dune Restoration / Beach Reconstruction

Cape Lookout State Park Dune Restoration

Tillamook County, Oregon
https://pubs.usgs.gov/sir/2010/5254/pdf/sir20105254_chap12.pdf

Humboldt Bay Dune Restoration Project

Humboldt County, California
https://www.fws.gov/refuge/Humboldt_Bay/wildlife_and_habitat/DunesRestoration.html

Pt. Reyes National Seashore Dune Restoration Project

Marin County, California
https://www.nps.gov/pore/learn/management/planning_dunerestoration_project.htm

Surfer's Point Living Shoreline Project

Ventura County, California
https://toolkit.climate.gov/case-studies/restoring-surfers-point-partnerships-persistence-pays

Ocean Beach Master Plan

San Francisco County, California
http://www.spur.org/sites/default/files/migrated/anchors/Ocean_Beach_Master_Plan052012.pdf

Santa Monica Bay Dune Restoration Project

Los Angeles County, California
http://www.santamonicabay.org/explore/beaches-dunes-bluffs/beach-restoration/santa-monica-beach-restoration-pilot/

Cardiff State Beach Living Shoreline Project

San Diego County, California
http://scc.ca.gov/webmaster/ftp/pdf/sccbb/2016/1609/20160929Board13_Cardiff_Beach_Living_Shoreline.pdf

Category 2: Protected Bays and Estuaries: Oyster Reefs & Eelgrass Beds

San Francisco Bay Living Shorelines Project

San Francisco County, California
http://www.sfbaylivingshorelines.org/sf_shorelines_about.html

Upper Newport Bay Living Shorelines Project

Orange County, California
http://www.coastkeeper.org/eelgrassrestoration

San Diego Bay Native Oyster Restoration Plan

San Diego County, California
http://scc.ca.gov/webmaster/ftp/pdf/san_diego_bay_native_oyster_restoration_plan_final_reduced

Category 3:
Tidal Salt Marsh/Wetland Restoration

Tijuana Estuary Tidal Restoration Program

San Diego County, California
http://trnerr.org/tijuana-estuary-tidal-restoration-program/

South San Diego Bay Coastal Wetland Restoration Project

San Diego County, California
http://scwrp.org/projects/south-san-diego-bay-restoration/

Humboldt Bay Tidal Salt Marsh Restoration Project

Humboldt County, California
http://scc.ca.gov/webmaster/ftp/pdf/sccbb/2015/1503/20150326Board09_White_Slough_Restoration_Ex4.pdf

Category 4: Offshore Restoration

Palos Verdes Kelp Forest Restoration Project

Palos Verdes, California
http://www.santamonicabay.org/explore/in-the-ocean/kelp-forest-restoration/

Articles

1. **The Time to Start is Now: How Implementing Natural Infrastructure Solutions Can Improve and Protect Our Coasts** by Shannon E. Cunniff, Environmental Defense Fund: https://www.edf.org/sites/default/files/cunniff-shore-beach-magazine.pdf

2. **Participatory Conservation of Coastal Habitats: The Importance of Understanding Homeowner Decision Making to Mitigate Cascading Shoreline Degradation** by Steven B. Schyphers, J. Steven Picou and Sean P. Powers: http://onlinelibrary.wiley.com/doi/10.1111/conl.12114/full

3. **Resilient Coastal Systems and Community Planning**, ASPBA Science and Technology Committee: http://www.asbpa.org/publications/white_papers/Reslience_White_Paper_Spring2014_82_2-4.pdf

4. **Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide** by American Rivers et al.: https://www.asla.org/uploadedFiles/CMS/Government_Affairs/Federal_Government_Affairs/Banking%20on%20Green%20HighRes.pdf

5. **Developing Alternative Shoreline Armoring Strategies: The Living Shoreline Approach in North Carolina** by C.A. Currin et al.: https://pubs.usgs.gov/sir/2010/5254/pdf/sir20105254_chap10.pdf

6. **Economic Impacts of Climate Adaptation Strategies for Southern Monterey Bay**, The Nature Conservancy: http://www.slc.ca.gov/Info/AB691/2016_TNC_EconomicImpactsAdaptationSMontereyBay.pdf

7. **Economic Analysis of Nature-Based Adaptation for Climate Change in Ventura County, CA**, ENVIRON: https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/FINAL_CRV%20NBA%20Econ%20Final%20Report%20March%202015%20with%20appendices.pdf

Guides

8. **Coastal Ecosystems: A Critical Element of Risk Reduction** by Mark D. Spalding et al.: http://onlinelibrary.wiley.com/doi/10.1111/conl.12074/pdf

9. **Nature-based Solutions to Address Global Societal Challenges,** IUCN: https://www.iucn.org/sites/dev/files/content/documents/2016-036.pdf

10. **Measures Guidebook for Flood and Storm Risk Reduction Projects: North America Risk Reduction and Resilience Priority (2017)**, The Nature Conservancy: https://www.researchgate.net/publication/315065811_Measures_Guidebook_for_Flood_and_Storm_Risk_Reduction_Projects_North_America_Risk_Reduction_and_Resilience_Priority

11. **Management, Policy, Science and Engineering of Nonstructural Erosion Control in the Chesapeake Bay,** Proceedings of the 2006 Living Shoreline Summit: http://www.vims.edu/cbnerr/_docs/ctp_docs/ls_docs/06_LS_Full_Proceed.pdf

12. **Restore, Adapt, Mitigate: Responding to Climate Change through Coastal Habitat Restoration**, Restore America's Estuaries: https://www.estuaries.org/images/stories/RAE_Restore-Adapt-Mitigate_Climate-Chg-Report.pdf

13. **Performance of Natural Infrastructure and Nature-based Measures as Coastal Risk Reduction Features**, Environmental Defense Fund: http://www.edf.org/sites/default/files/summary_ni_literature_compilation_0.pdf

14. **Guidance for Considering the Use of Living Shorelines (2015)**, NOAA: http://www.habitat.noaa.gov/pdf/noaa_guidance_for_considering_the_use_of_living_shorelines_2015.pdf

15. **Living Shorelines: From Barriers to Opportunities**, Restore America's Estuaries: https://www.estuaries.org/images/stories/RAEReports/RAE_LS_Barriers_report_final.pdf

16. **Natural Defenses in Action: Harnessing Nature to Protect our Communities,** National Wildlife Federation: http://www.nwf.org/~/media/PDFs/Global-Warming/Reports/NWF_Natural-Defenses-in-Action_Report.pdf

17. **Financing Natural Infrastructure for Coastal Flood Damage Reduction,** The Nature Conservancy and Middlebury Institute for International Studies: http://conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/FinancingNaturalInfrastructureReport.pdf

18. **Natural and Structural Measures for Shoreline Stabilization,** SAGE: http://sagecoast.org/docs/SAGE_LivingShorelineBrochure_Print.pdf

Websites

19. **Naturally Resilient Communities Solutions:** http://nrcsolutions.org/

20. **Coastal Resilience** by The Nature Conservancy: http://coastalresilience.org/

21. **Living Shorelines Academy**: https://www.livingshorelinesacademy.org/

22. **100 Resilient Cities**: http://www.100resilientcities.org/#/-_/

23. **Rebuild by Design**: http://www.rebuildbydesign.org/our-work/city-initiatives

24. **Green Infrastructure Effectiveness Database,** NOAA: https://www.coast.noaa.gov/digitalcoast/training/gi-database

The 8 example projects used during the activity

#1 Location: Protected Bay A man-made oyster reef is constructed using bags of oyster shells, and reef "castles" are put into place to initiate oyster population. Goal: Reduce coastal erosion and aid in wave dissipation.	#2 Location: Outer coast A beach nourishment project is conducted, by which sand is brought by a dredge from offshore sand sources and pumped onto the beach. Goal: Increase storm protection and biodiversity.	#3 Location: Protected Bay Vegetation is planted on a man-made horizontal levee on a bay's edge. Goal: Reduce the effects of breaking waves.	#4 Location: Offshore A single-layer reef of quarry rock is distributed on the seafloor. Approximately 126,000 tons of boulder-sized quarry materials are deposited. Goal: Compensate for the loss of kelp forests, increase biodiversity and coastal protection.
#5 Location: Outer coast Marsh grass, sand and rock are placed on a shoreline; approximately 2,000 plants, 300 tons of sand and 500 tons of rock are used. Goal: Reinforce the shoreline against waves and encroaching tides and to increase biodiversity and increase water quality.	#6 Location: Outer coast A 200-foot long sea wall is built out of concrete and steel along with vegetation and boulders to create a more porous edge Goal: Reduce wave energy, increase the deposition of sediment, and increase aesthetics.	#7 Location: Protected Bay Salt ponds are restored to allow for additional flooding plains and increase natural habitat. Goals: Reduce flood impact and restore natural habitat.	#8 Location: Outer coast Artificial dunes made of sand-filled geotextile cubic shaped bags are constructed, along with a cobble berm in front of it, composed of gravel and stones. Goals: Increase sand collection on the dunes and decrease coastal erosion.

Below is a summary of how 12 different breakout groups ordered the example projects on a spectrum from green to grey.

Green							Grey
#1 Oyster reef	#7 Salt ponds	#5 Marsh grass	#2 Nourishment	#4 Reef	#6 Sea wall	#3 Vegetation	#8 Dunes
#7 Salt ponds	#5 Marsh grass	#1 Oyster reef	#2 Nourishment	#3 Vegetation	#4 Reef	#8 Dunes	#6 Sea wall
#7 Salt ponds	#2 Nourishment	#1 Oyster reef	#8 Dunes	#5 Marsh grass	#3 Vegetation	#4 Reef	#6 Sea wall
#7 Salt ponds	#2 Nourishment	#5 Marsh grass	#1 Oyster reef	#4 Reef	#3 Vegetation	#8 Dunes	#6 Sea wall
#7 Salt ponds	#1 Oyster reef	#3 Vegetation	#5 Marsh grass	#8 Dunes	#2 Nourishment	#6 Sea wall	#4 Reef
#7 Salt ponds	#1 Oyster reef	#5 Marsh grass	#2 Nourishment	#3 Vegetation	#4 Reef	#8 Dunes	#6 Sea wall
#7 Salt ponds	#1 Oyster reef	#3 Vegetation	#5 Marsh grass	#4 Reef	#2 Nourishment	#8 Dunes	#6 Sea wall
#7 Salt ponds	#1 Oyster reef	#8 Dunes	#5 Marsh grass	#2 Nourishment	#4 Reef	#3 Vegetation	#6 Sea wall
#7 Salt ponds	#5 Marsh grass	#3 Vegetation	#2 Nourishment	#1 Oyster reef	#8 Dunes	#4 Reef	#6 Sea wall
#7 Salt ponds	#1 Oyster reef	#5 Marsh grass	#2 Nourishment	#3 Vegetation	#8 Dunes	#4 Reef	#6 Sea wall
#7 Salt ponds	#3 Vegetation	#1 Oyster reef	#5 Marsh grass	#2 Nourishment	#8 Dunes	#4 Reef	#6 Sea wall
#7 Salt ponds	#2 Nourishment	#1 Oyster reef	#5 Marsh grass	#4 Reef	#8 Dunes	#3 Vegetation	#6 Sea wall