OCEAN & COASTAL RESOURCES

REGIONAL CONTEXT

The joining of land and sea along Southern California's coastlines is a dynamic place where terrestrial and ocean characteristics jointly shape the coastal environment. The effects of climate change filter into the watershed and impact communities throughout the Los Angeles region, even beyond the coast. Los Angeles County's coastal zone is a critical asset for the entire region, consisting of 11 coastal cities and a few unincorporated areas, many with convoluted and discontinuous coastal boundaries. The region's major watersheds – the Los Angeles River, Ballona Creek, Santa Monica Bay, and Dominguez Watershed – touch all of these communities and eventually flow to the Pacific Ocean. Los Angeles County beaches stretch approximately 25 miles and attract more than 50 million annual visitors. Beach-related tourism plays a major role in the region's economy, accounting for more than $16.5 billion in expenditures in 2012.[135] The areas that constitute this large region are intensely interconnected through their geographies, communities, and economies, and decisions made in one jurisdiction will undoubtedly affect its neighbors.

Climate threats to the coastal zone exacerbate an already complicated network of land, sea, and human pressures, all of which are rapidly changing. These variables are regionally specific and manifest in unique impacts to a highly urbanized coastline, necessitating strategies for building coastal resilience that are informed equally by regional monitoring, research, and planning.

Sea level rise and coastal impacts planning in Los Angeles

Los Angeles County's coastal communities are vulnerable to impacts from climate change, such as sea level rise, which can be further exacerbated by concurrent flooding from coastal storms and extreme tides. The National Research Council projects that sea levels south of Cape Mendocino will increase between 10 and 167 cm, with 12 to 61 cm rise by 2050, and 42 to 167 cm rise by 2100.[136] These projections have been adopted by the State of California through the Ocean Protection Council's *Sea Level Rise Guidance Document* as well as by the California Coastal Commission's Sea Level Rise Policy Guidance. These guidance documents, however, are currently under revision by the state to consider the potential for higher, and thus direr, sea level rise projections, due to the current global

greenhouse gas emissions trajectory and more rapid melting of ice sheets than scientists had previously projected.[137] Civic and community leaders in the Los Angeles region recognize the need to build capacity and begin planning for the impacts of climate change now, rather than in 20 or 30 years when disruptions and damage to business, critical infrastructure, and communities will prompt ad hoc and poorly coordinated responses.

In 2011, the City of Los Angeles engaged the University of Southern California Sea Grant Program to develop "AdaptLA," a science-based, stakeholder-supported sea level rise vulnerability study and adaptation planning process.[138] AdaptLA provides a methodology to help the City of Los Angeles identify the climate vulnerabilities of its assets, resources, and communities. The vulnerability study, released in January 2014, focused on the potential impacts of sea level rise and associated flooding from storms and high tides on the coastal areas within city boundaries. The study examined the physical, social, and economic impacts of sea level rise, discussed the ecological vulnerability of the Ballona Wetlands, and provided a set of guidelines for identifying and evaluating possible adaptation strategies and measures.

AdaptLA brought together key city department officials at the forefront of confronting the impacts of sea level rise and regional stakeholders with a shared concern and interest in the results of this process and scientific study. This group included representatives from Los Angeles County, the State of California, city governments in the region, business, industry, government associations, and non-governmental organizations. Through the USC Sea Grant engagement process, regional stakeholders expressed a need for expanding this process to include all coastal sub-regions, such as neighboring cities and unincorporated areas of the county that are outside of the discontinuous coastal political boundaries of the City of Los Angeles but are still interdependent and interconnected.[139] As a result, 11 coastal cities, Los Angeles County, and six supporting organizations formed a regional coalition. The State of California provided additional funding for this coalition to expand the AdaptLA project to the regional scale. This new project is entitled Regional AdaptLA: Coastal *Impacts Planning for the L.A. Region*, and it will give the region access to sophisticated modeling information for coastal storms, shoreline change, and sea level rise. USC Sea Grant has been funded to conduct outreach around the model findings and to build local technical capacity to help coastal communities use the information.

The U.S. Geological Survey is currently updating its Coastal Storms Modeling System (CoSMoS 3.0) for the Southern California coast, from Point Conception to the U.S. and Mexican border. This model will provide a suite of 40 sea level rise and coastal storm scenarios (daily, annual, 10-year, and 100-year), shoreline evolution, and fluvial discharge projections. Bolstering this information for the region, two consultant teams from Environmental Science Associates (ESA) and TerraCosta Consulting Group (TCG) are developing high-resolution information on changes to beach width due to short-term winter storms and long-term sea level rise, shoreline-change projections focusing on the Los Angeles coast, and high-level vulnerability assessment for the entire county coastline.

Sea level rise adaptation in Los Angeles requires regional cooperation and planning due to the large number of stakeholders and the intensely interconnected nature of its geographies, communities, and economies. Although the municipal authorities are independent entities, actions taken by any single one will affect the others. Addressing climate change issues in a regional context builds opportunities for cooperative and mutually beneficial planning while taking advantage of economies of scale in

training, information acquisition, and scientific guidance. Los Angeles has a strong coalition of regional stakeholders working to address coastal climate impacts, and LARC, with USC Sea Grant, will continue to provide opportunities for this coalition to coordinate and collaborate.

Ocean and coastal health in the Los Angeles region

The ocean is Earth's largest climate buffer and serves as a massive sink for global heat and greenhouse gases. Humans have benefitted from this natural heat and carbon sequestration for millennia. However, anthropogenic-induced changes to the climate have begun to outpace the rate at which the ocean can absorb heat and gases in a balanced manner. Since 1971, over 90% of the excess heat trapped by greenhouse gases has been absorbed in the ocean, correlated with a 0.10°C increase in surface ocean temperature each decade.[140] Similarly, a third of the anthropogenic carbon has been absorbed by surface water, driving our oceans to become about 30% more acidic since the Industrial Revolution.[141]

These changes to the ocean environment could have significant implications for Southern California coastal ecosystems. Warmer temperatures may lead to greater stratification of coastal waters, weaker upwelling and less nutrient delivery from depth, and coastal low-oxygenated (or hypoxic) zones. Scientists have correlated these changes with impacts on marine life. Locally, researchers have correlated warmer waters with an 80% reduction in zooplankton off Southern California since 1951 and negative impacts on kelp forest ecosystems.[142] In laboratory tests, acidifying ocean waters also impose ecological challenges on marine species, impinging upon some species such as shell-forming organisms, while other species and habitats may benefit.[143] These impacts have potential to alter the ecological interactions that underpin today's living ocean.

Ocean changes due to climate impacts may also cascade through ocean food webs and, therefore, link to public health concerns. Scientists have observed a global increase of harmful algal blooms in recent decades. This trend is generally attributed to increasing nutrient availability and changes in water temperature and chemistry.[144] While blooms can be related to many algal species, of key concern are blooms that produce noxious or toxic compounds related to domoic acid poisoning, paralytic shellfish poisoning, and diarrhetic shellfish poisoning that are harmful to wildlife and humans.

Several areas along the California coast, including the San Pedro Shelf and Santa Monica Bay, are known to be 'hotspots' for harmful algal bloom events. For example, King Harbor in Redondo Beach has suffered recurrent algal blooms in the last two decades, with two massive fish mortality events in 2005 and 2011.[145] In the latter phenomenon, more than 2 million (175 tons) of sardines swam into the marina and died due to low oxygen levels associated with an algal bloom. Cleanup from that event reportedly cost the city about $425,000. The San Pedro shelf region has also become one of the biggest wildlife intoxication hotspots in California, with domoic acid regularly detected along California coasts since 1991 and linked to periodic fisheries closures and marine mammal strandings in the region. During 2003 and 2004 alone, domoic acid-poisoning was implicated in more than 1,400 mammal stranding incidents within Southern California waters.[146] As recently as 2015, the California Dungeness crab fishery was closed for months as a result of high domoic acid levels along the coast, halting a California fishery valued at $60 million per year. The closure had implications for the rest of the state's commercial, recreational, and aquaculture industries, along with impacts to wildlife. It resulted in the state seeking federal disaster declarations in February 2016.

Data records for the ocean are often less complete than those on land, and for many variables, researchers still have difficulty discerning long-term climate-related trends from natural variability. As relevant data accumulate on local ocean conditions and wildlife impacts, managers will better be able to anticipate, identify, and mitigate threats to coastal resources as they arise. Monitoring Southern California's ocean conditions over time is, therefore, critical to sustaining resilient coastal resources for the region. Sustained funding and research for monitoring programs will be vital, as well as improved methods for integrating local-scale observations and public alerts into coastal communities. This ability to rapidly identify emerging coastal health risk events is a prerequisite for preventing human exposure and for taking steps to minimize or mitigate potential ecological impacts, which will intensify as coastal resources are increasingly challenged by changing climates.

Finally, as discussed in the Water section of this Framework, coastal ocean waters are tightly connected to urban freshwater inputs. Anthropogenic urban sources, such as non-point source pollution from untreated stormwater, may increase if precipitation and episodic storm patterns alter with changing climates. Policy makers should ensure reduced impacts to coastal water quality through coordination and planning with stormwater and wastewater regulators throughout the region. Regional leaders should use a watershed-level approach that considers the interconnectivity from precipitation to surface water to the coastal ocean environment, in order to properly maintain and manage water resources and ensure the vitality of the coastal environment.

POLICY LANDSCAPE

Sea level rise policy in California

Coastal communities in California are concerned about the projections for sea level rise and have begun planning efforts throughout the state. Results from the 2011 California Climate Adaptation Needs Assessment led by USC Sea Grant, in partnership with 15 local, regional, state and federal organizations, demonstrated that the majority of California coastal communities believe climate change is happening and is caused by humans.[147] Ninety percent of these communities indicated that they are in the early stages of planning for sea level rise and other climate-induced coastal impacts. Many of these communities began planning without state- or federal-level mandates, including many coastal communities in the Los Angeles region. When asked about barriers to planning for and implementing adaptation strategies, these communities identified the lack of financial and staff resources and capacity as the top challenges.

In response to the barriers identified in the 2011 survey, the California Ocean Protection Council (OPC) launched a grant program to help build local capacity and improve scientific information for adaptation planning. The California Coastal Commission and State Coastal Conservancy have also offered several climate-focused grant programs. Recognizing the need for sophisticated and downscaled sea level rise and storm modeling, state-level funding was also provided to support the development of the Coastal Storm Modeling System (CoSMoS) for Southern California.

In addition to the financial grant programs and incentives, the California Coastal Commission released its Sea Level Rise Policy Guidance document in 2015, which provides information on how coastal

communities can "apply the Coastal Act to the challenges presented by sea level rise through Local Coastal Program (LCP) certifications and updates and Coastal Development Permit (CDP) decisions."[148] The new guidance encourages communities to incorporate the best available science in their permitting and planning and to employ an "adaptive management" approach that allows them to update their planning as new information becomes available. The guidance also states that a range of sea level rise estimates should be used and that local officials should consider more extreme flooding scenarios if they will cause significant impacts to coastal resources. This guidance is not regulatory but is already informing how coastal communities are approaching future coastal planning.

In 2014, the California Natural Resources Agency (CNRA) released its update to the state climate adaptation plan, *Safeguarding California: Reducing Climate Risk*. CNRA also released *Safeguarding California: Implementation Action Plans* in 2016 that shows how state government is acting to adopt the 2014 recommendations. Both policy guidance documents include a chapter on ocean and coastal ecosystems and resources to help inform state decision makers when preparing for climate risks and describe current state government actions. Local and regional entities are also using this guidance document to help develop local actions. The plan outlines four action areas: 1) better understand climate impacts on the coastal and ocean resources and ecosystems, 2) improve management practices and increase capacity to withstand and recover from impacts, 3) better understand evolving trends, and 4) information sharing and education. The plan stresses that the state should not allow development of new structures and infrastructure if sea level rise protection is required during the life of the structure, "unless there is compelling need." The plan prioritizes the use of innovative design, especially green or nature-based infrastructure when appropriate. The plan also prioritizes continued modeling to support local planning and the need for vulnerability assessments and cost analyses to fully assess risks and evaluate potential solutions. The plan emphasizes that local coastal programs and general plans are key tools to address sea level rise under California law and that the state will continue to invest in these local planning efforts.

Federal leaders must also take sea level rise considerations into account for federal infrastructure construction and investment projects. In 2015, President Obama issued an executive order requiring that sea level rise projections be incorporated into construction and planning on the nation's coasts. It established a Federal Flood Risk Management Standard, requiring that all federally funded projects located in floodplains, including buildings and roads, be built to withstand flooding. This mandate followed recommendations from the President's *State, Local and Tribal Task Force on Climate Preparedness and Resilience*. The Federal Emergency Management Agency also issued a new policy requiring states to have climate resilience plans to qualify for preparedness funds.

Ocean health policy in California

Ocean health policy is largely the purview of the Natural Resources Agency in California, with policy setting charged to the California Ocean Protection Council (OPC). The council has a mandate to ensure that California "maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations." Recognizing the interconnectedness of the land and the sea, supporting sustainable uses of the coast, and ensuring the health of ecosystems, the council develops policy guidance for the protection, conservation, restoration, and management of coastal and ocean ecosystems through enhanced scientific understanding, including monitoring and data gathering. To this end, the council coordinates the activities of ocean-related state agencies, establishes

policies to coordinate scientific data among agencies, and recommends changes in state and federal law to the governor and legislature. In partnership with the Ocean Protection Council, the California Ocean Science Trust (OST) is an independent nonprofit body that convenes and manages the Ocean Protection Council's Science Advisory Team. The California Ocean Science Trust's executive director serves as Ocean Protection Council's science advisor.

In 1999, the California Legislature passed the Marine Life Protection Act (Assembly Bill 993, Shelley). The goal of this Act is to protect California's marine natural heritage through establishing a statewide network of marine protected areas (MPAs). The California Fish and Game Commission established marine protected areas following multi-stakeholder-based regional deliberations, and they are managed by the California Department of Fish and Wildlife. As of 2016, there are 50 marine protected areas in the Southern California region, covering approximately 356 square miles or about 15% of Southern California state waters. Sites within Los Angeles County include marine protected areas at Point Vicente, Point Dume, and Santa Catalina Island. Although climate change was not explicitly incorporated into the goals and objectives of California's marine protected areas, the network is viewed as a key management strategy for monitoring climate impacts on California ocean environments. The MPA Monitoring Enterprise, managed by the California Ocean Science Trust, was tasked with developing and implementing monitoring of California's emerging statewide marine protected area network. The program recognized that future evaluations of marine protected area performance would occur in the context of a changing climate. As such, program leaders are designing monitoring efforts to include tracking climate change effects on habitats and species, understanding the effects on marine protected area performance, and evaluating climate change adaptation measures. Within Los Angeles County, the Los Angeles Collaborative Network brings together agency and nonprofit representatives to further develop strategies for local marine protected area management and outreach. Citizen-science activities, such as the MPA Watch program, also help with observations of human uses of marine resources and reporting of violations.

The West Coast Ocean Acidification and Hypoxia Science Panel, convened by California Ocean Science Trust at the request of the Ocean Protection Council in 2013, brought California experts together with counterparts in Oregon, Washington, and British Columbia to present the current state of knowledge and emerging scientific consensus about available management options to address ocean acidification and hypoxia on the West Coast. The Panel, which was convened for a three-year period, released its report *Major Findings, Recommendations and Actions* and recommended development of a coordinated regional management strategy.[149] Although local actions cannot wholly undo the global impacts of ocean acidification, the panel advised West Coast managers to take action to improve local conditions by managing local factors that contribute to declining water quality. In particular, they cited opportunities to implement better controls on nutrients and organic matter pollution that flow from land into coastal waters, as these chemicals provide nourishment for algae and bacteria that, in turn, can trigger hypoxia and exacerbate acidification. The panel also advised on the need for a comprehensive monitoring network, research priorities investigating ocean acidification impacts in the context of multiple stressors, and modeling tools to meet management needs.

With regard to harmful algal blooms, a California workshop in 2008 of leading harmful algal bloom research groups, water quality managers, public health managers, and animal rescue groups led to the 2009 formation of the California Harmful Algal Bloom Monitoring and Alert Program ("California HABMAP"). The goal of California HABMAP is to implement a proactive harmful algal bloom alert

network that provides information on current algal blooms and facilitates information exchange among researchers, managers, and the general public throughout California. The Southern California Coastal Water Research Project (SCCWRP) manages the program with Steering Committee representatives from NOAA, the Ocean Protection Council's Science Advisor, Northern and Southern California harmful algal bloom researchers, and the commercial shellfish and wildlife management communities. The program maintains a shared data portal and an active communication network across California's harmful algal bloom stakeholders. Ongoing research helps to continually refine the program's predictive capabilities. The California Department of Public Health's Marine Biotoxin Program also works to monitor for toxic phytoplankton, such as domoic acid, and issues health advisories against consuming seafood products during toxic events.

GOAL 1 — Prepare coastal infrastructure for higher sea levels and coastal storms

Critical infrastructure that sustains Los Angeles County is located in the coastal zone. Coastal roadways, rail lines, power generation and transmission infrastructure, waste water treatment facilities, local groundwater resources, coastal buildings, and the tourism industry are all threatened by projected sea level rise in the coming decades. The 2009 Climate Adaptation Strategy prepared by the California Climate Action Team identified the need to fortify existing protective infrastructure by 0.1 to 0.2 feet per year to maintain adequate levels of protection. The report stated that Los Angeles County will require 20% of future statewide funding allocations for sea level rise adaptation to maintain adequate protection of coastal infrastructure.

Policy makers should adopt the following strategies and actions in order to prepare the coastal infrastructure for climate change impacts:

Strategy 1.1 — Support communities financially and through in-kind resources as they undertake scientific assessments of vulnerabilities to sea level rise and coastal storm impacts

Action 1.1.1 — Assist infrastructure managers to utilize modeling information provided by AdaptLA to identify infrastructure vulnerability.

Action 1.1.2 — Examine the costs and benefits of a suite of adaptation strategies, with an emphasis on nature-based solutions, that are potentially applicable in the Santa Monica Bay.

Strategy 1.2 — Incorporate sea level rise and coastal impacts into local planning, such as to protect and maintain beaches, relocate critical infrastructure, and mitigate through development permitting processes

Action 1.2.1 — Build capacity in local communities to support adaptation planning and vulnerability assessment processes.

Action 1.2.2 — Provide technical assistance to communities that are updating local plans to include sea level rise considerations, such as local coastal programs and general plans.

Action 1.2.3 — Facilitate the sharing of lessons learned and best practices in incorporating sea level rise considerations into planning.

Action 1.2.4 — Facilitate the development of a robust beach-width monitoring program that provides critical information to beach managers, public works officials, planners, and other municipal and county staff on the response of the beach to short-term seasonal and storm events, as well as to long-term sea level rise-driven beach position change.

Action 1.2.5 — Facilitate the development of a robust cliff-monitoring program that provides critical information to beach managers, public works officials, planners, and other municipal and county staff on the vulnerability of the cliffs along the coastline.

Action 1.2.6 — Integrate coastal climate change considerations in emergency management and hazard-mitigation planning.

Action 1.2.7 — Train local government and community leaders on the key dimensions of social vulnerability and how to use social vulnerability assessments in emergency management, climate preparedness, and adaptation planning.

Action 1.2.8 — Evaluate the effectiveness of coastal strand and dune ecosystem restoration and enhancement as an appropriate sea level rise adaptation strategy for coastal communities in Southern California.

Action 1.2.9 — Facilitate the development of a robust beach-width monitoring program that provides critical information to beach managers, public works officials, planners, and other municipal and county staff on the response of the beach to short-term seasonal and storm events as well as long-term sea level rise-driven beach position change.

Strategy 1.3 — Identify examples of innovative solutions that utilize adaptive management approaches to managing assets and facilitate sharing of lessons learned

Action 1.3.1 — Provide capacity-building and knowledge-sharing opportunities to showcase innovative solutions and processes to address sea level rise in the state and nationally.

GOAL 2 — Prepare communities for higher sea levels and coastal storms

As local governments begin evaluating and implementing various adaptation measures to address vulnerabilities, they will need to enhance public knowledge and develop a public engagement strategy to successfully implement these strategies. Those responsible for emergency preparedness and response, climate change adaptation, and the long-term resilience and sustainability of regional

communities should utilize a human-centered approach. The impacts of climate change are often disproportionately distributed across populations, and the diverse socio-economic communities of Los Angeles vary significantly in their ability to prepare for, cope with, and respond to threats such as climate change. Some populations, especially those who experience social inequalities, are less able to prepare for, respond to, or recover from a disastrous event.[150] Los Angeles County has a high proportion of the population that is socially vulnerable to the impacts of climate change. Twenty-seven percent of Californians live in Los Angeles County, and 40% of that population lives with high social vulnerability to extreme events.[151] An examination of social vulnerability of the region's coastal communities used U.S. Census data to screen for those socioeconomic characteristics associated with higher sensitivity and lower adaptive capacity.[152] The communities of Venice, Wilmington, and low-lying portions of San Pedro had the highest vulnerability to sea level rise impacts. In portions of San Pedro and Wilmington, average income is about $13,000. These communities also have large proportions of renters and single-parent families, and English is often not the primary language. Expanding this work in all communities in Los Angeles County, and developing outreach and engagement strategies focused on building resilience in vulnerable communities, is critical. Examining community strengths and weaknesses can become an empowering and creative way to engage the public and build cohesion. The social cohesion of a community can be a critical factor in its resilience both during and after an emergency.

Strategy 2.1 — Understand community social vulnerability

Action 2.1.1 — Identify vulnerable communities through social vulnerability analyses and conduct community workshops to validate results and develop strategies to build community resilience.

Strategy 2.2 — Engage the community in building resilience

Action 2.2.1 — Create opportunities to foster periodic, meaningful public engagement that gathers information about affected neighborhoods and communities' concerns, vulnerabilities, and constraints.

Action 2.2.2 — Engage community members in discussion of social vulnerability, understand its implications for their community, and help develop strategies to build community resilience.

Action 2.2.3 — Engage students, schools, educators, and informal education institutions in community-resilience building activities.

Action 2.2.4 — Develop materials and provide engagement opportunities in multiple languages, especially Spanish.

Strategy 2.3 — Foster economic sustainability of coastal communities by developing policies that pull developments back from vulnerable shorelines

Action 2.3.1 — Compile information on costs and benefits of adaptation methodologies.

Action 2.3.2 — Develop economic indicators to help decision making on sea level rise.

Action 2.3.3 — Engage communities in understanding the costs and benefits of coastal adaptation methods.

GOAL 3 — Protect natural resources from higher sea levels and coastal storms

As sea levels rise and impacts from coastal storms lead to more flooding and subsequent inundation of the county coast, the vulnerability of coastal resources, such as beaches, wetlands, rocky intertidal zones, and groundwater water aquifers, will increase. Many of these ecological systems have ambulatory (shifting) lines that migrate throughout seasons, decades, and climate cycles. However, when backshore development constrains these lines, as along most of the Los Angeles County shoreline, they lose the ability to naturally migrate and shift.

Accordingly, the California Coastal Commission Sea Level Rise Guidance identified commercial fisheries, coastal agriculture, public beaches, recreational resources, and wetlands as at risk due to the impacts of sea level rise. The natural systems that protect and maintain water quality are threatened by the increased severity of "King Tides" and coastal storms under the predicted sea level rise scenarios. Protecting ocean and inland ground water quality is essential for the sustainability of coastal ecosystems and the viability of local groundwater resources. Protecting and rebuilding coastal dunes, wetlands, and natural ecosystems to minimize saltwater intrusion, in conjunction with more traditional shoreline protection techniques, can mitigate the more severe impacts of sea level rise on regional water quality.

Strategy 3.1 — Protect and maintain coastal resources such as wetlands, aquifers, and rocky intertidal zones

Action 3.1.1 — Evaluate the impacts of sea level rise to coastal habitats (i.e. lagoons, estuaries, marshes, and rocky intertidal zones) and freshwater aquifers, and provide recommendations for conservation, restoration, and governance strategies to build resilience of these critical resources.

Action 3.1.2 — Identify the vulnerabilities and adaptation potential for tidal marshes in Southern California under projected sea level rise scenarios, and identify opportunities for conservation and restoration.

GOAL 4 — Maintain and improve coastal and ocean health

Many of the factors influencing ocean health are global in scale. Working to curb local greenhouse gas emissions will have global implications that can limit many of the direst projected oceanic climate impacts. Improving global ocean health locally will also lead to a healthier Santa Monica Bay and San Pedro Basin in the Los Angeles region. As a result, complying with global greenhouse gas emissions reductions will translate to local benefits to coastal waters. The Framework addresses these actions in other sections. However, in a highly urbanized coastal environment such as Los Angeles, anthropogenic actions have an equal amount of impact on coastal and ocean ecosystems. Local planning and actions, taken in concert with planning and actions throughout the watershed, will allow the Los Angeles region to positively influence the health of its coastal waters.

Managers should reduce relevant ecological stressors within their jurisdictions, such as overfishing and coastal pollution. Untreated stormwater is the primary conduit for non-point source pollution of coastal ecosystems and human health. The confluence of runoff impacts with changing and unpredictable ocean climates calls for the design of more robust stormwater management solutions. Upland management is key, particularly with strategies that mitigate runoff and emphasize stormwater reclamation as close to the source as possible. Policy makers should link efforts to watershed management (see the previous Water section), including the use of green infrastructure to make Los Angeles surfaces more permeable and to divert runoff through infiltration and retention, as well as public education and monitoring to reduce non-point source pollution. The outcomes of these efforts would augment water resources for Southern California communities while reducing the human footprint on the fragile and changing ocean resources.

Finally, regional leaders should understand the linkages between the region's ocean health and the ecosystem services on which local coastal populations depend. Sustained funding and research for Southern California's harmful algal bloom, ocean acidification, and hypoxia, and marine protected area monitoring programs will be vital, as well as methods for integrating local-scale observations and public alerts into coastal communities.

Strategy 4.1 — Understand status and trends in the Los Angeles oceanic regimes

Action 4.1.1 — Promote and sustain ongoing monitoring programs for ocean health indicators.

Action 4.1.2 — Better understand the biological impacts of regional ocean change.

Action 4.1.3 — Prioritize and maintain sustainable fisheries and healthy ecosystems.

Strategy 4.2 — Facilitate community engagement

Action 4.2.1 — Evaluate effectiveness of public alert systems for ocean health indicators.

Action 4.2.2 — Reinforce public awareness of MPA function and regulations to aid in enforcement and stakeholder participation.

Strategy 4.3 — Maintain coastal water quality to promote public health and ecosystem resilience in the face of perturbations caused by climate change

Action 4.3.1 — Develop and foster a watershed-level hydrological community of practice that includes all actors that regulate and manage local water resources. This COP will be comprised of storm-, waste-, and potable water managers and regulators as well as coastal managers.

The best practices compendium contains additional information regarding case studies and steps for implementation.

GOAL 5 — Begin exploring opportunities and policies to move the built environment back from the shoreline in at risk areas

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