Developing Adaptive Policy to Climate Disturbance in Santa Barbara County

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The south-central coast bioregion of California. *Graphic image by Robert Arenz.*

acknowledgment

- PRESSURES
- EXPECTED IMPACTS
- COMMUNITY INFRASTRUCTURE
- COASTAL ECOSYSTEMS
- THE PACIFIC OCEAN

The unique native species of the region face significant pressures associated with long-term change in the climate. Santa Barbara County should carefully consider the impacts and policy responses that are needed to protect coastal marine biodiversity. It is especially urgent to begin planning for adaptation now with regard to land-use in coastal watersheds of important areas such as the Gaviota coast, which is in the County's administrative jurisdiction. Failure to proactively plan for and respond to climate change impacts will have ecological as well as social and economic implications.

Photo: Morgan Ball

While California is encouraging local governments to develop plans that support the reduction of greenhouse gases into their general plans, there has been little if any formal policy or program development at the county level in the State to address the major threats to coastal marine biodiversity posed by climate disturbance. California policy requires that the public and private sectors participate in reducing California's greenhouse gas (GHG) emissions. In addition, the existing California policy framework includes Assembly Bill (AB) 32, Senate Bill (SB) 375, SB 97, as well as a host of additional topic-specific bills. The California policy framework presents various obligations and opportunities for each county and city to participate in this emerging State directive.

The City of Santa Barbara voluntarily opted to initiate a climate action plan, which set benchmarks and outline strategies for the reduction of GHG emissions. The City's strategy does not include programs or policies that emphasize the protection of coastal areas, including the harbor, in light of expected impacts from climate change.

Santa Barbara County has initiated several climate-related programs in the areas of air, green building, water, waste, land use and transportation.

executive summary

In March 2009, the Santa Barbara County Board of Supervisors voted to support the long-term development of a Climate Action Strategy that would include or consider biodiversity concerns. If the County's *Climate Action Strategy* includes biodiversity protection measures and policies to address the expected impacts from climate change on coastal marine ecosystems, it would represent *the first such strategy in a coastal county in the State*. In addition, the County Board of Supervisors voted to support a Gaviota Coast Rural Regional Planning (RRP) process, which may lead to the development of new policies in the County's General Plan and Local Coastal Plan (LCP). Future planning efforts should link and integrate the planning elements associated with the County's Climate Action Strategy with special plans, such as the RRP and Local Coastal Plan updates.

Coal Oil Point reserve.
Photo: Morgan Ball

The emphasis in this report is on the threats posed to coastal marine biodiversity. The report also describes a sample of policy tools that are needed to begin to address these threats to coastal marine biodiversity. At the March 2009 Santa Barbara County Board of Supervisors hearing on the long-range planning effort to develop a Climate Action Strategy, the supervisors voted in favor of including in the Strategy biodiversity protection measures. *This represents an important step toward biodiversity protection at the county level; it may represent the first such effort in coastal cities and counties to address the climate-related pressures and expected impacts on biodiversity*.

In March 2009, the Santa Barbara County Board of Supervisors voted to support the long-term development of a Climate Action Strategy that would include or consider biodiversity concerns.

Two goals of this report are to offer preliminary recommendations and policy tools that can be used by the County in future plans for the coast to protect biodiversity in an era of climate change. This report includes a number of general planning tools for County and City policymakers. The report does not include an overview of terrestrial issues and concerns or policy recommendations that support the reduction of greenhouse

American Kestrel. ***Photo: Morgan Ball***

gas emissions, such as transportation and agricultural elements of the General Plan. Additional measures by state and federal authorities will also be required. Ideally, new partnership across political, economic and administrative jurisdictions that include non-governmental organizations and the private sector should be developed to address the transboundary pressures of climate change. This report should be viewed as a preliminary assessment, and does not include much needed regional assessment and vulnerability analysis for the county that identifies coastal developments, species and habitats that will likely be threatened by climate disturbance. Additional adaptive strategies, policies and actions in support of the protection of coastal marine biodiversity and other land-use issues at the local level are available in the report's Appendices. A copy of this report is available on-line at http://ocpc.msi.ucsb.edu/.

The geographic focus of this report extends from Santa Barbara County's coastal environment to the marine area, including the northern Channel Islands and the Santa Barbara Channel. This coastal area includes the Gaviota coast, the coastal wetlands and nearshore marine environment of the County. Inland areas that influence the coast or are influenced by coastal processes (e.g., sediment sources from coastal watersheds) are included in the scope. Important coastal areas such as the Gaviota coast and marine areas such as Naples reef and intertidal wetland include important habitats for the native species of California. Adapting to the impacts of climate change is more than a problem of reducing energy consumption or developing new methods of energy production. Scientists indicate that even if greenhouse gas emissions are dramatically cut, we can expect impacts to coastal marine ecosystems from climate change. Ideally, an integrated and ecosystem-based approach to protect coastal marine biodiversity is needed today to confront the many pressures associated with climate change. The County's General Plan does not include policies that protect coastal marine biodiversity from the threats posed by climate change.

One important part of this project is the integration of information from participants who attended public workshops sponsored by UC Santa Barbara's Ocean and Coastal Policy Center during the spring of 2009. Participants in the first public workshop held in April 18, 2009 included County planners, members of state and federal resource agencies, elected officials, members of conservation organizations, and scientists.

The first workshop included a presentation by Dr. David Revell on the potential impacts of sea level rise. A second workshop held on May 26, 2009 and included interested students and members of the community in a dialogue on climate change and the coastal marine areas of the region. The goal of the workshops were to foster a shared understanding of the impacts from climate change on the region's coastal and marine environment, and to receive community input and feedback from experts and professionals on the policy tools and recommendations support biodiversity protection in an era of climate change. The proceedings of these two workshops are attached as appendices to this report.

The report includes three major parts. Part One of the report describes the climate-related pressures to the region's coastal and marine ecosystems. To characterize the threats and expected impacts from climate disturbance the project includes the use the "pressure-state-response" (PSR) model. The PSR model emphasizes an assessment and analysis of present and future "pressures" posed by climate change on coastal and marine biodiversity. The identification of "pressures" is based on the gathering and synthesizing of existing scientific and technical information, data and material on the impacts and threats posed by climate change. Data and information from government and non-government sources, including scientific reports on the region, federal and state government reports, and regional conservation plans was used to produce this report. The report includes a characterization of the general "state" of the coastal marine environment. The "state" refers to the condition of the coastal marine ecosystems that result from pressures, e.g. trends in sea surface temperature and acidification, sea level rise, expected impacts on coastal and marine biodiversity, among others. This part of the report offers a number of case studies that provide a characterization of the particular pressures on specific species or habitats of the region, including the northern Channel Islands and the Gaviota coast.

Part One identifies a range of pressures on coastal marine biodiversity in an era of climate disturbance. Climate change will have direct impacts on existing coastal protected areas such as ecological reserves, wildlife areas, undesignated lands, mitigations sites, and easements. Sea level rise and changes in the intensity of storm events could impact low lying coastal areas and result in the loss or inundation of coastal wetlands

California Thrasher. ***Photo: Hugh Smith***

The report includes three major parts.

and dune habitat resulting in salt water intrusion and loss of fresh water resources for fish and wildlife. Changes to the timing and intensity of freshwater input may impact marine and nearshore populations through increased runoff resulting in pollution and sedimentation contamination and shifts in urban growth and development will place new or increased pressure on existing coastal resources and available habitat. Inundation of coastal infrastructure will cause widespread pollution and contamination further jeopardizing marine and near-marine environments.

Ruby-crowned Kinglet.
Photo: Hugh Smith

Changes in the atmosphere, oceanographic processes, and biology are linked to changes in the life-support and life-giving ecosystems of the earth. The report includes an analysis of a sample of the major pressures outlined below:

Pressures

Sea Level Rise, Inundation, and Coastal Storms

- Sea level rise and erosion risks
- Coastal storms and extreme weather events

Changing Ocean and Coastal Conditions

- Salinity changes (especially in estuaries)
- Temperature changes (air and sea)
- Changes to ocean currents, upwelling, and stratification
- Ocean acidification

Photo: Morgan Ball

Expected Impacts

Effects of Sea Level Rise, Inundation, and Coastal Storms – Impacts to the Built Environment

- Infrastructure at risk
- Impacts to coastal populations
- Economic impacts

Effects of Changing Ocean and Coastal Conditions – Impacts to the Natural Environment

- Impacts to coastal ecosystems – beaches, wetlands, intertidal and subtidal habitats
- Changes in protected species populations (endangered species, marine mammals, etc.) commercially significant species (fisheries), marine ecosystems and food webs, and introduction of new invasive species, and economic impacts

The effects of climate changes can be generally described, even though their magnitude, timing, and location cannot be known for certain.

Anticipating both gradual change and episodic events is essential to enable communities to become resilient to effects from climate change. The potential impacts on our coastal community include:

Community Infrastructure

As climate conditions change, some infrastructure systems may be less effective or may fail altogether, which could alter the function, value, or viability of improvements these systems protect or serve.

- **Coastal roads, highways, and rail lines** are at risk from the effects of increased winter precipitation, increased coastal erosion, and flooding. Over the long term, roads, highways, and railroads will be affected by sea level rise and increased tidal elevations along the ocean shore, estuaries, and coastal creeks and river.
- **Santa Barbara Airport runway** is located on filled estuarine wetlands and may be at risk of inundation from storm surge and high tides and, over time by sea level and increased tidal heights.
- **Harbor facilities, jetties and groins** will be subject to damage from larger storm waves. Watershed flooding may increase sediment loads into estuaries and thus increase the need for dredging of navigational channels. Increased tidal height will affect docks and bulkheads.
- **Shore protection improvements:** Some portions of the County's ocean shorelines have been armored against erosion from ocean waves. As shorelines erode landward in response to higher sea level and storms, armored properties are at risk of becoming peninsulas, then islands, and then overtopped. An increase in significant wave heights is likely to damage or cause failure of some hardened shorelines, potentially resulting in damage to nearby unprotected property and infrastructure.
- **Municipal Services/Stormwater systems:** The capacity of local stormwater management systems may be exceeded as the magnitude or frequency of rainfall events increases, especially as tidal elevations rise leading to localized flooding, accelerated deterioration, and possible system failure. Systems at or near capacity today may be unable to handle future storm loads, which could have a significant effect on location of future development.
- **Water supply and wastewater treatment:** Rainfall in winter is projected to increase. However, storing water across longer, drier summers may be a problem for some coastal communities where storage systems are already at or over capacity during summer. Reduced precipitation in summer months, especially in conjunction with warmer winter temperatures, may reduce the water available for municipal supply systems. In addition,

Great Horned Owl. ***Photo: Morgan Ball***

Many familiar coastal habitats, ecosystems, and natural resources will be affected by climate change. Low-lying habitats and ecosystems are especially vulnerable to floods, tides and ocean waves.

wastewater treatment facilities are usually located at the lowest elevation in a watershed, which places those facilities at risk from rising sea level and tidal elevation.

- **Recreational facilities:** Increased erosion along ocean shore from rising sea levels and coastal storms may seriously alter beaches, and in some cases, the infrastructure necessary for safe access to and from beaches and coastal parks. Coastal trails and campgrounds may experience frequent damage from high winds and flooding.

Coastal Ecosystems

Many familiar coastal habitats, ecosystems, and natural resources will be affected by climate change. Low-lying habitats and ecosystems are especially vulnerable to floods, tides and ocean waves. Temperature and precipitation changes will affect the distribution and composition of forests, riparian areas, and other terrestrial habitats. Even rocky intertidal habitats are vulnerable to increased atmospheric and ocean temperatures.

- **Coastal creeks and rivers:** Streams that drain into the Santa Barbara Channel will carry increased runoff from greater winter rainfall but will become drier in summer due to decreased rainfall. More severe rainfall events in these streams may increase the frequency and severity of flooding episodes. Warmer summer temperatures and lower summer stream flows may raise water temperatures to the detriment of aquatic species, such as southern steelhead salmon and other coldwater.
- **Coastal wetlands** are vulnerable to rising sea level and tidal elevations, depending on rate of sediment deposition, the nature of the shoreline, and pace of sea level rise. Freshwater tidal wetlands may be inundated more frequently by saline waters, triggering changes in wetland communities. An adequate supply of sediments to the estuary could enable tidal wetland elevations to keep pace with rising tidal elevation.
- **Benthic ecosystems:** Higher air temperatures can heat mudflats and raise estuarine water temperatures, especially upstream of ocean influence, thus affecting benthic communities and productivity. The loss of benthic habitat will directly affect the composition and productivity of estuarine ecosystems.
- **Non-native invasive species:** Habitat changes in response to shifts in temperature, salinity, and precipitation will provide opportunities for invasion by non-native species that are adapted to the new habitat conditions or that out-compete native species weakened by habitat change.
- **Acidification:** As ocean waters become more acidic, estuaries will be subjected to these same acidic conditions. The effects of increased acidity on estuarine ecosystems are not yet known,

Lesser Goldfinch. ***Photo: Hugh Smith***

but scientists are concerned about the potential effects on clams, crabs, oysters and other shellfish.

The Pacific Ocean

- **Ecosystem shifts:** Summer winds are critical to upwelling that drives productivity of marine ecosystems. Recent El Niño events demonstrated that warmer ocean temperatures and shifting wind patterns can, from just one season to the next, affect upwelling and the production of phytoplankton, zooplankton, and forage fish. Seabirds, marine mammals, southern steelhead salmon and other species are adversely affected by climate changes.
- **Distribution of species:** Long-term changes in ocean conditions are likely to result in a northward shift in the distribution of marine species, including sea birds and marine mammals. El Niño conditions have been cited as a factor in marine mammal mortality, and lack of seabird reproductive success.
- **Changes in upwelling:** Timing of the seasonal upwelling in the Pacific off Oregon, which provides the nutritional foundation for the marine food web, is changing. A long-term shift in the timing of up-welling would have long-lasting effects on commercial and recreational fish species.
- **Hypoxia:** While it is not clear that climate change is causing the hypoxic 'dead zones' in ocean waters off California, the forces causing the hypoxia are all linked to, and affected by, climate change.
- **Ocean acidification:** Increasing ocean acidification due to its absorption of CO2 has the potential to reduce the ability of marine species to form shells, which in turn would have a dramatic effect on the entire marine food web. Shellfish such as clams, oysters, and crabs will be particularly sensitive to an increasingly acid environment.
- **Beach ecology:** The beach ecology will likely be altered in many places due to higher sea level, higher waves, more frequent and stronger storms, and possible shifts in predominant wind directions. Beach and bluff erosion will result in shoreline retreat. Ocean shores armored with rip-rap and seawalls will be increasingly at risk over time.

Part Two of the report describes a range of alternative "responses". The "response" component of the PSR model relates to the actions taken by governments and non-government organizations that are designed to ease or prevent negative coastal marine impacts, to correct existing damage, or to conserve or enhance coastal marine ecosystem integrity. These responses may include regulatory and non-regulatory policy, management actions, planning elements, changes in coastal marine

Nuttail Woodpecker.
Photo: Hugh Smith

Seabirds, marine mammals, southern steelhead salmon and other species are adversely affected by climate changes.

resource management and coastal land use, and the provision of environmental information.

This report recommends the following general policy tools to begin the planning process to address expected biodiversity loss from climate change at the local, County-wide level:

1) **Vulnerability analysis** should be produced that establishes the type and extent of potential climate changes such as sea level rise, storm surges, and changing ocean conditions and how these changes will impact coastal infrastructure and development, human populations, economy, and natural habitats and species. The vulnerability analysis should be used as one foundation to develop coastal adaptation strategies (both overarching and specific) to both protect coastal marine biodiversity, and address risks or hazards associated with coastal development and land-use. As much as possible, each adaptive strategy should be accompanied by case studies that elucidate that strategy and guidance on how it should be implemented. For example, changes in buffer areas and other adaptive strategies that are needed to protect sensitive habitat areas should be incorporated in the County's *Thresholds and Guidelines Manual.*

Raccoon. ***Photo: Morgan Ball***

2) **Form An Interagency and Public Working Group** representing government and non-governmental organizations, e.g. state parks, and the private sector to discuss and recommend adoption of policies to protect coastal biodiversity. Such a Working Group could also include the use of a Scientific Advisory Panel to assist in the development of guiding principles to protect coastal marine biodiversity. A number of guiding principles should be emphasized in the Climate Action Strategy to support biodiversity protection, including:

   - Maintain healthy, connected, genetically diverse populations
   - Improve resiliency of existing habitats in order to maintain existing or new assemblages of species
   - Reduce non-climate stressors on ecosystems (i.e. invasive species)
   - Protect coastal wetlands and accommodate sea level rise
   - Consider climate change models as well as historical data when making projections
   - Employ monitoring and adaptive management
   - Adopt adaptation approaches that reduce risks to species and habitats and provide time for species evolution and development.

3) **Precautionary Principle** must be employed to buffer against uncertainty. There are synergistic effects and positive feedback loops of human-induced climate change, other human impacts, and natural disturbances which make decisions about policy solutions difficult. We can only control the human impacts. Therefore the precautionary principle should be employed.

4) Increase and preserve future **wetlands and buffers.** The County and City should establish new buffer zones to allow the migration of wetland ecosystems. Planners should develop new policies that restrict land-use activities and new development near future wetlands by establishing specific language in the County's plans.

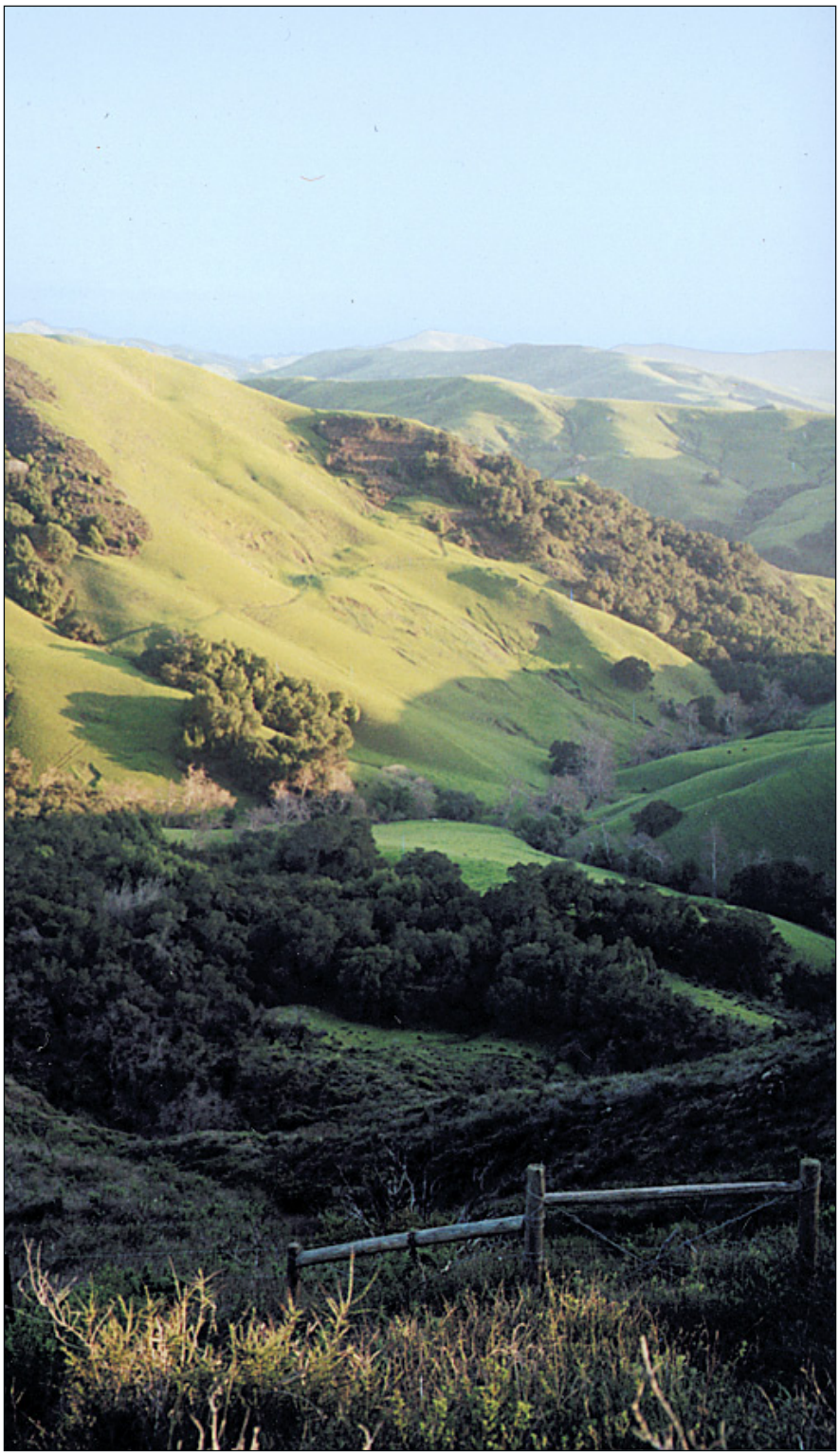
5) Increase **Coastal Setbacks.** Current County policy requires a 75-yr bluff setback for new development. New information regarding sea level rise and resulting bluff erosion should be used to develop new policies that translate into much larger coastal setback distances in the County. The 75-yr. policy should be increased pursuant to Precautionary Principle and because many structures would last over 75 years, possibly leading to future demands for sea walls.

6) Implement **Rolling Easement Policy.** Rolling easements are a special type of easement placed along the shoreline to prevent property owners from holding back the sea but allow any other type of use and activity on the land. As the sea advances, the easement automatically moves or "rolls" landward. Because shoreline stabilization structures cannot be erected, sediment transport remains undisturbed and wetlands and other important tidal habitat can migrate naturally. Similarly, there will always be dry or intertidal land for the public to walk along, preserving lateral public access to the shore. Unlike setbacks, which prohibit development near the shore and can often result in "takings" claims if a property is deemed undevelopable due to the setback line, rolling easements place no restrictions on development. They allow the landowner to build anywhere on their property with the understanding that they will not be able to prevent shoreline erosion by armoring the shore, or the public from walking along the shore—no matter how close the shoreline gets to their structure. If erosion threatens the structure, the owner will have to relocate the building or allow it to succumb to the encroaching sea. State and local governments, as well as federal agencies and environmental organizations, purchase "rolling easements". Under these arrangements, which can come in a variety of different forms, private landowners on the oceanfront could continue to use and develop their properties as long as they refrain from armoring the shoreline. Often property owners can receive tax benefits for placing a conservation easement on their property. Rolling easements help maintain natural shoreline processes.

Garter. ***Photo: Morgan Ball***

The County and City should establish new buffer zones to allow the migration of wetland ecosystems.

Photo: Mike McGinnis



Hills. *Photo: Mike McGinnis*

Current County policy requires a 75-yr bluff setback for new development. New information regarding sea level rise and resulting bluff erosion should be used to develop new policies that translate into much larger coastal setback distances in the County.

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Human beings and their activities are important parts of a changing ecology of the south coast. With respect to climate change, the California policy framework requires that counties and cities develop Climate Action Strategies. In December 2008, the California Air Resources Board released the state's *Climate Change Scoping Plan*, which describes a range of strategies that are necessary for the state to reduce its greenhouse gas emissions to 1990 levels by 2020. By building an adaptation strategy on existing climate science and frameworks like the Scoping Plan, California has begun to address the challenges and necessary policy responses that may reduce the vulnerability of residents and ecosystems to the consequences of a changing climate. Santa Barbara's Climate Action Strategy may include strategic elements to reduce greenhouse gases which are contributing to climate change. In response to the California Governor's Executive Order S-13-2008, the *2009 California Climate Adaptation Strategy Discussion Draft* (August 4, 2009) outlines a wide range of strategic elements that address other important policy areas, such ocean and coastal biodiversity protection. This Discussion Draft represents a comprehensive characterization of adaptive policy goals that may be needed for county and city governments to address the expected threats and impacts from climate change on coastal marine ecosystems.

Hermit Thrush. ***Photo: Hugh Smith***

The primary goal of this report is to support coastal marine biodiversity policy development in Santa Barbara County that can respond to the

the ecology of the south coast

multiple pressures from climate change on the region's coastal marine biodiversity. Santa Barbara County includes nationally significant coastal ecosystems, such as the Gaviota coast. The protection of these coastal habitats in an era of climate change will likely be essential for the future of bio diversity of this bioregion.

There are two important planning efforts that are underway in Santa Barbara County. Both planning opportunities will likely contribute to the future ecology of the region. In March 2009, the County of Santa Barbara Board of Supervisors supported the development of Gaviota Coast Rural Regional Plan (GC RRP), which will include a planning process that includes a General Plan Advisory Committee (GPAC). The GC RRP should include policies and plans that can better protect the biodiversity of the region from the pressures associated with climate change and human use of resources, such as the protection of general watershed health.

While there are limits to the county's ability to influence the larger-scale political, economic and ecological processes that influence the status of coastal marine ecosystems in the region, local citizens and policymakers can play an essential leadership role in biodiversity protection. Since we cannot "manage" ecosystem processes or conditions, such as the currents or climate, we need to recognize that we can only "manage" or regulate the human behavior (e.g., land uses) and associated impacts to ecosystems. The management of human behavior, resource use, and associated impacts at the county level is one key facet of future climate change policy. Section Three of this report provides a number of preliminary recommendations to begin to protect biodiversity in these county planning efforts.

In terms of climate change policy, there is a trend in California and federal government levels toward an emphasis on local and regional adaptive policy development and innovation. The development of a Santa Barbara County Climate Action Strategy per the requirements of California law has also begun. The County's Climate Action Strategy includes an important biodiversity protection element. To date, this is the only county or city action strategy that includes such an element. The Climate Action Strategy may lead to policy innovation at the grass-roots level, which can, in turn, influence the future of policy development in other government levels.

Overall, the GC RRP should be linked to the County's Climate Action Strategy, so that planning elements in the General Plan for the Gaviota

coast, including the Local Coastal Plan (LCP) are amended to address and potentially provide mitigation measures that can protect valuable coastal ecosystems from the range of pressures and associated impacts on biodiversity.

This introductory section describes the importance of the ecology of the coastal and marine ecosystems associated with Santa Barbara County. With a basic understanding of the ecological status of the coastal marine ecosystems, the report shows that it is important that we begin to develop county-wide public policies and planning tools that can better protect biodiversity in an era of climate change.

1.1 THE STATUS OF MARINE ECOSYSTEMS

Santa Barbara County is part of the coastal marine ecosystem of California's Mediterranean biome. Mediterranean-type ecosystems or MTEs cover only 2.25 percent of the earth's land surface, and contain 20 percent of its named vascular plant species. MTEs are found in parts of Australia, Chile, and South Africa; ,in the California floristic province; , and in and around the Mediterranean Basin. These areas face greater immediate threats per unit of area than any other species-rich regions on earth. As depicted in red in the figure below, the MTE of California is one

Figure 1. Hot Spots of Biodiversity in the World. *Source: Stein et al. 2000.*

of the world's hot spots for threatened biodiversity (Stein et al. 2000).

This report emphasizes the pressures of climate change on coastal marine biodiversity associated with the County of Santa Barbara. This section of the report briefly characterizes the expected pressures on coastal marine biodiversity from climate change, and includes case study material on particular species of the Southern California Bight, which is a recognized coastal marine ecosystem that extends from Point Conception to the US-

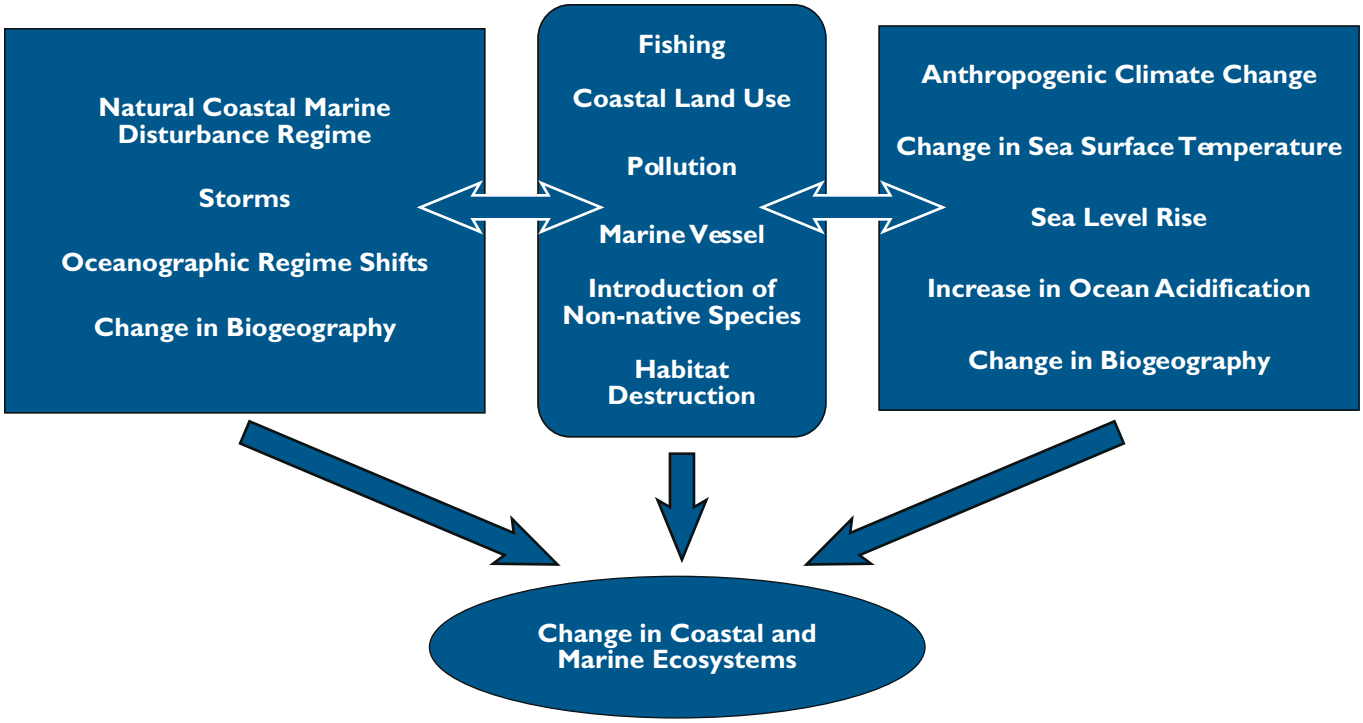

Figure 2.
Pressures on Coastal Marine Ecosystems. ***Source: McGinnis 2009.***

Mexican border. A general depiction of the indicators and pressures that are impacting coastal marine ecosystems are identified in Figure 2 below.

For example, one important pressure on ecosystems is the significant rise in non-native species in both coastal and marine areas. *The biota of California's floristic province is increasing in numbers, but this increase is from the introduction of non-native species.* The number of species in California counties has increased on average by 17%, and the California Channel Islands have increased by 44% (Sax and Gaines 2008). The introduction of non-native species is the second leading cause of loss in native species diversity (Wilcove et al. 2000).

In addition to the introduction of non-native species, it is important to recognize the synergistic impacts of multiple-use of coastal marine

ecosystems, including the human use of coastal marine resources, and the expected threats posed by climate change. Human impacts (e.g., overfishing, pollution, habitat degradation, among other pressures) and climate change (caused by increases in greenhouse gas emissions) exacerbate an ecosystem's ability to withstand stress and associated disturbance events. Scientists have begun to assess the cumulative impacts of these multiple pressures on coastal marine ecosystems.

A recent study by Halpern et al. (2009) includes an analysis of the cumulative impacts of human use and climate-related factors on the California Current. The California Current is an oceanographic process of primarily cooler water which extends from Washington down the coast to southern California. A global map of the cumulative impact of human activities on marine ecosystems showed the California Current region to have many areas of high impact and few marine areas of low impact (Halpern et al. 2009). As Figure 3 shows, southern California's nearshore marine environment includes areas of high impact (indicated by the red areas along the coast). The figure represents information from spatial data

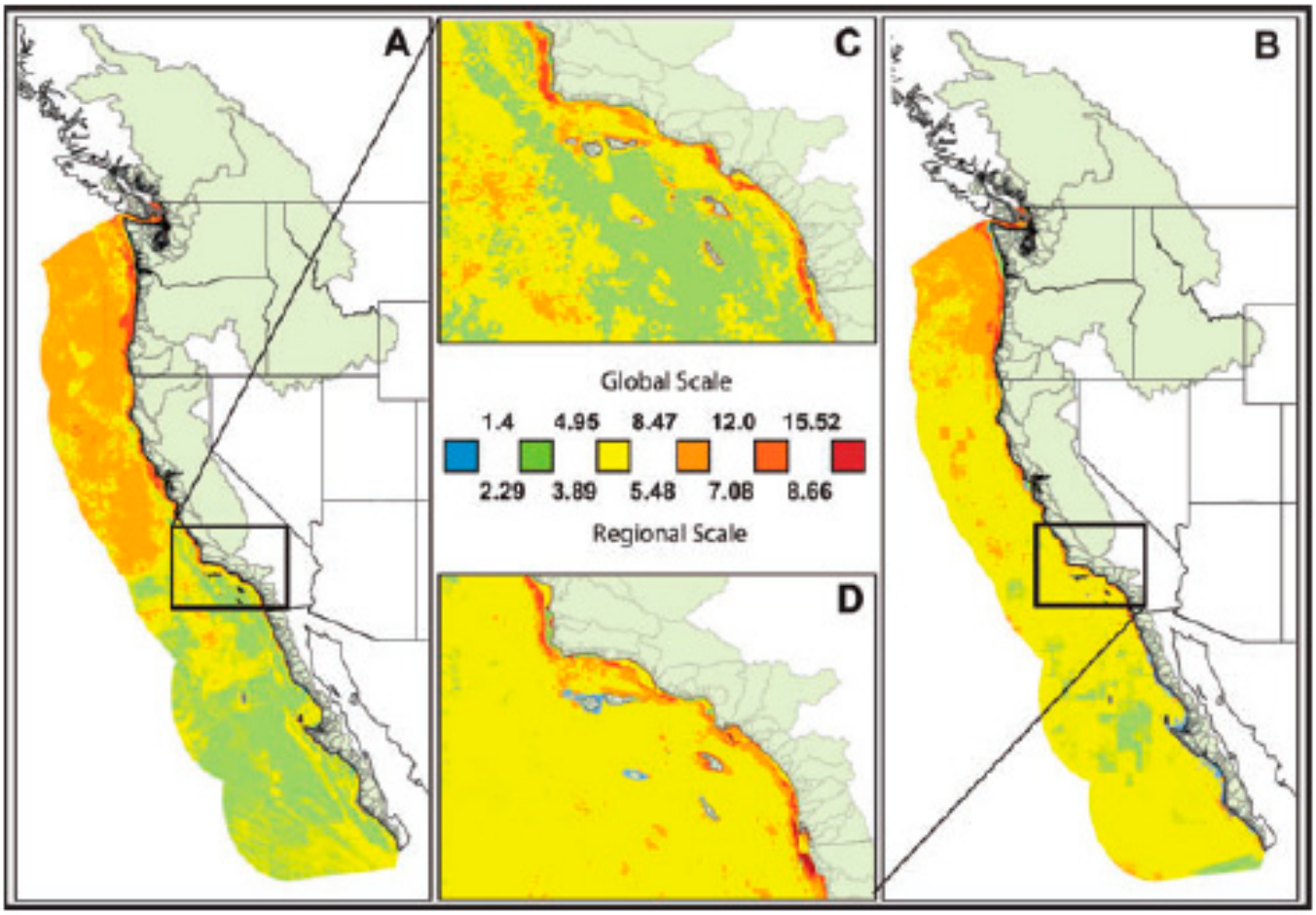

Figure 3.
Cumulative Impacts on Southern California's Marine Environment.

sets for 25 pressures and 19 ecosystems relevant to the California Current identified by several regional experts.

Halpern et al. (2009) characterizes the synergistic and cumulative impacts from our use of resources and drivers of anthropogenic climate change on the southern California marine environment, including general water quality concerns from coastal run-off from streams and rivers.

Overall, the cumulative impacts associated with a range of pressures on coastal marine ecosystems will likely contribute to a decline in the ecosystem "goods and services" that we receive from healthy ecosystems. The "ecosystem goods and services" (listed in Figure 4 can only be maintained if the cumulative impacts from multiple-use of resources do not overstress the capacity of ecosystems to sustain ecological processes, function and complexity.

1.2 THE CHANGING ECOLOGY OF OUR COAST

Santa Barbara County is part of the coastal marine ecosystem of the Southern California Bight (hereafter, the Bight). The Bight extends from the U.S.-Mexico border to the south to Point Conception in central California (Dailey et al. 1993).[1] The Bight's oceanography is a transition zone that includes the mixing of warmer and cooler surface waters, and eight Channel Islands. The Bight hosts a wide diversity of species, including at least 481 species of fish, 492 species of algae, 4 species of seagrass, 4 species of sea turtles, 195 species of birds, at least 33 species of cetaceans, 7 species of pinnipeds, and over 5000 species of invertebrates. The northern Channel Islands are internationally and national recognized areas because of their biodiversity values.

Santa Barbara County includes several essential coastal areas that support the region's rich biodiversity as well. For example, the Gaviota coast extends from Coal Oil Point to Point Conception in the county. This coast is an *amphitheater to the sea*—the region is influenced by ecological linkages that exist between the coastal mountains, foothills, the Santa

Ecosystem processes include:

- Hydrological flux and storage
- Biological productivity
- Biogeochemical cycling and storage
- Decomposition
- Maintenance of biological diversity

Ecosystem goods include:

- Food
- Construction materials
- Medicinal plants
- Wild genes for domestic plants and animals
- Tourism and recreation

Ecosystem services include:

- Maintaining hydrological cycles
- Regulating climate
- Cleansing water and air
- Maintaining the gaseous composition of the atmosphere
- Pollinating crops and other important plants
- Generating and maintaining soils
- Storing and cycling essential nutrients
- Absorbing and detoxifying pollutants
- Providing beauty, inspiration, and educational research

Figure 4.
Ecosystem Goods and Services

1 For a detailed characterization of the Southern California Bight's ecology (including coastal watershed impacts, physical oceanography, and biodiversity) see California Department of Fish and Game, Marine Life Protection Act, *Regional Profile of the South Coast Study Region*. Final Draft. July 24, 2009. http://www.dfg.ca.gov/mlpa/regionalprofile_sc.asp

Ynez River, numerous creeks, and the marine areas of the northern Channel Islands and the Santa Barbara Channel. The *Final Gaviota Coast Feasibility Study* (NPS 2004) determined the area contains nationally significant natural and cultural resources, and was "suitable but not feasible" for inclusion in the National Park System (NPS). The federal government's decision was based on the promise of President Bush's Executive Order in support of "Cooperative Conservation", which emphasized deregulation, community-based decision-making, and voluntary arrangements of local interests and stakeholders to protect areas. The federal government's decision emphasized the need for landowner-based initiative to protect the coast. Since the feasibility study was completed, there has been no new plan or program for the Gaviota coast, and there are currently no permanent protective measures or policies for this unique coastal area.

Gaviota Coast Facts

1) **There is currently no up-to-date comprehensive plan to permanently protect the Gaviota coast. A new planning process (GC RRP) has begun in the County to update and revise the local coastal plan (LCP) for the coastal area.**
2) **In the County's Gaviota Coast Projects List (July 2009), there are 108 residential projects proposed from the urban limit boundary to Gaviota pier.**
3) **The Gaviota coast includes ome of the last remaining healthy habitat for southern steelhead trout, and other threatened and endangered species. There are well over 195 bird species that depend on coastal and nearshore habitats in this region.**
4) **The Gaviota coast is part of the world's top 15 "threatened hot spots" for biodiversity.**
5) **The Gaviota coast includes a history of Chumash inhabitation dating back 8,000 years or more, and includes several important coastal village and sacred sites.**

The Gaviota coast includes a range of habitats that support coastal dependent species, including a significant number of species of concern.

For instance, in the spring 2007 survey conducted by the USGS, scientists identified 29 southern sea otters (*Enhydra lutris nereis*) in the Naples Reef area. The southern sea otter is listed as a threatened species under the Endangered Species Act (50 C.F.R § 23.23). The riparian areas associated with many of Gaviota's coastal creeks provide important habitat for a range of aquatic species, and should be considered as important "core areas" for biodiversity (Conception Coast Project 2005).

1.3 INDICATORS OF ECOSYSTEM DISTURBANCE

With respect to the general status of the coastal marine environment of this region, scientists document large-scale disturbance of the Bight. McGowan et al. (1998) document a decline in primary and secondary levels of marine ecological productivity since that began in 1958.

The Bight is one of the most studied coastal marine areas in the world. Scientists have collected information on a number of important indicators of ecosystem disturbance since 1950, with the development of surveys of the marine area by the California Cooperative Oceanic Fisheries Investigations or CalCOFI. There have been a number of changes in the status of coastal marine ecosystems of the area. Figure 5 identifies key ecological indicators that influence coastal marine ecosystem disturbance.

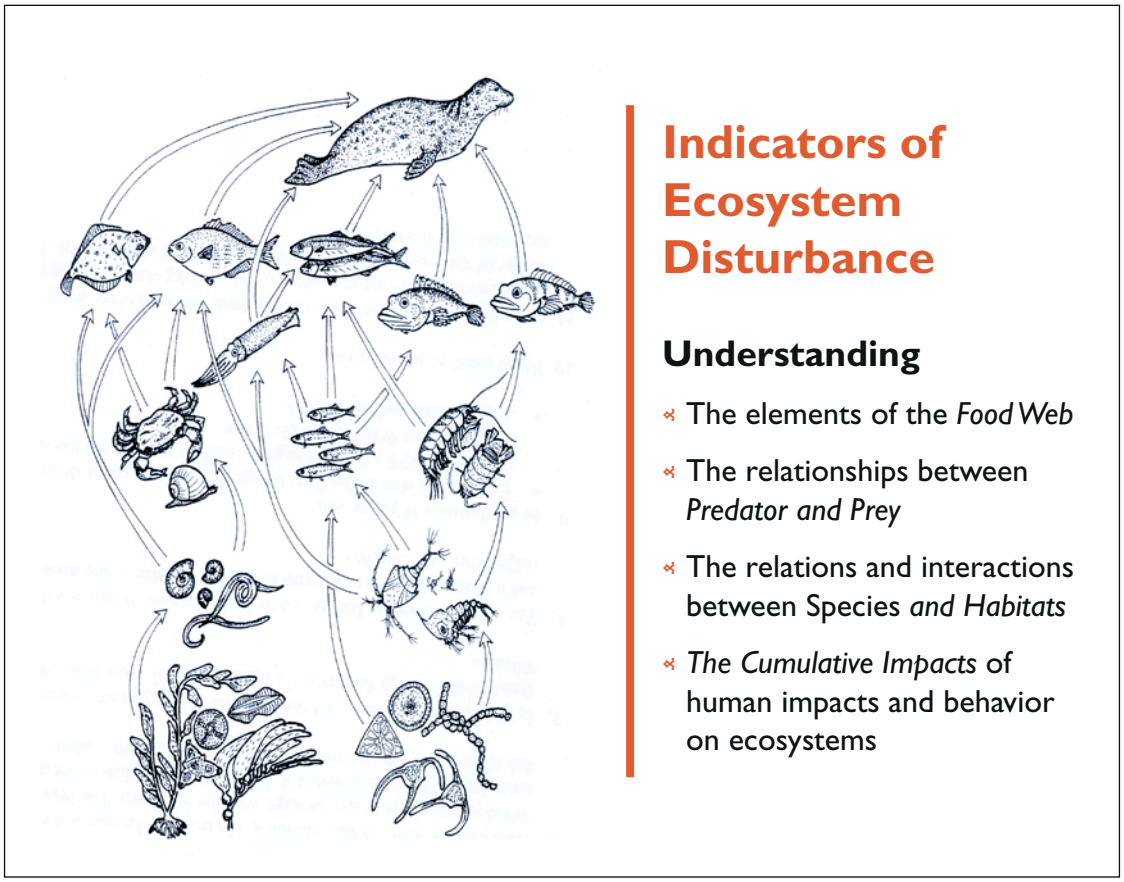

Figure 5. Indicators of Coastal Marine Ecosystem Disturbance.

One major factor contributing to coastal marine ecosystem disturbance is the impacts associated with short-term and long-term changes in oceanographic and climatic processes, such as El Niño events, which

includes such pressures as the warming of sea surface temperature and increase in storm run-off from coastal waterways into the marine environment. El Niño events have a number of biological impacts:

- Population shifts in marine species to the north;
- Transport of enormous volumes of sediments and suspended materials from the mainland to coastal and offshore waters;
- Disturbance to critical marine habitats, notably storm and water temperature damage to kelp forests;.
- Proportional reductions in the growth and reproductive success of organisms within coastal ecosystems;. and
- Warm waters associated with El Niño events may change the abundance, species composition, and temporal dynamics of the prey community in local species assemblages.

In general, scientists indicate that the marine area has been influenced by a warming water trend that is reflected in a low-nutrient oceanographic regime that began in 1977. The factors that continue to contribute to the low productivity of the coastal marine ecosystems of the region reflect changes in atmosphere, biology, and oceanographic processes, and are depicted in Figure 6.

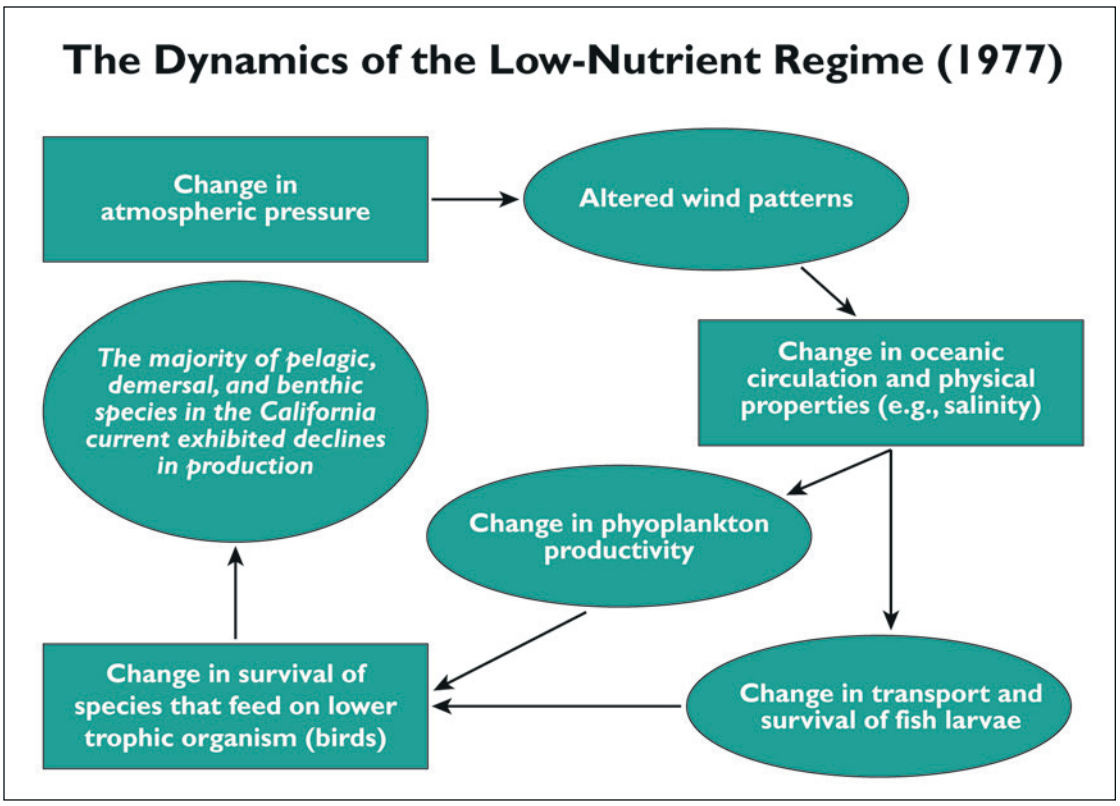

Figure 6. Factors that contribute to the Low-nutrient Regime

Scientists show that the dynamics of this low nutrient regime are analogous to the types of changes that may occur from climate change. First, there has been a decline in abundance and distribution of many endemic species. Second, scientists have shown that changes in biodiversity have led to declines in lower trophic levels that accumulate into larger scale impacts at higher trophic levels (McGowan et al 1998). For example, of the 2,000 northern fur seals born on San Miguel since June 1997, 75% died by December of that year. Of the 23,000 sea lions born at the same time, roughly 20%, or about 4,500, were found dead in September. Warm episodes of El Niño have been more frequent and intense since the mid-1970s, compared with the previous 100 years (Houghton 2001). The increase in frequency and intensity is unlikely to be due solely to natural variability (Trenbert and Hoar 1997). In an article published in the journal *Science*, Jeremy Jackson et al. (2001) describe the history of the coastal marine ecosystem disturbance. "Overfishing and ecological extinction", according to Jackson et al. (2001), "predate and precondition modern ecological investigations and the collapse of marine ecosystems in recent times, raising the possibility that many more marine ecosystems may be vulnerable to collapse in the near future".

In many ways, the impacts from climate change will likely exacerbate the capacity of endemic species to adapt to a dynamic ecological context that is showing signs of significant disturbance. The preservation of this bioregion's unique biological and cultural heritage is of ever-increasing importance given the forecasted impacts associated with climate change. Climate change will exacerbate the ability of coastal marine biodiversity to adapt to the ecosystem disturbance brought on by the low nutrient regime. Climate change will also impact the types of ecosystems services and goods that are provided by healthy coastal marine systems. There is an important role that counties and cities can play in developing adaptive policy to respond to these dramatic changes in coastal marine ecosystems. *The 2009 California Climate Adaptation Strategy Discussion Draft* (2009: 9) notes:

> *Communities with General Plans and Local Coastal Plans should begin when possible to amend their Plans to assess climate change impacts, identify areas most vulnerable to these impacts, and to develop reasonable and rational risk reduction strategies.*

1.4 CLIMATE CHANGE REFUGIA

Identifying "climate refuge areas" should be an important priority in the Gaviota RRP and the County's Climate Action Strategy planning processes.

Along coastal southern California, entire ecological communities are considered threatened or endangered. Coastal sage scrub communities and a number of other coastal ecosystems in southern California are reported by the U.S. Department of the Interior as "endangered or threatened ecosystems" (Noss et al. 1995). In the south coast, one likely consequence of climate disturbance will be a shift of biodiversity to the north, and consequently the Gaviota coastal will likely become more important for sustaining the region's ecological integrity. The native plants unique to California are so vulnerable to global climate change that two-thirds of these "endemics" could suffer more than an 80 percent reduction in geographic range by the end of the century, according to a recent University of California, Berkeley, study.[2]

Important areas such as the Gaviota coast and the northern Channel Islands will likely become more important habitat areas for endemic species in an age of climate change, as plant species are relocating or migrating to the north across southern California to adapt to climate change. These areas are likely to become more important to biodiversity as essential "climate refuge areas"—the protection of climate refuge areas will likely be an important part of larger-scale habitat conservation measures in light of recent evidence of the dramatic impacts on biodiversity from anthropogenic climate change.

California's Threatened Biodiversity

55% of the State listed animals and 25% of the threatened plants depend on wetlands

43% of the Federally listed species rely directly on wetlands for survival

Lost Coastal Ecosystems

Estuarine wetlands = 75-90%

Riparian Community = 90-95%

Vernal Pools = 90%

2 http://www.sciencedaily.com/releases/2008/06/080625073809.htm

Researchers who are studying the impacts of climate change on biodiversity note that we cannot reliably predict the fate of specific species. However, the trend is clear: The researchers project that, in response to rising temperatures and altered rainfall, many plants could move northward and toward the coast, following the shifts in their preferred climate, while others, primarily in the southern part of the state and in Baja California, may move up mountains into cool but highly vulnerable refugia.

Scientists have begun to identify several "climate-change refugia" scattered around the state. These are places where large numbers of the plants hit the hardest by climate change are projected to relocate and hang on. Many of these refugia are in the foothills of coastal mountains along California's coast and the Transverse Ranges such as the Santa Ynez Mountains. Many of these areas are already under increasing pressure from encroaching suburban development and other land uses. If plants are able to disperse in time to find more suitable habitat, the researchers found that ranges will shift by an average of 150 kilometers (95 miles) under higher climate change, often with no overlap between the old and new ranges. Paradoxically, this may separate species that now live together: Substantial numbers of floral communities may be split up as some species move south and uphill while others move north and towards the coast. The shifting and shrinking ranges of endemic species likely will affect animal diversity as well.

Biodiversity and Habitat Impacts Due to Warming

- Barriers to Species Migration and Movement
- Temperature Rise - Lakes, Streams, and Oceans
- Increase in Invasive Species Potential
- Changes in Natural Community Structure
- Threats to Rare, Threatened, or Endangered Species
- Altered Timing of Phenological Events
- Timing Disruptions Between Predators and Prey and Pollinators and Plants
- Loss of Ecosystem Goods and Services

Source: ***2009 California Climate Adaptation Strategy Discussion Draft*** **(2009: 48)**

One potential impact from climate change on southern California's biodiversity is that animal species may be separated from their major food sources, or a pollinator from its preferred plant.

- SEA LEVEL RISE
- OCEAN ACIDIFICATION
- RISING SEA SURFACE TEMPERATURE & CHANGE IN OCEANOGRAPHIC PROCESSES
- EXPECTED IMPACTS ON COASTAL MARINE BIODIVERSITY

Photo: Morgan Ball

The Intergovernmental Panel on Climate Change (IPCC 2007) note that long term change in the world's coastal marine ecosystems is expected even if greenhouse gas emissions were significantly reduced. The IPCC (2007) reports the following:

- Atmospheric concentrations of carbon dioxide (CO_2) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values... The atmospheric concentrations of CO_2 ... in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution;
- It is likely that anthropogenic warming over the last three decades has had a discernible influence on many natural systems;
- Greenhouse gas emissions will continue to grow over the next few decades; and
- The uptake of anthropogenic carbon since 1750 has led to the ocean becoming more acidic. Increasing atmospheric CO_2 concentrations lead to further acidification. The resilience of many ecosystems is likely to be exceeded this century.

A comprehensive review of the expected impacts on coastal marine ecosystems from climate change can be found in Schubert et al. (2006). Inexorable sea level rise, for example, caused by the contributions of glacial runoff, the melting of inland ice sheets, and the expansion of seawater as it warms, may be difficult to predict but will likely lead to major changes in coastal marine ecosystems. Hansen et al. (2005) note that a warming of more than 1°C, relative to 2000, will constitute dangerous climate change as judged from likely effects on sea level and

pressures on coastal marine ecosystem

extermination of species. The sixth mass extinction of plants and animals is underway—nearly 50 percent of all species could disappear within the lifetimes of people now living on Earth (Cadotte et al. 2008). The last mass extinction took place 65 million years ago during the Cretaceous Tertiary extinction event.

This section focus is on three primary pressures linked to climate change: sea level rise, increasing oceanic acidification, and changes in sea surface temperature. Local coastal policy and planning should emphasize biodiversity protection measures along coastal areas, including beaches, bluffs, coastal wetlands and watersheds, and foothills that exist within the county's jurisdiction. The section also briefly describes the expected impacts on coastal marine biodiversity associated with these pressures.

2.1 SEA LEVEL RISE

A comprehensive review of the potential impacts from sea level rise on coastal infrastructure and development has been published by The Pacific Institute (2009). Additional analysis of the potential impacts of sea level rise on particular coastal areas of Santa Barbara County is available in Griffin et al. (2009). State-of-the-art climate models are predicting that global temperature may rise by 2 to 9° F (1 to 5°C) over the next 100 years (Field et al. 1999). There is a large uncertainty in these estimates of future temperature change and even greater uncertainty about the sea level response to this warming. Over the past century, global temperature has increased about 1° F (0.56° C to 0.92° C) per decade with the trend over the last 50 years twice that. Additionally, mean sea level has risen by 1.3 to 2.3 mm per year over 1993 to 2003 with a rate of 3.1 mm per year from 1993 to 2003 (IPCC 2007). There is strong certainty that a future rise in global temperature of 2 to 9° F (1 to 5°C) will be accompanied by a rise in sea level. There is uncertainty as to the rate and amount of rise that could occur by any specific time in the future. Future sea level will depend, among other factors, upon:

- Future global temperature
- Lag time between atmospheric changes and oceanic reactions
- Thermal expansion of ocean water
- Effects of atmospheric temperature changes on Antarctica, Greenland and other glaciers
- Local subsidence and uplift

One method to assess future sea level rise is in the development of alternative scenarios—of a high rate of sea level rise, a medium rate and a low rate. The most obvious consequence of a significant rise in sea level will be changes in coastal areas that are submerged, including coastal developments and infrastructure. Many coastal areas in southern California are significantly at risk from sea level rise particularly in conjunction with winter storms (The Pacific Institute 2009). A combination of severe storms, rising sea levels, and high tides may result in very high temporary sea levels that could expose the coast to flooding, erosion, damage to infrastructure and property, and salt water intrusion into coastal aquifers.

Structures that are built above the water, like docks and piers, will be closer to the water, or eventually submerged. A second consequence will be an increase in wave energy which means more impact on coastal infrastructure, increased flood risks and more potential storm damage. Much of the potential damage from rising sea levels will occur when tides, weather, and climate anomalies combine with rising sea levels and increasing risk of major flood events. (California Coastal Commission 2001; The Pacific Institute 2009).

Figure 7 depicts primary factors that contribute to sea level rise, and other

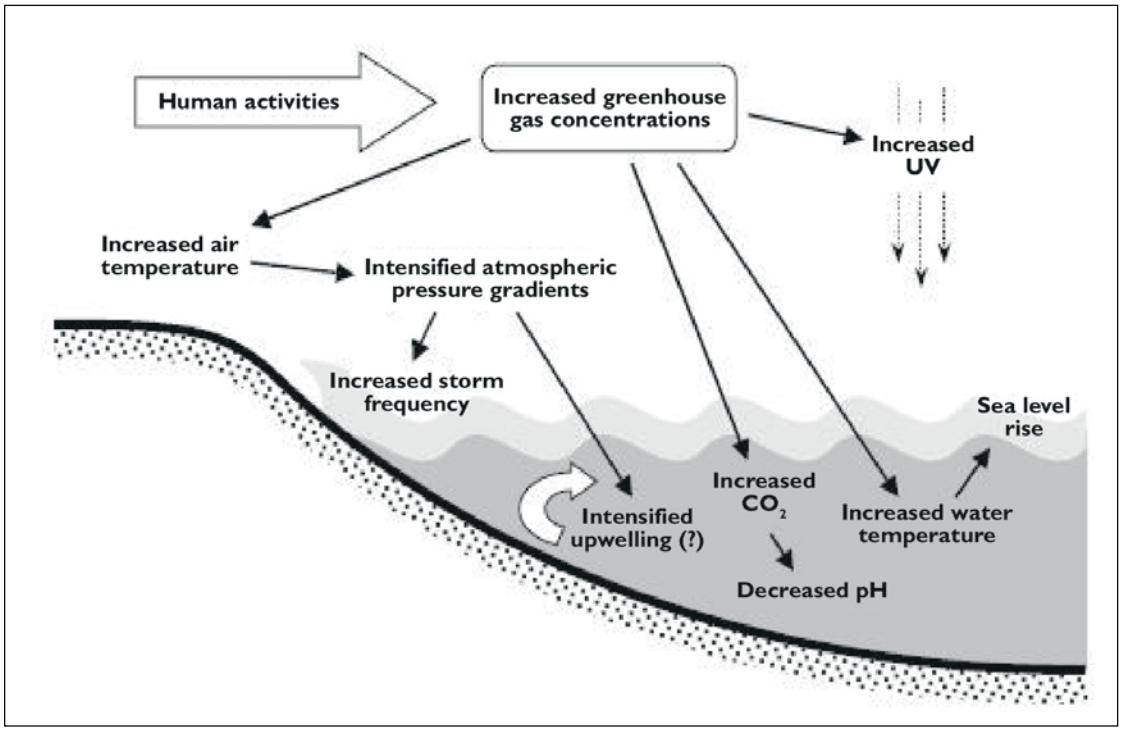

Figure 7. Climate change and impacts on coastal marine ecosystems. *Source: Harley et al. 2006.*

ecological changes in coastal marine ecosystems, including the increase is sea surface temperature and increases carbon dioxide in the ocean which decreases pH.

A number of international studies indicate that we can expect a 1.5 to 3.5 meter change in sea level within the next 100 years (personal correspondence with Dr. Revell 2009). The expected impacts from sea level rise on coastal wetlands, watersheds and other habitats are described further below. For a comprehensive review of the expected impacts from sea level rise on California's social infrastructure, see The Pacific Institute (2009).

2.2 OCEAN ACIDIFICATION

An additional pressure from anthropogenic climate change is increasing ocean acidification. A comprehensive review of the potential impacts of ocean acidification on the Santa Barbara Channel is found in Polefka and Forgie (2008). Oceanic CO_2 uptake results in chemical changes in seawater, and directly impacts the calcification cycle and the ocean's array of calcifying organisms. Rising atmospheric CO_2 levels correspond to a higher CO_2 concentration in oceans, and a consequently lower carbonate ion concentration (CO32-), higher hydrogen ion concentration (H+), and continuously dropping alkalinity, denoted by decreasing pH levels. Known as "ocean acidification", this complex chemical phenomenon directly results in both reduction of certain calcifying organisms' ability to make calcium carbonate ($CaCO_3$) shells for survival (e.g. coralline red algae and urchins) , and the dissolution of already existing shells (e.g. pteropods, an ecologically significant group of planktonic swimming snail species) (Orr et al. 2005). Other biological effects of decreasing ocean water pH have been noted, including hypercapnia, a condition caused by excessive CO_2 in the blood, in fish and cephalopods (e.g. squids), adverse impacts to reproduction, metabolism and growth in some invertebrates, and beneficial and adverse impacts to various photosynthetic organisms.

IPCC forecasts indicate that this atmospheric carbon concentration is likely to occur within the next 5-7 decades. Rising CO_2 levels could affect many organisms by reducing calcification, increasing dissolution of shells, causing hypercapnia, and reducing growth, reproduction and

survival rates. Uncertainty about the impacts on photosynthesis and the possibility that some organisms might thrive in, or at least successfully adapt to, changing conditions makes predictions about species survival and ecosystemic change difficult.

For example, California Spiny Lobster is one of the top three commercial fisheries in California. Given the expected impacts from oceanic acidification, the ecological productivity of this commercial and recreational fishery may decline within the next 20 years, according to some estimates. Ironically, this fishery is one of the more sustainable commercial fish landed in the State.

2.3 RISING SEA SURFACE TEMPERATURE & CHANGE IN OCEANOGRAPHIC PROCESSES

Rising sea surface temperature and changes in oceanographic processes are additional pressures associated with climate change. The California Current is the cooler water oceanographic province that travels southward from the Gulf of Alaska, and influences the ecology of the Bight. For example, the process of oceanographic upwelling near Point Conception carries cold, nutrient-rich water to the surface within the Santa Barbara Channel. Upwelling provides food for the complex marine food web. Significant changes in upwelling can result in changes of biological productivity. For example, if upwelling weakens, phytoplankton production is negatively effected as the warmer surface water lacks nutrients that exist deeper in the water.

Recent studies in interdisciplinary marine science show the impacts of climate change on these upwelling processes within the California Current. Barth et al. (2007) note that the delayed and intensification of upwelling are linked to climate change. It is a complex process, in which the contrast between land-sea temperatures drives equator winds northward, causing intensified upwelling. Experiments based on regional climate models found that increased greenhouse emissions delayed upwelling by 1 month. Barth et al. (2007) include a review of recent observations off the coast of Santa Barbara. During the 2005 season in southern California, the Santa Barbara Channel experienced a minimal effect of sea surface temperature due to wind-driven upwelling events. It is important to consider that small changes in ocean temperature induce impacts on coastal marine communities, such as kelp.

2.4 EXPECTED IMPACTS ON COASTAL MARINE BIODIVERSITY

Figure 8 provides a general summary of the range of expected impacts on biodiversity from the climate-related pressures.

- Increase in the frequency and severity of extreme weather events such as storms, heat waves, flooding, and drought
- Changes in cloud cover and rainfall patterns
- Changes in the level of snow pack and the timing of their melt
- Sea level rise and wave intensity
- Increased intrusion of seawater into estuaries due to sea level rise
- Timing of animal and plant life cycles (phenology)
- Increase in invasive species including parasites and disease-causing organisms
- Altered migration patterns of fish, birds and mammals
- Changes in forage base by many species
- Wetland losses
- Pollution from storm runoff and flooding i.e. silt, sewage, farm chemicals
- Vegetation changes
- Increased frequency and intensity of wildfire
- Increased interactions between two or more of the above
- Possible reduction in coastal fog

Figure 8.
Factors Contributing to Change in Abundance and Distribution of Biodiversity

This section briefly describes expected impacts from climate change on biodiversity with a focus on particular habitats and species of coastal Santa Barbara County

2.4.1 Coastal Watersheds and Wetlands

The California Environmental Resources Evaluation System (CERES) identifies six major coastal wetlands in southern Santa Barbara County. Prior development of coastal wetland areas has made the remaining habitat significantly more important to resident species, and significantly more vulnerable to the impacts of climate change.

Wetlands of southern Santa Barbara County

Coastal Wetland	Current Acreage	Historic Acreage
Andree Clark Bird Refuge	29	Not Specified
Campus Lagoon	37+	37+
Goleta Slough	430	1,150
Devereux Slough	70	140-210
Carpinteria Salt Marsh	230	>500
Rincon Creek	.5	Not Specified

The biological productivity of coastal wetlands makes them very effective in carbon sequestration and storage. Ecologists estimate that a healthy salt marsh produces five to ten times as much oxygen and corresponding carbohydrate biomass per acre as a wheat field. The low elevation of coastal wetlands creates a context in which these coastal ecosystems are vulnerable to the impacts of sea -level rise. Most coastal wetlands are within one tidal range of mean sea-level, thus if sea-levels rose by one tidal range overnight, then all of the existing wetlands in an area would drown (The Pacific Institute 2009). Increased nearshore wave intensity and large storm events are predicted to increase shoreline erosion, breaking natural barriers and increasing the likelihood for more frequent and potentially permanent inundation. Areas permanently below the rising tide level will be converted to open water and lose value as wetland habitat.

The inflow of freshwater and salt water determines the salinity of the soil, which directly affects the distribution of plants, and therefore wildlife, within the wetland. The predicted variability of rainfall and temperature, particularly with respect to increasingly common drought and increased storm intensity, could challenge even very adaptive wetland plants and animals. Many migratory bird species, marine fish (particularly juveniles), and rare plant species depend on coastal wetland habitats for food and shelter. Nearly 2/3 of the federally listed threatened and endangered species depend on aquatic habitats during part of their life cycle.

Humans also benefit from healthy wetlands and coastal processes. An important function of wetlands is their ability to filter out pollutants, improving water quality of south coast groundwater. If droughts become more frequent and intense, water that previously made its way into coastal wetlands, and then into groundwater, could significantly decline or could be increasingly sequestered behind dams. This lack of freshwater and associated sediments would further degrade wetland habitats, reduce vertical accretion, and decrease local groundwater quality and quantity. Wetlands may also be able to adapt to rising water levels over time by trapping sediment, a process referred to as vertical accretion (The Pacific Institute 2009). Given the south coast's high variability in rainfall and freshwater input from year to year, and unknown changes to channel morphology, the ability of wetland accretion rates to keep up with rising sea-levels is unclear. Impacts of climate change to particular wetland ecosystems will vary depending on bathymetry and sediment flows, supporting the need for assessments of coastal wetlands.

Below, we describe a number of case studies of coastal species that will likely be impacted by climate change.

Case Study: The Southern Steelhead Salmon.

Southern steelhead is vulnerable to a range of human impacts to Santa Barbara coastal watersheds.[3] The distribution of the southern steelhead range is from the Santa Maria River in San Luis Obispo to the US-Mexico border. In Santa Barbara, the greater Santa Ynez watershed has experienced reductions in steelhead runs of 90% or more. The southern steelhead of Santa Barbara is linked seasonally to the ocean through the creeks that span the Santa Barbara coast.

The southern steelhead depends on winter rains for access upstream through "seasonally opened" estuaries. After the spawning period, which lasts from January to May, steelhead return to the ocean. If this species cannot access the ocean, they remain in cold upstream water during the summer. The inability to return to the ocean is strongly linked to climate change in that the estuaries that steelhead use as intermediaries will be negatively affected by sea level rise.

3 See: NOAA–National Marine Fisheries Service, 2008. *Southern California Coast Steelhead Recovery Planning Area. Conservation Action Planning (CAP) Workbooks Threats Assessment.* http://swr.nmfs.noaa.gov/recovery/SC_Steelhead_Threats_Assessment_Summary.pdf

As climate change is likely increasing the frequency and intensity of droughts, steelhead runs are compromised as their voyage from the ocean coastal creeks and the Santa Ynez River is removed because estuaries become progressively drier. Also, reductions in summer freshwater habitat occur due to droughts. Rains that follow wildfires generate high water flows that cause severe sedimentation in rivers, covering steelhead habitat and the fish themselves. The future of the southern steelhead in an era of climate change remains uncertain.

Case Study: Sea-Level Rise and Migratory Shorebirds.

Shorebirds undertake twice yearly migrations that are among the longest known among animal species. In the Americas, these may involve annual journeys of up to 18,000 miles between their breeding areas in the high arctic and their wintering areas in the southernmost parts of South America. These long-range migrations are energetically costly, thus shorebirds require a series of coastal "staging" sites where they can rest and replenish their fat reserves, the main fuel for long distance migration. During their stopovers, individuals of some shorebird species may double their weights in a few days to accumulate enough fat to fuel their flight to the next staging site. Such weight gains are only possible at sites where extremely rich food supplies are readily available. Thus, the availability of staging sites with rich and accessible food supplies is a critical factor in a species' migration schedule and the elimination of any one important site could potentially undermine the feasibility of the entire flyway strategy.

Threats to shorebird staging sites has been recognized, habitat loss due to sea- level rise caused by global climate change. Important questions remain unanswered, particularly regarding the effects of human responses to sea -level rise. For example, the installation of extensive coastal protection structures with a concomitant reduction in the ability of the coastal site to migrate inland could exacerbate the effects of sea- level rise (The Pacific Institute 2009). Also significant is that the severity of effects will likely vary widely between habitat areas.

2.4.2 Marine Habitats and Biodiversity

It is important to consider the expected impacts from climate change on the region's coastal marine ecology given the scientific information that shows the existence of the long-term, low-nutrient oceanographic regime. As noted earlier, the coastal marine ecosystem of the Bight is currently in a

warmer water oceanographic regime, and scientists have shown a decline in primary and secondary levels of ecological productivity began in 1958. While the marine area is not in the county jurisdiction, important activities on land can exacerbate the general impacts of human activities on marine biodiversity (Stoms et al. 1999; Halpern et al. 2009).

Overall, coastal marine ecosystems change character in response to short and long term climate shifts much more quickly than California's terrestrial habitats. Shifts in the physical processes of the currents and ocean circulation could rapidly redistribute individuals and species along a coastline.

One potential impact from climate change is increases in El Niño's frequency and/or intensity, which will likely have severe impacts on coastal marine habitats, such as kelp and rocky reef areas, and beach ecosystems. Forests of giant kelp are seriously damaged during El Niño as a consequence of nutrient depletion, warmer water, and intense winter storms. The damage to the kelp is especially severe in southern California. The effects of El Niño on giant kelp cascade through much of the food web. The productivity of nearshore and beach ecosystems is also dramatically influenced by the warming events of El Niño. An example is the impact of warming events of the biodiversity of the northern Channel Islands.

Case Study: Biodiversity of the northern Channel Islands.

The northern Channel Islands (Anacapa Island, Santa Cruz Island, Santa Rosa Island, and San Miguel Island) are surrounded by the Pacific Ocean. Coastal marine habitats are particularly sensitive to climate disturbance in the form of sea level rise, increase in sea surface temperature, and other climate-related changes that are developing across the world's oceans, such as a decline in prey species due to change in oceanographic processes. Coastal ecosystems provide valuable habitat for birds, fishes, pinnipeds and other marine species.

For example, Ashy Storm-petrel, a small, smoke-gray seabird nests on small offshore islands. Its ranged is confined by its foraging habits, it feeds on small fish and crustaceans along the continental slope from northern California to northern Baja California. The total population is currently estimated at less than 5,400 breeding individuals. Eighty-nine percent of the population is concentrated on three islands in central and southern California: south Farallon Islands, San Miguel Island, and Santa

Barbara Island (Wolf 2007). The small size of the population, a restricted distribution, and few concentrated colony sites make the Ashy Storm-petrel vulnerable to threats posed by climate change. Climate change threatens to the Ashy Storm-petrel in many ways, including the effects of ocean acidification on crustacean prey, sea level rise affecting habitat availability, and decline in primary productivity associated with warming waters and reduced upwelling.

Sea caves and offshore rocks offer predator-free nesting habitats for Ashy Storm-petrels. Sea level rise will eliminate sea cave habitat offshore rock habitats in the Channel Islands. On Santa Cruz Island, Ashy Storm-petrels nests have only been documented in sea caves and offshore rocks (McIver 2002; Carter et al. 2007). The rise in sea levels makes these habitats unsuitable or inaccessible further constraining habitats for the already small population.

Sea level rise is a more obvious climate disturbance on the Northern Channel Islands because a relatively larger proportion of terrestrial habitat will be affected than on the mainland. Pinniped populations appear to be sensitive to climatic events such as El Niño (Barlow et al. 1998). California sea lions, Pacific harbor seals, northern elephant seals, and northern fur seals breed on the Channel Islands, with the largest rookeries on San Miguel Island (Stewart et al. 1997). San Miguel Island is the southern extent of the Northern fur seal's range. The population of northern fur seals on San Miguel Island has increased steadily since the early 1970s, except during the El Niño of 1982 to 1983 (DeLong 1982) and the El Niño of 1997 (Fernandez 1997).

Pinnipeds are good indicators of the health of marine ecosystems responding to global climate change because they quickly react to oceanic conditions, such as during El Niño events leading to lower availability of food resources.[4] Figure 9 depicts the pinniped and sea lion haul out areas on San Miquel Island. During El Niño episodes, pinniped food sources, such as many species of fish, migrate to waters with more comfortable temperatures, making it more difficult for pinnipeds to find food. Preferred food sources often move further north or into deeper waters, so the more easily accessible food sources are

4 Trillmich, Fritz and Ono, Kathryn, eds. Pinnipeds and El Niño: Responses to Environmental Stress, Springer-Verlag, New York, 1991

often of lower quality, weight, density or not as nutritional as in non- El Niño years. Therefore, another likely result of climate change will be a migration of species more adapted to cold waters toward the poles. Furthermore, other species move into pinniped territory resulting in a new source of competition for ideal prey species.[5] These El Niño events provide evidence for what will likely occur to pinnipeds in light of climate change.

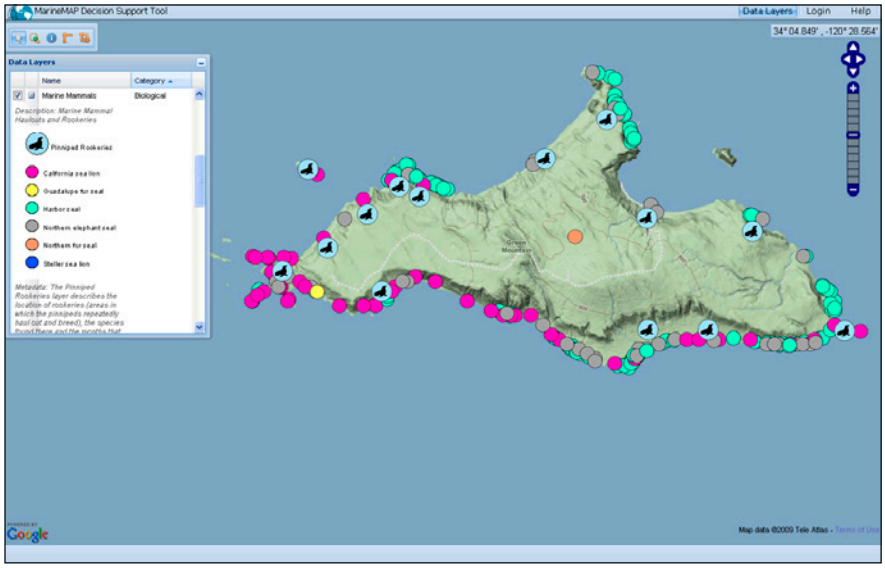

Figure 9.
Haul out areas on San Miguel Island.
Source: MarineMap Decision Support Tool: San Miguel Island. http://marinemap.org/marinemap/

In general, marine mammals, birds, cetaceans and pinnipeds (seals, sea lions and walruses), which feed mainly on plankton, fish and squid, are vulnerable to climate change-driven changes in prey distribution, abundance and community composition in response to climatic factors.[6] The reproduction of pinnipeds is affected negatively by increased water temperatures due to decreased prey abundance because time between breeding attempts is prolonged and/or the mothers breeding condition declines.[7] For example, in the 1982 major El Niño event, all of the female Galapagos fur seals lost their pups due to high rates of juvenile mortality and failure in female reproduction.[8] Therefore, the long term trend in increasing sea surface temperature that is one result from climate change may result in a decrease in the population of pinnipeds due to decreased abundance of prey species, as well as lower rates of reproduction.

Though lower reproduction and decreased food supply are common problems that affect pinnipeds during El Niño years (and associated warming events), there are some differences between species and the region the particular population resides in. The main four species found in southern California are northern fur seals, northern elephant seals,

5 Ibid.
6 Parry, Martin L. *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Working Group II Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
7 Ibid.
8 United Nations Environment Programme, Secretariat, Convention on Migratory Species. *Migratory Species and Climate Change.*

California sea lions, and harbor seals.[9] The northern fur seals experienced fewer births, smaller pups, and lower survival rates among pups that were born, as well as a decline in females and juvenile males left at the end of the 1982-1983 event.[10] The California sea lions off the coast of California went through all the same problems as the northern fur seals, but also females were observed to have lower copulation rates, a decline in fecundity, production of less and lower quality milk, and an increased abortion rate.[11] Elephant seal pups experienced a higher mortality rate as a result of intense storms sweeping pups off beaches before they learned to swim.[12] These species experiences with the El Niño event of 1982-1983 provide a good indication as to the likely responses of pinnipeds to global climate change.

9 Trillmich, *Pinnipeds and El Niño: Responses to Environmental Stress.*
10 Ibid.
11 Ibid.
12 Ibid.

- THE CALIFORNIA POLICY FRAMEWORK
- GENERAL RECOMMENDATIONS FOR SANTA BARBARA COUNTY AND CITY PLANNING

This section includes a brief overview of the California policy framework, and offers a number of important planning tools that can be adopted by county policymakers to begin to address the pressures and associated impacts from climate change. The *Appendices* to this report include a detailed characterization of policy tools and adaptive strategies that can be used by County planners.

Great Horned Owl. ***Photo: Morgan Ball***

3.1 THE CALFORNIA POLICY FRAMEWORK

The California policy framework includes thirteen bills and the Governor has signed four executive orders to provide greenhouse gas (GHG) producers and regulators with additional direction regarding implementation activities as of August 2009. This includes the passage of Senate Bill (SB) 97, on August 24, 2007, which provides guidance on how GHG emissions are to be addressed through CEQA analysis, as well as the recent passage of the SB 375. Signed on September 30, 2008, SB 375 aligns the State's housing mandate with regional transportation plans to effectuate a reduction in vehicle trips. Under SB 375, each of the California's 18 Municipal Planning Organizations (MPO), is required to develop an aligned transportation and housing plan for adoption by 2013. California Assembly Bill (AB) 32 Scoping Plan (June 2008) contains the main strategies the State will use to reduce the greenhouse gases (GHG) that cause climate change. AB 32 charged the California Air Resources Board (CARB) to develop a Scoping Plan outlining the State's strategy to achieve the 2020 GHG goals. The Scoping Plan proposes 18 emission reduction measures, which are expected to be adopted in December 2009, with final reduction measures expected to be adopted

policy responses

by January 2011. These measures seek to implement AB 32's goal of framing a new statewide policy paradigm by outlining specific strategies and actions, including those related to energy conservation and efficiency, improvements to the state's infrastructure, regionally coordinated transportation planning practices, and market-mechanisms such as an emissions cap-and-trade program. These measures will be legally enforceable at the beginning of 2012, in order to reach the statewide emissions reduction target by 2020. The State also recommends the development of regional blueprints by county governments.

In response to the California Governor's Executive Order S-13-2008, the *2009 California Climate Adaptation Strategy Discussion Draft* (2009) identifies a range of climate adaptation strategies on a per-sector basis, including:

- Biodiversity and Habitat
- Infrastructure (roads, levees, buildings, etc.)
- Oceans and Coastal Resources
- Public Health
- Water
- Working Landscapes (forestry and agriculture)

There are a number of strategic recommendations in the Discussion Draft.[13] A complete overview of the entire range of strategic recommendations described in the Discussion Draft (2009) is not the focus of this report. Two major components of the Discussion Draft (2009) are worth noting:

1) The need for regional vulnerability assessments that establish the type and extent of potential climate changes such as sea level rise, storm surges, and changing ocean conditions and how these changes will impact infrastructure and development, human populations, economy, and natural habitats and species.
2) The need for regional coastal adaptation strategies (both overarching and specific) to respond to these expected impacts from climate change. As much as possible, each strategy will be accompanied by case studies that elucidate that strategy and guidance on how it should be implemented (i.e., potential changes to policies or legislation).

The Discussion Draft (2009) includes a description of a number of programmatic goals, including the following:

13 See: http://www.climatechange.ca.gov/adaptation/

Monitoring

- Establish a framework for comprehensive research program combining predictive modeling and monitoring of focal species and ecosystems to assess changes in the ecological resources while also assessing viability.
- Conduct long term monitoring to evaluate changes in focal species and ecosystems. Develop regional climate change scenarios for California
  - Include micro-region weather data collection protocols and coordinate with other scientists at regional level to ensure repeatability and data integration.
- Ensure that monitoring is comprehensive across species, ecosystems, and relevant climatic variables, and that data can be statistically analyzed to detect change.
- Centralize data banks that synthesize data for land managers. This could be in the form of response plans based on different scenarios. Need to be able to easily transform data into regulatory schemes and on-the-ground management plans.
- Use predictive models to focus on which species are most likely at risk (sensitivity, likely habitat shifts, etc).
- Develop tools to forecast species' responses to climate change using modeling tools to predict range shifts, demographic and population trends, and physiological responses across taxonomic groups over a range of climate models, emissions scenarios, and management timelines (25, 50, 100 years).
- Where possible, improve models with data from experimental and observational studies that monitor species and ecosystem responses to changing climate conditions.
- Develop tools that integrate data from range shift modeling efforts to illustrate areas of land and water that will become important for supporting biodiversity in the future under a range of climate models, emissions scenarios, and management timelines (25, 50, 100 years), including corridors and stepping stone habitat to facilitate climate-induced migration.
  - Identify data gaps and update this map as new information becomes available.

  - Incorporate data from state, federal, academic, and NGO sectors, and make the data and mapping tool available to all.

- Identify activities that agencies are already undertaking and evaluate how/if they should be modified ;
- Identify gaps in data for fish, wildlife and plants.

Connectivity

- Identify critical connections/corridors taking into account changes due to climate change? (Model change in precipitation and temperature, land-use change, corridors, other existing or projected threats, e.g., invasives, development, etc)
  - Linkages should include heterogeneity (soil, vegetation type, elevation, latitudinal).
  - More potential to accommodate changes with more habitat variability.
  - Consideration of multiple types of corridors.
  - Species home ranges and movement behavior.
  - Corridors should facilitate native species movement and not create "disturbance corridors" for invasive plants to move through and proliferate.
  - Corridors should contain intact native habitat in good health.

Changes to Community Composition

- Develop ability to predict community composition changes based on areas where biodiversity is currently high and would likely support high biodiversity in the future (due to such elements as heterogeneity, soil, topography, etc).
- Focus on wetlands habitat and specific mechanisms to achieve conservation, stream alteration permitting, integrating potential significant impacts resulting from climate change.

County policymakers should adopt similar strategic goals that can lead to better policies in support of biodiversity protection. This is especially the case given the nationally significant habitats that exist in Santa Barbara County, such as the Gaviota coast.

3.2 GENERAL RECOMMENDATIONS FOR SANTA BARBARA COUNTY AND CITY PLANNING

To begin to address the pressures and expected impacts from climate change on biodiversity, there are a number of overarching challenges for city and county governments including but not limited to the following:

- How to develop a flexible approach to manage resource use, incorporating new knowledge about adaptation techniques and climate change as it becomes available.
- How to build capacity within local agencies in order to implement an adaptation strategy within a broader context that includes fiscal, technical and political constraints.
- How to devise a strategy for communication/outreach that is substantive and socially responsible.
- How to establish a permanent and dedicated funding source for biodiversity adaptation within the region and across the region.
- How to integrate and coordinate efforts among local, state and federal agencies, academics, and NGOs.
- How to invest today in the social network necessary to continually improve that scientific understanding, e.g., monitoring, of pressures on coastal marine biodiversity.
- How to develop a regional data storage and retrieval system for all monitoring and climate related data.
- How to identify the particular vulnerable coastal areas and developments, and the costs for implementing each component of a future climate action strategy to respond to biodiversity loss.

A case in point is the issue of adapting to rising sea levels. The need for sea level rise policy is particularly acute in California, where 72 percent of California's coastline consists of steep cliffs or bluffs. These areas, whose natural erosion replenishes beaches, are hemmed in between strong demand for urban development and high population growth in coastal cities, and increased sea level rise producing greater rates of erosion.

The conventional approach has been to "armor" coastal bluffs with seawalls, groins, or bulwarks. At least 10.2 percent of California's coast is armored, including one-third of the southern California coast. However, in addition to being costly and unsightly, these defense structures are likely to produce beach loss and reduced public access by blocking beach migration, increased erosion on seawall edges, and loss of biodiversity and habitat associated with the land-sea interface (Caldwell & Segall 2007).

While numerous studies show coastal armoring and associated impacts to be a poor policy choice, the U.S. Environmental Protection Agency has made maps showing the extensive armoring needed in coastal states under business as usual climate change scenarios (Titus 2004) – conceding that beach and coastal habitat loss is preferable to human development loss. However, a 2006 California court decision granted $2.3 million dollars to compensate the public for the lost future recreational value of a beach lost due to shoreline armoring (Ocean Harbor House Homeowners Association v. California Coastal Commission, Case No. M 73109); and at least six states have official policies prohibiting armoring (Caldwell & Segall 2007). The result leaves coastal policymakers stuck between demand for protection of public and private coastal infrastructure, and public and legal opposition to the standard policy tools for doing so.

Ultimately, leadership at the county and state levels will be required to develop innovative policy responses to the multiple threats posed by climate change on coastal areas. At the state and local level, there are a range of policy opportunities for coastal managers to balance the legal burdens of protecting public access and welfare through the public trust doctrine while avoiding triggering the "takings clause" through development restrictions. Table 1 depicts a general summary and description of policy tools that are available to address sea level rise, which is one pressure among many associated with climate disturbance. One such option is rolling easement policy, which is defined loosely as "a broad collection of arrangements under which human activities are required to yield the right of way to migrating shores" (Caldwell & Segall 2007). In practice, the option of rolling easement policy consists of securing easements in a coordinate manner either through permit conditions, purchase, or litigation that allocates the space necessary for the inevitable migration of ecosystem habitat and services. While few coastal governments have instituted rolling easement policy in their Local Coastal Plans, most likely due to legal concerns related to restricted private development, rolling easements will likely produce better economic results than seawalls (Landry et al. 2003).

Policy Options	Subcategory	Description
Managed Retreat	Rolling Easement	Creating open coastal space in order to allow publicly-owned tidelands to migrate inland as the sea rises; either through development removal, targeted land purchase, donation, or other easement mechanism.
	Prescriptive Easement	Legally securing public use of a private coastal area through demonstration of historical and continuous use by the public.
	Statutory restrictions on shoreline armoring	Prohibition of coastal armoring for all coastal development activities in order to mitigate beach loss and avoid increased erosion.
	Shoreline Armor Removal	Removal of shoreline armor in order to avoid loss of public coastal land due to sea level rise.
	Development Planning	Mandating that all applications for new development of a beach, beachfront, or bluff-top property must account for projected sea level rise.
		Requiring dune restoration, sand nourishment, and other design criteria on beaches in order to protect new or existing development.
		Considering accelerated sea level rise in addition to FEMA base flood elevations when calculating development setbacks.
	Wetland restoration	Creation or expansion of wetlands in order to store floodwaters and mitigate future sea level rise.
	Removal and relocation of buildings	Removing and relocated buildings threatened by sea level rise and increased coastal erosion.
Elevation of Land and Structure	Beach Nourishment	Placement of suitable (adequate particle size) sand, usually a large initial fill followed by periodic renourishment to make up for losses.
	Raising Existing Land or Structures	Raising height of low-lying land or structures to avoid flood-related damages.
Shoreline armoring	Seawalls/Bulkheads/ Revetments	Concrete, wood, steel, or rock used to "armor" the coast in order to prevent wave erosion.

	"Living Shoreline" Coastal Protection	Utilizing habitat restoration and/or bank stabilization through strategic placement of plants, stone, sand fill and other structural and organic materials in order to minimize coastal erosion and maintain coastal processes.
	Groins	Structures built perpendicular to the shore to trap sand transported alongshore by waves and/or to hold existing sand from being transported away.
	Dikes	A dike or levee is an earth fill mound, usually having a trapezoidal cross-section, which is placed along the land/water edge to prevent water from flooding the lower dry land area.
	Offshore Breakwaters	Abovewater structures parallel to the shore that reduce both wave heights at the shoreline and along the shore by intercepting a large portion of the incident wave energy and thereby decreasing the offshore and alongshore sediment transport capacity of waves.
	Perched Beach	A continuous submerged structure built offshore and parallel to shore, with beach built between the structure and shore by artificial nourishment. The structure retains the toe of the beach and perhaps diminishes wave energy by causing larger waves to break.

In addition to these policy responses to address sea level rise, a number of county and city coastal policy tools are recommended below. Additional measures by state and federal authorities will also be required. Ideally, new partnership across political, economic and administrative jurisdictions that include non-governmental organizations and the private sector should be developed to address the trans-boundary pressures of climate change. Additional adaptive strategies, policies and actions in support of the protection of coastal marine biodiversity measures at the local level are available in this report's *Appendices*.

1) **A comprehensive vulnerability analysis** should be conducted to establish the type and extent of potential climate changes such as

sea level rise, storm surges, and changing ocean conditions and how these changes will impact coastal infrastructure and development, human populations, economy, natural habitats and species. Scientists from the US Geological Survey developed the Coastal Vulnerability Index (CVI) to assess the physical vulnerability of the California coast. They found that from San Luis Obispo to the Mexico border, communities along this coastline have "high" or "very high" vulnerability to climate change. Smaller communities are particularly vulnerable as they lack many important resources for effective adaptation. A vulnerability analysis must include detailed mapping that contains "measures of physical risk," an inventory of armory structures, and identification of threatened habitats.

An important planning tool for coastal managers is a detailed vulnerability analysis that accounts for the implications of sea level rise, specifically coastal flooding and erosion under various scenarios of sea level rise. Specific to coastal habitat migration (i.e. estuaries and salt marshes), an undertaking of a vulnerability analysis is of utmost importance at present. Coupled with an inventory, this analysis can determine the most successful places that exist for ensuring inward migration of this sensitive habitat. In addition, the best location for development can be produced by a careful analysis and inventory of estimated wetland inland migration and general pressures on coastal watersheds in light of climate change.

The vulnerability analysis should be used as one foundation to develop coastal adaptation strategies (both overarching and specific) to protect coastal marine biodiversity, and address risks or hazards associated with coastal development and land-use. As much as possible, each adaptive strategy should be accompanied

West Coast Reports on Climate Change and Biodiversity

California Resources Agency. August 4, 2009. ***California Climate Adaptation Strategy Discussion Draft.*** **http://www.climatechange.ca.gov/adaptation/**

Defenders of Wildlife and Oregon Department of Fish and Wildlife. 2008. ***Preparing Oregon's Fish, Wildlife, and Habitats for Future Climate Change:A Guide for State Adaptation Efforts.*** **Subcommittee on Fish, Wildlife, and Habitat Adaptation. Oregon Global Warming Commission. http://www.defenders.org/programs_and_policy/global_warming/wildlife_and_global_warming/oregon_adaptation_efforts.php**

Climate Impacts Group. 2009. ***The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate.*** **http://cses.washington.edu/cig/**

by case studies that elucidate that strategy and guidance on how it should be implemented. For example, changes in creek, wetland, and coastal bluff buffer areas and other adaptive strategies that are needed to protect sensitive habitat areas should be incorporated in the County's Local Coastal Plan.

2) **Form An Interagency and Public Working Group** representing government and non-governmental organizations, e.g. state parks, and the private sector to discuss and recommend adoption of policies to protect coastal biodiversity. Such a Working Group could also include the use of a Scientific Advisory Panel to assist in the development of guiding principles to protect coastal marine biodiversity. A number of guiding principles should be emphasized in the Climate Action Strategy to support biodiversity protection, including:

   - Maintain healthy, connected, genetically diverse populations
   - Improve resiliency of existing habitats in order to maintain existing or new assemblages of species
   - Reduce non-climate stressors on ecosystems (i.e. invasive species)
   - Protect coastal wetlands and accommodate sea level rise
   - Consider climate change models as well as historical data when making projections
   - Employ monitoring and adaptive management
   - Adopt adaptation approaches that reduce risks to species and habitats and provide time for species evolution and development.

3) **Precautionary Principle** must be employed to buffer against uncertainty. There are synergistic effects and positive feedback loops of human-induced climate change, other human impacts, and natural disturbances which make decisions about policy solutions difficult. We can only control the human impacts. Therefore, the precautionary principle should be employed.

4) **Increase and preserve future wetlands and buffers.** The county and city should establish new buffer zones to allow the migration of wetland ecosystems. Planners should develop new policies that restrict land-use activities and new development near future wetlands by establishing specific language in county's plans.

5) **Increase Coastal Setbacks.** Current County policy requires a 75-year bluff setback for new development. New information regarding sea level rise and resulting bluff erosion should be used to develop new policies that translate into much larger coastal setback distances in the County. The 75-yearr. policy should be increased pursuant to Precautionary Principle and because many structures would last over 75 years, possibly leading to future demands for sea walls.

6) **Implement Rolling Easement Policy.** Rolling easements are highly valuable climate change policy responses in that they work to restrict development and protect ecosystem "structures and functions" in accordance with ecological importance. Rolling easements are implemented through permit conditions, purchase/donation by landowners, and regulation of the public trust doctrine, with the vital goal of maintaining ecosystems. According to the public trust doctrine, rolling easements prohibit the construction of armoring and erosion control structures in the present to protect future public rights and ecosystem preservation, including "migrating shores." An important case in point for rolling easements is the migration of estuaries and salt marshes due to sea level rise. If a bulkhead is in place to protect development directly behind it, the migration of wetlands will halt and they will gradually "drown" due to increasing water height. However, if rolling easements are in place as adaptation measures for climate change, the state holds the power to express to property owners that they do not possess the right to prevent inland migration. Thus development must be adjusted to account for this valuable habitat.

   Rolling easements are a special type of easement placed along the shoreline to prevent property owners from holding back the sea but allow any other type of use and activity on the land. As the sea advances, the easement automatically moves or "rolls" landward. Because shoreline stabilization structures cannot be erected, sediment transport remains undisturbed and wetlands and other important tidal habitat can migrate naturally. Similarly, there will always be dry or intertidal land for the public to walk along, preserving lateral public access to the shore. Unlike setbacks, which prohibit development near the shore and can often result in "takings" claims if a property is deemed undevelopable due to the setback line, rolling easements place no restrictions on

development. They allow the landowner to build anywhere on their property with the understanding that they will not be able to prevent shoreline erosion by armoring the shore, or the public from walking along the shore—no matter how close the shoreline gets to their structure. If erosion threatens the structure, the owner will have to relocate the building or allow it to succumb to the encroaching sea. State and local governments, as well as federal agencies and environmental organizations, purchase "rolling easements". Under these arrangements, which can come in a variety of different forms, private landowners on the oceanfront could continue to use and develop their properties as long as they refrain from armoring the shoreline. Often property owners can receive tax benefits for placing a conservation easement on their property. Rolling easements help maintain natural shoreline processes. The figure below depicts an example of a rolling easement. Appendix 3 describes policy language that has been adopted by other cities and counties to address climate change.

7) Implement Managed Retreat Policies. In vulnerable coastal areas, coastal planners should support policies that reflect a "managed retreat" option to existing development (structures, utilities, roads, rails, airports, power plants, sewage plants, etc.). Coastal policy should also be developed that incorporates the necessary economic incentives to landowners to support a managed retreat option to armoring the coast.

8) Identify and Preserve Core Habitat and Migration Corridors. The 2009 California Climate Adaptation Strategy Discussion Draft (2009) emphasizes the need to develop new strategies to set aside important habitat areas for the preservation of native species diversity. Climate disturbance will continue to cause plant communities and species' ranges to shift. Corridors of continuous habitat must be preserved to enable future shifts in ranges and resiliency in ecosystems. Routes containing viable native habitats for plant pollination vectors (wind and insect) and which connect existing and predicted future habitat areas can be mapped and protected. Appendix 2 describes additional adaptive strategies that support biodiversity protection. Overall, the designation of "climate refuge areas" should be an important part of the County's Climate Action Strategy. Identifying hot spots for threatened biodiversity in the

region, e.g., the Gaviota coast, should be a priority. A range of incentives to landowners and property owners should be integrated into a more comprehensive ecosystem-based approach to protect coastal watersheds and associated species diversity.

Conclusion.

This report has described a range of pressures and a sample of policy responses and tools that are needed to begin to plan for protection of coastal marine biodiversity in an era of climate change. Beaches with seals, the songs of birds, abalone shells and sand dollars at low tide, farmers working the land, otters peaking their heads above the kelp canopy, the majesty of oak and sycamore along the creek's edge—all are part of the long walk along the wild shoreline or trail in the canyons of along a coastal stretch of this region. Author and historian Wallace Stegner once wrote that the preservation of the last tracts of natural area represents a "geography of hope." This report calls on the development of a collective will—a geography of hope—that can match the scenery of our coastal region, and to begin to address the impacts of climate change.

Pacific Slope Flycatcher.
Photo: Morgan Ball

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- APPENDIX 1: WORKSHOP PROCEEDINGS
- APPENDIX 2: ADAPTIVE STRATEGIES
- APPENDIX 3: POLICY GOALS AND ACTIONS IN OTHER CITIES AND COUNTIES
- APPENDIX 4: CALIFORNIA COASTAL CONSERVANCY

Western Toad. *Photo: Morgan Ball*

Workshop 1: Developing Adaptive Policy to Climate Disturbance in Santa Barbara County

Date: April 18, 2009

Time: 10am – 1pm

Location: Flying A Studios, UCEN, University of California Santa Barbara

Sponsor: UCSB's Ocean and Coastal Policy Center

Guest presenter, Dr. David Revelle, managed and was a contributor to The Pacific Institute's report, *The Impacts of Sea-Level Rise on the California Coast.* The report, released March 2009, concluded that sea-level rise will inevitably change the character of the California coast. Adaption strategies must be evaluated, tested and implemented if the risks identified in the report are to be reduced and avoided. Funded by the California Energy Commission, California Department of Transportation, and the Ocean Protection Council, the report focuses on human infrastructure, changes to human habitats and wetland impacts although impacts on coastal marine biodiversity will also be significant. The discussion following Dr. Revelle's presentation discussed the report and further explored policy tools to protect coastal marine biodiversity.

Climate change impacts on biodiversity will be difficult to quantify for many areas due to a lack of an existing baseline. Many at the table agreed that research will have to continue and will need to be supported. Complicating matters further, the sea level rise zero baseline is shifting due to the 19-year tidal gauge update. Meanwhile, suggestions include implementing interim protection policies until more site specific information is available to make sound management decisions, basically

[appendix 1]

workshop proceedings

using a precautionary multi-disciplinary approach which translates the science of climate change into zoning and other local policies as needed. Restoration projects along coastal areas are of particular concern especially when it comes to projects that may be severely impacted by climate change in the form of sea-level rise. The existence of restored areas provides refuge for species which may become more vulnerable due to the habitat threats posed by climate threats, and also becomes a source in situations where repopulation may be necessary. Along with this concern for restoration projects, there also appeared some positive opportunities for creating and restoring wetlands. This is particularly true in areas where infrastructures are not built up right to the edge of wetland ecosystems, where zoning can be altered to accommodate future climate threats or marine reserves implemented. Restoration of watersheds will protect water systems which may be threatened by salt water inundation from sea-level rise. There is a lack of a system of incentives to promote restoration as a buffer against climate change.

Climate change provides opportunities to combine conservation with planning. For example, an assessment of the economic impacts of not providing a climate buffer around infrastructure or biodiversity hotspots melds these two disciplines. While a biodiversity focus in conservation planning for climate change is admirable, broadening the scope to include ecosystem services and functions is the key to ensuring ecosystem resiliency. For planning, it will be imperative to create a list of species and habitats at risk. There is still quite a bit that humans do not know about some species. In these cases, it will be necessary to make predictions based on the best available science while regional and local vulnerability assessments are developed. Another option to consider is wildlife corridors which can be used not just over space but also over time as climate changes, thus climate corridors. In this way, not just wildlife but habitat can migrate over time as habitats adjust to climate change. These linkages will be an important tool in protecting the ecosystem particularly in fragmented areas. Maintaining ecosystem processes allows ecosystem resiliency. Again there should be incentives in place to promote preserving ecosystem services and planning for resiliency. To account for all the benefits that these natural systems provide, natural capital evaluation methods need to improve.

In the process of conservation planning for climate change impacts on

biodiversity, there are many hurdles. For one, many regulatory agencies are involved. The overlap in jurisdiction, as well as unclear agency goals, results in delay after delay in the permitting process. Some roundtable members offered the idea of using legitimate state interest clauses to implement policy although there are inter-jurisdictional differences in the interpretation of "legitimate state interest." Others discussed the idea of expanding California's coastal zone designation to include areas that will be in the coastal zone in the future so the California Coastal Commission would gain more funding under the Coastal Zone Management Act. Additionally, a gap exists between policy and science. Whereas science offers long-term predictions, policy focuses on the short-term. There exists an inherent conservatism in the scientific community as well which needs to be recognized when creating policy based on scientific information. For example, when planning for 2050 use 2100 predictions for sea-level rise and realize that it may occur well before 2100. Lastly, the implementation of the AB 32 statutory requirement at the local city and county level will result in fewer resources dedicated to sea level rise and biodiversity-focused policies.

Several possible responses to these hurdles were suggested. Increased public communication and community involvement will raise awareness of the challenges that the environment is facing. Education may help to raise additional funds for projects. The University of Washington's Local Climate Adaptation template plan provides an example of a plan that incorporates climate change. A LEED-like system which adds value to ecosystem restoration and preservation for property-owners would encourage conservation. Giving the general voting population power to amend the General Plan would avoid specific interest-related amendments. Further participation in the Coastal Commission Adaptation Process would ensure that biodiversity issues remain on the table. The CZMA renewal this year by Congress will ensure the continuance of coastal planning processes. Additionally, it was mentioned that since the Coastal Commission and local governments have little political capital, most agencies are looking towards a California Supreme Court decision on public trust doctrine before taking action on climate change responses.

In closing, the discussion members agreed that climate change impacts on biodiversity are uncertain and that further research as well as a

precautionary approach would be the best management decision until local or regional ecosystem and biodiversity assessments are carried out.

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Workshop 2: Developing Adaptive Policy to Climate Disturbance in Santa Barbara County

Date: May 26, 2009

Time: 4 – 6 pm

Location: Flying A Studios, UCEN, University of California Santa Barbara

Sponsor: UCSB's Ocean and Coastal Policy Center

Students and interested members of the public, including members of the League of Women Voters and UCSB's Coastal Fund Board Members, participated in the second workshop. After a presentation by Dr. McGinnis on the range of pressures and the report's recommendations for policy responses, participants in the workshop discussed the need for further public outreach and education on the importance of developing County and City policy that can protect biodiversity in an era of climate change

The following adaptation strategies are recommended to support the protection of coastal marine biodiversity at the County level.

Horned Lark. *Photo: Morgan Ball*

Adaptation Strategies – Protecting Coastal Marine Biodiversity

2.1 Coastal Habitat Reserves

Establish a system of priority habitat reserves that provides for protection of representative examples of coastal habitat in the south central region. In order to help species survive in the face of climate change reserves should represent to the extent practical all aspects of ecosystem structure, composition, and function within aquatic, terrestrial, and near-shore marine habitats. In addition, any effort to establish a system of priority reserve areas should follow the basic principles listed below:

- Protect a range of ecosystems, environmental gradients (latitudinal and elevational), and key ecosystem features (structural characteristics, keystone species, soil representation, functional groups, i.e. composition, and ecosystem functions).
- Identify and protect habitat that is likely to become important habitat in the future as species ranges shift and habitat is lost due to changing climate conditions
- Identify matrix lands (between reserves, surrounding protected areas, etc) to provide buffers from external pressures, including the creation of incentives and other mechanisms to ensure that private lands are managed to provide buffer zones.
- Provide connectivity for species movement between current and future suitable habitat by protecting sufficient corridors and stepping stone habitat including latitudinal corridors (i.e. major river valleys that trend north-south) and elevational corridors that span broad climatic gradients over shorter distances; maintain

[appendix 2]

adaptive strategies

roadless areas to provide connectivity;

- Protect refugia at large and small scales (i.e. microclimates). Refugia are areas with more resistance to changing climate conditions due to unique topography, local weather patterns, geographic locations, etc.;
- Protect less impacted ecosystems when possible as they are likely to be inherently more resilient to climate change;
- Maintain natural disturbance regimes (i.e. fire cycles) to maintain ecosystem resilience;
- Protect diverse gene pools to provide genetic capacity for wildlife to respond to climate change (i.e. protect species across their range since populations are likely to have different adaptations to local climate conditions).
- Accommodate range shifts of multiple endemic plant species
- Protect evolutionary hot spots and areas with high levels of endemism.
- Offer protection from catastrophic loss (e.g. through fire, flood, disease, invasive species).
- Improve reserve boundary configurations, e.g. increasing area to perimeter ratio, and thereby reducing the negative impacts of adjacent land uses, especially residential, along interface.
- Provide for public access and recreational use as appropriate;
- Use selected reserve areas to pursue opportunities for public education;
- Use adaptive management strategies to maintain flexibility.

Sub-strategies

2.1.1: Identify relatively large reserve areas from existing public lands (federal and state) and protected nonprofit and private conservation lands.

a. Establish spatially explicit reserve priorities for each ecological region.

b. dentify potential sustainable reserves in each bioregion on public and private land which will represent priority areas for acquisition of easements, fee title and land use requirements, i.e. NCCP.

c. Establish priorities within ecological regions of identified federal based reserves.

d. Look at different ownership collectively, comprehensively, and on landscape scale across ownership boundaries.

e. Work with partners and stakeholders to maximize planning efforts

2.1.2: Pursue opportunities listed below to provide incentives for conservation of private lands including working landscapes that contributes to ecosystem and species resiliency within and between reserves (matrix lands) and establishes priorities for focusing resources towards areas with highest risks.

- **a.** Develop multi-county regional restoration plans
- **b.** Assist private landowners when possible with land management and restoration.
- **c.** Improve/enhance habitat on private land

2.1.4: Expand institutional cooperation between State, Federal, academic, private, and non-profit entities to better improve communication, share resources and information, establish priorities, reserve planning, and develop solutions.

2.1.5: Base policies, priorities, and actions on the best available science and incorporate mechanism for adapting strategies as new scientific information becomes available.

2.1.6: Pursue opportunities to leverage co-benefits through cross-sector assessments that encourage sustainability and that expands political, economic, and social capacity.

2.1.7: Pursue modifications to laws, regulations and practices that frustrate NPS, USFS, and USFWS from acquiring land or interest in land beyond Congressional boundaries in order to encourage federal assistance in strengthening the landscape reserve system.

2.1.8: Establish targets for implementing, establishing, and improving reserves planning. Review progress and make adjustments periodically.

2.1.9: Immediately implement those components of adaptation strategy that have a high probability for success based on current knowledge and that can be modified or adaptively managed as scientific knowledge evolves.

2.1.10: Build upon existing frameworks and programs to identify and manage reserve areas. The NCCP program of the DFG is an unprecedented effort by the State of California, and numerous private and public partners that takes a broad-based ecosystem approach to planning for the protection and

perpetuation of biological diversity. An NCCP identifies and provides for the regional or area wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity.

2.1.11: Reserve Planning: The reserve system is envisioned as a number, possibly 4-5, of mapped reserves representing the natural resources values in each ecological region. Reserves should be naturally sustainable, and, therefore, of relatively large acreage, possibly 150,000 acres and greater.

- Conservation biologists of the federal and state land managing agencies, nonprofits and academia who have established statewide conservation planning initially should be a part of planning efforts.
- A method for comprehensive review should be identified.
- The California Wildlife Action Plan should be used and could include spatially explicit maps of priority areas for conservation of California's biodiversity across all land use types with consideration for climate change.
- In most cases it seems appropriate to identify reserves beyond the 2050 projected growth areas.
- This effort should be undertaken immediately in help ensure conservation dollars are spent on priority needs.
- The results of this planning effort should be comprehensively reviewed periodically in order to ensure program actions are being carried out properly, priorities are current, research is successfully addressed, and collaboration is sufficient.

2.2 MANAGEMENT OF HABITAT AND RESTORATION

Increase the resiliency of California's natural resource lands by increasing the adaptive capacity of the managing institutions. Land management and restoration actions should give priorities to the identified reserves. The actions will focus on, but are not restricted to, reducing the environmental stressors on plant and animal species and habitats and providing increased resiliency within the reserve or other protected lands.

Sub-strategies

2.2.1: Collaboration and Cooperation: Work with federal and other

management agencies, and private landowners to more effectively manage habitat and species.

2.2.2: Resource Assessment and establishing a baseline.

- **a.** Conduct baseline surveys/inventories of plant and animal species on reserves
- **b.** Establish management goals for maintaining optimal and feasible levels of biodiversity
- **c.** Implement long-term monitoring to measure change over time. Use modeling to predict ecological changes for acquisition purposes

2.2.3: Conduct cost/benefits analysis to inform priorities.

2.2.4: Identify success criteria and desired future conditions with clearly articulated milestones. Pursue priority actions to reduce stressors including but not limited to:

- **a.** Eliminating invasive exotic species where feasible and/or most effective
- **b.** Removing barriers to wildlife movement in both terrestrial and aquatics systems.
- **c.** Restoring damaged systems and natural processes (e.g. reducing sedimentation through road repairs and maintenance) and maintaining natural disturbance regimes).
- **d.** Reducing risks of catastrophic loss from wildfire
- **e.** Reducing pollution caused by runoff and flooding
- **f.** Reducing the threat of exotic disease, pests, and pathogens.
- **g.** Restore impacted ecosystems in order to increase resiliency.
- **h.** To increase resiliency in aquatic areas consider the following management areas:
  - Genetic diversity
  - Habitat complexity
  - Cold water resources
  - Connect river/stream and floodplain
  - Alpine meadows and riparian areas
  - Wild and hatchery fish.

2.2.5: Pursue specific priority actions contained in *California's Wildlife Action Plan,* 2007, for each of the bioregions of California.

2.2.6: Identify areas of priority species movement including endemics within and between each reserve, especially latitudinal and elevational migration. These areas should be priority areas for resource management and restoration actions.

2.2.7: Develop guidelines for resource managers planning large restoration actions to determine if impacts of climate change, e.g. natural resource vulnerabilities, will adversely impact primary purpose or cost/benefit analysis of restoration actions.

2.2.8: Each land management agency should review current land and resource management goals, objectives, and practices relative to providing resiliency on landscape reserves and other major holdings. Develop a mitigation plan that optimizes resiliency and management objectives.

2.2.9: Continue to support stewardship of protected lands not included in the reserve system and improve their resiliency through additional climate change conservation efforts, including management and restoration actions.

2.2.10: Encourage land managing entities to protect habitat heterogeneity and resiliency through minimizing the impacts of catastrophic events

2.2.11: Develop criteria for determining where limited resources should be placed in order to have the most benefit.

2.2.12: Define commonly used terms to insure that agencies are working from the same platform and outcomes are measurable.

2.2.13: Expand criteria for acquisition planning and wildlife corridors to include an assessment of the potential changes to habitat structure and species from climate change and conservation strategies. Utilize a habitat-based model for conserving percentages of representative vegetation types.

- Species composition in vegetation communities is likely to change and will require new approaches including modeling future habitat types or looking at habitats most vulnerable to change rather than a hard-line "preserve" based on development footprints and local jurisdictional boundaries.

2.2.14: Use of existing frameworks/programs.

- The DFG's Areas of Conservation Emphasis (ACE)

mapping effort involved a statewide prioritization of areas considered to be of highest conservation value. The intended purpose of ACE is to:

- Help identify opportunities for expanding existing reserves
- Use in conjunction with other mapping efforts to identify areas overlooked within biological subregions and ensure representative examples of every ecotype have been accounted for.
- Identify linkages and corridors that will help species movement.
- Assist coordination with our conservation partners and inform all levels of governments to better build collaboration and focus resources to the highest priorities.

- The DFG administers a program for mitigation banking. This program provides enhanced mitigation opportunities by creating large reserves rather than scattered piecemeal mitigation sites with little conservation value. Conservation or mitigation banks are privately or publicly owned land managed for their natural resource values. In exchange for permanently protecting the land, the bank operator is allowed to sell habitat credits to developers who need to satisfy legal requirements for compensating environmental impacts of development projects. These banks can be strategically located in areas identified as potential reserves or can be situated to provide needed habitat linkages.

2.3 RESEARCH AND GUIDELINES

Establish standing groups of research scientists and resource managers to work closely together to ensure that the best available science is used in management and restoration activities aimed at long-term species protection in California and increasing resiliency in ecosystems.

Sub-strategies

2.3.1: Develop a vulnerability and adaptation research process that:

- Covers large landscapes and ecosystems to help determine which systems are most vulnerable to climate change.
- Focuses research on critical needs of resource managers

- Ensures relevant science is evaluated for effectiveness and proper application
- Provides real time, continuous access by the public
- Identify principles and "best practices" for resource management institutions.
- Uses appropriate guidelines to determine projected species range changes and migration pathways, especially endemics on currently protected lands.
- Accurately forecast responses to climate change in the short and long term.

2.3.2: Develop a statewide, long-term monitoring effort that evaluates climate related change in range and health of identified indicator species, populations and communities, and ecosystems.

2.3.3: While coordinating research through standing science and land managing groups, provide transparency and open up the process to include other outside interested parties that want to participate.

2.4 REGULATORY REQUIREMENTS

Sub-strategies

2.4.1: Seek appropriate California Environmental Quality Act (CEQA) guidance and land use regulations to offset the impacts of land divisions and new development on species survival in light of climate change.

2.4.2: Seek guidance for determining thresholds of significance relative to species adaptation capacity and the potential for significant direct, indirect or cumulative impacts resulting from implementation of CEQA projects under a climate change scenario.

2.4.3: Encourage local government to recognize and adopt conservation measures consistent with the State's objectives while carrying out land use and regulatory requirements. With appropriate local land use planners, seek measures to reward concentration of development and reduced pressure on matrix lands.

- Land management agencies should re-evaluate existing policies and programs to i ncorporate climate change

context. Pursue regulatory research to see what adjustments may need to be made to address climate change. What holes exist in regulatory schemes- need to make sure climate change included in regulations.

2.4.4: The primary objective of the NCCP program is to conserve natural communities at the ecosystem scale while accommodating compatible land use. The program has the potential to substantially contribute to building reserves and habitat linkages but suffers from incompatible land uses in and adjacent to sensitive habitats, inadequate funding for acquisition of lands and/or the timing at which fund are available concurrent with lands becoming available to purchase, and there is insufficient funding for monitoring effectiveness which precludes adaptive management of resources. Addressing these deficiencies in State and local regulations, general plans, and ordinances and establishing a more stable funding stream would benefit this planning process.

2.4.5: Appropriate water for natural resources.

- Conduct climate change modeling based on flow requirements for fish bearing streams.
- Dedicate new instream flow requirements based on climate change modeling.
- Develop new policies to preemptively deal with conflicts.

2.5 IMPLEMENTATION

Sub Strategies

2.5.1: All programs managed by the Resources Agency and departments within the Agency, e.g. State Parks local assistance program and WCB's restoration grants programs, should review the implication of climate change and adopt relevant policy, criteria, directives, or other measures to ensure the broadest application of adaptation measures. In addition, the Agency and departments should ensure their daily operations are geared towards reducing greenhouse gas emissions and other appropriate mitigation measures to reduce contributing to climate change.

2.5.2: Capacity and Continuity: To carry out the following strategies

a significant amount of time and effort is required within the Resources Agency and departments overseeing or carrying out the adaptation strategies herein. This effort requires full time dedicated personnel to manage and implement these urgent needs over the long run. The effort must endure change in administrations over the decades, and therefore should be managed by full time permanent civil servant personnel.

2.5.3: Public understanding and support is critical to long-term implementation. Early in the process of implementing the strategies a comprehensive public outreach effort is needed that clearly communicates key aspects of the program. This can be difficult since the lay person will not be familiar with much of the science behind the strategies and efforts to carry them out. Planned outreach to the lay public should include most all entities, e.g. nonprofits, to ensure a standard, understandable message to all.

2.5.4: Measuring progress and success: The Resources Agency is responsible for seeing the strategies are implemented in a timely fashion and that the appropriate parties are invited to contribute. As each strategy is undertaken and planned, quantifiable and qualitative short term targets, midterm milestones and measures of success must be identified. The Agency will be responsible for monitoring these requirements.

2.5.5: Timing of Implementation: With limited fiscal resources at all levels of government and in the private sector, identifying adequate resources for initiating the strategies is a huge challenge. The Resources Agency should convene a group of stakeholders and state agency staff to discuss prioritizing strategies as well as existing opportunities to pursue implementation in a time when resources are scarce. All strategies are in need of implementation as soon as possible and require a timeline for achieving goals based on what we can do right now with current resources and what we could do if we had more staff/funding.

Policy Language Used to Address Climate Change Issues in Cities and Counties

	Status of Coastal Plan	Biodiversity and Habitat	Infrastructure	Oceans & Coastal Resources
Solano	Long term LCP implementation strategy, has included numerous policies and programs which are components of The Year 2081 Shoreline Management Plan		• Develop criteria/plans for relocating/ managing city infrastructure including, public streets, utilities, marine safety center, community center, lifeguard towers, public access stairways • Identify bluff properties for possible acquisition • Develop incentives not to build in hazard areas • Establish a Shoreline Planning Commission • Define Preferred Bluff Retention Design Solutions: Lower, Mid and Upper bluffs • Implement Sand Mitigation/Land Lease Fee Program • Establish a list of Pre-Qualified geotechnical engineers • Evaluate the formation of assessment districts	• Establish an inventory of surf breaks • Establish an inventory of submerged reefs and related resources • Advance a multi-use submerged reef project at Fletcher Cove • Recertify Shoreline Master EIR or Prepare new Program

[appendix 3]

policy goals and actions in other cities and counties

	Status of Coastal Plan	Biodiversity and Habitat	Infrastructure	Oceans & Coastal Resources
Marin County	Public comments requesting action addressing sea level rise concerns	• Add land that will be submerged in the future to the Baylands Corridor • ID locations of sensitive features, existing vegetation cover and special-status species that will be affected by sea level rise • Use focal species and other ecological tools to determine the relationship between the baylands and uplands • ID methods to maintain connectivity between sensitive habitat feature and baylands • Specify criteria and thresholds used in determining extent of upland habitat essential to the baylands ecosystem • Make recommendations on an appropriate new biologically-based boundary for expanding Baylands Corridor • ID lands that could provide refuge from sea level rise • Identify strategies to protect park resources from the effects of climate change, such as violent weather, plant loss or change due to moisture and temperature changes, and sea level rise	• Establish criteria to determine buffer zone between development and possible sea level rise • Implement floodplain ordinances to regulate development in order to minimize flooding impacts • Amend the Marin County Code to include construction standards for areas threatened by future sea level rise • Review and inspect dams, update map inundation maps • Maintain permit authority over and continue to oversee construction of dams too small to be regulated by the State or federal government • Continue to implement adopted flood control programs, including limitations on land use activities in flood hazard areas and through repair and maintenance of necessary flood control structures • Limit repair, replacement, or construction of coastal sea walls and erosion barriers consistent with Local Coastal Program requirements, and as demonstrated to be necessary to protect persons and properties from rising sea level • Pursue funding for levee reconstruction in those areas threatened by sea level rise • Revise policy to include properties threatened by sea level rise as more information about the sea level rise threat becomes available • Continue to require all improvements to be designed to be more resistant to damage from flooding, tsunamis, seiches, and related water-borne debris, and to be located so that buildings and features such as docks, decking, floats, and vessels would be more resistant to damage • Consider expanding Floodway Districts to include areas of the unincorporated county that lie within primary and secondary floodways, and/or establishing an ordinance that will ensure that land use activities in flood hazard areas will be allowed only in compliance with federal standards	• Determine essential habitat connectivity in site-specific planning that serves to preserve and enhance existing wildlife habitat values • Work with the U.S. Geological Survey, the San Francisco Bay Conservation and Development Commission, and other monitoring agencies to track bay and ocean levels; utilize estimates for mean sea level rise to map potential areas subject to future inundation (including by updating information about watershed channel conditions and levee elevations); and amend the Development Code to incorporate construction standards consistent with the policies of BCDC's Bay Plan for any areas subject to increased flooding from a rise in sea level • Consider sea level rise in future countywide and community plan

	Status of Coastal Plan	Biodiversity and Habitat	Infrastructure	Oceans & Coastal Resources
		• Analyze risks to park resources from violent weather, plant and aquatic changes, and sea level rise, and prepare appropriate contingency plans	• Notify owners of property in areas with inundation or flooding potential regarding those hazards when they seek development review or other related County services • Continue to regulate development in Special Flood Hazard areas by applying the County's Floodplain Management Ordinance, Federal Emergency Management Agency regulations, and environmental review pursuant to the California Environmental Quality Act • Prohibit placement of public safety structures within tsunami inundation or flood-prone areas • Work with BCDC and the Marin Disaster Council to analyze implications of sea level rise and increased violent storm events and flooding on neighborhood safety, and prepare contingency plans • Analyze potential safety implications from sea level rise and prepare contingency plans in consultation with the Marin Disaster Council • Maintain publicly controlled flood ponding areas in a natural state for flood control, and continue to promote compatible uses in ponding areas, such as agriculture, open space, and recreation	
San Francisco Bay	Amended July 2001	• Any tidal restoration project should include the effects of relative sea level rise; impact of the project on the Bay's sediment budget; localized sediment erosion and accretion; the role of tidal flows; potential invasive species introduction, spread, and their control; rate of colonization by vegetation; expected use of the site by fish and other aquatic organisms and wildlife; and site characterizations		

	Status of Coastal Plan	Biodiversity and Habitat	Infrastructure	Oceans & Coastal Resources
San Francisco Bay Conservation and Development Commission (BCDC)		• Take full advantage of ecosystem-based management • ID strategies and techniques that will make future conservation and development projects more resilient to climate change	• ID significant structural, environmental, aesthetic, social, cultural and historic resources that must be protected	• Ensure that future development, shoreline retreat, flood protection and wetland enhancement strategies will be coordinated • ID areas that are inappropriate for protection from inundation • ID areas that are most suitable for wetland restoration, habitat enhancement, etc. that would enhance biological productivity • ID undeveloped uplands that are suitable for marsh migration
San Diego			• Provide an appropriate defensible space between open space and urban areas through the management of brush, the use of transitional landscaping, and the design of structures • Continue to implement a citywide brush management system	• Apply the appropriate zoning and Environmentally Sensitive Lands (ESL) regulations to limit development of floodplains, sensitive biological areas including wetlands, steep hillsides, canyons, and coastal lands • Limit grading and alterations of steep hillsides, cliffs and shoreline to prevent increased erosion and landform impacts. • Minimize alterations of cliffs and shorelines to limit downstream erosion and to ensure that sand flow naturally replenishes beaches • Limit the use of beaches and shorelines to appropriate coastal dependent and ocean oriented recreational/ educational uses as identified in local coastal/community plans
Santa Cruz	City Council accepted draft and policies		• Avoid or reduce the potential for life loss, injury, and property and economic damage from flooding	

POLICY STATEMENT OR CLIMATE CHANGE

Draft: 5/21/09 Draft for June 4, 2009 Board Meeting

Cedar Waxwing. *Photo: Hugh Smith*

Coastal Conservancy staff has prepared a proposed Coastal Conservancy Climate Change Policy and revised Project Selection Criteria,. These were presented to the Conservancy Board for their consideration and possible adoption on June 4th , 2009. The Climate Change Policy describes the concerns about the effects of global warming on coastal, marine, and near-coast resources within the Conservancy's jurisdiction. It further identifies the legislative and policy directives that call for the Conservancy to address these impacts, and it describes strategies and actions that the Conservancy will use to address climate change. The Project Selection Criteria includes three new proposed criteria to address greenhouse gas emissions and vulnerability to sea level rise and other climate change impacts.

Pertinent Facts

A. The State Coastal Conservancy Act of 1976 (Division 21 of the Public Resources Code) establishes the State Coastal Conservancy (Conservancy) to work cooperatively to protect and restore natural resources, agricultural lands, and to provide public access to and along the coast.

B. The Legislature later amended the Conservancy's geographic and programmatic jurisdiction to include the entire nine-county San Francisco Bay Area, the protection of coastal and marine habitats, urban waterfronts, coastal watersheds, educational projects and programs, administration of the Ocean Protection Council, and

[appendix 4]

california coastal conservancy

implementation of the California Coastal Trail and the San Francisco Bay Area Water Trail Plan.

C. The Global Warming Solutions Act of 2006 (AB 32) declares that global warming poses a serious threat to the environment of California and requires California to reduce its total greenhouse gas (GHG) emission levels.

D. AB32, the Governor's Executive Orders S-3-05 (2005) and S-13-08 (2008), the Governor's Office of Planning and Research Technical Advisory dated June 18, 2008, and pending revisions to formal Guidelines for the California Environmental Quality Act (CEQA) all require that agencies consider global warming with respect to their proposed actions.

E. The Conservancy's *Strategic Plan 2007* identifies the many effects that climate change will have on ocean, coastal and near-coastal resources, and the need to consider these impacts in determining the priority of expenditures in the design and siting of Conservancy-funded infrastructure projects; to support others in order to improve our understanding of the effects of climate change; and to identify tools to mitigate and plan for a range of predicted changes.

F. The California coast, ocean, and the San Francisco Bay area are experiencing documented adverse changes as a result of global warming, and climate scientists are predicting that these changes will accelerate, posing tremendous impacts and threats to the resources within the Conservancy's jurisdiction.

G. California's coastal, near shore, and marine resources are expected to experience dramatic physical, ecological, economic and social impacts due to predicted higher air and water temperatures, altered precipitation patterns, significant sea level rise, salinity changes, more severe El Niño climate events, increased storm frequency and intensity, higher coastal erosion rates, greater fire intensity and frequency, increased ocean acidification, changes in ocean circulation and upwelling, saltwater intrusion into water sources for agriculture, and other changes.

H. Coastal and bay wetland habitats, already significantly altered and reduced in size due to human activities, are expected to be significantly affected by changes in climate-driven processes such as sea level rise, fresh water flows, and sediment supplies.

I. Increased coastal erosion will likely reduce the lifespan of and threaten California's existing public and private facilities and structures, beaches and coastal habitats. Sea level rise and other effects of climate change on the coast and ocean threaten California's $46 billion ocean-dependent economy.

J. Agricultural protection projects are expected to be vulnerable to higher air temperatures and changes in water supplies, including from saltwater intrusion into groundwater sources.

K. The protection, restoration, and enhancement of habitats, ecosystem processes, and open space is essential to minimizing threats from global warming to California's biodiversity—an important part of the Conservancy's mission.

L. The coastal regions of the state are projected to have less severe temperature increases than inland regions, rendering the coastal region even more significant as a refuge for human use and overall biodiversity.

M. Protection of habitat inland and adjacent to tidal wetlands is essential for offsetting some wetland losses due to sea level rise and changes in storm frequencies and intensities.

N. Many habitat restoration projects can sequester carbon, an important factor in reducing the concentration of greenhouse gas emissions and slowing the rate of global warming.

O. The effects of climate change make adaptive management, coupled with monitoring of eco-system processes, more important than ever to assure that non-climate related stressors are identified and addressed early on, to assure that management actions are effective or "do no harm," and to contribute toward the collective knowledge for use of scientists, managers, and the public.

Climate Change Policies

In light of the Pertinent Facts, above, the Conservancy adopts the following climate change policies:

1. The Executive Officer is directed to consider climate change in evaluating which projects to fund and the manner in which projects are selected, in order to reduce vulnerabilities from climate change while continuing to support the resources (public access, open space, etc.) the Conservancy is charged with protecting.

2. **Sea Level Rise.** Prior to the completion of the National Academies of Science report on sea level rise, consistent with Executive Order S-13-08, the Conservancy will consider the following sea level rise scenarios in assessing project vulnerability and, to the extent feasible, reducing expected risks and increasing resiliency to sea level rise:
   a. 16 inches (40 cm) by 2050.
   b. 55 inches (140 cm) by 2100.
3. **Collaboration to Support Adaptation Strategies.** The Conservancy will collaborate with other agencies and entities to develop, support, and implement climate change adaptation plans, strategies and projects that minimize or offset impacts to natural resources, public access, and other matters specified in the Conservancy's enabling legislation.
4. **Adaptation Strategies.** The Conservancy encourages applications for climate-sensitive projects that include robust adaptation measures and strategies, including pilot or demonstration projects that are consistent with its enabling legislation, strategic plan, and available funding. These may employ innovative strategies for adaptation and mitigation of greenhouse gas emissions to minimize effects of climate change on natural resources and public access. Applications are encouraged for, but not limited to the following types of projects or project elements:
   a. Living Shoreline Projects which restore and enhance nearshore and tidal habitats such as tidal wetlands, eelgrass and native oysters, to promote sedimentation and protect against shoreline erosion.
   b. Protection of Areas Adjacent to Shoreline Habitats in order to support the inland shift of habitats such as tidal wetlands, in response to sea level rise.
   c. Regional Sediment Management to support adequate sediment supplies to enable tidal wetlands and other shoreline habitats to keep pace with sea level rise.
   d. Setbacks, Rolling Easements and Planned Retreat which 1) relocate developments further inland or away from areas likely to be affected by flooding and erosion within the life of the structure, 2) remove development as hazards encroach into developed areas, or 3) facilitate landward movement of coastal ecosystems subject to dislocation by sea level rise and other climate change impacts.

e. Innovative Designs that incorporate features that are resilient to climate change impacts and can serve as demonstration projects.

f. Clustered Development and Smart Growth to focus development in areas of low vulnerability to climate change impacts, minimize impacts to habitats and open space through the clustering of development, and support reduced greenhouse gas emissions from transportation.

g. Management of Invasive Species, especially projects which prevent introduction or spread of invasive species, in order to reduce the impacts of this major stressor on biodiversity.

h. Riparian Protection, Enhancement, and Restoration Projects that allow for wider riparian corridors to accommodate increased flooding, or provide other benefits such as increased shading to moderate water temperature increases.

i. Acquisition Planning Projects that apply the latest information on climate change impacts and recommendations on reserve design, to protect wildlife migration corridors and natural lands that have a diversity of topography, soils and microclimates, to maximize the survival of native species and biodiversity and preserve ecosystem processes.

j. Adaptive Management and Monitoring of ecosystem and physical processes to support implementation of management actions to achieve project objectives under rapidly changing climatic conditions.

5. **Climate Change Research.** When appropriate and consistent with the Conservancy's enabling legislation, the Conservancy will support priority research projects that are targeted to increasing understanding of climate change impacts to coastal and bay resources, support vulnerability assessments, quantify carbon sequestration benefits of habitat enhancement and restoration projects, and that demonstrate the effectiveness of applied management strategies.

6. **Education, Outreach and Guidance.** To the extent feasible with staffing and funding limitations, the Conservancy will collaborate with others to provide current information and guidance to grantees on the latest relevant climate change information and best management practices.

7. **Greenhouse Gas Emissions.** Conservancy staff will work with applicants to identify, evaluate, and incorporate reasonable measures to reduce the greenhouse gas emissions of Conservancy-funded projects. The Conservancy will encourage use of best management practices and innovative designs that reduce greenhouse gas

emissions and, as possible will support the development of such practices and designs through funding and other actions.

8. **Carbon Reduction and Offsets.** Conservancy staff will continue to measure, verify and report its overall GHG emissions with the end of reducing them; and will explore opportunities to offset emissions from Conservancy operations. The Conservancy will require grantees to obtain the approval of the Executive Officer prior to sale of carbon credits on land for which the Conservancy provided funding to purchase, restore, enhance, or develop.
9. **Transportation**. Conservancy staff will, where feasible, attempt to reduce their work-related greenhouse gas emissions from travel, through the use of public transportation, carpooling, bicycling, use of low fuel vehicles, clustering meetings and events, and using phone- and web-based conferencing technologies.