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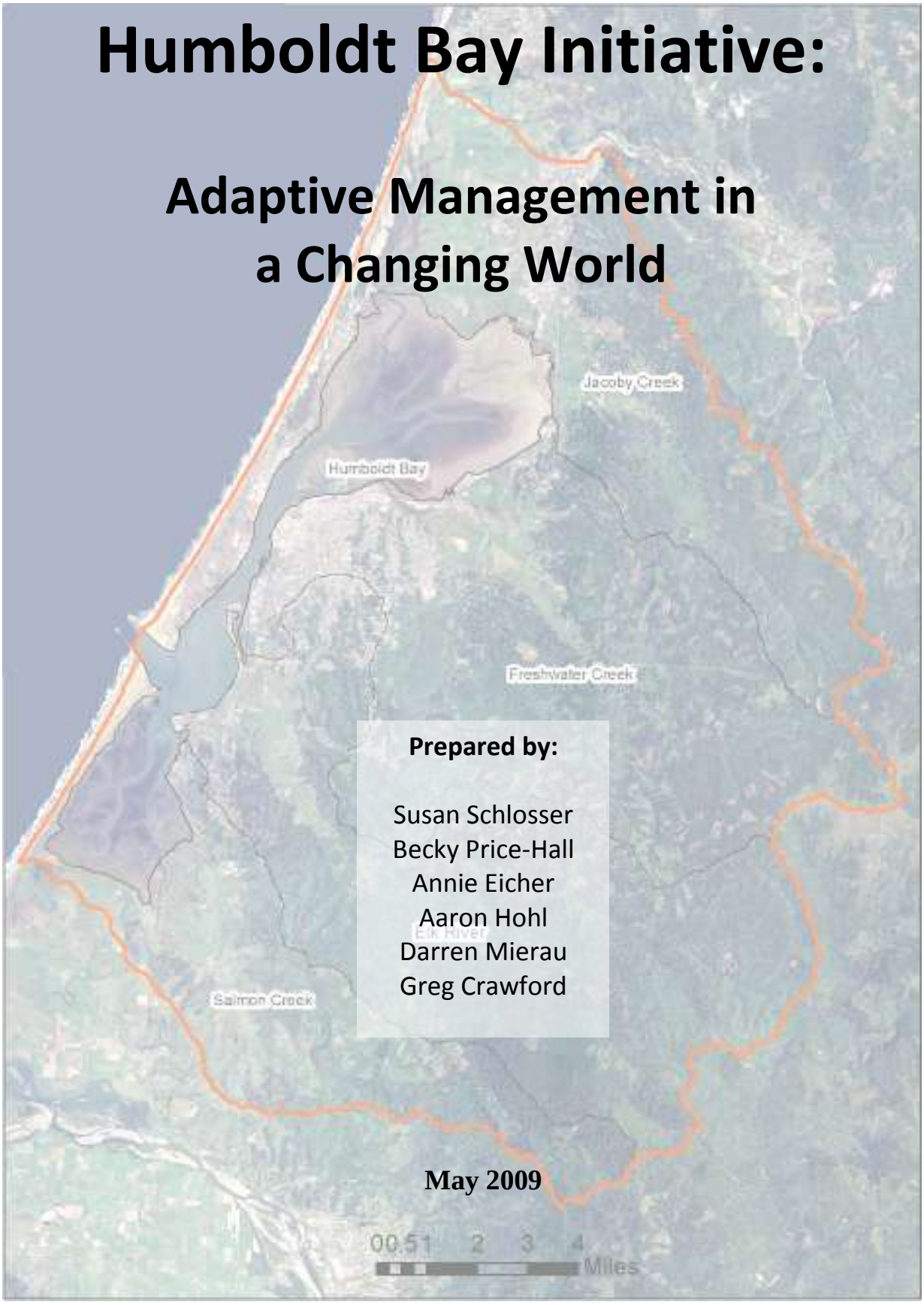
Humboldt Bay Initiative:

Adaptive Management in a Changing World



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May 2009

Humboldt Bay Initiative

Project Abstract

Our vision is a vibrant, thriving, and resilient Humboldt Bay ecosystem that supports the well-being of our human and natural communities.

The Humboldt Bay Initiative seeks to bring people together to help envision the desired future state of the Humboldt Bay ecosystems, to help understand past, current and future conditions, and to move forward in the spirit of collaboration towards a sustainable and dynamic future. In order to address priority stresses to the ecosystems due to human activities, climate change, excessive sediment, and invasive species, the Humboldt Bay Initiative proposes a set of strategies that help create the conditions necessary for a shared vision of the future. Through an ecosystem-based management approach, the Humboldt Bay Initiative enhances integrated management to address these stresses with strategies to adapt to climate and coastal change, coordinate a response to invasive species, study and control sediment sources, promote sustainable community development, and ultimately support integrated forest management.

Acknowledgements

The Humboldt Bay Initiative is possible thanks to the enormous contributions of the Project Team. Many people from many walks of life worked together to prepare this strategic plan. We are especially grateful for direct support of the planning, workshop and follow-up efforts. Special thanks from all of us to:

- The David and Lucile Packard Foundation
- The Coastal Conservancy
- California Sea Grant College Program
- North Coast Regional Water Quality Control Board

We were fortunate to meet N. Salafsky and C. Stem from Foundations for Success through colleagues at the San Luis Obispo Science and Ecosystem Alliance (SLOSEA). Without their expertise this plan would not be possible. We would also like to thank Debbie Marshall for her tireless efforts and patience with all the many drafts and changes to this plan.

The Project Team includes members from:

Bureau of Land Management (BLM)
California Department of Fish and Game (CDFG)
California Coastal Commission
California Coastal Conservancy
California Waterfowl Association
City of Arcata
City of Eureka
Coast Seafood
Community Members
Friends of the Dunes
H.T. Harvey & Associates
Humboldt Bay Harbor, Recreation and Conservation District
Humboldt Baykeeper
Humboldt Bay Stewards
Humboldt County
Humboldt Redwoods Company
Humboldt State University
Institute for the Study of Alternative Dispute Resolution
Jacoby Creek Land Trust
McBain and Trush
NOAA Coastal Services Center
NOAA Fisheries
North Coast Regional Water Quality Control Board (NCRWQCB)
Northern Hydrology
Pacific Coast Joint Venture (PCJV)
Planwest Partners
Redwood Community Action Agency (RCAA)
United States Army Corps of Engineers (USACE)
United States Fish and Wildlife Service (USFWS)
United States Forest Service (USFS)
University of California Cooperative Extension (UCCE)
University of California Sea Grant Program
West Coast Ecosystem-Based Management Implementers Network
Wiyot Tribe

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INTRODUCTION

Located 360 km north of San Francisco, the Humboldt Bay region contains a wealth of aquatic and terrestrial ecosystems that support a diversity of wildlife species, unique Native American cultures, small communities and towns, and an economy strongly dependent on natural resources. The region is home to approximately 80,000 people. Humboldt Bay is California's second largest estuary. Over 40% of the eelgrass beds in the state occur in Humboldt Bay, which also serves as habitat for juvenile Dungeness crab, rockfish, salmonids, shorebirds, waterfowl and marine birds. More than 60% of the oysters sold in the state are grown in Humboldt Bay and 60% of the Pacific brant population uses Humboldt Bay for foraging, roosting and staging. In sum, the Humboldt Bay region presents a rich physical, biological and cultural setting.

Humboldt Bay is a drowned river mouth that formed when the rising sea level of the last Ice Age inundated its lower river reaches. The watersheds contributing to the Bay are geologically young with a high rate of tectonic activity. Historically, Humboldt Bay was a large complex of wetland, marsh, and slough habitats, and although the Bay is technically an estuary, in the summer months it functions as a marine lagoonal system. Layered over this physical setting is a legacy in the bay and its contributing watersheds of logging, road building, dairy farming, fishing, lumber and pulp mills, residential development, waterfront development, diking, and dredging.

The Bay and its ecosystems presently experience stresses from both its geological setting and the anthropogenic activities that sustain our local economies. Streams and rivers in the region have been impacted by sediment runoff from surfaced and unsurfaced roads, and three of the four major tributaries to Humboldt Bay are now on the California Clean Water Act Section 303(d) list as impaired due to excessive sediment (NCRWQCB 2001). Many bird and fish populations have declined significantly since the 1970s. Habitat loss and modification are widespread in terrestrial and marine environments. Over ninety species of plants and animals have been accidentally or intentionally introduced into Humboldt Bay (Boyd et al 2002). Threatened and endangered species listed in the Humboldt Bay ecosystem include coho and Chinook salmon, tidewater goby, longfin smelt, marbled murrelet, snowy plover, northern red-legged frogs, Humboldt Bay owl's clover, and Humboldt Bay wallflower. Pollution has left a legacy of toxins in and adjacent to the Bay, and past and present contamination remains a serious problem.

For many years, scientists and resource managers working and living in the Humboldt Bay region have been exploring alternative approaches to improve conventional natural resource management. Those newer approaches emphasize collaborative, science-based management, sustainability, ecological health and inclusion of humans in the ecosystem. One result of this collaboration is a belief founded in our scientific understanding that conventional resource management approaches will ultimately prove to be somewhat ineffective in protecting the bay's ecosystems and natural resources. As a result, the productivity of many of these ecosystems has continued to decline, and the many human benefits derived from the bay and its surroundings, (e.g., property values, water quality and local economies) continue to be significantly impaired.

In 2006, with initial funding from the California State Coastal Conservancy, a group of scientists, resource managers, and local stakeholders in the Humboldt Bay area established a science Advisory Team to explore an ecosystem-based management approach to resource

management. These efforts continued in 2008 with funding from the David and Lucile Packard Foundation to conduct a formal strategic planning process in Humboldt Bay following the Conservation Measures Partnership's (CMP)(2007) *Open Standards for the Practice of Conservation*. CMP is a group of national and international conservation organizations working together to develop an adaptive management framework and a logical process for developing, implementing and monitoring conservation projects. The Open Standards process provided an essential foundation for formulating a strategic plan for Humboldt Bay. In tandem with the Open Standards approach, our Advisory Team recognized that ecosystem-based management requires fully integrating human needs as well as clearly identifying key conservation targets. We did not lose sight of our overall vision for thriving human and natural resources, and we were able to fit our unique resource management challenges and cultural setting into the Open Standards process.

We engaged in many hours of meetings, extensive collaboration with local stakeholders, discussions with regional and statewide programs and partners with similar goals and aspirations. Through our own blend of scientific understanding and conviction that local resource management needs a stronger scientific foundation, vision and leadership, we are now poised to propose a program that we hope will help carry forward a shared vision for Humboldt Bay. Our ultimate goal is to promote productive and resilient ecosystems that can help ensure a healthy and sustainable future for Humboldt Bay's natural and human communities.

The Humboldt Bay Initiative (HBI) is the result of these efforts. The mission of HBI is threefold: to promote increased scientific understanding of our natural and human communities; to create an integrated natural resource management framework that links the needs of people, habitats and species; and to facilitate community-wide collaborative problem solving. We recognize that an ecosystem-based management approach to natural resource management requires an understanding of the consequences of human actions to natural systems.

The Humboldt Bay region provides an excellent setting in which to develop and implement an ecosystem-based management approach for several key reasons:

- There is a strong network of community partnerships
- Community awareness and involvement in natural resource issues is high
- Community connection to the land is strong
- Community has been at the forefront of habitat restoration for over 40 years
- Size of the ecosystem and human community are manageable
- Ecosystem boundaries are definable
- Community desire to protect quality of life is strong
- Premier ecosystem is changing in unprecedented ways
- Opportunity exists to address long term and large scale priority issues

This strategic plan is divided into two sections: Section 1and Section 2. In the remainder of the introduction we trace the evolution of HBI, describe program participation, and describe the strategic planning process. Section 1 describes the project in terms of its scope and conservation targets, the current state of the system and critical threats. Section 2 describes our strategies and

work plans for addressing the critical threats. Sections 1 includes Open Standards conceptualization activities. Section 2 includes actions and monitoring.

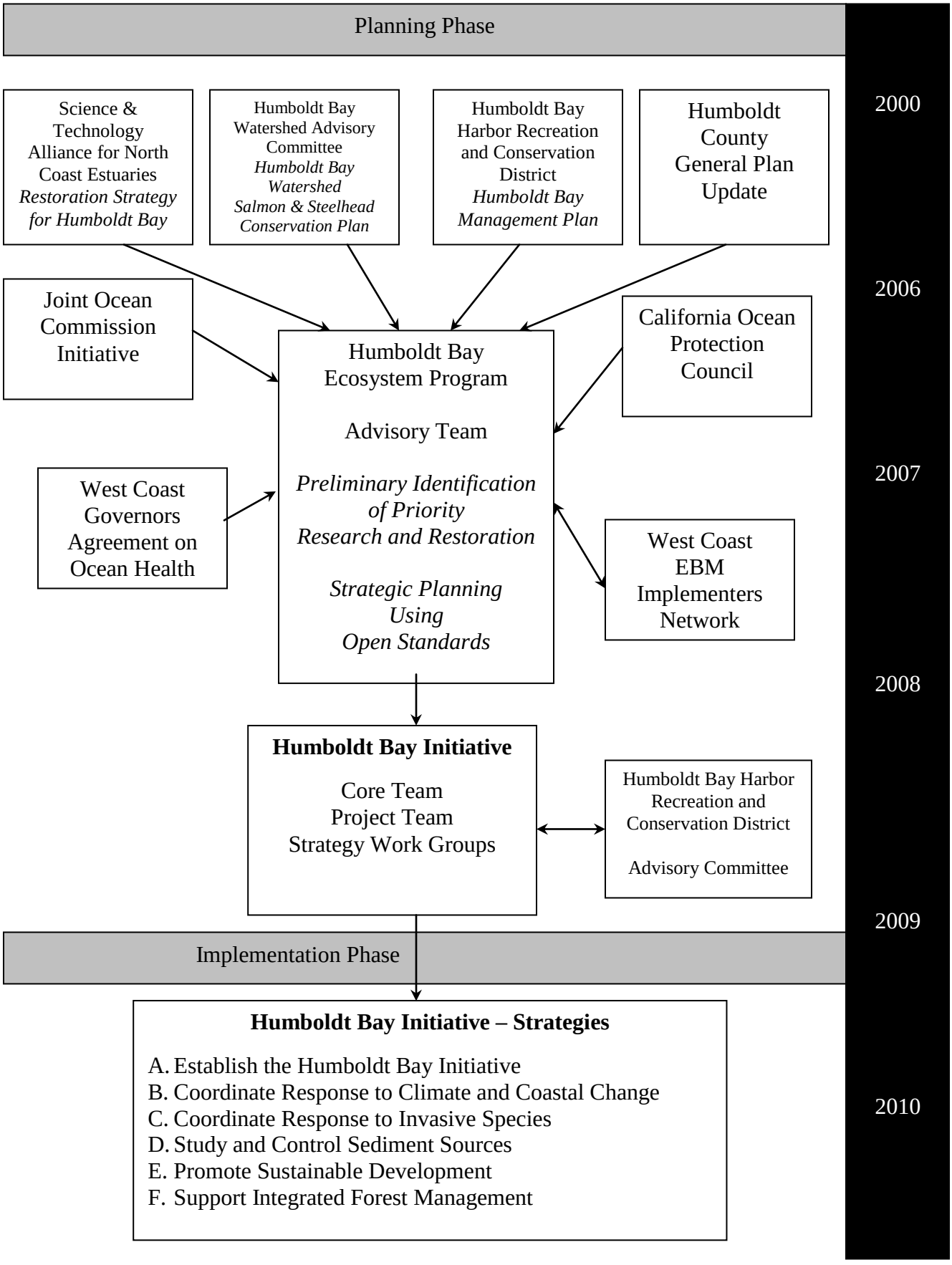
Evolution of the Humboldt Bay Initiative

The Humboldt Bay Initiative (HBI) is an expression of sustained community effort and support. During the last several years, the HBI Advisory Team and project partners have sought to build HBI on a foundation created by several completed and ongoing planning and policy efforts (Figure 1, Appendix A):

- Science and Technology Alliance for North Coast Estuaries (STANCE)
- Humboldt Bay Watershed Advisory Committee (HBWAC)
- Humboldt Bay Management Plan (HBMP)
- Humboldt County General Plan Update (HCGP)
- California Ocean Protection Council (COPC)
- West Coast Governors Agreement on Ocean Health (WCGA)
- Joint Ocean Commission Initiative (JOCI)

The immediate precursor of HBI, the Humboldt Bay Ecosystem Program, was created in 2006 by a group of resource managers and scientists who were inspired by a unique combination of planning, community involvement, national, state and local policy. Humboldt Bay watershed and bay management plans were developed concurrently between 2002 and 2006. Because many people participated in both processes, awareness emerged of the need to integrate issues common to both plans. At the national level, the U.S. Commission on Ocean Policy and the Pew Oceans Commission completed ocean policy plans in 2003 and 2004. A compelling concept in these plans was the recommendation for an ecosystem-based management (EBM) approach to coastal and ocean management. California responded definitively to the national ocean policy plans and passed the Ocean Protection Act in September 2004. Ecosystem-based management is a priority of the Ocean Protection Council Strategic Plan. The West Coast Governor's Agreement on Ocean Health, signed in September 2006, places ecosystem-based management among its priorities and organizing concepts. These regional, state and national plans support and encourage ecosystem-based management. Consequently, the management strategies detailed in the Humboldt Bay Initiative plan are well aligned with local community-based planning efforts as well as regional, state and national plans and policies (Appendix C).

Figure 1. Evolution of the Humboldt Bay Initiative.



Community Participation

Phase 1: January 2007 to October 2008

The Humboldt Bay Initiative is characterized by a bottom-up approach encompassing many people, diverse viewpoints and a broad spectrum of knowledge and expertise. We have brought people together to help envision the desired future state of Humboldt Bay ecosystems and economies; understand past, current, and future conditions; identify priority threats; and chart a course towards a more sustainable future. All participation in the Humboldt Bay Initiative is voluntary.

Between December 2006 and November 2008, with funding from the California Coastal Conservancy, the Project Team consisted of 30 local leaders, scientists, managers, planners, community groups, tribes, businesses and educators. The Project Team met monthly and Work Groups met once or twice a month (Table 1). The total hours of participation are roughly equivalent to one year of full time work, 2100 hours.

Table 1. The hours contributed by team members and a conservation estimate of its value for work completed between January 2007 and November 2008. ***We estimated the in-kind value of donated time using the University of California Cooperative Extension 4-H program volunteer hour value of $20. This is a very conservative estimate for the group of public and private scientists, university faculty, municipal and county personnel, stakeholders, and tribal representatives. These activities funded by the California Coastal Conservancy.***

Group	Attendance	Meeting length (hours)	Hours of participation	Estimated in-kind value of program participation
Core Team	146	2	292	$5840
Project Team	370	3	1110	$22,200
Work Groups	349	2	698	$13960
TOTAL	**n/a**	**n/a**	**2100**	**$42,000**

During this period we interacted with over 500 individuals and groups through outreach efforts, and sought widespread community input and support (Figure 2).

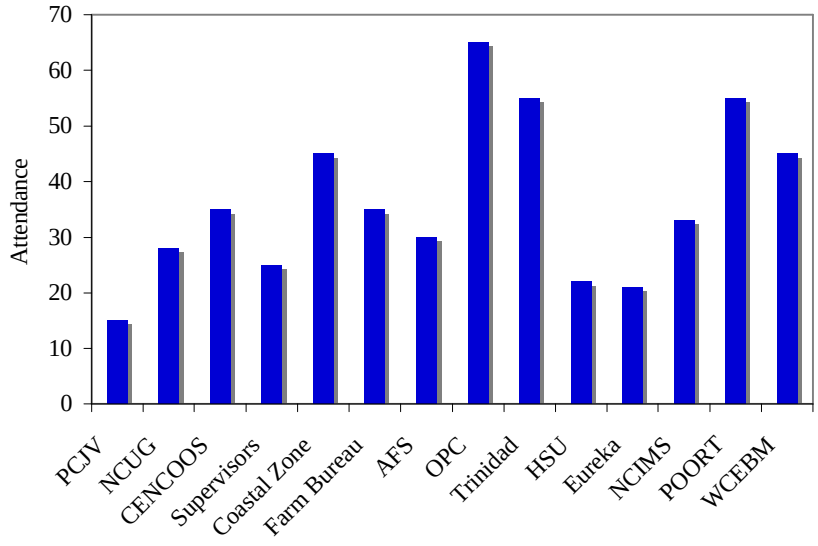


Figure 2. Outreach Results: Over 500 people attended meetings where invited presentations on the Humboldt Bay Ecosystem Program were given between June 2007 and September 2008. Acronyms are: Pacific Coast Joint Venture (PCJV), North Coast Users Group (NCUG, a local GIS workgroup), Central and Northern California Ocean Observing Systems (CENCOOS), Humboldt County Supervisors (Supervisors), Coastal Zone Conference 2007 (Coastal Zone), Humboldt County Farm Bureau (Farm Bureau), American Fisheries Society Conference (AFS), Ocean Protection Council (OPC), City of Trinidad, Fisheries Class at Humboldt State University (HSU), City of Eureka, North Coast Institute of Marine Science (NCIMS), Port Orford Ocean Resources Team (POORT), West Coast EBM Implementers Network (WCEBM).

Phase 2: October 2008 to April 2009

The Project Team met with representatives of the David and Lucille Packard Foundation and the Resources Legacy Fund Foundation in April 2008. We were encouraged to increase stakeholder participation and to conduct a strategic planning process. The Project Team conducted a stakeholder analysis and developed a list of individual to invite to the Strategic Planning Workshop. Stakeholder participation nearly doubled following the strategic planning workshop, increasing the Project Team from 30 to 58.

Workshop planning with Foundations for Success took place between October and December 2008 and consisted of webinars at Project and Core Team meetings and conference calls. The four-day Strategic Planning Workshop took place on January12-15, 2009 at the Humboldt State University Aquatic Center in Eureka, California. Work Groups were established based on strategies and results chains. The Work Groups met four times each between February and April 2009 and include many new stakeholders.

The Project Team also organized a one-day workshop to examine institutional design ideas for the Humboldt Bay Initiative. Representatives from the San Francisco Estuary Institute, the Southern California Coastal Water Research Project, and Humboldt State University gave

presentations on several types of institutes and organizational design, followed by a facilitated discussion. This workshop was funded by the North Coast Water Quality Control Board and California Sea Grant.

During the project period funded by the David and Lucille Packard Foundation, planning meetings, the strategic planning workshop, follow-up work group meetings, and conference calls and WEBEX sessions with C. Stem from Foundations for Success occurred between October 2008 and April 2009 (Table 2). Over 2000 hours of participation by the Humboldt Bay Initiative Project Team and Work Groups were focused on the Open Standards for Conservation Strategic Planning process and products.

Table 2. Attendance, meeting length, and hours of participation for the Humboldt Bay Initiative November 2008 to April 2009. There are six workgroups, one for each strategy. ***We estimated the in-kind value of donated time using the University of California Cooperative Extension 4-H program volunteer hour value of $20. This is a very conservative estimate for the group of public and private scientists, university faculty, municipal and county personnel, stakeholders, and tribal representatives. These activities were funded by the David and Lucille Packard Foundation***. * Workshop funded by the North Coast Regional Water Quality Control Board and California Sea Grant.

Group	Attendance	Meeting length (hours)	Hours of participation	Estimated in-kind value of program participation
Strategic Planning Workshop	36	32	1152	$23,040
Core Team	35	2	70	$1400
Project Team	90	3	270	$3600
Work Group	243	2	486	$9270
Humboldt Bay Initiative Workshop*	42	4	168	$3360
TOTAL	**n/a**	**n/a**	**2146**	**$42,920**

Ecosystem-Based Management

We are fortunate that significant areas throughout the Humboldt Bay ecosystem are relatively healthy, and, if conserved, will protect the vital processes of life. However, many ecosystem products (e.g., trophic support for fisheries, salmon fisheries habitat) are currently stressed because of the lingering effects of wide-ranging and cumulative historical activities. Others are threatened or likely to be threatened if current trends continue. For example, tidal ecosystems, which are an important food source for fish and birds, are threatened by the spread of invasive species and sea level rise. Salmonid habitat in freshwater tributaries are significantly impaired by excessive sediment from several land use practices. Consequently, we must be proactive in

protecting ecosystem services of the Humboldt Bay region. Protection requires that we understand ecosystem processes at multiple scales, recognize the interactions between social and economic systems and natural systems, and mitigate the human factors that potentially stress ecosystem processes and functions.

Our working definition of ecosystem-based management encompasses basic principles and an organizational framework that guides the decisions and actions of this project.[1] Ecosystem-based management seeks to balance ecological, economic, and social considerations in a science-based management approach so that ecosystem integrity and human well-being[2] are maintained, improved, and perhaps most importantly, that they are sustainable.[3] It takes into consideration external influences, cumulative impacts and changing conditions, and acknowledges that ecosystem processes and human interactions are inherently linked, and that our understanding of them is incomplete. Science, community policy and education all have a role to play in implementing ecosystem management strategies. The strategies introduced below are intended not only to support existing, science-based, community driven, solutions but also to respond to problems that are not currently being addressed.

It is important to note that managed ecosystems cannot be completely controlled. For example, humans have little control over where the fish swim or the extent of upwelling conditions. We also recognize that resource policies and governance structures impose constraints on the implementation of ecosystem-based management. However, there are significant opportunities within the current legal and management system to implement ecosystem-based management. A more coordinated approach to management of stresses and issues of concern in the Humboldt Bay Ecosystem would benefit both the system and those who depend on it.

The potential benefits of EBM can be illustrated with a local example: management of local salmonid populations. Currently fisheries management, endangered and threatened species recovery, coastal zone management, water quality management and timber harvest are managed separately, though all these activities interact and have unknown cumulative impacts to salmon. Because salmon use freshwater, estuarine and marine habitats to complete their life cycle, healthy salmon populations depend on a healthy, productive, and connected series of ecosystems. Salmon populations have declined because structure, function and processes of the ecosystem are lost under this scenario of fragmented management. The interconnectedness throughout the ecosystem is not accounted for. Nor are ecological, social, economic and institutional

[1] This definition was adapted from *McLeod et al. 2005, Scientific Consensus Statement on Marine Ecosystem-Based Management, statement released at first California Ocean Protection Council meeting in March 2005; Coast Information Team Ecosystem-based Management Framework, 2004, http://www.citbc.org/; Ecosystem Science Capabilities Required to Support NOAA's Mission in the Year 2020, NOAA Technical Memorandum NMFS-F/SPO-74, July 2006:* and two original definitions developed by Advisory Team members.

[2] Human well-being, includes materials for a good life including income, household assets, food, water, shelter; freedom and choice of a range of options a person has in deciding what kind of life they want to lead; health and good social relations (Carpenter, S.R., P.L. Pingali, E.M. Bennett, and M. G. Zurik, 2005. Ecosystems and Human Well-Being. Scenarios, Vol. 2, 560 p). Millennium Assessment Project

[3] Sustainable: Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

perspectives integrated. An EBM approach to declining salmonid populations would include integrated management that considers the entire ecosystem, including humans.

Strategic Planning Process[4]

As noted above, this plan was developed using the CMP's *Open Standards for the Practice of Conservation* (Conservation Measures Partnership 2007). The process is outlined here. More detailed information can be found on the CMP website (www.conservationmeasures.org).

The goal of the Open Standards is to improve the practice of conservation by providing people with common concepts, approaches and terminology for conservation project design, management and monitoring. The standards are meant to provide general guidance necessary for the successful implementation of conservation projects. They also lay out specific, iterative and interactive steps for developing adaptive management plans for conservation projects. The five steps that comprise the project management cycle are: 1) conceptualizing the project vision and context; 2) planning actions and monitoring; 3) implementing actions and monitoring; 4) analyzing data and using the results to adapt the project; and 5) capturing results and sharing what has been learned.

This report describes steps 1 and 2 of the Humboldt Bay Initiative. The first step requires A) defining the initial project team; B) defining the scope, vision and conservation targets; C) identifying critical threats; and D) completing a situation analysis. The second step requires: A) developing/ identifying goals, strategies, assumptions and objectives; B) developing a work plan and monitoring plan. Several terms used in the process have particular meanings, which are defined below.

The scope defines broad parameters related to what the project will affect and, for our project, is geographically defined. Because our project employs ecosystem-based management, we include more information about social and economic parameters than would be included in a more traditional conservation project. Conservation targets are specific species, ecological systems/ habitats or ecological processes that are chosen to represent and encompass the full suite of biodiversity in the project area. Our conservation targets are ecosystems. The vision is a description of the desired state or ultimate condition that the project is working to achieve. Threats are primarily human activities that immediately affect a target, but they can be natural phenomena altered by human activities or natural phenomena whose impact is increased by other human activities. The situation analysis represents a common understanding, or conceptual model, of the project's context – including the biological environment and the social, economic, political, and institutional systems that affect the conservation targets.

We feel that referring to human activities, as threats may be problematic for some of our project partners. In communicating with project partners, we want to be clear that our work absolutely strives to achieve conservation within a context that sees humans as part of the ecosystem and recognizes their need to maintain a high quality of life, including maintaining a viable livelihood. Consequently, we sometimes use the terminology adopted by San Luis Obispo Science and

[4] The information in this section is a close paraphrase of sections of *Conservation Measures Partnership. 2007, Open Standards for the Practice of Conservation. Version 2.0.*

Ecosystem Alliance (2008) and refer to direct threats as "human actions" or "human factors" or "human drivers."[5] We feel that this language is more appropriate and does not imply that humans, in and of themselves, are threats. For example, forestry and fisheries are human factors that affect ecosystems and economies in a multitude of ways—including many benefits as well as stresses.

Goals are formal statements of the ultimate impacts the project hopes to achieve. Goals represent the desired status of the targets over the long-term. A well-formulated goal should be linked to targets, impact-oriented, measurable, time limited and specific. Strategies are interventions designed to take advantage of key leverage points identified in the conceptual model. Objectives specify the desired changes in specific threats and opportunities. A well-formulated objective should be results oriented, measurable, time limited, specific and practical.

[5] Driver: a driver is a natural or human-induced factor that directly or indirectly causes a change in the ecosystem. Examples: A direct driver such as habitat change, explicitly influences ecosystem processes. An indirect driver such as human population change operates more diffusely by altering one or more direct drivers.

Report Layout

This report uses the same numbering system as the Open Standards and presents the Humboldt Bay Initiative main products associated with each step. These steps include:

1. Project Description
    - 1A. Initial Project Team
    - 1B. Project Vision, Scope and Targets
        - Targets, goals, and indicators
    - 1C. Critical Human Drivers
    - 1D. Situation Analysis

2. Strategies & Plans:
    - 2A and 2B. Strategy Descriptions, Results Chains, Work Plans and Monitoring Plans
        - Strategy A: Establish the Humboldt Bay Initiative
        - Strategy B: Coordinate Response to Climate and Coastal Change
        - Strategy C: Coordinate Response to Invasive Species
        - Strategy D: Study and Control Sediment Sources
        - Strategy E: Promote Sustainable Development
        - Strategy F: Support Integrated Forest Management

1. Project Description

1A. Project Team (list of names and affiliations in Appendix B)

Core Team

The Core Team provides leadership and direction for all HBI efforts. The Core Team meets monthly, develops Project Team meeting agendas, actively supports the Project Team, tracks progress of meetings and products, and ensures an efficient flow of information among the Project Team and Workgroups

Work Groups

Work Groups are groups of individuals actively working on HBI strategies, including members who plan to implement them. It is likely that additional collaborators will join HBI Work Groups over the next year. Work Groups meet once or twice a month.

Project Team

The Project Team is comprised of over 50 people and numerous organizations who have expressed interest in the program (Table 3). It also includes active participants from Work Groups. The Project Team meets monthly. Project Team members who are not directly involved in the HBI Strategies, contribute ideas and advice.

Table 3. The Project Team includes representatives of over 30 organizations

Organization Category	Number
Tribe	1
Land Trust	1
Educational Institution	3
State Agency	4
Local government or commission	4
Federal agency	5
Private business	6
Non-profit	9

In some cases an organization is represented by more than one division. For example, the federal partner, NOAA, has representatives from NOAA Fisheries and the NOAA Coastal Services Center. The USFWS Coastal Program and USFWS Humboldt Bay National Wildlife Refuge have been actively involved. CDFG Marine Region and Inland Fisheries Divisions both participate. From Humboldt State University, Biology, Fisheries, Oceanography, Sociology and Wildlife faculty and students are involved in HBI.

A complete list of Project Team members and their affiliations is in Appendix B.

1B. Humboldt Bay Initiative: Vision, Scope and Targets

Vision

Our vision is a vibrant, thriving and resilient Humboldt Bay Ecosystem that supports the well-being of human and natural communities.

Mission

The Humboldt Initiative (HBI) seeks to create an integrated and coordinated resource management framework that links the needs of people, habitats and species by increasing our scientific understanding of our ecosystem and by promoting community-wide collaboration to ensure a healthy future for Humboldt Bay's natural and human communities.

Scope

The project scope includes ecological, social, cultural and economic processes as well as the biological and physical components of the ecosystem. We have engaged the community and received input from many relevant organizations in development of our project scope.

The geographical scope of the Humboldt Bay Initiative program extends along the coast from Trinidad Head south to Cape Mendocino and offshore to 700 fathoms, the edge of the continental shelf. The nearshore and terrestrial component of the project scope includes the Humboldt Bay watershed, Humboldt Bay and the estuaries of the Mad River and Eel River (Figure 3a-d).

The Eureka littoral cell is geographically limited by Trinidad Head and Cape Mendocino. Sand and sediment enter the littoral cell from rivers and streams and are transported along the coast. Usually sand is lost from the littoral cell via deposits into submarine canyons and dune fields or is directly removed by dredging. Watersheds adjacent to nearshore area include Trinidad creeks, Little River, Mad River, Humboldt Bay, Eel River, Bear River and the Mattole River. The bay and estuaries of the lower watershed regions are significant transition zones between land and sea, fresh and salt, and are critical linkages for species such as salmon, steelhead and marbled murrelets.

The California Current system in the project area and north to Cape Blanco, Oregon, is diffuse and has highly variable oceanic conditions. Energetic and complex upwelling processes in the nearshore marine environment and substantial freshwater inputs to the coastal ocean from river systems affect transport of sediment, nutrients and organisms. Productivity of the California Current ecosystem off northern California plays an important role in our climate, sediment and nutrient dynamics and the population dynamics of important fish stocks, marine mammal and bird populations along the Pacific Coast of North America.

Figure 3. Maps of the Humboldt Bay Initiative

a. Location map: The Humboldt Bay ecosystem is in the northwest corner of California, north of Cape Mendocino

b. Trinidad Head to Cape Mendocino showing broad continental shelf in the project scope and portion of submarine canyon systems. From NOAA Ocean Uses Atlas Project

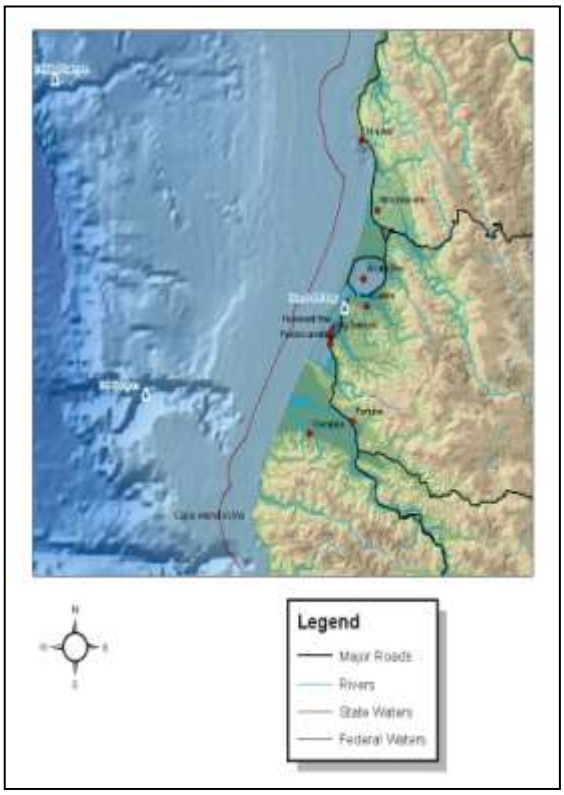
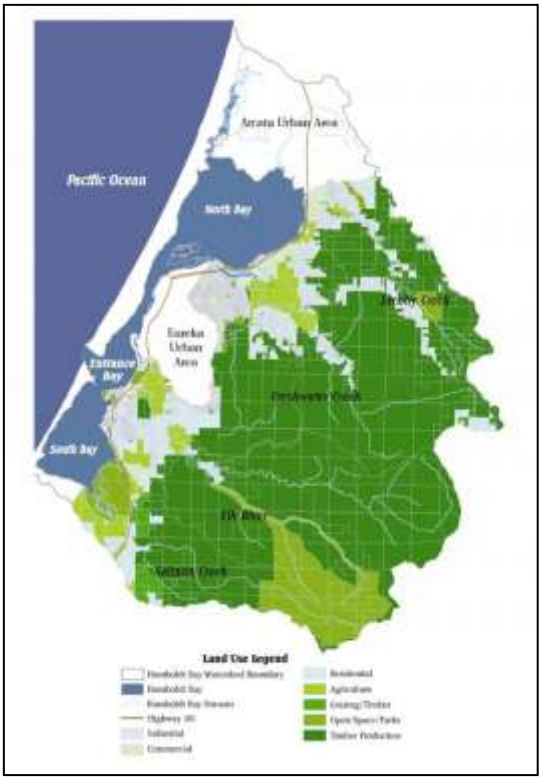


Figure 3 (continued)

c. Humboldt Bay and its watershed showing sub-basin borders. From McBain and Trush, Arcata CA

d. Land use in Humboldt Bay watershed. Used with permission from RCAA



Targets

Selection of EBM Targets

Ecosystem-based Management (EBM) Targets were developed in January 2009 at the Humboldt Bay Initiative Strategic Planning Workshop. The Conservation Measures Partnership definition of a target is:

> *A limited suite of species, communities and ecological systems that are chosen to represent and encompass the full array of biodiversity found in a project area. They are the basis for setting goals, carrying out conservation actions, and measuring conservation effectiveness. In theory - and hopefully in practice - conservation of the focal targets will ensure the conservation of all native biodiversity within functional landscapes.*

The targets encompass key habitat types, critical species, ecological functions, ecosystem processes and associated human benefits. The Humboldt Bay Initiative Project Team explored a variety of potential targets that were narrowed down to 7 ecological system targets which the team felt could collectively describe the health of the project area ecosystems.

The following targets were selected to represent the range of ecosystem types found within the project scope:

- Forests
- Freshwater Tributaries
- Coastal Plains
- Estuaries
- Humboldt Bay
- Beaches and Dunes
- Nearshore Marine

Forests

This target consists of the forests in the Humboldt Bay watershed. The watershed is characterized by north and northwest trending mountain ridges and long narrow valleys. The Humboldt Bay watershed is 225 square miles and consists of several sub-watersheds: Arcata urban creeks, Jacoby Creek, Freshwater Creek system, Eureka urban creeks, Elk River and Salmon Creek (Figure 3c).

The forests are the southern extension of temperate coastal rainforests of the Pacific Northwest. The valleys contain lowland forests consisting principally of second and third growth redwood and Douglas-fir. Inland and higher up the watershed, Douglas-fir/tanoak forests dominate, with mixed evergreens, tanoak and grasslands. At higher elevations, mixed coniferous forests of white

fir, ponderosa pine and Douglas-fir form the largest forest systems. Approximately 60% of the watershed is owned by commercial timber production companies.

Local forests also contain significant remnant old growth stands and are home to several rare or endangered species, notably the spotted owl and marbled murrelet. They protect the rivers and streams that provide drinking water to local residents and habitat for the salmonids that potentially underpin the regional fishing economy. Corridors of riparian vegetation along steams provide significant habitat to amphibians, mammals, birds and reptiles that rely on adjacent forested areas for at least part of their life cycle. Bald eagles, osprey and murrelets use marine areas for feeding but roost and nest on land. This constant moving back and forth of wildlife and fishes highlights the importance of ecosystem linkages.

The human factors affecting forests are development, timber management, roads, and climate change. Over a century of logging activities and development in forest ecosystems with erosive, friable soils has resulted in significant sedimentation issues in adjacent freshwater systems. We have developed strategies to address issues associated with timber harvest, timber related roads and inadequate public dialog. The rapid growth and high quality wood produced in the forests surrounding Humboldt Bay make the area an important center of timber production and give it an important role in sequestering carbon.

Forest Goals:

- By 2025, hydrologic functions of forests in the Humboldt Bay watershed forests will be viable.
    - Indicators: road density, square feet of impervious surfaces, acres converted from timber production to residential

Freshwater Tributaries

The freshwater tributaries of the Humboldt Bay watershed are ecological corridors that transport water, wood, sediment, organic matter, and nutrients downstream where they influence freshwater, estuarine, bay and nearshore systems. Large woody debris, derived from riparian forests, provides wildlife habitat within tributaries, estuaries, bays and dunes.

Freshwater tributaries originate in the forested terrain of coastal mountains. Their lower reaches flow through narrow valleys and across coastal plains to the Pacific Ocean. Tributaries draining into Humboldt Bay directly include Elk River and Salmon Creek (each with a watershed about 12 miles in length), Jacoby Creek, Freshwater Creek, and smaller urban creeks in Eureka and Arcata.

Humboldt Bay tributaries support some of the last viable[6] and evolutionarily significant units[7] of wild coho salmon in California as well as Chinook salmon, steelhead and cutthroat trout (Browne et al. 1994). The salmonid life cycle is intricately tied to water quality and quantity. Sedimentation, increased water temperature, biological and chemical pollution, migration barriers and poor quality habitats negatively affect various stages of the salmonid life cycle. Water quality impacts to salmonids (coho, Chinook, steelhead and cutthroat trout) occur during migration, spawning, reproduction and early development life stages. Spawning salmon require adequate flow and access in order to return to their natal streams, and they need clean gravels to spawn, for subsequent egg development, and for successful emergence as fry. Survival of juvenile salmonids requires intact complex habitat: pools, riffles, large woody debris and riparian vegetation to provide shelter and cool water temperatures. Coho salmon use tidal freshwater habitats in their first year and then redistribute to overwintering habitats. Smolts, which are young fish headed to the ocean from freshwater, require access to intact, unpolluted estuarine habitat to adjust to salinity prior to outmigration. Salmonids are important for a range of social, economic and cultural values. Healthy fish populations have traditionally supported subsistence, commercial and recreational fishing industries and have been an important component of both Native American and Euro-American social structure and economy.

Designated critical habitat for coho salmon (70 FR 52488) includes:

- juvenile summer and winter rearing in small headwater streams and side channels
- juvenile migration and adult migration corridors in headwater streams, side channels and mainstem reaches and estuarine zones
- growth and development to adulthood in near- and off-shore marine waters
- adult spawning habitat in headwaters and side channels

The major human drivers affecting freshwater tributaries are forestry, development and roads, sediment, invasive species and climate change.

Freshwater Tributaries Goals:

- By 2025, 80% of freshwater tributary substrates support salmon spawning, egg development, and juvenile rearing.
  - Indicator: Percent of gravel and cobble substrates embedded by <20% fine sediments
- By 2025, 80% of freshwater tributaries have riparian buffers of 50-100 feet on both sides of the channel.
  - Indicator: diameter and length of large woody debris, pieces/mile

[6] Viable salmon population: a viable salmonid population is defined as an independent population of any Pacific salmonid genus (genus *Oncorhynchus*) that has negligible risk of extinction due to threats from demographic, local environmental variation, and genetic diversity changes over a ten year time frame (McElhany P, M.H. Ruckelshaus, M.J. Ford, T. C. Wainwrigktt and E. P. Bjorkstedt. 2000 Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. NOAA Technical Memorandum NMFS-NWFSC-42. 174 p.)

[7] Evolutionarily significant unit (ESU): It must be reproductively isolated from other conspecific population units, and it must represent an important component in the evolutionary legacy of the species. (McElhany P, M.H. Ruckelshaus, M.J. Ford, T. C. Wainwrigktt and E. P. Bjorkstedt. 2000 Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. NOAA Technical Memorandum NMFS-NWFSC-42. 174 p.)

- By 2025, 80% of salmonid habitat supports viable populations of coho and Chinook salmon, and steelhead.
    - Indicator: catch per unit effort from California Department of Fish and Game annual sampling programs

Coastal Plains

Coastal plains are low elevation, flat or rolling terraces. The coastal plain is largely managed for agriculture, recreation, cultural uses and other activities associated with human communities. Nearly all urbanized areas occur in the coastal plains. Outside developed areas, the coastal plain is primarily grazed grass pasture, protected from tidal inundation by a system of levees. Public and private wetlands provide habitat for a variety of migratory and resident birds and fishes as well as amphibians, mammals, invertebrates and plants. Nearly the entire world population of Aleutian cackling geese has used this habitat from December through March since 2002. Much of the coastal plain is seasonally inundated by rainwater and freshwater runoff.

The coastal plain is the most complex and challenging target because of intense interactions between agriculture, habitat restoration, intersecting wetland types, sea level rise and urban areas. Coastal plains are key to transportation, energy production and food resources for humans. While it may be a relatively small area, it is critical for us to understand the processes and interactions in this target (Tally et al. 2003).

Much of the coastal plain bordering freshwater tributaries, estuaries, Humboldt Bay and the Eel River estuary were formerly tidal marsh. In Humboldt Bay and the Eel River estuary, approximately 90% of the historic tidal marsh was diked and drained for agricultural over 100 years ago. What was once a tidally driven system characterized by a salt-brackish-freshwater continuum of marshes is today a highly fragmented modified system of fresh, seasonally inundated agricultural wetlands.

Sloughs and creeks were rerouted and channelized, with significant impacts to hydrology, sedimentation and topography. Some sloughs and tributaries crossing the coastal plain, such as Salmon Creek in South Humboldt Bay, and Roper Slough in the Eel River estuary, support well developed riparian corridors, but most have little forest remaining on channel banks. Because of the combination of upstream culverts, roads and woodcutting, there is a very small amount of large woody debris found on the coastal plain.

The major human factors affecting coastal plains are agriculture, development, invasive species, polluted urban runoff, sea level rise, salt water intrusion and an increase in severity and frequency of flooding. All have the potential to alter ecosystem dynamics and impact human communities. Shoreline infrastructure is threatened over the next decades.

<u>Coastal Plains Goals</u>:

- By 2020, restored connectivity between coastal plain and estuarine habitats is sufficient to allow for sea level rise without harming human communities.
    - Indicator: Number of parcels inundated by sea level rise
- By 2025, restored former tidelands in priority areas will support healthy native biotic communities.

- Indicator: percent native biota in restored areas
- By 2025, 80% of restored tidal channels have riparian buffers of 20 feet on both sides
  - Indicator: miles of riparian cover
- By 2025, urban runoff pollution is reduced by 80% for pollutants of concern
  - Indicator: water samples taken in tributaries during annual First Flush monitoring

Estuaries

This target includes two large estuarine systems: the Mad River estuary (to the north of Humboldt Bay) and the Eel River estuary (to the south of Humboldt Bay). Humboldt Bay estuaries are included in the Humboldt Bay target.

Estuaries are unique transitional ecosystems where ocean waters meet streams flowing off the land. These complex, dynamic, productive systems are significantly different from the nearshore marine and bay tributary systems. The Mad River and Eel River estuaries include estuarine waters, tidelands, tidal marshes and submerged habitats. Estuarine influence generally extends upstream to the head of the tide. The physical habitat is dynamic, moving and varying in size with the tide and season. For example, salinity gradients suitable for salmonids and other species are farther inland during summer and fall than during winter and spring. The biotic habitats of tidal marshes, eelgrass beds and others are also dynamic, highlighting the essential connectivity of physical and biotic estuarine components.

The winding channels and overhanging vegetation of estuaries provide a wide diversity of fish and wildlife species with a food-rich environment and refuge from predators. Estuaries provide critical habitat for salmonids; brackish water allows salmonids to make the physiological transition between fresh and marine environments. Local studies have shown that juvenile salmonids, especially young-of-the-year (YOY = fish less than one year old), rear in the tidal freshwater portions of tributaries and tidal sloughs throughout the summer (Wallace 2006, 2008; Wallace and Allen 2007). Some coho continue to rear in the estuarine/freshwater interface over winter, bringing their total time in the estuary to eight months. In winter, the coho move off the main stream channel to low velocity habitats such as Martin Slough or Wood Creek. Tidal meanders, dead end sloughs, salt marshes, non-natal streams and golf course ponds are used by coho during winter months in the Humboldt Bay ecosystem. YOY coho reared in estuarine habitats grow larger than cohorts reared in streams. Larger size of juvenile salmon at the time they enter the ocean results in increased ocean survival rates (Solazzi et al. 1991). Estuaries are also important for adult salmon, providing a necessary transition zone before they begin their upstream migration to reproduce.

<u>Designated critical habitat for Northern California Steelhead and Central California (Chinook salmon includes:</u> (70 FR 52488)

> Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Intertidal and subtidal vegetated habitats are unique components of the estuarine landscape. They provide many vital roles to ecologically and economically important fishes and crustaceans as well as large shorebird, waterfowl and waterbird populations. In many studies, fish were more than twice as abundant and larger in intertidal marshes adjacent to eelgrass beds (Irlandi and Crawford 1997, Demers et al. 2000), demonstrating important linkages between these estuarine habitats. Both the maintenance of complex, heterogeneous habitats and the distribution of those habitats are vital to healthy and productive estuarine ecosystems.

The major human drivers affecting estuaries are excessive sediment, habitat loss and degradation from development, invasive species and sea level rise.

Estuaries Goals:

- By 2025, 60% of salmonid habitat supports viable populations of coho and Chinook salmon and steelhead
  - Indicator: CDFG annual salmonid sampling
- By 2025, All estuarine tidal marsh communities support native flora
  - Indicator: percent tidal marsh with cordgrass present

Humboldt Bay

Humboldt Bay includes the bay surface area at high tide, bay islands and estuarine habitats at the mouth of watershed tributaries. Humboldt Bay is dominated by marine influences of the California Current Large Marine Ecosystem (LME). Freshwater input is limited and seasonally variable. Tidal flushing is the dominant physical process affecting the bay. Humboldt Bay is 14 miles long and from 0.5 to 3.5 miles wide, with a water surface area of 25 square miles at high tide and 8 square miles at low tide. The bay is located at the seaward edge of several stream valleys, bounded to the east by coastal plains and to the west by sand spits. A central deepwater navigation channel connects North and South Bays.

Humboldt Bay supports over 110 species of fishes (Fritzsche and Cavanagh 1995), 260 species of birds and 300 intertidal invertebrates (Barnhart et al. 1992) and 200 subtidal invertebrates (Bott and Diebel 1982). The extensive intertidal flats of Humboldt Bay and other soft substrate habitats are characterized by a high biodiversity. Abundant organic matter from adjacent marshes and eelgrass meadows support rich benthic communities. Tens of thousands of shorebirds, waterfowl and water birds use the intertidal flats around Humboldt Bay for foraging, resting and roosting. Humboldt Bay eelgrass beds provide habitat and food for 60% of the world's Pacific brant goose population.

Humboldt Bay contains both estuarine and freshwater wetlands including salt marshes, vast intertidal flats, eelgrass beds and adjacent soft bottom subtidal habitats. Intertidal habitats, which are characterized by gradual slopes and sandy or muddy substrate, comprise over 65% of the total bay surface area. They provide habitat for animals that depend on detritus based food webs. The intertidal areas that are the dominant habitat in Humboldt Bay are considered a key migratory staging, roosting and refueling area for migrating and wintering shorebirds of the Pacific Flyway. Over 100,000 shorebirds, representing approximately 30 species, use Humboldt Bay as an overwintering area and migration stopover site.

Large eelgrass beds are extensive in North and South Bay and fringing eelgrass beds about 20 to 40 feet in width are found along the navigation channel. Eelgrass beds are a source of food for brant geese and a refuge for mobile animals such as crabs, small fishes, salmon and marine mammals. Eelgrass beds are essential spawning habitat for herring; in turn, larval and juvenile herring are likely important prey for outmigrating juvenile salmonids. Most of the bottom of Humboldt Bay consists of soft sediments, ranging from coarse sands near the entrance to fine silts and clays. Communities of sediment dwelling animals vary according to sediment type, water depth and location around the bay.

Humboldt Bay is designated as an International site in the Western Hemisphere Shorebird Reserve Network and an Important Bird Area (IBA) by the American Bird Conservancy. The bay is a site in two North American monitoring projects: International Shorebird Survey and the Pacific Flyway Project. These projects assess trends in shorebird populations and gauge the relative importance of wetland complexes to non-breeding shorebird populations. Humboldt Bay is one of 58 important North American sites for shorebirds.

Humboldt Bay contains Primary Constituent Elements[8] of federally listed salmon habitat since it provides migratory and rearing habitat connectivity for juveniles and adults between high value freshwater spawning and rearing habitat and the ocean rearing and maturation habitat (70 FR 52488). This includes accessible reaches of all rivers (including estuarine areas and tributaries).

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The major human factors affecting Humboldt Bay are climate change, invasive species, sediment, polluted runoff and oil spills.

Humboldt Bay Goals:

- By 2025, eelgrass distribution and plant density in Humboldt Bay remain within 20% of 2001 -2006 levels
  - Indicator: eelgrass acreage, plant density (# shoots/m^2)
- By 2025, shoreline habitats supporting native plant and animal communities increases by 20%.
  - Indicator: percent invasive species in monitored areas

Beaches and Dunes

Beaches and dunes occur along the coastline of most of the study region, interspersed in some spots by rocky intertidal areas. Winter storms flush sand from coastal rivers to the ocean, where

[8] Primary constituent elements (PCE): those sites and habitat components that support one or more life stages of coho salmon, Chinook salmon, and steelhead (Federal Register (FR). 2005. Endangered and threatened species; designation of critical habitat for seven evolutionary significant units of Pacific salmon and steelhead in California; Final Rule. Federal Register, vol. 70, No. 170, September 2, 2005, p. 52488.)

it is transported by ocean currents along the coast and pushed onto the beach by gentle summer waves. Dune systems develop along shorelines perpendicular to the prevailing winds. Active dunes are nearly bare because constant shifting of sand precludes vegetation establishment. The sand is constantly shifted by northwesterly summer winds. Some of the dune habitats in this area are among the most pristine and rare in the world.

On the beach, shorebirds feed on small invertebrates that live in the sand and on seaweed that has washed onshore. At the upper end of waveslope, inundated only at the highest tides, is the beach strand, where a few colonizer plant species establish. Foredunes are vegetated ridges paralleling the beach. Dune hollows contain wetlands that form in the troughs between dunes, where sand has eroded below the water table and seasonal ponds form. Dune hollows provide a water source for wildlife, and they support wetland plants and amphibians including the Pacific tree frog and red-legged frog. Willow thickets and eventually dune forests may develop in the hollows. Older stabilized dunes contain forests of beach pine, Sitka spruce and grand fir. The dunes ecosystem has been recognized for its unique insects, including numerous beetles, grasshoppers, thatch ants, over 40 species of bees and jumping spiders. The dune ecosystem also has a very rich diversity of bird species. The relatively small extent of dune habitats in the Humboldt Bay area provides habitat for approximately the same number of bird species, as does the entire Klamath Basin. Mammals that use the dunes include gray fox, skunk and raccoon. Dunes and their associated plant communities are also recognized for their capacity to protect coastal communities, agriculture operations, and other infrastructure from ocean waves and tsunamis.

The dune mat community provides habitat for two federally listed plant species, the Humboldt Bay wallflower and beach layia. The Pacific coast population of the western snowy plover nests on foredunes in the project area and is a threatened species under the federal Endangered Species Act and is listed by the California Department of Fish and Game as a "species of special concern."

The major human factors affecting beaches and dunes are invasive species, climate change, oil spills and sediment. The U.S. Army Corps of Engineers (2007) is concerned about the long-term stability of the jetties at the bay entrance and is monitoring sand movement on beaches north and south of the entrance.

Beaches and Dunes Goal:

- By 2020, 80% of monitored dune habitats support healthy native plant and animal communities.
    - Indicator: Percent invasive species in monitored areas

Nearshore Marine

The nearshore marine target extends west to 700 fathoms depth. This zone includes vast submarine canyons, large areas of soft bottom continental shelf, rocky reefs, off shore coastal rocks, abundant fishery resources and spawning and nursery grounds for deepwater fish. The nearshore marine target encompasses Trinidad Bay, Coastal National Monuments and fishing grounds on the continental shelf.

Characteristics such as depth, bottom type, gradient and the interaction between the open sea and the seafloor (benthos) control the distribution of plants and animals in the nearshore marine ecosystem. The ecosystem supports top level predators (e.g., whales, sea birds, adult salmon, rockfish and sea lions) as well as their prey (e.g., herring, anchovy, crabs, snails and small birds).

The nearshore marine target is part of the 2000 mile long California Current Large Marine Ecosystem (CCLME) which extends from the northern tip of Vancouver Island to Punta Eugenia in Baja California (Duda and Sherman 2002). Major physical oceanographic processes linked to atmospheric circulation and oceanic currents determine the CCLME ecosystem. At a local level, coastal upwelling, nearshore currents, and river outflows influence the productivity of the nearshore marine system.

Rocky shores, offshore rocks and nearshore marine habitats provide fragile breeding and rich feeding grounds for seabirds and pinnipeds. Most of these species are top level predators that subsist almost entirely on fish or other vertebrates. Northern elephant seals and harbor seals breed on the rocky shores; California and stellar sea lions are common throughout the area. The offshore rocks of the Coastal National Monument system are structurally diverse and include deep topsoil, vegetated terraces, sheer rock cliffs, protected sand beaches and reef habitat. The rocks support breeding habitat for common murre; Brandt's, pelagic and double-crested cormorants; western gull; fork-tailed and Leach's storm petrel; Cassin's and rhinoceros auklet; pigeon guillemot; tufted puffin and black oyster catchers. Brown pelicans gather in non-breeding, communal roosts. Offshore rocks offer an ideal location to document trophic interactions between prey fish species and predator birds, and to assess breeding and fledgling success. Seabirds and marine mammals may well prove to be some of the best species for monitoring and assessing changes to the ocean food webs brought on by climate change and/or other anthropogenic causes.

Groundfish and pink shrimp trawl fisheries occur from the three-mile state waters limit out to the edge of the continental shelf at approximately 700 fathoms. Trap fishing for black cod and coonstripe shrimp and mid-water trawling for hake generally occurs at depths of 400 to 700 fathoms. The trap fishery for Dungeness crab takes place between the beach and 100 fathoms. The albacore fishery occurs at the interface of warm and cold surface water and varies in location each year from a few miles off the beach to over a hundred miles offshore. Salmon fishing, when it is permitted, occurs from the beach to about 20 miles offshore. Trinidad Bay is important for crab, salmon, rockfish and recreational fisheries. Currently, multiple agencies at both the state and federal level manage and regulate the human activities affecting fish.

The human factors affecting the nearshore marine habitats are primarily associated with climate change, including changes to ocean temperature, acidity and unknown changes to ocean currents, upwelling patterns and nutrient cycles. It is possible our section of coast will experience stronger winds and increased stratification. The section of coast between Trinidad Head and Cape Mendocino is geographically situated west of the northern end of California's Central Valley. Our seawater and air temperatures have been anomalously low for the past few years because of increased winds and upwelling (PaCOOS 2008-2009, California Climate Tracker website http://www.wrcc.dri.edu/monitor/cal-mon/index.html). Ocean energy development from wave

and wind farms and establishment of marine protected areas are human use changes expected over the next ten years.

Nearshore Marine Goal:

- By 2025, nearshore marine productivity patterns and trends support marine bird, mammal and fish populations
    - Indicators: copepod abundance, sea bird prey composition, fledgling success of common murre and Cassin's auklet.

Goals Summary

Goals for targets are linked throughout the Humboldt Bay Ecosystem. We summarize our goals by beginning in the forests at the top of the watershed and working our way to the beach. HBI goals strive to improve hydrologic function of the forest through integrated management of roads, increasing riparian corridors, and supporting community dialog on long-term forest management goals. With less sediment entering freshwater tributaries from the forest and established riparian reserves providing large woody debris, salmonid habitat will improve in abundance and quality. In the coastal plain, physical restoration is needed to increase connectivity between freshwater, estuarine and bay habitats; biological restoration (e.g., riparian planting on restored tidal channels) is needed in some locations. Sustainable development practices are needed to reduce urban runoff pollution, and maintain or restore natural hydrologic functions. Reducing sediment inputs through increased tidal wetland habitats will improve drainage on lands adjacent to estuaries and the bay and will improve habitat for fish, birds and other wildlife. In estuaries, dunes, and Humboldt Bay, removal of invasive species, along with restoration of shoreline habitats will reduce turbidity and increase habitat for fish and wildlife. Finally, in the nearshore marine environment, monitoring productivity using marine birds and monthly sampling of plankton and physical ocean factors will identify trends in the nearshore marine environment, and provide a better understanding of climate change impacts to marine birds and fishes, and increase understanding of fish recruitment in Humboldt Bay. Targets, goals, indicators and methodologies are described in Table 4.

Table 4. Targets, Goals and Indicators

PROJECT GOALS				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
TARGET: FORESTS				
Goal FOR-1: By 2025, hydrological function of the Humboldt Bay forest ecosystem are not degraded				
Road density	Aerial images, GIS	2012, and every three years	HBI Forest Work Group	Use existing map and aerial image resources of Humboldt County, Google Earth, and California Dept. of Fish and Game
TARGET: FRESHWATER TRIBUTARIES				
Goal FWT-1: By 2025, 80% of freshwater tributary substrates support salmon spawning, egg development and juvenile rearing.				
Gravel and cobble stream habitats are embedded by <20% fine sediments	Review and analyze California Department of Fish and Game Reports	Baseline (2005-2008) and every year	HBI Forest Work Group	California Department of Fish and Game Anadromous Fishery Resource Assessment Monitoring Program samples Humboldt Bay tributaries annually.
Goal FWT-2: By 2025, 80% of freshwater tributaries have riparian buffers of 50-100 feet on both sides of channel.				
Diameter and length of large woody debris per stream mile	Review and analyze California Department of Fish and Game Reports	Baseline (2005-2008) and every year	HBI Forest Work Group	California Department of Fish and Game Anadromous Fishery Resource Assessment Monitoring Program samples Humboldt Bay tributaries annually.
Goal FWT-3: By 2025, 80% of salmonid habitat supports viable populations of coho, Chinook, and steelhead.				
Catch per unit effort (seines and traps)	Review and analyze California Department of Fish and Game Reports	Baseline (2005-2008) and every year	HBI Forest Work Group	California Department of Fish and Game Anadromous Fishery Resource Assessment Monitoring Program samples Humboldt Bay tributaries annually.
Goal FWT-4: By 2025, urban runoff pollution is reduced by 80% for pollutants of concern				
Urban runoff water samples	Review annual First Flush Reports	2010 and every year	North Coast Stormwater Coalition	The North Coast Stormwater Coalition and Humboldt Baykeeper have conducted First Flush sampling annually since 2006.
TARGET: COASTAL PLAINS				
Goal CP-1: By 2025, 80% of tidal marsh channels have riparian buffers of 20 feet on both sides				
Miles of riparian buffer	Aerial images, GIS	2012, and every three years	HBI Climate Change Work Group	Use existing map and aerial image resources of Humboldt County, City of Eureka, City of Arcata, USFWS, NOAA Fisheries, California Sea Grant, Google Earth, and California Dept. of Fish and Game

PROJECT GOALS				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Goal CP-2: By 2025, hydrologic connectivity between estuaries and bays and coastal plain supports native biota.				
Acres restored salt marsh on former tidelands	Review permit records and project evaluations and personal contacts	Baseline (restored acres in 2009) and every 3 years	HBI Climate Change Work Group and HBI Invasive Species Work Group	The HBI Climate Change and HBI Invasive Species Work Groups include many individual and organizations that conduct estuarine restoration projects in the project area. Their knowledge of projects in addition to public records will be used to track this indicator.
TARGET: ESTUARIES				
Goal EST-1: By 2025, 60% of salmonid habitat supports viable populations of coho				
Catch per unit effort spring sampling	Review and analyze CDFG reports	Annual	S. Schlosser	The Natural Stocks Assessment Program of CDFG samples juvenile coho salmon annually in Humboldt Bay tributaries. The data is publicly available as are the annual reports.
Goal EST-2: By 2025, cordgrass is eliminated from tidal marsh communities				
Percent tidal marsh dominated by native plant species	Aerial images, remote sensing, some field surveys	2010 and every 3 years	HBI Invasive Species Work Group	The USFWS has a protocol for this indicator for intertidal lands they manage in the Humboldt Bay National Wildlife Refuge. We will use USFWS methodology for other areas monitored by HBI.
TARGET: HUMBOLDT BAY				
Goal HB-1: By 2025, eelgrass distribution and plant density in Humboldt Bay remains within 20% of 2001-2006 levels				
Acres of eelgrass, number of shoots/m^2	Seagrass Net Program results will be synthesized, aerial images analyzed for distribution	Plant density, annual eelgrass distribution, every 5 years	S. Schlosser	Humboldt Bay was established as a Seagrass Net site in 2007. The Humboldt Bay Harbor District conducts sampling by a defined protocol. Baseline information is available from the Humboldt Bay Cooperative Eelgrass Projects, which sampled between 2001 and 2006.
Goal HB-2: By 2025, intertidal habitats supporting native plant and animal communities increases by 20%.				
Acres of coastal habitat restored	Review permit records and project evaluations and personal contacts	Baseline (restored acres in 2009) and every 3 years	HBI Climate Change Work Group and HBI Invasive Species Workgroup	The HBI Climate Change and Invasive Species Work Groups includes many individual and organizations that conduct estuarine restoration projects in the project area. Their knowledge of projects in addition to public records will be used to track this indicator.

PROJECT GOALS				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Goal HB-3: By 2025, Humboldt Bay subtidal habitats support resident and migratory biota				
Annual YOY rockfish sampling by Sea Grant	Review and analyze annual reports prepared by California Sea Grant	Baseline and trends (2001-2008) and annual	S. Schlosser	The California Sea Grant Marine Advisory Program in Eureka has conducted annual juvenile fish trapping in Humboldt Bay subtidal habitats since 2001.
TARGET: BEACHES AND DUNES				
Goal BD-1: By 2025, 80% of dune habitat supports native plant and animal communities				
western snowy plover – fledgling survival	Review USFWS annual reports	Baseline and trends (2000 – 2008) and annual	HBI Work Group	USFWS conducts annual surveys of western snowy plover nesting and fledgling success along Humboldt County Beaches. This data and published papers will be used to track western snowy plover population and fledgling success.
% maintained sites dominated by native plant species	Review reports of Friends of the Dunes and USFWS	Every three years	HBI Invasive Species Workgroup	A local non-profit, the Friends of the Dunes and the USFWS conduct mapping and surveys of dune vegetation and restored areas every three – five years.
TARGET: NEARSHORE MARINE				
Goal NM-1: By 2025, nearshore marine productivity supports marine bird and fish populations				
Copepod abundance	Review PaCOOS reports	Quarterly	HBI Work Group	PaCOOS conducts monthly cruises off Trinidad and produces quarterly reports.
Sea bird prey composition	Review PaCOOS reports	Quarterly	HBI Work Group	PaCOOS conducts monthly cruises off Trinidad and produces quarterly reports
Fledgling success of common murre and Cassin's auklet	Review USFWS Castle Rock annual reports	Annual	HBI Work Group	The USFWS monitors Castle Rock with a video camera and prepares annual reports of this indicator.

1C. Critical Human Drivers

The human element in the ecosystem is addressed through human drivers. Drivers are natural or human-induced factors that directly or indirectly cause a change in the ecosystem

Human Drivers (Direct Threats)

As noted above, the Open Standards for the Practice of Conservation define a direct threat as: A human action that immediately degrades one or more conservation targets. We prefer to use the terminology human drivers. We feel that this language is more appropriate and does not imply that humans, in and of themselves, are threats. For example, forestry, agriculture, and fisheries are human drivers that affect ecosystems—including many benefits and also sources of stress. In communicating with project partners, we want to be clear that our work strives to achieve conservation within a context that sees humans as part of the ecosystem and recognizes their need to maintain a high quality of life, including maintenance of viable and sustainable livelihoods.

With this in mind, we identified and prioritized 22 human drivers that directly affect one or more of our targets. We rated the factors using three criteria: scope of the area or population affected, severity of the impacts on the area or population affected, and the degree to which the impacts could be undone if the human driver were to cease (irreversibility). Human drivers that ranked very high, high, or medium are shown in Table 5. For these high priority human drivers, a suite of proposed interventions (strategies) were developed that can be effectively implemented in the near future. In the following section, each of the high priority human drivers is described and then proposed strategic actions are presented.

Table 5. Human Drivers (Direct Threats) Rating Summary.

Targets are listed across the top of the table and human factors on the left. Blank cells in the table indicate a human driver is not a priority impact to its corresponding target. For example, shoreline infrastructure is not a factor affecting Beaches and Dunes.

The right hand column "Summary Threat Rating" indicates the rating for each human factor in all targets. For example, climate change has a very high overall threat rating and shoreline infrastructure has on overall medium threat rating. The bottom row "Target Threat Rating" shows the overall rating of each target across all Human Drivers. For example, Beaches, Coastal Plains, and Estuaries are highly threatened when all threats to each target are considered. Humboldt Bay and Freshwater Tributaries are very highly threatened.

⇒Targets⇒ ⇓Human Drivers⇓	Forests	Freshwater Tributaries	Coastal Plains	Estuaries	Humboldt Bay	Beaches & Dunes	Nearshore Marine		Summary Threat Rating
1. Climate Change	Medium	High	Medium	High	Very High	Very High	Very High		Very High
2. Invasive Species		Very High	Low	High	High	High			Very High
3. Sediment		High		High	High				High
4. Roads	Medium	High			High				High
5. Development	High	Medium	Very High	Low	Low	Low			High
6. Shoreline Infrastructure		Low		High	Medium				Medium
7. Forestry	Medium	High							Medium
8. Urban Runoff		Low	Medium		Medium		Low		Medium
9. Oil Spills		Low		Medium	High	Medium	Medium		Medium
Target Threat Level	Medium	Very High	High	High	Very High	High	High		

1. Climate Change

The project team ranked climate change as a very high threat that affects all targets and the entire project scope. A strong scientific consensus exists that anthropogenic warming is occurring and that mitigation and adaptation strategies are needed. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Bates et al. 2008) established with 90% confidence the anthropogenic warming influence on climate. Locally, while public awareness of the impacts of climate change on the targets is rising, important questions about both the impacts of and ways to address climate change remain.

In the past few years, it has become clearer that global climate change has the potential for irreversible deleterious effects. At the state level, two Executive Orders direct state agencies to "report on mitigation and adaptation to combat the impacts of climate change" (Executive Order S-3_05 June 1, 2005) and to plan for sea-level rise and climate impacts (Executive Order S-13-08, Nov. 14, 2008). State legislation, AB 32, contains quantified CO_2 emission reduction goals. State and local governments are actively addressing climate change by developing detailed elevation maps of the shoreline, CO_2 emission reduction targets, and adaptation plans for coastal communities. Climate change is expected to impact coastal communities through:

- Sea level rise damage to coastal infrastructure
- Saltwater intrusion to freshwater sources including near coast aquifers
- Higher storm surges and more frequent flood events
- Increased erosion
- Ocean acidification, the impacts of which we are only beginning to understand but which may threaten entire groups of marine life and ecosystems
- Patterns and timing of upwelling and subsequent predator/prey interactions

Accelerated sea level rise resulting from climate change is the greatest concern, although the severity of the threat to the Humboldt Bay Ecosystem cannot be precisely predicted. In California, sea level rise has been six to eight inches over the past century (Caldwell and Segall 2007). In addition to the relatively small steady impacts, sea levels along the California coast are expected to undergo more variability above or below historic tide levels because sea level rise will coincide with intensified climactic cycles such as the El Nino Southern Oscillation, La Nina and the Pacific Decadal Oscillation (Cayan et al. 2006).

Major impacts from sea level rise include inundation of coastal property, loss of terrestrial and aquatic habitats, saltwater intrusion and an increase in the frequency and severity of flooding events. Sea level rise directly threatens agricultural lands, public lands, urban waterfronts and parks. Other effects associated with climate change will alter patterns of sedimentation, turbidity, currents and wave energy. These factors will alter ecosystem functions and shift or reduce the distribution of some habitats, native species and land uses. For example, salt marshes and eelgrass habitat will be at risk because changes in water temperature, salinity and depth will alter the mix of plant and animal species able to survive in a given location. Remaining salt marshes may not survive inundation as altered shorelines prevent their inland migration. Foraging habitat of wintering and migratory shorebirds may be reduced as sea level inundates intertidal foraging areas (Galbraith et al. 2002). Changes in groundwater elevations may impact coastal agriculture.

Sea level rise is an enormously complex public policy issue (Caldwell and Segall 2007). Reducing our vulnerability to sea level changes, and climate change generally depends on our ability not only to understand climate science, but also to integrate and use that knowledge effectively in management and policy. Successful mitigation of climate change will require changes in our economy, infrastructure, government policies and individual actions.

Climate change impacts on salmonids will vary by watershed. Lower summer flows, increasing air and stream temperatures and increasing peak winter flows are expected to negatively impact salmon production. Locally, low summer flows had dire consequences for salmon in 2001 in the Klamath River and in 2008 in the Mattole River. Warmer ocean temperatures may affect ocean migration by diverting fish northward. This could dramatically alter commercial fisheries. Fisheries management will require strategic actions that take advantage of population surpluses in some fisheries and declines in others.

It is likely that climate change will result in a change in the intensity and direction of surface winds and upwelling patterns in the nearshore marine environment. In fact, Snyder et al. (2003) found a delayed timing of the onset of upwelling winds off northern California and southern Oregon coasts. Upwelling patterns influence the abundances, distribution and timing of major prey sources. Consequently, marine mammals will be indirectly affected by climate change. Marine birds such as common murres have reduced breeding success and limited population increases during El Nino years, when ocean temperatures are warmer than normal. Seabirds, marine mammals and other animals lower on the food web may be impacted by climate change in terms of abundance, distribution and the availability of prey sources.

2. Invasive Species[9]

Human commerce, trade and travel over the past two centuries have resulted in both intentional and inadvertent movement of species worldwide. Many non-native species introductions are benign, but some, due to aggressive traits, favorable environmental conditions, and/or a lack of predators, become a serious problem. Known as invasive species, these non-native organisms have the ability to cause serious economic and/or environmental harm.

Invasive species imperil ecosystems around the world. Highly damaging invasive species are found in freshwater, estuarine, bay and dune habitats. They are high priority issues in the strategic and action plans of both the Ocean Protection Council (California Resources Agency and California Environmental Protection Agency 2004) and West Coast Governors Agreement on Ocean Health (Washington, Oregon, and California 2008). California and the federal government have Invasive Species Management Plans (California Department of Food and Agriculture and California Invasive Weed Awareness Coalition 2005, California Resources Agency and California Department of Fish and Game 2008; National Invasive Species Council 2008).

[9] Invasive species: species alien to a particular ecosystem whose introduction does or is likely to cause economic or environmental harm or to harm human health (Executive Order 13112, 2/2/99).

The threat from invasive species is expected to increase significantly due to climate change. Invasive species from warmer regions will likely expand their ranges to include the Humboldt Bay Ecosystem. Existing natural communities will be severely disrupted by sea level rise and more frequent fire. These disturbances could create conditions allowing invasive species to greatly increase their range.

We do not fully understand all of the pathways by which new species invade or how to prevent new invasions. When new invasions do occur, they often go undetected for long periods. When detected, they may go untreated because we underestimate the threats that they pose or because we are unprepared to respond. Non-native species are too numerous and too well established in our ecosystems to eradicate them all. We need a mechanism for prioritizing which species are of concern and for determining a course of action to address those species.

Invasive species are both an ecological and economic management problem. Loss of ecosystem services due to invasive species can either be immediate and disastrous or incremental over time. Impacts include reduced biodiversity and alterations in ecological processes such as nutrient cycling and natural disturbance patterns. Socio-economic losses associated with invasive species are incurred in agriculture, forestry, fisheries, commerce, and human health (Convention on Biological Diversity 2009). Over $82 million per year is spent in California for monitoring, control and outreach pertaining to invasive plants alone, with estimates of actual impacts costing billions of dollars (California Invasive Plant Council and Sustainable Conservation 2008).

Prevention and early detection are the most cost effective methods of controlling invasive species. Two studies on invasive weeds in Oregon showed early detections, control and eradication yielded cost to benefit ratios of 1:17 and 1:34, respectively (U.S. Congressional Office of Technology Assessment 1993, Oregon Department of Agriculture 2000). This means a potential savings of $17 or $34 for every $1 invested in early detection programs. Eradication is not the end of invasive species control. Routine monitoring is also required.

3. Sediment

Sediment is the primary stress linked to land use practices in the Humboldt Bay Ecosystem. Erosion and deposition are natural processes that occur throughout terrestrial and aquatic ecosystems. However, excessive sediment causes problems in all aquatic targets. These processes continually modify stream habitat, intertidal and subtidal bay features, the nearshore seafloor, and—most significantly—contribute to the total suspended solid (TSS)[10] load of Humboldt Bay waters. In the Humboldt Bay system, significant sediment supplies are believed to come not only from freshwater tributaries of the bay, but also via marine transport, from other watersheds between Trinidad Head and Cape Mendocino—especially the Mad and Eel Rivers.

Excess sediment loads and concentrations have impaired water quality throughout the Humboldt Bay watershed. Although we do not fully understand how watershed sediment loads affect Humboldt Bay's ecological attributes such as eelgrass distribution and productivity, shellfish

[10] Total suspended solids: all particulate matter suspended in the water column (US EPA 1999 Guidance Manual, Turbidity Provisions, Chapter 7. http://epa.gov/ogwdw/mdbp/pdf)

production or fish survival, we do know that excess sediment has negatively impacted designated salmonid habitat. The major tributaries to Humboldt Bay (i.e. Freshwater Creek, Elk River) have been listed as sediment impaired under Section 303(d) of the Clean Water Act by the North Coast Regional Water Quality Control Board (2001).

Human activities have substantially altered natural sediment transport processes within the Humboldt Bay ecosystem. Timber harvest, land development and road construction strip vegetation and expose watershed soils, which causes accelerated erosion. Sediment is released in volumes much larger than from unaltered land. If the cleared land is covered with roads, buildings and other impervious surfaces, increased runoff of water increases sediment transport. Straightening a channel and removing meanders may lead to streambed erosion or incision that migrates up through the channel and creates sediment problems downstream. Constructing dikes and levees that isolate channels from their floodplains also interferes with natural sediment transport. Dikes and levees prevent sediment from being deposited on floodplains, as well as increasing erosion during peak flows by preventing floodwaters from dissipating their energy on the floodplain.

Accelerated sediment delivery to tributaries and estuaries reduces the quality of aquatic habitat. When fine sediments are suspended in the water column, the turbidity[11] of the water increases and water clarity, the apparent contrast between objects and the background, is reduced. This limits the growth of aquatic plants and the visibility and successful capture of prey by visual predators. High loads of suspended sediment potentially clogs the gills of fish in freshwater, estuarine and marine waters. Deposition of sediment in aquatic habitats can smother benthic habitats and spawning substrates. Increased concentrations of suspended sediments not only adversely affect animals, but they also attenuate light and can cause the collapse of seagrass and algal primary producers. Seagrasses, such as the eelgrass in Humboldt Bay, are considered critical fish habitat and are particularly vulnerable to the loss of light caused by suspended sediments or nutrient loading. In Humboldt Bay, the primary cause of light attenuation appears to be suspended sediments. Re-suspension of fine particles occurs from reworking of sediment during rapid filling at low tide or during strong winds, resulting in high turbidity (Shaughnessy et al. 2007).

Stream, estuarine, bay and nearshore marine water quality is directly influenced by wetland ecosystem functions in the coastal plain. Floodplain wetlands, ponds and backwater habitats reduce the amount of water that flows downstream, spread water over a large surface area, and attenuate flooding. Some sediment deposition can be beneficial to agricultural areas because it adds soil and nutrients, but excessive sedimentation is detrimental because it impedes floodwater drainage.

Coastal structures such as the Humboldt Bay jetties alter sediment transport along the coast. Harbor maintenance activities such as dredging and disposal practices modify transport patterns. Annual dredging of Humboldt Bay Federal navigation channels in March through May, as well

[11] Turbidity: Turbidity is a principal physical characteristic of water and is an expression of the optical properties that causes light to be scattered and absorbed by particles and molecules rather than transmitted in a straight lines through waters. It measures water clarity. Turbidity is caused by the suspended matter that interferes with water clarity (US EPA 1999 Guidance Manual, Turbidity Provisions, Chapter 7. http://epa.gov/ogwdw/mdbp/pdf).

as periodic (7-10 years) dredging around docks and marinas, suspends sediments and increases turbidity, thereby resulting in a localized decrease in water clarity in the water column (National Marine Fisheries Service 2007).

Sediments are the main reservoirs for contaminants in Humboldt Bay: pollutants such as phosphorous, heavy metals, and pathogens are often attached to soil particles. Pollutants come not only attached to sediments carried to the bay by freshwater tributaries, but in runoff from lands directly adjacent to the bay. Sediment contamination is a major environmental problem in U.S. coastal areas (U.S. Environmental Protection Agency 1997). The management of contaminated sediment is necessary to maintain healthy ecosystems. We intend to develop a strategy that addresses contaminated sediments in the second phase of the HBI adaptive management process.

Humboldt Bay is currently listed on the Clean Water Act 303(d) List for impairment by dioxin and polychlorobiphenols (PCB), expected to be primarily from historic land use practices. Control strategies for these contaminants are likely to include identification of historic sources of contaminants, source control of mobile contaminants from stormwater and contaminated sites, and an investigation of aerial deposition and sources within Humboldt Bay. While a results chain for these impairments is not contained in this proposal, Strategy D offers excellent tools to help lead toward recovery. Specifically the Humboldt Bay Initiative could help analyze and frame the dialog surrounding monitoring and assessment techniques that will ultimately inform control strategies. Additionally the sediment model will help point out locations where Humboldt Bay sediments are remobilized, if there is an overlap between in-bay contaminated sediment and areas of mobilization, and assist development of appropriate control strategies. Phase 2 of the Humboldt Bay Initiative may address these legacy contaminants.

4. Roads

A variety of road types occur throughout the project area, including improved and unimproved, public and private. Roads are essential infrastructure that link urban and rural areas, residences, businesses and communities locally and regionally. All roads create physical changes to the landscape, resulting in habitat fragmentation, migration barriers and altered hydrology. Vehicles using the roads pose threats to wildlife. Runoff from roads can be a significant non-point source of water pollution. Erosion from gravel and dirt road surfaces is a significant source of fine-grained sediment, which degrades water quality and is unhealthy for aquatic organisms. Debris washing from roads into streams alters natural disturbance regimes. Proper design and maintenance of roads can help alleviate many of these problems. Municipalities and counties are required to reduce urban runoff pollutants to meet strict water quality standards. Forest managers and public agencies are working to achieve cost-effective reduction of sediment delivery from roads by removing, maintaining, and upgrading roads. HBI will address this human driver by increasing community awareness of road related problems, delivering best available science and technology on road construction and maintenance, and providing alternatives.

5. Development

Development can degrade or destroy habitat, impair water quality and hydrologic function, and reduce biological productivity. In some cases, it can sever the corridors used by plants and animals for migration, dispersal and genetic exchange. Development directly affects forests, coastal plains and freshwater tributaries. For our purposes, development includes structures, septic systems, wells and landscaping. Roads and urban runoff are treated as separate human drivers. The impacts of development are due not only to the physical infrastructure itself, but also to the increased levels of human activity associated with the structures.

Low impact development (LID)[12], reducing runoff and other technologies can be used not only when converting agricultural or timber production land to other uses, but also during remodels or retrofits of existing infrastructure. HBI will contribute to the efforts of the statewide network of LID practitioners--California Stormwater Quality Association (CASQA)--to provide the best available technology and science information to homeowners, contractors, developers and others by developing an LID Center. HBI will also contribute to effectiveness research program at U.C. Davis, examining which LID technologies effectively remove specific pollutants from soils and runoff.

6. Shoreline Infrastructure

Shorelines and floodplains have been disproportionately affected by human activities: more than 90% of the intertidal marshes in Humboldt Bay and the Eel River Estuary have been modified to support agricultural and industrial uses. Shoreline infrastructure was initially constructed to reduce erosion, improve water access, and control tidal flows. It ranges from small docks and piers, which provide access to the water, to large levees and dykes, which protect land from flooding. The infrastructure continues to be extremely important for many sectors of the economy including agriculture, fishing, shipping, and recreational boating.

Infrastructure and associated maintenance activities have many effects on habitats and species of concern. Tidegates, culverts, bulkheads and dikes prevent recruitment of native sediment, alter water chemistry and channel morphology, eliminate shallow water habitat critical for juvenile salmonids and other fish, and reduce habitat complexity (Peterson 2003). Docks can fragment or eliminate eelgrass beds (Burdick and Short 1999, Eicher and Bivin 1995). Construction activities at and around inlets can impact fish recruitment rates by interfering with recirculation and behavioral cues that direct recruitment of larval fish into estuaries. Dredging to enlarge and deepen coastal ports can alter the salinity regime, changing the composition of phytoplankton and zooplankton, which are prey for young and adult fish (Kimmerer et al 1998, Kimmerer 2002). Indirect impacts from associated boating or shipping activities can also impair water quality (largely from chemicals associated with these activities), alter hydrology, degrade habitat, and disrupt migratory behavior. Currently, restoration efforts are underway which include removing some levees and dikes, replacing tidegates with fish friendly versions and reevaluating channel maintenance activities.

[12] LID – Low Impact Development technologies aim to maintain the natural flow of water through watersheds and reduce polluted water runoff (WA OR CA 2008).

As sea level rises, areas protected by shoreline infrastructure will need to be fortified or abandoned. This is an important societal issue and requires objective assessment, including cost/benefit and risk analyses.

7. Forestry

Erosion from forestry roads, timber harvest, and forestry related landslides can degrade water quality and impair hydrologic function. Significant improvements in road design and implementation have occurred throughout the region during the last two decades, however, well-designed and maintained roads require significant investment of time and resources for landowners. Furthermore, many legacy issues exist from early harvest activities in the Humboldt Bay watershed. Poorly designed or maintained roads are an example of persisting legacy impacts that alter hydrologic patterns and deliver high sediment loads to streams.

Particular issues include roads with poorly installed culverts that impede fish passage, in-board ditches that accelerate erosion and deliver sediment laden water directly to streams, undersized culverts that fail during high rainfall events, improperly surfaced roads that contribute surface erosion and poorly designed road networks that have placed roads in geologically unstable or sensitive areas. Maintaining, upgrading and designing roads to facilitate timber operations has been widely recognized as critical to reduce environmental impacts as well as facilitate access for timber operations (Kramer 2001). The forest industry has road management plans and is regulated on their implementation and maintenance by state and federal agencies including CAL FIRE, North Coast Regional Water Quality Control Board, California Department of Fish and Game, U.S. Fish and Wildlife Service, and NOAA Fisheries.

8. Urban Runoff

As it moves across the urbanized landscape, storm water picks up sediments and contaminants from roads, parking lots, industrial facilities, and other impervious surfaces. Lawns, golf courses, and other urban land-uses can also contribute chemicals to the water. In the urbanized areas of Humboldt Bay, storm drains are separate from the sewer systems, so stormwater flows untreated into creeks, sloughs, and coastal waterways. The contaminants in urban runoff are a threat to human health, recreation, and the commercial fishing industry.

Many urban runoff issues are currently addressed by the North Coast Stormwater Coalition. The Coalition is a partnership of local government agencies, non-profit organizations, local businesses, and community members. The primary goal of the Coalition is to reduce stormwater pollution in local streams, rivers, Humboldt Bay and the ocean through: public education and outreach, coordinating pollution prevention efforts, and implementing pollution control measures. HBI will support and augment North Coast Stormwater Coalition activities.

9. Oil Spills

Oil spills were rated as a human driver having a high impact on the bay. However, HBI did not develop a strategy to address large oil spills because local committees currently addressing the issue are well funded and mandated by legislation. On the other hand, cumulative threats from

fuel spills related to generator use, logging, fuel terminals, docks and urban runoff are dealt with differently than large single spills. These cumulative impacts are addressed by Strategy E - Promote Sustainable Development.

Two shipping related oil spills in the past 12 years resulted in significant damage to natural resources: thousands of seabirds and shorebirds were killed and thousands of acres of intertidal habitats were harmed. Timing of a large oil spill is a significant factor affecting the level of impact. An oil spill during February, March or April—when juvenile salmonids rear in estuary and bay habitats—would be devastating. During winter months Humboldt Bay and the Eel River Estuary are used by over 100,000 shorebirds on a daily basis. From November through April over 60% of the Pacific brant goose population stages, roosts and feeds in the region during their annual migrations between Alaska and Baja California.

Exposure to petroleum products is life threatening for birds. For birds, the primary problem involves physical alteration to feather structure. Oiled feathers lose their ability to trap air and repel water. Birds can no longer maintain body heat; they become hypothermic; and their need for food increases. At the same time, due to oil on their plumage, birds do not float well; their swimming and foraging ability decreases; and they often cannot fly and will haul out of the water.

Birds were among the most impacted wildlife in the 1997 M/V Kure and 1999 M/V Styvesant oils spills in Humboldt Bay. Over 240 loons and grebes, 200 pelicans, cormorants and gulls, 900 common murres, 130 marbled murrelets, 400 waterfowl, and 2000 other shorebirds were killed by the M/V Kure Oil Spill. Over 70 loons and grebes, 130 pelicans, cormorants and gulls, 1600 common murres, 135 marbled murrelets, and 115 wetland birds, were killed during the M/V Stuyvesant oil spill.

Habitat impacts were also extensive. In 1997, approximately 6000 acres of mudflat, rocky intertidal, beach and wetlands were exposed to oil. In 1999, over 3100 acres of rocky intertidal and sandy beach were impacted. Within the water column, an estimated 4.6 million shrimp and 6000 fish were killed.

The Oil Spill Area Planning Committee (chaired by the California Department Fish and Game Oil Spill Prevention and Response Division) and the Harbor Safety Committee (chaired by the Humboldt Bay Harbor Recreation and Conservation District) establish protocols, conducts trainings, store and test response materials in preparation for oil spills.

HBI conferred with the oil spill response local committees. They are currently addressing the issue with many activities and are coordinated with state and west coast oil spill response programs.

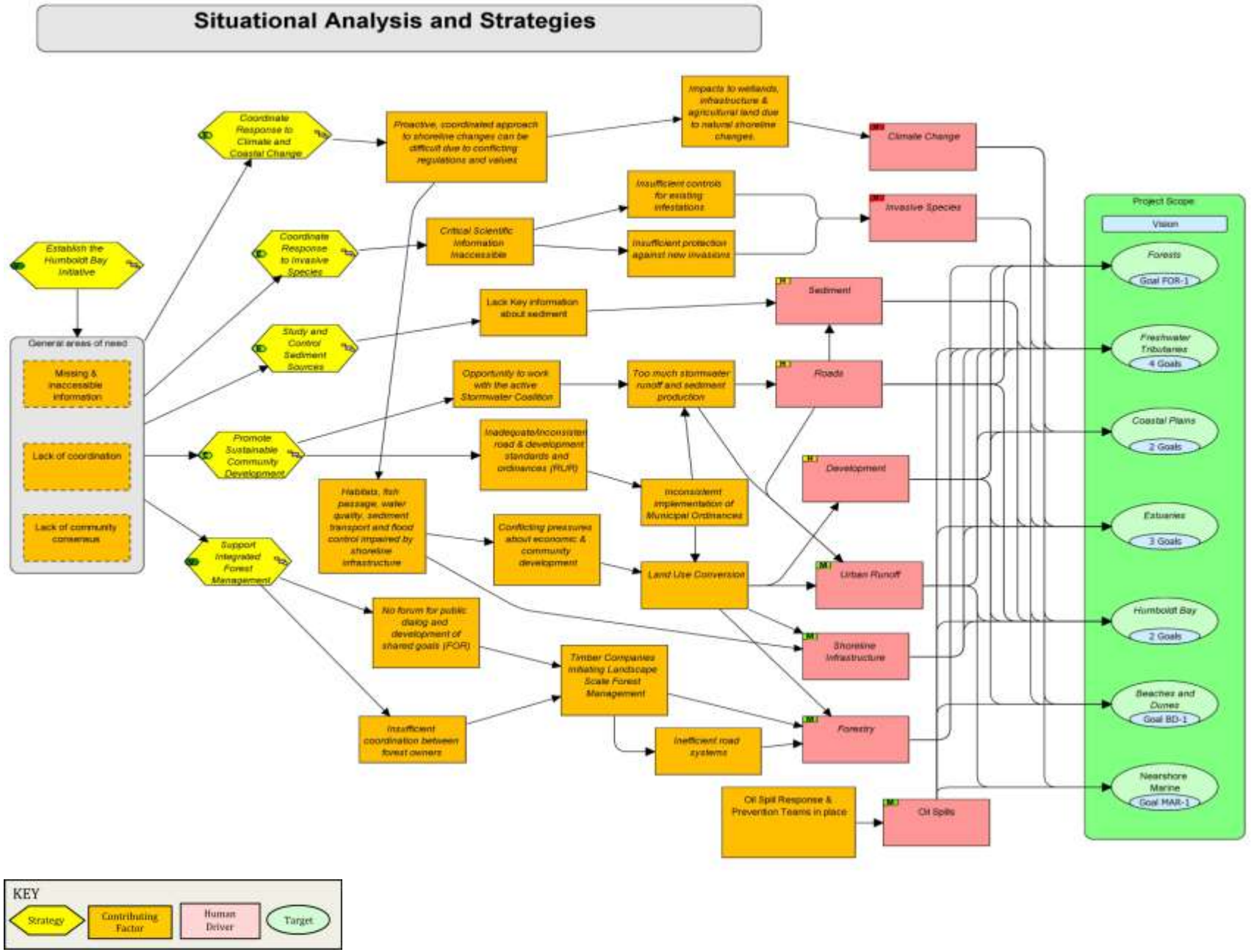
1D. Situation Analysis: The current picture of the ecosystem

The Project Team developed a conceptual model, which depicts the current state of the Humboldt Bay ecosystem and shows the network of ecosystem targets, threats and other factors (Figure 3). This model reflects a collective understanding of the of the current condition of the ecosystem from the forests and freshwater tributaries down to the coastal plains, estuaries, Humboldt Bay, the beaches and dunes and out to the nearshore marine environment. This model has helped Project Team members prioritize issues and formulate strategies for addressing them and will provide a key link between early planning and later evaluation and implementation of priority strategies.

Through an informal situation analysis, we identified a range of human factors affecting ecosystem targets. Climate change, sea level rise, and associated shoreline changes threaten biodiversity, human communities and economic activities—especially on the perimeter of aquatic systems. Much shoreline infrastructure is old and in need of maintenance and repairs. Shoreline infrastructure has impacts on habitats, urban and working landscapes and aquatic species. Aquatic habitats are also seriously threatened by invasive species, with impacts to biodiversity and foraging habitat for birds and fishes. A number of threats are generated by human activities on land that impact aquatic habitats and functions. In particular, sediment originating from roads was considered the most pressing threat, impacting a wide range of aquatic systems and critical species. One of the key information gaps is understanding how sediment moves through the watersheds and bay. Development, in both rural and urban areas, has the potential to disrupt habitats and working landscapes. Urban runoff, which impacts aquatic systems, critical species and human health is actively addressed by the North Coast Stormwater Coalition, but getting needed technical and scientific information to developers, homeowners and others is lacking. Roads supporting forest industry activities contributes sediment that then impacts freshwater tributaries, estuaries and the bay. Oil spills were identified as a priority human factor, which is currently being addressed by two existing local committees.

Strategies developed and prioritized by the project team to address priority human drivers are shown on the conceptual model in relation to the associated factors and targets.

Figure 4. Humboldt Bay Initiative Conceptual Model



2. Strategies and Plans:

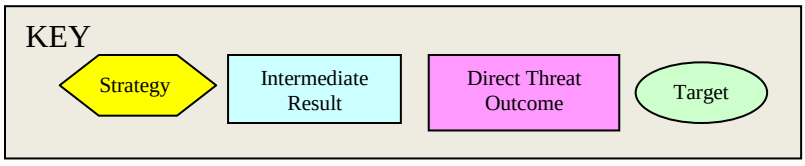
2A and 2B. Strategy Descriptions, Results Chains, Work Plans and Monitoring Plans

Strategies are designed to respond to the threats and human factors. Strategies are composed of results chains, which are a series of "if, then" statements that end in the desired results. The results chains outline a specific course of action needed to lead to the desired change. Each desired result must also consider the project's budget and human capacity, and be acceptable by social, cultural and biological standards.

Strategies are a challenging and creative step in the Open Standards process. It is hard to distill a strategy into a step-by-step procedure. Work Group meetings following the workshop allowed the Project Team time to understand the strategies and to develop results chains and objectives.

The action plan addresses the details of activities required to complete the strategies and objectives achieved by doing so. The associated monitoring plan identifies the how (methods), who and timeframe for data collection. The work plan then details the tasks, activities and responsibilities associated with the strategies. This is the level of detail where most Project Team members got really excited. We are used to organizing ourselves around activities. The tension experienced when working on the more general targets, goals and strategies was reduced when the Project Team moved on to develop the Work Plan.

The Monitoring Plan is used to track our progress. A draft Monitoring Plan follows each strategy and identifies collaborators and their responsibilities. An indicator to monitor the progress towards our goals is also included. Some indicators require collecting and analyzing data and indicators are useful to narrow down our work to a manageable level.



Strategy A. Establish the Humboldt Bay Initiative (HBI)

During the strategic planning process, strategies were identified to reduce critical threats to ecosystem targets. For each strategy, the project team looked at existing efforts and resources and identified the unique role the Humboldt Bay Initiative could play in achieving the threat reduction results. The Humboldt Bay Initiative will promote the conditions needed to accomplish the objectives of the priority strategies. HBI will facilitate implementation of EBM by addressing three broad needs identified in the situation analysis: 1) Enhanced information development, integration and dissemination; 2) Improved coordination mechanisms for EBM, resource and economic development efforts; 3) Increased community capacity for collaborative planning and management.

The Humboldt Bay Initiative will organize initially as a non-profit organization or as an institute at Humboldt State University. HBI will develop stable funding while continuing to coordinate the ongoing EBM effort, and implement HBI strategies by taking on the specific roles that are not feasible or appropriate for existing entities and partners in the project area. These roles include:

1) Developing, integrating and disseminating the information necessary for taking an ecosystem approach in community planning, economic development and restoration efforts. HBI strategies have identified specific information needs. HBI will take responsibility to maintain and update the conceptual model with new information to facilitate adaptive management.
2) Promoting effective, efficient coordination mechanisms between local, state and federal government agencies for better planning, implementation, regulation and monitoring.
3) Facilitating collaborative planning and management involving government agencies, industry and community groups to promote achievement of shared ecosystem and community goals.
4) Informing society with comprehensive understanding of role of Humboldt Bay ecosystem to make the best social and economic decisions

Key aspects of the Humboldt Bay Initiative include 1) maintaining neutrality as a facilitator; 2) employing independent, best social natural and technical sciences; and 3) using a collaborative, ecosystem scale approach. Ultimately, EBM's success will necessitate a transition to a sustainable and dynamic balance between our ecosystems and economies.

It is important to acknowledge that organization of HBI with is not complete. The objectives in this strategy reflect the roles of HBI.

Figure 5:

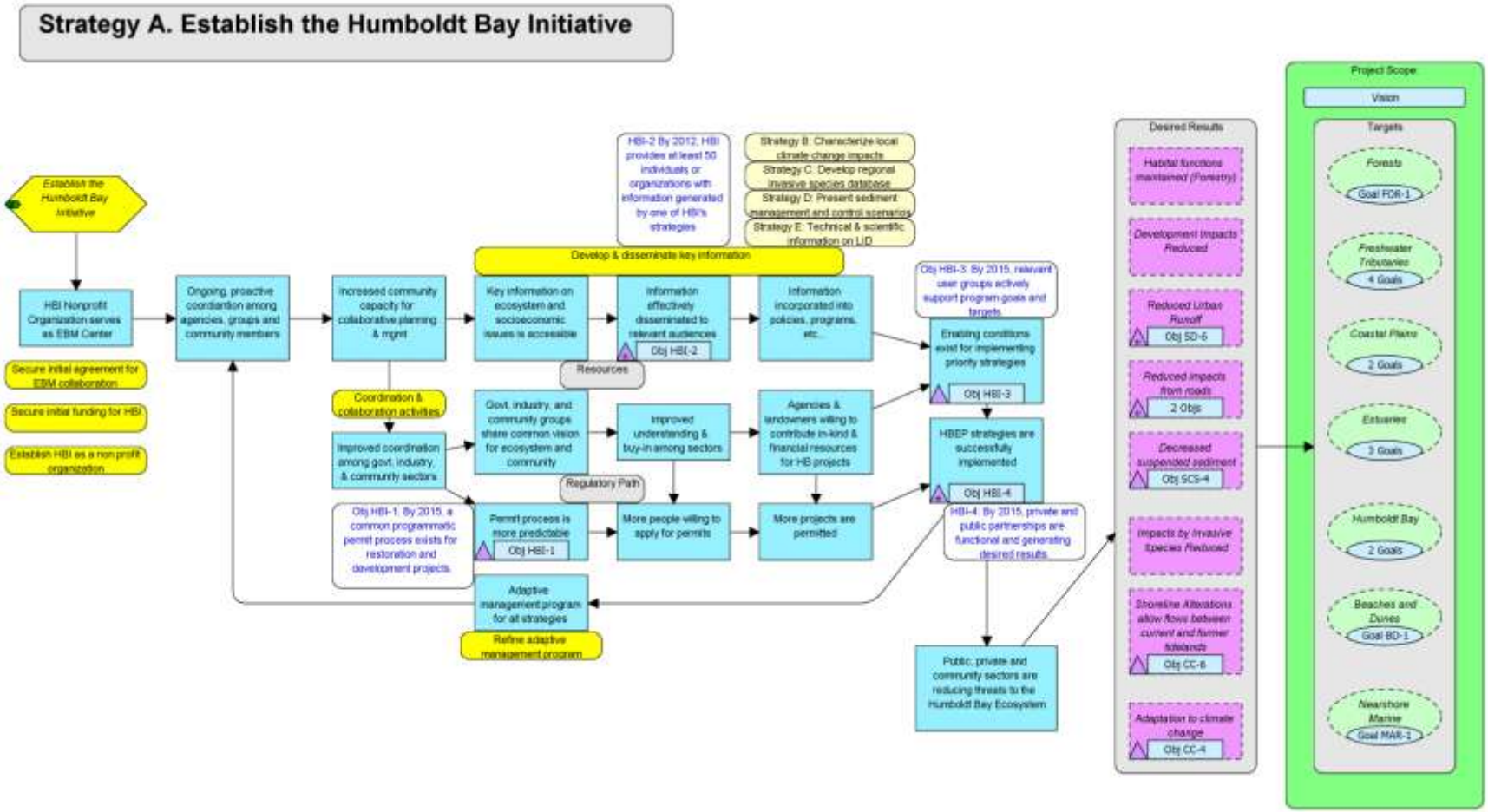

Strategy A. Establish the Humboldt Bay Initiative
Establish the Humboldt Bay Initiative
HBI Nonprofit Organization serves as EBM Center
Secure initial agreement for EBM collaboration
Secure initial funding for HBI
Establish HBI as a non profit organization
Ongoing, proactive coordination among agencies, groups and community members
Increased community capacity for collaborative planning & mgmt
Coordination & collaboration activities
Improved coordination among govt, industry, & community sectors
Obj HBI-1: By 2015, a common programmatic permit process exists for restoration and development projects
Develop & disseminate key information
Key information on ecosystem and socioeconomic issues is accessible
Govt, industry, and community groups share common vision for ecosystem and community
Permit process is more predictable
Obj HBI-1
Information effectively disseminated to relevant audiences
Obj HBI-2
HBI-2 By 2012, HBI provides at least 50 individuals or organizations with information generated by one of HBI's strategies
Strategy B: Characterize local climate change impacts
Strategy C: Develop regional invasive species database
Strategy D: Present sediment management and control scenarios
Strategy E: Technical & scientific information on LID
Resources
Improved understanding & buy-in among sectors
More people willing to apply for permits
Regulatory Path
Information incorporated into policies, programs, etc.
Agencies & landowners willing to contribute in-kind & financial resources for HB projects
More projects are permitted
Adaptive management program for all strategies
Refine adaptive management program
Obj HBI-3: By 2015, relevant user groups actively support program goals and targets
Enabling conditions exist for implementing priority strategies
Obj HBI-3
HBEP strategies are successfully implemented
Obj HBI-4
HBI-4: By 2015, private and public partnerships are functional and generating desired results
Public, private and community sectors are reducing threats to the Humboldt Bay Ecosystem
Desired Results
Habitat functions maintained (Forestry)
Development impacts Reduced
Reduced Urban Runoff
Obj SD-6
Reduced impacts from roads
2 Objs
Decreased suspended sediment
Obj SCS-4
Impacts by Invasive Species Reduced
Shoreline Alterations allow flows between current and former tidelands
Obj CC-6
Adaptation to climate change
Obj CC-4
Project Scope
Vision
Targets
Forests
Goal FOR-1
Freshwater Tributaries
4 Goals
Coastal Plains
2 Goals
Estuaries
3 Goals
Humboldt Bay
2 Goals
Beaches and Dunes
Goal BD-1
Nearshore Marine
Goal MAR-1

Table 6. Work Plan Associated with Strategy A

STRATEGY A: Establish the Humboldt Bay Initiative			
Objective HBI Initial: By 2009, secure an initial agreement for HBI Collaboration (NOTE: this objective is not on the HBI Results Chain)			
Activities	**Person responsible**	**Date to be done**	**Comments**
Secure initial agreement for HBI collaboration	S. Schlosser and B. Price-Hall	December 2009	On-going HBI Project Team meetings will finalize Memorandum of Mutual Understanding. Signatory organizations agree to continue collaborating in the HBI process and ecosystem-based management.
Objective HBI 1: By 2015, a common programmatic permit exists for restoration and development projects.			
Activities	**Person responsible**	**Date to be done**	**Comments**
HBI Project Team meetings	B. Price-Hall	2011	NOAA Fisheries and the Humboldt Bay Harbor District started but halted this process due to staffing issues. HBI will build on these efforts to complete development of programmatic permits for more efficient restoration and development project completion. Most of the development projects are expected to be repair of coastal protection infrastructure. A most important consideration for the programmatic permit(s) is to provide flexibility for future generations to address sea level rise
Objective: HBI 2: By 2012, HBI provides at least 50 individuals or organizations with information generated by one of HBI's strategies			
Activities	**Person responsible**	**Date to be done**	**Comments**
Develop and disseminate key information: Volunteers and staff of HBI provide HBI generated information via individual contacts, websites, workshops, demonstration projects, and publications.	HBI staff, Core Team, and Project Team members.	2012 and on-going	A core task of HBI is to provide the best available technological and scientific information through diverse outreach mechanisms to local governments, agencies, community members and others.
Objective: HBI 3: By 2015, relevant users groups actively support program goals and targets. **Objective: HBI 4: By 2015, private and public partnerships are functional and generating desired results.**			
Activities	**Person responsible**	**Date to be done**	**Comments**
Volunteers and staff of HBI track participation in HBI strategies	HBI staff, Core Team, and Project Team members	2015	HBI will track program participation, results and new partnerships as part of staff and volunteer responsibilities.

Table 7. Monitoring Plan Associated with Strategy A

STRATEGY A: Establish the Humboldt Bay Initiative				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Objective: HBI 1: By 2015, a common programmatic permit exists for restoration and development projects.				
Existence of common programmatic permit for restoration and development projects	HBI workgroup collaborating with local, state and federal agencies.	2010 - 2014	HBI Work Group	HBI will build on preliminary efforts by NOAA Fisheries and the Humboldt Bay Harbor, Recreation and Conservation District.
Objective: HBI 2: By 2012, HBI provides at least 50 individuals or organizations with information generated by one of HBI's strategies				
2a: number of HBI packets mailed out, 2b: number of pdf downloads from HBI website, 2c:number of websites hits, 2d: number of participants at HBI outreach events	HBI website tracking software and HBI outreach events such as workshops, demonstration projects	2010-2012	HBI Work Group	
Objective: HBI 3: By 2015, relevant users groups actively support program goals and targets.				
Number of user groups that understand and support the program	Quantified participation in HBI outreach events using sign-in sheets, evaluation forms submitted at workshops	2010-2012	HBI Work Group	
Objective: HBI 4: By 2015, private and public partnerships are functional and generating desired results.				
4a: Number of private/public partnerships established after 2009, 4b: Percent of private/public partnerships initiating or actively implementing projects.	HBI staff will follow public/private partnerships at HBI workgroup meetings and outreach events and quantify them in reports to the Board of Directors.	2010-2015	HBI Work Group	

Strategy B. Coordinate Response to Climate and Coastal Change

Rising sea levels will be among the most significant impacts of climate change (Heberger et al. 2009). The Humboldt Bay Initiative will promote a proactive, coordinated response to shoreline and hydrologic changes, and the resulting shifts in land use, human communities, species and habitats due to climate change. This Work Group will synthesize and provide the most recent information on understanding the impact of climate variability and change on biological and physical properties of the ecosystem and the implications for infrastructure and human activities. Important elements of this strategy include 1) synthesis and presentation of information for agencies & community using best available predictions of local and regional climate change impacts; 2) detailed assessment of wetland elevation compared to future tidal elevation and possible wetland migration, viable habitat distribution and restoration opportunities to understand potential impacts of sea level rise; 3) preparing a handbook on coastal protection infrastructure construction and repair; and 4) building agency and community understanding and willingness to coordinate shoreline infrastructure protection. The desired result is protection of habitats, land uses and restored connectivity of some former tidelands.

Audiences for this strategy are elected officials, resource managers, land owners and the community.

Figure 6:

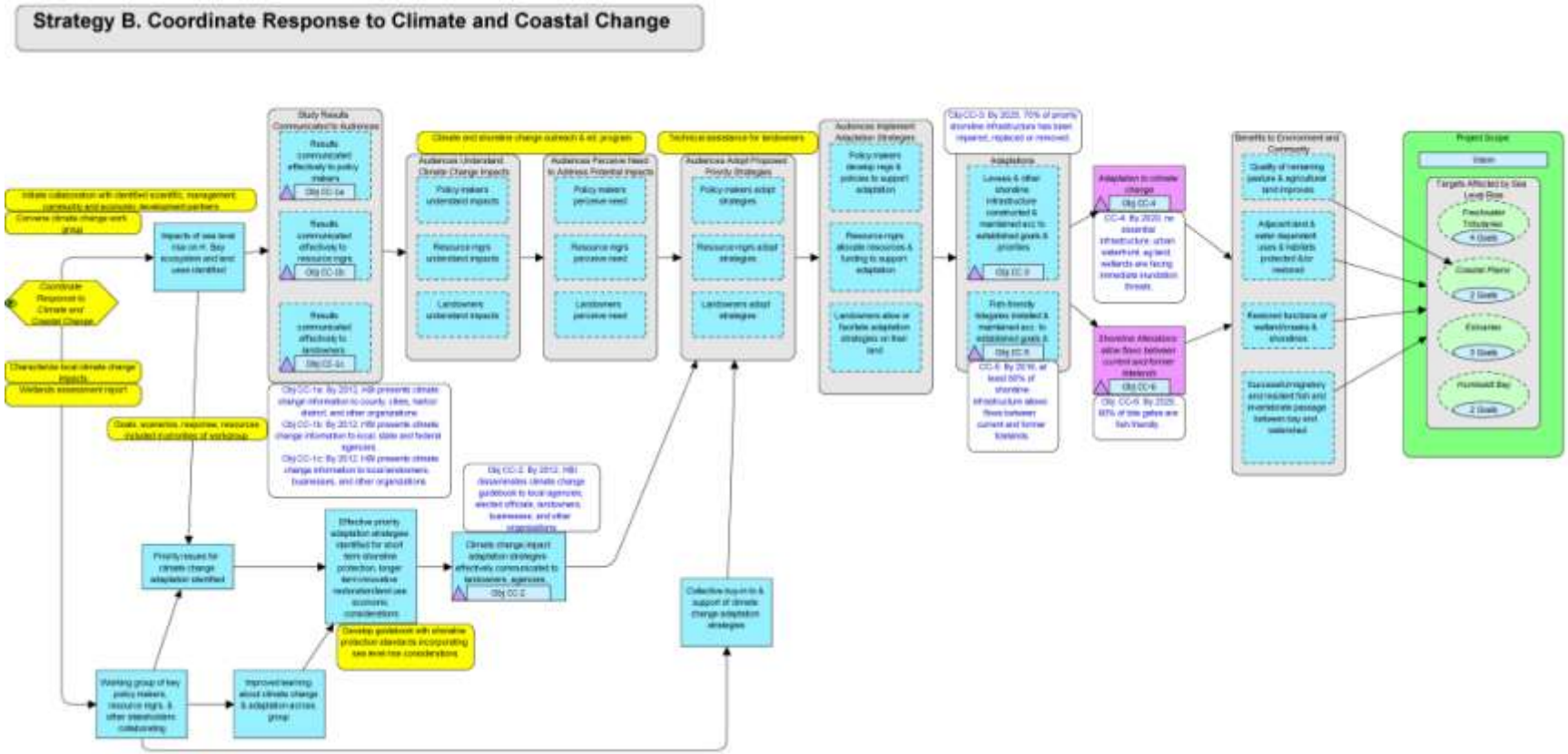

Strategy B. Coordinate Response to Climate and Coastal Change

Table 8. Work Plan Associated with Strategy B

STRATEGY B: Coordinate Response to Climate and Coastal Change			
Objective: CC 1a, 1b, and 1c: By 2012, HBI presents climate change information to county, cities, harbor district, local, state and federal agencies, landowners, businesses, and other organizations and develops Wetlands Assessment Project.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Climate and coastal change outreach program	S. Schlosser, HBI staff and Climate and Coastal Change workgroup	2012	Purpose of the outreach program is to effectively communicate climate change information to policy makers, resource managers, and landowners.
Wetland Assessment Project	D. Mierau, J. Anderson	2012	Detailed assessment of wetlands potentially impacted by sea level rise and restoration and protection strategies
Objective: CC2: By 2015, HBI disseminates coastal protection infrastructure handbook to local agencies, elected officials, landowners, businesses, and other organizations.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Develop handbook with coastal protection standards	Subcontract to local consultant	2015	Develop a comprehensive database of the location and type of existing coastal protection structures in Humboldt Bay. Handbook will include the most current coastal protection design and engineering standards or relevant coastal protection infrastructure.
Objective: CC 3: By 2025, priority coastal infrastructure has been repaired, replaced or removed.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Make handbook and other technical assistance available to landowners, agencies, community members and others.	HBI Climate and Coastal Change Workgroup	2015	Outreach to landowners with technical information, the guidebook, and other relevant coastal protection infrastructure information developed by others (California Energy Commission, etc.) will be an on-going activity of HBI.

Table 9. Monitoring Plan Associated with Strategy B

STRATEGY B: Coordinate Response to Climate and Coastal Change				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Objective: CC 1a, 1b, and 1c: By 2012, HBI presents climate change information to county, cities, harbor district, local, state and federal agencies, landowners, businesses, and other organizations and develops Wetlands Assessment Project.				
Number of climate change presentations	Records of number of presentations and number of participants	2011 - 2012	S. Schlosser, HBI Coordinator, Climate and Coastal Change Workgroup	Results of HBI climate and coastal change report effectively disseminated
Wetlands Assessment Project Report complete	HBI tracks number of reports disseminated via mail, website and workshops	2012-2013	D. Mierau and J. Anderson	Report will also be disseminated by HBI project collaborators
Objective: CC2: By 2015, HBI disseminates coastal protection infrastructure handbook to local agencies, elected officials, landowners, businesses, and other organizations.				
Number of coastal protection infrastructure handbooks distributed	HBI records and tracking software on website	2015	HBI, Sea Grant	Handbook will also be disseminated by HBI project collaborators
Objective: CC 3: By 2025, priority coastal protection infrastructure has been repaired, replaced or removed.				
Percent of priority coastal protection infrastructure repaired, replaced or removed.	Updated coastal protection database analysis	2018	Climate and Coastal Change Work Group	Members of the Work Group who have been involved in coastal protection inventories and restoration projects will mostly likely be the group leader of this activity.
Objective: CC 4: By 2020, no essential coastal infrastructure, urban waterfront, agricultural land, or wetlands are facing immediate inundation threats.				
Number of properties facing inundation	Updated coastal protection database analysis	2020	Climate and Coastal Change Work Group	Members of the Work Group who have been involved in coastal protection inventories and restoration projects will mostly likely be the group leader of this activity.
Objective: CC 5: By 2020, there is an increase in coastal protection infrastructure that allow flows between current and former tidelands.				
Number of reconnections between current and former tidelands	Updated coastal protection database analysis and permit data review	2020	Climate and Coastal Change Work Group	Members of the Work Group who have been involved in coastal protection inventories and restoration projects will mostly likely be the group leader of this activity.

STRATEGY B: Coordinate Response to Climate and Coastal Change				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Objective: CC 6: By 2020, there is an increase in tide gates that are fish friendly.				
Number of stream miles open to migratory fish	Updated coastal protection database analysis and aerial images	2020	Climate and Coastal Change Work Group	Use existing map and aerial image resources of Humboldt County, City of Eureka, City of Arcata, USFWS, NOAA Fisheries, California Sea Grant, Google Earth, and California Dept. of Fish and Game

Strategy C. Coordinate Response to Invasive Species

This strategy includes development of a regional database that integrates the best available scientific information on: 1) the current distribution and impacts of existing invasive species, 2) the potential for invasion by new species, including the likelihood of invasion and level of threat, and 3) the effectiveness and feasibility of control methods for both existing and potential invasive species. Species in the database will be ranked based on the severity of threat and the feasibility for detection and control. Based on these rankings, the species will be prioritized for monitoring and control measures.

An early detection, rapid response strategy has been widely recognized as the most cost effective and efficient means of controlling invasive species. We will take a pro-active approach by implementing a multi-species monitoring program focusing on early detection of invasive species and collection of field data for species as needed to evaluate their level of threat. When this critical scientific information on invasive species is readily accessible, then policy makers and resource managers will be better equipped to monitor the situation and to respond rapidly, implementing control measures effectively when and where deemed necessary.

Figure 7:

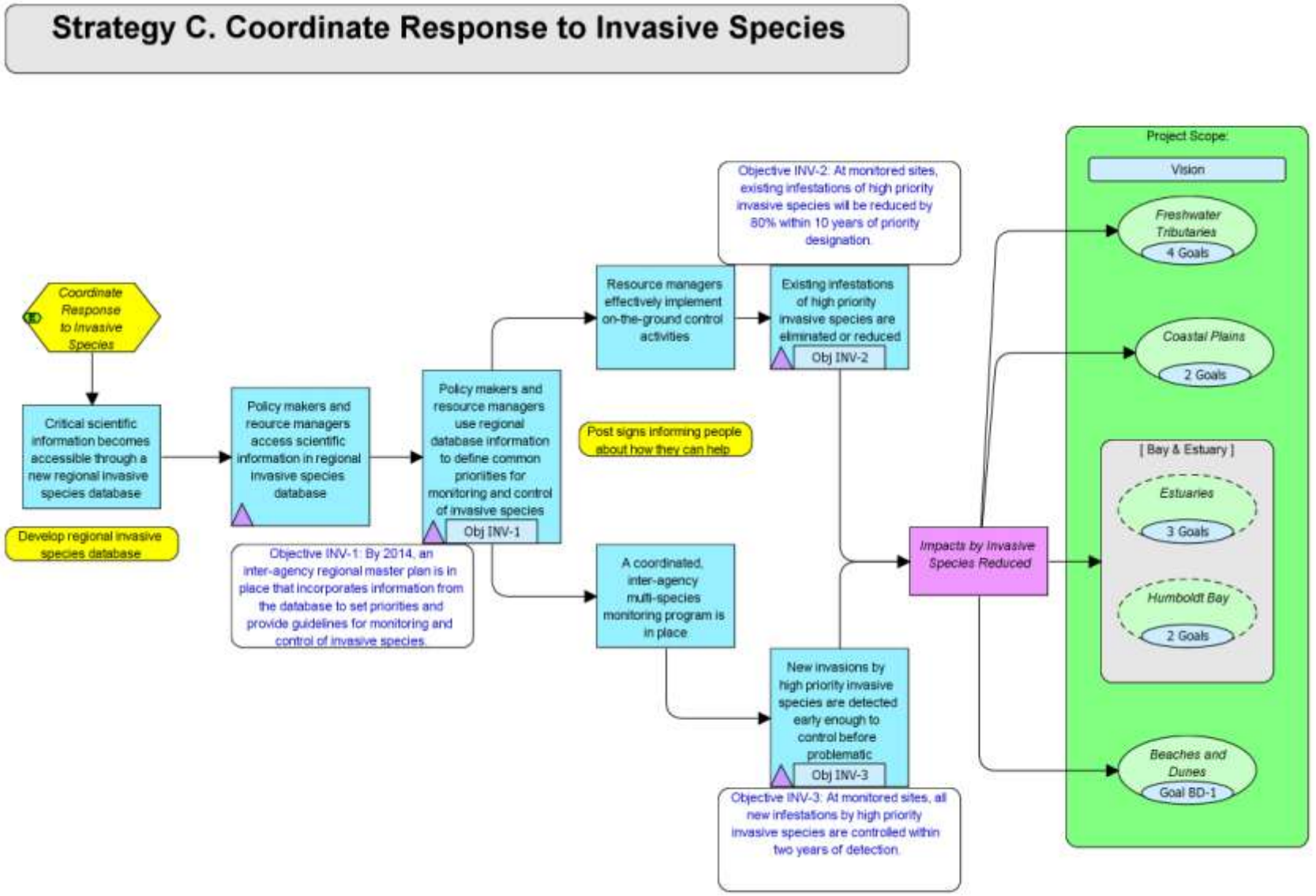

Strategy C. Coordinate Response to Invasive Species
Coordinate Response to Invasive Species
Critical scientific information becomes accessible through a new regional invasive species database
Develop regional invasive species database
Policy makers and reource managers access scientific information in regional invasive species database
Objective INV-1: By 2014, an inter-agency regional master plan is in place that incorporates information from the database to set priorities and provide guidelines for monitoring and control of invasive species.
Policy makers and resource managers use regional database information to define common priorities for monitoring and control of invasive species
Obj INV-1
Post signs informing people about how they can help
Resource managers effectively implement on-the-ground control activities
Objective INV-2: At monitored sites, existing infestations of high priority invasive species will be reduced by 80% within 10 years of priority designation.
Existing infestations of high priority invasive species are eliminated or reduced
Obj INV-2
A coordinated, inter-agency multi-species monitoring program is in place
New invasions by high priority invasive species are detected early enough to control before problematic
Obj INV-3
Objective INV-3: At monitored sites, all new infestations by high priority invasive species are controlled within two years of detection.
Impacts by Invasive Species Reduced
Project Scope:
Vision
Freshwater Tributaries
4 Goals
Coastal Plains
2 Goals
[Bay & Estuary]
Estuaries
3 Goals
Humboldt Bay
2 Goals
Beaches and Dunes
Goal BD-1

Table 10. Work Plan Associated with Strategy C

STRATEGY C: Coordinate Response to Invasive Species			
Objective INV-1: By 2014, an inter-agency regional master plan is in place that incorporates information from the database to set priorities and provide guidelines for monitoring and control of invasive species.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Develop Humboldt Bay and Eel River Estuary invasive species database	A. Eicher, S. Schlosser, K. Ramey	2011	Portions of this information are assembled in the Humboldt Bay and Eel River Estuary Habitat Goals Draft Report.
Develop Humboldt Bay and Eel River Estuary Invasive Species master plan	Interagency	2014	
Objective INV-2: At monitored sites existing infestations of high priority invasive species will be reduced by 80% within 10 years of priority designation. **Objective INV-3:** At monitored sites, new infestations by high priority invasive species are controlled within two years of detection.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Develop monitoring protocol and conduct monitoring surveys for high priority invasive species	A. Eicher, S. Schlosser, K. Ramey	2025	A multi-species survey protocol for intertidal regions of Humboldt Bay, the Eel River and Mad River estuaries, would maximize efficiency and enable early detection. Monitoring cordgrass and dwarf eelgrass are on-going projects of USFWS and CDFG/Sea Grant, respectively.
Control and eradication conducted under programmatic permit for invasive species in Humboldt Bay and the Eel River Estuary	A. Eicher, S. Schlosser, K. Ramey	On-going	CDFG and Sea Grant plan to continue a 6-year collaboration. Future work would benefit from an invasive species/restoration programmatic permit developed through higher level HBI strategy.
Post signs informing people about invasive species dispersal	A. Eicher, S. Schlosser, K. Ramey	2012	Signs will be posted at boat ramps, marinas, HSU marine lab and other locations.

Table 11. Monitoring Plan Associated with Strategy C

STRATEGY C: Coordinate Response to Invasive Species				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
% policy makers and resource managers that access database	Database use determined by website software	2014	A. Eicher, S. Schlosser	
Objective INV-1: By 2014, an inter-agency regional master plan is in place that incorporates information from the database to set priorities and provide guidelines for monitoring and control of invasive species.				
Existence of invasive species master plan	Plan available on HBI website	2014	A. Eicher, S. Schlosser, K. Ramey	
Objective INV-2: At monitored sites, existing infestations of high priority invasive species (joint agreement) will be reduced by 80% within 10 years of priority designation.				
Invasive species reduction, number of acres removed	Permit records, aerial images and GIS	2025	CDFG and USFWS, K. Ramey and A. Pickart	
Objective INV-3: At monitored sites, new infestations by high priority invasive species (joint agreement) are controlled within two years of detection.				
Annual # of new infestations by high priority invasive species controlled, and average number of years for new infestations to be controlled	Monitoring surveys to detect new invasive species	2025	CDFG and Sea Grant	

Strategy D. Study and Control Sediment Sources

This strategy provides key information needed for management and control of sediment impacting eelgrass productivity in Humboldt Bay and estuaries through a sediment study and development of a sediment circulation model. This model includes a second step to predict the amount of eelgrass productivity in the bay based on the effects of those suspended sediments on light availability The HBI Study and Control Sediment Sources strategy arose out of the need: 1) to quantify what is driving the increasing sedimentation in freshwater, estuarine and bay habitats; 2) to address whether human activities and which ones, are major causes, and to evaluate the potential corrective actions; and 3) to evaluate the potential corrective actions. Residential development in urban/forest and urban/agriculture interfaces is rising because of a growing population. Concerns exist that these activities could adversely affect sediment loading. Aquatic habitats in the Humboldt Bay Ecosystem are susceptible to water quality problems because of a relatively young geology and friable, erosive soils.

This strategy includes a collaboration of managers and scientists to assemble information about the condition of freshwater, estuarine and bay habitats. It will provide local officials information that could impact the health of the coastal ecosystem. It will provide information on sediment that needs to be considered when making decisions about changes to zoning, amending regulations, or considering permits for development. For example, when considering a development proposal, it may be important to consider the potential impacts on adjacent nearshore habitat for important fish species. Local governments cannot collect and analyze every possible piece of information when making decisions. In order to prioritize management measures this study develops a simple visual tool for ecosystem sediment sources and sinks and how the sources of sediment might impact fish habitat or urban creeks prone to flooding. The tool will help local leaders, managers and the community, understand key interconnections of the ecosystem relative to sediment sources and sinks.

Controlling sediment input into tributaries and management of sediment within the bay will decrease suspended sediment levels. Lower levels of suspended sediment improves light penetration to eelgrass beds, which improves eelgrass distribution and productivity and supports provision of ecosystem services associated with eelgrass productivity, improves secondary productivity (e.g., Dungeness crab, Pacific herring, coho salmon, Chinook salmon, brandt) and supports a variety of beneficial uses in the bay. In addition, control of sediment input may potentially reduce the frequency and cost of maintenance dredging of docks, marinas, and the Federal Navigation Channel. The calibrated, validated sediment circulation model for Humboldt Bay will support both regulatory and stakeholder approaches by identifying effective sediment management and control scenarios that lead to decreased suspended sediment and improved conditions for beneficial uses in Humboldt Bay. The sediment model will also be a valuable tool for addressing other contemporary and legacy pollutants such as dioxin, oil spills or for understanding the effects of a breached levee or other shoreline infrastructure changes.

Collecting and integrating relevant, high quality information is critical for informed local decision making. We are fortunate to have many local scientists from the public and private sector with expertise able to collect sediment transport information useful for making local decisions. Information about regional scale movement of sediment will help managers make better decisions about shorelines and land use and how to adapt to climate change.

Many persistent pollutants from current human activity and legacy sources are deposited in marine sediments. These chemicals are picked up by benthic animals and transferred through the food web. Growing evidence suggests that toxic contaminants are not confined to a few specific hot spots associated with industrial uses. The Study and Control Sediment Sources strategy lays the foundation for future assessment and monitoring of Humboldt Bay sediments to document persistent pollutants in different components of the ecosystem. Understanding where sediments accumulate and erode will assist managers to design future actions.

While a results chain for these impairments is not proposed in this proposal, the Sediment Study research project offers excellent tools to help lead toward recovery. Specifically the Humboldt Bay Initiative could help analyze and frame the dialog surrounding monitoring and assessment techniques that will ultimately inform control strategies. Additionally the sediment model will help inform locations where Humboldt Bay sediments are remobilized, if there is an overlap between in-bay contaminated sediment and areas of mobilization, appropriate control strategies can be developed. Phase 2 of the Humboldt Bay Initiative may address these legacy contaminants.

Figure 8:

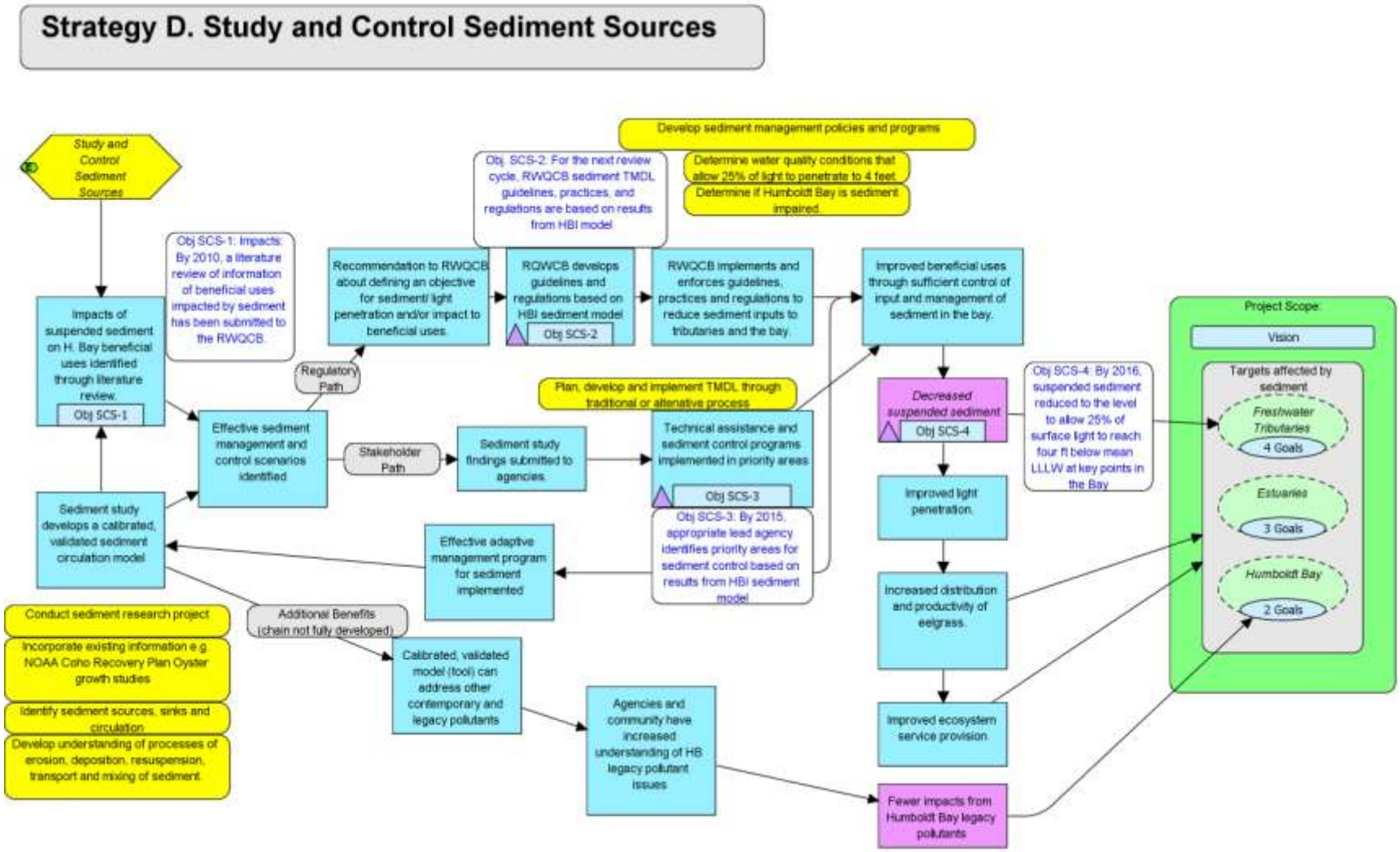

Strategy D. Study and Control Sediment Sources
Study and Control Sediment Sources
Develop sediment management policies and programs
Determine water quality conditions that allow 25% of light to penetrate to 4 feet
Determine if Humboldt Bay is sediment impaired
Obj SCS-2: For the next review cycle, RWQCB sediment TMDL guidelines, practices, and regulations are based on results from HBI model
Obj SCS-1: Impacts: By 2010, a literature review of information of beneficial uses impacted by sediment has been submitted to the RWQCB.
Impacts of suspended sediment on H. Bay beneficial uses identified through literature review.
Obj SCS-1
Recommendation to RWQCB about defining an objective for sediment/ light penetration and/or impact to beneficial uses
RQWCB develops guidelines and regulations based on HBI sediment model
Obj SCS-2
RWQCB implements and enforces guidelines, practices and regulations to reduce sediment inputs to tributaries and the bay.
Improved beneficial uses through sufficient control of input and management of sediment in the bay.
Regulatory Path
Plan, develop and implement TMDL through traditional or alternative process
Effective sediment management and control scenarios identified
Stakeholder Path
Sediment study findings submitted to agencies
Technical assistance and sediment control programs implemented in priority areas
Obj SCS-3
Obj SCS-3: By 2015, appropriate lead agency identifies priority areas for sediment control based on results from HBI sediment model
Decreased suspended sediment
Obj SCS-4
Obj SCS-4: By 2016, suspended sediment reduced to the level to allow 25% of surface light to reach four ft below mean LLLW at key points in the Bay
Improved light penetration
Increased distribution and productivity of eelgrass
Improved ecosystem service provision
Fewer impacts from Humboldt Bay legacy pollutants
Project Scope:
Vision
Targets affected by sediment
Freshwater Tributaries
4 Goals
Estuaries
3 Goals
Humboldt Bay
2 Goals
Sediment study develops a calibrated, validated sediment circulation model
Effective adaptive management program for sediment implemented
Conduct sediment research project
Incorporate existing information e.g. NOAA Coho Recovery Plan Oyster growth studies
Identify sediment sources, sinks and circulation
Develop understanding of processes of erosion, deposition, resuspension, transport and mixing of sediment.
Additional Benefits (chain not fully developed)
Calibrated, validated model (tool) can address other contemporary and legacy pollutants
Agencies and community have increased understanding of HB legacy pollutant issues

Table 12. Work Plan Associated with Strategy D

STRATEGY D: Study and Control Sediment Sources			
Objective: SCS 1: By 2010, a literature review of information on beneficial uses impacted by sediment has been submitted to the North Coast Regional Water Quality Control Board.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Complete sediment impacts literature review	J. Anderson, F. Shaughnessy, G. Crawford, V. Frey, D. Ashton	2010	The sediment impacts literature review will include impacts to coho salmon, shellfish culture, and eelgrass.
Objective: SCS 2: For the next Humboldt Bay Basin Plan Triennial Review, the North Coast Regional Water Quality Control Board sediment TMDL guidelines, practices, and regulations will be based on the results from the HBI model.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Sediment Control Study	G. Crawford, J. Anderson, F. Shaughnessy, A. White, V. Frey, D. Ashton, S. Schlosser	2013	Identify sediment sources and sinks in the watershed and bay and identify the total suspended solid concentration in Humboldt Bay that allows eelgrass to grow at 4 feet below mean lower low water.
Objective: SCS 3: BY 2015, North Coast Regional Water Quality Control Board identifies priority areas for sediment control based on HBI sediment model.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Develop sediment management scenarios, policies and programs	Regional Water Quality Control Board, A. White	2015	This will include determining if Humboldt Bay is sediment impaired.
Technical assistance and sediment control programs are developed by HBI using sediment model results.	J. Anderson, G. Crawford, V. Frey, A. White, S. Schlosser, F. Shaughnessy	2015	This outreach will also be developed in collaboration between the researchers and managers and HBI staff.
Objective: SCS 4: By 2016, suspended sediment reduced to the level to allow 25% of surface light to reach four feet below mean lower low water at monitored sites in Humboldt Bay.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Monitor Humboldt Bay water quality using Central and Northern California Ocean Observing Systems in-situ water quality monitoring program	F. Shaughnessy, G. Crawford	On-going since 2003	CENCOOS data from three sites will be used to determine Humboldt Bay total suspended sediment concentrations.

Table 13. Monitoring Plan Associated with Strategy D

STRATEGY D: Study and Control Sediment Sources				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Objective: SCS 1: By 2010, a literature review of information on beneficial uses impacted by sediment has been submitted to the North Coast Regional Water Quality Control Board.				
Literature review submitted to RWQCB by 2010.	Literature review available	2009-2019	J. Anderson, F. Shaughnessy, G. Crawford, V. Frey, D. Ashton	
Objective: SCS 2: For the next Humboldt Bay Basin Plan Triennial Review, the North Coast Regional Water Quality Control Board sediment TMDL guidelines, practices, and regulations will be based on the results from the HBI model.				
Sediment TMDL guidelines, practices, and regulations based on the results from the HBI sediment model.	Analysis of TMDL is consistent with HBI sediment model	2009-2011	J. Anderson, G. Crawford, F. Shaughnessy	HBI provides sediment model outputs. RWQCB develops TMDL guidelines, practices and regulations.
Objective: SCS 3: BY 2015, North Coast Regional Water Quality Control Board identifies priority areas for sediment control based on HBI sediment model.				
List of defined priority areas for sediment control	List of priority sites is available on website.	2012	Regional Water Quality Control Board, A. White, J. Anderson, G. Crawford, F. Shaughnessy	This is an essential part of the TMDL process.
Objective: SCS 4: By 2016, suspended sediment reduced to the level to allow 25% of surface light to reach four feet below mean lower low water at monitored sites in Humboldt Bay.				
Eelgrass depth distribution, total suspended solids concentration	Data on CENCOOS website	2012	F. Shaughnessy	Baseline and trends data from 2003 to 2008)

Strategy E. Promote Sustainable Development

This strategy aims to reduce the impacts of development and roads--particularly urban runoff and hydromodification--on forest and coastal plains ecosystems, and the bay. This will be accomplished through coordinated regulatory assistance and non-regulatory application of water quality Best Management Practices (BMPs), along with protection of streams, wetlands, & open space. The Humboldt Bay Initiative will assist local governments, developers, and landowners by 1) providing information and training on the benefits and successful implementation of Low Impact Development (LID), Smart Growth, and other land-use planning techniques, 2) developing model policies, standards, & ordinances to address urban runoff, 3) supporting programs implementing LID in new development and retrofits of existing development, and 4) promoting implementation of road BMPs.

Many land-based water quality issues may be addressed through the Sustainable Development strategy. Local leaders will play an important role, as this is a challenging activity that calls for influencing activities on both private and public property. Working with landowners and businesses to implement Best Management Practices for water quality protection from a broad range of land-use activities is a unique role for local leaders to create incentives and/or require BMP implementation. Humans have considerable control over modes of development, and the magnitude and distribution of impact that land uses will have on particular habitats. Managers can choose development pathways that conserve and restore Humboldt Bay Ecosystem habitats. Many new technologies offer potential environmental and economic advantages, including higher home values, lower development costs, and social and ecological benefits including maintenance of ecosystem processes. It may require different regulations and planning, it may not be as profitable as traditional development, and it may require research to understand the specific effects of new technologies.

Figure 9:

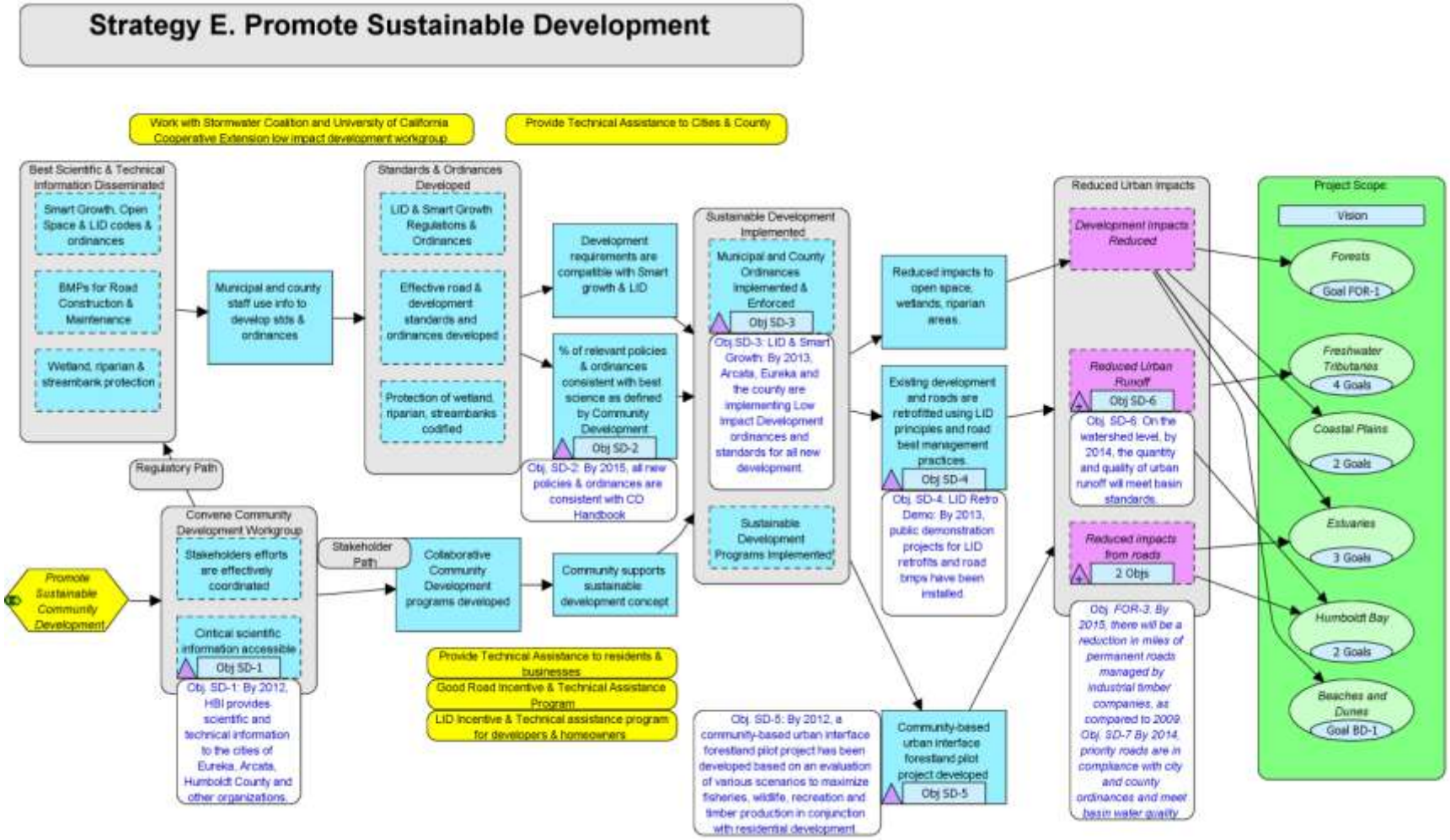

Strategy E. Promote Sustainable Development
Work with Stormwater Coalition and University of California Cooperative Extension low impact development workgroup
Provide Technical Assistance to Cities & County
Best Scientific & Technical Information Disseminated
Smart Growth, Open Space & LID codes & ordinances
BMPs for Road Construction & Maintenance
Wetland, riparian & streambank protection
Municipal and county staff use info to develop stds & ordinances
Standards & Ordinances Developed
LID & Smart Growth Regulations & Ordinances
Effective road & development standards and ordinances developed
Protection of wetland, riparian, streambanks codified
Development requirements are compatible with Smart growth & LID
% of relevant policies & ordinances consistent with best science as defined by Community Development
Obj SD-2
Obj. SD-2: By 2015, all new policies & ordinances are consistent with CO Handbook
Sustainable Development Implemented
Municipal and County Ordinances Implemented & Enforced
Obj SD-3
Obj SD-3: LID & Smart Growth: By 2013, Arcata, Eureka and the county are implementing Low Impact Development ordinances and standards for all new development
Sustainable Development Programs Implemented
Reduced impacts to open space, wetlands, riparian areas
Existing development and roads are retrofitted using LID principles and road best management practices
Obj SD-4
Obj. SD-4: LID Retro Demo: By 2013, public demonstration projects for LID retrofits and road bmps have been installed
Community-based urban interface forestland pilot project developed
Obj SD-5
Obj. SD-5: By 2012, a community-based urban interface forestland pilot project has been developed based on an evaluation of various scenarios to maximize fisheries, wildlife, recreation and timber production in conjunction with residential development
Reduced Urban Impacts
Development Impacts Reduced
Reduced Urban Runoff
Obj SD-6
Obj. SD-6: On the watershed level, by 2014, the quantity and quality of urban runoff will meet basin standards
Reduced impacts from roads
2 Objs
Obj. FOR-3: By 2015, there will be a reduction in miles of permanent roads managed by industrial timber companies, as compared to 2009. Obj. SD-7 By 2014, priority roads are in compliance with city and county ordinances and meet basin water quality
Project Scope
Vision
Forests
Goal FOR-1
Freshwater Tributaries
4 Goals
Coastal Plains
2 Goals
Estuaries
3 Goals
Humboldt Bay
2 Goals
Beaches and Dunes
Goal BD-1
Regulatory Path
Promote Sustainable Community Development
Convene Community Development Workgroup
Stakeholders efforts are effectively coordinated
Critical scientific information accessible
Obj SD-1
Obj. SD-1: By 2012, HBI provides scientific and technical information to the cities of Eureka, Arcata, Humboldt County and other organizations.
Stakeholder Path
Collaborative Community Development programs developed
Community supports sustainable development concept
Provide Technical Assistance to residents & businesses
Good Road Incentive & Technical Assistance Program
LID Incentive & Technical assistance program for developers & homeowners

Table 14. Work Plan Associated with Strategy E

STRATEGY E: Promote Sustainable Development			
Objective SD-1: By 2012, HBI provides scientific and technical information to the cities of Eureka and Arcata, Humboldt County, and other organizations on sustainable development technologies.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Synthesize sustainable development technical and scientific information	V. Metz, B. Price-Hall	2012	There is an extensive literature on low impact development and other related technologies from the 1980's. This report will review the literature for technologies suitable for north coast soils and topography.
Objective SD-2: By 2015, all new or updated land use policies and ordinances are consistent with best available science for promoting sustainable development.			
Develop technical assistance on sustainable development, and model LID policies and ordinances	V. Metz, B. Price-Hall, Northcoast Stormwater Coalition	2015	
Evaluate existing municipal codes and ordinances, and provide technical assistance on sustainable development to cities, counties, and commissions.	V. Metz, B. Price-Hall, Northcoast Stormwater Coalition	2015	
Objective: SD-3: By 2013, Arcata, Eureka and the county have developed and are implementing Low Impact Development and Smart growth ordinances & standards for new development.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Assist cities and county by providing technical assistance program for developers, the construction trade, homeowners, and others	V. Metz, B. Price-Hall	2013	
Objective SD-4: By 2013, Public demonstration projects for Smart growth and LID retrofits have been installed.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Assist a public entity in development of an LID or other sustainable development technology demonstration project	V. Metz, B. Price-Hall	2013	
Objective SD-5: By 2015 most* of the highest priority roads have been upgraded to meet best management practice standards. (*Project Team needs more information to be able to determine % of priority roads to upgrade.)			
Activities	**Person responsible**	**Date to be done**	**Comments**
Develop road incentive and technical assistance program	Sustainable Development Work Group	2015	

Objective SD-6: By 2012, a community-based urban interface forestland pilot project has been developed based on an evaluation of scenarios to maximize fisheries, wildlife, residential development, recreation and timber production.			
Activities	**Person responsible**	**Date to be done**	**Comments**
HBI and partners develop a dialog project around the urban/forestland interface	Sustainable Development Workgroup	2012	Project will involve GIS maps from Humboldt County, state and federal agencies as educational tools as well as facilitated meetings to conduct the analysis.

Table 15. Monitoring Plan Associated with Strategy E

STRATEGY E: Promote Sustainable Development				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Objective SD-1: By 2012, HBI provides scientific and technical information to the cities of Eureka and Arcata, Humboldt County, and other organizations on sustainable development technologies.				
Community Development Science and Technology Report available	Community Development Science and Technology Report on HBI website and available at local offices	2012	V. Metz and B. Price-Hall	
Objective SD-2: By 2015, all new or updated policies and ordinances are consistent with best available science for promoting sustainable development				
Policies and ordinance consistent with best science and technology	Analyze existing policies and ordinances for consistency with best science and technology, and make recommendations for improvement	2015	V. Metz and B. Price-Hall	
Objective: SD-3: By 2013, Arcata, Eureka and the county have developed and are implementing Low Impact Development and Smart growth ordinances & standards for new development.				
% of new development projects in which Sustainable Community Development ordinances are applied	Review and synthesize development permit records	2013	V. Metz and B. Price-Hall	
Objective SD-4: By 2013, Public demonstration projects for Smart growth and LID retrofits have been installed.				
Public demonstration projects for Smart growth and/or LID retrofits been installed.	Demonstration project site visit	2013	V. Metz and B. Price-Hall, HBI Sustainable Community Workgroup	
Objective SD-5: By 2012, a community-based urban interface forestland pilot project has been developed based on an evaluation of scenarios to maximize fisheries, wildlife, residential development, recreation and timber production.				
Existence of pilot urban/forestland interface project		2012	V. Metz and B. Price-Hall	
Objective SD-6: On the watershed level, by 2014, the quantity and quality of urban runoff will meet Humboldt Bay Basin water quality standards.				
First flush water quality data	Analyze and synthesize Northcoast Stomwater Coalition and Humboldt Bay Keeper data	2014	V. Metz, HBI Sustainable Community Workgroup	Cities and county analyze their data but not comprehensive report is available.
Benthic aquatic macro-invertebrate survey (BMI)	California Department of Fish and Game BMI protocol	2012	HBI Sustainable Community Development Workgroup	This indicator requires a training workshop.

Strategy F Support Integrated Forest Management

This strategy will promote better environmental outcomes and economic efficiency through longer term forest plans that are integrated in the Humboldt Bay watershed and across ownership boundaries. A key objective of this strategy is to prevent new sources and minimize existing sources of management related sediment from entering freshwater tributaries. The Humboldt Bay Initiative could play a critical role in promoting coordination of forest management plans, developing community supported forest conservation and use goals, and facilitating refinement of the regulatory process to meet the needs of multiple agencies and the public.

HBI will bring together timber companies, regulators and community groups in a collaborative dialogue about forestry and related environmental, social and economic issues. On the basis of these dialogs participants develop shared and realistic goals for resource use and conservation, support public outreach and education and lend legitimacy to ecosystem-based forest management plans. Key to this would be development of effectiveness monitoring and reporting programs to demonstrate practices are meeting the intended goals and to provide accountability to the community.

Humboldt Bay watersheds have been central to timber wars over the years. Among the issues of contention are the rate and scale of timber harvesting, appropriate management prescriptions in the context of watershed conditions, and the relative effectiveness of the prescriptions aimed at protecting resources. The Humboldt Bay Initiative will facilitate the development of a forum for discussion of goals which support ecosystem and economic resilience, facilitate the development and dissemination of watershed plans, with monitoring and reporting of the effectiveness of management strategies.

If a suite of ecosystem goals were mutually agreed upon, timber owners and regulators would be better able to tailor their management to meet these common goals while at the same time securing their economic interests. For example, road construction and maintenance plans could be optimized at the watershed scale based on 10-20 year harvest plans for that watershed rather than short term (3-5 years) Timber Harvest Plans (THPs). This could reduce both the environmental impact of the roads and the financial costs associated with the roads. Furthermore, comparing the anticipated results of longer term plans across ownerships and in the context of watershed conditions would enable assessments of the cumulative environmental impacts. Adjusting and integrating plans at the watershed scale (either within an ownership or across ownerships) should lead to better environmental outcomes especially with respect to landscape scale concerns such as habitat connectivity and patch size.

Figure 10:

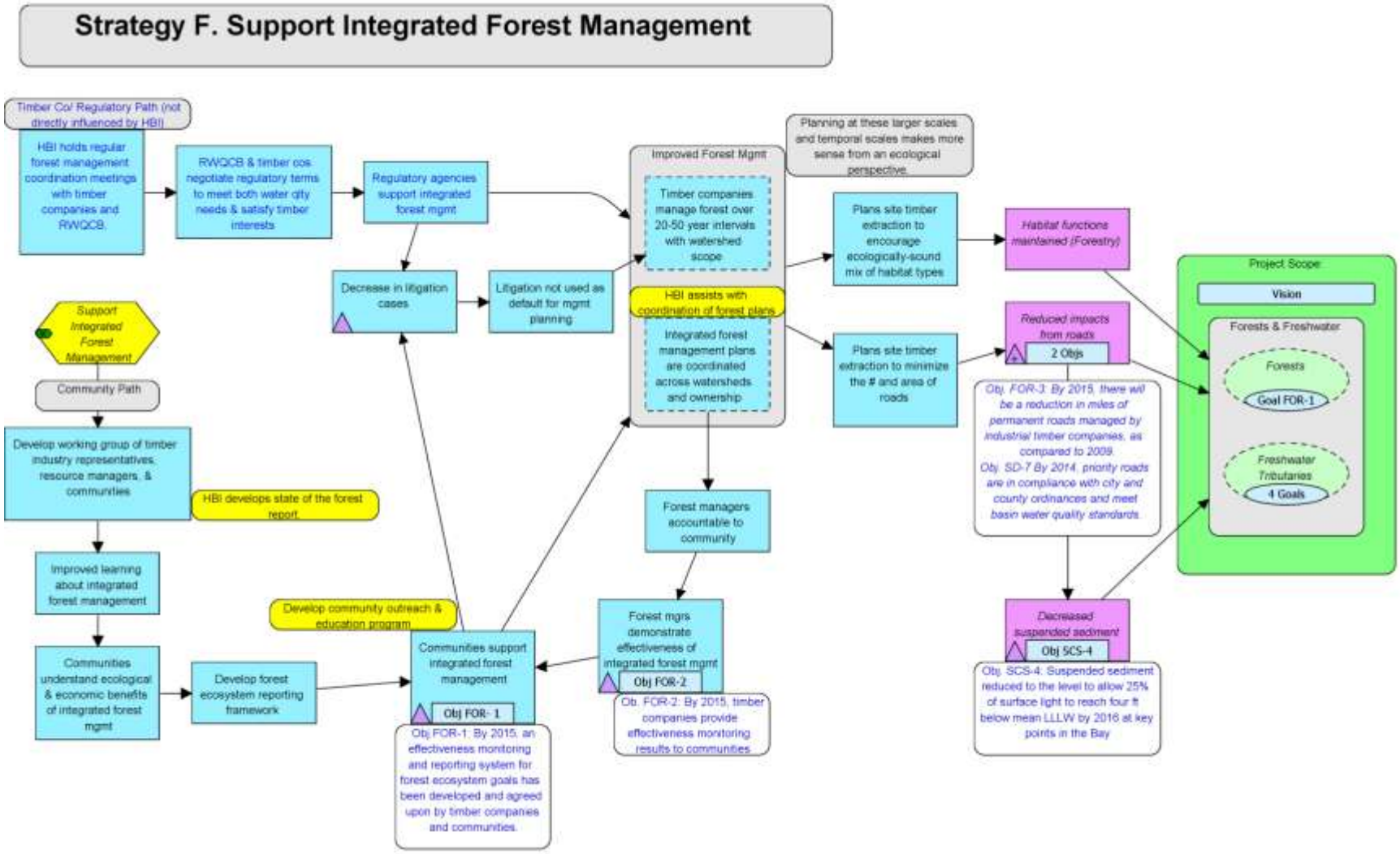

Strategy F. Support Integrated Forest Management
Timber Co/ Regulatory Path (not directly influenced by HBI)
HBI holds regular forest management coordination meetings with timber companies and RWQCB
RWQCB & timber cos negotiate regulatory terms to meet both water qlty needs & satisfy timber interests
Regulatory agencies support integrated forest mgmt
Decrease in litigation cases
Litigation not used as default for mgmt planning
Improved Forest Mgmt
Timber companies manage forest over 20-50 year intervals with watershed scope
HBI assists with coordination of forest plans
Integrated forest management plans are coordinated across watersheds and ownership
Planning at these larger scales and temporal scales makes more sense from an ecological perspective
Plans site timber extraction to encourage ecologically-sound mix of habitat types
Plans site timber extraction to minimize the # and area of roads
Habitat functions maintained (Forestry)
Reduced impacts from roads
2 Objs
Obj. FOR-3: By 2015, there will be a reduction in miles of permanent roads managed by industrial timber companies, as compared to 2009.
Obj. SD-7 By 2014, priority roads are in compliance with city and county ordinances and meet basin water quality standards
Decreased suspended sediment
Obj SCS-4
Obj. SCS-4: Suspended sediment reduced to the level to allow 25% of surface light to reach four ft below mean LLLW by 2016 at key points in the Bay
Project Scope
Vision
Forests & Freshwater
Forests
Goal FOR-1
Freshwater Tributaries
4 Goals
Support Integrated Forest Management
Community Path
Develop working group of timber industry representatives, resource managers, & communities
HBI develops state of the forest report
Improved learning about integrated forest management
Communities understand ecological & economic benefits of integrated forest mgmt
Develop forest ecosystem reporting framework
Develop community outreach & education program
Communities support integrated forest management
Obj FOR- 1
Obj FOR-1: By 2015, an effectiveness monitoring and reporting system for forest ecosystem goals has been developed and agreed upon by timber companies and communities.
Forest managers accountable to community
Forest mgrs demonstrate effectiveness of integrated forest mgmt
Obj FOR-2
Ob. FOR-2: By 2015, timber companies provide effectiveness monitoring results to communities

Table 16. Work Plan Associated with Strategy F

STRATEGY F: Support Integrated Forest Management			
Objective FOR-1: By 2015, forest monitoring and reporting is agreed upon by timber companies and communities.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Humboldt Bay Watershed Forest Report	A. Hohl	2012	Comprehensive report on Humboldt Bay watershed forest structure, harvest, biota and ecological processes will be used to inform the community dialog process.
HBI facilitates community dialog about forestry issues	A. Hohl, B. Price-Hall	2015	The HBI Forest Workgroup will work with the community, developers, and timber companies to identify options for integrated forest management, sustainable community development, community forestry, and other ideas.
Objective FOR 2: By 2015, timber companies provide effectiveness monitoring results to communities.			
Activities	**Person responsible**	**Date to be done**	**Comments**
HBI assists with coordination of integrated forest management plans	A. Hohl. A. White	2015	
Objective FOR 3: By 2015, the area and/or number of industrial timber road miles will be reduced.			
Activities	**Person responsible**	**Date to be done**	**Comments**
Road assessment in Humboldt Bay watershed	Forest Management Work Group	2015	Road assessment data from timber company roads management plans, California Department of Fish and Game watershed assessments, and NCRWQCB reports will be integrated with a county road assessment in the Humboldt Bay watershed. New data collected will be on the county roads in the Humboldt Bay Watershed.

Table 17. Monitoring Plan Associated with Strategy F

STRATEGY F: Support Integrated Forest Management				
What? *(Indicator)*	**How?** *(Methods)*	**When?**	**Who?**	**Comments**
Objective FOR-1: By 2015, forest monitoring and reporting is agreed upon by timber companies and communities.				
Develop Forest Ecosystem Report	Forest ecosystem report available at workgroup meetings, HBI website	2012	A. Hohl	Comprehensive Humboldt Bay Watershed Forest Ecosystem Report
Community Dialog Project participation	HBI tracks number of presentations and participants in community dialog project on forest issues	2015	B. Price-Hall	
Objective FOR 2: By 2015, timber companies provide effectiveness monitoring results to communities				
Effectiveness monitoring data reports	Presentations of timber company effectiveness monitoring and acceptance by community	2015	HBI Forest Work Group	
Objective FOR 3: By 2015, the area and/or number of industrial timber road miles will be reduced.				
No net increase of roads on forest lands	Analysis from Humboldt Bay Watershed Road Assessment Report	2015	HBI Forest Work Group	
Length of roads next to streams is reduced by 25% on forest lands	Analysis from Humboldt Bay Watershed Road Assessment Report	2015	HBI Forest Work Group	
Length of roads out-sloped is increased by 50% on forest lands	Analysis from Humboldt Bay Watershed Road Assessment Report	2015	HBI Forest Work Group	

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Appendix A. Plan Descriptions

Arcata General Plan

The City of Arcata General Plan shapes how the City will look, function, provide services, and manage resources for the next 20 years. It guides the physical development and change within the city boundaries. It includes laws, policies, and ordinances. A large portion of Arcata lies in the Coastal Zone and the General Plan includes the Local Coastal Plan.

The City of Arcata General Plan is available on-line at: http://www.arcatacityhall.org/

Eureka General Plan

The City of Eureka General Plan was adopted in 1997 and amended in 1998 and 2008. It is a policy document with a comprehensive, long-term vision containing standards, policies and programs to guide day-to-day decisions of Eureka's development. It includes the City's Local Coastal Program. There are seven elements in the plan that address strategies addressed by the Humboldt Bay Initiative program.

The City of Eureka General Plan is available on-line at: http://www.ci.eureka.ca.gov/

Humboldt County General Plan

The General Plan provides long-term direction for the growth and development of the unincorporated areas of the County. It expresses community values and goals, and portrays the community's vision of the future. The core elements of the Plan address land use, circulation, housing, resource conservation, open space, noise and protection from hazards. The General Plan is updated about every twenty years. It is an important plan for all County residents. Elements of the General Plan are discussed in great detail at Humboldt County Planning Commission meetings, public meetings and special events.

The Humboldt County General Plan Update, meeting schedules, and other information are available on-line at: http://co.humboldt.ca.us/gpu/overview.aspx

North Coast Integrated Regional Water Management Plan

The North Coast Integrated Regional Water Management Plan (NCIRWMP) is an innovative, stakeholder-driven collaboration among local government, watershed groups, tribes and interested partners in the North Coast region of California. The *North Coast* comprises seven counties and multiple major watersheds, with a land mass of 19,390 square miles—which represents 12% of the landscape of California. The NCIRWMP integrates long term planning and high quality project implementation in an adaptive management framework—fostering

coordination and communication among the diverse stakeholders in the Region. Focus areas for the NCIRWMP include salmonid recovery, enhancement of the beneficial uses of water, and the synchronization of state and federal priorities with local priorities, knowledge, and leadership.

Available on-line at http://www.northcoastirwmp.net/

Humboldt Bay Management Plan

This plan was developed by the Humboldt Bay Harbor, Recreation and Conservation District between 1999 and 2006. Harbor District Commissioners formed a Task Force of 17 stakeholder representatives. District staff provided support for the meetings including facilitation, meeting notices and dissemination of meeting notes. The plan resulted for over 30 public meetings and 300 pages of written comments. There are 104 policies in the Humboldt Bay Management Plan. These policies will direct the work of the Harbor District Commissioners over the next 20 years. The geographic scope of the Humboldt Bay Management Plan includes Humboldt Bay, its intertidal and subtidal area. The adoption of an EBM approach by the Humboldt Bay Harbor Recreation and Conservation District in the Humboldt Bay Management Plan offers the exciting prospect of implementing EBM in the Humboldt Bay Ecosystem.

The Harbor District Commissioners formed an Advisory Committee of 28 stakeholders in December 2008, which includes eight members of the Humboldt Bay Initiative Project Team. Integration of Harbor District policy implementation and Humboldt Bay Initiative programs are expected to result in significant management and policy actions.

The Humboldt Bay Management Plan is available on-line at: http://www.humboldtbay.org/

Humboldt Bay Watershed Salmon and Steelhead Conservation Plan

The Redwood Community Action Agency led development of this plan through a 28-person stakeholder committee, the Humboldt Bay Watershed Advisory Committee. This committee met between 1999 and 2006. Committee members wrote chapters, organized public meetings, watershed tours, and symposia. The plan includes extensive historical information on watershed forestry, salmonid habitat restoration and cultural uses. The plan was adopted in its entirety by the California Department of Fish and Game in its Coho Salmon Recovery Plan.

The Humboldt Bay Watershed Salmon and Steelhead Conservation Plan is available at: http://groups.ucanr.org/HumboldtBayEBM/

Prosperity!

A Comprehensive Economic Development Strategy (CEDS) adopted by the Humboldt County Board of Supervisors to guide local economic development investments, including those from the U.S. Economic Development Administration. *Prosperity! The North Coast Strategy*, lays out

a strategy that prioritizes the needs of nine "base" industry clusters-those that export products and services to customers outside the region. This strategy applies the leading economic theory and research on how economies function and grow. Base industry clusters compete for customers globally and labor locally, thereby driving greater growth in wages, productivity, and jobs in the local economy.

Available on line at http://www.northcoastprosperity.com/localeconomy/prosperitystrategy

West Coast Governors' Agreement on Ocean Health "Action Plan"

This plan was conceived in 2006 and completed in 2008. Many public meetings were held throughout Washington, Oregon and California. Input from these meetings was used to prepare an ambitious vision for the health of West Coast coastal and ocean resources. The plan's actions include ten priorities, including implementing ecosystem-based management. This plan recognizes ecosystem-based management as an integrating tool and recommends the ecosystem approach to implement their other priority action strategies.

This plan is available on-line at: http://westcoastoceans.gov/

Joint Ocean Commission Initiative "One Coast, One Future: Securing the Health of West Coast Ecosystems and Economies"

This report responds to a request from nineteen West Coast elected officials requesting guidance on high priority areas to improve the health of coastal and ocean ecosystems. The report contains twelve recommendations with substantive analysis. It provides insightful descriptions of root cause of coastal ecosystem problems, short-term and long-term actions local leaders can implement, and strategies for communities to work with local leaders.

This report is available on-line at: http://www.jointoceancommission.org/

The California Ocean Protection Council Five Year Strategic Plan "A Vision for our Ocean and Coast"

This plan was developed by the California Ocean Protection Council in 2006. The plan guides the State of California to protect our unique coastal natural resources and heritage. The Ocean Protection Council was formed following passage of the Ocean Protection Act in 2004. This strategic plan recommends adoption of ecosystem-based management to address coastal natural resource issues. The plan includes long term goals and short term actions for the Ocean Protection Council to pursue. The fourth objective of this plan is to develop and support practical approaches to ecosystem-based management and encourage its implementation throughout the State.

This plan is available on-line at: http://resources.ca.gov//copc

Humboldt Bay National Wildlife Refuge Complex Draft Comprehensive Conservation Plan and Environmental Assessment

The Draft Comprehensive Conservation Plan and Environmental Assessment Plan will guide management of fish, wildlife, plants and other natural resources, and visitor uses on the Humboldt Bay National Wildlife Refuge Complex for the next 15 years. The Plan reflects the responsibilities of the USFWS for migratory birds, threatened and endangered species, interjurisdictional fish, and certain marine mammals. The Humboldt Bay National Wildlife Refuge has units distributed around Humboldt Bay.

This plan is available on line at http://www.fws.gov/humboldtbay/

Appendix B. Project Team

CORE TEAM

Jeff Anderson	Darren Mierau
Greg Crawford	Becky Price-Hall
Vicki Frey	Susan Schlosser
Paula Golightly	Adam Wagschal
David Hull	Mark Wheetley
John Mello	

WORK GROUPS

Strategy A: Establish the Humboldt Bay Initiative	
Jessica Eden	Eric Nelson
Vicki Frey	Christy Prescott
Katie Glover	Becky Price-Hall
Dave Hankin	Ted Romo
Maggy Herbelin	Susan Schlosser
Sharon Kahara	Kate Sullivan
Bill Kier	Betsy Watson
Catherine Kulman	Mark Wheetley
Strategy B: Coordinate Response to Climate and Coastal Change	
Jeff Anderson	Eric Nelson
Diane Ashton	Susan Ornelas
Joél Benegar	Kirsten Ramey
Jesse Eden	Ted Romo
Vicki Frey	Susan Schlosser
Gayle Garman	Lisa Shikany
Paula Golightly	Carol Vander Meer
Peter Jarausch	Adam Wagschal
Aldaron Laird	Betsy Watson
Darren Mierau	Mark Wheetley
Julie Neander	
Strategy C: Coordinate Response to Invasive Species	
Jessica Eden	Katie Glover
Annie Eicher	Aldaron Laird
Yvonne Everett	Julie Neander
Vicki Frey	Andrea Pickart
Joel Gerwein	Kirsten Ramey

Strategy C: Coordinate Response to Invasive Species - continued	
Ted Romo	Carol VanderMeer
Susan Schlosser	Adam Wagschal
Frank Shaughnessy	Betsy Watson
Strategy D: Study and Control Sediment Sources	
Jeff Anderson	Darren Mierau
Diane Ashton	Susan Schlosser
Greg Crawford	Frank Shaughnessy
Vicki Frey	Adona White
Strategy E: Promote Sustainable Development	
Ralph Faust	Vanessa Metz
Joel Gerwein	Julie Neander
Maggy Herbelin	Becky Price-Hall
Tom Hofwebber	Miles Slattery
Catherine Kulhman	
Strategy F: Support Integrated Forest Management	
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Appendix C. Alignment of the Humboldt Bay Initiative strategies with Goals, Objectives & Policies of Other Plans

Strategy A. Establish the Humboldt Bay Initiative	
Planning Document	**Goals, objectives & policies**
Arcata General Plan	RC-11: Participate in HB Mgmt Plan
Eureka General Plan	1.A.3: Work with Bay District on Waterfront Programs
Humboldt County General Plan – Draft Policies	ED-G3: Strategic Planning ED-G4: Cooperation & Collaboration ED-G8: Regulatory & Permit Streamlining
North Coast IRWM Plan	OBJECTIVE 6: Provide an ongoing, inclusive framework for efficient intra-regional cooperation, planning & project implementation
Humboldt Bay Management Plan	RIO 1: Develop interpretive program CPE-3: Establish Advisory Committee HRS-1: Develop and implement a regulatory coordination process for projects around Humboldt Bay that are consistent with adopted plans
Humboldt Bay Watershed Salmon & Steelhead Conservation Plan	B III Water Quality G (entire section): education and coordination
Prosperity! The North Coast Strategy	Goal 4: Invest in our Businesses Strategy B – Invest in the restoration of our natural resources. Watershed improvement program, GIS database of natural resources, Incentives for environmental stewardship in private lands. Strategy F – Recognize & promote industry clusters, businesses, government & community leadership
West Coast Governors' Agreement on Ocean Health	Priority Area 3: Promote the Effective Implementation of Ecosystem-based Management · Promote a strong foundation of knowledge for ecosystem-based management using indicators of health · Strengthen coastal communities' ability to engage in ecosystem-based management initiatives Priority Area 6: Expand Ocean & Coastal Scientific Information, Research & Monitoring · Improve understanding of existing and emerging issues that affect ocean health, and the drivers of change so that ocean and coastal managers have necessary information to make appropriate management decisions
Joint Ocean Commission Initiative (2009) One Coast, One Future: Securing the	Recommendations: 1. Identify a coordination area and engage stakeholders in setting goals

Health of West Coast Ecosystems & Economies	2. Understand and monitor ecosystem health 3. Establish coordination mechanisms 4. Make the land-sea connection 5. Collect and integrate locally relevant information 6. Support integrated, ecosystem-based approaches, particularly at the local level 8. Plan for climate change impacts at all levels of government 11. Creatively consolidate or reallocate existing resources 12. Establish public-private partnerships for funding and in-kind resources.
Ocean Protection Council "Five Year Strategic Plan"	A. Governance 2b. Interagency Collaboration 4a, b. Ecosystem-based Management
Humboldt Bay Nat'l Wildlife Refuge Plan	GOAL 4: Promote long-term viability of HB ecosystems through EBM coordinated with both public & private partners around the bay 4.1.1: Participate in HBEP
Strategy B. Coordinate Response to Climate and Coastal Change	
Planning Document	**Goals, objectives & policies**
Arcata General Plan	RC-4: Open Waters of Arcata Bay & Tidelands PS-3: Floodplain Mapping & Mgmt Program PS-4: Flood Hazards
Eureka General Plan	1.A.3.a: Wetland Management Program 3.G.1: Fishing/Boating Facilities 6.1: Wetland Mgmt Plan 7.B.3: Shoreline Protection
Humboldt County General Plan – Draft Policies	ED-G2: Natural Resources Assets
North Coast IRWM Plan	
Humboldt Bay Management Plan	HSM-7: Identify needs for potential shoreline improvements necessary to accommodate bay water surface elevation changes, including potential effects of climate change
Humboldt Bay Watershed Salmon & Steelhead Conservation Plan	
Prosperity! The North Coast Strategy	
West Coast Governors' Agreement on Ocean Health	
Joint Ocean Commission Initiative (2009) One Coast, One Future: Securing the Health of West Coast Ecosystems & Economies	Recommendation 8: Plan for climate change impacts at all levels of government. Require the coordinated development of local and state climate change adaptation plans to prepare coastal communities and ecosystems for sea level rise, changes in the habitat and life cycles of marine life, and increasing

	frequency and intensity of coastal hazards and other impacts.
Ocean Protection Council "Five Year Strategic Plan"	D. Physical processes and habitat structure 3a. Understand impacts of climate change
HB Nat'l Wildlife Refuge Plan	4.1.2: Bay ecosystems studies & modeling, including sea level rise 4.1.3: Work with partners on sea level rise and climate change
Strategy C. Coordinate Response to Invasive Species	
Planning Document	**Goals, objectives & policies**
Arcata General Plan	RC-1b: Non-native species
Eureka General Plan	
Humboldt County General Plan – Draft Policies	BR-P9: Invasive Plant Species – cooperate with others
North Coast IRWM Plan	OBJECTIVE 1: Conserve & Enhance native salmonid habitat populations by protecting and restoring required habitats, water quality & watershed processes OBJECTIVE 6: Provide an ongoing, inclusive framework for efficient intra-regional cooperation, planning & project implementation
Humboldt Bay Management Plan	CAS-4: Control or remove non-indigenous invasive species CAS-3: Maintain and enhance habitat for sensitive species
Humboldt Bay Watershed Salmon & Steelhead Conservation Plan	
Prosperity! The North Coast Strategy	
West Coast Governors' Agreement on Ocean Health	Priority Area 2: Protect and Restore Ocean and Coastal Habitats · Restore estuarine habitats and their function · Eradicate invasive cordgrasses coast-wide by 2018
Joint Ocean Commission Initiative (2009) One Coast, One Future: Securing the Health of West Coast Ecosystems & Economies	
Ocean Protection Council "Five Year Strategic Plan"	E. Ocean and coastal ecosystems 3a, b, c. Control invasive species
Humboldt Bay Nat'l Wildlife Refuge Plan	GOAL 3: Conserve and restore all refuge habitats through prevention & control of invasive plants and animals 3.1: Prevention & Early Detection – collaboration 3.2: Control and reduce the spread of established invasive species
Strategy D. Study and Control Sediment Sources	
Planning Document	**Goals, objectives & policies**
Arcata General Plan	
Eureka General Plan	
Humboldt County General	

Plan – Draft Policies	
North Coast IRWM Plan	
Humboldt Bay Management Plan	HWM-6: Identify sediment dynamics and develop sediment management CAE-1: base management decisions on maintaining ecosystem, CAE-5: Work cooperatively to develop and implement water quality plan CEP-5:Water quality protection is required.
Humboldt Bay Watershed Salmon & Steelhead Conservation Plan	A III. Habitat Structure. Channel A1, A2, C5, C,- all on sediment; B III Water Quality A Pollution
Prosperity! The North Coast Strategy	
West Coast Governors' Agreement on Ocean Health "Action Plan"	Priority Area 7: Foster Sustainable Economic Development in Coastal Communities · Ensure regional sediment management efforts assist coastal communities with both the long term economic benefits associated with ports, harbors, beaches, and shoreline protection as well as the ecological benefits of coastal and estuarine habitat.
Joint Ocean Commission Initiative (2009) One Coast, One Future: Securing the Health of West Coast Ecosystems & Economies	
Ocean Protection Council "Five Year Strategic Plan"	C. Ocean and coastal water quality 2b. Innovation D. Physical processes and habitat structure 2a. Regional sediment management
Humboldt Bay Nat'l Wildlife Refuge Plan	4.1.2 Bay ecosystems studies & modeling, including sediment transport & currents

Strategy E. Promote Sustainable Development	
Planning Document	**Goals, objectives & policies**
Arcata General Plan	Principles & Goals · Ag, Forest, NR Land Greenbelt · Concentrate Development · Encourage Infill · Retain Ag & NR lands GM-1d: Greenbelt GM-1e: Resource Protection GM-4a: Urban Services Boundary POLICY PF-2: Wastewater Collection, Treatment & Disposal POLICY PF-3: Stormwater Mgmt Wetland & Creek Protection Coastal Zone 4.2: Open Space Policies Resource Conservation Policies RC-5: Ag Resources Mgmt

	RC-7: Water Resources Mgmt RC-9: Soils & Mineral Resources
Eureka General Plan	1.A.4: Coastal Zone Policies for Land Use 4.A.7: Urban Service Extension 4.D: Stormwater Drainage Policies 6.B: Agricultural Preservation Policies 6.5: Gulch Greenway Mgmt 6.D:1 & 2 Timber Resources 6.6: Stormwater Mgmt Guidelines
Humboldt County General Plan – Draft Policies	10.3.4: Standards for Sensitive Critical & Essential Habitats BR-S5: Streamside Management Areas Defined CU-G1: Protection & Enhancement of Cultural Resources SR-G2: Community Separators
North Coast IRWM Plan	OBJECTIVE 1: Conserve & Enhance native salmonid habitat populations by protecting and restoring required habitats, water quality & watershed processes OBJECTIVE 4: Support implementation of TMDLs, the North Coast RWQCB's Watershed Management Initiative, and the Non-Point Source Program Plan
Humboldt Bay Management Plan	
Humboldt Bay Watershed Salmon & Steelhead Conservation Plan	
Prosperity! The North Coast Strategy	
West Coast Governors' Agreement on Ocean Health	Priority Area 1: Ensure Clean Coastal Waters and Beaches · Improve coastal water quality by reducing water pollution through better stormwater management, pollution source detection and reduction and other strategies to reduce polluted runoff
Joint Ocean Commission Initiative (2009) One Coast, One Future: Securing the Health of West Coast Ecosystems & Economies	Recommendation 4: Make the land-sea connection. Ensure that existing codes and ordinances adequately protect the health of coastal and ocean ecosystems, focusing in particular on reducing the impacts of land uses and development on water quality
Ocean Protection Council "Five Year Strategic Plan"	C. Ocean and Coastal Water Quality 2a. Innovation
Humboldt Bay Nat'l Wildlife Refuge Plan	

Strategy F. Support Integrated Forest Management	
Planning Document	**Goals, objectives & policies**
Arcata General Plan	RC-6: Forest Resources Mgmt
Eureka General Plan	6.D.1 & 2: Timber Resources
Humboldt County General Plan – Draft Policies	CO-G2: Conservation of Working Lands CO-P2: Support for Working Lands CO IM2: Working Landscapes SR-G1: Scenic Resource Protection ED-G2: Natural Resources Assets
North Coast IRWM Plan	OBJECTIVE 1: Conserve & Enhance native salmonid habitat populations by protecting and restoring required habitats, water quality & watershed processes OBJECTIVE 4: Support implementation of TMDLs, the North Coast RWQCB's Watershed Management Initiative, and the Non-Point Source Program Plan OBJECTIVE 6: Provide an ongoing, inclusive framework for efficient intra-regional cooperation, planning & project implementation
Humboldt Bay Management Plan	
Humboldt Bay Watershed Salmon & Steelhead Conservation Plan	B III Water quality B: Socioeconomic impacts of watershed management
Prosperity! The North Coast Strategy (Comprehensive Economic Development Strategy) *Forest Products Industry Cluster Work Plan*	Goal 4: Invest in our Businesses Strategy B – Invest in the restoration of our natural resources. Watershed improvement program, GIS database of natural resources, Incentives for environmental stewardship in private lands. Goal 5: Enhance Regional Quality of Life FP Goal 1: Apply efficient mitigation practices that both protect the environment and allow timberland owners see a return on investments… FP Goal 2: Sustainable industry practices and long-term vitality.
West Coast Governors' Agreement on Ocean Health	
Joint Ocean Commission	

Initiative (2009) One Coast, One Future: Securing the Health of West Coast Ecosystems & Economies	
Ocean Protection Council "Five Year Strategic Plan"	D. Physical processes and habitat structure 1c. Habitat restoration
Humboldt Bay Nat'l Wildlife Refuge Plan	