4 Pressures and Stressors

The conservation elements in the RCIS Area are influenced by a variety of pressures, both anthropogenic and natural, that create degraded ecological conditions known as stressors. This section describes the historic, current, and projected pressures and stressors to provide general background information about these factors influencing biodiversity and natural systems in the region.

The pressures and stressors were identified through review of the *State Wildlife Action Plan* (CDFW 2015) for the Bay Delta and Central Coast Province; the list presented therein was expanded and refined through review of additional literature, professional experience, and input from the RCIS technical advisors.

The order of the pressures and stressors presented in the tables and discussion does not reflect their relative impact or importance in the RCIS Area. Rather, they are listed in order of the mechanisms by which they predominantly influence the natural systems (Section 4.1). Specifically, pressures and stressors from land uses (e.g., development, working lands, and mines/quarries) are listed first, followed by water use and other factors that degrade natural systems and threaten species populations. Although climate change is listed near the bottom, it is recognized as one of the largest threats to biodiversity in the RCIS Area and globally.

The pressures and stressors are summarized for aquatic systems (Table 4-1) and upland/terrestrial systems, bat habitat, habitat connectivity, and working lands (Table 4-2). In each table, check marks indicate the pressures and stressors that impact specific conservation elements. The 23 conservation strategies in Section 5.3 describe the unique pressures and stressors impacting each conservation element and identify actions to address them.

4.1 Overview of Mechanisms

The pressures and stressors discussed in this chapter threaten the conservation elements and other biological resources in the RCIS Area through three primary mechanisms:

1. **Habitat Loss**: Reduction of the areal extent of the natural community or species' habitat in the RCIS Area, due to type conversion or other modification caused by a variety of factors including development, mining, and working lands.
2. **Habitat Fragmentation:** Reduction in the patch size and continuity of natural community and species' habitat in the landscape due to habitat loss, which can cause remaining habitat to become isolated. Fragmentation results from habitat loss and habitat degradation.
3. **Habitat Degradation:** Reduction in the quality of the habitat for a species, loss of community structure and species composition or loss of critical ecological functions, due to a variety of anthropogenic factors (e.g., land and water use, exotic species, pollution, artificial light pollution, alteration of disturbance regimes, and unauthorized activities).

Table 4-1: Pressures and stressors affecting the aquatic conservation elements

Pressure	Stressors	Bar Built Estuaries	Riparian and Riverine	Ponds, Lakes, and Reservoirs	Wetlands	Coho Salmon	Santa Cruz Long-Toed Salamander	Southwestern pond turtle
Development: Maintenance of Existing and Creation of New Residential and Commercial Development, as well as Transportation, Water, and other Infrastructure	Reduction in areal extent, complexity, and function of riparian and wetland habitats, which can reduce species distributions, populations, migration, and persistence.	X	X	X	X	X	X	X
	Fragmentation of habitat due to habitat loss and human-created barriers (e.g., dams, culverts, transportation corridors, and other in-stream barriers; fences, structures, and other built environment elements), which can limit access to important habitat, dispersal, and migration, and obstruct metapopulation dynamics.	X	X	X	X	X	X	X
	Degradation of habitat through removal of large woody debris, sediment bars, and riparian vegetation to increase channel capacity and reduce roughness for flood risk reduction.	X	X	X	X	X		X
	Degradation of habitat due to pollution: input of fine sediment (see stresses below), sewage, nutrients, pesticides, and other contaminants; light pollution; and increased water temperature due to loss of vegetation canopy	X	X	X	X	X	X	X
	Reduction in water quantity due to water withdrawals (see specific stresses below); hydromodifications resulting from run-off patterns on impervious surfaces; direct fill of seeps, wetlands, and water bodies.	X	X	X	X	X	X	X
	Disconnection of streams from their floodplains, causing reduced groundwater recharge; and increased seawater intrusion, desiccation of floodplain wetlands; loss of winter refugia and rearing habitat for fish and other aquatic species; reduction of natural sediment and nutrient inputs; disruption of natural flood regimes that create and maintain stream and riparian complexity.	X	X	X	X	X	X	X
	Channel straightening and channel bed/banks armoring for flood control that reduce instream habitat complexity and heterogeneity	X	X	X	X	X	X	X
	Hydrologic impacts and degradation due to impervious surfaces which increase erosion potential during high flow, reduced summer base flows, and degrade water quality through pollutants in run off.	X	X	X	X	X	X	X
	Degradation of habitat through introduction of exotic species (see specific stresses below)	X	X	X	X	X	X	X
Working Lands	Removal of aquatic and riparian communities, which reduces, fragments, and degrades habitat, thus reducing species populations	X	X	X	X	X	X	X
	Habitat fragmentation and reduced landscape permeability through habitat conversion, culverting of streams, installation of fences, and associated human activities	X	X	X	X	X	X	X
	Introduction of effluents, including runoff, fine sediment from chronic erosion (see stresses below), pesticides, pathogens, pollutants, noise, and light	X	X	X	X	X	X	X
	Stream channel modifications (straightening, realignment) that reduce stream length, increase channel slopes, increase stream energy, and result in loss of habitat complexity and connectivity to adjacent habitats.	X	X	X	X	X	X	X
	Elimination or reduction of riparian vegetation and loss of large woody debris which is essential for aquatic habitat conditions (nutrient inputs, temperature regulation, hydrologic regimes, stream bank protection, habitat structure and complexity, etc.).	X	X	X	X	X	X	X
	Introduction of exotic plants and animals	X	X	X	X	X	X	X
Mining and Quarrying	Removal of natural communities, which can reduce, fragment, or degrade habitat		X	X	X	X	X	X

Pressure	Stressors	Bar Built Estuaries	Riparian and Riverine	Ponds, Lakes, and Reservoirs	Wetlands	Coho Salmon	Santa Cruz Long-Toed Salamander	Southwestern pond turtle
	Creation of pollution from noise, light, dust, and stormwater, including fine sediments and turbidity, that can affect species and communities		X	X	X	X	X	X
	Introduction of exotic species (specific stresses are described below)		X	X	X	X	X	X
Water use (diversions, pumping, storage, and return flows)	Habitat loss, due to reduced areal extent of wetted area, critically shallow riffles and pools, and loss of wetland and riparian vegetation due to groundwater depletion		X		X	X	X	X
	Habitat fragmentation due to habitat loss, which isolates pools during the low flows, and fragments riparian and wetland habitat	X	X	X	X	X	X	X
	Degradation of aquatic habitat including: increased salinity and stratification, increased water temperatures, elevated risk of algal blooms, creation of oxygen-deficient conditions, and reduction of aquatic macroinvertebrates.	X	X	X	X	X	X	X
	Invasion and spread of exotic animals (e.g., carp, mosquito fish, bass, and American bullfrog) that out-compete native animals and thrive in non-natural, perennial aquatic features including ponds, lakes, streams, wetlands, and reservoirs created as part of water use projects.	X	X	X	X	X	X	X
Increase Supply of Fine Sediment	Habitat loss due to reduced hydrologic capacity of water bodies (streams, ponds, lakes, and reservoirs) as well as freshwater wetlands	X	X	X	X	X	X	X
	Degradation of stream habitat for foraging, through increased turbidity and reduction in benthic macroinvertebrates, loss of coarse substrate (e.g., cobbles) for spawning, and filling of pools that provide refugia	X	X	X	X	X	X	X
Exotic Plants	Degradation of habitat by outcompeting native plants, including rare plants; reducing habitat diversity and complexity; altering community structure and species composition; killing trees, which increases water temperature, reduces nutrient inputs, and increases predation risk; reducing hydrology through increased water demand; altering water chemistry including dissolved oxygen and nutrients.	X	X	X	X	X	X	X
	Promote fire outside of the natural regime (i.e., increased intensity, frequency, severity, or altered type) by increasing fuels		X		X	X	X	X
Exotic/Domestic Animals	Prey upon native plants and animals; outcompete native animals; and modify food webs	X	X	X	X	X	X	X
Incompatible Recreation	Tramples species or alters their key habitat features (e.g., stream banks, burrows, redds, breach sandbars)	X	X	X	X	X	X	X
	Deters use of habitat by species wary of humans (due to noise, scent, etc.)	X	X	X	X	X	X	X
	Promotes invasion and spread of exotic plants and animals	X	X	X	X	X	X	X
	Disturbs soil and causes erosion, which can lead to sediment deposition that reduces water quality and degrades habitat	X	X	X	X	X	X	X
	Spreads disease	X	X	X	X	X	X	X
	Pollutes water (e.g., with trash, petroleum products, etc.)	X	X	X	X	X	X	X
	Harasses native animals directly (e.g., through fishing)	X	X	X	X	X	X	X
Unauthorized Activities (e.g., camping, cannabis cultivation, dumping and breaching)	Removes established native plants and alters plant community structure and species composition	X	X	X	X	X	X	X
	Pollutes land and water (e.g., with trash, pesticides, etc.)	X	X	X	X	X	X	X
	Reduces water levels (i.e., as a result of unauthorized diversions and consumption)	X	X	X	X	X	X	X
	Ignites wildfires that can degrade habitat	X	X	X	X	X	X	X
	Reduces animal populations through poaching and illegal fishing	X	X	X	X	X	X	X

Pressure	Stressors	Bar Built Estuaries	Riparian and Riverine	Ponds, Lakes, and Reservoirs	Wetlands	Coho Salmon	Santa Cruz Long-Toed Salamander	Southwestern pond turtle
	Impacts water quality, creates unnatural timing and magnitude of breaching events, temporarily fragments habitat through rapid draining of inundated marsh plains	X	X		X	X		X
	Promotes populations of human commensal species (e.g., rats and corvids) that prey upon other native species)	X	X	X	X		X	X
Climate Change	Altered hydrology through more frequent and extended droughts and higher intensity rainfall and runoff events	X	X	X	X	X	X	X
	Altered riparian and wetland vegetation, through anticipated increases in temperature and drought, and reduction in summer fog, which can degrade aquatic habitat for animals	X	X	X	X	X	X	X
	Degrade water quality by increasing temperature, which increases metabolic demand of aquatic species and reduces dissolved oxygen content	X	X	X	X	X	X	X
	Altered disturbance regimes, by increasing the frequency, intensity, and severity of fire or altering the fire behavior – in turn impacting structure and composition of vegetation.	X	X	X	X	X	X	X
Loss of Genetic Diversity	Loss of genetic diversity due to population bottlenecks and fragmentation, which limits interbreeding among distantly related individuals.					X	X	X

Table 4-2: Pressures and stressors affecting the terrestrial conservation elements

Pressure	Stressors5-25	Grasslands	Maritime Chaparral Knobcone Pine Forest	Sandhills and Sand Parkland	Santa Cruz Cypress Forest	Monterey Pine Forest	Oak Woodland and Forest	Redwood and Douglas-Fir Forest	Beach, Dunes, and Rocky Cliffs	Karst Caves	Santa Cruz Tarplant	Mount Hermon June Beetle	Marbled Murrelet	Mountain Lion	Santa Cruz Long-Toed Salamander	Southwestern pond turtle	Bat Habitat	Habitat Connectivity	Working Lands
Development-Maintenance of Existing and Construction of New Residential, Commercial, Transportation, and other Infrastructure	Reduction in the areal extent of habitat, which can reduce species distributions, populations, and persistence	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
	Fragmentation of habitat, by removing habitat, creating barriers (e.g., buildings, transportation, and fences), which reduces connectivity and permeability of the landscape to movement by species and ecological processes (e.g., fire)	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
	Degradation of habitat due to: exotic (incl. domestic) species; noise, light, and air pollution; pesticides; runoff; altered disturbance regime (e.g., fire exclusion and flood control); other human activities	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Working Lands	Removal (i.e., type conversion) of natural communities, which reduces, fragments, and degrades habitat, thus reducing species populations	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	
	Alteration of community structure and species composition due to grazing and selective harvest, which changes abiotic and biotic habitat	X					X	X			X		X	X	X	X	X	X	
	Fragmentation and reduced landscape permeability through including through fences and human activities	X	X	X	X	X	X	X	X					X	X	X	X	X	
	Introduction of effluents, including runoff, pesticides, pollutants, noise, and light	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Introduction of exotic plants and animals	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
Mining and Quarrying	Removal of natural communities, which can reduce, fragment, or degrade habitat	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
	Creation of pollution to noise, light, and air that can affect species and communities	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
	Introduction of exotic species (see specific stresses below)	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Altered Disturbance Regimes	Exclusion of fire, which can inhibit fire-adapted species (e.g., fire followers) and cause unnatural succession that eliminates, fragments, and degrades habitat earlier successional species	X	X	X	X	X	X	X	X		X	X			X	X	X	X	X
	Increase the size, intensity, and severity of fires, and alter the fire type (e.g., canopy rather than ground fire), impacting species and altering post-fire community structure and species composition	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X

Pressure	Stressors5-25	Grasslands	Maritime Chaparral Knobcone Pine Forest	Sandhills and Sand Parkland	Santa Cruz Cypress Forest	Monterey Pine Forest	Oak Woodland and Forest	Redwood and Douglas-Fir Forest	Beach, Dunes, and Rocky Cliffs	Karst Caves	Santa Cruz Tarplant	Mount Hermon June Beetle	Marbled Murrelet	Mountain Lion	Santa Cruz Long-Toed Salamander	Southwestern pond turtle	Bat Habitat	Habitat Connectivity	Working Lands
	Reduction/elimination of native ungulate grazing mammals, resulting in shrub encroachment and thatch buildup	X									X				X	X		X	
Unauthorized Uses (e.g., illegal camping, illegal cannabis cultivation, and illegal dumping)	Removes established native plants and alters plant community structure and species composition	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Pollutes land and water (e.g., with trash, pesticides, etc.)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Reduces water levels (i.e., as a result of unauthorized diversions and consumption)									X					X	X	X		X
	Ignites wildfires that can degrade habitat	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
	Reduces animal populations through poaching and illegal fishing								X					X		X	X		
	Promotes populations of human commensal species (e.g., rats and corvids) that prey upon other native species)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Incompatible Recreation	Tramples species and their key habitat features (e.g., burrows)	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X
	Deters use of habitat by species wary of humans (due to noise, scent, etc.)	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X
	Promotes invasion and spread of exotic plants	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X
	Disturbs soil and causes erosion	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X
	Spreads disease	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Exotic Plants	Outcompete native plants, reducing rare plant populations	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X
	Degrade habitat for native animals by reducing populations of palatable plants and altering community structure and species composition	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Increase soil nutrients (e.g., nitrogen), promoting further invasions and altering community structure and species composition	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Promote fire outside of the natural regime (i.e., increased intensity, frequency, severity, or altered type) by increasing fuels	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Exotic Animals (incl. domestic animals)	Prey upon native plants and animals; outcompete native animals	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X
	Spread disease	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Deter animal use through presence (incl. scent)	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Climate Change	Directly reduce suitability of habitat by affecting temperature and precipitation regimes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Pressure	Stressors5-25	Grasslands	Maritime Chaparral Knobcone Pine Forest	Sandhills and Sand Parkland	Santa Cruz Cypress Forest	Monterey Pine Forest	Oak Woodland and Forest	Redwood and Douglas-Fir Forest	Beach, Dunes, and Rocky Cliffs	Karst Caves	Santa Cruz Tarplant	Mount Hermon June Beetle	Marbled Murrelet	Mountain Lion	Santa Cruz Long-Toed Salamander	Southwestern pond turtle	Bat Habitat	Habitat Connectivity	Working Lands
	Change abiotic habitat conditions including surface and ground water	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Modify the structure and species composition of communities which can reduce, fragment, or degrade habitat	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Alter disturbance regimes, by increasing the frequency, intensity, and severity of fire or altering the fire type, and changing flood regimes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Loss of Genetic Diversity	Loss of genetic diversity due to population bottlenecks and habitat fragmentation, which limits interbreeding among more distantly related individuals.											X		X	X				

In addition, **climate change**, or alteration of the climate (i.e., temperature, precipitation, wind, fog, etc.) due to anthropogenic greenhouse gas emissions, can result in the widespread loss, fragmentation, and degradation of habitat. Habitat loss, fragmentation, degradation, climate change, can interact to threaten habitat connectivity which, in turn, impacts the other conservation elements.

Reductions in population size and fragmentation of populations can cause species to go through genetic bottlenecks that **reduce genetic diversity**. These declines in genetic diversity also constitute pressures, as they can increase susceptibility of populations to disease and reduce their ability to adapt to changing conditions in ways that can reduce their long-term persistence.

4.2 Development

The RCIS Area is subject to various development activities including the construction, maintenance, and use of: residential and commercial development and infrastructure for water, energy, transportation, and related public services. Such development converts habitat directly, fragments remaining habitat, and often degrades adjacent habitat as a result of intensified human activities that lead to pollution, introduction of invasive species, and changes in sound, light, and other environmental variables. These impacts can be associated with new development and ongoing use and maintenance of existing development and infrastructure.

Most new development and operations and maintenance of public infrastructure are subject to local, state, and federal regulations to protect sensitive biological resources that reduce the pressures and stressors. However, some ongoing improvements to existing developed lands are not subject to environmental protection measures and mitigations. Section 2.2 describes the current land uses including development and planned future development and infrastructure improvements in the RCIS Area.4- 4-4-Table 4-1 and Table 4-2 identify some of the primary stressors to the conservation elements and other natural systems caused by development-related activities.

4.3 Working Lands

Although working lands are a conservation element addressed in this RCIS (Section 3.4), cultivated agriculture, timber harvest, and livestock grazing can also constitute a pressure for some of the natural communities and focal species addressed in this RCIS. If and how working lands present stresses depends on the location and type of land use and management actions (Table 4-1 and Table 4-2). Cattle grazing can help maintain coastal terrace prairie and other grassland habitat; in the absence of recurring fire, livestock grazing can also help prevent shrub encroachment and thus type conversion of much of the grassland habitat in the RCIS Area, which is essential for foraging raptors and a high percentage of the county's rare plants. Grazing is also essential to maintaining populations of some special-status species, including Santa Cruz tarplant and Ohlone tiger beetle. Nonetheless, incompatible grazing can degrade habitat for some species, by removing plants required for shelter and food; promoting the invasion and

spread of exotic plants; affecting hydrologic and erosional processes; and degrading water quality in streams and ponds.

Economically viable timber harvests help maintain redwood forest habitat in the RCIS Area, which might otherwise be subject to rural residential development. Selective timber harvest, as practiced in the Santa Cruz Mountains region, reduces tree density and, in doing so, can help re-create natural community structure and species composition in redwood forests that were historically clear cut around the turn of the 20th century (O'Hara et al. 2010, Plummer et al. 2012). Nonetheless, timber harvest, like any disturbance, can degrade habitat for some species, by altering plant community structure and species composition, including by promoting the invasion and spread of exotic species through road construction and equipment that has not be adequately decontaminated; timber harvest and associated road construction can also influence both hydrologic and sediment delivery processes, thereby reducing habitat quality and water quality in aquatic systems with specific water quality BMPs are not installed and monitored for effectiveness. Historic timber harvest activities have resulted in reduced recruitment of large woody debris into streams, which degrades riverine and associated riparian habitat by simplifying the channel structure, disconnecting streams from floodplains, reducing sediment and nutrient retention capacity, disrupting hydrologic processes, and reducing cover for aquatic organisms. It is important to note that California Forest Practice Rules (Section 14 CCR 916.9) have specific, legally required, local practices for Santa Cruz County and these are arguably the most restrictive and protective in North America. Moreover, the Forest Practice Rules specifically require retention of the largest trees along watercourses, explicitly to maximize future the recruitment of large woody debris by retaining trees that are most likely to fall into stream channels.

Cultivated agriculture can benefit certain species that utilize aspects of cultivated land (e.g., tricolored blackbirds, pollinators), and through implementing management practices that steward the soil and water, cultivated agriculture can provide critically important ecosystem services like carbon sequestration, improved soil microbe diversity, and water treatment and infiltration. Economically viable agriculture helps maintain open space in the RCIS Area, preventing conversion to other developed land uses. However, it generally negatively impacts biological systems by converting and fragmenting habitat and in some cases blocking migrations/movement corridors. Activities associated with food production can also degrade adjacent habitat through a variety of mechanisms as outlined in Table 4-1and Table 4-2. The cultivation of cannabis can have similar impacts to other cultivated crops. Illegal operations conducted without local land use permits and associated protections and mitigations (Section 4.9) can remove, degrade, and fragment habitat, introduce pesticides that can cause impacts to native animals and plants, and reduce the quality and quantity of water in streams and ponds (County of Santa Cruz 2017).

4.4 Mines and Quarries

The RCIS Area features mines and quarries that are used to obtain raw materials for building and product development, mines for limestone, shale, granite, and sand. While the scale of

mining activities in the RCIS Area is small compared to other land uses, such as development and working lands, mining activities result in the direct removal of established natural communities, fragmentation of habitat, and if not well managed, degradation of adjacent habitat by introducing exotic plants and pollution (e.g., effluents, sediment, and noise). The impacts depend on the natural system being evaluated but are most acute for those subject to mining including the sandhills, which have been extensively mined for sand. Karst caves, which were subject to limestone quarrying. In addition, streams and associated aquatic systems including wetlands in and adjacent to mines, have also been impacted by mining, which can alter flow patterns and increase input of fine sediments and other pollutants.

Current regulations including the Surface Mine and Reclamation Act (SMARA) and the County Mining Ordinance require reclamation following mining activities; however, habitat restoration is not required and instead, the modified areas must be reclaimed for an end use which could include development. Moreover, many quarries in the RCIS Area, including three quarries in the Santa Cruz Sandhills, were created before the passage of SMARA in 1975, leaving some mined areas and entire quarries un-reclaimed.

4.5 Water Use

Water use associated with commercial and residential development and agriculture in the RCIS Area can negatively impact the region's aquatic and groundwater dependent ecosystems. The region derives most of its water from surface and groundwater sources located within the RCIS Area, which are the same sources that are critical for maintaining natural hydrologic regimes and, in turn, the native vegetation and fish/wildlife species adapted to aquatic habitats (Mackenzie et al. 2011). Stream diversions can reduce stream flows during periods that are critical for fish and other aquatic species, while groundwater pumping can lower water tables, result in seawater intrusion, and reduce hyporheic water that supports stream flows and wetland and riparian plants; these changes can, in turn, lead to increased sun exposure, higher water temperatures, algal blooms and/or oxygen deficient conditions that impact aquatic invertebrate populations. Meanwhile, water storage (e.g., ponds and reservoirs), irrigation and return flows (e.g., agricultural, residential, or industrial) can create unnatural perennial aquatic features that provide habitat for invasive species that outcompete native aquatic species adapted to seasonal precipitation and run-off patterns in the RCIS Area.

4.6 Altered Disturbance Regimes

Various anthropogenic factors have altered the regime of natural disturbances, including floods and fire, that structured the RCIS Area's natural communities and to which many species, including rare species, are adapted (Section 2.4.3).

Natural flood regimes and storm hydrographs play an important role in structuring riverine and riparian habitat, as well as other natural communities that are surface and groundwater dependent, such as ponds and wetlands. The aerial extent, frequency, and intensity of flooding has been altered by development (e.g., increased storm peaks resulting from impervious

surfaces and increased stream energy due to straightened channels), and historic tide gates intended to limit the flow of saline water upstream, but often fail or leak, which can negatively impact plants and animals adapted to freshwater regimes, and water management infrastructure (e.g., dams and flood control levees that reduce peak flows, disconnect natural floodplains, and interrupt natural sediment transport processes). These changes, including flood control projects on the San Lorenzo and Pajaro rivers, can affect the structure and composition of vegetation in these communities and can result in loss or extirpation of native fish and animals that are adapted to the natural disturbance regimes. The changes to flood related disturbance regimes are being further influenced by climate change.

Fire exclusion/suppression to protect lives and property have reduced fire frequency, leading to senescence risk for species that require fire to regenerate. When fires do eventually occur, the unnaturally high fuel levels can increase fire severity and intensity (Steel et al. 2015) and even alter the fire type from surface to canopy fire in some systems; these changes in the fire regime can alter the effects of fire for even fire-adapted systems. Meanwhile, increasing temperatures and drought due to climate change can expand the seasonality of fire, which historically occurred primarily during the dry season but can occur throughout much of the year as a result of reduced precipitation and warmer temperatures; these climate changes also have the potential to increase fire frequency.

Increased incidence of fire in the landscape can degrade habitat through a variety of mechanisms, including altering plant community structure and species composition, promoting the invasion and spread of exotic plants (which can also promote fire), and leading to fire suppression activities including use of fire retardant and installation of fire (i.e., dozer) lines that can degrade habitat through a variety of mechanisms including denuding habitat, promoting exotic plants, and altering soil nutrient cycles and surface water flow paths.

In addition, increased wildfire risk has increased vegetation clearing and tree removal, including the construction and maintenance of fuel breaks and shaded fuel breaks, and increased defensible space vegetation clearing around buildings and roads, particularly in the in the Wildland Urban Interface. Such fuel reduction degrades and fragments habitat through a variety of mechanisms, including: 1) removing native plants, including rare plant species (e.g., silverleaf manzanita); 2) alter the structure of vegetation (e.g., removing litter, herbaceous, shrub, and/or tree cover) and downed woody debris used by decomposers; 3) removing food plants used by native animals, and 4) promoting the invasion and spread of exotic plants that are adapted to disturbance.

4.7 Exotic Species

Exotic plants are stressors resulting from various land uses including development, mining, and working lands, and are a pressure themselves, causing a host of stresses for natural communities and species (Table 4-1 and Table 4-2). Due to its history of land use and diversity of natural systems, Santa Cruz County supports (at last tally) 556 exotic plant taxa (i.e., those not native to California), which constitute slightly more than one third of the region's flora

(Neubauer 2013). Some of these exotic species are regarded as invasive, as they exert strong negative impacts on native species and communities through competition, altering natural community structure and species composition, or altering ecosystem properties including nutrient cycling and disturbance regimes. Many of these invasive plant species provide limited or no habitat or food for native animals and, without their native predators to control their populations, can rapidly increase their populations and degrade natural communities.

Non-native animals can similarly stress natural systems through various mechanisms, including competition, predation, disease transmission, and altering community structure, food webs, and ecosystem functions. Aquatic systems have been acutely impacted by non-native invertebrates (e.g., New Zealand mudsnail), fish (e.g., mosquito fish, carp, and bass), and American bullfrogs. Upland systems are affected by wild turkeys, which have become abundant in the Santa Cruz Mountains in the past decade, as well as wild boar (feral pigs).

4.8 Incompatible Recreation

Though well-managed outdoor recreation can be compatible with many of the focal species and natural communities, some recreational activities can impact aquatic and terrestrial systems through a variety of mechanisms (Table 4-1 and Table 4-2). Terrestrial recreation activities, including hiking, dog walking, horseback riding, mountain biking, and off-highway vehicle use, can degrade habitat by trampling established plants and animals or their habitat (e.g., burrows); cause erosion; result in direct harassment of native animals; polluting habitat through unmanaged waste and debris; and promoting the invasion and spread of exotic plants. The extent of these impacts depends on a variety of factors including the type, intensity, frequency, areal extent, and seasonality of uses.

Trampling and erosion from terrestrial recreational activities can also negatively impact aquatic systems, including by removing established vegetation and degrading water quality (e.g., through sedimentation and animal waste). Additionally, aquatic systems can be impacted by water-based activities including boating, fishing, and surfing (incl. kite surfing), which can harass native animals, introduction of exotic animals (e.g., New Zealand mudsnail) and plants, and introducing effluents and light pollution, which can alter aquatic species behaviors (movements and habitat use) and lead to increased predation.

4.9 Unauthorized Activities

Natural communities and species have been negatively impacted by a host of additional human activities. These include unauthorized activities that occur on protected as well as unprotected lands and are generally not designed or implemented to avoid, minimize, and mitigate their impacts on sensitive habitat and species. These unauthorized activities include:

- Unauthorized camping;
- Illegal dumping;
- Illegal cannabis growing;

- Unauthorized grading;
- Unauthorized breaching of lagoons; and
- Unauthorized vegetation removal.

These and other similar unauthorized activities, can degrade habitat and impact populations of native species through a variety of mechanisms including: temporary loss of habitat, removal of established vegetation; degradation of water quality; reduction in water availability; ignition of wildfires; introduction of chemicals that impact native species; poaching; and introduction of trash that promotes populations of human commensal species including exotic rats, and native corvids including common raven. These animals associated within human activity can outcompete native species, including marbled murrelet, through predation. The potential impacts of lagoon breaching (authorized and unauthorized) is discussed in more detail in Bar-Built Estuary conservation element.

4.10 Climate Change

4.10.1 Projected Climate Changes

4.10.1.1 Temperature

Within the RCIS Area, overall temperature is anticipated to increase substantially as a result of climate change (Table 4-3). Under the projection based on Representative Concentration Pathway 4.5 (RCP 4.5), which represents a mitigation scenario where global carbon dioxide emissions peak by 2040, average annual minimum temperatures will increase by 3.7 °F by mid-century and 4.8 °F by the end of the century, while changes in the average annual maximum temperature will be 3.4 °F and 4.4 °F, respectively (Table 4-3). Under the 'Business as Usual' scenario, where global CO2 emissions continue to rise through the 21st century (RCP 8.5), average annual minimum temperatures will increase by 4.7 °F by mid-century and 7.7 °F by the end of the century, while average annual maximum temperatures will increase by 4.3 °F and 7.0 °F, respectively (Table 4-3; Langridge 2018).

Table 4-3: Projected climate change in Santa Cruz County (Langridge 2018)

Climate Variable (Average Annual)	Historical (1961-1990)	RCP 4.5 Mid-Century (2040-2069)	RCP 4.5 End of the Century (2070-2099)	RCP 8.5 Mid-Century (2040-2069)	RCP 8.5 End of the Century (2070-2099)
Minimum Temperature (°F)	42.8	46.5	47.6	47.5	50.5
Maximum Temperature (°F)	67.5	70.9	71.9	71.8	74.5
Precipitation (inches)	37.2	40.6	41.3	41.5	47.0

4.10.1.2 Precipitation

Precipitation in the RCIS Area is expected to increase slightly, while precipitation variability will increase substantially (Table 4-3, Langridge 2018). Under the RCP 4.5, average annual precipitation will increase 3.4 inches by mid-century and 4.1 inches by the end of the century, while these increases will be 4.3 inches and 9.8 inches, respectively, under RCP 8.5 (Table 4-3; Langridge 2018).

Climate change is anticipated to increase the frequency of atmospheric rivers: narrow regions in the atmosphere that transport most of the water vapor outside of the tropics and are the dominant drivers of locally extreme rainfall events (Dettinger 2011). At the same time, climate change is anticipated to bring future extreme and prolonged droughts. Overall, precipitation is anticipated to have more extreme 'swings' between drought and flood; the California Central Coast region is predicted to have a 25 to 100 percent increase in extreme dry-to-wet precipitation events, despite only modest changes in mean precipitation (Langridge 2018).

Changes in precipitation and temperature are likely to reduce stream flows during the summer low-flow season, causing negative effects on aquatic systems and species including salmonids (Crozier et al. 2019). Even if there are increases in annual average precipitation, summer low flows are likely to decrease due to increased evapotranspiration caused by increased temperature, more than offsetting the potential increase in precipitation.

4.10.1.3 Fog

The impacts of climate change on coastal fog, an important aspect of the climate in the RCIS Area for a variety of terrestrial and aquatic systems and species including coast redwood and maritime chaparral, are difficult to predict; this is because fog is the result of interactions between ocean, air, and land systems, which are poorly understood (Langridge 2018).

4.10.1.4 Sea Level Rise

Sea level in the San Francisco Bay, just north of the RCIS Area, is anticipated to rise between 7 and 33 cm by the middle of the century and 35 to 141 cm by the end of the century under RCP 4.5; under RCP 8.5, these levels are 10-38 cm and 72-240 cm, respectively (Pierce et al. 2018). Estimates for sea level rise in Monterey to the south of the RCIS Area are similar albeit slightly lower (Pierce et al. 2018). Figure 4-1 illustrates the areas along the coast of the RCIS Area that are anticipated to be affected by an 8-foot rise in sea level (NOAA 2017). Accelerating sea level rise combined with lack of sediment in the system is anticipated to 'drown' or 'squeeze' beaches between the rising sea and the backing cliffs and/or urban areas (Langridge 2018).

4.10.1.5 Interactions and Influence on Disturbance

The predicted changes to climate outlined above, along with other potential changes such as to wind, will interact to alter the landscape through complex mechanisms that will influence species and communities by altering disturbance regimes (Langridge 2018):

- Fire size, frequency, and/or severity may increase due to increases in temperature and drought, which together increase the climatic water deficits—a measure of water availability relative to water demand, which influences fuel moisture (Westerling et al. 2006, Sankey et al. 2017); and
- Flooding along the coast and streams may increase as a result of periodic El Niño, atmospheric rivers, and sea level rise.

These and other indirect effects of climate change via altered disturbance regimes are projected to have large consequences for communities and species in the Central Coast. Increased fire, in particular, can promote type conversion of forests and shrublands to grasslands, which in turn can promote more frequent fire as part of the grass-fire cycle (D'Antonio and Vitousek 1992, Syphard et al. 2019).

4.10.2 Vulnerability of Conservation Elements

Climate change will impact the conservation elements of the RCIS through a variety of direct and indirect mechanisms including by causing changes in: 1) abiotic conditions that influence suitability of the habitat directly in terms of temperature, moisture, humidity, and other factors that influence life; 2) resource availability, including soil moisture, carbon dioxide, and nutrients for plants and other primary producers, and food for animals; 3) interactions among species, including competition, predation, as well as facilitation; 4) disturbance regimes, which can influence plants and animals directly as well as indirectly, by altering habitat through the mechanisms above; and 5) alterations to human systems. These changes will interact in complex ways that render it difficult to predict the net effects on individual species and communities in many cases.

To assess the vulnerability of the conservation elements to climate change, this RCIS assesses three elements (Glick et al. 2011):

1. **Exposure:** the character, extent, and magnitude of the changes that the species or system will experience, based on extrinsic factors (i.e., the climate changes themselves);
2. **Sensitivity:** tolerance of the species or system to climate changes based on the innate characteristics (i.e., aspects of the community or species);
3. **Adaptive capacity:** ability of the species or system to accommodate or cope with climate change impacts with minimal disruption.

These climate change vulnerability analyses are outlined in the conservation strategy sections presented for each conservation element (Section 5.3), which also identify how the strategy (goals, objectives, actions, and priorities) will aid adaptation to climate change.

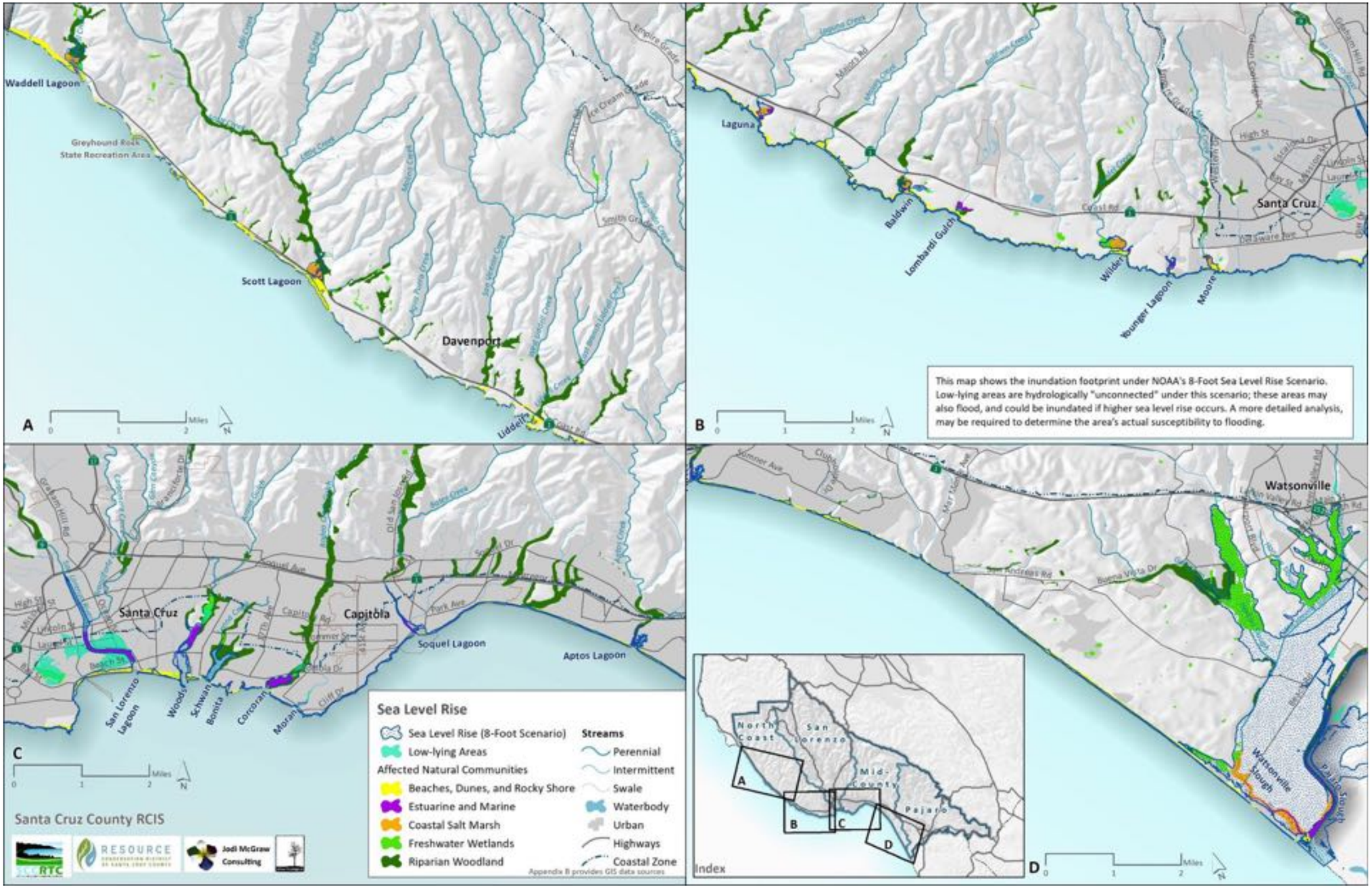

Figure 4-1: Sea Level Rise