Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
Coastal/Marine							
Altamaha—Ogeechee Estuarine Complex, USA	Regularly Flooded Salt Marsh	Size/Extent	**SLR**	Sea Level Rise (20-55cm)	1	Predicted increase in sea level will exceed accelerated sediment accretion, resulting in habitat loss	**Habitat loss/extent of habitat decrease**
	Intertidal Oyster Reef Communities	Characteristic Faunal Communities / (Species/Community Health)	**SST**	Sea Surface Temperature Increase (1-3 deg C)	2	Predicted increase in sea surface temperature will increase the ability of invasive species to expand their range into oyster reef habitat, competing for resources and spreading disease , thus reducing the oyster population.	**Pests and invasives**
	Sandy Beach Ecosystems	Size/Extent / (Sediment Regime)	**SLR**	Sea Level Rise (20-55cm) / Increased Frequency & Intensity of Storm Events (10-20% increase in maximum intensity)	1	Predicted increase in sea level will upset the natural accretion/loss balance while increased frequency and intensity of storms will cause additional loss of substrate. Overall result = loss of habitat.	**Habitat loss/extent of habitat decrease**
	Tidal Creek Systems	Water Quality (Salinity)	**SLR**	Sea Level Rise (20-55cm)	1	Saltwater intrusion resulting from sea level rise will impact the ecosystem, affecting the condition of rivers, tributaries, tidal creeks and sounds	**Habitat conditions (integrity/viability)**
Edge of Ice, Massachusetts, USA	Coastal Xeric Complex	Community architecture (fire regime; early seral)	**Precip**	Increased annual precipitation (increased winter precipitation [+11 - +16%] and increased short-term summer drought [+7 droughts per 30 years])	2	Less opportunity for prescribed burns because of out-of-prescription conditions. Increased risk of summer wildfire and adverse human response towards prescribed burning.	**Fire regime**
	Coastal Moraine	Size/extent of characteristics communities	**Precip**	Increased annual precipitation (increased winter precipitation [+11 - +16%] and increased short-term summer drought [+7 droughts per 30 years])	1	Increased drought stress increases tree mortality, encourages pests and pathogens, and variable inter-annual precipitation decreases parasitoid control of pest moths. Canopy openings and artificial clearing increase invasive plant establishment, enhance fire risk.	**Pests and invasives**

Project Team Comments		
Sources (SLR): http://www.sciencedaily.com/releases/2009/01/090108101629.htm Source (sediment accretion): Craft, C., J. Clough, J. Ehman, S. Joye, D. Park, S. Pennings, H. Guo and M. Machmuller. 2009. Effects of Accelerated Sea level Rise on Delivery of Ecosystem Services Provided by Tidal Marshes: A Simulation of the Georgia (USA) Coast. Frontiers in Ecology and the Environment. **8/4/2009: Changed KEA from Sediment Regime to Size/Extent; Likelihood of Impact = 1		
Source (SST): IPCC Climate Change 2007 Synthesis Report 4 Summary for Policymakers p. 19 (http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm) Source (Invasives): Need to contact Thomas Bliss at UGA MAREX and Danny Gleason at GSU (potential changes in ocean pH impact on oyster reef?); Likelihood of Impact = 2?		
Source (climate change impacts on coastlines): Evans, R.L. 2004. Rising Sea Levels and Moving Shorelines. Oceanus p. 1-6 (http://www.whoi.edu/page.do?pid=11914&tid=282&cid=2484); Source (frequency and intensity of storms): Saunders, M.A. and A.S. Lea. 2008. Large contribution of sea surface warming to recent increase in Atlantic hurricane activity. Nature p. 557-561 and IPCC 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability p. 349; Likelihood of Impact = 2? May need to get more input on this from Clarke Alexander or Jim Henry? Additionally, while sandy beaches in the project are are currently able to migrate due to the absence of jetties, seawalls and other shoreline hardening infrastructure, if human response to sea level rise includes building this infrastructure then the previously mentioned impacts would be greatly exacerbated. Likelihood of Impact = 1		
Lilkelihood of impact = 1		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Unfragmented Forest Block	Minimum dynamic area	**Precip**	Increased annual precipitation (increased winter precipitation [+11 - +16%] and increased short-term summer drought [+7 droughts per 30 years])	2	Increased drought stress increases tree mortality, encourages pests and pathogens, and variable inter-annual precipitation decreases parasitoid control of pest moths. May require larger minimum dynamic area to accommodate larger and/or more frequent disturbance regime.	**Pests and invasives**
	Large Wetlands	Groundwater hydro regime (water level fluctuation)	**Precip**	Increased short-term summer drought (+7 droughts per 30 years).	4	Increased demand on groundwater supplies during drought may further or prolong lower groundwater levels, inviting tree stress, pathogens, loss of habitat and isolation of nested species.	**Water availability**
	Coastal Ponds and Bays	Ability of species and systems to shift within and between systems (fen and marsh migration)	**SLR**	Sea level rise (+.6 - .9 meters).	1	In long run, SLR will drive fens and marshes in-land, where they will conflict with existing/future development.	**Habitat loss/extent of habitat decrease**
	Low-gradient coastal watershed >500 sq mi (Taunton River, tributaries and wetlands)	Flow regime timing/magnitude/duration	**Precip**	Increase in summer low-flow duration (up to 30 days)	3	Human response to drought risk results in holding back more water in reservoirs, effecting diadromous fish.	**Water availability**
	Low-gradient coastal watershed >500 sq mi (Taunton River, tributaries and wetlands)	Water chemistry regime	**Temp**	Increased summer temperature (average annual surface temperatures 4.5-5.3 C)	2	Increased frequency & duration of high water temp/low DO make waters chemistry less viable for many species	**Hydrologic regime**

Project Team Comments		
(Note: increased storm events and human-maintained beach openings may locally lower pond levels in short term.)		

Project Name and Location	Conservation Target	Key Eecological Attribute	Climate Factor		Likelihood of Climate Factor Change	Hypothesis of Change	Impact category
Northern Reefs, Palau	corals	presence/abundance of coral species, coral species composition/dominance (diversity)	**SST**	Increased seawater temperature (+1-1.5 C)	2	Increase in seawater temperature causes bleaching of corals leading to lower abundance and diversity of coral species	**Altered species composition**
	spawning aggregation sites	Presence/abundance of keystone species	**SST**	Increased seawater temperature (+1-1.5 C)	4	Increase in seawater temperature will lead to declines in abundance of aggregating fish species because of the degradation of habitat by bleaching	**Habitat loss/extent of habitat decrease**
	corals	Presence/abundance of keystone species	**OA**	Ocean acidification	4	Increase in ocean acidification would lead to lower growth rate of corals therefore favoring growth of non-calcifying organisms	**Altered species composition**
	Corals	Presence/abundance of keystone species	**OA**	Ocean acidification	4	Increase in ocean acidification would lead to lower recruitment of corals leading to lower coral cover and diversity	**Direct impacts on species survival; Habitat loss/extent of habitat decrease**
	giant clams	presence and abundance of keystone species (clams)	**SST**	Increased seawater temperature (+1-1.5 C)	2	increased sea temperatures will lead to reduced abundance of clams due to bleaching	**Direct impact on species survival**
	Giant Clams	Presence/abundance of keystone species	**OA**	Ocean acidification	4	Increase in ocean acidification would lead to lower growth rate of clams leading to lower abundance	**Growing/mating season**
	Giant Clams	Presence/abundance of keystone species	**OA**	Ocean acidification	4	Increase in ocean acidification would lead to lower recruitment of giant clams leading to lower abundance	**Growing/mating season**

Project Team Comments		

Project Name and Location	Conservation Target	Key Eecological Attribute	Climate Factor		Likelihood of Climate Factor Change	Hypothesis of Change	Impact category
Western Arctic, Alaska, USA and Canada	Ice-dependent marine mammals (polar bear, Pacific walrus, ribbon seal, ringed seal, bearded seal, and spotted seal)	sea ice (length of ice-free season, measured in days per year)	**Temp**	warming air (5-13 degrees F) and water temperatures	2	Warming water and air temperatures will continue to accelerate sea-ice loss, and loss of thick, multi-year ice, will result in loss of denning, pupping, molting, resting, and hunting habitat	**Habitat loss/extent of habitat decrease**
	seabirds (Common Eider)	availablity of barrier island nesting habitat	**Extremes**	storm intensity	3	Longer ice-free season results in increased intensity and frequency of storms, leading to increased erosion of barrier islands and less available habitat.	**Habitat loss/extent of habitat decrease**
	Bowhead whale	calf survival	**SST**	increased water temperature	4	increased water temperatures lead to a northerly shift in killer whale range; increased predation pressure on bowhead calves leads to decreased calf survival	**Shift in geographic space of habitat; Food web/trophic level disruptions**
	Benthic Fauna (epifauna and infauna)	community composition	**SST**	increased water temperature	2	Increased water temperatures fosters northern expansion of competitive species resulting in change in community composition favoring southern speicies over arctic species	**Altered species composition**
	Greater and Lesser Scaup	nesting habitat	**Temp**	increased air temperatures (5-13 degrees F)	2	Increased air temperature leads to increased permafrost melt causing change in hydrography (e.g., fissures, drainage, reduced sheetflow) and causes loss of nesting habitat.	**Growing/mating season; Hydrologic regime**
	Barren ground caribou	Access to winter forage	**Precip**	Increased occurrence of rain on snow events	4	Episodic decreased access to winter forage due to thick ground ice from rain on snow events, results in poorer condition and increased mortality	**Direct impact on species survival**

Project Team Comments		
The extent, depth/thickness, and age of sea ice (as well as sea ice drift and other dynamics) are all important considerations for this target; however, for the purposes of a quantifiable KEA, as well as one which is relevant to sea-ice projections regarding the onset of an ice-free Arctic in summer, we focus here on the length of the ice-free season.		
An increase in the area of open water, along with an increase in the acceleration of sea ice drfit, is linked to an increase in surface wind stress, which leads to increased storminess.		
The highest benthic biomass in our region occurs over the Chukchi continental shelf (less than 100m depth); at this depth water temperature will increase. Specific species are not included in this target, as community composition in the benthos of this region is still poorly quantified.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
Estuaries, Lakes and Wetlands							
Chongming Dongtan Estuary, China	Dongtan Intertidal Flats	Hydrologic regime - (timing, duration, frequency, extent): Duration and frequency of flooding from wind tides	**SLR**	Sea level rise	2	Predicated increase in sea level rise will increase duration and frequency of flooding for intertidal flats, which finally cause the loss of the bare flat and Scirpus mariqueter.	**Hydrologic regime; Direct impact on species survival**
	Dongtan Intertidal Flats	Soil/sediment stability & movement: Annual rate of seawards accretion of estuarine (salt marsh) soil	**Temp/Precip**	Temperature & Precipitation	3	Higher mean annual and summer temperatures and lower and/or unequally distributed precipitation will significantly alter hydrologic flow due to decreased water quantity from the river source and intensity and frequency of flow control of water works along the river, which cause the change of erosion and deposition sediment regime.	**Hydrologic regime; Habitat conditions (integrity/viability)**
	Dongtan Intertidal Flats	Species composition and dominance: species number of macrozoobenthos	**SLR/SST**	Sea level rise + Ocean temperature	3	Predicted increase in sea level and ocean temperature will alter species types and number of macrozoobenthos, and finally impact biomass of macrozoobenthos which are important food resources for birds.	**Food web/trophic level disruptions**
	Dongtan Intertidal Flats	Size/Extent of characteristic communities/ecosystems: Minimum dynamic area	**SLR**	Sea level rise	3	Predicted increase in sea level will accelerate flooding area and cause most area of dynamic regimes loss. The predicted increase in sea level will also accelerate dyke works building and heightened for preventing and controlling flooding which decrease the dynamic changing area for the tidal flats.	**Habitat loss/extent of habitat decrease**
	Dongtan Salt Marsh Complex	Species composition/dominance: % of native species/ Scripus Mariqueter	**SLR/SST**	Ocean temperature(+x-y degrees) + Sea level rise	3	Predicted temperature and sea level will alter PH condition of soil which impact the growing of Scripus Mariqueter	**Habitat conditions (integrity/viability)**

Project Team Comments		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Migratory Shorebirds	Healthy habitat availability: area of Scripus Mariqueter Community + bare flat	**SLR/SST**	Sea level rise + ocean temperature	2	Predicted increase in sea level and ocean temperatures will reduce the staying habitat and food resources of migratory shorebirds in spring and autumn. 7 species of this group have met the 1% criterion qualifying wetland of international importance	**Habitat conditions (integrity/viability); Habitat loss/extent of habitat decrease**
	Migratory waterfowls/Migratory Geese and Ducks	Habitat availability: area of the intertidal mudflat + aquaticulture area	**SLR/SST**	Sea level rise + ocean temperature	2	Predicted increase in sea level and ocean temperatures will reduce the wintering habitats and food resources of migratory waterfowls.	**Habitat conditions (integrity/viability); Habitat loss/extent of habitat decrease**
	Hooded Crane (Grus monacha)	Habitat availibity: area of Scripus Mariqueter Community + tidal creek	**SLR/SST**	Sea level rise + ocean temperature	2	Predicted increase in sea level and ocean temperatures will reduce the staying and food area of Hooded Crane.	**Habitat conditions (integrity/viability); Habitat loss/extent of habitat decrease**

Project Team Comments		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
Gulf of California and Coastal Watersheds, Mexico	Estuaries - aquatic systems	Hydrologic flow regime (season, duration, frecuency, extent)	**Temp/Precip**	Temperature increase 1-2° C (3° in upper watersheds) Precipitation 33%-75% decrease	3	Reduced precipitation during normally rainy seasons Jan-Mar and June-Sep and increase in temperatures will alter seasonal hydrologic regime and between year variability [for example droughts, floods] causing among other responses loss of freshwater inflow and physical connectivity to estuaries impacting one or more characteristics of the flow regime, of which the habitats and life cycles of the biota are intimately related and affect the physical conditon and functionality of the estuary (example bathymetry, sediment transport, mouth condition, water quality for example salinity and nutrients, etc.) Increases in precipitation in southern region may cause severe flooding.	**Hydrologic regime; Water availability**
	Estuaries	Estuarine faunal community	**SLR/SST**	Ocean temperature (1° +) Sea level rise (50- 60 cm), Precipitation(33-75% decrease)	3	1° C or greater ocean temperature will change distributional ranges, because of physiological thermal tolerances and food resources such as from primary productivity; recruitment habitat may be temporarily lost due to sea level rise. The wetland bird community composition and distribution will change with .50-60 cm or > sea level rise, due to loss of wetland habitat for feeding; temperature increases of 1-2° C and precipitation decreases in critical months may cause seasonal shifts to reproduction and migration as well as asynchrony with food availability. Change in regime of the freshwater inflows[plus sediment flows, nutrients and water chemistry],morphology (sediment, physcial habitat), thermal and salinity dynamics and of estuary, will impact primary productivity with knock on effects on rest of trophic web and therefore on faunal compostion. There will also be direct impcts of such changes in the property fo the estuary.	**Food web/trophic level disruptions; Altered species composition; Growing/mating season**

Project Team Comments		
revised 08/25/09 Anthropogenic change: Increased change spatial and temporal water demand, reduction in water basin security for all water users, increased pressure on water resources through increased demand for water storage as a climate adaptation response, pressure for desalinization, possible changes in time lines for hydropower dam development [renewable energy portfolio and CDM] processes. Note: current water resource mgmt practices are already impacting on the hydroecological integrity and resiliency of rivers and their estuaries that is likely to make these systems more vulnerable and less flexibility to adaptively respond in the context of climate change.	1. Kennedy, V. S., R.R. Twilley, J.A. Kleypas, J.H. Cowan, Jr, S.R. Hare (2002). Coastal and marine ecosystems and global climate chage. Potential effects on U.S. resources, Prepared for Pew Center on Global Climate Chage. 2. http://www.climatewizard.org	1-magnitude, 2-duration, 3-frequency, 4-timing, 5 rate of change
revised 08/25/09	1) Roessig, J. M., C.M. Woodley, J.J. Cech, Jr., L.J. Hansen (2004). "Effects of global climate change on marine and estuarine fishes and fisheries." REview in Fish Biology and Fisheries 14: 251-275. 2) Portner, H. O. and R. Knust (2007). "Climate Change Affects Marine Fishes Through the Oxygen Limitation of Thermal Tolerance." Science 315(5808): 95-97. 1) United Nations Environment Programme (UNEP) / Convention on Migratory Species (CMS) Secretariat. 2006. Migratory Species and Climate Change: Impacts of a Changing Environment on Wild Animals. Bonn, Germany. 46 pp. Available at http://www.cms.int/publications/pdf/CMS_CimateChange.pdf 2)http://www.geo.arizona.edu/dgesl/research/other/climate_change_and_sea_level/sea_level_rise/gulf_california/slr_gc_a_s.htm	abundance, recruitment index and species compostion of (elasmobranch nursery habitat, fish, shrimp, etc) trophic webs, and wetland birds

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	River Systems (Basin drainage networks)	Physical Connectivity of river network	**Temp/Precip**	Temperature increase 1-2° C (3° in upper watersheds) Precipitation decrease 33-75%	3	Biophysical change:changes in degree of connectivity across the drainage network, implications for access of species to refuge areas, opportunities for recolinization, passage to preferred habitats. . (look at 7R table) Reduced precipitation and increase in temperatures will cause changes of a loss or increase of connectivity extends into the riparian zone flood plain and other linked ecosystems influencing its resiliency.	**Habitat loss/extent of habitat decrease**
	Shoreline (in general)	shoreline habitat characteristics- dimension and configuration, erosion, deposition	**SLR**	Sea level rise (50-60 cm or >)	1	With sea level rise, some shoreline habitats will be completely inundated. 50 cm or > slr may inundate some beaches or restrict size due to adjacent landuse, causing loss or temporary loss of nesting habitat. (there is an optimal range and preference for sea turtle females to lay above high tide mark)	**Growing/mating season; Habitat loss/extent of habitat decrease**
	Mangrove shoreline (nested target split)	erosion deposition regime, tidal range, wave action, periodicity, sediment accretion rate, slope, substrate	**SLR**	Sea level rise scenario 1(increase 50-60cm) scenario 2(increase < 21cm)	1	Scenario 1: Rapid sea level rise will change the erosion-deposition regime causing die off at sea fringe and forcing coastal squeeze into landward habitats.	**Shift in geographic space of habitat; Habitat loss/extent of habitat decrease**

Project Team Comments		
Added 08/25/09 Anthropogenic: Increase development of hydrolic infrastructure and water extraction and changes in spatial temporal distribution of hte development, will increase risk of loss of connectivity through for example loss of flowing water section of the system, physical barriers to the movement of organisms.. current mgmt practices can exacerbate 1st order and 2nd order change, anticipate to make system more resilient before climate change		degree of fragmentation of entire river network in the basin from source to sea (basin, river channel and riparian scale)
revised 08/25/09	http://www.geo.arizona.edu/dgesl/research/other/climate_change_and_sea_level/sea_level_rise/gulf_california/slr_gc_a_s.htm IPCC Climate Change 2007: Synthesis Report (p.45) 1) Fish, M.R. et. al. 2005. Predicting the impact of sea-level rise on Caribbean sea turtle nesting habitat. Conservation Biology, 19: No.2, pp. 482-491 2)http://www.geo.arizona.edu/dgesl/research/other/climate_change_and_sea_level/sea_ level_rise/gulf_california/slr_gc_a_s.htm	% area/shoreline length of unfragmented and type of native habitats, land cover change
revised 08/25/09 Anthropogenic change: construction of dikes, mouth management, decrease of sediment deposition, subsidence. Scenario 2, Slower or attenuated sea level rise (no rapid dynamical change in ice flow) could increase tidal range into areas with minimal wave action allowing accumulation of mud and provide new shallow water areas for mangroves to shift into adjacent low lying areas with slopes of x, embedded in adjacent unaltered land and with unaltered freshwater flows, at the expense of other shoreline habitat types.	Citation: McLeod, Elizabeth and Salm, Rodney V. (2006). Managing Mangroves for Resilience to Climate Change. IUCN, Gland, Switzerland. 64pp Nybakken, J.W. 2001. Marine Biology: An Ecological Approach, Fifth Edition. Chapter 9.Tropical Communities.	slope, substrate, landuse behind mangroves and hydrologic flows

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Rocky reefs	rocky reef fish community, trophic webs influenced by freshwater inflows	**SLR/SST**	Sea level rise (50-60cm) / sea temperature (1° C + increase)	3	According to Ayala Bocos (2008), species richness and diversity will increase with a 1° C increase and drop gradually with higher temperatures, distribution and composition will change due to increase in sea level rise and temperature exceeding depth and temperature tolerances for some reef fish , (particularly to Caba Pulmo add freshwater flow regime inflows salinity wedge and sedimentation also impacts phytoplankton)	**Altered species composition**
	Blue water systems	upwellings, temperature, acidity, surface wind stress	**Temp**	temperature increases 1-2° C causing shifts in ENSO	3	freshwater implications: cumulative impacts from reductions of freshwater inflow (and chemical composition and thermal properties) and changes in the pattern and timing, will effect primary productivity [phytoplankton blooms in open water]	**Hydrologic regime**
	Groundwater dependent wetlands (oases, springs, marshes, vernal pools)	hydrologic regime	**Temp/Precip**	Temperature increase 1-2° C (3° in upper watersheds) Precipitation decrease 33-75%	3	biophysical change: Decrease of precipitation will decrease recharge of aquifers not directly connected to rivers, increase salinity (water chemistry composition of salts EC etc.), temperature increase will increase evaporation, decreasing recharge, causing changes in habitat and biotic composition of the systems such as endemic species, ecological processes	**Hydrologic regime; Water availability**
	Migratory species - birds, sea turtles, whales	distribution and movements	**SST; Temp/ Precip**	Sea surface temperatures, increased temperature and changes in precipitation	3	Changes in distribution and abundance due to temperature and precipitation changes causing mistimed migrations with increasing sea surface temperatures shifting ocean circulation and prey base* or changing productivity in or loss of habitats.	**Indeterminate**

Project Team Comments		
revised 08/25/09	1 Ayala Bocos, A. and H. Reyes Bonilla (2008). "Analysis of fish abundance in the Gulf of California and projection of changes by global warming." Coral Reef Symposium 2008.	abundance, recruitment index and species diversity and compostion
added 08/25/09		(indicator is biotic composition, whales presence, birds, etc,)
added 08/25/09 anthropogenic change: Increase groundwater extraction, increased pressure for desalinization processes. (description:groundwater and river system interaction (mangroves too), palustrine wetlands in Marismas)		water level, magnitude of groundwater discharge, water chemistry-salts, presence absence of endemic species
remove	1 Robinson, R. A., H.Q.P. Crick, J.A.Learmonth, I.M.D. Maclean, C.D. Thomas, F. Bairlein, M.C. Forchhamer, C.M. Francis, J.A. Gill, B.J. Godley, J. Harwood, G.C. Hays, B. Huntley, A.M. Hutson, G.J. Pierce, M.M. Rehfisch, D.W. Sims, M.B. Santos, T.H. Sparks, D.A. Stroud, M.E. Visser (2008). "Travelling through a warming world: climate change and migratory species." Endangered Species Research: 1-13. 2) Luch-cota review of sustainability of the GOC Probably, the best-documented features of the Gulf of California circulation are the large-scale seasonally reversing gyres in the northern gulf (cyclonic from June to September, and anticyclonic from November to April),	abundance and movements

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
Hudson River Estuary, New York, USA	Diadromous Fish Assemblage (Tomcod)	recruitment	**Temp/SLR**	Increased winter air temperatures (3.3-9.8 degrees F) as well as sea level rise will lead to warmer river water temps and warmer ocean water will move further up the estuary due to Sea Level rise. 3.2 inches for 2020s, 9.0 inches for 2050's, and 16.5 inches by the 2080's.	3	Increased river temperatures are likely to exceed survival threshold for tomcod eggs (requiring temps below 44 F for 9 weeks between Nov-Feb). Decreased tomcod recruitment would affect availability of a key forage fish for the river fish community.	**Growing/mating season**
	Diadromous Fish Assemblage (American Shad & river herring)	recruitment	**Extremes**	Increased frequency of extreme rainstorms (7-14% increase in intensity on any given day, 1-1.5 more days per year with >2" rainfall)	2	Increased flooding/high flows during critical spawning and rearing times can significantly reduce spawning success of shad and river herring. During high flows eggs can be washed downstream out of quality rearing habitats. Increasing turbidity in SAV beds near tributary mouths. Juvenile shad (which are sensitive to turbidity) in SAV beds are likely to move out of shelter where they are more vulnerable to predation. A robust, resilient population could likely persist through moderate climate change, however, current status of many diadromous fish populations may not be resillient enough to weather this type of change.	**Hydrologic regime; Growing/mating season**
	Intertidal wetlands and flats	Community structure	**SLR**	Sea Level rise projections: 3.2 inches for the 2020s, 9.0 inches for the 2050's and 16.5 for the 2080's.	2	Sea level rise will increase inundation of intertidal habitats. While many habitat types will be able to shift inland, where adjacent uplands are disconnected or unsuitable, high marsh and supratidal systems will decline in representation.	**Habitat loss/extent of habitat decrease**

Project Team Comments		
Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions: A report of the Northeast Climate Impacts Assessment (NECIA), July 2007		
Source: Northeast Climate Impact Assessment(NECIA). 2006. Climate Change in the U.S.Northeast. A Report of the Northeast Climate Impacts Assessment. Cambridge, Massachusetts: Union of Concerned Scientists.		
Source: The NYC DEP Climate Change Program Assessment and Action Plan: A Report Based on the Ongoing Work of the DEP Climate Change Task Force; May 2008, Report 1		

Project Name and Location	Conservation Target	Key Eecological Attribute	Climate Factor		Likelihood of Climate Factor Change	Hypothesis of Change	Impact category
	Subtidal flats and SAV	Characteristic native vegetation (Vallinsneria beds)	**Extremes**	Increased frequency of extreme rainstorms (7-14% increase in intensity on any given day, 1.1-5 more days per year with >2 inches of rainfall.	2	Increased storminess/flooding will lead more turbid waters, decreasing light availability for Vallisneria. Light attenuation is a critical KEA for persistence of these beds over time.	**Habitat conditions (integrity/viability)**
	Tributary and floodplain ecosystems	Lateral connectivity	**Extremes**	Increased frequency of extreme rainstorms (7-14% increase in intensity on any given day, 1.1-5 more days per year with >2 inches of rainfall.	2	Increased frequency of extreme precipitation events will lead to more flooding. Human reaction in many places will be to fight erosion/flooding by armoring riverbanks,building levees or other flood control structures. This would disconnect the river from the floodplain.	**Hydrologic regime; Fragmentation**
Lakes Huron and Ontario	Coastal terrestrial systems	Community Architecture	**Temp**	Increase in annual mean air temperature of 3.6-4.2 C (source - Climate Wizard, for mid century, A1B and A2 projections for ensemble of models)	3	Increasing air temperature leading to a lowering of average seasonal lake levels by 0.5-1.5 m will result in an increased area of exposed substrate (sand/cobble beaches, spits and foredunes) which, combined with range expansions of plant species will lead to increasing cover of invasive species such that these habitats in northern Lake Huron will become dominated by non-native species with some invasive, mainly opportunistic native species (fair), and in southern Lake Huron will become dominated by invasive non-native and opportunistic native species (poor)	**Pests and invasives**
	Offshore aquatic systems	Native macroinvertebrate distribution	**Temp**	Air temperature increase of 3.6-4.2 C (source - Climate Wizard, for mid century, A1B and A2 projections for ensemble of models)	3	Increasing air temperature leads to increasing water temperature (no precise predictions) and new invasions of aquatic invasive species, reducing the area of benthos inhabited by native macroinvertebrates to less than 40% (poor)	**Pests and invasives**

Project Team Comments		
Source: Northeast Climate Impact Assessment(NECIA). 2006. Climate Change in the U.S.Northeast. A Report of the Northeast Climate Impacts Assessment. Cambridge, Massachusetts: Union of Concerned Scientists.		
Source: Northeast Climate Impact Assessment(NECIA). 2006. Climate Change in the U.S.Northeast. A Report of the Northeast Climate Impacts Assessment. Cambridge, Massachusetts: Union of Concerned Scientists.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Nearshore aquatic systems	Community Architecture	**Temp**	Air temperature increase of 3.6-4.2 C (source - Climate Wizard, for mid century, A1B and A2 projections for ensemble of models)	3	Increasing air temperature leads to increasing water temperature (no precise predictions) and an increasing rate of introductions of non-native aquatic species (poor)	**Pests and invasives**
	1) Nearshore aquatic systems OR 2) Coastal wetlands (PICK ONE)	1) Area of submerged aquatic vegetation 2) Area of functional wetlands? Not sure what the biggest threat is…maybe to fish & connectivity???	**Extremes**	Increase in amount of precip released in extreme rain events (top 5% of events) of 25% (sum across a year of events) by 2050s (when compared to 1990s). Source: Gutowski et al. 2008, average across emissions scenarios.	2	Increasing intensity of extreme rain events, especially in late winter and spring, will increase the amount of sediments carried via overland flow through agricultural systems and other erosive substrates into streams, resulting in higher sediment loads in nearshore systems. These sediments can bury aquatic plants, and reduce growth by reducing water clarity.	**Hydrologic regime; Habitat conditions (integrity/viability)**
	Nearshore aquatic systems	Water quality - Oxygen availability, water clarity (?)	**Extremes**	Increase in amount of precip released in extreme rain events (top 5% of events) of 25% (sum across a year of events) by 2050s (when compared to 1990s). Source: Gutowski et al. 2008, average across emissions scenarios.	2	Increasing intensity of extreme rain events will increase the amount of nutrients carried via overland flow through agricultural systems into streams, resulting in increased nutrient concentrations in nearshore zones. These additions, along with increases in water temperature, will promote algal blooms and reductions in oxygen availability (eutrophication).	**Hydrologic regime**

Project Team Comments		
Gutowski, W. J., G. C. Hegerl, G. J. Holland, T. R. Knutson, L. O. Mearns, R. J. Stouffer, P. J. Webster, M. F. Wehner, and F. W. Zwiers. 2008. Causes of observed changes in extremes and projections of future changes Pages 81-116 in T. R. Karl, G. A. Meehl, C. D. Miller, S. J. Hassol, A. M. Waple, and W. L. Murray, editors. Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Carribean, and U.S. Pacific Islands. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington D.C.		
Gutowski, W. J., G. C. Hegerl, G. J. Holland, T. R. Knutson, L. O. Mearns, R. J. Stouffer, P. J. Webster, M. F. Wehner, and F. W. Zwiers. 2008. Causes of observed changes in extremes and projections of future changes Pages 81-116 in T. R. Karl, G. A. Meehl, C. D. Miller, S. J. Hassol, A. M. Waple, and W. L. Murray, editors. Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Carribean, and U.S. Pacific Islands. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington D.C.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Coastal Wetlands	Amount of functional coastal wetland habitat	**Temp**	Predicted area average temperature changes for the Great Lakes: Increase in annual temperature (+3.2 C under warm and dry scenario - CGCM A21) -> decreased ice cover (and increased evaporation that largely will not be overcome by increases in precipitation (+1.4% annual), especially since precip will come in winter and fall more as rain than snow, and there will be less summer precip. Lake level decline is more certain for Huron than for Ontario though, where precip increases MIGHT be enough to counteract, especially combined with regulation.	3	"Landward wetland migration: Under sustained low water level scenarios (0.5-1.5 m decrease by 2080), exposed shorelines adjacent to wetlands will experience modificaion (e.g., hardening, physically structures) preventing natural wetland transition... Lakeward wetland migration: Under sustained low water levels (0.5 - 1.5 m decrease by 2080), lakeward migration of lacustrine wetland vegetation will be limited in Precambrian Shield areas by steep offshore rocky slopes, and deep, high energy water.	**Habitat conditions (integrity/viability); Habitat loss/extent of habitat decrease**
Grasslands and drylands							

Project Team Comments		
Climate change scenarios developed from the Global Climate Model (Croley, T.E. 2003. Great Lakes Climate Change Hydrologic Impact Assessment. IJC Lake Ontario-St. lawrence River Regulation Study, NOAA Technical Memorandum GLERL-126, Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan, 85pp. Mortsch, L. Alden, M., Klaassen, J. 2005. Development of Climate Change Scenarios for Impact and Adaptation Studies in the Great Lakes-St. Lawrence River Basin. Report prepared for the IJC, International Lake Ontario-St. Lawrence River Study Board, Hydrologic and Hydraulic Modelling Technical Working Group. Ice cover reference: Lofgren, B.M, Quinn, F.H., Clites, A.H., Assel, R.A., Eberhardt, A.J., Luukkonen, C.L. 2002. Evaluation of potential impacts of Great Lakes water resources based on two GCM climate scenarios. Journal of Great Lakes Research 28. 537-554.		

Project Name and Location	Conservation Target	Key Eecological Attribute	Climate Factor		Likelihood of Climate Factor Change	Hypothesis of Change	Impact category
Moses Coulee Arid Lands, Washington, USA	Shrub-Steppe Matrix	Species composition and productivity	**Temp/Precip**	Temperature (average increase 1.61 °C by 2045) & precipitation seasonality (average summer decrease 9.24% and winter increase 4.3% w/ more as rain)	2	Higher temperatures coupled with drier summers and wetter winters (with more precipitation falling as rain) will lead to: -More spring productivity, leading to greater fuel load later in the season; -Greater exotic annual growth, creating fine, flashy fuels; -Increased frequency of dry, convective thunderstorms; -Greater winter runoff and less soil storage. The factors all contribute to greater frequency, intensity and season length of wildfires. They directly favor the expansion of the invasives cheatgrass and medusahead, and through changes in the fire regime lead to decreased cover of key native functional groups, including shrubs, woody shrubs and bunchgrasses, changing species composition and productivity.	**Fire regime; Altered species composition**
	Shrub-Steppe Matrix	Distribution and connectedness of shrub-steppe habitat	**Other**	Strategies and incentives to reduce CO_2 emissions	1	Efforts to reduce CO_2 emissions will result in alternative energy development (wind, solar, hydro, biofuels), leading to further conversion of shrub-steppe habitats in favor of energy infrastructure development. This will directly reduce habitat area and decrease connectivity among remaining shrub-steppe habitat blocks.	**Habitat loss/extent of habitat decrease**
	Shrub-Steppe Matrix	Distribution and connectedness of shrub-steppe habitat	**Temp/Precip**	Temperature (average increase 1.61 °C by 2045) & precipitation seasonality (average summer decrease 9.24% and winter increase 4.3% w/ more as rain)	2	Changes in composition and productivity lead to conversion of shrub steppe to exotic annual grasslands. This conversion reduces the amount and modifies the distribution of shrub steppe, and where it occurs in critical connecting areas, reduces the connectedness of remaining shrub-steppe habitat.	**Habitat loss/extent of habitat decrease**

Project Team Comments		
In addition, when cheatgrass is not present, fire can create an opening for entry into the sytem. Also noting that decreased precipitation alone, especially in the summer, leads to cheatgrass expansion of up to 45% (Bradley 2008). These changing climatic conditions may also lead to juniper forest expansion into shrub-steppe habitat. All temperature and precipitation data are from Climate Impacts Group reports (http://cses.washington.edu/cig/).		
Alternative energy development is already starting in this area. The Conservancy is involved in a wind energy study, to influence the siting of wind turbins and research biodiversity impacts. We will use this study to help inform this process. Wind energy will affect nested species under this target (shrub-steppe obligate birds species including the sage grouse), by altering their movement across the landscape (avoidance) and due to direct mortality.		
We added this hypothesis of change after discussing the major impacts with our team (Added: 8/17/09).		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Bats	Bat abundance, overall and by species	**Temp/Precip**	Temperature (average increase 1.61 °C by 2045) & summer precipitation (average decrease 9.24%)	3	Higher temperatures and reduced summer precipitation results in less standing surface water, which is essential for bat hydration and insect foraging. Bats need to migrate further distances from roosting sites to find surface water, causing stress especially to smaller bat species (that do not travel as far). Where those distances become too long, suitable roosting locations may be abandoned, leading to this becoming a limiting factor for some species. This is especially critical for reproductive females, since they require more water for lactation. Reproductive success may decrease, as well as bat abundance.	**Water availability; Growing/mating season**
	Bats	Abundance, composition and diversity of bat species	**Other**	Strategies and incentives to reduce CO2 emissions	3	Alternative energy development, particularly wind, leads to direct mortality of bats, and potentially avoidance of otherwise suitable habitat. Depending on location and management of wind farms, this could significantly affect all bats, or have differential effects on different species (e.g. migratory vs. non-migratory), leading to decreases in abundance, and/or changes in the composition of bat species.	**Direct impact on species survival; Altered species composition**
	Groundwater-dependent Systems	Water Delivery (Quantity, Location, Timing, and Duration)	**Temp**	Increased temperatures in the shoulder seasons (range) leading to a greater proportion of rain events (vs. snowfall), less snow accumulation and earlier snowmelt	2	Since snowmelt infiltrates in greater proportions than rainfall, shift in the rain/snow ratio lead to reduced groundwater recharge, and therefore reduced output to groundwater-dependent ecosystems. In addition, the human response to climate change will increase groundwater extraction, furthering this reduction. The relative timing of these impacts on recharge and extraction from aquifers will lead to changes in timing of upwelling flows.	**Water availability**

Project Team Comments		
This likelihood rating may change once we find out more on bats.		
This likelihood rating may change once we find out more on bats.		
*In addition, the human response to climate change will increase groundwater extraction, furthering this reduction. Note: We just received more information on groudwater sytems in this area, and will be adding details soon.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Groundwater-dependent Systems	Water Temperature and Water Table Depth	**Temp**	Temperature (average increase 1.61 °C by 2045) & Precipitation Type (rain vs snow)	3	Many of the small streams and springs result from groundwater seeping from cracks and fissures in the underlying geology. Less groundwater recharge will, therefore, result in less surface flow. Reduced groundwater input, coupled with increased air temperature will likely cause an increase in surface water temperature. The reduced water input will result in lowering of the water table, leading to less groundwater-dependent vegetation (phreatophytes) and less water with higher temperatures will lead to increased stress, mortality, or displacement of cold-water species (fish (especially salmonids), amphibians, and aquatic insects.	**Water availability**
	Vernal Pools	Water input quantity and timing	**Precip**	Snowmelt and Precipitation (timing and quantity of spring rain)	2	Reduced snowmelt and changing precipitation patterns will lower water supply to vernal pools and may increase time intervals during which pools are dry. This may decrease vernal pool existence and increase stress to/loss of associated species.	**Water availability**
	Vernal Pools	Pool-Pool Connectivity	**Precip**	Snowmelt and Precipitation (timing and quantity of spring rain)	3	As snowmelt decreases and precipitation patterns change, there will be less water to fill vernal pools, reducing the size and number of pools. Vernal pools may become more isolated, reducing dependent-species movement between pools. [Other vectors that move organisms between pools may also change, such as waterfowl)	**Fragmentation; Water availability**

Project Team Comments		
We need more information on vernal pools in Washington aridlands ecosystems.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
Mount Hamilton, California, USA	Blue Oak Woodlands	Extent of blue oak woodlands	**Temp/Precip**	Increased temperature of 2-5°F by 2055 increases evapotranspiration rates and reduces soil moisture (likely). Precipitation decreases by as much as 25% annually (uncertain) which would magnify the soil moisture reduction.	4	We hypothesize that increased evapotranspiration and reduced soil moisture will cause acorn, seedling, and sapling mortality from desiccation during dry years [1-3] which could lead eventually to conversion of this key system to more open oak savannas or grasslands.	**Habitat loss/extent of habitat decrease; Altered species composition**
	Native Fish	Flow regime	**Temp/Precip**	Increased air temperature of 2-5°F by 2055 and associated increases evapotranspiration rates (likely). Precipitation decreases by as much as 25% annually (uncertain).	4	We hypothesize that reduced precipitation and increased evapotranspiration will reduce annual flows and increase stream temperatures which could lead to an increase in non-native fish and a decrease in native fish richness [6].	**Hydrologic regime; Altered species composition**

Project Team Comments		
Background: The climatic controls on blue oak distribution are not precisely known, but the literature and their range in a relatively narrow band of foothills around California's central valley suggests a strong correlation with climatic factors [4]. Adult blue oaks and advance regeneration in the form of understory seedlings and saplings persist in areas with high seasonal and inter-annual variability in climate [5], but large recruitment events may naturally occur infrequently [1]. Adult oaks also provide shade for seedlings and act as a water pump bringing moisture closer to the soil surface, so as the adult oaks die from natural or human causes and are not replaced by a new generation, the decreasing density of oaks will create a negative feedback for regeneration [2]. Initial Results: Species distribution models suggest roughly 2800 sq km (43% of the study area) is currently climatically suitable for blue oak. Under the A2 emissions scenario, the majority of 11 future climate models analyzed indicate 2,600 sq km (93% of the existing potential distribution) will no longer be climatically suitable by 2050. Most of the remaining 200 sq km is uncertain. 1. Tyler, C.M., B. Kuhn, and F.W. Davis, Demography and recruitment limitations of three oak species in California. Quarterly Review Of Biology, 2006. 81(2): p. 127-152. 2. Swiecki, T.J., E.A. Bernhardt, and C. Drake. Factors Affecting Blue Oak Sapling Recruitment. in Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues. 1997. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, San Luis Obispo, CA. 3. Matzner, S.L., K.J. Rice, and J.H. Richards, Patterns of stomatal conductance among blue oak (Quercus douglasii) size classes and populations: implications for seedling establishment. Tree Physiology, 2003. 23(11): p. 777-784. 4. Kueppers, L.M., et al., Modeled regional climate change and California endemic oak ranges. Proceedings Of The National Academy Of Sciences Of The United States Of America, 2005. 102(45): p. 16281-16286. 5. Zavaleta, E.S., K.B. Hulvey, and B. Fulfrost, Regional patterns of recruitment success and failure in two endemic California oaks. Diversity And Distributions, 2007. 13(6): p. 735-745.		
Background: 58% of all inland native fish in California are either extinct or in serious decline [7]. Native fish in California are under threat from water diversion, habitat alteration, pollution, invasive fish, and exploitation [7, 8]. While the native fishes of Mount Hamilton are adapted to large variations in annual and seasonal flows, studies have found that native fish diversity is positively correlated with cooler temperatures, fewer pools, faster streamflow, and more stream shading [6]. Non-native species richness is correlated with higher temperatures, less flow, and more pools [6]. High winter flows flush out non-native fish and improve conditions for native fish breeding, while maintained summer flows improve conditions for native rearing [6]. Initial Results: A correlation analysis of 12 undammed watersheds in Mt. Hamilton using annual precipitation, maximum temperatures, and drainage area to explain annual flow indicates that an increase of 2-5°C could reduce flows by 12-27%, and a decrease in annual precipitation by 25% could reduce flows by 50%. 6. Marchetti, M.P. and P.B. Moyle, Effects of flow regime on fish assemblages in a regulated California stream. Ecological Applications, 2001. 11(2): p. 530-539. 7. Moyle, P.B., Inland Fishes of California. 2002, Berkeley, California: University of California Press. 502. 8. Light, T. and M.P. Marchetti, Distinguishing between invasions and habitat changes as drivers of diversity loss among California's freshwater fishes. Conservation Biology, 2007. 21(2): p. 434-446.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	California tiger salamander	Habitat suitability and connectivity	**Temp/Precip**	Increased temperature of 2-5°F by 2055 increases evapotranspiration rates (likely). Precipitation decreases by as much as 25% annually (uncertain).	4	We hypothesize that increased air temperature and evapotranspiration rates and decreased precipitation will lead to shorter inundation times and higher water temperatures for wetlands and ponds that form much of the species habitat.	**Hydrologic regime**
	Chaparral/ Shrublands	Fire regime - (timing, frequency, intensity, extent)	**Temp/Precip**	Increased temperature of 2-5°F by 2055 increases evapotranspiration rates and reduces soil moisture (likely). Precipitation decreases by as much as 25% annually (uncertain) which would magnify the soil moisture reduction.	4	We hypothesize that increased temperature and drier vegetation will increase fire frequency, intensity, and extent beyond recent historical ranges which could reduce native plant community richness and distribution, especially the area's more mesic communities that naturally burn infrequently.	**Fire regime**
Nevada and Utah Mountains, USA	Seral Aspen & Stable Aspen	Soil moisture (amount and timing)	**Temp**	Higher mean winter temperature; earlier snowmelt by 1 month	3	Predicted higher mean winter temperatures and earlier snowmelt will cause water stress for the lower elevation aspen, perhaps causing the loss of some of the aspen clones.	**Hydrologic regime; Water availability**
	Montane Riparian & Wet Meadows	Hydrologic regime	**Temp**	Higher mean winter temperature, earlier snowmelt by 1 month	4	Earlier snow melt will cause earlier peak spring flows, longer summer base flow, higher temperature.	**Water availability; Hydrologic regime**

Project Team Comments		
Background: The aquatic life history stage of juvenile California tiger salamanders (CTS, a federally-listed Threatened species) requires predator-free wetlands and ponds in the winter and spring to hatch and mature. The inundation period of these wetlands and ponds must be long enough for the larvae to complete metamorphic transformation (a minimum of 10 weeks which is longer than other amphibians) but not too long, since perennial wetlands and ponds tend to support predators [9]. Terrestrial adults utilize abandoned burrows in upland habitats to feed and disperse, and then when early winter rains come, they migrate back to pond breeding habitats through moist ground and temporary pools [10]. Initial Results: Species distribution models for CTS are currently underway. With the results of these models, we will explore multiple connectivity scenarios using Circuitscape. 9. U.S. Fish and Wildlife Service, Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the California Tiger Salamander; and Special Rule Exemption for Existing Routine Ranching Activities, Department of the Interior, Editor. 2004, Federal Register. p. 47212-47248. 10. Shaffer, H.B. and P.C. Trenham, The California tiger salamander (Ambystoma californiense), in Amphibian declines: The conservation status of United States species, M.J. Lanoo, Editor. 2005, Univerisity of California Press: Berkeley, California.		
Background: Fire is a natural component of chaparral systems in California, but increasing fire frequency can lead to a loss of native plant diversity and an increase in non-native species invasions [11]. Reconstructing fire histories and determining optimal fire return intervals in these dynamic and heterogeneous natural community types is complex [12]. However, literature and expert opinion suggests that, although species richness peaks in the first 5 years after fires in these systems [13], an appropriate, conservative fire return interval for chaparral in the Central Coast is a minimum of 30 years [14]. 11. D'Antonio, C.M. and P. Vitousek, Biological invasions by exotic grasses, the grass/fire cycle and global change. Annual Review of Ecology, 1992. 23: p. 63-87. 12. Callaway, R.M. and F.W. Davis, Vegetation dynamics, fire, and the physical environment in coastal central California. Ecology, 1993. 74: p. 1567-1578. 13. Keeley, J.E., C.J. Fotheringham, and M. Baer-Keeley, Factors affecting plant diversity during post-fire recovery and succession of mediterranean-climate shrublands in California, USA. Diversity And Distributions, 2005. 11(6): p. 525-537. 14. Greenlee, J.M. and J.H. Langenheim, Historic Fire Regimes and Their Relation to Vegetation Patterns in the Monterey Bay Area of California. American Midland Naturalist, 1990. 124: p. 239-253.		
Higher temperature results in several linked changes: higher mean winter temperature, earlier snowmelt by 1 month; higher mean summer temperature and increased evapotranspiration		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Montane Riparian & Wet Meadows	Riparian species (cottonwood & willow) recruitment	**Temp**	Higher mean winter temperature, earlier snowmelt by 1 month	3	Earlier snowmelt and increased temperatures will result in a decoupling of peak spring flow from cottonwood and willow recruitment; favoring woody species recruitment and impairing riparian species recruitment.	**Growing/mating season; Hydrologic regime**
	Montane Riparian & Wet Meadows	Plant species composition	**Other**	Increased CO_2	4	Increased CO_2 will fertilize exotic forb invasion, especially during wetter than average years.	**Pests and invasives**
	Mountain Big Sagebrush: mountain sites	Fire regime	**Temp/Precip**	Increased temperature & precipitation	3	Increased precipitation and temperature will favor herbaceous and woody growth and fuel accumulation resulting in altered (increased) fire regime.	**Fire regime**
	Mountain Mahogany & Pinyon-Juniper Woodlands, Wyoming Big Sagebrush, Mountain Big Sagebrush: upland sites, & Black Sagebrush	Plant species composition (non-native cheatgrass recruitment)	**Precip/ Other**	Increased CO_2 & precipitation	2	Increased CO_2 will fertilize cheatgrass invasion during wetter than average years.	**Pests and invasives**
	Low Sagebrush & Basin Wildrye	Plant species composition (pinyon and juniper encroachment)	**Precip/ Other**	Increased CO_2 & precipitation	3	Increased CO_2 will fertilize pinyon and juniper resulting in encroachment into these veg types during wetter than average years.	**Altered species composition**
Tallgrass Aspen Parkland, Minnesota, USA	Rivers & Streams	riparian species composition (condition)	**Precip**	increasing average precipitation (approx. 20%) in fall (17% to 27%) & winter (7% to 17%) (1); (fall 4.63" (historical), (winter 1.83" (historical)) (2)	2	Timing of increased precipitation will exacerbate floods, increasing vulnerability of riparian areas to invasive and exotic species.	**Hydrologic regime; Pests and invasives**

Project Team Comments		
Also linked to increase in fire number, size & intensity.		
Altered hyrology (timing and amount of water) will likely affect the entire target, degrating areas currently in "good" condition to "fair" and possibly "poor" condition. Riparian areas will likely experience increased erosion in some areas and deposition in others. These disturbed areas represent "vacuums" that are vulnerable to invasion by rapidly-colonizing, invasive species. Likely already occurring due to climate change, as with many river systems around the world. (1) Historical precipitation based on 1971-2000 averages for fall (Sep., Oct., Nov.) and winter (Dec., Jan., Feb.) from Minnesota Climate Data Center. (2) Range for % increase based on IPCC 4th Assessment - 3 models for NWMN (C, U, M).		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Mobile Mammals	health (condition)	**Temp**	increasing temperature (+6 deg F) throughout the year, particularly increase in mean summer temperature; (historical range = 65.3 deg F (min) to 70.7 deg F (max))(3)	1	Moose experience increased mortality linked to heat stress and disappear from landscape (warmer mean summer temperatures in particular, but perhaps heat stress in late winter and early fall as well).	**Direct impact on species survival**
	Upland Mosaic	successional dynamics (condition)	**Temp/Precip**	increasing temperature and precipitation throughout the year (+6 deg. F and +12%); (see above detail for historical temperature ranges); Historical average annual monthly precipitation range = 1.7 " (min) to 2.0" (max) (3)	2	Proportion of prairie & savanna:closed canopy aspen woodland will decrease due to a longer, wetter growing season and enriched CO_2 atmosphere, both of which are likely to favor aspen encroachment.	**Altered species composition**
	Upland Mosaic	successional dynamics (condition)	**Temp/Precip**	increasing temperature and precipitation throughout the year (+6 deg. F and +12%) (see detail above for historical ranges)	2	Wetter spring weather conditions (precipitation and higher water table) will lead to fewer spring fires and/or fires less effective at controlling aspen encroachment.	**Fire regime**
	Beach Ridge Wetlands	groundwater regime (landscape context)	**Temp/Precip**	increasing average precipitation (approx. 20%) in fall (17% to 27%) & winter (7% to 17%) (fall 4.63" (historical), (winter 1.83" (historical))	2	Extent of relatively uncommon wet meadows will be reduced leading to homogenization of wetland types (1).	**Habitat loss/extent of habitat decrease**

Project Team Comments		
There has been a large and well-documented decline in moose in NW Minnesota and SE Manitoba since 1984. Research in NW Minnesota reports population decreases often occur in years following summers with higher-than-average temperatures. Other research indicates that March temperatures above 23˚F and September temperatures above 57˚F require moose to expend excessive energy to keep cool. Since 1984 (peak moose population in NW Minnesota), an increasing number of dates in March and September exceed these thresholds. (+3-7 deg F under medium emmission scenarios). While the exact mechanism involved in this response is not understood, the additional heat stress may accentuate poor body condition due to parasite induced chronic malnutrition, resulting in lower reproductive rates. (3) Min/Max temperatures recalculated in deg. F from Galatowitsch et al. 2009 ensemble models.		
The extremely low-relief landscape supports a mosaic of closed aspen woodland, shrubby & open prairie, shrubby, wooded & open wetlands, and oak savanna. The relative proportion of these communities historically fluctuated over time. Over the centuries, wetter periods likely resulted in longer fire return interval and higher water table, favouring woodland and shrublands. In contrast, drier periods likely resulted in shorter fire return interval and lower water table, favouring open prairie and savanna. In recent decades, fire suppression outside managed areas has resulted in succession of open grasslands to aspen woodlands and forests, a trend of great concern in an ecoregion where <1% of original open prairies remain today. (Min/Max average precipitation recalculated in inches/month from (1) Galatowitsch et al. 2009 ensemble models. (1970-1999))		
Fire return intervals are a component of the previous HoC, but it is useful to discuss them separately for planning purposes (especially since it is a somewhat 'manageable' factor through the application of prescribed fire). Different aspects of the natural fire regime may be altered in differnt ways.. For example, fire frequency may be reduced with gernally warmer, wetter growing seasons. Assuming drier years continue to occur occasionally, fire intensity may increase following higher productivity/fuel accumulation from wetter years. NOTE ON FUTURE USE OF PRESCRIBED FIRE: it is expected that a more humid and increasingly closed woodland system, combined with higher water tables, will make the application of prescribed fire more difficult at many sites and possibly less effective at controlling woody encroachment. The timing of prescribed and wildfire may change as well, with uncertain results (high water tables and possibly earlier leaf-out may reduce spring wildfires/potential for using prescribed fire in spring)).		
Increased fall and winter precipitation will likely lead to enhanced groundwater recharge and rising water tables, despite increased ET resulting from a longer growing season and warmer temperatures. NOTE ON POTENTIAL LINK TO CLIMATE CHANGE-INDUCED ALTERATIONS TO GROUNDWATER TABLE AND SURFACE WATER ACCUMULATION/MOVEMENT: Increased spring surface water may result in a transformation of dry prairie into wet prairie, and wet prairie into sedge meadow, further reducing habitat available for prairie endemics. These changes could be offset by a lower summer water table, however. Already occurring because of climate change? We need to define the "reference" range for wetlands in TAP before conditions and related thresholds can be adequately assessed. In some cases the change may facilitate encroachment by woody vegetation. (2) Gerla, P. 2009. Inventory of Tallgrass Aspen Parkland NWI Wetlands. Unpubl. report).		

Project Name and Location	Conservation Target	Key Eecological Attribute	Climate Factor		Likelihood of Climate Factor Change	Hypothesis of Change	Impact category
	Lake Plain Wetlands	hydrological regime - surface water (landscape context)	**Precip**	increasing fall & winter precipitation (+20%) (see detail above for historical ranges)	3	Wetlands may transition from palustrine to lacustrine conditions, with more open water during the spring and a shallower water table during the early summer.	**Hydrologic regime; Habitat conditions (integrity/viability)**
	Lake Plain Wetlands	species compostion (condition)	**Precip**	increasing fall & winter precipitation (+20%) (see detail above for historical ranges)	3	Altered hydropatterns may faciliate invasion by invasive plants (including native shrubs) at the expense of native graminoids and forbs.	**Pests and invasives**
Mountains							
Atitlan Watershed Multiple Use Reserve, Guatemala	Broad-leaved and pine-oak forests	Fire regime (frequency, intensity, and extent)	**Temp/Precip**	Temperature (+2 ºC for year 2,100) and distribution of precipitation (seasonality) (50 mm/month less in May-Agust)	2	Warmer temperatures and longer dry season will cause an increase in fire's frequency, intensity and extent, changing the composition and structure of broad-leaved forest and increasing the pine abundance in pine-oak forest.	**Fire regime**
	Broad-leaved forests	Presence and abundance of ensembles of key species (bromeliads and mosses) Water catchment capacity?	**Precip**	Distribution of precipitation (seasonality) (50 mm/month less in May-Agust)	3	Longer and drier seasons will cause a decrease in the presence and abundance of bromeliads and mosses, and consequently a decrease in the water catchment capacity of the ecosystem, and a decrease in the populations of amphibians.	**Habitat conditions (integrity/viability)**
	Horned Guan (Oreophasis derbianus)-a bird of the Cracid family that lives only in the cloud forest, endemic to Chiapas and Guatemala	Habitat quality available for Horned Guan (Presence of key fruiting species, like Oreopanax equinops, Rhamnus capreifolia and Phoebe salvinii)	**Temp/Precip**	Temperature (+2 ºC for year 2,100) and distribution of precipitation (seasonality) (50 mm/month less in May-Agust)	3	Warmer temperatures and longer dry season may cause a push up-ward of the inferior altitudinal limit of cloud forest, and consequently diminishing the aviailability of key fruiting species and habitat for horned guan.	**Food web/trophic level disruptions**

Project Team Comments		
The indicator rating for this KEA is already downgraded to "fair" because of altered hydrology related to roads and ditches and will likely slip to "poor" with increased winter and spring precipitation.		
This transition of species composition because of disrupted hydrology can already be observed along ditches and monitored in 2008 & 2009 at Beaches WMA. Invasive plant species = cattails, Phragmites, reed canary grass, willows, among others		
This seems to have started to happen already in some of the cloud (broad-leaved) forests of the Atitlán area.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	High-altitude coniferous forest	Size of ecosystems	**Temp/Precip**	Temperature and distribution of precipitation (seasonality)	4	An increase in the temperature and a decrease in annual precipitation will reduce the size of the ecosystem, by pushing up-wards the altitudinal range of distribution of high-altitude coniferous forest.	**Habitat loss/extent of habitat decrease**
	Xerophytic vegetation	Connectivity among patches of xerophytic vegetation	**Temp/Precip**	Temperature (+2 ºC for year 2,100) and precipitation (200 mm/year less by 2100)	3	An increase in the temperature and a decrease in annual precipitation will create suitable habitat for xerophytic vegetation in higher and unfragmented areas, increasing the connectivity of patches of this type of vegetation, at the expense of pine-oak forests.	**Shift in geographic space of habitat**
	Hydrological system of Lake Atitlan	Lake mixes	**Temp**	Temperature (+2 ºC for year 2,100)	3	An increase in annual temperature may cause a decrease in lake mixings events, contributing to decrease algae bloomings.	**Hydrologic regime**
	Hydrological system of Lake Atitlan	Dissolved oxygen (DO)	**Temp**	Temperature (+2 ºC for year 2,100)	4	An increase in annual temperature may cause a decrease in oxygen solubility and therefore its concentration in the epilimnium (warm water surface), stressing aerobic aquatic species.	**Hydrologic regime**
	Hydrological system of Lake Atitlan	Presence and abundance of key wetland species (Typha sp.-cattail, and Scirpus sp.-sedge)	**Precip**	Precipitation (200 mm/year less by 2100)	2	A decrease in the annual precipitation will cause a decrease in the lake's level, diminishing the area covered by key emergent wetland species in the northern shore, but maybe increasing it in the southern shore.	**Shift in geographic space of habitat**
	Hydrological system of Lake Atitlan	Nutrients concentration, and primary productivity	**Precip**	Precipitation (increase in 20-50 mm/month during September-November by year 2100, specially due to extreme events, like tropical storms and hurricanes)	4	An increase in average monthly precipitation in September-November may cause an increase in nutrients and accelerate the lake transition from oligotrophic to mesotrophic conditions, increasing primary productivity	**Hydrologic regime**

Project Team Comments		

Project Name and Location	Conservation Target	Key Eecological Attribute	Climate Factor		Likelihood of Climate Factor Change	Hypothesis of Change	Impact category
	Hydrological system of Lake Atitlan	Submerged macrophytic species composition	**Temp/Precip**	Temperature (+2 ºC for year 2,100) and precipitation (increase in 20-50 mm/month during September-November by year 2100, specially due to extreme events, like tropical storms and hurricanes)	3	Increase in water temperature and nutrient concentration may increase the populations of invasive aquatic species, like Hydrilla verticilata, and reduce native species composition.	**Pests and invasives**
Central Appalachian Integrated Landscape	Appalachian Rivers and Streams	Species Composition/Dominance	**Precip**	Altered precipitation (Increased frequency of small to moderate precipitation events) [+6% to +24% by 2095]	2	Distribution and abundance of flood sensitive species will decrease.	**Altered species composition**
	Appalachian Rivers and Streams	Species Composition/Dominance	**Precip**	Altered precipitation (Increased frequency of small to moderate precipitation events) [+6% to +24% by 2095]	2	Distribution and abundance of species intolerant of fine sediments will decrease.	**Altered species composition**
	Appalachian Rivers and Streams	Change in size/extent of characteristic communities	**Temp**	Increased water temperature. [Air Temperature Increase 2.3C to 5.5C by 2100]	2	Available warm water habitat will increase.	**Habitat conditions (integrity/viability)**
	Appalachian Rivers and Streams	Change in size/extent of characteristic communities	**Temp**	Increased water temperature. [Air Temperature Increase 2.3C to 5.5C by 2100]	1	Suitable habitat for trout/cold water species will decrease and be confined to higher latitudes in the southern Appalachians due to increased water temperature.	**Habitat loss/extent of habitat decrease**
	Appalachian Forest	Change in size/extent of characteristic communities	**Temp/Precip**	Increased Air Temperature/ Changes in Precipitation [Air Temperature Increase 2.3C to 5.5C by 2100/ +6% to +24% by2095]	1	Forest species requiring cool/wet conditions will shift to higher elevations and north facing aspects.	**Shift in geographic space of habitat**

Project Team Comments		
Includes nest builders.		
Overall, we expect a net increase in fine sediment deposition to streams. Regulatory regime established to deal with 2-, 5-, 10- year storm events may already be inadequate. Small roads may not be fragmenting features but are significant contributors of sediment.		
Water temperature will increase due to increased air temperature and loss of hemlock increases likelihood of temperature rise (air temp increases stress on hemlock). Limestone streams will remain cooler due to more consistent groundwater inputs. Flebbe, P.A. et al 2006. Spatial Modeling to Project Southern Appalachian Trout Distribution in a Warmer Climate		
Shifts in distribution and composition will occur, though few components will be completely lost from the landscape. Occurrences east of the Allegheny rain shadow will be most vulnerable to extirpation.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Appalachian Forest Appalachian Rivers and Streams	Species composition/ dominance	**Temp**	Air Temperature Increase [2.3C to 5.5C by 2100]	3	Plant bloom, insect emergence, & animal movement will occur earlier in spring and later in autumn potentially delinking predator/prey, and pollinator/ disperser relationships.	**Food web/trophic level disruptions**
	Appalachian Forest	Fire Regime	**Precip**	Altered Precipitation	2	Fire tolerant species will expand into adjacent habitats.	**Shift in geographic space of habitat**
	Appalachian Forest	Landscape Context/Connectivity	**Other**	Human Adaptation	1	Increased development of low carbon energy sources (wind, natural gas) will accelerate fragmentation of remote forested areas.	**Fragmentation**
Dugout Ranch, Utah, USA	Grassland	Percent composition of functional groups	**Temp**	Mean Annual Temperature (+3-4 deg C)	3	Predicted increase in mean annual temperature will reduce perennial C3 grasses to 0% canopy cover between 2025 and 2074.	**Direct impact on species survival**
	Grassland	Soil surface protection: Vegetation cover	**Temp**	Mean Annual Temperature (+3-4 deg C)	3	Predicted increase in mean annual temperature will reduce % cover of C4 grasses on shallow shale soils.	**Altered species composition**
	Grassland	Soil surface protection: Vegetation cover	**Temp**	Mean Annual Temperature (+3-4 deg C)	3	Loss of vegetation cover due to increased mean annual temperature will result in wind and water erosion of soil surface	**Habitat conditions (integrity/viability)**
	Grassland, Shrub steppe, Piñon-Juniper	Soil surface protection: Biological soil crust	**Temp**	Maximum June Temperature (+4-5 deg C)	3	Increase in maximum June temperature will reduce % cover of dominant N fixing lichen (Collema spp.) thus reducing soil stability, increase N efflux, alter soil fertility.	**Habitat conditions (integrity/viability)**
	Piñon-Juniper	Species composition	**Temp**	Mean Annual Temperature (+3-4 deg C)	3	Increase in mean annual temperature will increase background Pinus edulis mortality rates regardless of changes in ecosystem water balance resulting in an increase of Juniperus.	**Altered species composition**

Project Team Comments		
Wildfire frequency may increase due to drier conditions facilitated by earlier snowmelt and patchier precip distribution during the growing season. Fuels in cooler moister coves may become more available and facilitate expansion of dry oak hickory and oak pine forests.		
Maybe it's not appropriate to use human adaptation as a climate factor, but we thought we'd see what people thought.		
This hypothesis is based on long-term data. We are currently experiencing loss of C3 grasses in non-grazed (domesitic livestock) areas. C4 and other species not likely to invade because of nutrient limitations. These plants are edaphically controlled.		
This hypothesis is based on long-term data		
This hypothesis is based on experimental data		
Based on literature review from Colorado Plateau		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Riverine-Aquatic	Soil surface protection: Vegetation cover and Biological soil crust	**Temp**	Mean Annual Temperature (+3-4 deg C) and Maximum June Temperature (+4-5 deg C)	3	Loss of upland shallow rooted and riparian plants and biological soil crust from changes in critical temperature thresholds will result in increased flooding and sediment loading due to reduced infiltration and increased surface runoff	**Hydrologic regime**
Meili Snow Mountains, China	Temperate coniferous-broad-leaved mixed forests	Fragmentation of habitat	**Temp/Precip**	temperature (+1.4-2.02 degrees) annual precipitation (+ 55 -131 mm)	2	The increase of temperature and precipitation will both benefit the growth of broad-leaved species much better than coniferous species. The mixed forests will be shift to higher elevation. Therefore the fragmentation will be increased.	**Habitat loss/extent of habitat decrease**
	Alpine Mosaic (alpine meadow, alpine screes, and alpine-subalpine shrub/alpine-rhododendron shrub)	Fire regime - (timing, frequency, intensity, extent)	**Precip**	frenquency of the extreme dry events	4	The extreme climate events such as the drought will increase the fire frequency and intensity.	**Fire regime**
	Alpine Mosaic (alpine meadow, alpine screes, and alpine-subalpine shrub/alpine-rhododendron shrub)	Species composition / dominance	**Temp/Precip**	temperature (+1.4-2.02 degrees) annual precipitation (+ 55 -131 mm)	2	The alpine mosaic is combining with alpine shrub, alpine meadow and alpine scree. The species composition is going to change in the transection area. Typically, the woody speices is going to increasly occupy the alpine meadow area. In addition, in the alpine meadow, the species composition will change as well, some of the plant species will under great preasure of the extinction. In the alpine scree area, the saussurea is going to loss it habitats.	**Altered species composition**

Project Team Comments		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	High-gradient Stream Systems	Water level fluctuations	**Temp/Precip**	temperature (+1.4-2.02 degrees) annual precipitation (+ 55 -131 mm)	2	Water flow regmie would change and desynchronise life cycles of sensitive species	**Hydrologic regime; Growing/mating season**
	High-gradient Stream Systems	Presence / abundance of keystone species	**Temp/Precip**	temperature (+1.4-2.02 degrees) annual precipitation (+ 55 -131 mm)	2	Increasing water temperature would influence the life cycles of senstive aquatic communities, for instance,benthic algea, macroinvertebrate and cold water adapted fish	**Growing/mating season**
	High-gradient Stream Systems	Water quality	**Temp**	temperature (+1.4-2.02 degrees)	2	Increasing water temperatures enhances production and decomposition intensity, thus leading to oxygen depletion, particularly at night times.Consequently, it leads to eutrophication	**Hydrologic regime**
Regional scale land/sea-scapes							
Atlantic Forest, Brazil	Birds - forest depended species, high fidelity to habitats, sensitive to disturbance, high levels of endemism, important for a variety of ecological processess	Biological community composition	**Temp/Precip**	temperature and precipitation - there will be a increase of temperature up to 3,5C. Intensification of precipation regime - It will present drier dry seasons (up to - 110mm) - and increase of rain fall during the summer (up to + 80mm)	2	Loss or shift of species. High risk of chain extinction/ Impact in forest ecological processes	**Food web/trophic level disruptions**

Project Team Comments		
Species with better capacity of dipersal may migrate but due to high levels of fragmentation and human disturbance a great number of species is leaving in sub-optimal conditions. This might cause a chain extinction affecting the whole biological community. Birds are the most important group of seed dispersers in the Atlantic Forest of Brazil. Thomas et al Nature Jan 2004 - vol 427.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Endemic species with restricted ranges	Habitat Size/Extent	**Temp/Precip**	temperature and precipitation - there will be a increase of temperature up to 3,5C. Intensification of precipation regime - It will present drier dry seasons (up to - 110mm) - and increase of rain fall during the summer (up to + 80mm)	3	Increase in water soil content seasonality leading to changes in plant species composition and changes in habitat suitability	**Habitat conditions (integrity/viability)**
	Endemic species with restricted ranges	Habitat Connectivity	**Temp/Precip**	temperature and precipitation - there will be a increase of temperature up to 3,5C. Intensification of precipation regime - It will present drier dry seasons (up to - 110mm) - and increase of rain fall during the summer (up to + 80mm)	3	Increase in water soil content seasonality leading to changes in plant species composition and decrease connectivity in current corridors	**Fragmentation; Habitat conditions (integrity/viability)**
	Endemic species with restricted ranges	Fire Regime	**Temp/Precip**	temperature and precipitation - there will be a increase of temperature up to 3,5C. Intensification of precipation regime - It will present drier dry seasons (up to - 110mm) - and increase of rain fall during the summer (up to + 80mm)	2	Increase on fire occurrences due to more severe droughts leading to habitat degradation	**Habitat loss/extent of habitat decrease; Fire regime**

Project Team Comments		
Knapp, A. K., Smith, M. D., Smith, S. D., Bell, J. E., Fay, P. A., Heisler, J. L., et al. (2008). Consequences of More Extreme Precipitation Regimes for Terrestrial Ecosystems. October, 58(9), 811-821.		

Project Name and Location	Conservation Target	Key Eecological Attribute	Climate Factor		Likelihood of Climate Factor Change	Hypothesis of Change	Impact category
	Mixed Ombrophyllous moist forests - Araucaria Forest	Habitat reduction	**Temp/Precip**	Temperature increase (up to 2,5C) and precipitation (decrease during the winter up to -70mm)	3	Increase of evapotranspiration due to increase of dryeness and temperature leading to retraction of ecossystem distribution	**Habitat loss/extent of habitat decrease; Water availability**
	Semideciduous and Decidous Stationary Forest	Habitat expansion	**Temp/Precip**	temperature (increase up to 3,5 during the winter) and precipitation (decrease of precitation up to 100mm during the winter)	3	Increase of semidecidous forest species in areas that will became dryer due to drier dry season.	**Shift in geographic space of habitat**
	Ombrophylus Dense Forest/Evergreen Rain Forest	Species composition - Habitat shift	**Precip**	Precipitation (decrease of precitation up to 100mm during the winter)	1	Species decline, change in the flora species composition (rain dependend) and consequently in the fauna depended of it due to apperance of a dry period. Overall several complexes ecological process will be impacted.	**Food web/trophic level disruptions; Altered species composition**
	Coastal and eastern ecosystems	Species composition	**SST**	Surface wind speed (speed increase)	1	Increased coastal wind speeds will interact with drier dry seasons to cause shifts in species composition in the atlantic cost.	**Altered species composition**
	Coastal and eastern ecosystems	Fire Regime	**SST**	Surface wind speed (speed increase)	3	Increased coastal wind speeds will interact with drier dry seasons to increase fire frequency and intensity, resulting in fragmentation of the target.	**Fragmentation; Fire regime**
Coastal Cordillera Dry Forests, Ecuador	Deciduos and semideciduos forests	Water availability	**Temp**	Increase in temperature (1.7-1.9 C)	3	Increase stress in plants. Higher temperatures increases evapotranspiration and the need to use more water in a region where water is scarce.	**Water availability**
	Deciduos and semideciduos forests	Rainfall pattern for plant regeneration	**Precip**	Altered rainfall pattern (intense rains in short periods (less than 3 months), longer dry season (more than 9 months)	3	Alter floristic and phenology patterns in these forests which are closely linked with seasonality	**Growing/mating season**

Project Team Comments		
This ecossystemoriginally doesnt have a biological dry period along the year. 1) Mortality of the species no tolerant of dry season and/or warmer temperature. 2) Increase of the dominance of species from tropical climate. 3) Habitat shift for cooler areas. The current fragmentation Colombo e Joly 2009- in press - Atlantic Forest: The most ancient Brazilian Forest and a biodiversity hotspot, is high thereathen by climate change.		
It is also possible to have a extention of the period with leafless. Colombo e Joly 2009- in press - Atlantic Forest: The most ancient Brazilian Forest and a biodiversity hotspot, is high thereathen by climate change		
This forest has a high conection/dependence to rain fall, is a very diverse and complex system. Species extinction will occurr.Colombo e Joly 2009- in press - Atlantic Forest: The most ancient Brazilian Forest and a biodiversity hotspot, is high thereathen by climate change. Source: Carnaval & Moritz, Historical Climate modeling predicts patterns of current biodivertity in the Brazilian Atlantic Forest. Journal of Biogeography 2008.		
This is results from increased sea surface temperarure. Source: The coastal winds of western subtropical South America in		
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This will also increase the risk of fire which is one of the main threats to the targets		
This will also increase the risk of fire which is one of the main threats to the targets		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Seasonal evergreen forest	Presence of mist on dry season	**Temp**	Increase in temperature (1.7-1.9 C)	3	Increase in temperature will impede development of mist.Mist development during the dry season is key for maintaining vegetation and epyphytes through fog interception.	**Water availability**
	Seasonal evergreen forest	Area	**Temp**	Increase in temperature (1.7-1.9 C)	3	"An increase in the temperature will reduce the size of the ecosystem, by pushing up-wards the altitudinal range of distribution of forests that are distributed in high areas of the coastal range	**Shift in geographic space of habitat; Habitat loss/extent of habitat decrease**
	Freshwater ecosystems	Water quantity	**Precip**	Altered rainfall pattern (intense rains in short periods (less than 3 months), longer dry season (more than 9 months)	3	Changes in precipitation will affect hydrological regime. Longer dry seasons can result in streams getting completely dry. Higher temperature will raise evapotranspiration rates of forest reducing runoff. Intense rainfall in the wet season can produce floods, increasing stream erosion and affecting riparian vegetation	**Water availability; Hydrologic regime**
	Freshwater ecosystems	Water quality	**Temp**	Increase in temperature (1.7-1.9 C)	2	Increase temperature will increase water temperature, particularly in dry season when water flows are low, altering freshwater habitats.	**Habitat conditions (integrity/viability)**
	Timber species	Regeneration	**Precip**	Altered rainfall pattern (intense rains in short periods (less than 3 months), longer dry season (more than 9 months)	3	Shorter rainy seasons do not allow good development of seeds longer dry seasons do not allow to seedlings develop	**Growing/mating season**
Mediterranean Baja California, Mexico	Sand beaches and dunes	Sand beaches and dunes cover/extension	**SLR**	Sea level rise (50 cm increase)	4	Predicted increase will cause partial or complete loss of sand beaches and dunes on Barra-Mazo and Punta-Azufre.	**Habitat loss/extent of habitat decrease**

Project Team Comments		
Epyphytes and bromeliads depend on mist for survival, if mist dissapears, epyphytes will dissapear as well		
Forests are distributed from 500 up to 800 m which is the highest elevation in the area		
Good example is Guayacan one of the highly logged species. It is having trobule regenerating due to shorter but more intense rainy seasons, and longer dry seasons.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Wetlands system	Wetland cover/extension	**SLR**	Sea level rise (50 cm increase)	1	Predicted increase will convert significant areas of the wetlands to shallow water (open water).	**Habitat loss/extent of habitat decrease**
	Coastal Scrub	Plant community composition	**Temp/Precip**	Temperature (increase of ~2 · 5C, increased evapotranspiration and decreased annual rainfall (20%)	3	Predicted Increased temperature and annual rainfall (increased aridity) will cause dieback of coastal sage scrub community and transition of this type of vegetation to succulent and xerophytes plant communities (sarcophyllous desert plant community).	**Altered species composition**
	Bays	Hydrodynamics and morphology	**SLR**	Sea level rise (50 cm increase)	3	Predicted increase will mean increased coastal erosion, higher storm-surge flooding, inhibition of primary production processes, more extensive coastal inundation, drastic changes in surface water quality and groundwater characteristics.	**Hydrologic regime**
	Bays	Presence of key species	**Temp**	Temperature	3	Temperature increase will cause changes in abundance and availability of eelgrass (Zostera marina - look at reference in comments) and this may have indirect effects over black brant (Branta bernicla nigricans) population.	**Altered species composition**
	Hypersaline lagoons	Size/Extension	**SLR**	Sea level rise (50 cm increase)	3	Predicted sea level rise will flood Laguna Figueroa converting it from a hyper saline lagoon to a small bay and inundating low-lying areas around its edges where salt marshes will form.	**Habitat conditions (integrity/viability)**
	Washes and riparian vegetation	Floristic composition and structure	**Temp/Precip**	Temperature (increase of ~2 · 5C, increased evapotranspiration and decreased annual rainfall, 20%)	2	Vegetation composition and structure will be affected by less water available to bushes and tree seedlings due to predicted annual rainfall decrease and less water table recharge.	**Water availability**

Project Team Comments		
For example, the small salt marsh at the northwestern end of Bahia Falsa could be almost entirely converted to open water. This loss of marsh area could be partially or totally compensated for by inundation of other areas suitable for the development of salt marsh as long as these areas are not fortified to prevent flooding.		
This coastal scrub community is already considered as of in a transition stage (Peinado et al. 1995. Shrubland formations and associations in mediterranean-desert transitional zones of northwestern BC.) Coastal scrub plant species might dissapear and be replaced by succulent/xerophytes species		
Extreme water temperatures had an overall negative impact on eelgrass, although via different mechanisms. (In this study) High temperatures (25–30 °C) increased mortality (12-fold) and lowered both photosynthetic rate (by 50%) and growth (production of new leaves by 50% and leaf elongation rate by 75%). The optimum water temperature for eelgrass appeared to lie between 10 and 20 °C. These results show that extreme conditions may affect the fitness of eelgrass and, thus, may potentially limit its distribution in coastal and estuarine waters. Effects of salinity and water temperature on the Ecological performance of Zostera marina. Lars Brammer Nejrup and Morten Foldager Pedersena. Aquatic Botany, Vol. 88, Issue 3, April 2008, Pag. 239-246		
Big and old deep rooted trees are the ones that survive, changing age structure and vertical structure. In addition, this area could be invaded by other plants adapted to this low availability of water situation, such as mesquite and others. This would also affect mammals and bird populations. Sand taken out of the washes and water pumping also exacerbate this effect.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
Yucatan Peninsula, Mexico	Coral reefs	Live hard coral cover	**SST**	1°-4° increase in seawater temperature over the next 50 years	1	With an expected 1°-4° C increase in seawater temperature over the next 50 years, severe bleaching events (affecting over 50% of the live hard coral cover) will increase in frequency, leading to a higher mortality of the reef.	**Direct impact on species survival**
	Seagrasses						
	Beaches and coastal dunes	Extension of this ecosystem; Adequate nesting ground for marine turtles and other reptiles	**SLR**	0.5 to 1.5 m sea level in the next 50 years	1	With an expected 0.5-1.5 m sea level rise in the next 50 years, 60-80% of the coastal line with sand beaches and dunes will be severely affected and may disappear, affecting up to 100% of the known critical nesting habitat for marine turtles	**Habitat loss/extent of habitat decrease; Growing/mating season**
	Coastal wetlands	Extension of ecosystem and communities	**SLR**	0.5 to 1.5 m sea level rise in the next 50 years	1	With an expected 0.5-1.5 m sea level rise in the next 50 years scenarios, 100% of the coastal wetlands will be affected and 60-80% will be unable to migrate given inland anthropogenic use and terrain elevation	**Habitat loss/extent of habitat decrease**

Project Team Comments		
Raising seawater temperatures around the tropics are affecting live hard corals cover through bleaching events (loss of symbiotic photosynthetic algea). Corals are the basis for the whole trophic chain in tropical coral reefs, and the loss of hard coral throught repeaded bleaching compromise the survival of the whole ecosystem. In the Yucatan region, coral reefs are under stress in certain parts due to increased tourism, so corals are even more sensitive to the effect of raising water temperature. On the same token, reduced quality of the coral reef will affect the tourism industry which is an important driver of the region's economy. The most significant mass bleaching events in the MAR occurred in 1995 and 1998, with 50-90% of corals bleaching in some areas. Moderate bleaching from 30-40% occured in some areas in 2005 (McField and Kramer, 2007)		
The fact that beaches and coastal dunes are only found as a very narrow strip along the coast makes this ecosystem one of the most vulnerable ones to predicted sea level rise. The high vulnerability of this system is enhanced by heavy coastal development in large sections of the Yucatan Peninsula coast, with construction happening directly over the beach/dune, and other major infrastructure including large buildings and roads, spreading just behind the beach/dune ecosystem. With a few meters of water level rise, this ecosystem could completely disappear, with nowhere to migrate further inland. In addition to the very high impact to wildlife "nested within this habitat", such as marine turtles whose nesting habitat would be totally lost, the impact on the region's economy dependent on "beach and sun" tourism is highly compomised. There is an estimated 1,250 kms of sand dunes coastline around the Peninsula and only 475 kms have inland areas to migrate. The rest exist on narrow strips on land disconnected to mainland by coastal lagoons, that once flooded have nowhere to migrate, or are found in areas with urban and road infrastructure built right next to the beach and dune (GIS analysis done by team).		
With coastal development happening so close to the coast, mangroves will be limited in their ability migrate inland, therefore, reducing their total extension. Coastal wetlands are very important in securing water quality and nutrients inflow to marine ecosystems, so their reduction or disappearance will have a compounded effect in the marine habitats (coral reefs and seagrasses). Coastal wetlands are also important nurseries for fisheries and other species that are commercially extracted, so these economic activities will also be compromised by a reduction or disappearance of coastal wetlands. There are 501,000 ha of mangroves in the Peninsula. Estimation of 60-80% loss were based on a comparison of 1 and 2 mts sea level rise maps done by the University of Arizona, Department of Geosciences Environmental Studies and the vegetation and land use map of CONAFOR 2002, and urban and roads map. Coastal lagoons and other estuaries were not considered yet under this hipothesis.		

Project Name and Location	Conservation Target	Key Eecological Attribute	**Climate Factor**		Likelihood of Climate Factor Change	Hypothesis of Change	**Impact category**
	Underground freshwater system	Freshwater layer depth and width	**SLR**	0.5 to 1.5 m sea level rise in the next 50 years	1	With an expected 0.5-1.5 m sea level rise in the next 50 years, saltwater intrusion will increase from 50 m to 1800 m inland, reducing the amount of freshwater available for human use near the coast.	**Hydrologic regime; Water availability**
	Superficial freswater bodies	Size, presence and distribution of temporary water bodies (ponds, "aguadas")	**Precip**	5 months of reduced precipitation (May-Sep)	2	With an expected 5 months of reduced precipitation (May-Sep), existence of temporary freshwater bodies during the dry season will be drastically reduced, affecting wildlife depending on them.	**Water availability**
	Tropical dry forest	Structure, abundance and composition of vegetation and functional guilds	**Temp/Precip**	Increase of 0.5-2.5 °C in the next 10 years, 5 months of reduced precipitation (May-Sep), and an increase in hurricanes intensity	2	With an expected increase of 0.5-2.5°C in the next 10 yeares, and 5 months of reduced precipitation (May-Sep), XXX number of key fruting plant species critical to migratory birds will delay the production of fruit creating an asynchrony between the timing of migratory birds landing in the Northern part of the Peninsula, and the availability of the needed plants, affecting the population dynamics of XX migratory species.	**Food web/trophic level disruptions**
	Tropical moist forest	Extension of forest cover; Structure, abundance and composition of vegetation and functional guilds	**Temp/Precip**	Increase of 0.5-2.5 °C in the next 10 years, 5 months of reduced precipitation (May-Sep), and an increase in hurricanes intensity	2	With an expected increase of 0.5-2.5°C in the next 10 years, 5 months of reduced precipitation (May-Sep), and an increase in the hurricanes intensity, forest fires will probably increase in frequency and size, potentially affecting large swaths of forest and changing its structure and composition, particularly in the Eastern part of the Peninsula.	**Fire regime**

Project Team Comments		
Due to the karstic (limestone) nature of the ground, rainwater percolates fast into the acquifer flowing then underground from the central parts of the Peninsula towards the coasts (east, north and west), following a very complex underground network of faults and other geologic features. Therefore, the largest amount of freshwater available for human consumption in the Peninsula is found underground. With sea level water raising, salt water from marine intrusion will go farther inland into the acquifer around the coast, reducing the size of the freshwater layer (Langevin and Dausman,). This effect might be compounded with the effects of reduced precipation. Less freshwater available will certainly have an effect on biodiversity (very specialized endemic species associated to sinkholes and underground "rivers", coastal and marine wildlife) and the human population (at least 3 million people living in the Peninsula) that depend on it.		
With no superficial rivers flowing through or into the Peninsula, Yucatan's frewshwater intake comes mainly from precipatation (rain). Several scenarios (including the ones from climate wizzard) predict a later on-set of the rainy season every year, and less rain falling during every rainy month. This reduced precipitation will probably affect the freshwater intake essential to feed the superficial freshwater bodies, therefore reducing the temporal availability of intermitent water bodies (ponds, "aguadas"). The effect for terrestrial wildlife will be critical during dry months.		
With a reduction in precipitation and an increase in temperature, the phenology of many plant species (flowering, fruiting and germination), and the ensuing effect to other symbiotic species (migratory birds, reproductive cycles timed with fruit availability, etc..) could be altered to a degree that will affect the whole structure and composition of this ecosystem, and the viability of many important functional guilds (polinators, migratory birds coming across the Gulf of Mexico). Change in phenological patterns could also affect important crops, vital to the livelihood of local human population.		
An important effect of less rain, higher temperatures and higher frequency of hurricanes is the potential increase in forest fires due to an increase of combustible material, increased probability of ignition and longer dry period during which fires can affect. Tropical moist forest is a system that does not require a natural fire regime. Increased forest fire would affect the quality and extension of forest cover, particularly in the Eastern part of the Peninsula that could be hit more frequently by hurricanes. Sustainable forestry operations, an important economic activity in the south-eastern part of the Peninsula can be severly affected, compromising the forest-dependent livelihood of thousands of Maya inhabitants of the region.		