SOCIETY FOR CALIFORNIA ARCHAEOLOGY
CLIMATE CHANGE AND CALIFORNIA ARCHAEOLOGY SERIES

TECHNICAL REPORT 1. OVERVIEW AND WORKPLAN

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Cover Image: Archaeological Site CA-SMA-238, denuded to bedrock as a function of sea-level rise and shifting wind patterns. View to the southeast. Photo by author (August 2013)

SECTION I. INTRODUCTION

THE PURPOSE OF THIS DOCUMENT

Climate change is a global phenomenon that affects us all. The Society for California Archaeology (SCA) recognizes that California faces a wide spectrum of potential climate-change related-impacts, and that these impacts will have a deleterious effect on many of our state's important cultural resources. These impacts will span the property holdings of many public agencies. While these agencies have ongoing responsibilities to be stewards of their lands and the resources on them, the extent of climate change impacts will be beyond the jurisdiction of any single agency, most of whom are working at their full financial and staff capacity to manage their lands under current conditions. There is no single state college, university, or private institution with the financial or infrastructure resources to assess the scope of these impacts statewide. No private firm can or should be expected to accept the financial burden of voluntarily undertaking a detailed statewide assessment of impacts.

The SCA, as the largest archaeological organization focused on California, with a broad membership that extends to all corners of the state, is best suited to assist agencies in preparing for the effects of climate change on archaeological resources. The SCA could achieve this through conducting inventories, seeking grant funding in collaboration with non-profit and university partners, and coordinating directly with agencies and tribal governments. By providing professional guidance, regional expertise, and an overarching framework for such preparations, the SCA hopes to accomplish what no individual agency or university can do on its own. It is expected that this will be primarily a volunteer effort, with a large number of participants, and that it will progress steadily but slowly. The full extent and nature of climate change over the next century has yet to be determined, the evidence behind its occurrence is conclusive and accepted globally by the scientific community and policy makers. Given this evidence, the SCA has an obligation to act.

This document, therefore, presents a scope of work for these preparations. It presents an outline for the kinds of impacts we can expect in California, based on the current understanding of climate change as it has progressed, and a work plan for moving forward. As of this writing, our primary goal is agency coordination, archaeological inventory, and public outreach. This is a living document; as our volunteer coordinators undertake each survey effort, they will provide recommendations for improving our efforts and for taking into account unanticipated impacts as they are discovered. Work has already commenced in Marin and Monterey counties, and the observations of the coordinators of these efforts have been incorporated here. We anticipate that the scope of work presented here will be modified for each county or each effort, to reflect the terrain, types of impacts, agency requirements, and availability and abilities of the volunteers.

In addition, this document is freely offered and is available online to other archaeological organizations and agencies around the world. Every country, every government, every culture will be effected by climate change to some degree. We hope that we can assist similar efforts globally through this series of documents or through consultation with our membership.

DEFINING CLIMATE CHANGE

What is climate change? The Intergovernmental Panel on Climate Change (IPCC) has prepared a definition, decided what constitutes evidence for climate change, what its causes are, what the short- and long-term effects of it might be, how to slow or stop it, and how to mitigate its effects. The IPCC is the leading international body for the assessment of climate change, established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to "provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socioeconomic impacts" (IPCC 2007). Thousands of scientists and 194 countries participate in the IPCC's assessments, contributing the most recent scientific, technical and socio-economic information relevant to the understanding of climate change so that the IPCC can reach informed decisions. In 2007, the IPCC was awarded the Nobel Peace Prize "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change" (IPCC 2011).

The IPCC defines climate change as

> a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity [IPCC 2007:30].

Recent review of the existing literature published in the Proceedings of the National Academy of the Sciences shows that there is near world-wide consensus within the scientific community that climate change is human caused (Anderegg et al. 2010). In 2007, IPCC released a four-volume assessment of the current state of climate change world-wide, their fourth such assessment. The IPCC is in the process of releasing the fifth assessment, portions of which have been published online for circulation. For the purposes of the SCA's study, the fourth IPCC assessment will form the backbone of the discussion on evidence for, causes, and world-wide effects of climate change, with updates from the fifth assessment added when available.

PROJECT HISTORY TO DATE

In 2010, the National Park Service (NPS) launched a study to assess the potential impacts of pending climate change on Point Reyes National Seashore (PRNS). The study was contracted through the Anthropological Studies Center (ASC) at Sonoma State University through a cooperative agreement between ASC and NPS. ASC Staff Archaeologist Michael Newland was assigned to the project, as he had conducted several projects at PRNS for the ASC. The task was to identify the range of likely impacts and rank archaeological sites by the degree to which they were threatened by climate change, particularly sea level rise. After several months of reviewing journal articles, projection models, maps, policy documents, and discussing the issue with researchers working on climate change, it appeared that the data and future projections of climate impacts indicated that archaeological sites up and down the California coastline and interior delta areas were threatened by sea level rise, coastal erosion, and increased storm strength.

In the spring and summer of 2011, ASC archaeologists, PRNS cultural staff, and representatives from the Federated Indians of Graton Rancheria visited and recorded several sites that sea level rise models indicated could be inundated or eroded. Two of these sites, CA-MRN-278 and -287, were found to be already eroding due to the specifics of the topography and drainage issues unrelated to sea-level rise and so test excavations were conducted. Sites within Tomales Bay were reached by boat and their threat level assessed. ASC prepared a report in 2012 containing the results of the fieldwork, an analysis of different types of expected impacts to cultural resources within PRNS, and a ranking of sites by level of threat. Several revisions have been made since the original submittal with the intent on creating a version that could be released to the public. Updates and edits have been made to the report, reflecting feedback from NPS personnel working on the topic of the impacts of climate change to archaeological sites.

In an unrelated coincidence, Newland was elected President of the SCA in spring of 2011, and was giving presentations on the threats posed by climate change to archaeological sites in California. During the Q&A session a presentation for the Santa Cruz Archaeological Society (SCAS) in June. , one of the audience members suggested that the entire California coastline should be surveyed. At the timer, such a survey seemed impossible—too many agencies, too much private land, and no funding. Following that meeting, however, after further consideration, Newland concluded that this indeed needed to happen and that the SCA was the most likely organization to be able to carry it out.

At the 2011 June SCA Board Meeting, data from the PRNS project and others were presented. It was proposed that the SCA begin surveying California coastline public lands, in direct coordination with agencies and tribal governments, on a volunteer basis as much as possible. The Board agreed. Marin County was chosen as a test case for the study, as the local agencies and tribe were already in agreement on the importance of the research, and access would be easy to obtain..

The issue was discussed with archaeologists in the Bay Area and Central Coast. Dustin McKenzie, Anthropology Instructor at Cabrillo College, expressed interest in participating in the project by using the college's archaeological field school to complete some of the survey work. In the winter of 2011, McKenzie and Newland, on behalf of Cabrillo College and the SCA, applied for an Archaeological Resource Protection Act (ARPA) permit to conduct survey work on the Los Padres National Forest in Mendocino County. The SCA holds a five-year permit, with Cabrillo College launching a task-specific project under that permit. Staff of the Northwest Information Center (NWIC) of the California Historical Resources Information System (CHRIS) supplied free access for students and researchers working on this issue. The SCA would cover the costs of photocopies. Annamarie Leon Guerrero, a Cultural Resources Management graduate student at the time at Sonoma State University (SSU) who had helped bring about Cabrillo College's involvement in the project, volunteered her time to conduct the records search and serve as crew chief for the Cabrillo effort.

At the 2011 SCA Northern California Data Sharing (NCDS) meeting, Newland presented on the potential impacts of climate change to archaeological sites and extended an invitation to all SCA members to participate in the developing coastal surveys in conjunction with the NCDS and again at the 2012 Annual Meeting in Riverside. Sign-ups were available at the annual meeting, and volunteers and crew chiefs for the Marin effort were recruited.

In June 2012, the United States Forest Service (USFS) issued ARPA permits for the project and helped arrange camping for the field school. The SCA covered the costs of the campground. Cabrillo completed their field research in June 2012; the results have been prepared by Guerrero and will appear as Volume 2 of the current report series.

At the start of the fall semester 2012 at SSU, Newland recruited a team of graduate students to serve as coordinators for the Marin effort. Reaching out to those who volunteered, an initial field effort at PRNS and at Tomales Bay State Park were launched, to coincide with the weekend of the NCDS meeting in October, held at PRNS. A subsequent effort was held a few weeks later. In the spring of 2013, a third weekend rotation was conducted.

In total, between the Cabrillo and PRNS efforts, over 80 volunteers from six different universities have donated their time and energy towards this project, covering some 40 miles of coastline. As of this writing, other agencies and archaeologists are noting damage done to sites that can be linked with climate change and it is hoped that their work will serve as additional volumes in what is hoped will be an on-going series. Newland has recorded essays describing the project that have been aired on KQED in San Francisco and has given media interviews highlighting the effort. It is worth noting that, to date, this work has been done entirely without funding and has relied totally on the good will and participation of a community of citizen scholars who understand the gravity of undertaking. While grant funding will be sought to further the goals of the study and hasten the speed of the research, the importance of the work mandates that it continue at the pace that it can. Other organizations and archaeologists elsewhere are encouraged to join our efforts and launch their own surveys locally.

SECTION II. THE IMPACTS OF CLIMATE CHANGE ON ARCHAEOLOGICAL RESOURCES

INTRODUCTION

The world's major scientific organizations are united in their assessment that the climate change now occurring is likely the result of anthropogenic greenhouse gas emissions (IPCC 2007; National Academy of Sciences 2011; Royal Society 2005). The evidence for climate change is pervasive and can be seen through several indicators, from sea level rise to ocean acidification to changing global temperatures. Evidence also suggests that climate change may be affecting terrestrial forest communities, making them more susceptible to disease and infestation. Some of the studies supporting this evidence, the different indicators of climate change, and their potential implications, are discussed below.

CLIMATE CHANGE AS A GLOBAL PHENOMENON

Climate change has been an ongoing event for all of our planet's history. There are many reasons the world's climate could be dramatically altered—volcanic eruption, solar flares, changes in the earth's magnetic fields, or objects from space such as comets. Some are short term: the massive dinosaur extinction that took place 65 million years ago is widely thought to have been caused by a single comet impact leading to a nuclear winter-type freeze (Kerr 2009: 335; Perkins 2001). Others are long term: a catastrophic series of massive volcanic eruptions 250 million years ago that spanned several hundred thousand years resulted in the largest terrestrial and marine species die off on record (Sephton et al. 2005).

The rise and fall of sea levels can be both a response to, and a trigger for, climate change. The melting and drainage of the massive Lakes Ojibwa and Assazi about 8,200 years ago caused the relatively rapid introduction of 105,000 to 164,000 km^3 of fresh water to the North Atlantic, resulting in an average 3.0 (+/- 1.2 m) sea level rise worldwide on top of the post-Pleistocene glacial thawing (Gornitz 2007; Hijma and Cohen 2010:275). Recent studies tracking sea level curves, based on soil cores from mangrove-fringed embayments around Singapore, now show as much as −16 m to +2 m (- 52 ft. to -6 ft.) fluctuation over the past 8,800 years (Bird et al. 2010:804). Similar, smaller scale changes have been noted along the Brazilian, British, and Antarctic coastlines at a similar time depth (Edwards 2001; Martin, Dominguez, and Bittencourt 2003:101; Zwartz et al. 1998:131).

Even within the Late Holocene, changes in relative sea level (RSL) as a result of polar ice melt have been identified along the North American coasts (Long 2000:419) as have rapid ocean temperature increases by as much as 3°C (5.4°F) within a 50-year time span (Euler and

Ninnemann 2010:647). On a larger scale, at least four to five major global climate changes have occurred over the past 5,800 years (Billeaud, Tessier, and Lesueur 2009:1033). Studies of sediment deposits along the Atlantic seaboard indicate sub-meter changes in oceanic mean high-water levels over the past 1,500 years (Edwards et al. 2004; van de Plassche 2000; van de Plassche, van der Borg, and de Jong 1998). However, in general, sea levels changes have been relatively stable during the Late Holocene (Gornitz 2007).

EVIDENCE FOR CLIMATE CHANGE OCCURING TODAY

Geologists, geographers, and researchers reconstructing paleoenvironmental conditions have found abundant evidence for naturally occurring climate change during the Holocene. There are several key indicators for climate change, including changes in sea level, loss or expansion of polar ice and mountain glaciers, major changes in vegetation regimes, changes in solar energy absorption and reflection from the earth's surface and atmosphere, consistent and long-term seasonal temperature changes, and changes in precipitation.

Rising Sea Levels

The stability of the world's sea levels is changing. Sea levels began to rise in the mid-to-late 19th century to early-20th century at a rate of roughly 1.7 to 1.8 mm/yr (.06 to .07 inch), and appear to be related to a global warming event (Kemp et al. 2009:1035). Numerous studies, ranging from assessment of sea level changes in salt water marshes in North Carolina (Kemp et al. 2009), the effects of rising sea levels on dune formations along the Baltic Sea (Pruszak and Zawadzka 2005), to erosion on pocket beaches on the French Mediterranean (Brunel and Sabatier 2006:77). Water runoff from receding mountain glaciers worldwide, warmer ocean waters, and a dramatic doubling of the rate of ice loss from Greenland glaciers by the end of the 19th century have led to estimates of 2.8 mm/yr (0.11 inch) sea level rise in the early 1990s (Gornitz 2007). Since the 1990s, sea level rise has jumped to 3.8 mm (0.15 inch) a year, and sea level rise now appears to be a global phenomenon (IPCC 2007:30). In the early-21st century, Greenland meltwaters and ice continue to contribute to sea levels at an increasing pace, and the West Antarctic Ice Sheet is thinning. Vivian Gornitz (2007), special research scientist with the NASA Goddard Institute for Space Studies and Columbia University Center for Climate Systems Research states that

> Either ice sheet, if melted completely, contains enough ice to raise sea level by 5-7 m [16. to 23 ft.]. A global temperature rise of 2-5°C might destabilize Greenland irreversibly. Such a temperature rise lies within the range of several future climate projections for the 21st century.

Increased Temperatures and Weather Changes

According to the IPCC (2007:30) assessment, in eleven of the twelve years immediately prior to their study, global surface temperatures were among the highest recorded in the past century and a half. The temperature increase is a global phenomenon and appears to be greater in the higher northern latitudes, particularly in the Arctic, where temperatures have increased

at almost twice the global rate over the past century. Research on ocean temperatures indicates that, globally, ocean temperatures have increased to a depth of 3000 m (9,842 ft.) and that the oceans have been taking on over 80 percent of the heat added to the climate system. Land masses are heating up faster than the ocean, and lower- and mid-tropospheric temperatures appear to be warming at a rate similar to that of the surface. The IPCC note that, in general, it appears that cold days, cold nights, and frosts have decreased while hot days and nights have increased, that heat waves have increased (IPCC 2007:30). The increased temperatures have resulted in the IPCC (2007:31, 33) stating that

> There is a *high confidence* that recent regional changes in temperature have had discernible impacts on physical and biological systems… There is a *very high confidence*, based on more evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems**,** including such changes as earlier timing of spring events, such as leaf-unfolding, bird migration and egg-laying; and poleward and upward shifts in ranges in plant and animal species…There is *high confidence*, based on substantial new evidence, that observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation. These include: shifts in ranges and changes in algal, plankton and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers [italics in original].

The terms *very high* and *high confidence* refer to the likelihood that the associated studies, taken as a whole and assessed by third-party reviewers, are correct. *Very high confidence* indicates that the assessment has a 9 out of 10 chance being correct; *high confidence,* about 8 out of 10.

In addition, the IPCC (2007:30) note that some parts of the world are seeing high increases in heavy precipitation, particularly in the upper Northern Hemisphere; in other locations, such as the Mediterranean and the equatorial belt, the extent of areas affected by drought have increased. In an editorial discussing climate change and droughts effecting the U.S. heartland, physicist Joseph Romm (2011) forecasts that what he terms as the "dust-bowlification" of this region—increased evaporation, baked topsoil, and loss of water during the dry months as a result of earlier snowmelt. In some locations, such as the Iberian Peninsula, the seasonal annual rainfall has shifted dramatically to be predominantly in the fall rather than winter or spring (de Luis et al. 2010). Across the rest of the Mediterranean, ten of the twelve driest winters in over a century have been seen in the last 20 years (Hoerling et al. 2011). Precipitation simulations for the southern Canadian prairie systems for the next century show signs of dramatic increases in drought (Sushama et al. 2010). The number of pre-monsoon tropical cyclones in the northern Indian Ocean and Arabian Sea has been increasing and are likely the result of anthropogenic aerosols (Evan et al. 2011).

Glacial Heating Signals

Several important studies have been done looking at the rates of shrinking glaciers and models predicting future glacial retreat. Oerlemans (2005) of the Institute for Marine and Atmospheric Research at Utrecht University conducted a study on glacial climate signals of 169 different glaciers from around the world. His research concluded that they universally showed temperature increases starting in the middle of the 19th century and accelerating into the 20th century (Oerlemans 2005:675). Brown, Harper, and Humphrey (2010:98) have projected retreat rates for the Sperry Glacier in the Rocky Mountains and have found that, across the range of IPCC temperature increase projections, glacier retreat can be expected to continue through the next century.

Changes in Physical and Biological Systems

For the purposes of the IPCC study, physical systems include snow, ice, and frozen ground cover, hydrology, and coastal processes (2007:32). Worldwide, between 1970 and 2004, over 765 separate data sets show evidence of changes in the physical systems of the planet's surface, the vast majority of which are consistent with impacts expected specifically with global warming (IPCC 2007:32). Arctic ice cover is shrinking on an average of 2.7 percent per decade since 1978, with larger average percentages during summer months. Permafrost layers in the northern hemisphere have shrunk by 7 percent since 1900, and soil temperature has increased by as much as 3° C (5.4° F) in some areas. Average snow and glacier cover have receded in both the Northern and Southern hemispheres (IPCC 2007:30). There is a marked increase in glacier lakes, representing melted glaciers, rock avalanches and ground instability as a result of thawed permafrost, and changes in the Arctic and Antarctic ecosystem. The resulting melt-off is also changing stream dynamics and water quality of rivers and lakes (IPCC 2007:31).

While studies of some other indicators that might suggest climate change (significant permanent loss of the Antarctic ice sheet, shifts in major ocean circulatory patterns, increased events such as tornadoes, dust storms, and hurricanes/typhoons) are so far inconclusive, overall, the IPCC (2007:33) concludes that "[o]f the more than 29,000 observational data series, from 75 studies, that show significant change in many physical and biological systems, more than 89 percent are consistent with the direction of change expected as a response to warming."

The term "biological system" used by the IPCC simply means the totality of life forms living in terrestrial, fresh water, or marine environments (2007:32). Globally, between 1970 and 2004, nearly 29,000 data sets collected by researchers around the world show evidence of changes to biological systems. One of the major impacts that is linked to increased temperatures and subsequent lessening of precipitation is the widespread increase in tree mortality seen across the U.S. Joint research between U.S. and Canadian universities and government agencies and universities indicates that

> Our analyses of longitudinal data from unmanaged old forests in the western United States showed that background (noncatastrophic) mortality rates have increased rapidly in recent decades, with doubling periods ranging from 17 to

> 29 years among regions. Increases were also pervasive across elevations, tree sizes, dominant genera, and past fire histories [van Mantgem et al. 2009: 522].

This massive tree die-off can be at least in part attributed to raising temperatures and increased bark beetle infestations due to stressed conditions, which, in some stands, has resulted in the complete loss of adult tree stands. Like the physical systems, the vast majority of changes are consistent with global warming trends (van Mantgem et al. 2009:523).

Ocean acidification

Recent studies and risk assessments of global ocean pH levels indicate that the world's oceans and estuaries are becoming more acidic (Blackford 2010; Dupont, Dorey, and Thorndyke 2010; Fabry et al. 2008; Feely et al. 2010; Shi et al. 2010). Acidification is currently occurring as a result of CO_2 being absorbed by seawater; over the past 200 years, the world's oceans have absorbed roughly half of anthropogenic CO_2 (Royal Society 2005:vi). Water near the ocean's surface is typically slightly alkaline, with an average pH of about 8.2. Inorganic carbon is critical to ocean life and is largely responsible for controlling the pH of seawater; naturally occurring CO_2 is an important source of that carbon (Fabry et al. 2008:414; Royal Society 2005:iv). When CO_2 dissolves in seawater, it forms carbonic acid. Normally, part of the carbonic acid is neutralized by the slightly basic nature of the ocean water. The increase in atmospheric CO_2 is altering the pH balance of the world's oceans (Royal Society 2005:iv, 1). Higher concentrations of carbonic acid are binding calcium, needed by the world's coral reefs and shellfish species, as well as oxygen, making it more difficult for fish and other marine life to breath (Kerr 2009:459).

Ice cores from Antarctica indicate that CO_2 in the atmosphere dating back 650,000 has been stable, ranging between 160 and 290 parts per million by volume (ppmv) (Siegenthaler et al. 2005:1316). Currently, atmospheric CO_2 concentration is 401 ppmv and is rising at a rate of 0.5 percent annually (NOAA 2014). Fabry and others (2008:427) in their *Impacts of Ocean Acidification on Marine Fauna and Ecosystem* state that "[S]ufficient information exists to state with certainty that deleterious impacts on some marine species are unavoidable, and that substantial alteration of marine ecosystems is likely over the next century." Perhaps more grimly, in a general public article in *Scientific American* marine biologist Marah Hardt and ecologist Carl Safina summarized the situation in this way:

> Marine life has not experienced such a rapid shift in millions of years. And paleontology studies show that comparable changes in the past were linked to widespread loss of sea life. It appears that massive volcanic eruptions and methane releases around 250 million years ago may have as much as doubled atmospheric CO_2, leading to the largest mass extinction ever. More than 90 percent of all marine species vanished. A completely different ocean persisted for four million to five million years, which contained relatively few species… Alarmingly, the pH drop observed so far and the predicted trajectory under current emissions trends are 100 times faster than any changes in prior

millennia. Left unchecked, CO_2 levels will create a very different ocean, one never experienced by modern species [Hardt and Safina 2010].

While the studies of the effects of ocean acidification on the ocean biosphere are underway, less clear are the effects of an increasingly acidic ocean on bedrock and cliff faces. Further study needs to be done to assess the effects of ocean acidification and landform stability, the responses of different bedrock formations to ocean acidification, and what potential mitigation options are available on a site-specific basis.

CAUSES OF CLIMATE CHANGE

Climate change originating from natural phenomenon has been a reoccurring process throughout the history of the planet. Cyclical changes in the earth's orbit, or Milankovich Cycles, have been a driving force behind the major glacial periods that took place throughout the Pleistocene (Helama et al. 2010:1981). Certainly, within the Holocene, some triggers for climate change have been identified. The substantial release of over 160,000 km^3 fresh water from Lakes Agassiz and Ojibwa into the North Atlantic may have contributed to a world-wide cooling event that started 8200 years B.P., or 6200 B.C., and lasted some 600 years (Gornitz 2007; Hijma and Cohen 2010:275). Sun spots and similar changes in the sun's surface may have triggered substantial climate changes over the past 12,000 years, and may have been at least partially responsible for two important Late Holocene climatic events, the Medieval Climatic Anomaly and the Little Ice Age (Helama et al. 2010:1981).

However, the vast majority of recent research indicates that the current climate change phenomena are the results of human activity, specifically, the introduction of massive amounts of greenhouse gases into the atmosphere(Anderegg et al. 2010).. The IPCC has released the following synopsis of the driving forces behind climate change:

> Global atmospheric concentrations of CO_2, CH_4 and N_2O have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years… The atmospheric concentrations of CO_2 and CH_4 in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution. It is *very likely* that the observed increase in CH_4 concentration is predominantly due to agriculture and fossil fuel use. The increase in N_2O concentration is primarily due to agriculture… There is *very high confidence* that the global average net effect of human activities since 1750 has been one of warming… The combined radiative forcing due to increases in CO_2, CH_4 and N_2O…and its rate of increase during the industrial era is very likely to have been unprecedented in more than 10,000 years… Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG [greenhouse gas] concentrations… It is *likely* that there has been significant anthropogenic warming over the past 50 years

> averaged over each continent (except Antarctica)… discernible human influences extend beyond average temperature to other aspects of climate, including temperature extremes and wind patterns [IPCC (2007:37-40].

This finding is reiterated by the international team of researchers assembled by the Royal Society (2005:iv) in their review of the effects of atmospheric CO_2 and ocean acidification: "All the evidence collected and modeled to date indicates that acidification of the oceans, and the changes in ocean chemistry that accompany it, are being caused by emissions of CO_2 into the atmosphere from human activities."

This has been more recently voiced by the U.S. National Academy of Sciences (2011), Division of Earth and Life Studies:

> Climate change is occurring, is very likely caused primarily by the emission of greenhouse gases from human activities, and poses significant risks for a range of human and natural systems. Emissions continue to increase, which will result in further change and greater risks. In the judgment of this report's authoring committee [Board on Atmospheric Sciences and Climate], the environmental, economic, and humanitarian risks posed by climate change indicate a pressing need for substantial action to limit the magnitude of climate change and to prepare for adapting to its impacts.

Recent independent studies are now quantifying the amount of human contribution to climate change—at least 74 percent of observed global warming can be attributed to human activities (Schiermeier 2011). These human activities have sparked a positive feedback loop. Global warming trends lead to increased water vapor in the air, greater cloud cover, and, as a result, warmer air temperatures that continue to feed the global warming cycle (Stanhill and Moreshet 1992:57). There is currently a high risk of permafrost thaw in the high latitudes, which is expected to release carbon at the same rate as current levels of global deforestation, and will include significant amounts of methane, resulting in an impact 2.5 times greater than that of deforestation (Schuur and Abbott 2011).

EXPECTED LONG-TERM IMPACTS OF CLIMATE CHANGE

The impacts that result from climate change are extraordinarily difficult to predict. Changes in sea level within the Late Holocene have not, perhaps counter-intuitively, been uniform across all coastlines as a result of salinity, ocean temperatures, subsidence, and changes in the gravity field as a result of uneven in-flow of meltwater from the poles (Long 2000:419). Overall increases in air temperature have a direct effect on raising sea levels, and not just in terms of melting glaciers or polar ice formations. Raised air temperatures result in changes in atmospheric pressure, wind regimes, ocean circulation, ocean surface topography, and ocean thermohaline structure—essentially, the density of the ocean water (van de Plassche 2000:96).

According to the IPCC (2007:44), under the current climate change mitigation policies and sustainable economic and energy development practices, global greenhouse gas emissions will continue to grow. Over the next 20 years, greenhouse gas emissions are expected to increase

anywhere between 40 to 100 percent. Over the next century, temperatures can be expected to change anywhere between 1.1 and 6.4° C (2 and 11.5° F) (IPCC 2007:45). These temperature increases are most likely going to be over land masses in the northern hemisphere. Snow levels and sea ice formations are expected to continue to contract. Extreme heat events and heavy precipitation are very likely to occur with greater frequency. The size, number, and range of typhoons and hurricanes are likely to increase (IPCC 2007:46). Base sea level can be expected to rise 0.18 to 0.59 m (0.59 to 1.94 ft.) over the next century as well, though more localized models suggest that this amount can be up 1.0 to 1.4 m (3.3 to 4.6 ft.) (Heberger et al. 2009:5–6; IPCC 2007:45). Locations with Mediterranean climates along coasts are specifically singled out as areas where the effects of climate change will hit hardest (IPCC 2007:52).

The IPCC (2007:48-52) outlines a number of expected impacts from climate change including:

1. The resilience of many ecosystems is *likely* to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects, ocean acidification) and other global change drivers (e.g. land use change, pollution, fragmentation of natural systems, overexploitation of resources).
2. Over the course of this century, net carbon uptake by terrestrial ecosystems is likely to peak before mid-century and then weaken or even reverse, thus amplifying climate change.
3. Approximately 20 to 30 percent of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C (2.7 and 4.5° F).
4. For increases in global average temperature exceeding 1.5 to 2.5°C (2.7 and 4.5° F) and in concomitant atmospheric CO_2 concentrations, there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity and ecosystem goods and services, e.g. water and food supply.
5. Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas.
6. Precipitation can be expected to decrease by 10 to 30 percent over some dry regions at mid-latitudes and dry tropics, due to decreases in rainfall and higher rates of evapotranspiration.
7. The large amounts of CO_2 in the atmosphere have led to increased acidification of ocean waters. While research on this is still beginning, it is expected to have a negative effect on the biosphere.

SECTION III. WORK PLAN

INTRODUCTION

With the preceding discussion of effects of global warming to California's coastlines in mind, the SCA is embarking on an effort to inventory the resources most likely to be affected. This section of the report contains recommendations for carrying out the survey work in a way that is consistent with the other studies happening elsewhere along the coast. Lacking funding, volunteers participating in the study will need to carve out small survey blocks that can be completed with the resources at hand. In parts of the state where large numbers of volunteer surveyors are available, perhaps a county or large landform is doable. Elsewhere, perhaps only a few miles are achievable. It is recommended that at least a mile be attempted, for the simple reason that it is easier to track completion at the state level.

Throughout this section, there will be references to technology that past experience has shown will be obsolete before long, perhaps in a matter of a decade if not sooner. It is intended that this be a living document that will adjust to both new technology and new methods as warranted, based on experience.

APPROACH TO THE STUDY

The goals of the study are two-fold. The first is to inventory public lands that are likely to be impacted by climate change over the next century based on the projections currently available, and to get that information to public agencies and tribes so that they can consider options. The second is to present those results to the public, in a responsible way, so that the public can see another facet of the threat that climate change poses. By working towards these two goals, it is hoped that the SCA can contribute to the ongoing public dialogue about climate change and what our responses as citizens and governments should be.

The entire stretch of the California coastline, including interior Delta areas, has been broken into 1-mile blocks, each block assigned an individual number. As each block is completed, it is checked off the master list maintained by the SCA Climate Change Committee. Blocks that are picked for survey by a Regional Coordinator by the Committee are set aside for them and other Coordinators will be directed elsewhere if there is potential for overlap.

Access to private lands is not being sought. Different land owners have different opinions regarding scientific research, climate change, and public planning. Rather than adding the complexity of navigating these discussions at this time, it is recommended that the SCA continue to focus on public lands, where access can be arranged via a permitting process and wherein the public agencies have legal responsibilities towards responsible stewardship of any

resources found. If a private property owner wishes to open lands for survey, then the SCA can make arrangement on a case-by-case basis.

As of the time of this writing, aside from the original research funding the Point Reyes assessment, no funding has been given to the project, either through grants or cash donations.

The SCA has covered photocopy costs, camping for the Cabrillo College effort in Monterey, and some meal supplies for the Point Reyes efforts. While grant funds are being sought, it is not expected that such funds will cover the costs of any the inventory efforts. It is expected that this has been, and will continue to be, driven primarily by volunteers who understand the threats that climate change presents and what is at risk of loss. Fundraising is not the primary purpose of these studies.

What has been given is time, access, camping locations, vehicles, and gear, particularly global positioning equipment (GPS). Coordinating all of the different aspects of conducting volunteer inventory work at this scale, with this many participants, requires a team of people committed to carrying the inventory to completion. A recommended organizational structure for this team is presented later in this section.

TRIBAL COORDINATION

It is important to note that tribal consultation, coordination, and collaboration are critical components of these studies. Given that these lands are public, it will be the appropriate agency's responsibility to enter into formal consultation with the appropriate tribe, despite there being no regulatory nexus for these surveys. For that reason, the tern "coordination" will be used throughout the current document to differentiate discussions and arrangements between tribes and the Regional Coordinator and the government-to-government consultation conducted between a land-owning agency and tribes. It may often fall to the Regional Coordinator to make that first contact, and to work cooperatively with the appropriate tribes throughout the study. Wherever possible, having tribal involvement in the design of the study, the fieldwork, and interpretations is desired.

Tribal perspectives on climate change may differ, perhaps greatly, from that of the archaeological and scientific community. The key decision for many tribes will be whether climate change is the will of the Creator or solely the work of humans. If the former, many tribes may feel that the erosion of sites be left to continue as they always have, with any concerns focused on the possible exposure and looting of graves or artifacts in highly visible locations. In such a scenario, these tribes may not wish to participate in the study and may not support its efforts. If the latter decision, some tribes may be willing to work with the archaeological community, and some may not. Coming to a mutual understanding with tribal groups around these issues is critical to the long-term success of the project.

With that in mind, it is highly recommended that where a tribal group either chooses not to participate because it either does not agree that climate change is human caused or does not want to work with the archaeological community, that component of the survey within that tribe's territory be postponed until such time where a mutual agreement can be reached. The

factors leading to decisions made by any one tribal council are complex and multi-faceted, and it is unlikely that individuals outside the tribe would have a complete understanding as to why a tribe has chosen not to participate in a study. Pushing this issue with the tribe, or attempting to override their decision, is counter-productive and places agency partners in an unnecessarily difficult position. Furthermore, it will complicate discussions with other tribes and study elsewhere in the state and beyond.

Discussions with coastal tribal representatives in different areas of the state suggest that they are already noting the impacts of climate change on ancestral gathering areas and rapid erosion of previously stable or slowly eroding sites. Each tribe is intimately familiar with the coastal areas within their ancestral territory. The impacts of climate change will be recognized soon if they have not already. The decision may largely be a spiritual one, and it is not the place of archaeologists to interfere.

ORGANIZATIONAL STRUCTURE

To keep the workload of such a project manageable to its participants, we recommend an organizational structure that spreads the planning responsibilities out to a small group with defined roles. This group consists of a Regional Coordinator, Geographic Information Systems (GIS) Coordinator, Information Center (IC) Coordinator, Logistics Coordinator, Data Management Coordinator, and Media Coordinator. The roles of each are defined below.

REGIONAL COORDINATOR (RC)

The Regional Coordinator (RC) oversees the survey, data management, and report processing for a section of coastline. This could include everything within a county's boundaries, agency lands, or substantial landform. The RC recruits the rest of the team for that area, with help as needed from the SCA Climate Change Committee Chair and SCA Executive Board. The RC leads the effort for the SCA to obtain necessary permits and access to land, works with the other coordinators to plan surveys, and reports back to the SCA Climate Change Committee on progress. The RC represents the SCA effort in that region at local meetings and to the media. The RC should be expected to be listed as a responsible party for carrying out survey work on any permits, meeting permit requirements and communicating directly with agencies and tribes about progress.

The success of the program lies largely with the RC's ability to reach out to agencies and tribes, and to motivate the other coordinators and volunteers. It is recommended that the RC be familiar with the region, with an established excellent reputation with agencies and tribes. The RC is the public face of the effort for that region and should have diplomatic skills and willingness to interact with the media. The willingness of some agencies and tribes to participate may rest solely with the RC's track record.

The RC must also recruit a team that works well together and is likewise committed to see the work through (and has enough time to do so). If any one of the other coordinators is unable

to carry out their positions, then the RC must replace them quickly or the work will lose momentum. The loss of any coordinator can stall the process if not addressed immediately.

It is important that the RC participate in part of the field effort. It is the one opportunity that the RC gets to thank the people volunteering personally and it shows a commitment on the part of the RC to carry the project through. If the RC cannot be present for the field effort, the Logistics Coordinator will stand in their stead.

The RC is expected to be the primary author of the final report, collating the different pieces prepared by the other coordinators and having report writing and production skills—or having access to someone who does—to bring their part of the project to completion.

GIS COORDINATOR (GC)

The GIS Coordinator (GC) works closely with the RC to determine what the geographic boundaries of the survey area are going to be. The first step of the project is to determine property lines defining private and public land. Most professional GIS practitioners know where to find these layers online through county or state agency websites. The GIS Coordinator should have easy and regular access to GIS software capable of creating shapefiles for survey preparation, design or work with existing data dictionaries, and work with the Data Management and IC Coordinator to track sites following survey work. The GC also works with the Logistics Coordinator to borrow appropriate GPS field gear compatible with the GIS software being used on the project. If the local Information Center (IC) is transferring their data into GIS, then the GC is responsible to get the data into a database that the IC can use. The GIS Coordinator should be prepared to write a short section of the report describing the GPS issues and GIS database.

INFORMATION CENTER COORDINATOR (ICC)

Once the project area has been decided upon and maps created that delineate the study area, the Information Center Coordinator (ICC) is responsible for obtaining the site records and reports that fall within the area's boundaries. The ICC will work with the RC to get access to the IC—at the time of this writing, free access has been arranged at the Northwest IC, and it is hoped that the other IC's will grant such as well. While access is free, the IC is expected to charge for copies, a cost that the SCA has, in the past, covered. Before costs are expended,, the ICC and the RC should consult the Climate Change Committee to ensure funds are available for this effort. Estimated costs must be presented to the SCA Executive Board for approval. Available funds may vary from year to year.

Following the survey work, the ICC works with the GC and Data Management Coordinator to make sure that the finished records and report get back to IC in accordance with that IC's submittal requirements. The ICC should be prepared to write a section of the report describing the records search results.

LOGISTICS COORDINATOR (LC)

After the boundaries of the project, permits, IC research, and access issues have been resolved, the work of the Logistics Coordinator (LC) begins. The LC is responsible for recruiting volunteers, with the RC's assistance, for the field effort. The LC identifies individuals capable of being crew chiefs, finds public campgrounds willing to donate space if necessary, and helps design the survey strategy. The LC arranges to borrow GPS and other equipment, and balances crews based on experience. The LC tracks volunteer field time, arranges meeting locations, and ensures that all finished field documents make their way back to the Data Management Coordinator and the GPS data to the GC. The LC is expected to take part in the field effort and will be the Field Director in the absence of the RC.

During the Point Reyes rotations, the number of people available for crew was different than what had been previously planned No shows, last-minute volunteers and cancellations, and other unplanned for events will necessitate the LC and RC making decisions on the fly about which crews go where and what the makeup of those crews will be. The LC is responsible for knowing the skill set of the available volunteers and helping make those last minute decisions. The LC will work with the RC to prioritize the survey effort if crew size is different than expected.

At the completion of fieldwork, the LC will coordinate with the IC and Data Management Coordinator regarding areas that were surveyed and unsurveyed, and who surveyed where. This will assist everyone in following up for additional data if needed.

Because the workload of the LC can be large, it is recommended that the LC recruit crew chiefs ahead of time that can assist with tracking volunteers and paperwork. If crew chiefs are picked ahead of time, and those crew chiefs are willing to help recruit their own crews and equipment, and be responsible for making sure that the paperwork is in presentable shape, then the LC's job is made significantly easier. The SCA encourages private firms, public agencies, or university classes or fieldschools that participate in the project to form their own teams, with their own equipment.

The LC is expected to write up a short section of the report detailing the field methods and to provide a final list of volunteers and how many hours were volunteered on what days. As the project progresses, it will be critical to demonstrate the amount of volunteer time donated for each effort. A suggested form for tracking hours is attached as an appendix to this document.

DATA MANAGEMENT COORDINATOR (DMC)

The Data Management Coordinator (DMC) is responsible for receiving all of the information as it returns from the field and overseeing its input into site record forms and conferring with the GIS Coordinator to make sure the final GIS shapefiles match the written record. The DMC makes sure that all records are completed and sent to the IC for trinomials, then submitted to the RC in final form for report production. The DMC ensures consistency in the records and is responsible for quality control. By the time that the DMC is finished with the

records, they should be ready for final report production. The DMC also prepares pre-field packets for field crews in collaboration with the GC and ICC.

MEDIA COORDINATOR (MC)

The role of the Media Coordinator (MC) is to disseminate the information, in redacted form, to the public. The MC should also work with the SCA Business Office and SCA website admin to get the redacted report online at the SCA website. Once that has been completed, the MC will have a link to share in a press release, should reporters want to gather more information.

The MC should work with the RC to craft short press statements regarding the purpose of the project, individuals, agencies and tribes involved, and a summary of the results. There should be a clear connection in the press statement regarding the following:

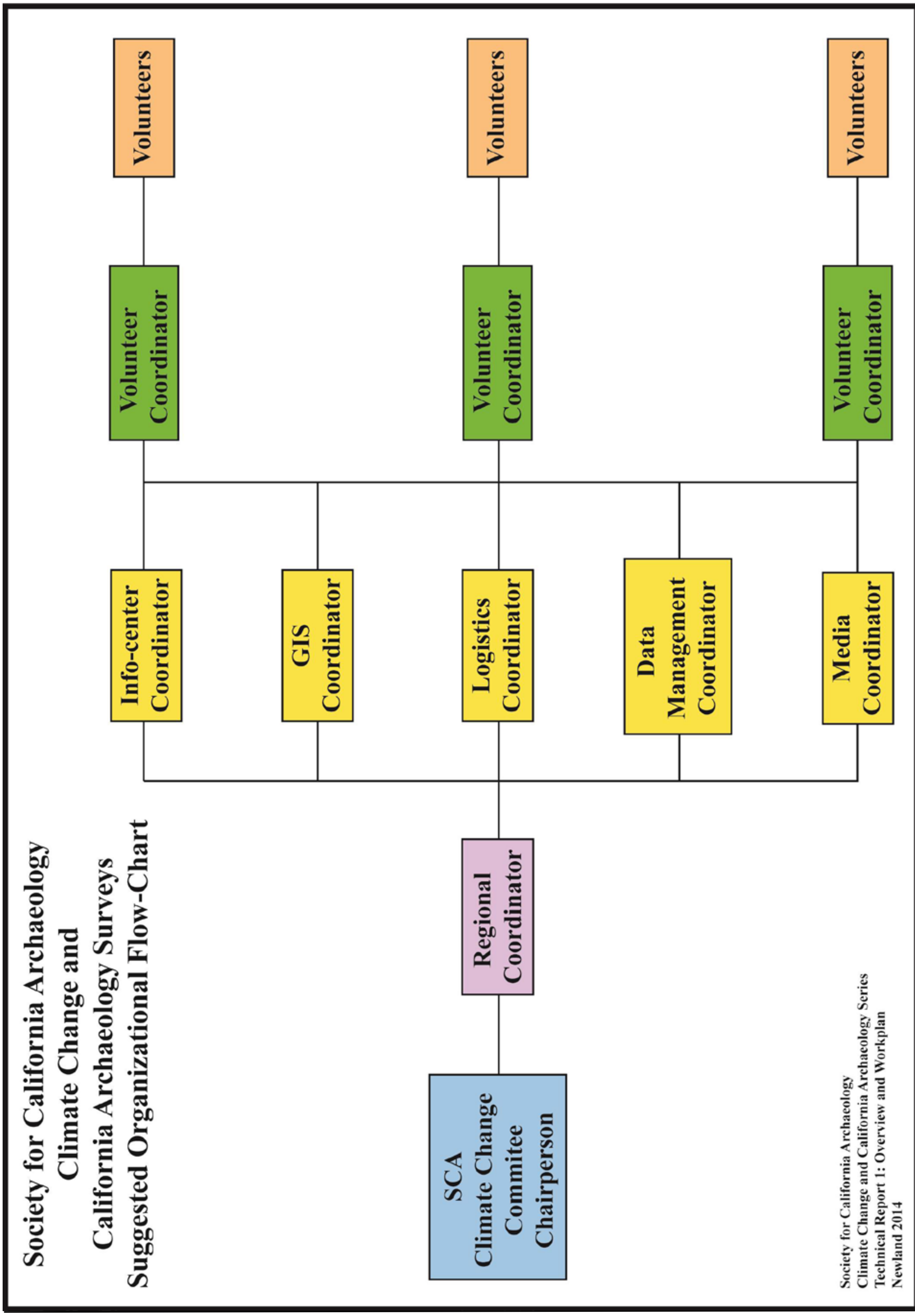
1) The kinds of threats that climate change poses to these archaeological sites;
2) The kinds of sites found;
3) The RC's thoughts on the importance of the sites found;
4) The potential of the recorded sites to inform the public about what to expect from future climate impacts.

Each of these points needs to be addressed in order for the project to have relevance and immediacy to the general public, and, by definition, to be of interest to the media. The MC should work with the RC, and the project's agency and tribal partners to determine if there are sites that can be visited by media to get images to supplement articles or news reports.

In general, print media may not have staff with the budget to visit field projects, so it is critical that the MC work with the LC and participants to gather images in the field suitable for augmenting press releases. This may necessitate the MC or a volunteer chosen for this purpose to be in the field taking photographs of volunteers and climate change impacts. On sites that are heavily eroding, the MC should work with the ICC and DMC to see if earlier photos of these sites exist, so that a before-and-after comparison can be made.

OTHER VOLUNTEERS

It is recommended that, as needed, other volunteers are brought on board who are willing to see the project to completion. In particular, it is helpful to have volunteers work with the LC to track participant availability for the field survey, and to follow up with participants to ensure that the records come back to the DMC from the field. The scale of each effort will be different, as will the number of volunteers. The RC, in coordination with the team, may decide that it makes more sense for the team to produce records rather than rely on participants. If so, then it is recommended that volunteers for site record production and report production be found as well. The figure below contains a chart with a suggested organizational structure for carrying a climate change study to completion.


Society for California Archaeology
Climate Change and
California Archaeology Surveys
Suggested Organizational Flow-Chart
SCA
Climate Change
Commitee
Chairperson
Regional
Coordinator
Info-center
Coordinator
GIS
Coordinator
Logistics
Coordinator
Data
Management
Coordinator
Media
Coordinator
Volunteer
Coordinator
Volunteer
Coordinator
Volunteer
Coordinator
Volunteers
Volunteers
Volunteers
Society for California Archaeology
Climate Change and California Archaeology Series
Technical Report 1: Overview and Workplan
Newland 2014

PREFIELD PLANNING

Typically, an RC will have some sense of an area intended for survey at the time of agreeing on taking on the role. There are several steps necessary for getting access to, and preparing to survey that area:

1. **Choose a GC and carve out a survey area**. Work with the GC to determine which lands are public vs. private. Online government databases typically have shapefiles that can be downloaded which contain this information.
2. **Recruit remaining coordinators for the different organizational roles willing to commit to the project and carry it to completion**.
3. **Track hours**. As these projects progress, it will be important to demonstrate the number of hours in the event that matching funds are sought through grants or to demonstrate volunteer time to agency partners, the media, and other organizations wishing to conduct similar studies.
4. **Conduct a preliminary records search.** It may be that the intended area has recently been surveyed and does not need further work. Other areas may have been done piecemeal, limiting the level of effort needed. If the SCA Climate Change Committee has not obtained permission through the local IC to conduct the records search *gratis*, the Committee Chairperson should be contacted to arrange access.
5. **Coordinate with the SCA Climate Change Committee Chairperson**. The Chairperson will work with you to obtain the necessary permits for access. In some cases, it may be that the SCA has already either obtained permits at a county or state level. Typically, the SCA will hold a multi-year agreement with the agency, with either the SCA President or the Climate Change Committee Chairperson acting as the main contact for the permit. The RC listed as a field director for a specific task. By coordinating with the Chairperson early, the RC enlists help in obtaining volunteers, equipment, and technical support.
6. **Contact land-owning agencies and obtain permits and necessary access permission**. Without the necessary permits and right of access, the survey cannot happen, and any further planning should cease until the permit is acquired. This process can take months; it is recommended that the permitting component begin at least six months prior to the planned field component.
7. **Contact the appropriate tribal communities**. Once an area has been chosen and permits from the lead agencies requested, tribal communities should be contacted. By making the preceding steps before contacting the tribe, the RC will have prepared maps, identified land-owning agencies, and have a rough idea as to what kinds of resources will be present, all of which will be necessary and helpful for discussing the project with tribal representatives. As noted earlier, if the tribal community does not wish the study conducted within their ancestral lands, it is recommended that areas within those lands be excluded from survey.

8. **Conduct a full records search**. Gather records for surveys and sites within the proposed survey block. Work with the SCA Climate Change Committee Chairperson (CCCC) to arrive at a budget for photocopies. The SCA will pay for the photocopies. Annual budget restrictions may limit the amount of material that can be photocopied.
9. **Digitize results of records search**. Reports and site records should be scanned and their locations digitized into GIS. This will greatly facilitate planning as it progresses.
10. **Schedule the survey**. It is recommended that weekends be chosen for the field effort, and that if multiple weekends are necessary, they should be spaced so people can commit without sacrificing a month's worth of time. Plan around good weather, different parts of the state have different weather conditions depending on the time of year.. Scheduling should be coordinated with land-owning agencies and the tribes.
11. **Recruit volunteers**. With a date set and area chosen, the whole team should tap into their professional and academic network to gather volunteers. Ideally, each survey team consists of three people, a crew chief and two crew members. The types and number of volunteers should reflect the ability to meet that ratio. At least one person on each team should be capable of reading GPS data points or taking points with higher-end models. Recruiting can happen at conferences, classroom or club meetings, local archaeological societies, or through business or academic connections.
12. **Work with local agencies to get lodging**. Most agencies will grant free camping if they are getting free professional work in return. Others have arrangements with agency partners when campgrounds are not available, fire barracks, research field stations, or secluded areas suitable for camping can be offered free or for a nominal charge. If there is no option other than a barracks that come with costs (typically $5-10 a night per person for agency partners) then the RC should coordinate with the CCCC regarding budget. To arrange the camping, a rough count of volunteers will be needed, so it is recommended that initial arrangements be made early, and then finalized when a more realistic number of participants are known. Failing to block out a camping area early on may result in not having enough space or having to move volunteers farther from the project area, which will put a strain on planning and time resources.
13. **Reach out to local agencies and CRM businesses.** These organizations may be able to lend out equipment (preferably with one of their staff), crew, or support—possibly helping provide some or all of a meal for the volunteers, vehicles, post-field processing, equipment, or funding..
14. **Prepare packets.** Each mile to be surveyed should get a packet of maps, including maps showing appropriate access routes if necessary, and aerial photos at sufficient scale to see local detail along the corridor (1:6000 scale or greater). The packet should be labeled with the mile number for easy reference. Copies of records for all known sites, a copy of the permit, and blank DPR 523 forms should be included. This packet should be given to the appropriate crew chief of each mile survey team.
15. **Prepare Safety Plan and Communication Protocol.** Each agency partner may have different emergency protocol in the event someone is injured. Some agencies will have their own nearby ranger staff, while others rely entirely on local county sheriff or city police. In addition, some agencies have their own safety checklist or pre-field discussion

that must be gone over with the crew prior to fieldwork. The RC and the LC should review this issue with the partner agencies to determine what is required. If no such checklist exists, the RC and LC should identify potential hazards and develop a safety plan which outlines those hazards, the appropriate response, provides a map to the local hospital, and contact numbers for all safety personnel, the RC, and LC.

Table 1. Recommended Division of Pre-field Tasks

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Task	CCCC	RC	GC	ICC	LC	DMC	MC
Choose GC and survey area	X	X				X	
Recruit other coordinators	X	X				X	
Track hours						X	
Conduct preliminary records search				X		X	
Coordinate with CCCC	X	X				X	
Contact agencies/ obtain permits	X	X				X	
Contact tribes	X	X				X	
Conduct full records search				X		X	
Digitize records search			X	X		X	
Schedule survey		X	X	X	X	X	X
Recruit volunteers	X	X	X	X	X	X	X
Arrange lodging	X	X			X	X	
Initiate contact with partners	X	X	X	X	X	X	X
Prepare packets		X	X		X	X	
Prepare Safety Plan/Communication Protocol		X			X	X	

FIELDWORK

As with any volunteer project, the skill set and physical abilities of the crew will vary greatly. It is also worth noting that even volunteers who have committed to the project will have plans change and be no-shows at the last moment, while other volunteers are likely to arrive either unannounced or show with very short notification. It is important to be flexible—it is unlikely that the crew an RC has to work with on the day of the survey is the same crew he or she planned on having leading up to the work.

1. **Designate field crews:** Each field crew should reflect the size of the area being surveyed. The crew chief chosen for each crew should be capable of overseeing the recording of a wide range of cultural resources, both indigenous and historic-era, that could be expected within the region. That person should also be capable of interacting with tribal representatives, agency staff, and the public in a productive and collaborative manner. Finally, the crew chief will be responsible for preparing a summary page of the survey and getting equipment and all field records back to the RC and/or lender.

2. **Dissemination of packets and gear:** The LC, GC, and DMC will work together to prepare packets for each team that contain maps showing where known resources are, copies of records of those resources, and maps showing access points. Gate codes, radio protocol if necessary, contact numbers, and copies of the permit granting access should also be included.

3. **Transportation arrangements:** There may be access or parking restrictions that require limiting the number of vehicles or the kinds of vehicles (4wd, high clearance etc.) that can be used. As the final head counts and vehicle commitments will likely not be known until the day of the survey, the decision as to who will drive may have to be made at the last minute, and it may in turn affect which volunteer is on what crew. Crew composition should therefore be decided in conjunction with transportation capabilities and requirements.

4. **Communication protocol:** Some form of communication protocol must be worked out prior to fieldwork. Some agencies will lend the RC and or/LC a field radio that can reach ranger stations or agency headquarters. In other cases, agency or tribal people may know where cell phone reception is sufficient to make outgoing calls. Emergency situations such as injury or immobilized vehicles can occur in even the most easily accessible project area. Also, many tribal groups have burials along the coastal edge that could be exposed by erosion or looting. Having a protocol for calling for help or alerting agency staff in accordance with tribal custom as well as with state and federal law is critical.

5. **Establish survey methods** In general, based on a cursory review of erosion and inundation models of the coastline, each mile-long transect is expected to be roughly 200 m in width. These may vary widely depending upon bedrock, topography, and overall direction of wind and waves. A three-person crew—one crew chief and two crew--spaced 30 m apart is the recommended approach, though agency or tribal requirements for tighter transects or the nature of the resources or topography present may require adjustments. There will be some areas that are considerably larger, and the RC and LC should take this into account when deciding how many volunteers and who should go where, rather than simply looking at the mileage count and dividing by three

6. **Establish site recording standards:** California Department of Parks and Recreation 523 forms should be filled out for all sites. The protocol for filling out these records can be found at the California Office of Historic Preservation Publications and Forms website (http://ohp.parks.ca.gov/?page_id=1069), and if necessary, copies of the DPR instruction book can be handed out. Forms, such as condition assessment records, may be required by agency partners.

7. **Transferring data at the end of the day:** All records must be turned into the LC (or someone the LC designates), at the end of fieldwork each day unless work is expected to continue on a site the next day or other arrangements made. The LC or GC should download GPS data onto a main computer or make arrangements for data to be transferred. The records for each mile should be kept with the crew chief's survey notes, maps, and copies of previous work. All equipment must be returned to its owners, and it is the LC's responsibility to make sure this is carried out. The LC should confirm which people worked on which crew doing what tasks, and this should be written on the envelopes for their survey block—many crews traditionally use initials on record forms, however, given the number of volunteers it may not be clear who was present on each crew based on initials alone**.**

8. **Closing fieldwork:** The LC must check in with each crew to make sure they have returned from the field safely and turned in their paperwork and equipment. Any overarching issues should be addressed or collected, including recommendations for future work and improving the ongoing effort. The DMC or LC should tally the number of hours each field team did. Finally, the LC or RC should check in with the agency partner and tribal representatives to notify them of the completion of fieldwork, a brief summary of findings, and to return any radios or other equipment.

Table 2. Recommended Division of Field Tasks

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Task	CCCC	RC	GC	ICC	LC	DMC
Designate field crews					X	
Dissemination of packets and gear			X		X	X
Tracking hours						X
Transportation arrangements					X	
Communication protocol		X			X	
Establish survey methods		X	X		X	
Establish site recording standards		X			X	
Data transfer		X	X		X	X
Closing fieldwork					X	

REPORTING

1. **Report format.** The report template was created by the Anthropological Studies Center at Sonoma State University, as have the Word version of the DPR 523 forms, and they have been graciously donated to the project. Unless agency or tribal partners request more robust reporting, the report itself should be fairly basic:
    a. **Executive Summary**—include the identification of the agency and tribal partners, a tally of miles surveyed and number of sites, and any immediate threats or condition assessments that warrant highlighting.
    b. **Acknowledgements**—each report should have an acknowledgements section thanking, at a minimum, agency and tribal partners, volunteers, donors, and the different coordinators.
    c. **Introduction**—provide a brief summary of the reasoning for the survey, a list of the agency and tribal partners, volunteers, referring back to the current document if needed. A summary of the process leading to the acquisition of the permits and the participating parties should be included. This section should also identify all of the coordinators and a one to two sentence summary of each coordinator's qualifications.
    d. **Regional and vicinity maps**—indicate where the work was done in California and again at the 1:24000 topographic map scale.
    e. **Crew chief summaries**—the one page synopsis of each mile by each crew chief should be digitized and placed into the report.
    f. **Maps**—following each crew chief summary, include a map indicating the survey area and any results.

g. **Recommendations and conclusions—summarize** any concerns noted on the survey—looting, site erosion, identification of human remains, etc. should be summarized here, in addition to concluding comments about the results of the survey.
h. **Appendix of site records**—Site records should all have trinomials and/or primary numbers assigned by the relevant information center prior to the completion of the final report.

2. **Report writing.** The RC should either be the report author or the lead author if co-authors contribute. The RC is likely listed as the Field Director on the permit or agency agreement and will be expected to be the lead author or perform in some review capacity, and to be responsible for the final product.
3. **Documentation and production of resource records** will be a team effort, among the RC, crew chiefs, GC, and DMC. Ideally, there will be a small team of volunteers working on site records, receiving organized field data from the DMC with field numbers, and maps from the GC to prepare for final records. This team should coordinate with the RC regarding terms and phrasing for consistency of the record. Either the RC or the DMC should act as site record editor.
4. **Editing.** If the RC is the lead or sole author, it is recommended that the RC have one of the other coordinators or an outside individual edit the report. The CCCC or another member of the committee would be good alternates.
5. **Maps.** All maps will be produced within GIS and exported as pdf, Adobe Illustrator, or other graphic formats. The GC will assist in preparing all project maps.
6. **References cited.** This section should only include those references cited in the report and resource records. References not cited should be omitted. The *American Antiquity* style guide, which is followed by all SCA publications, will be used for citations and references.
7. **Draft report production. The report will be prepared by the RC as a** draft pdf and/or Word document for agency or tribal review. If the RC does not have capabilities to prepare such reports,, they should solicit help from other coordinators. The report should be completely edited and free from spelling and common grammatical errors that word processing software normally catches. Ideally, the draft report will go for review to agency and tribal partners in digital format.
8. **Agency review. In the transmittal letter** to the reviewing agency, a proposed schedule for review and comments returned should be proposed and the report attached. As this is likely to be an unfunded effort on the part of the agency reviewer, some leeway in the turnaround time should be granted if such time is not spelled out in the permit. It is preferable that an understanding with the reviewing agency be reached wherein the RC can, after a certain amount of time passes, submit the draft report as final to the appropriate IC and tribes and prepare redacted versions for the public (see 11 infra).
9. **Tribal review.** Many tribes will simply want a copy of the final report. Others will want to review the report and make comments before a final is produced. In such cases, the RC should coordinate ahead of time with the reviewing agency to determine the order of reviewing and expected time for receiving comments.

10. **Final report production.** Final report production should be done in coordination with the CCCC, the agency and tribal partners, and the ICC. Each may have requirements regarding digital vs. paper copies.
11. **The Redacted Report.** After the final report has been approved, a redacted version should be prepared. The purpose of the redacted report is to give the public a general sense of what the project, goals, results, and why the results are important. This report will be a much smaller summary of the technical report and should only be a few pages. A regional overview map should be included but any maps showing specific site locations should be omitted. General data including territory coverage, number of resources found, and the *kinds* of sites described (without getting into locational or constituent detail) should be provided. Emphasis should be placed on the potential specific threats that climate change poses to these sites rather than site details. This version also needs to be vetted by both agency and tribal partners.
12. **Coordinate with the CCCC.** When the final report is produced and copies distributed, the RC should contact the CCCC so that the CCCC can coordinate with agency partners regarding the completion of the requirement for permits or agreements, and can report to the SCA Executive Board at the quarterly meetings.

Table 3. Recommended Division of Report Production Tasks

Task	CCCC	RC	GC	ICC	LC	DMC
Report writing		X	X	X	X	X
Site record production		X	X	X	X	X
Editing		X				
Maps		X	X	X	X	X
References cited		X				
Draft report production		X	X			X
Agency review	X	X				
Tribal review	X	X				
Final report production		X	X			X
Redacted report		X				
Coordinate with the CCCC	X	X				

DISSEMINATION

Two versions of each study will be prepared: (1) a report that includes an account of the fieldwork and findings meant for property owners, relevant agencies, the appropriate IC, and tribal representatives; and (2) a redacted version for the public available on SCA and agency websites. The RC is responsible for bringing both reports to completion. The overarching goal is to reach as much of the general public regarding this topic as possible without compromising the sensitivity of the archaeological site location and contents. There may be restrictions placed on how, or how much, of this information get shared.

Before agreeing to be a RC, each candidate should consider whether they can adhere to the restrictions placed on what can be shared. Site protection over the short term trumps long-term damage that climate change may inflict, if for no other reason than agencies, tribes, and other parties should be given the time to consider options without adding the threat of immediate looting or vandalism. This section of the report discusses options for public outreach for regional studies; the recommended distribution of the technical report follows.

1. **Agency partners**. Each agency will have different requirements for dissemination; typically, a digital copy and a small number of hard copy reports are required. The agency will likely request both complete and redacted versions, the former for their files and planning purposes and the latter for public release and possible posting on the agency website. It is possible that either report could be circulated through other offices and come back with comments from reviewers higher in the bureaucracy of the agency; if this is anticipated, the RC should coordinate with the agency partner to attend to comments if and/or when they come in. Agencies will also have requirements for the submittal of field notes, typically the originals, a complete set of digital photographs with photologs, and copies of both uncorrected GPS files from the field and final GIS shapefiles.
2. **Tribal partners.** Tribal partners may request a wide range of assistance in dissemination of the results within the tribal community. At a minimum, tribal representatives will want both the complete and redacted versions, for their own files and to monitor what information is being released to the public and partner agencies. Tribal representatives may request site visits in consultation with the agency partner and the RC, may bring elders to the sites, or use a site as an educational tool in instructing other tribal members. Tribal representatives may also request that a presentation be given to tribal members, through tribal schools, council meetings, office meetings, or other gatherings. It is recommended that any field visits be attended by both the RC and the LC. Any presentations given to tribal members should be done by the RC. The RC is expected to be available to answer questions directly by tribal representatives.

3. **Information Centers.** The ICC is responsible for identifying the final submission requirements for the appropriate IC and to coordinate with the RC, GC, and DMC on report submittal. The ICC's responsibilities to a project are complete when the all site records have been accepted, primary numbers assigned, the final report accepted, and the report given a study number.

4. **SCA website.** The SCA website will host a redacted version of the report. The RC will coordinate with the CCCC and SCA webmaster in getting the document uploaded and appropriate contact information posted.

5. **SCA files.** Contracts, permits, hard copies of the report, any original field notes not submitted to the agency, and digital copies of the report, shapefiles, GPS field data, and digital photos should be submitted to the SCA Business office for long-term storage. The material should be clearly labeled and stored in manila envelopes, with digital data burned to CD/DVD or stored on a secure ftp or similar site.

6. **Local media.** The local media should be contacted and a short-(three-four sentences) summary of the project provided, with links to the redacted report online. The task should be primarily achieved by the MC, who will need to be familiar with the local media outlets. Typically, city or town newspapers or monthly papers or magazines that serve the community will garner the most interest. Daily newspapers often have a specific reporter assigned to science, nature, and other research topics, and a review of the newspaper's website or inquiries with the paper should help identifying that individual. Wherever possible, request and arrange to review a draft before it goes to print. A few misunderstood terms or phrases taken out of context can greatly change the tone and intent of a statement. Again, the MC or RC should be ready to respond quickly.

   Local TV or radio news programs have similar individuals and are much more competitive for time; there is often only a narrow window wherein they are available to respond to a story. It is therefore recommended that, when the TV or radio news organizations are contacted, the MC or RC be available at short notice to respond to calls, give interviews, and, if appropriate, make field visits.

7. **Responding to inquiries.** When requests are made for more information, particularly from the press, they are often accompanied by requests to make site visits. The appropriateness of visiting a site should be discussed ahead of time with the agency and tribal partners, and protocol for this determined. During survey, the RC and LC should be reviewing the results to see if one or two sites would be appropriate for press visits to illustrate the impacts of climate change or reflect upon the significance of what will be lost. The image that reporters will want to capture is a site being destroyed by climate change. As of this writing, this data is only now starting to come in, and there may be stretches of coastline where major erosion is expected over the next century, but such erosion has yet to occur and sites may be stable or only slightly eroded. Choosing locations to that illustrate where sea level rise may cover (e.g., low-lying areas, cliffs that will erode, such as locations with friable sedimentary bedrock), may help illustrate the point without having to show physical damage to a site. Ease of access should be

another consideration, particularly for a TV film crew. Any site or location used for illustration should be safe to access and close to parking.

Media representatives may also want to be present during survey. This is particularly true of newspaper, radio, or magazine reporters, all of whom may need only a minimum amount of heavy equipment to carry. In instances where multiple rotations of survey are planned, the RC and MC should coordinate and consider reaching out to media organizations after the first rotation and arrange for the reporter to join either the RC or the LC in the field. The RC or LC should chose a relatively easy transect and one with no known burials or sacred sites. A note of caution: if the RC choses to bring a reporter with them, that reporter should be someone that has a track record of responsible reporting and who clearly understands and agrees in writing, not to reveal the location or specific information about any site in the piece. An example of such a waiver is included in the Appendix. Again, the level of media involvement has to be vetted by both agency and tribal partners ahead of time. The advantage to the reporter is that the RC or LC has time to discuss issues and concerns, and use different areas to illustrate. That accessibility of the RC or LC to the reporter, and the longer interaction, can help focus the reporter's piece to be more nuanced than a few-minutes sound-bite.

Reporters may also request telephone interviews. These are typically taped with the interviewee's permission. It is recommended that a list of project numbers—actual sites found, miles covered, number of sites impacted, etc.—be prepared ahead of time. Avoid grand statements or conjecture on the significance of sites unless there are reliable data to back up such statements—they could be taken out of context.

8. **Professional presentations.** Professional presentations demonstrating the results of the survey, identification of erosion issues, or other aspects of the impacts of climate change on archaeological sites are encouraged. If the work is conducted under the SCA permit, it is requested that the presenter acknowledge the project's tribal and agency partners, the SCA, donors and volunteers. Showing images of human remains is discouraged and should only be done if when it adds significantly to the presentation and if permission is granted from the appropriate tribe and agency. As with any presentation on archaeological sites, the exact location of sites should not be shown to prevent looting or vandalism. All coordinators are encouraged to give presentations.

9. **Public presentations.** The topic of climate change continues to be a controversial subject among some members of the public. There are a number of reasons for this, too many to list here and beyond the scope of this work plan. It is enough to say that the subject is emotionally charged and that there will be individuals who disagree vehemently about different aspects of climate change. Avoid getting into these debates in a public setting as they detract from the presentation of the data.

The models of sea level rise and coastal erosion the SCA is using are worst-case scenarios that have been put forth by a number of different organizations and are commonly accepted within this field of study. The presenting archaeologist is not responsible for defending the research that went into the creation of those models. The

presenter is encouraged, however, to bring copies of the following bibliography with them regarding those models that could be handed out if anyone wishes to explore these issues further. All coordinators are encouraged to participate in giving presentations.

Table 4. Recommended Division of Dissemination Tasks

Task	CCCC	RC	GC	ICC	LC	DMC	MC
Agency partners		X					
Tribal partners		X					
Information centers		X	X	X		X	
SCA website		X					
SCA files		X					
Local media		X					X
Responding to inquiries		X					X
Professional presentations		X	X	X	X	X	X
Public presentations		X	X	X	X	X	X

SECTION IV. SUMMARY AND CONCLUSION

Four nearly five decades, the Society for California Archaeology has been committed to encouraging responsible archaeological research and sharing the results of that research with the public. SCA members have fought for stronger cultural resource laws, the establishment of professional ethics, site presentation, and increased agency and public involvement in the preservation of the state's cultural heritage. Archaeologists work more collaboratively with tribal partners than in the past and will continue to do so. The SCA has a large membership of engaged archaeologists, avocationalists, agency representatives, and members of the tribal community, all of whom believe that archaeological sites have important cultural and educational values.

Many sites are now threatened, at a scale that spans the responsibilities of multiple agencies and tribes. The SCA has an opportunity to help identify threatened sites and to assess ongoing and future impacts from climate change to those sites. Indeed, with a mandate to preserve sites and promote the importance of archaeology to the public encoded in its own bylaws, the SCA has a responsibility to help this identification and assessment process go forward. As the largest archaeological organization in the state, the SCA has a leadership role to play in this effort. This document is the first step towards fulfilling that role.

Volunteer archaeological studies have probably not been conducted at this scale in California for several decades. New technology, new methods, new partnerships, and robust existing databases now make what was once an impossible task, possible. Similar efforts are underway in Scotland through the Scottish Coastal Archaeology and the Problem of Erosion [SCAPE] program; the UNESCO World Heritage Centre has put the impacts of climate change on world heritage sites at the top of their concerns (UNESCO 2014). Globally, the threats that climate change poses to cultural resources is slowly gaining attention. The SCA has the opportunity to bring this issue into the public spotlight and be a role model for similar efforts nationwide. There is still time to identify sites that will be lost over the next century and to work with tribes and agencies in considering options. Society members are encouraged to contact the SCA Climate Change Committee Chairperson or the SCA Business Office regarding involvement with the effort.

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APPENDIX: SUGGESTED FORMS

SCA CALIFORNIA CLIMATE CHANGE SURVEY

Crew Chief:
Crew:
County:

Mile:
Date:
Landowner:

Findings:

Methods:

Field conditions:

Restrictions:

Other observations/remarks:

SCA CALIFORNIA CLIMATE CHANGE SURVEY

Project:_____ Regional Coord._____ Data Mgmt. Coord._____

Date	Name	Task	Hours	In-kind rate/hr	In-kind cost

CONFIDENTIALITY AGREEMENT

I, _____, as part of the Society for California Climate Change Survey, shall keep all information regarding archaeological site location and contents of sites visited, discussed, or shown in presentations, confidential. I shall not release any site location or content information to the media, general public, or other non-authorized personnel. I will not post images of artifacts or archaeological sites on social media websites without prior consent of the Regional Coordinator. I agree to provide copies of my field notes, drawings, photos, and other pertinent documents to the project's Regional Coordinator or agency representative upon request.

_____ _____

Signature Date

_____ _____

Contact Phone # Email