Impact Sciences, Inc., as revised March 2010, "Global Climate Change and Its Effects on Sensitive Biological Resources

APPENDIX F8.0

GLOBAL CLIMATE CHANGE AND ITS EFFECTS ON SENSITIVE BIOLOGICAL RESOURCES

Global climate change may affect sensitive biological resources (e.g., endangered, threatened, rare, and/or special-status species) through potential, though uncertain, changes related to future air and water temperatures; such effects may impact the timing of seasons, affect a species' range, and a species' ability to adapt to changing temperatures. At the same time, the ways in which global climate change may impact sensitive species and biological resources are varied and often complicated due to the intersection of numerous causal forces.

In order to better understand and evaluate the potential impacts to sensitive biological resources as a result of global climate change, a literature survey was undertaken, as set forth below.[1] The results of this survey confirm that, at this time, impacts to sensitive biological resources are speculative and cannot be assessed with much certainty. Accordingly, the analysis of sensitive biological resources is terminated under CEQA.

ARTICLES ADDRESSING GLOBAL CLIMATE CHANGE AND ITS EFFECTS ON SENSITIVE BIOLOGICAL RESOURCES

(a) *Rising to the Challenge: Strategic Plan for Responding to Accelerating Climate Change (Draft)* (September 21, 2009) -- U.S. Fish and Wildlife Service ("Draft Strategic Plan")

The September 2009 Draft Strategic Plan sets forth the U.S. Fish and Wildlife Service's ("USFWS") programmatic three-part strategy with respect to climate change, which turns on adaptation, mitigation, and engagement. Within each component of the strategy, the following goals are identified:

Adaptation

1. Develop long-term capacity for biological planning and conservation design and apply it to drive conservation at broad, landscape scales.

2. Plan and deliver near-term and long-term landscape conservation actions that support climate change adaptations by fish, plants, wildlife, and habitats of ecological and societal significance.

[1] Please note that all reports referenced in this discussion are available for public inspection and review at Impact Sciences, Inc., 803 Camarillo Springs Road, Suite A-1, Camarillo, California 93012, and are incorporated by this reference.

3. Develop monitoring and research partnerships that make available complete and objective information to plan, deliver, evaluate, and improve actions that facilitate fish and wildlife adaptations to accelerating climate change.

Mitigation

4. Change agency business practices to achieve carbon neutrality by the Year 2020.

5. To conserve and restore fish and wildlife habitats at landscape scales, build agency capacity to understand, apply, and share biological carbon sequestration science; and work with partners to sequester atmospheric greenhouse gases in strategic locations.

Engagement

6. Engage agency employees; local, state, national, and international partners in the public and private sectors; key constituencies and stakeholders; and everyday citizens in a new era of collaborative conservation in which, together, we seek solutions to the impacts of climate change and other 21st century stressors of fish, wildlife and habitats.

In the Draft Strategic Plan, the USFWS underscores that "[o]ne of the major challenges of addressing climate change effects on fish and wildlife will be identifying and accounting for the uncertainty that remains in our understanding of future climate change and how that change will affect ecological systems." (Draft Strategic Plan, p. 8.) Currently, impacts are assessed from global climate change models; however, the USFWS notes the import of "downscaling" such models to better account for regional and local impacts.[2]

(b) *Global Climate Change Impacts in the United States* (2009) -- U.S. Global Climate Research Program ("Impacts in the United States")

This report summarizes the science of climate change, and the current and projected impacts of climate change on the United States. The report observes that "[m]any factors affect biodiversity including: climatic conditions; the influences of competitors, predators, parasites, and diseases; disturbances such as fire; and other physical factors. Human-induced climate change, in conjunction with other stresses, is exerting major influences on natural environments and biodiversity, and these influences are generally expected to grow with increased warming." (Impacts in the United States, p. 79.) The report further

[2] The import of this finding recently was confirmed in the *5-Year Review: Summary and Evaluation for the Unarmored Threespine Stickleback*, issued by the Ventura Fish and Wildlife Office on May 29, 2009. On page 25 of the *5-Year Review*, the USFWS noted that "predictions of climatic conditions for smaller sub-regions, such as California, remain uncertain." Therefore, USFWS concluded that it lacked "adequate information to make accurate predictions" regarding the effects of climate change on this particular species.

notes that the distribution of species is modulating in response to the timing of the seasons. (*Id*. at pp. 80-82.)

With that said, the report "identifies a number of areas in which inadequate information or understanding hampers our ability to estimate future climate change and its impacts." (*Id*. at p. 11.) The potential impact to sensitive biological resources is one of those areas, as the report found that "[r]esearch on ecological responses to climate change is also limited." (*Ibid*.) The report recommended that additional research focus on improving the models used to project impacts to ecosystems:

> [Ecosystem simulation] models, when rigorously developed and tested, provide powerful tools for exploring the ecosystem consequences of alternative future climates. The incorporation of ecosystem models into an integrated assessment framework that includes socioeconomic, atmospheric and ocean chemistry, and atmosphere-ocean general circulation models should be a major goal of impacts research. This knowledge can provide a base for research studies into ways to manage critical ecosystems in an environment that is continually changing.

(*Id*. at p. 153.) In that regard, the report underscores the "indisputable need" for the development of regional, small scale modeling to enable local decision makers to render informed choices. (*Id*. at p. 154.)

(c) *A Framework for Categorizing the Relative Vulnerability of Threatened and Endangered Species to Climate Change* (February 2009) -- Hector Galbraith and Jeff Price for the Global Change Research Program, National Center for Environmental Assessment in the U.S. Environmental Protection Agency's Office of Research and Development ("Framework for Categorizing")

The Framework for Categorizing report describes an evaluative framework that may be used to categorize the relative vulnerability of threatened and endangered species to climate change. The report relies on four modules to assess vulnerability:

> Module 1 categorizes the baseline vulnerability of species to extinction or major population reduction through the use of 11 variables/stressors (not including climate change);
>
> Module 2 scores the likely vulnerability of a species to future climate change through the use of 10 variables;
>
> Module 3 combines the results of Modules 1 and 2 into a matrix to produce an overall score of the species' vulnerability to climate change -- the score mapped to categories such as "critically vulnerable," "highly vulnerable," "less vulnerable," and "least vulnerable;"
>
> Module 4 assigns a qualitative determination of uncertainty of overall vulnerability.

The four-module framework was applied to six threatened and endangered species: the golden-cheeked warbler; salt marsh harvest mouse; Mount Graham red squirrel; Lahontan cutthroat trout; desert tortoise;

and, bald eagle. The first four species were categorized as "critically vulnerable," the fifth was categorized as "highly vulnerable," and the sixth was categorized as "less vulnerable." (Framework for Categorizing, pp. vii-viii.)

Based on the modules and the species studied, the Framework for Categorizing report presents the following conclusion:

> Species that are most vulnerable tend to be: restricted in their distributions, small in population size, undergoing population reductions, habitat specialists, and found in habitats that are likely to be most adversely affected by future climate change. Conversely, species . . . which are widely distributed, are flexible in their habitat preferences and are considered to be stable or increasing, scored least vulnerable. . . . The results also indicate that major areas of uncertainty complicate any evaluations of vulnerability. For the species tested, the greatest uncertainties are associated with a relatively poor knowledge about the potential for direct, physiological effects on animal species; relationships between changes in temperature and precipitation regimes and the physiologies and behaviors of animals are, apparently, only poorly understood.

(*Id*. at p. viii; see also *id*. at p. 36.)

(da) ***The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*** **(May 2008) -- Synthesis and Assessment Product 4.3 Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research ("CCSP 2008 Report")**

This report assesses, among other issues, the effect of climate change on biodiversity, and is one of a series of 21 synthesis and assessment products being produced under the auspices of the U.S. Climate Change Service Program ("CCSP"). The lead sponsor of the CCSP 2008 Report summarized here is the U.S. Department of Agriculture.

The CCSP 2008 Report was prepared following the extensive review of scientific literature, measurements and data collected and published by U.S. government agencies in more than 1,000 separate publications. (CCSP 2008 Report, p. 1.) The overarching conclusions reached as a result of the CCSP's literature survey include findings that:

- Climate change already is affecting biodiversity in the United States;
- Climate change will continue to have significant effects on biodiversity over the next few decades and beyond;
- Many *other* stresses and disturbances, not related to climate change, also affect biodiversity;

- Climate change impacts on ecosystems will affect the services (e.g., carbon sequestration) that ecosystems provide, but we do not yet possess sufficient understanding to project the timing, magnitude, and consequences of these effects -- "there is not yet adequate integrated analysis of how climate change could affect ecosystem services;" "there is no analysis specifically devoted to understanding changes in ecosystem services in the United States from climate change and associated stresses," which constitutes a "significant gap in our knowledge base," and

- Existing monitoring systems, while useful for many purposes, are *not* optimized for detecting impacts to ecosystems resulting from global climate change.

(*Id.* at pp. 3-4.)

With respect to biodiversity, the report addresses impacts on species diversity and rare and sensitive ecosystems. (CCSP 2008 Report, p. 1.) The basic findings reached with respect to biodiversity include conclusions that:

- There has been a significant lengthening in the growing season and increase in net primary productivity in the high latitudes of North America;

- Many species studied have exhibited shifts in their distributions;

- Coral reefs are suffering major bleaching due to increases in sea surface temperatures and oceanic acidity;

- The rate of warming projected for the next century in the Arctic will reduce snow and ice cover, impacting polar bears;

- There are other possible impacts for which there is not yet a substantial observational database;

- It is difficult to pinpoint changes in ecosystem services that are related to changes in biological diversity, particularly as a specific assessment of changes resulting from climate shifts or other drivers of change has not been done; and

- Current modeling systems have not been developed with climate variability in mind, so the information derived from their results (with respect to climate change) is somewhat limited.

(*Id.* at pp. 9-10.)

(c~~b~~) *Climate Change 2007: Climate Change Impacts, Adaptation, and Vulnerability* (April 6, 2007) -- Working Group II Contribution to the Intergovernmental Panel on Climate Change, Fourth Assessment Report ("IPCC WGII 2007 Report")

This report addresses the "relationship between observed climate change and recent observed changes in the natural and human environment." (IPCC WGII 2007 Report, p. 2.) Based upon global assessment of data since 1970, the report concludes that "anthropogenic warming has had a discernable influence on

many physical and biological systems." (Id. at p. 3.) The report notes that recent warming "strongly" affects terrestrial biological systems, such that there is an earlier timing of spring events, and poleward/upward shifts in the ranges in plant and animal species. (Id. at p. 3.) Similarly, with regard to marine and freshwater biological systems, there is evidence that impacts are occurring due to rising water temperatures, which impact ice cover, salinity, oxygen levels, and circulation. (Ibid.) The specific impacts to marine and freshwater biological systems include range shifts, the earlier migration of fish in rivers, and changing abundance levels of algal, plankton, and fish in high-latitude oceans and high-altitude lakes. (Ibid.) If temperature increases exceed 1.5-2.5°C, major changes are projected for ecosystem structure and function, species' ecological interactions, and species' geographic ranges - all resulting in predominantly negative consequences for biodiversity. (Id. at p. 8.)

The IPCC WGII 2007 Report also summarizes, however, the considerable scientific uncertainty associated with global climate change and its causes and effects on sensitive biological resources:

> Limitations and gaps prevent more complete attribution of the causes of observed system responses to anthropogenic warming. First, the available analyses are limited in the number of systems and locations considered. Second, natural temperature variability is larger at the regional than the global scale, thus affecting identification of changes due to external forcing. Finally, at the regional scale other factors (such as land-use change, pollution, and invasive species) are influential.

(Id. at p. 4.) Similarly, the report notes that while climate change is beginning to have effects on many natural and human environments, "based on the published literature, the impacts have not yet become established trends." *(Ibid.)*

(fe) *Observed Impacts of Global Climate Change in the U.S.* (November 2004), prepared for the PEW Center on Global Climate Change, Camille Parmesan, Hector Galbraith ("Parmesan and Galbraith 2004")

Camille Parmesan and Hector Galbraith undertook a literature review to assess "the scientific evidence compiled to date on the observed ecological effects of climate change in the United States and their consequences" and the strength of that evidence. (Parmesan and Galbraith 2004 at p. iii.) The review included more than 40 studies showing a possible tie between global warming and ecological changes in the United States. In twenty of the studies, the authors found "strong evidence of a direct link" between climate change and observed ecological impacts in the United States. *(Ibid.)*

While the report identified general trends, such as shifts in the timing of ecological events and habitat ranges, it also noted that "many species and ecological systems of interest have yet to be studied (often due to inherent limitations of available data) and the attribution of ecological changes to a particular cause remains challenging." (*Id.* at pp. iii; see also p. 13 [there are "enormous difficulties biologists have

encountered in tackling the question of climate change impacts"].) Further, "[m]any if not most of the ecosystems and organisms in the United States are already suffering from other anthropogenic stressors . . . [and] [a]s yet, scientists do not have a clear idea how climate change might affect this already fragile situation." (*Id.* at p. v.) Accordingly, the report recommends that scientists achieve a better understanding of which systems or species are most or least susceptible to projected climate change in order to better evaluate and mitigate potential impacts. (*Id.* at p. 41.)

In response to Parmesan and Galbraith 2004, other scientists have noted that plants and animals have adapted to climate change for millions of years and that it is not surprising to see plants and animals respond to present-day temperature changes.[3] Such responses to climate change do not necessarily show the changes are linked to fossil fuel emissions and human-caused climate change. *(Ibid.)*

Some concern has been articulated that the Edith's, Quino, Bay, and Taylor's checkerspot butterfly species may be adversely impacted by global climate change. However, in a related context, USFWS has rejected similar claims that butterfly species may be endangered or threatened due to global climate change.[4] In the context of the Thorne's Hairstreak Butterfly, USFWS recognized recent evaluations by Parmesan and Galbraith 2004 that whole ecosystems are seemingly being shifted northward; however, USFWS found that the type, magnitude, or temporal effects of ecosystem changes that may be brought about by global climate change are speculative and stated it was not aware of any available documentation that directly links global warming as a threat to the butterfly. *(Ibid.)*

In addition, it should be noted that the butterfly species of concern are not believed to be present on the Project site. For example, the Quino checkerspot butterfly has been identified as a species that is *not* expected to be found on the Project site, because its presence was last documented in Los Angeles County in 1954.

(g~~d~~) *Status and Trends of the Nation's Biological Resources* (1998), U.S. Department of the Interior, U.S. Geological Survey, Biological Resources Division ("USGS 1998 Status/Trends Report")

A chapter of this report addresses the impacts of climate change on the nations biological resources. (USGS 1998 Status/Trends, at pp. 89-116.) The report closely considers impacts to avian species, and notes that "the ranges of most species moved north, up mountain slopes, or both." (*Id.* at p. 101.) Accordingly, such range shifts "could cause local extinctions in the more southern portions of the birds ranges, and, if

---

[3] Tom Stohigren, a U.S. Geological Survey ecologist, Fort Collins, Colorado.

[4] See, USFWS 90-day finding on petition to list the Thorne's Hairstreak Butterfly as threatened or endangered (2006 Federal Register, 71 FR 44980-44988).

movement to the north is impossible, extinctions of entire species could occur." (*Ibid.*) The report also considers impacts to reptiles and amphibians, and notes that they are likely to be impacted because they are especially susceptible to extreme temperature, must remain close to water sources, and are not able to disperse at a rapid rate. (*Ibid.*) In addition, "[i]n general, animals most likely to be affected earliest by climatic change are those in which populations are fairly small and limited to isolated habitats." (*Id.* at p. 102.)

Significantly, this report notes that "[w]hat is most needed to evaluate potential biological effects of temperature change is a regional projection of climatic changes that can be applied to ecosystems at a regional or local scale" and "estimates of climatic variability during the transition to a new equilibrium, particularly at the regional scale." (*Id.* at pp. 94-95.) In addition, "[a} focus of climate research toward changing climatic variability [citations] might be more useful for ecological impact assessments than the current focus among climatic modelers on climatic means." (*Id.* at p. 112.) Finally, these projections, in order to be "more realistic and useful . . . [require a] multiscale, multispecies, multitaxa analysis driven by regionally specific, transient climatic change forecasts." *(Ibid.)*

The report also states that "at present [transient regional changes] are very difficult to predict credibly." (*Id.* at p. 95; see also p. 110 [As contrasted with regional assessments, "[t]he most reliable projects for climatic models are for global-scale temperature changes."].) This point is further underscored by the conclusion that climate forecast models are "fraught with uncertainties," leading to "the perplexing question" of "whether they can be trusted as a reliable basis for altering social policies, such as those governing CO_2 emissions or the shape and location of wildlife reserves." *(Ibid.)*

After disclosing the inadequacies of the projection models, this report assesses the policy implications:

> Climatic change as now envisioned is not necessarily a threat to the well-being of all climate-sensitive species. However, the transient nature of most projected human- induced climatic change scenarios suggests that significant alterations are likely on a scale of decades, whereas the adaptability of many species - especially those upon which faster responding species depend - is on a scale of centuries. . . . The only forecast that seems unassailable is that the more rapidly the climate changes and the more extensively other human disturbances are forced on nature, the higher the probability of substantial disruption and surprise within natural systems.
>
> To forecast possible consequences of the projected climate changes, single-species studies should be guided by the overall effects that climate may have at the large scale or on range limits and abundance patterns, and on the interactions among species. Coupling such results with information from climatologists, geologists, and others will allow interdisciplinary teams to more reliably forecast the possible biological consequences of scenarios of global warming and other global changes. These forecasts can then be used by policy

> makers and the general public to determine what types of actions might be effective to mitigate potential impacts of forecasted climate changes. Research can help put such policy making of a firmer factual basis, but any plausible level of effort is not likely to reduce all important uncertainties before the global change experiment now under way on Earth is played out [citation].

(Id. at p. 113.)

(he) *The Regional Impacts of Climate Change: An Assessment of Vulnerability (1997),* Intergovernmental Panel on Climate Change, Special Report ("IPCC 1997 Report")

This report evaluates the regional impacts of climate change across the globe. With regard to impacts to North America, this report concludes that "the characteristics of the subregions and sectors . . . suggest that neither the impacts of climate change nor the response options will be uniform." (IPCC 1997 Report, Chapter 8 Executive Summary.) Nonetheless, the report concludes that reductions in terrestrial biological diversity are likely due to loss of habitat. *(Ibid.)* The same conclusion is reached as to fisheries and aquatic systems because of expected increases to water temperature, changes in freshwater flows and mixing regimes, and alterations to water quality. *(Ibid.)* In spite of the anticipated impacts, the report discloses significant scientific uncertainties:

> Our current understanding of the potential impacts of climate change is limited by critical uncertainties. One important uncertainty relates to the inadequacy of regional- scale climate projections relative to the spatial scales of variability in North American natural and human systems. This uncertainty is compounded further by the uncertainties inherent in ecological, economic, and social models - which thereby further limit our ability to identify the full extent of impacts or prescriptive adaptation measures. Given these uncertainties, particularly the inability to forecast futures, conclusions about regional impacts are not yet reliable and are limited to the sensitivity and vulnerability of physical, biological, and socioeconomic systems to climate change and climate variability.

(Ibid., italics added.) More simply, the report concludes "[u]certainty exists in our ability to predict ecosystem or individual species responses to elevated CO2 and global warming at either the regional or global scale." *(Ibid.)*

Conclusions Reached From Literature Survey

In light of the information provided above, evidence exists linking global climate change to ecological effects; however, the precise causes, extent, magnitude, and timing of such effects remain uncertain and preclude reliable forecasts of possible ecological effects resulting from global climate change. Therefore, and again based on the information presented herein, the effect of global climate change on sensitive species and other biological resources is too speculative at this time for any further evaluation.

Accordingly, it is appropriate to terminate any further analysis of such effects, consistent with Section 15145 of the CEQA Guidelines.